Chapter 5: Demand, services and social aspects of mitigation

Coordinating Lead Authors: Felix Creutzig (Germany), Joyashree Roy (India/Thailand)

Lead Authors: Patrick Devine-Wright (United Kingdom/Ireland), Julio Diaz-José (Mexico), Frank Geels (United Kingdom/the Netherlands), Arnulf Grübler (Austria), Nadia Maïzi (France/Algeria), Eric Masanet (the United States of America), Yacob Mulugetta (United Kingdom/Ethiopia), Chioma Daisy Onyige-Ebeniro (Nigeria), Patricia Perkins (Canada), Alessandro Sanches Pereira (Brazil), Elke Ursula Weber (the United States of America)

Contributing Authors: Jordona Composto (the United States of America), Anteneh Dagnachew (the Netherlands/Ethiopia), Nandini Das (India), Robert Frank (the United States of America), Bipashyee Ghosh (India/United Kingdom), Niko Heeren (Switzerland), Linus Mattauch (United Kingdom/Germany), Josephine Mylan (United Kingdom), Leila Niamir (Germany/Iran), Gregory Nemet (the United States of America), Mani Nepal (Nepal), Nick Pidgeon (United Kingdom), Narasimha Rao (the United States of America), Lucia Reisch (Denmark), Julia Steinberger (Switzerland/United Kingdom), Cass Sunstein (the United States of America), Linda Steg (the Netherlands), Charlie Wilson (United Kingdom), Caroline Zimm (Austria)

Review Editors: Nicholas Eyre (United Kingdom), Can Wang (China)

Chapter Scientists: Nandini Das (India), Leila Niamir (Germany/Iran)

Date of Draft:

15/01/2021

Table of Contents

Executive summary

The Sixth Assessment Report of the IPCC for the first time features a full chapter on demand, services, and social aspects of mitigation. Assessment of various branches of social science and case studies from across regions reveals that socio-cultural dynamics offer new entry points for mitigating climate change and organising economic and social activities. People demand services and not primary energy and physical resources per se. Focusing on demand for services and the different social and political roles people play broadens the climate solution space.

I. Potential of demand-side actions and service provisioning systems

Demand side mitigation and new ways of service provisioning tap a huge and largely overlooked mitigation potential of avoiding, shifting and improving final service demand. Demand side mitigation avoids planetary risks associated with other mitigation strategies, and in particular carbon dioxide removal (*high confidence*). {5.2, 5.3}

Demand-side strategies, categorised under Avoid, Shift, Improve, can reduce 50-80% of emissions across all sectors (*high confidence*). Avoid-Shift improve combines socio-behavioural, infrastructural and technological changes. Avoid potential is largest in the transport sector, omitting long-haul aviation and providing short-distance urban infrastructures. Shift potential is highest in food, shifting towards plant-based diets. Improve potential is highest in the building sector, especially with technologies and design option related to passive housing. {Figure 5.7}

Lifestyle changes can rapidly deliver climate change mitigation, while reducing mitigation costs (*medium confidence*). Behaviour changes and individual avoid options such as car-less living, reduced air travel, heating and cooling set-point adjustments, reduced appliance use, shifts to public transit, and less meat intensive diets can deliver an additional 2 and 3 $GtCO_2$-eq savings in 2030 and 2050, respectively, beyond the savings achieved in traditional technology-centric mitigation scenarios. Models that include lifestyle changes indicate that the economic costs of reaching mitigation targets are lower when incorporating ASI strategies for deep energy and resource demand reductions. {5.3.1, Table 5.5}

Low demand scenarios reduce both supply side capacity additions and the need for negative emissions technologies to reach emissions targets (*medium confidence*). This reduces supply side sustainability risks related to large-scale land use or material demand. These upstream effects are largest for very low demand scenarios when primary energy demand by 2050 is 40% lower than in 2020. {5.3.2, 5.3.3, Figure 5.10}

Among 60 identified actions to change individual consumption, individual mobility choices have the largest potential to reduce carbon footprints (*high confidence*). Car free travel and adoption of electric mobility amount to $2tCO_2\ cap^{-1}\ yr^{-1}$ saving, in average. Flying less and shift to active and public transport are other main transport-related mitigation options. In the food sector, any shift away from animal protein and dairy realises mitigation benefits. In the building sector, fitting housing with renewable energy, adopting passive house standards, and reducing hot water and overheating all reduces GHG emissions. {5.3}

Leveraging improvements in end-use service delivery through behavioural, technological, and market organisational innovations leads to large reduction in upstream resource use (*high confidence*). Indicative potentials for improvements range from a factor 10 to 20 with the highest improvement potentials at the end-user and service provisioning levels. Realisable service level efficiency improvements from 14% in 2020 to 41% in 2050 correspond to saving 334 EJ, i.e. two thirds (66%) of 2020 primary energy use. {5.3.1.1, 5.3.1.2, 5.3.2, Figure 5.9}

Total efficiency gains by way of changing service delivery system are the largest in buildings (*high confidence*). By 2050, efficiency gains are the largest for buildings (including appliances): -160 EJ (pervasive adoption of "Passivhaus" building designs), followed by materials with -100 EJ (dematerialisation via digitalisation and shared mobility and recycling) and mobility with -50 EJ (more public transport, shared mobility, and electrification of vehicles). {5.3.1.2}

Granular energy end-use and prosumer technologies, characterised by modularity, small unit sizes and small unit costs, diffuse faster into markets, improve in cost and performance faster (technological learning), offer more efficiency savings, escape technological lock-in more easily, and create more employment than alternatives with larger unit sizes and costs (*high confidence*). {5.3, 5.5}

Alternative service provision systems through digitalisation, sharing economy, and the circular economy have to date contributed little to climate change mitigation as seen from current energy and GHG emission trends (*medium confidence*). While digitalisation holds potential for climate change mitigation through new products and applications that can improve service-level efficiencies, it may also give rise to absolute increases in demand for products and energy use. An important consideration in all ASI strategies is the potential for unintended rebound and run-away effects, which can however be avoided by carefully crafted regulatory and socio-behavioural measures and improved data collection and monitoring of digitalised system energy use. {5.3.4, 5.3.4.1, Figure 5.10, Figure 5.11}

The circular economy can contribute to climate change mitigation if policies constrain undesired indirect effects (*medium confidence*). Product reuse, refurbishment, and recycling have been shown to reduce emissions in many cases, but mitigation potentials are reduced where such activities create new secondary markets that do not substitute for primary production, where GHG emissions from energy use required for recycling, refurbishment and reusing exceed their respective benefits, and where lifespans of energy-inefficient products are extended. A considerable part of the literature claims circular economy benefits for sustainability and climate change mitigation but does not prove it on economy-wide bases. Regulations or taxations on GHG emissions and raw material extraction, balanced with potential wellbeing benefits of secondary markets, can help ensure efficient circular economy systems. {5.3.4.2}

Providing better services with less energy and resource input is possible and consistent with providing wellbeing for all (*medium confidence*). Low-energy demand-side scenarios demonstrate the feasibility of reducing global final energy demand in 2050 to 245 EJ, 40% lower than final energy demand in 2018, while maintaining or improving wellbeing for all. Better service provisioning can be made with less wasteful energy and resource use. Assessment of 19 demand-side mitigation options and 18 different constituents of wellbeing show that positive impacts on wellbeing outweigh negative ones by a factor of 11. {5.1.1, 5.3, 5.3.15.3}

II. Social aspects of demand side mitigation actions

Redesigning service provisioning system enables reaching the twin goal of attaining wellbeing for all and mitigating climate change (*high confidence*). Energy is required for guaranteeing access to basic needs. A reduction in primary energy use and/or shift to renewable energy, if associated with the maintenance or improvement of services, can both ensure better environmental quality and enhance well-being. {5.2, 5.2.1}

Decent living standards for all can only be achieved by high efficiency low demand pathways (*medium confidence*). Decent Living Standards (DLS) is a benchmark of material conditions for human well-being and overlaps with many Sustainable Development Goals (SDGs). It sets minimum requirements of energy use consistent with enabling wellbeing for all at between 10 and 100 GJ cap^{-1}, depending on context. {5.2.1, 5.2.2, Table 5.1, Figure 5.5, Box 5.2}

Service provisioning for wellbeing is more granular, flexible, and culturally-appropriate than 'demand' as a way of considering climate futures and policy options *(high confidence*). Once subsistence needs are met, relative wellbeing is much more significant for human happiness than absolute consumption levels, and increased material consumption decouples from improvements in development indicators. {5.2.1, 5.2.3}

Demand-side measures are the single most important generic mitigation options, as they cut across all sectors and can bring multiple interacting benefits (*high confidence*). Energy services which together help meet human needs (e.g. nutrition, shelter, health, etc.) may be met in many different ways (with different emissions implications) depending on local contexts, cultures, geography, available technologies, social preferences, and other factors. In the near term, many less-developed countries and poor people everywhere require better access to low-emissions energy sources for DLS service provision. Substantial increases in service levels to meet the twin objectives of development in the less developed countries and decent living standards for all, take back some of the energy savings but enhance wellbeing faster. 70 EJ of additional energy demand are required to guarantee decent living standards for all in 2050. {5.2.1, 5.2.2, 5.4.5, Figure 5.4, Figure 5.5, Figure 5.6, Box 5.2}

Wealthy individuals have high potential for emissions reductions while maintaining DLS and wellbeing *(high confidence).* Individuals with high socio-economic status have high behavioural plasticity and capability to reduce their GHG emissions, especially in mobility by flying less and utilising electric two, three, or four wheelers, by becoming role models of low-carbon lifestyles, by investing into low-carbon business, and by lobbying for a stringent climate policies. {5.2.3}

The social domain takes centre stage in realising demand-side mitigation potential (*high confidence*). People act and contribute to climate change mitigation in their diverse capacities: consumers, citizens, professionals, role models, investors, policy makers. {5.4, 5.5}

Decision making that does not follow the standard rational choice model is prevalent in many energy-relevant contexts and requires interventions beyond economic incentives (*high confidence*). Individuals act in more roles than that of rational consumer when they make energy decisions, and the social environment, cultural practices, public knowledge, producer technologies and services all influence decisions. To influence consumer demand, policymakers have an assortment of tools that include prohibitions, mandates, taxes, fees, and subsidies, but also choice- and agency-preserving interventions that shape the choice environment and guide decisions in the form of information, warnings, reminders, uses of social norms, and setting sustainable defaults, such as automatic enrolment in "green energy" provision via wind or solar. {5.2.1, 5.4.1}

Coordinated change in several domains leads to the emergence of new low-carbon configurations with cascading mitigation effects *(high confidence).* Demand-side transitions involve interacting processes and struggles on the behavioural, socio-cultural, institutional, business and technological dimensions. Individual or sectoral level change may be stymied by reinforcing lock-ins in social, infrastructural, and cultural domains. Coordinating choice architectures, physical infrastructures, new technologies and related business models can rapidly realise system-level change. {5.4.2, 5.5}

Demand side solutions require both motivation and capacity for change (*high confidence*). Capacity for change requires the availability and knowledge about change options and the resources to consider, initiate and maintain change. Correctly understanding the roles, goals, and needs of different actors, their perceptions and decision processes and the feedback between their actions is imperative in designing effective policies and decision support systems. {5.4.1}

Behavioural change, not embedded in structural and cultural change, is insufficient for climate change mitigation (*medium confidence*). Despite large mitigation potentials associated with individual actions, motivation by individuals or households around the world to change energy consumption behaviour is low. Behavioural nudges can promote easy behaviour change, improve actions like energy efficiency investments, but fail to motivate harder lifestyle changes. Individual motivation and capacity are influenced by different factors in different demographics and geographies. These factors go beyond traditional socio-demographic and economic predictors and include psychological variables such as awareness, perceived risk, subjective and social norms, and perceived behavioural control. {5.4}

Cultural change and new or adapted infrastructures are necessary to enable and realise many Avoid and Shift options (*medium confidence*). Narratives enable people to imagine and share climate futures that are characterised by avoid or shift possibilities. By drawing support from diverse actors, narratives enable coalitions to form, providing the basis for social movements to campaign in favour of (or against) societal transformations. {5.4, 5.5}

Collective action by individuals as part of formal social movements or informal lifestyle movements underpins system change (*high confidence*). Collective action and social organising are crucial to shift the possibility space of public policy on climate change mitigation. For example, climate strikes have given voice to youth in more than 180 countries. In other instances, mitigation policies that allow the active participation of all stakeholders, result in building social trust, new coalitions, legitimising change and thus initiate a positive cycle in climate governance capacity and policies. {5.4.2}

Transition pathways require action by different actors at different stages (*high confidence*). Transition pathways often start with experimental attempts by dedicating individuals and social norm settings in niche cultures. In adequate constellation, these groups can find entry points in the political process resulting in infrastructure reconfigurations or policies that support the further uptake of technologies or lifestyles. Agency of individuals as social change agents and narrators of meaning is central. These bottom-up socio-cultural forces catalysed a supportive policy environment, which enabled improvements in technologies, such as photovoltaics, by innovative firms. {5.5.2}

Middle actors play a crucial albeit underestimated and underutilised role in establishing low-carbon professional standards and practices (*medium confidence*). Building managers, landlords, energy efficiency advisers, technology installers and car dealers, influence patterns of mobility and energy consumption by acting as ‘middle actors’ or ‘intermediaries’ in the provision of building or mobility services and need to be provided with greater capacity and motivation to play this role. {5.4.3}

Current effects of climate change are already threatening the viability of existing business practices (*medium confidence*). Lobby activism, protecting rent extracting business models, prevent political action. Concerns of job losses in particular industries are justified and public discourses and policies are required to preserve the livelihoods, respect, and dignity of all workers and employees involved. {5.4.3}

Values in society change (*medium confidence*). Some values align better with GHG emission societies than others. Preferences are malleable and align with cultural shift. As a result the good life can be realised in different service provisioning systems. {5.2, 5.3}

Descriptive social norms are a powerful lever for increased adoption of low-carbon technologies, behaviours, and lifestyles (*high confidence*). Between 10% and 30% of committed individuals are required to set new social norms. {5.4, 5.5, 5.6}

III. Preconditions and instruments to enable demand-side transformation

Social equity improves capacity for mitigating climate change (*medium confidence*). Impartial governance such as fair treatment by law and order institutions and gender and income equity increases social trust, thus enabling demand side climate policies. High status (often high carbon) item consumption can be reduced by taxing absolute wealth without compromising wellbeing. The main reason is that status is communicating by relative wealth, not absolute wealth. {5.2}

Policies that increase the political access and participation of women, and racialised and marginalised groups, increase the democratic impetus for climate action. (*high confidence*). Including more differently-situated knowledge and diverse perspectives make climate mitigation policies more effective. {5.2}

Carbon pricing works best if implemented as targeted and fair (*high confidence*). A carbon levy earmarked for green infrastructures or saliently returned to tax payers corresponding to widely accepted notions of fairness increases political acceptability of carbon pricing. {5.6, Box 5.10}

Greater contextualisation and granularity in policy approaches is important to address the challenges of rapid transitions towards zero-carbon systems (*high confidence*). Larger systems take more time to evolve, grow, and change compared to smaller ones**.** The creation of entirely new systems (diffusion) takes longer time than replacements of existing technologies/practices (substitution). Late adopters tend to adopt faster than early pioneers. Obstacles and feasibility barriers are high in early transition phases. Barriers decrease as a result of technical and social learning processes, network building, scale economies, cultural debates and institutional adjustments. {5.5, 5.6}

COVID-19 confinement showed that behavioural change at massive scale and in short-time is possible (*high confidence*). COVID-19 accelerated some specific trends, such as an uptake in urban cycling. It also induced a modal shift from public transit to cars. In many instances, confinement was undesired and increased social inequity. To achieve acceptability, collective social change towards less resource intensive lifestyles require a social mandate building on deliberative processes. Social norms, individual and social practices are self-stabilising together with economic incentive systems and physical infrastructures and hardly change without structural change or external shocks. COVID-19 reset daily practices, and personal values, combined with awareness of consequences and ascription of responsibility, led to heightened efficacy beliefs, further strengthened by descriptive social norms, resulting in pro-social action, demonstrating that rapid collective action is possible. {Box 5.1}

Mitigation policies that correspond to and communicate with the values people hold are more likely to be successful (*high confidence*). Values differ between cultures. Measures that support autonomy, energy security and safety, equity and environmental protection, and fairness will resonate well in many communities. {5.4.2}

Policy instruments applied in sequence help in accelerating change in a desired direction consistently (*high confidence*). Changing in consumption choices consistently require structural changes and political action that enable taking low-carbon choices. {5.6}

Meta-analyses demonstrate that nudges, choice architectures and information provide small to medium significant contributions to reduce GHG emissions of individuals. In tandem with price signals, they work better than each individually (*medium confidence*). Green defaults are highly effective, and judicious labelling, framing, and communication of social norms can accelerate and multiply the effect of mandates, subsidies, or taxes. {5.4}

Regulation and public policy are necessary to steer the digital economies towards effective climate change mitigation (*medium confidence*). Combining efficiency gains with service provisioning systems that are minimally resource intensive, such as comprehensive shared mobility schemes, could reduce GHG emissions by as much as one-third. Specific applications of digital services, such as telework, teleconferencing, and intelligent energy systems offer mitigation potential by substituting other applications. For example, a modern smartphone requiring 5 watts of power can provide the same end user services (e.g., telephony, music, video, etc.) as previously associated with over 15 different end-use devices that collectively required 449 watts of power. Early and proactive public policies can foster the mitigation impacts of digitalisation and help avoiding rebounds. Reducing energy use of servers and data infrastructure is possible and a key ingredient of managing low-carbon digitalisation. Digitalisation may also turbocharge consumption by better targeted advertisements, with possible detrimental impacts on GHG emissions. Regulation can avoid undesired effects of digitalisation. {5.3}

It is important to consider non-linear development in technologies and wider rationales of human behaviour to design policy mixes (*medium confidence*). Combining insights from psychological, economic and innovation studies on policy mixes suggests non linearity in technology development. Specifically, an understanding of changing concepts of wellbeing, along with the necessity to maintain capabilities/DLS for everyone, allows for a broader set of policy mixes compared to marginal welfare improvements under given preference settings. {5.4, 5.5, 5.6}

Policy mixes are optimal if policies operate complementary to each other (*medium confidence*). Specifically in the case of energy efficiency this involves CO_2 pricing, standards and norms, and information feedback, while grants, loans and tax rebates are less effective as part of policy mixes.{5.3, 5.6}

5.1 Introduction

The Sixth Assessment Report of the IPCC (AR6), for the first time, features a full chapter on demand, services, and social aspects of mitigation. It builds on the AR4, which linked behaviour and lifestyle change to mitigating climate change (IPCC 2007; Roy and Pal 2009; IPCC 2014a), the Global Energy Assessment (Roy et al. 2012), and the AR5, which identified sectoral demand-side mitigation options across chapters (IPCC 2014a,b; Creutzig et al. 2016b). Although research on the social science aspects of climate mitigation still represents only a tiny fraction of all climate change research funding (Overland and Sovacool 2020) , the literature on the nature, scale, implementation and implications of demand-side solutions, and associated changes in lifestyles, social norms, and well-being, has been growing rapidly(Creutzig et al. 2021a). Demand-side solutions support near-term climate change mitigation (Méjean et al. 2019; Wachsmuth and Duscha 2019) and include consumers' technology choices, behaviours, lifestyle changes, coupled production-consumption infrastructures and systems, service provision strategies, and associated socio-technical transitions. This chapter's assessment of the social sciences (also see Supplementary Material Chapter 5) reveals that social dynamics at different levels offer diverse entry points for acting on and mitigating climate change (Jorgenson et al. 2019).

People demand services for dignified survival, sustenance, mobility, communication, comfort and material wellbeing (Nakićenović et al. 1996; Johansson et al. 2012; Creutzig et al. 2018). Access to services is fundamental, rather than only physical resources (biomass, energy, materials, etc.) and technologies (e.g. cooking tools, appliances). Focusing on demand for services broadens the climate solution space beyond technological switches confined to the supply side, to include solutions that maintain or improve wellbeing related to nutrition, shelter and mobility while (sometimes radically) reducing energy and material input levels (Creutzig et al. 2018). It also recognises that mitigation policies are politically, economically and socially more feasible, as well as more effective, when there is a two-way alignment between climate action and well-being (OECD 2019). There is *medium evidence and high agreement* that well-designed demand for services scenarios are consistent with adequate levels of well-being for everyone (Rao and Baer 2012; Grubler et al. 2018; Rao et al. 2019b; Millward-Hopkins et al. 2020), with high and/or improved quality of life (Max-Neef 1995) and improved levels of happiness (Easterlin et al. 2010) and sustainable human development (Arrow et al. 2013; Dasgupta and Dasgupta 2017). While demand for services is high as development levels increase, and related emissions are growing in many countries (Yumashev et al. 2020), there is also evidence that provisioning systems delink services provided from emissions (Patra et al. 2017; Kavitha et al. 2020). Various mitigation strategies, often classified into Avoid-Shift-Improve (ASI), effectively reduce primary energy demand and/or material input (Haas et al. 2015; Haberl et al. 2017; Samadi et al. 2017; Hausknost et al. 2018; Haberl et al. 2019; van den Berg et al. 2019; Ivanova et al. 2020). Users' participation in decisions about how services are provided, not just their technological feasibility, is an important determinant of their effectiveness and sustainability (Whittle et al. 2019).

Sector specific mitigation approaches (Chapters 6-11) emphasise the potential of mitigation from improvements in energy- and materials- efficient manufacturing(Gutowski et al. 2013; Gramkow and Anger-Kraavi 2019; Olatunji et al. 2019; Wang et al. 2019), new product design (Fischedick et al. 2014), and energy-efficient buildings (Lucon et al. 2014), shifts in diet (Bajželj et al. 2014; Smith et al. 2014), transport infrastructure design shifts (Sims et al. 2014), compact urban forms (Seto et al. 2014). In this chapter the service-related mitigation options are presented categorising them in **A**void, **S**hift, **I**mprove (ASI) options to show how mitigation potential and social groups who can deliver them are much broader than usually considered in traditional sector specific presentations. ASI originally arose from the need to assess the staging and combinations of interrelated mitigation options in the provision of transportation services (Hidalgo and Huizenga 2013). In the context of transportation services, ASI seeks to mitigate emissions through *avoiding* as much transport service demand as possible (e.g., telework to eliminate commutes, mixed-use urban zoning to shorten commute distances), *shifting* remaining demand to more efficient modes (e.g., bus rapid transit replacing passenger vehicles), and *improving* the carbon intensity of modes utilised (e.g., electric buses powered by renewable electricity) (Creutzig et al. 2016a). This chapter summarises ASI options and potentials across sectors, and generalises the definitions. 'Avoid' refers to all mitigation options that reduce wasteful energy consumption by redesigning service provisioning systems; 'shift' refers to the switch to already existing competitive efficient technologies and service provisioning systems; and 'improve' refers to improvements in efficiency in existing technologies. Avoid-Shift-Improve operate in three domains: 'Socio-behavioural', where social norms, culture, and individual choices play an important role – a category especially but not only relevant for avoid options; 'Infrastructure', which provides the cost and benefit landscape for realising options, is particularly relevant for shift options; 'Technologies', which are especially important for the improve options.

There is *high evidence and high agreement* that poverty, social equity, and policy contexts including global support affect delinking demand for services from emissions (Nabi et al. 2020; Ortega-Ruiz et al. 2020; Parker and Bhatti 2020; Teame and Habte 2020). There is growing evidence that multi-sectoral policy package approaches accelerate mitigation and increase wellbeing by supporting service provision cascades (Leemans et al. 1996; Bassi and Baer 2009; Berry et al. 2014; Papa et al. 2015; Ramaswami et al. 2017; Kalt et al. 2019). Promising policy entry points include stimulating low-emission energy sources and socially-oriented means of service provision and energy use focused on wellbeing (Geerts 2017; Burke 2020), innovative infrastructure and technology, and social equity in general for improved governance (see sections 5.2.3 and 5.6). In particular, the spread of "sufficiency" norms increases public acceptability and participation in the more-rapid Avoid and Shift types of mitigation (Toulouse et al. 2019).

Based on growing literature in this chapter we also adopt the concept of Decent Living Standards (DLS) as a universal set of service requirements essential for achieving basic human wellbeing (Frye et al. 2018; Rao and Min 2018a) provides a fair, direct way to understand the basic low-carbon energy needs of society. Ambitious low-emissions demand-side scenarios suggest that wellbeing could be maintained or improved while reducing global final energy demand, and some current literature estimates that it is possible to meet Decent Living Standards for all within the 2-degree warming window (Grubler et al. 2018; Burke 2020). This involves many context-specific challenges, however, and thus effective action on policy priorities (including how to blend new technologies with social change to integrate Improving ways of living, Shifting modalities and Avoiding certain kinds of emissions altogether) requires leadership from social role models in the context of equitable, appropriate governance.

There is *high evidence and high agreement* in the literature that the core operational principle for sustainable development is equitable access to services to provide wellbeing for all, while minimising resource inputs and environmental and social externalities/trade-offs, underpinning the Sustainable Development Goals (SDGs) (Princen 2003; Dasgupta and Dasgupta 2017; Lamb and Steinberger 2017). Sustainable development is not possible without changes in consumption patterns within the widely recognised constraints of planetary boundaries, resource availability, and the need to provide decent living standards for all (Toth and Szigeti 2016; O'Neill et al. 2018).

Throughout this chapter we discuss how people can realise various opportunities to reduce GHG emission intensive consumption (5.2 and 5.3), act in various roles (5.4), within an enabling environment created by policy instruments and infrastructure that are cognisant of social dynamics (5.6).

5.1.1 Demand-side solutions and planetary health

Demand-side solutions entail fewer environmental risks than many supply side technologies (Von Stechow et al. 2016) and make negative emission technologies, such as Bio-Energy with Carbon

Capture and Storage (BECCS) irrelevant (Grubler et al. 2018) or at least less relevant (Van Vuuren et al. 2018). Well-designed demand for services scenarios are consistent with adequate levels of well-being for everyone (Rao and Baer 2012; Grubler et al. 2018) , with high and/or improved quality of life (Max-Neef 1995) and improved levels of happiness (Easterlin et al. 2010) and sustainable human development (Arrow et al. 2013; Dasgupta and Dasgupta 2017). Well-being focus emphasises equity and universal need satisfaction, compatible with SDG progress (Lamb and Steinberger 2017). Interrogating demand for services from the well-being perspective also opens new avenues for assessing new potentials for mitigation (Brand-Correa and Steinberger 2017; Mastrucci and Rao 2017; Rao and Min 2018b; Mastrucci and Rao 2019). Demand-side solutions may also support near-term goals towards climate change mitigation and reduce the need for politically challenging high global carbon prices (Méjean et al. 2019). In the IPCC's SR1.5C (IPCC 2018), four stylised scenarios have explored possible pathways towards stabilising global warming at 1.5°C (SPM SR.15 Figure 3a (IPCC 2014a), (Figure 5.1) One of these scenarios, LED-19, investigates the scope of demand-side solutions (Figure 5.1). The comparison of scenarios reveals that such a low-energy demand pathways can be constructed to eliminate the need for technologies with high uncertainty, such as BECCS.

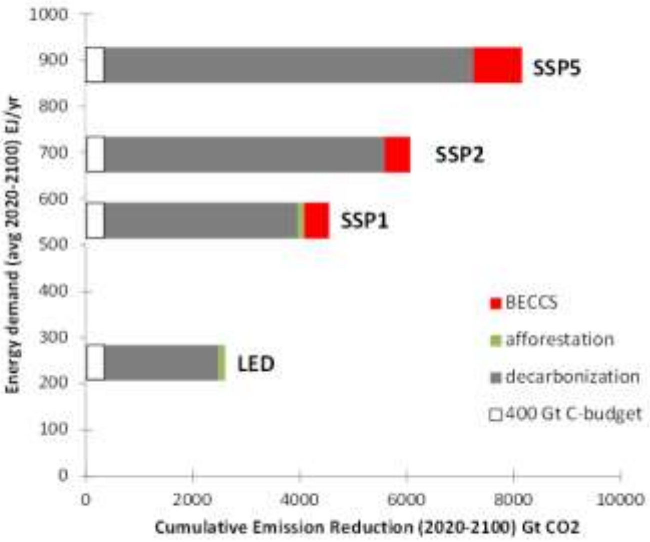


Figure 5.1 Low Energy Demand (LED) Scenario needs no BEECS and needs less decarbonisation efforts. Dependence of the size of the mitigation effort to reach a 1.5°C climate target (cumulative $GtCO_2$ emission reduction 2020-2100 by option) as a function of the level of energy demand (average global final energy demand 2020-2100 in EJ yr^{-1}) in baseline and corresponding 1.5°C scenarios (1.9 W m^{-2} radiative forcing change) based on the IPCC Special Report on 1.5°C global warming (data obtained from the scenario explorer database, LED baseline emission data obtained from authors). An illustrative remaining carbon budget consistent with a 1.5°C target of 400 $GtCO_2$ post 2020 also shown (Rogelj et al. 2019)

5.1.2 Bibliometric foundation of demand-side climate change mitigation

A bibliometric overview of the literature found 99,065 academic peer-reviewed papers identified with 34 distinct search queries addressing relevant content of this chapter (Creutzig et al. 2021a). The literature is growing rapidly (15% yr^{-1}) and the literature body assessed in the AR6 period (2014-2020) is twice as large as all literature published before.

A large part of the literature is highly repetitive and/or includes little quantitative or qualitative data of relevance to this chapter. For example, a systematic review on economic growth and decoupling identified more than 11,500 papers treating this topic, but only 834 of those, i.e. 7%, included relevant data (Wiedenhofer et al. 2020). In another systematic review, assessing quantitative estimates of consumption-based solutions (Ivanova et al. 2020), only 0.8% of papers were considered after consistency criteria were enforced. Other important papers were not captured by systematic reviews, but included in this chapter through expert judgement. Based on topical modelling and relevance coding of resulting topics, the full literature body can be mapped into two dimensions, where spatial relationships indicate topical distance (Figure 5.2). The interpretation of topic demonstrates that the literature organises in four clusters of high relevance for demand-side solutions (housing, mobility, food, and policy), whereas other clusters (nature, energy supply) are relatively less relevant.

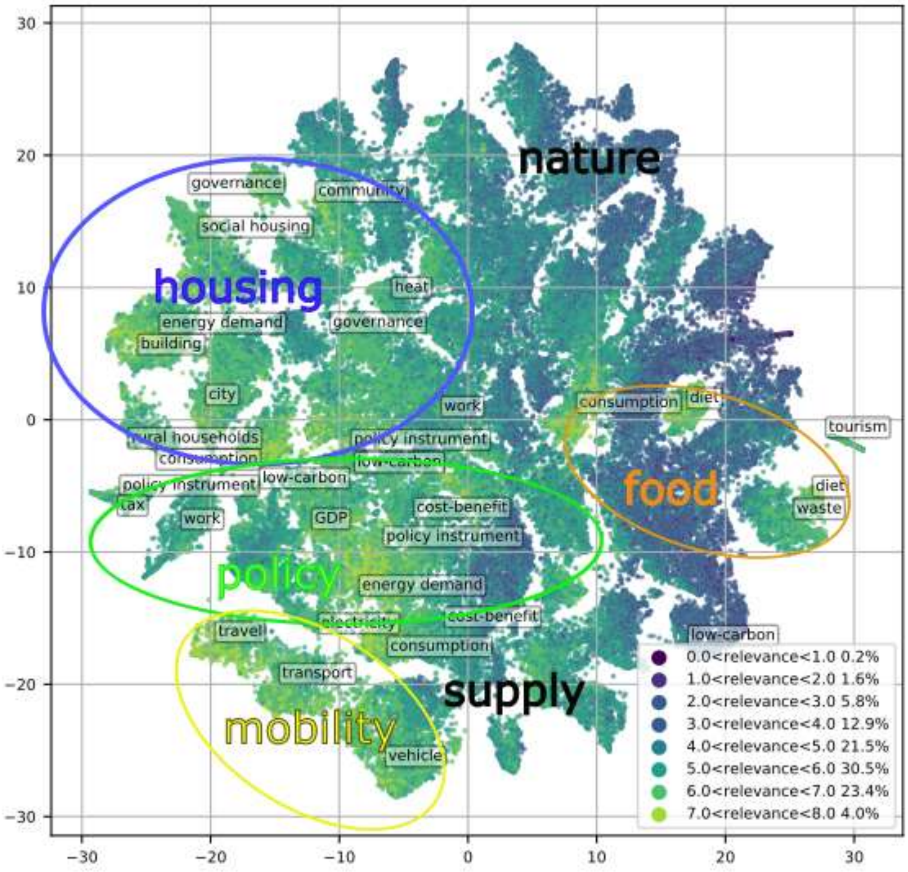


Figure 5.2 Map of the literature on demand, services and social aspects of climate change mitigation. Dots show document positions obtained by reducing the 60-dimensional topic scores to two dimensions aiming to preserve similarity in overall topic score. The two axes therefore have no direct interpretation, but represent a reduced version of similarities between documents across 60 topics. Documents are coloured by query category. Topic labels of the 24 most relevant topics are placed in the centre of each of the large clusters of documents associated with each topic. % value in caption indicates the proportion of studies in each "relevance" bracket. Source: (Creutzig et al. 2021a)

Section 5.2 provides evidence on the links among mitigation and wellbeing, services, equity, trust, and governance. Section 5.3 quantifies the demand-side opportunity space for mitigation, relying on the Avoid, Shift and Improve framework. Section 5.4 assesses the relevant contribution of different parts of society to climate change mitigation. Section 5.5 evaluates the overall dynamics of social transition processes while Section 5.6 summarises insights on governance and policy packages for demand-side mitigation and wellbeing. A Social Science Primer defines and discusses key terms and social science concepts used in the context of climate change mitigation.

Box 5.1 COVID-19, service provisioning and climate change mitigation

There is now *high evidence and high agreement* that the COVID-19 pandemic has increased the political feasibility of large-scale government actions to support the services for provision of public good, including climate change policies. Many behavioural changes due to COVID-19 reinforce sufficiency and emphasis on solidarity, economies built around care, livelihood protection, collective action, and basic service provision, linked to reduced emissions.

COVID-19 led to direct and indirect health, economic, and confinement-induced hardships and suffering, mostly for the poor, and reset habits and everyday behaviours of the well-off too, enabling a reflection on the basic needs for a good life. Although Covid-19 and climate change pose different kinds of threats and therefore elicit different policies, there are several lessons from COVID-19 for advancing climate change mitigation (Klenert et al. 2020; Manzanedo and Manning 2020; Stark 2020). Both crises are global in scale, requiring holistic societal response; governments can act rapidly, and delay in action is costly (Bouman et al. 2020a; Klenert et al. 2020). The pandemic highlighted the role of individuals in collective action and many people felt morally compelled and responsible to act for others (Budd and Ison, 2020). COVID-19 also taught the effectiveness of rapid collective action (physical distancing, wearing masks, etc.) as contributions to the public good. The messaging about social distancing, wearing masks and handwashing during the pandemic called attention to the importance of effective public information (e.g. also about reducing personal carbon footprints), recognising that rapid pro-social responses are driven by personal and socio-cultural norms (Bouman et al. 2020a; Sovacool et al. 2020a).

The COVID-19 shutdown temporarily reduced emissions - relatively most in aviation, and absolutely most in car transport (Le Quéré et al. 2020, Sarkis et al. 2020), and induced disproportionally strong reductions in GHG emissions from coal (Bertram et al. 2020)(Chapter 2). Global energy demand was projected to drop by 5% in 2020, energy-related CO_2 emissions by 7%, and energy investment by 18% (IEA 2020a). Plastics use and waste generation increased during the pandemic (Klemeš et al. 2020; Prata et al. 2020). Responses to COVID-19 had important connections with energy demand and GHG emissions due to quarantine and travel restrictions (Sovacool et al. 2020a). Reductions in mobility and economic activity reduced energy use in sectors such as industry and transport, but increased energy use in the residential sector (Diffenbaugh et al. 2020). COVID-19 induced behavioural changes that may translate into new habits, some beneficial and some harmful for climate change mitigation. New digitally enabled service accessibility patterns (videoconferencing, telecommuting) play an important role in sustaining various service needs while reducing overall emissions. Public transit lost customers to cars, personalised two wheelers, walking and cycling, while suburban and rural living gained initially popularity, possibly with long-term consequences. Reduced air travel, pressures for more localised food and manufacturing supply chains (Hobbs 2020; Nandi et al. 2020; Quayson et al. 2020), and governments' revealed willingness to make large-scale interventions in the economy also reflect sudden shifts due to COVID-19 with various service provision and climate implications, some likely to be lasting (Aldaco et al. 2020; Bilal et al. 2020; Norouzi et al. 2020; Prideaux et al. 2020; Sovacool et al. 2020a; Hepburn et al. 2020). If changes in some preference behaviours, e.g. for larger homes and work environments to enable home working and online education, lead to sprawling suburbs or gentrification with linked environmental consequences, this could translate into long-term implications for climate change (Beaunoyer et al. 2020; Diffenbaugh et al. 2020). Recovering from the pandemic by adapting low energy demand practices – embedded in new travel, work, consumption and production behaviour and patterns– could reduce prices for a 1.5°C consistent pathway by 19%, save energy supply investments until 2030 by 2.1 trillion USD, and lessen pressure on the upscaling of renewable energy technologies (Kikstra et al. 2021).

COVID-19 drove hundreds of millions of people below poverty thresholds, reversing decades of poverty reduction accomplishments (Krieger 2020; Mahler et al. 2020; Patel et al. 2020; Sumner et al. 2020) and raising the spectre of intersecting health and climate crises that are devastating for the most vulnerable (Flyvbjerg 2020; Phillips et al. 2020). Like those of climate change, pandemic impacts fall heavily on disadvantaged groups, exacerbate the uneven distribution of future benefits, amplify existing inequities, and introduce new ones (Beaunoyer et al. 2020; Devine-Wright et al. 2020). Addressing such inequities is a positive step towards the social trust that leads to improved climate policies as well as individual actions. Increased support for care workers and social infrastructures within a solidarity economy is consistent with lower-emission economic transformation (Shelley 2017; Di Chiro 2019; Pichler et al. 2019; Smetschka et al. 2019).

Finally, in a fiscal sense, the pandemic may have slowed the transition to a sustainable energy world: governments redistributed public funding to combat the disease, adopted austerity and reduced capacity, i.e. among nearly 300 policies implemented to counteract the pandemic, the vast majority are related to rescue, including worker and business compensation, and only 4% of these focus on green policies with potential to reduce GHG emissions in the long-term; some rescue policies also assist emissions-intensive business (Leach et al. 2021; Hepburn et al. 2020). However, climate investments can double as the basis of the COVID-19 recovery (Stark 2020), with policies focused on both economic multipliers and climate impacts such as clean physical infrastructure, natural capital investment, clean R&D and education and training (Hepburn et al. 2020). This requires attention to investment priorities, including social investment, given how inequality intersects with and is a recognised core driver of environmental damage and climate change (Millward-Hopkins et al. 2020).

5.2 Services, wellbeing and equity in demand-side mitigation

Mitigation, equity and wellbeing go hand in hand. Actions/policies that advance wellbeing and build social trust strengthen governance and enhance mitigation. There is *high evidence and high agreement* that demand-side measures are the single most important generic mitigation option as they cut across all sectors and can bring multiple benefits. One of the necessary conditions for acceleration in mitigation through demand side measures is wider participation from the society. This section introduces metrics of wellbeing and their relationship to GHG emissions, and clarifies the concept of service provisioning.

5.2.1 Metrics of wellbeing and their relationship to GHG emissions

There is *high evidence and agreement* in the literature that human wellbeing and related metrics provide a wider societal perspective which is inclusive and compatible with sustainable development and provide multiple ways to mitigate emissions. Development targeted to basic needs and wellbeing for all entails less carbon-intensive development than GDP-focused growth (Rao et al. 2014; Lamb and Rao 2015).The current operations within socioeconomic systems are based on high-carbon economic growth and resource use (Steffen et al. 2018). Several systematic reviews (reviewing more than 8000 individual papers) confirmed that economic growth is tightly coupled with increasing CO_2 emissions (Ayres and Warr 2005; Tiba and Omri 2017; Mardani et al. 2019; Haberl et al. 2020; Wiedenhofer et al. 2020). Different patterns emerge in the causality of the energy-growth nexus; (i) energy consumption causes economic growth; (ii) growth causes energy consumption; (iii) bidirectional causality; and (iv) no significant causality (Ozturk 2010). In a systematic review, Mardani et al. (2019) found that in most cases energy use and economic growth have a bidirectional causal effect, indicating that as economic growth increases, further CO_2 emissions are stimulated at higher levels; in turn, measures designed to lower GHG emissions may reduce economic growth. However, energy substitution and efficiency gains may offer opportunities to break the bidirectional dependency (Komiyama 2014; Brockway et al. 2017; Shuai et al. 2019). Worldwide trends reveal that, at best only relative decoupling (resource use grows at a slower pace than GDP) was the norm during the twentieth century (Jackson 2009; Krausmann et al. 2009; Ward et al. 2016), while absolute decoupling (when material use declines as GDP grows) is rare, observed only during recessions or periods of low or no economic growth (Heun and Brockway 2019; Wiedenhofer et al. 2020). Panel data integration reveals that every 1% increase in GDP was associated with a 1% increase in CO_2 emissions controlling for other factors. Emissions reductions were realised by (i) energy system decarbonisation, (ii) increased economic efficiency, (iii) electrification, and (iv) deindustrialisation with 1% increase in these factors translating into 0.2-1.8% reductions in CO_2 emissions per year (Wang et al. 2021). High-income economies realised most reduction in CO_2 emissions with energy system decarbonisation, low-income economies with economic efficiency and electrification (Wang et al. 2021). Recent trends in OECD countries demonstrate the potential for absolute decoupling economic growth not only from territorial but also from consumption-based emissions (Le Quéré et al. 2019), albeit at scales insufficient with mitigation pathways (Chapter 2).

Energy demand and demand for GHG intensive products increased from 2010 until 2020 across all sectors and categories. 2019 witnessed a reduction in energy demand growth rate to below 1% and 2020 an overall decline in energy demand, with repercussions into energy supply disproportionally affecting coal vie merit order effects (Bertram et al 2021, Cross-Chapter Box 1 in Chapter 1). Disproportional expansion in GHG intensive economic activities includes aviation (+28.5% from 2010 to 2020), SUVs (+17% from 2010 to 2020), while meat consumption followed population growth (12% from 2010 to 2020). There was a slight but significant shift from high carbon beef consumption to medium carbon intensive poultry consumption. Final energy use in buildings grew from 118 EJ in 2010 to around 128 EJ in 2019 (increased about 8%). The highest increase was observed in non-residential buildings, with a 13% increase against 8% in residential energy demand (IEA, 2019b). While electricity accounted for one-third of building energy use in 2019, fossil fuel use also increased at a marginal annual average growth rate of 0.7% since 2010 (IEA, 2020a). Energy-related CO_2 emissions from buildings have risen in recent years after flattening between 2013 and 2016. Direct and indirect emissions from electricity and commercial heat used in buildings rose to 10 $GtCO_2$ in 2019, the highest level ever recorded. Several factors have contributed to this rise, including growing energy demand for heating and cooling with rising air-conditioner ownership and extreme weather events. Global energy demand for cooling in the residential sector increased by 40% from 2010 to 2018.

Literature now has *high evidence and high agreement* around the observation that policies and infrastructure interventions that lead to change in human preferences are more valuable for climate change mitigation than previously thought. In economics, welfare evaluations are predominantly based on the preference approach. Preferences are typically assumed to be fixed, so that only changes in relative prices will reduce emissions. However, as decarbonisation is a societal transition, individuals' preferences do shift and this can contribute to climate change mitigation (Gough 2015). Even if preferences are assumed to change in response to policy, it is nevertheless possible to evaluate policy, and demand-side solutions, by approaches to wellbeing/welfare that are based on deeper concepts of preferences across disciplines (von Weizsäcker 1971; Schipper 1989; Roy and Pal 2009; Fleurbaey and Tadenuma 2014; Komiyama 2014; Dietrich and List 2016; Mattauch and Hepburn 2016). In cases of past societal transitions, such as smoking reduction, there is evidence that societies guided the processes of shifting preferences, and values changed along with changing relative prices (Nyborg and Rege 2003; Stuber et al. 2008; Brownell and Warner 2009). Further evidence on changing preferences in consumption choices pertinent to decarbonisation includes (Grinblatt et al. 2008; Weinberger and Goetzke 2010) for mobility; (Erb et al. 2016; Muller et al. 2017; Costa and Johnson 2019) for diets; (Baranzini 2017) for solar panel uptake. If individuals' preferences and values change during a transition to the low-carbon economy, then this overturns conclusions on what count as adequate or even optimal policy responses to climate change mitigation in economics (Jacobsen et al. 2012; Schumacher 2015; Dasgupta et al. 2016; Daube and Ulph 2016; Ulph and Ulph 2018). In particular, if policy instruments, such as awareness campaigns, infrastructure development or education, can change people's preferences, then policies or infrastructure provision – socially constrained by deliberative decision making -- which change both relative prices and preferences, are more valuable for mitigation than previously thought (Creutzig et al. 2016b; Mattauch et al. 2016, 2018). The provisioning context of human needs is participatory, so transformative mitigation potential arises from social as well as technological change (Lamb and Steinberger 2017). Many dimensions of wellbeing and 'basic needs' are social not individual in character (Schneider 2016), and since over-consumption is also a social construct, extending wellbeing and DLS analysis to emissions also involves understanding individual situations in social contexts. This includes building supports for collective strategies to reduce emissions (Chan et al. 2019), going beyond individual consumer choice. Climate policies that affect collective behaviour fairly are the most acceptable policies across political ideologies (Clayton 2018); thus collective preferences for mitigation are synergistic with evolving policies and norms in democratic contexts that reduce risk, ensure social justice and build trust (Atkinson et al. 2017; Cramton et al. 2017; Milkoreit 2017; Tvinnereim et al. 2017; Smith and Reid 2018; Carattini et al. 2019).

Because of data limitations, which can make cross-country comparisons difficult, health-based indicators and in particular life expectancy (Lamb et al. 2014) have sometimes been proposed as quick and practical ways to compare local or national situations, climate impacts, and policy effects (Decancq et al. 2009; Sager 2017; Burstein et al. 2019). A number of different wellbeing metrics are valuable in emphasising the constituents of what is needed for a good life in different dimensions (Porter et al. 2017; Smith and Reid 2018; Lamb and Steinberger 2017). The SDGs overlap in many ways with such indicators, and the data needed to assess progress in meeting the SDGs is also useful for quantifying wellbeing (Gough 2017). For the purposes of this chapter, indicators directly relating GHG emissions to wellbeing for all are particularly relevant.

Well-being can be categorised either as "hedonic" or "eudaimonic". Hedonic well-being is related to a subjective state of human motivation, balancing pleasure over pain, and has gained influence in psychology assessing 'subjective well-being' such as happiness and minimising pain, assuming that the individual is motivated to enhance personal freedom, self-preservation and enhancement (Sirgy 2012; Brand-Correa and Steinberger 2017; Lamb and Steinberger 2017; Ganglmair-Wooliscroft and Wooliscroft 2019). Eudaimonic well-being focuses on the individual in the broader context, associating happiness with virtue (Sirgy 2012) allowing for social institutions and political systems and considering their ability to enable individuals to flourish. Eudaimonic analysis supports numerous development approaches (Fanning and O'Neill 2019) such as the capabilities (Sen 1985), human needs (Doyal and Gough 1991) and models of psychosocial well-being (Ryan and Deci 2001). Measures of wellbeing differ somewhat in developed and developing countries (Sulemana et al. 2016; Ng and Diener 2019); for example, food insecurity, associated everywhere with lower subjective wellbeing, is more strongly associated with poor subjective wellbeing in more-developed countries (Frongillo et al. 2019); in wealthier countries, the relationship between living in rural areas is less strongly associated with negative wellbeing than in less-developed countries (Requena 2016); and income inequality is negatively associated with subjective wellbeing in developed countries, but positively so in less-developed countries (Ngamaba et al. 2018).

Integrated assessment models (IAMs) evaluate the costs of mitigation options as a function of loss in sustained economic growth. Both the specific implementation of this cost evaluation as well as the general framework are incomplete. Specifically, the models insufficiently reflect the loss of economic growth induced by climate damages, thus underestimating the social costs of carbon(Moore and Diaz 2015; Waisman et al. 2019). The use of GDP loss alone is an insufficient metric in reflecting wellbeing; for example, it counts specific climate solutions that achieve more wellbeing with less throughput as a burden to GDP. Identifying solutions as optimum equilibrium, IAMs identify solutions vis-a-vis losses due to climate policies (Mercure et al. 2018), ignoring that climate-change induced innovation drives value creation (Mazzucato 2018). Integrated Assessment Models, in their current state, are inadequate tools to evaluate either demand-side solutions to climate change mitigation, or the impacts on human wellbeing of climate change and climate mitigation options (*medium evidence, medium agreement*).

5.2.1.1 Services for wellbeing

Wellbeing needs are met through services. Provision of services associated with low-energy demand is a key component of current and future efforts to reduce carbon emissions. Services can be provided in various culturally-appropriate ways, with diverse climate implications. There is *high evidence and high agreement* in the literature that many granular service provision systems can make 'demand' more flexible and help in mitigation with new options for mitigation and support access to basic needs and enhance human wellbeing. Energy services offer an important lens to analyse the relationship between energy systems and human well-being (Jackson and Papathanasopoulou 2008; Druckman and Jackson 2010; Mattioli 2016; Walker et al. 2016; Fell 2017; Brand-Correa et al. 2018; King et al. 2019; Pagliano and Erba 2019; Whiting et al. 2020). Direct and indirect services provided by energy, rather than energy itself, deliver benefits for wellbeing (Kalt et al. 2019). Illumination and transport are intermediary services in relation to education, healthcare, meal preparation, sanitation, etc. which help meet human needs. Sustainable consumption and production revolve around 'doing more and better with less' and thereby increasing wellbeing from economic activities 'by reducing resource use, degradation and pollution along the whole lifecycle, while increasing quality of life' (UNEP 2010). Although energy is required for delivering human development by supporting access to basic needs (Lamb and Rao 2015; Lamb and Steinberger 2017), a reduction in primary energy use and/or shift to renewable energy, if associated with the maintenance or improvement of services, can not only ensure better environmental quality but also directly enhance well-being (Roy et al. 2012). At the interpersonal and community level, cultural specificities, use of renewables, infrastructure, norms, and relational behaviours differ. For example, demand for space heating and cooling depends on building materials and designs, urban planning, vegetation, clothing and social norms as well as geography, incomes, and outside temperatures (Brand-Correa et al. 2018; Campbell et al. 2018; Ivanova et al. 2018; IEA 2019a; Dreyfus et al. 2020). In personal mobility, different variable need satisfiers (e.g., street space allocated to cars, busses, or bicycles) can satisfy human needs, such as accessibility to jobs, health care, and education (Mattioli 2016). Social interactions and normative values play a crucial role in determining energy demand. Hence, demand-side and service-oriented mitigation strategies are most effective if geographically and culturally differentiated (Niamir et al. 2020a).

Decent Living Standards (DLS) serves as a socio-economic benchmark as it views human welfare not in relation to consumption but rather in terms of services which together help meet human needs (e.g. nutrition, shelter, health, etc.), recognising that these service needs may be met in many different ways (with different emissions implications) depending on local contexts, cultures, geography, available technologies, social preferences, and other factors. Therefore, one key way of thinking about providing well-being for all with low carbon emissions centres around prioritising ways of providing services for DLS in a low-carbon way (including choices of needs satisfiers, and how these are provided or made accessible). They may be supplied to individuals or groups / communities, both through formal markets and/or informally, e.g. by collaborative work, in coordinated ways that are locally-appropriate, designed and implemented in accordance with overlapping local needs.

The most pressing DLS service shortfalls, as shown in Figure 5.3, lie in the areas of nutrition, mobility, and communication. Gaps in regions such as Africa and the Middle East are accompanied by current levels of service provision in the highly industrialised countries at much higher than DLS levels for the same three service categories. The lowest population quartile by income worldwide faces glaring shortfalls in housing, mobility, and nutrition. Meeting these service needs using low-emissions energy sources is a top priority. Reducing emissions associated with high levels of consumption and material throughput by those far above DLS levels has potential to reduce GHG emissions and reduce inequality in energy and emission footprints (Otto et al. 2019). In some countries, carbon intensive ways of satisfying human needs have been locked-in, e.g., via car-dependent infrastructures (Druckman and Jackson 2010; Jackson and Papathanasopoulou 2008; King et al. 2019; Mattioli 2016), and both infrastructure reconfiguration and adaptation are required to organise need satisfaction in low-carbon ways (see also Ch.10.2).

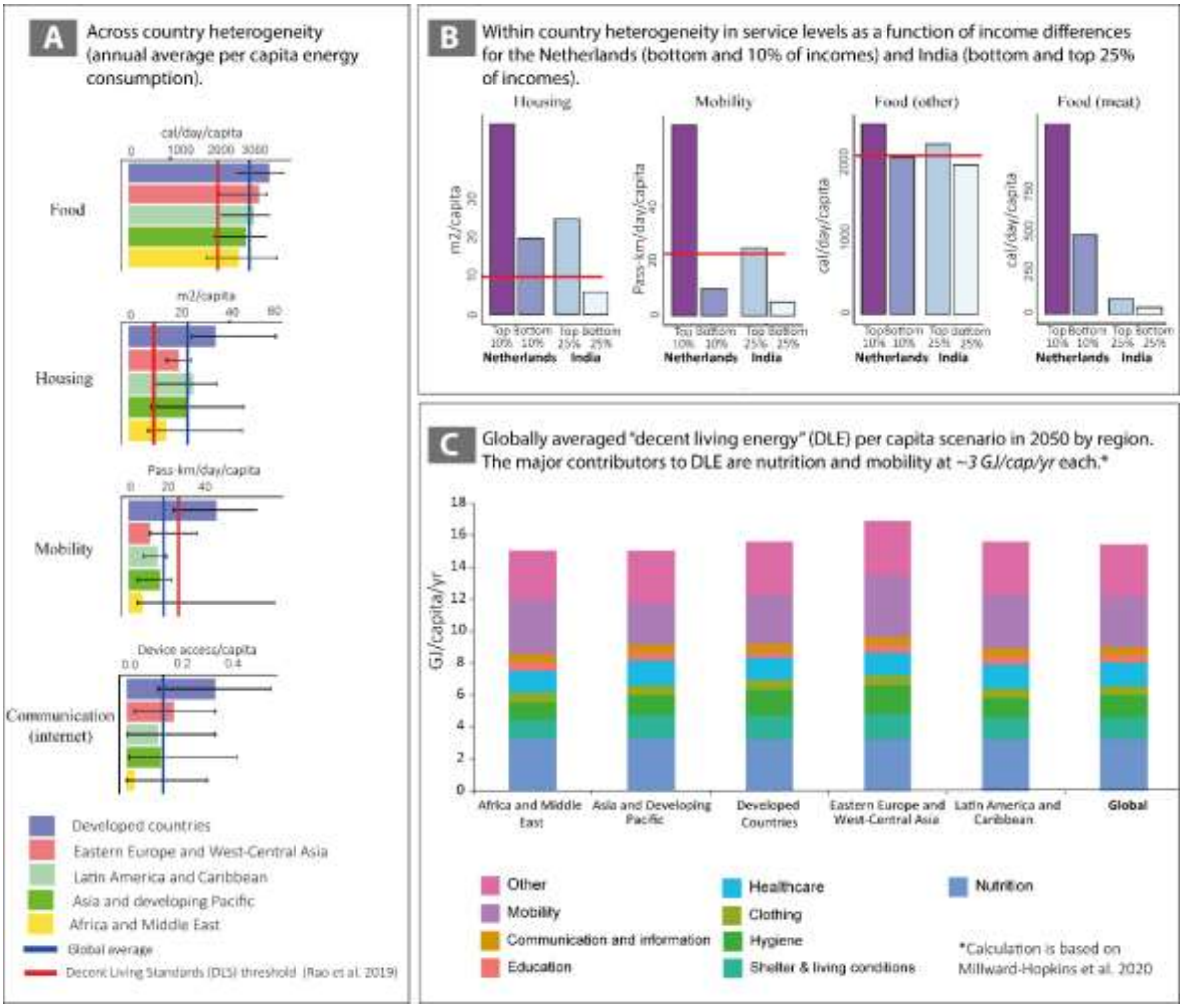


Figure 5.3 Heterogeneity in access to and availability of services for human well-being within and across countries. Panel A. Across –country differences in panel (a) food-meat, (b)food other, (c) housing, (d) mobility, (e) Communication –mobile phones, and (f) high speed internet access. Variation in service levels across countries within a region are shown as error bars (black). Values proposed as decent standards of living threshold (Rao et al. 2019b) are shown (red dashed lines). Global average values are shown (blue dashed lines). Panel B. Within-country differences in service levels as a function of income differences for the Netherlands (bottom and top 10% of incomes) and India (bottom and top 25% of incomes) (Grubler et al. 2012b)(data update 2016). Panel C. Decent living energy (DLE) scenario using global, regional and DLS dimensions for final energy consumption at 149 EJ (15.3 GJ capita^{-1}yr^{-1}) in 2050 (Millward-Hopkins et al. 2020), requiring advanced technologies in all sectors and radical demand-side changes. Values are shown for 5 world regions based on WG III AR6 Regional breakdown

The emerging literature with *high evidence and high agreement* vital dimensions of human wellbeing correlate with consumption, but only up to a threshold. High potential for mitigation lies in using low-carbon energy for new basic needs satisfaction while cutting emissions of those whose basic needs are already met (Grubler et al. 2018; Rao and Min 2018a; Millward-Hopkins et al. 2020; Rao et al. 2019b). Decent Living Standards indicators serve as tools to clarify this socio-economic benchmark and identify wellbeing for all compatible mitigation potential. Energy services provisioning opens up avenues of efficiency and possibilities for decoupling energy services demand from primary energy supply, while needs satisfaction leads to the analysis of the factors influencing the energy demand associated with the achievement of wellbeing (Brand-Correa and Steinberger 2017). Since vital dimensions of wellbeing correlate with consumption, but only up to a threshold, a mitigation strategy that protects minimum levels of service delivery for DLS, but critically views consumption beyond the point of diminishing returns of needs satisfaction, is able to sustain wellbeing while generating emissions reductions (Goldemberg et al. 1988; Jackson and Marks 1999; Druckman and Jackson 2010; Girod and De Haan 2010; Vita et al. 2019a). Such relational dynamics are relevant both within and between countries, due to variances in income levels, lifestyle choice (see also 5.4.4), geography, resource assets and local contexts. Provisioning for human needs is recognised as participatory and interrelational; transformative mitigation potential can be found in social as well as technological change (Mazur and Rosa 1974; Goldemberg et al. 1985; Lamb and Steinberger 2017; O'Neill et al. 2018; Hayward and Roy 2019; Vita et al. 2019a). More equitable societies which provide DLS for all can devote attention and resources to mitigation (Dubash 2013; Rafaty 2018; Richards 2003). For further exploration of these concepts, see the Supplementary Material Chapter 5.

5.2.2 Inequity in access to basic energy use and services

5.2.2.1 Variations in access to needs-satisfiers for Decent Living Standards

There is very *high evidence and very high agreement* that globally, there are differences in the amount of energy that societies require to provide the basic needs for everyone. At present nearly one-third of the world's population are 'energy-poor' , i.e., more than 2.6 billion people have little or no access to energy for clean cooking. About 1.2 billion lack energy for cleaning, sanitation and water supply, lighting, and basic livelihood tasks (Sovacool and Drupady 2016; Rao and Pachauri 2017). The per capita energy requirement to provide a decent standard of living has been calculated at 30 GJ to 40 GJ (Lamb and Steinberger 2017), while other studies place it in an order of magnitude from 10 GJ to 100 GJ (Steckel et al. 2013; Lamb and Rao 2015), while others suggest ranges from 5 GJ cap^{-1}yr^{-1} to over 200 GJ cap^{-1}yr^{-1}, which in both cases shows the level of inequality that exists (Millward-Hopkins et al. 2020); but this depends on the context and how services are provided (Brand-Correa et al. 2018). Through efficient technologies and radical demand-side transformations, the final energy requirements for providing DLS is estimated at 15.3 GJ cap^{-1}yr^{-1} (Millward-Hopkins et al. 2020). Recent DLS estimates for Brazil, South Africa, and India are in the range between 15 and 25 GJ cap^{-1}yr^{-1}. The most gravely energy-poor are often those living in informal settlements, particularly women who live in sub-Saharan Africa and developing Asia, whose socially-determined responsibilities for food, water, and care are highly labour-intensive and made more intense by climate change (Guruswamy 2016; Wester et al. 2019). For example, in Brazil, India and South Africa, where inequality is extreme (Alvaredo et al. 2018) mobility (51-60%), food production and preparation (21-27%) and housing (5-12%) dominate total energy needs (Rao et al. 2019b). Inequality in access to and availability of services for human well-being varies in extreme degree across countries and income groups. In developing countries the bottom 50% receive about 10% of the energy used in land transport and less than 5% in air transport, while the top 10% use ~45% of the energy for land transport and around 75% for air transport (Oswald et al. 2020). Within-country analysis shows that disadvantaged groups in China— women born in the rural West with worse family backgrounds— face unequal opportunities for energy consumption (Shi 2019). Figure 5.4 shows the wide variation across world regions in people's access to some of the basic material prerequisites for meeting DLS, and variations in energy consumption, providing a starting point for comparative global analysis.

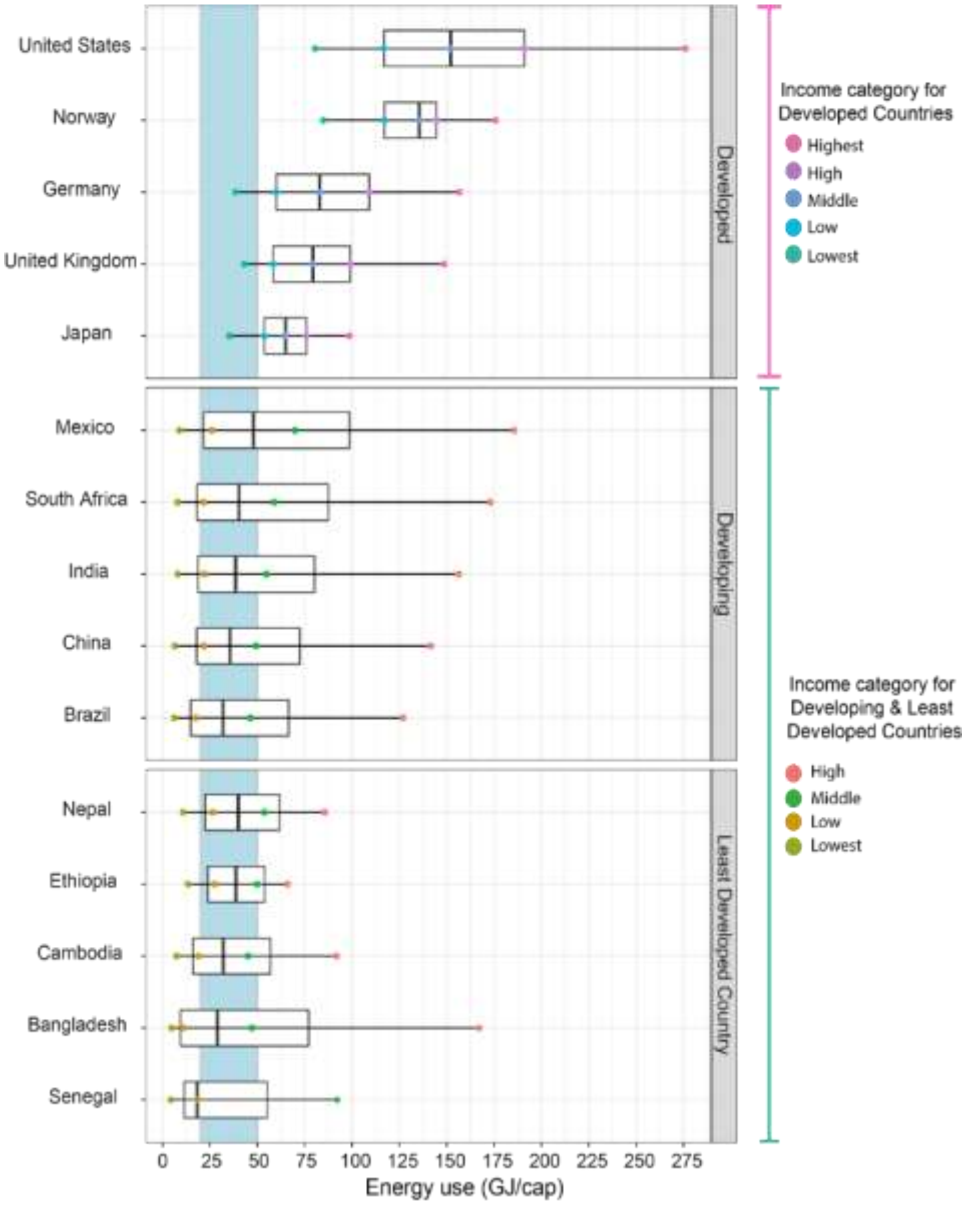
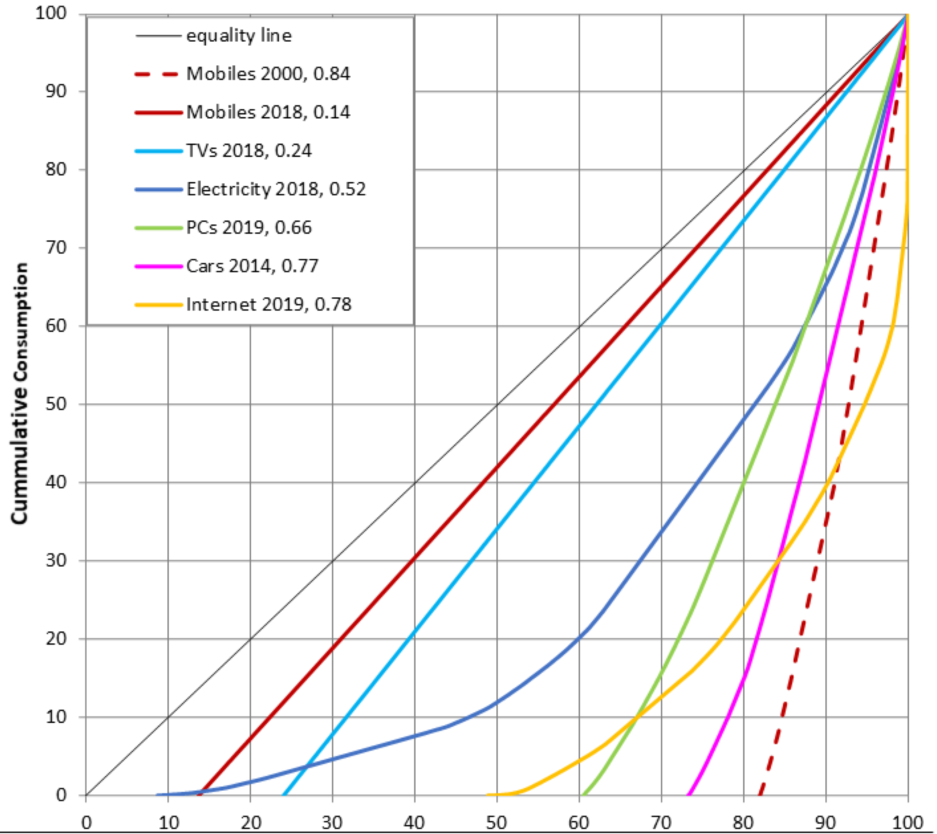


Figure 5.4 Energy use per capita of three groups of countries ranked by socioeconomic development and displayed for each country based on four or five different income groups (according the data availability) as well as geographical representativity. The energy required for decent living standards (20-50 GJ cap^{-1}) is indicated in the blue column (Rao et al. 2019b). Data based on (Oswald et al. 2020)

Box 5.2 Inequities in access to and levels of end-use technologies and infrastructure services

Acceleration in mitigation action needs to be understood from societal perspective. Technologies, access and service equity factors sometimes change rapidly. Access to technologies, infrastructures and products, and the service they provide, are essential for raising global living standards and improving human well-being (Alkire and Santos 2014; Rao and Min 2018a). Yet access to and levels of service delivery are distributed extremely inequitably. How fast such inequities can be reduced by granular end-use technologies is illustrated by the cellphone (mobile phone subscriptions), comparing the situation between 2000 and 2014. In this four-year period, cellphones changed from a very inequitably-distributed technology to one with almost universal access, bringing accessibility benefits especially to populations with very low disposable income and to those whose physical mobility is limited (Porter 2016). Every human has the right to dignified decent life, with the means to live in good health and participate in society. This is a daunting challenge, requiring that in the next decade governments build out infrastructure to provide billions of people with access to a number of services and basic amenities in comfortable homes, nutritious food, and transit options (Rao and Min 2018a). For long, this challenge was thought to also be an impediment to developing countries' participation in global climate mitigation efforts. However, recent research shows that this need not be the case (Millward-Hopkins et al. 2020; Rao et al. 2019b).

Several of the United Nations' Sustainable Development Goals (SDGs) (United Nations 2015) deal with providing access to technologies and service infrastructures to the share of population so far excluded, showing that the UN 2030 Agenda has adopted a multidimensional perspective on poverty. Multi-dimensional poverty indices, such as the Social Progress Indicator (SPI) and the Individual Deprivation Measure, go beyond income and focus on tracking the delivery of access to basic services by the poorest population groups, both in developing countries (Fulton et al. 2009; Alkire and Santos 2014; Alkire and Robles 2017; Rao and Min 2018a), and in developed countries (Townsend 1979; Aaberge and Brandolini 2015; Eurostat 2018). At the same time, the SDGs, primarily SDG 10 on reducing inequalities within and among countries, promote a more equitable world, both in terms of inter- as well as intra-national equality.



Technology/Infrastructure	Gini	Year	Population without access bn	%	Coverage world population %	included countries number	Source
Mobiles*	0.84	2000	4.0	81.9	79.6	43	ITU+/WBWDI/WPDS+
Mobiles*	0.14	2018	0.8	13.7	78.3	43	ITU+/WBWDI/WPDS+
TVs*	0.24	2018	1.6	24.1	89.8	86	ITU+/WBWDI/WPDS+
Electricity (kWh)	0.52	2018	0.6	8.7	95.9	142	WB WDI/IEA
PCs	0.66	2019	4.6	60.5	98.0	183	ITU/WBWDI/WPDS+
Cars*	0.77	2014	4.2	73.3	78.9	44	PEW/WBWDI
International bandwidth (bits/sec)	0.78	2019	3.7	48.8	99.3	197	ITU/WBWDI

Box 5.2, Figure 1 International inequality in access and use of goods and services. Upper panel: International Lorenz curves and Gini coefficients accounting for the share of population living in households without access (origin of the curves on the y-axis), multiple ownership not considered. Lower panel: Gini, number of people without access, access rates and coverage in terms of share of global population and number of countries included. *Reduced samples lead to underestimation of inequality. A sample, for example, of around 80% of world population (taking the same 43 countries as for mobiles and cars) led to a lower Gini of around 0.48 (-0.04) for electricity. The reduced sample was kept for mobiles in 2018 to allow for comparability with 2000. Source: (Zimm 2019)

Access to various end-use technologies and infrastructure services features directly in the SDG targets and among the indicators used to track their progress (United Nations 2015; UNESC 2017): Basic services in households (SDG 1.4.1), Improved water source (SDG 6.1.1); Improved sanitation (SDG 6.1.2); Electricity (SDG 7.1.1); Internet - fixed broadband subscriptions (SDG 17.6.2); Internet - proportion of population (SDG 17.8.1). Transport (public transit, cars, mopeds or bicycles) and media technologies (mobile phones, TVs, radios, PCs, Internet) can be seen as proxies for access to mobility and communication, crucial for participation in society and the economy (Smith et al. 2015). In addition, SDG 10 is a more conventional income-based inequality goal, referring to income inequality (SDG 10.1), social, economic and political inclusion of all (SDG 10.2.), and equal opportunities and reduced inequalities of outcome (SDG 10.3).

5.2.2.2 Variations in energy use

There is *high evidence and high agreement* in the literature that through equitable distribution, well-being for all can be assured at the lowest-possible energy consumption levels (Steinberger and Roberts 2010; Oswald et al. 2020) by reducing emissions related to consumption as much as possible, while assuring DLS for everyone (Annecke 2002; de Zoysa 2011; Ehrlich and Ehrlich 2013; Spangenberg 2014; Toroitich and Kerber 2014; Dario Kenner 2015; Toth and Szigeti 2016; Smil 2017; Otto et al. 2019). For example, at similar levels of human development, per capita energy demand in the US was 63% higher than in Germany (Arto et al. 2016); those patterns are of course explained by various climate, cultural and historical factors influencing consumption. In China, inequality of energy consumption and expenditure varies highly depending on the energy type, end-use demand and climatic region (Wu et al. 2017).

Consumption is energy and materials-intensive and expands along with income. About half of the energy used in the world is consumed by the richest 10% of people, most of whom live in developed countries, especially when one includes the energy embodied in the goods they purchase from other countries (Arto et al. 2016; Wolfram et al. 2016). China acts as the largest importing market for EU and United States, being responsible for near half and 40% of their imports in energy use respectively (Wu et al. 2019). Wealthy countries have exported or outsourced their climate and energy crisis to low and middle-income countries (Baker 2018) exacerbated by intensive international trade (Steinberger et al. 2012; Scherer et al. 2018). Therefore, the issues of total energy consumption are inseparably related to the energy inequity among the countries and regions of the world.

Within the energy use induced by global consumer products, household consumption is the biggest contributor, contributing to around three quarters of the global total (Wu et al. 2019). A more granular analysis of household energy consumption, differentiated according to household consumption expenditure quintiles and quartiles, reveals that the lowest two quintiles in countries with average annual income below 15,000 USD cap^{-1} consume less energy than the international energy requirements for DLS (20-50 GJ cap^{-1}); 77% of people consume less than 30 GJ cap^{-1}yr^{-1} and 38% consume less than 10 GJ cap^{-1}yr^{-1}. In contrast, the richest half of consumers in all countries consume final energy above DLS levels, sometimes by an order of magnitude (Oswald et al. 2020). Many energy-intensive goods have high price elasticity (>1.0), implying that growing incomes lead to over-proportional growth of energy footprints in these consumption categories. Highly unequally distributed energy consumption is concentrated in the transport sector, ranging from vehicle purchase to fuels, and most unequally in package holidays and aviation (Gössling 2019; Oswald et al. 2020).

5.2.2.3 Variations in consumption-based emissions

The carbon footprint of a nation is equal to the direct emissions occurring due to households' transport, heating and cooking, as well as the impact embodied in the production of all consumed goods and services (Wiedmann and Minx 2008; Davis and Caldeira 2010; Hübler 2017; Vita et al. 2019a). There are large differences in carbon footprints between the poor and the rich. As a result of energy use inequality, the lowest global emitters (the poorest 10% in the poorest countries) in 2013 emitted about 0.1t CO_2 cap^{-1}, whereas the highest global emitters (the top 1% in the richest countries) emitted about 200-300 tCO_2 cap^{-1} (World Bank 2019). The poorest 50% of the world's population are responsible for only about 10% of total lifetime consumption emissions, in contrast about ~50% of the world's GHG emissions can be attributed to consumption by the world's richest 10%, with the average carbon footprint of the richest being 175 times higher than that of the poorest 10% (Chancel and Piketty 2015) consuming the global carbon budget by nearly 30% during the period 1990-2015 (Kartha et al. 2020). In low-income nations-which can exhibit per-capita carbon footprints 30 times lower than wealthy nations (Hertwich and Peters 2009) emissions are predominantly domestic and driven by provision of essential services (shelter, low-meat diets, clothing). Per capita carbon footprints average 1.6 tonnes per year for the lowest income category, then quickly increase to 4.9 and 9.8 tonne for the two middle-income categories and finally to an average of 17.9 tonnes for the highest income category. Global CO_2 emissions remain concentrated: the top 10% of emitters contribute about 35-45% of the total, while the bottom 50% contribute just 13-15% of global emissions (Chancel and Piketty 2015; Hubacek et al. 2017). In wealthy nations, services such as private road transport, frequent air travel, private jet ownership, meat-intensive diets, entertainment and leisure add significant emissions, while a considerable fraction of the carbon footprint is imported from abroad, embedded in goods and services (Hubacek et al. 2017). Thus, emissions accounting should preferably be consumption-based. For example, emissions generated in China in 2004 for the production of goods consumed in the UK were higher than all the direct emissions of UK households including gas and car fuel, at over 81 million of tonnes of CO_2; more than 43% of these emissions were associated with electronic equipment and textiles (Baker 2018).

High income household consume energy demand energy at an order of magnitude greater than what is necessary for DLS (Oswald et al. 2020). Energy-intensive goods, such as package holidays, have a higher income elasticity of demand than less energy-intensive goods like food, water supply and housing maintenance, which results in high-income individuals having much higher energy footprints (Oswald et al. 2020). Evidence highlights highly unequal GHG emission in aviation: only 2-4% of global population flew internationally in 2018, with 1% of world population emitting 50% of CO_2 from commercial aviation (Gössling and Humpe 2020). Some individuals may add more than 1,600 t CO_2 yr^{-1} individually by air travel (Gössling 2019). The food sector dominates in all income groups, comprising 28% of households' carbon footprint, with cattle and rice the major contributors (Scherer et al. 2018). Roughly 20-40% of food produced worldwide is lost to waste before it reaches the market, or is wasted by households, the energy embodied in wasted food was estimated at ~36 EJyr^{-1}, and during the period 2010-2016 global food loss and waste equalled 8-10% of total GHG emissions (Godfray and Garnett 2014; Springmann et al. 2018; Mbow et al. 2019). Global agri-food supply chains are crucial in the variation of per capita food consumption-related-carbon footprints, mainly in the case of red meat and dairy (Kim et al. 2020) since highest per capita food-consumption-related GHG emissions do not correlate perfectly with the income status of countries. Thus, it is also crucial to focus on high-emitting individuals and groups within countries, rather than only those who live in high-emitting countries, since the top 10% of emitters live on all continents and one third of them are from the developing world

(Chakravarty et al. 2009; Pan et al. 2019). A within-country analysis reveals that due to inequality in China, 17.5 % of the Chinese population (the rich urban dwellers) have carbon footprints of 6.4 tCO_2 cap^{-1}, which represents nearly four times the average in the country, and the three richest urban groups together (21% of the Chinese population) use 48% of the total household carbon footprint in the country (Wiedenhofer et al. 2017). However, a recent analysis reveals that most of the carbon emissions (78%) in China are caused by its middle class, whereas in India it is the poorest category which contributes 63% of the carbon total, and these differences are mainly explained due to the population size and consumption patterns of each category (Hubacek et al. 2017; Wiedenhofer et al. 2017); in the case of US, 20% of US energy related GHG emissions stem from heating, cooling and powering house, and wealthier citizens have per capita footprints ~ 25% higher than the lower income residents primarily due to larger homes (Goldstein et al. 2020).

The environmental impact of increasing equity across income groups can be either positive or negative (Hubacek et al. 2017; Scherer et al. 2018; Rao and Min 2018b; Millward-Hopkins et al. 2020). Projections for achieving equitable levels of service provision globally predict large increases in global GHG emissions and demand for key resources (Blomsma and Brennan 2017), especially in passenger transport, which is predicted to increase nearly three-fold between 2015 and 2050, from 44 trillion to 122 trillion passenger-kilometres (OECD 2019), and associated infrastructure needs, increasing freight (Murray et al. 2017), increasing demand for cooling (IEA 2018), and shifts to carbon-intensive high-meat diets (FAO 2018).

Increasing incomes for all to attain DLS raises emissions and energy footprints, but only slightly (Chakravarty et al. 2009; Jorgenson et al. 2016; Scherer et al. 2018; Millward-Hopkins et al. 2020; Oswald et al. 2020). The amount of energy needed for a high global level of human development is dropping (Steinberger and Roberts 2010) and could by 2050 be reduced to 1950 levels (Millward-Hopkins et al. 2020). The consumption share of the bottom half of the world's population represents less than 20% of all energy footprints, which is less than what the top 5% of people consume (Oswald et al. 2020).

Income inequality itself also raises carbon emissions (Hao et al. 2016; Sinha 2016; Uzar and Eyuboglu 2019; Baloch et al. 2020; Oswald et al. 2020; Wiedmann et al. 2020). Wide inequality can increase status-based consumption patterns, where individuals spend more to emulate the standards of the high-income group (the Veblenian effect); inequality also diminishes environmental efforts by reducing social cohesion and cooperation (Jorgenson et al. 2017).

5.2.3 Equity, trust, and participation in demand-side mitigation

There is *high evidence and high agreement* in literature that socio-economic equity builds not only wellbeing for all, but also trust and participatory governance, which in turn strengthen demand-side climate mitigation. Equity, participation, social trust, wellbeing, governance and mitigation are parts of a continuous interactive and self-reinforcing process (Figure 5.5). Wellbeing for all, increasingly seen as the main goal of sustainable economies (McGregor and Pouw 2017; Fioramonti et al. 2019; Women's Budget Group 2020), reinforces emissions reductions through a network of positive feedbacks linking effective governance, social trust, equity, participation and sufficiency. The width of the arrows corresponds to the level of confidence and evidence from recent social sciences literature.

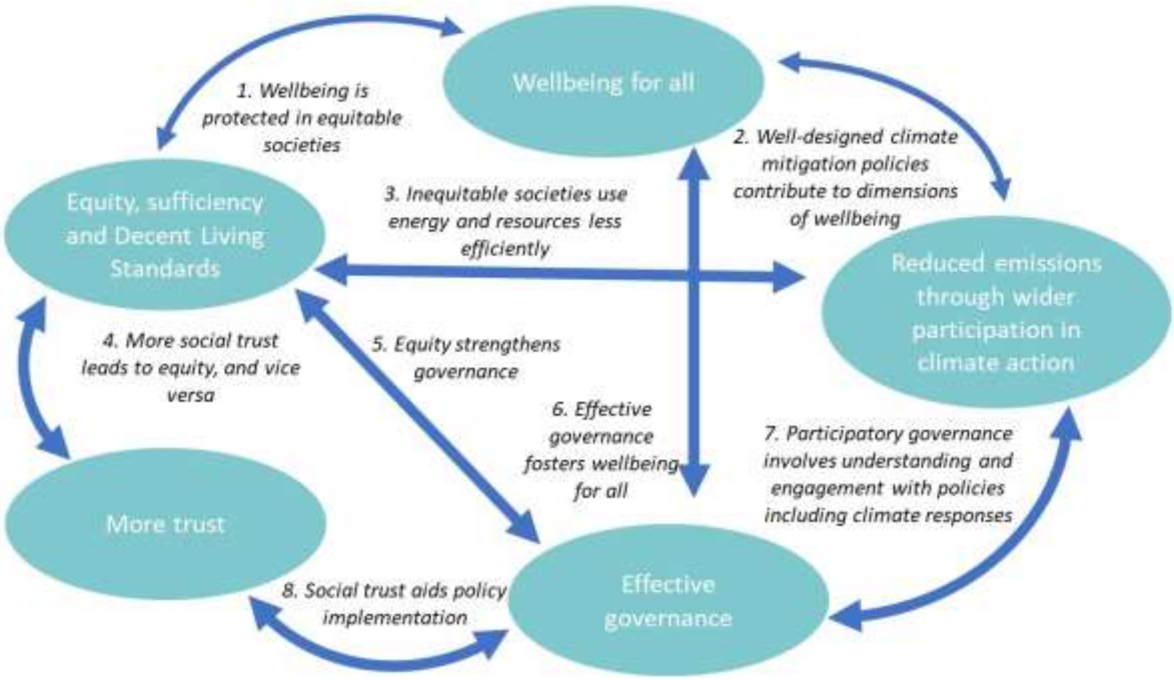
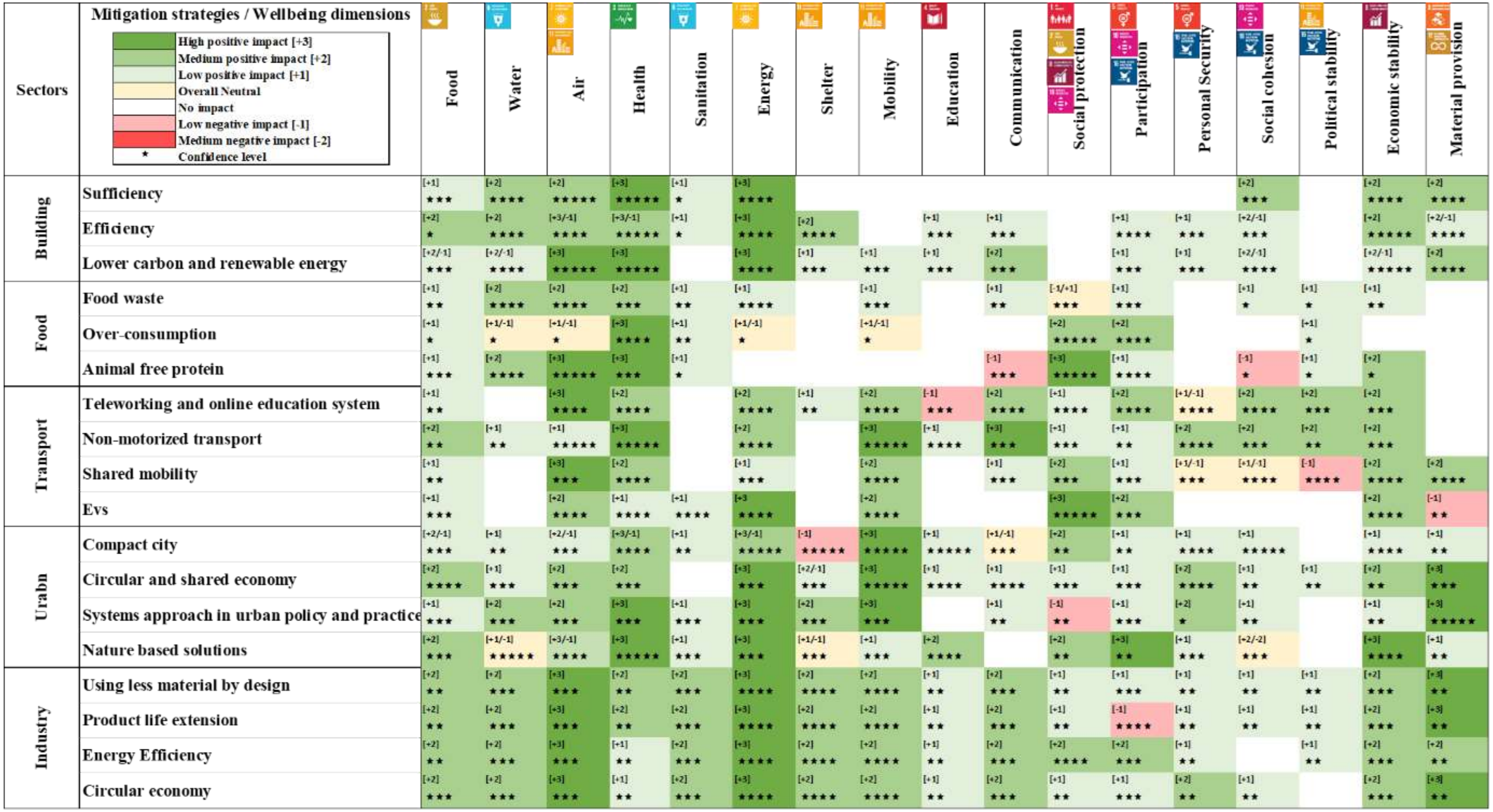


Figure 5.5 Wellbeing, equity, trust, governance and climate mitigation: positive feedback loops

Wellbeing is protected in equitable societies. Human wellbeing is socially-based and has a large relational component (Yellowfly 1992; Ball and Chernova 2008; Easterlin et al. 2010; D'Ambrosio and Frick 2012; Diener et al. 2013; McCubbin et al. 2013; Schneider 2016; Shields 2016; Lamb and Steinberger 2017; White 2017; Stone et al. 2018; Tu and Hsee 2018; Wang et al. 2019). Once subsistence needs are met, relative well-being is much more significant for human happiness than absolute consumption levels (Wilkinson and Pickett 2009; Frank 1999; Stiglitz 2012; Reyes-García et al. 2016; Oishi et al. 2018; Xie et al. 2018; Wilkinson and Pickett 2019), and the higher the income inequality, the more people compare themselves with their neighbours (Luttmer 2005; Cheung and Lucas 2016). Income inequality is associated with lower wellbeing, not only of the poor, but of everyone (Wilkinson 2005; Wilkinson et al. 2010; Cooper et al. 2014; Reyes-García et al. 2016; Schröder 2018). Some social components of wellbeing, such as community cohesion, social capital, and trust, are higher in more equitable societies (Delhey and Dragolov 2014; Schneider 2016; Roser et al. 2019). While differences in study indicators and methodologies complicate conclusions about the link between wellbeing and income, this shifts emphasis onto contextual social factors such as people's knowledge, values, norms and beliefs (Schneider 2016; Kragten and Rözer 2017; Ngamaba et al. 2018).

Beyond a threshold increased material consumption is not closely correlated with improvements in human progress (Frank 1999; Kahneman and Deaton 2010; Steinberger and Roberts 2010; Roy et al. 2012; Oishi et al. 2018; Xie et al. 2018; Wang et al. 2019; Vita et al. 2019b, 2020). The distinction between necessities and luxuries helps to frame a growing stream of social sciences literature with climate policy relevance (Arrow et al. 2004). Given growing public support worldwide for strong sustainability, sufficiency, and sustainable consumption, changing demand patterns and reduced demand are accompanying environmental and social benefits (Jackson 2008; Fedrigo et al. 2010; Schroeder 2013; Figge et al. 2014; Spangenberg and Germany 2016; Spengler 2016; Burke 2020; Mont et al. 2020). Policies focusing on the "super-rich," also called the "polluter elite," are gaining attention for moral or norms-based as well as emissions-control reasons (Kenner 2019; Otto et al. 2019; Pascale et al. 2020; Stratford 2020) (see section 5.2.2.3). Since no country now meets its citizens' basic needs at a level of resource use that is globally sustainable, while high levels of life satisfaction for those just escaping extreme poverty would require even more resources, the need for transformative shifts in governance and policies is large (O'Neill et al. 2018).

Well-designed climate mitigation policies ameliorate constituents of wellbeing (Figure 5.5). More equitable societies are also more economically efficient societies (Stiglitz 2012; Singer 2018; Wilkinson and Pickett 2009). For example, job creation, retraining for new jobs, local production of livelihood necessities, social provisioning, and other positive steps toward climate mitigation and adaptation are all associated with more equitable and resilient societies (Okvat and Zautra 2011; Bentley 2014; Klinsky et al. 2016; Roy et al. 2018a). At all scales of governance, the popularity and sustainability of climate policies requires attention to the fairness of their health and economic implications for all, and participatory engagement across social groups – a responsible development framing (Cazorla and Toman 2001; Dulal et al. 2009; Chuku 2010; Shonkoff et al. 2011; Navroz 2019; Hofstad and Vedeld 2020; Muttitt and Kartha 2020; Waller et al. 2020; Roy and Schaffartzik 2020; Temper et al. 2020). Far from being secondary or even a distraction from climate mitigation priorities, an equity focus is intertwined with mitigation goals (Klinsky et al. 2016). Demand-side climate mitigation options have pervasive ancillary, equity-enhancing benefits, e.g. for health, local livelihoods, and community forest resources (Figure 5.6) (Chhatre and Agrawal 2009; Garg 2011; Shaw et al. 2014; Serrao-Neumann et al. 2015; Klausbruckner et al. 2016; Salas and Jha 2019). Limiting climate change risks is fundamental to collective wellbeing (Max-Neef et al. 1989; Yamin et al. 2005; Nelson et al. 2013; Gough 2015, 2017; Pecl et al. 2017; Tschakert et al. 2017). Section 5.6 discusses well-designed climate policies more fully, with examples. Rapid changes in social norms which are underway and which underlie democratic policy initiatives are discussed in section 5.4.



Mitigation strategies / Wellbeing dimensions

🟩 High positive impact [+3]
🟩 Medium positive impact [+2]
🟩 Low positive impact [+1]
🟨 Overall Neutral
⬜ No impact
🟥 Low negative impact [-1]
🟥 Medium negative impact [-2]
★ Confidence level

Sectors	Mitigation strategies / Wellbeing dimensions	Food	Water	Air	Health	Sanitation	Energy	Shelter	Mobility	Education	Communication	Social protection	Participation	Personal Security	Social cohesion	Political stability	Economic stability	Material provision
Building	Sufficiency	[+1] ★★★	[+2] ★★★★	[+2] ★★★★★	[+3] ★★★★★	[+1] ★	[+3] ★★★★								[+2] ★★★		[+2] ★★★★	[+2] ★★★★
	Efficiency	[+2] ★	[+2] ★★★★	[+3/-1] ★★★★	[+3/-1] ★★★★★	[+1] ★	[+3] ★★★★	[+2] ★★★★		[+1] ★★★	[+1[★★★		[+1] ★★★★	[+1] ★★★	[+2/-1] ★★★		[+2] ★★★★★	[+2/-1] ★★★★
	Lower carbon and renewable energy	[+2/-1] ★★★	[+2/-1] ★★★★	[+3] ★★★★★	[+3] ★★★★★		[+3] ★★★★	[+1] ★★★	[+1] ★★★	[+1] ★★★	[+2] ★★★		[+1] ★★★	[+1] ★★★	[+2/-1] ★★★★		[+2/-1] ★★★★★	[+2] ★★★★
Food	Food waste	[+1] ★★	[+2] ★★★★	[+2] ★★★★	[+2] ★★★	[+1] ★★	[+1] ★★★★		[+1] ★★★		[+1] ★★	[-1/+1] ★★★	[+1] ★★★		[+1] ★	[+1] ★	[+1] ★★	
	Over-consumption	[+1] ★	[+1/-1] ★	[+1/-1] ★	[+3] ★★★★	[+1] ★★	[+1/-1] ★		[+1/-1] ★			[+2] ★★★★★	[+2] ★★★★			[+1] ★		
	Animal free protein	[+1] ★★★	[+2] ★★★★	[+3] ★★★★★	[+3] ★★★	[+1] ★					[-1] ★★★	[+3] ★★★★★	[+1] ★★★★		[-1] ★	[+1] ★	[+2] ★	
Transport	Teleworking and online education system	[+1] ★★		[+3] ★★★★	[+2] ★★★★		[+2] ★★★★	[+1] ★★	[+2] ★★★★	[-1] ★★★	[+2] ★★★★	[+1] ★★★★	[+2] ★★★★	[+1/-1] ★★★★	[+2] ★★★★	[+2] ★★★	[+2] ★★★	
	Non-motorized transport	[+2] ★★	[+1] ★★	[+1] ★★★★★	[+3] ★★★★★		[+2] ★★★★		[+3] ★★★★★	[+1] ★★★★	[+3] ★★★	[+1] ★★★	[+1] ★★	[+2] ★★★★	[+2] ★★★	[+2] ★★	[+2] ★★★	
	Shared mobility	[+1] ★★		[+3] ★★★	[+2] ★★★★		[+1] ★★★		[+2] ★★★★		[+1] ★★★	[+2] ★★★	[+1] ★★★	[+1/-1] ★★★	[+1/-1] ★★★★	[-1] ★★★★	[+2] ★★★★	[+2] ★★★★
	Evs	[+1] ★★★		[+2] ★★★★	[+1] ★★★★	[+1] ★★★★	[+3 ★★★★		[+2] ★★★★			[+3] ★★★★★	[+2] ★★★				[+2] ★★★★	[-1] ★★
Urabn	Compact city	[+2/-1] ★★★	[+1] ★★	[+2/-1] ★★★	[+3/-1] ★★★★	[+1] ★★	[+3/-1] ★★★★★	[-1] ★★★★★	[+3] ★★★★★	[+1] ★★★★★	[+1/-1] ★★★	[+2] ★★	[+1] ★★	[+1] ★★★★	[+1] ★★★★★		[+1] ★★★★	[+1] ★★
	Circular and shared economy	[+2] ★★★★	[+1] ★★★	[+2] ★★★	[+2] ★★★		[+3] ★★★	[+2/-1] ★★★	[+3] ★★★★★	[+1] ★★★★	[+1] ★★★★	[+1] ★★★	[+1] ★★★	[+2] ★★★★	[+1] ★★	[+1] ★★	[+2] ★★	[+3] ★★★
	Systems approach in urban policy and practice	[+1] ★★★	[+2] ★★★	[+2] ★★★	[+3] ★★★	[+1] ★★★	[+3] ★★★	[+2] ★★★	[+3] ★★★		[+1] ★★	[-1] ★★	[+1] ★★★	[+2] ★	[+1] ★★		[+1] ★★	[+3] ★★★★★
	Nature based solutions	[+2] ★★★	[+1/-1] ★★★★★	[+3/-1] ★★★★	[+3] ★★★★★	[+1] ★★★	[+3] ★★★	[+1/-1] ★★★	[+1] ★★★	[+2] ★★★★		[+2] ★★	[+3] ★★	[+1] ★★★	[+2/-2] ★★★		[+3[★★★★	[+1] ★★
Industry	Using less material by design	[+2] ★★	[+2] ★★★	[+3] ★★★	[+2] ★★	[+2] ★★★	[+3] ★★★★	[+2] ★★★★	[+2] ★★★★	[+1] ★★	[+2] ★★★	[+1] ★★	[+1] ★★★	[+1] ★★	[+1] ★★	[+1] ★★	[+2] ★★★	[+3] ★★
	Product life extension	[+2] ★★	[+2] ★★★	[+3] ★★★	[+2] ★★	[+2] ★★★	[+3] ★★★★	[+2] ★★★★	[+2] ★★★★	[+1] ★★	[+2] ★★★	[+1] ★★	[-1] ★★★★	[+1] ★★	[+1] ★★	[+1] ★★	[+2] ★★★	[+3] ★★
	Energy Efficiency	[+2] ★★	[+2] ★★★	[+3] ★★★	[+1] ★★	[+2] ★★★	[+3] ★★★★	[+2] ★★★★	[+2] ★★★★	[+1] ★★	[+2] ★★★	[+2] ★★★★	[+2] ★★★	[+1] ★★		[+1] ★★	[+2] ★★★	[+2] ★★
	Circular economy	[+2] ★★★	[+2] ★★★	[+3] ★★★	[+1] ★★	[+2] ★★★	[+3] ★★★★	[+2] ★★★★	[+2] ★★★★	[+1] ★★	[+2] ★★★	[+1] ★★	[+1] ★★★	[+2] ★★	[+1] ★★		[+2] ★★★	[+3] ★★

Figure 5.6 Two-way link between demand-side climate mitigation strategies and multiple dimensions of human wellbeing and SDGs. All demand-side mitigation strategies improve wellbeing in sum, though not necessarily in each individual dimension. Incumbent business (in contrast to overall economic performance) may be challenged. Source: (Creutzig et al. 2021b)

Inequitable societies use energy and resources less efficiently. Higher income inequality is associated with higher carbon emissions, at least in developed countries (Grunewald et al. 2017a, Golley and Meng 2012; Grunewald et al. 2012; Sager 2017; Klasen 2018; Liu et al. 2019, Jorgenson et al. 2017; Chancel and Piketty 2015); reducing inequality in high-income countries helps to reduce emissions (Klasen 2018). In some less-developed countries, higher income inequality may in fact be associated with lower per capita emissions, but this is because people who are excluded by poverty from access to fossil fuels must rely on biomass (Klasen 2018). Such energy poverty – the fact that millions of people do not have access to energy sources to help meet human needs – implies the opposite of development (Guruswamy 2010, 2020). In developing countries, livelihood improvements do not necessarily cause increases in emissions (Chhatre and Agrawal 2009; Peters et al. 2012; Reusser et al. 2013; Creutzig et al. 2015a) and poverty alleviation causes negligible emissions (Chakravarty et al. 2009). Greater equity is an important step towards sustainable service provisioning (Godfray et al. 2018; Dorling 2019; Timko 2019).

As discussed in section 5.6, policies to assist the renewable energy transition can be designed to include additional benefits for income equality, besides contributing to greater energy access for the poor (Burke and Stephens 2017; Frank 2017; Healy and Barry 2017; Sen 2017; Chapman et al. 2018; La Viña et al. 2018; Chapman and Fraser 2019; Piggot et al. 2019; Sunderland et al. 2020). Global and intergenerational climate inequities impact people's wellbeing, which affects their consumption patterns and political actions (Gori-Maia 2013; Clayton et al. 2015; Pizzigati 2018; Albrecht et al. 2007; Fritze et al. 2008) (see Box 5.3). Consumption reductions, both voluntary and policy-induced, can have positive and double-dividend effects on efficiency as well as reductions in energy and materials use (Mulder et al. 2006; Harriss and Shui 2010; Figge et al. 2014; Grinde et al. 2018; Spangenberg and Lorek 2019; Vita et al. 2020).

Conspicuous consumption by the wealthy is the cause of a large proportion of emissions in all countries, related to expenditures on such things as air travel, tourism, large private vehicles and large homes (Brand and Boardman 2008; Roy and Pal 2009; Brand and Preston 2010; Roy et al. 2012; Gore 2015; Hubacek et al. 2017; Sahakian 2018; Jorgenson et al. 2017; Osuoka and Haruna 2019; Gössling 2019; Kenner 2019; Lynch et al. 2019).

Systems-dynamics models linking strong emissions-reducing policies and strong social equity policies show that a low-carbon transition in conjunction with social sustainability is possible (Kallis et al. 2012; Jackson and Victor 2016; Chapman and Fraser 2019; S. D'alessandro et al. 2019; Huang et al. 2019; Victor 2019).

More social trust leads to equity and vice versa. There is a well-documented correlation between social trust and income equality (Rothstein and Uslaner 2005; Jordahl 2011; Phan 2008; You 2012; Ivarsflaten and Strømsnes 2013; Bergh and Bjørnskov 2014). Trust is associated with greater human development (Özcan and Bjørnskov 2011) and with individual and country-level happiness (Tokuda et al. 2017) and life satisfaction (Mikucka et al. 2017). Social trust and trust in government institutions reduce wellbeing inequality and foster resilience, especially for those at lower levels of wellbeing (Nannestad et al. 2014; Helliwell et al. 2016). There is high agreement in the literature that alienation or distrust weakens collective governance and fragments political approaches towards climate action (Smit and Pilifosova 2001; Adger et al. 2003; Hammar and Jagers 2007; Van Vossole 2012; Bulkeley and Newell 2015; Smith and Howe 2015; ISSC et al. 2016; Alvaredo et al. 2018; Smith and Mayer 2018; Fairbrother et al. 2019; Hayward and Roy 2019; Kulin and Johansson Sevä 2019; Liao et al. 2019).

Equity strengthens governance. Less waste, better emissions control and more effective carbon policies lead to better governance and stronger democracies. Institutions work more fairly, with more public trust. Equitable income, wealth distribution, and tax policies make democracies stronger and more flexible (Sturm 2007; Jordahl 2011; Steijn and Lancee 2011; Levin-Waldman 2012; Stiglitz 2012;

You 2012; Yamamura 2014; Lazarus and van Asselt 2018; Okereke 2018; Di Gregorio et al. 2019). This includes recognition of the value of traditional ecological knowledge, Indigenous governance traditions, decentralisation, and appropriate technologies (Lange et al. 2007; Goldthau 2014; Whyte 2017). Better education, health care, valuing of social diversity, and reduced poverty – characteristics of more equal societies – all lead to resilience, innovation, and readiness to adopt progressive and locally-appropriate mitigation policies (Tanner et al. 2009; Scheffran et al. 2012; Lorenz 2013; Klinsky and Winkler 2014; Chu 2015; Cloutier et al. 2015; Martin 2016; Vandeweerdt et al. 2016; Turnheim et al. 2018; Mitchell 2019). There is less policy lock-in in more equitable societies (Seto et al. 2016).

Populism, non-empirical decision-making, and politics of fear are less prevalent under conditions of more income equality (Chevigny 2003; Bryson and Rauwolf 2016; O'Connor 2017; Fraune and Knodt 2018; Myrick and Evans Comfort 2019). Ideology and other social factors also play a role in populist climate scepticism, but many of these also relate to resentment of elites and desire for engagement (Swyngedouw 2011; Lockwood 2018; Huber et al. 2020). "Climate populism" movements are driven by an impetus for justice (Beeson 2019; Hilson 2019). When people feel powerless and/or that climate change is too big a problem to solve because others are not acting, they may take less action themselves (Williams and Jaftha 2020). However, systems for benefit-sharing can build trust and address large-scale "commons dilemmas", in the context of strong civil society (Barnett 2003; Mearns and Norton 2009; Inderberg et al. 2015; Sovacool et al. 2015; Hunsberger et al. 2017; Soliev and Theesfeld 2020). Leadership is also important in fostering environmentally-responsible group behaviours (Liu and Hao 2020).

Effective governance fosters wellbeing for all. There is strong evidence across many countries that government quality indicated by quality of service delivery and quality of democracy is linked to national happiness, mainly because effective governance implies better service delivery (Helliwell and Huang 2008; Ott 2011; Helliwell et al. 2018). Democratic satisfaction and social trust embedded in impartial, fair, and efficient institutions are also linked directly with wellbeing (Rothstein and Stolle 2008; Orviska et al. 2014). Public participation facilitates social learning and people's support of and engagement with climate change priorities; improved governance is closely tied to effective climate policies (Phuong et al. 2017).

Multi-level or polycentric governance can enhance wellbeing and improve climate governance and social resilience, due to varying adaptive, flexible policy interventions at different times and scales (Kern and Bulkeley 2009; Lidskog and Elander 2009; Amundsen et al. 2010; Keskitalo 2010; Lee and Koski 2015; Jokinen et al. 2016; Lepeley 2017; Marquardt 2017; Di Gregorio et al. 2019). Institutional transformation may also result from socio-ecological stresses that accompany climate change, leading to more effective governance structures (David Tàbara et al. 2018; Patterson and Huitema 2019; Barnes et al. 2020). An appropriate, context-specific mix of options facilitated by policies can deliver both higher wellbeing and reduced disparity in access to basic needs for services concurrently with climate mitigation (Thomas and Twyman 2005; Klinsky and Winkler 2014; Lamb et al. 2014; Mearns and Norton 2009; Lamb and Steinberger 2017). Hence, nurturing equitable human wellbeing through provision of decent living standards for all goes hand in hand with climate change mitigation (ISSC et al. 2016; OECD 2019).

Participatory governance involves understanding and engagement with policies, including climate policies. Greater public participation in climate policy processes and governance, by increasing the diversity of ideas and stakeholders, builds resilience and allows broader societal transformation towards systemic change even in complex, dynamic and contested contexts (Dombrowski 2010; Wise et al. 2014; Haque et al. 2015; Jodoin et al. 2015; Mitchell 2015). Activist climate movements are changing policies as well as normative values (see section 5.4). Environmental justice and climate justice activists worldwide have called attention to the links between economic and environmental inequities, collected and publicised data about them, and demanded stronger mitigation (Goodman

2009; Schlosberg and Collins 2014; Jafry et al. 2019; Cheon 2020). Youth climate activists, and Indigenous leaders, are also exerting growing political influence towards mitigation (Helferty and Clarke 2009; White 2011; Powless 2012; Petheram et al. 2015; United Nations 2015; Curnow and Gross 2016; Grady-Benson and Sarathy 2016; Claeys and Delgado Pugley 2017). Indigenous resurgence (activism fuelled by environmental injustices, land claims, and deep spiritual/cultural commitment to environmental protection) not only strengthens climate movements in many countries, but also changes social norms by raising knowledge of Indigenous governance systems which preserved sustainable lifeways over thousands of years (Wildcat 2014; Chanza and De Wit 2016; Whyte 2017, 2018; Temper et al. 2020). This is creating growing pressure for emissions reductions globally, and for wiser longer-term governance perspectives.

Social trust aids policy implementation. More equal societies display higher trust, which is a key requirement for successful implementation of climate policies (Rothstein and Teorell 2008; Carattini et al. 2015; Klenert et al. 2018). Inter-personal trust among citizens often promotes pro-environment behaviour by influencing perceptions (Harring and Jagers 2013), enhancing cooperation, and reducing free-riding and opportunistic behaviour (Gür 2020). Individual support for carbon taxes and energy innovations falls when collective community support is lacking (Bolsen et al. 2014; Simon 2020; Smith and Mayer 2018). Social trust has a positive influence on civic engagement among local communities, NGOs, and self-help groups for local clean cooking fuel installation (Nayak et al. 2015).

Section 5.6 includes examples of climate mitigation policies and policy packages which address the interrelationships shown in Figure 5.5 policies designed to foster higher well-being for all through climate mitigation, reduce emissions through wider participation in climate action, build more effective governance for improved mitigation, and include social trust, greater equity, and informal-sector support as integral parts of climate policies.

In summary, there is *high confidence* in the literature that addressing inequities in income, wealth, and DLS not only raises overall wellbeing and furthers the SDGs but also improves the effectiveness of climate change mitigation policies.

Box 5.3 Gender, race, intersectionality and climate mitigation

There is *high evidence* and *high agreement* that empowering women benefits both mitigation and adaptation, because women prioritise climate change in their voting, purchasing, community leadership, and work both professionally and at home (*high evidence, high agreement*). Increasing voice and agency for those marginalised in intersectional ways by race, ethnicity, and other factors has positive effects for climate policy (*high evidence, high agreement*).

Climate change affects people differently by gender, race, ethnicity and other measures of difference, which have intersectional impacts linked to economic vulnerability and marginalisation (Morello Frosch et al. 2009; Dankelman 2010; Habtezion 2013; Godfrey and Torres 2016; Walsh 2016; Flatø et al. 2017; Goodrich et al. 2019; Perkins 2019; Gür 2020). Gender and other disparities in climate change vulnerability not only reflect pre-existing inequalities, they also reinforce them. For example, inequities in income and in the ownership and control of household assets, familial responsibilities due to male out-migration, declining food and water access, and increased disaster exposure can undermine women's ability to achieve economic independence, enhance human capital, and maintain health and wellbeing (Chandra et al. 2017; Eastin 2018; Das et al. 2019). Women’s economic and productive lives have been affected disproportionately by the COVID crisis (Alon et al. 2020; ILO 2020). They have less access to social protections and their capacity to absorb economic shocks is very low, so they face a “triple burden” during health crises, including those resulting from climate change (Coates et al. 2020; McLaren et al. 2020; Wenham et al. 2020).

Women's wellbeing, in particular, has been emphasised in recent climate agreements, through the emphasis on a gender-responsive climate policy, including in the Paris accord (UNFCCC 2015) and the 2016 Decision 21/CP.22 on Gender and Climate Change (UNFCCC 2016; Larson et al. 2018). Participation of women and marginalised social groups helps to meet a range of SDGs, improve disaster and crisis response, increase social trust, and improve climate mitigation policy development / implementation(Alber 2009; Whyte 2014; Elnakat and Gomez 2015; Salehi et al. 2015; Buckingham and Kulcur 2017; Cohen 2017; Kronsell 2017; Lee and Zusman 2019).

Women have a key role in the changing energy economy due to their demand and end use of energy resources in socially-gendered productive roles in food production and processing, health, care, education, clothing purchases and maintenance, commerce, and other work both within and beyond the home (Räty and Carlsson-Kanyama 2009; Oparaocha and Dutta 2011; Bob and Babugura 2014; Macgregor 2014; Perez et al. 2015; Bradshaw 2018; Clancy and Feenstra 2019; Clancy et al. 2019; Fortnam et al. 2019; Rao et al. 2019a; Quandt 2019; Horen Greenford et al. 2020; Johnson 2020). Women's work and decision-making are central in the food chain and agricultural output in most developing countries, and in household management everywhere. Policies on energy use and consumption are often focused on technical issues related to energy supply, thereby overlooking 'demand-side' factors such as household decision-making, unpaid work, livelihoods and care (Himmelweit 2002; Perch 2011; Fumo 2014; Hans et al. 2019; Huyer and Partey 2020). Such gender-blindness represents the manifestation of wider issues related to political ideology, culture and tradition (Carr and Thompson 2014; Perez et al. 2015; Fortnam et al. 2019; Thoyre 2020).

Women, and people who are economically and/or politically marginalised, often have less access to energy and use less, not just because they may be poorer but because their consumption choices are more ecologically-inclined and their energy use is more efficient (Lee et al. 2013; Permana et al. 2015; Li et al. 2019). Women's carbon footprints are about 6-28% lower than men's (with high variation across countries), mostly based on their lower meat consumption and lower vehicle use (Isenhour and Ardenfors 2009; Räty and Carlsson-Kanyama 2009, 2010; Barnett et al. 2012; Medina and Toledo-Bruno 2016; Ahmad et al. 2017; Fernström Nåtby and Rönnerfalk 2018; Li et al. 2019). Since women have less leisure time and leisure is generally associated with lower carbon emissions, time use within households also affects relative carbon emissions, which may be a social justice indicator (Druckman et al. 2012). Gender-based income redistribution in the form of pay equity for women could reduce emissions if the redistribution is revenue-neutral (Terry 2009; Dengler and Strunk 2018).

Carbon emissions are lower per capita in countries where women have more political 'voice', controlling for GDP per capita and a range of other factors (Ergas and York 2012). Nearly all climate change deniers are men (McCright and Dunlap 2011; Anshelm and Hultman 2014; Jylhä et al. 2016; Nagel 2015), and women are more likely to be environmental activists, and support stronger environmental and climate policies (Stein 2004; McCright and Xiao 2014, Whyte 2014) –underscoring the synergies between equity and mitigation. The contributions of women, racialised people, and Indigenous people who are socially positioned as those first and most affected by climate change – and therefore experts on appropriate climate responses – are substantial (Dankelman and Jansen 2010; Wickramasinghe 2015; Black 2016; Vinyeta et al. 2016; Pearse 2017). Equitable power, participation, and agency in climate policy-making is hence an effective contribution for improving governance and decision making on climate change mitigation (Reckien et al. 2017; Collins 2019). Indigenous knowledge is an important source of information for customary resource management, biodiversity conservation, impact assessment, disaster preparedness and resilience (Salick and Ross 2009; Green and Raygorodetsky 2010; Speranza et al. 2010; Mekuriaw Bizuneh 2013; Mekuriaw 2017), and women are often the local educators, passing on and utilising traditional and Indigenous knowledge (Ketlhoilwe 2013; Onyige 2017; Azong et al. 2018).

People's views about the urgency of addressing climate change vary along gender, race, ethnicity and other social-difference categories, with women and the marginalised taking stronger stands on climate change. Racialised groups are more likely to be concerned about climate change and to take political action to support climate mitigation policies (Leiserowitz and Akerlof 2010; Godfrey and Torres 2016; Schuldt and Pearson 2016; Pearson et al. 2017; Ballew et al. 2020; Johnson 2020). Racial resentment and reduced agreement with the scientific consensuses on climate change are correlated, an effect termed the "spillover of racialisation" (Benegal 2018). Changing social norms on race and climate are linked and policy-relevant (Elias et al. 2018; Slocum 2018; Gach 2019; Wallace-Wells 2019; Temple 2020).

Higher female political participation, controlled for other factors, leads to higher stringency in climate policies, and results in lower GHG emissions (Cook et al. 2019). Gender equity also is correlated with lower per capita CO_2-eq emissions (Ergas and York 2012). In societies where women have more economic equity, their votes push political decision-making in the direction of environmental/sustainable development policies, less high-emission militarisation, and more emphasis on equity and social policies (Ergas and York 2012; Resurrección 2013; UNEP 2013; Glemarec et al. 2016; Bryan et al. 2018; Crawford 2019). For all these reasons, climate policies are strengthened by including more differently-situated knowledge and diverse perspectives. Inclusivity in climate governance spans mitigation-adaptation, supply-demand and formal-informal sector boundaries in its positive effects (Bryan and Behrman 2013; Wilson et al. 2018; Bell et al. 2020).

5.3 Mapping the opportunity space

Reducing global energy demand and resource inputs while improving wellbeing for all requires an identification of options and pathways that do not compromise essentials of a decent living. To identify such pathways, this section summarises socio-behavioural, technological and infrastructural interventions through the avoid/shift/improve (ASI) concept. ASI is used to provide a categorisation of options aimed at continuously eliminating wastes in the current systems of service provision (see section 5.3.1.1). It also succinctly presents demand side options to reduce GHG emissions by individual choices which can be leveraged by supporting policies, technologies and infrastructure. Two key concepts for evaluating the efficiency of service provision systems are: resource cascades and exergy. These concepts provide powerful analytical lenses through which to identify and substantially reduce energy and resource waste in service provision systems both for decent living standards (see section 5.3.3) and higher wellbeing levels. They typically focus on end-use conversion and service delivery improvements as the most influential opportunities for system-wide waste reductions. Review of the state of modelling low energy and resource demand pathways in long-term climate mitigation scenarios (recognising the importance of such scenarios for illuminating technology and policy pathways for more efficient service provision) and summary of the mitigation potentials estimated from relevant scenarios to date are in Section 5.3.3. Finally, it reviews the role of three megatrends that are transforming delivery of the services in innovative ways – digitalisation, the sharing economy, and the circular economy (see section 5.3.4). The review of megatrends makes an assessment highlighting the potential risks of rebound effects, and even accelerated consumption; it also scopes for proactive and vigilant policies to harness their potential for future energy and resource demand reductions, and, conversely, avoid undesirable outcomes.

5.3.1 Efficient service provision

This section organises deep demand reductions under the avoid, shift, and improve (ASI) framework. It presents service-oriented demand-side solution consistent with decent living standards (Table 5.1)

(Creutzig et al. 2018). The sharing economy, digitalisation, and the circular economy all can contribute to ASI strategies, with the circular economy tentatively more on the supply side, and the sharing economy and digitalisation tentatively more on the demand side (see section 5.3.3). These new service delivery models go beyond sectoral boundaries (IPCC sector chapter boundaries explained in Chapter 12) and take advantage of technological innovations, design concepts, and innovative forms of cooperation cutting across sectors to contribute to systemic changes worldwide. Some of these changes can be realised in the short term, such as energy access, while others may take a longer period such as radical and systemic eco-innovations like shared electric autonomous vehicles. It is important to understand benefits and distributional impacts of these systemic changes.

5.3.1.1 Integration of service provision solutions with A-S-I framework

Assessment of service-related mitigation options within the ASI framework is aided by decomposition of emissions intensities into explanatory contributing parameters, which depend on the type of service delivered. Table 5.1 Avoid-Shift-Improve options in selected sectors and services. Many options, such as urban form and infrastructures are systemic, and influence several sectors simultaneously. Linkages to concepts presented in sectoral chapters are indicated in parentheses. Source: adapted from (Creutzig et al. 2018) shows Avoid-Shift-Improve options in selected sectors and services. It summarises resource, energy, and emissions intensities commonly used by type of service (Cuenot et al. 2010; Lucon et al. 2014; Fischedick et al. 2014). Also relevant: the concepts of service provision adequacy (Arrow et al. 2004; Samadi et al. 2017), establishing the extents to which consumption levels exceed (e.g., high-calorie diets contributing to health issues (Roy et al. 2012); excessive food waste) or fall short of (e.g., malnourishment) service level sufficiency (e.g., recommended calories); and service level efficiency (e.g., effect of occupancy on the energy intensity of public transit passenger-km travelled (Schäfer and Yeh 2020). Service-oriented solutions in this chapter are discussed in the context of Table 5.1.

Table 5.1 Avoid-Shift-Improve options in selected sectors and services. Many options, such as urban form and infrastructures are systemic, and influence several sectors simultaneously. Linkages to concepts presented in sectoral chapters are indicated in parentheses. Source: adapted from (Creutzig et al. 2018)

Service	Emission decomposition	Avoid	Shift	Improve
Mobility [passenger-km] (Ch 8,10, 11,16)	kg CO_2 = (passenger km)*(MJ pkm^{-1})*(kg CO_2 MJ^{-1})	**Innovative mobility to reduce passenger-km:** Integrate transport & land use planning Smart logistics Tele-working Compact cities	**Increased options for mobility MJ pkm^{-1}:** Modal shifts: from car to cycling, walking, or public transit from air travel to high speed rail	**Innovation in equipment design MJ pkm^{-1} and CO_2-eq MJ^{-1}:** Lightweight vehicles Hydrogen vehicles Electric vehicles Eco-driving
Shelter [Square meters] (Ch 8,9, 11)	kg CO_2 = (square meters)*(tons material m^{-2})*(kg CO_2 ton $material^{-1}$)	**Innovative dwellings Reduce square meters:** Smaller decent dwellings Shared common spaces	**Material efficient housing m^{-2}:** Less material-intensive dwelling designs Shift from single-family to multi-family dwellings	**Low emission dwelling design kgCO_2 ton^{-1} material:** Use wood as material Use low-carbon production processes for building materials

		Multigenerational housing		(e.g., cement and steel)
Thermal comfort [indoor temperature] (Ch 9,16)	kg CO$_2$ = (Δ°C x m^3 to warm or cool) (MJ m^{-3})*(kg CO$_2$ MJ^{-1})	**Choice of Healthy indoor temperature Δ°C x m^3:** Reduce m^2 as above Change temperature set-points Change dressing code Change working times	**Design options to Reduce MJ Δ°C^{-1} x m^3:** Architectural design (shading, natural ventilation, etc.)	**New technologies to Reduce MJ/ Δ°C x m^3 and kgCO$_2$/MJ:** Solar thermal devices Improved insulation Heat pumps District heating
Goods [units] (Ch 11,12)	kg CO$_2$ = product units * (kg material product^{-1})*(kg CO$_2$ kg material^{-1})	**More service per product:** Reduce consumption quantities Long lasting fabric, appliances Sharing economy	**Innovative product design kg material product $^{-1}$:** Materials efficient product designs	**Choice of new materials kg CO$_2$ kg material^{-1}:** Use of low carbon materials New manufacturing processes and equipment use
Nutrition [Calories consumed] (Ch 6,12)	kg CO$_2$-eq = (calories consumed)*(calories produced calories consumed^{-1})*(kg CO$_2$-eq calorie produced^{-1})	**Reduce calories produced/calories consumed and calories consumed:** Keep calories in line with daily needs and health guidelines Reduce waste in supply chain and after purchase	**Add more variety in food plate to Reduce kg** CO$_2$-eq **cal^{-1} produced** Dietary shifts from ruminant meat and dairy to other protein sources	**Reduce kg** CO$_2$-eq **cal^{-1} produced:** Improved agricultural practices Energy efficient food processing
Lighting [lumens] (Ch 9, 16)	kg CO$_2$ = lumens*(kWh lumen^{-1})*(kg CO$_2$ kWh^{-1})	**Reduce artificial lumen demand:** Occupancy sensors Lighting controls	**Design options to increase natural lumen demand:** Architectural designs with maximal daylighting	**Demand innovation lighting technologies kWh lumens^{-1} and power supply kg CO$_2$ kWh^{-1}:** LED lamps Low-carbon electricity provision

Opportunities for avoiding excess provision of services, or avoiding excess demand for services themselves, exist across multiple service categories. Avoidance of food wastage – which accounts for around 8% of total annual GHG emissions (FAO 2014), while millions suffer from hunger and malnutrition – is a prime example (see Chapter 12). A key challenge in meeting global nutrition services is therefore to avoid food waste while simultaneously raising nutrition levels to equitable standards globally. Literature results indicate that consumers are the largest source of food waste, and that behavioural changes such as meal planning, use of leftovers, and avoidance of over-preparation can be important service-oriented solutions (Gunders et al. 2017; Schanes et al. 2018), while improvements to expiration labels by regulators would reduce unnecessary disposal of unexpired items (Wilson et al.

2017). The mitigation potential of food waste reductions globally has been estimated at 0.8-6.0 $GtCO_2$-eq yr^{-1} by 2050 (Smith et al. 2014; Olsson et al. 2019). Coupling food waste reductions with dietary shifts can further reduce energy, land, and resource demand in upstream food provision systems, leading to substantial GHG emissions benefits. Estimated GHG emissions reductions associated with dietary shifts to low meat diets, vegetarian diets, or vegan diets range from 0.7-7.3, 4.3-6.4, and 7.8-8 $GtCO_2$-eq yr^{-1} by 2050, respectively (Olsson et al. 2019). Current literature on health, diets, and emissions indicates that sustainable food systems providing healthy diets for all are within reach but require significant cross-sectoral action (Erb et al. 2016; Muller et al. 2017; Willett and et al. 2018; Graça et al. 2019).

In the transport sector, avoid-shift-improve opportunities exist at myriad levels, comprehensively summarised in Bongardt et al (2013). Modelling based on a plethora of bottom-up insights and options reveals that a balanced portfolio of avoid, shift, and improve policies brings the global transport sector emissions in line with global warming of not more than 1.5°C (Gota et al. 2019). For example, telework may be a significant lever for avoiding road transport associated with daily commutes, achievable through digitalisation, but its savings depend heavily on the modes, distances, and types of office use avoided (Kitou and Horvath 2003; Hook et al. 2020) and whether additional travel is induced due to greater available time (Mokhtarian 2002). More robustly, avoiding kilometres travelled through improved urban planning and smart logistical systems can lead to fuel, and, hence, emissions savings (IEA 2016, 2017a; Creutzig et al. 2015a; Wiedenhofer et al. 2018). At the vehicle level, light weighting strategies (Fischedick et al. 2014), avoiding inputs of carbon-intensive materials into vehicle manufacturing, can also lead to significant emissions savings through improved fuel economy (Das et al. 2016; Hertwich et al. 2019; IEA 2019a). For details see Chapter 10.

In the buildings sector, avoidance strategies can occur at the end use or individual building operation level. End use technologies/strategies such as the use of daylighting (Bodart and De Herde 2002) and lighting sensors can avoid demand for lumens from artificial light, while passive houses, thermal mass, and smart controllers can avoid demand for space conditioning services. Eliminating standby power losses can avoid energy wasted for no useful service in many appliances/devices, which may reduce household electricity use by up to 10% (Roy et al. 2012). At the building level, smaller dwellings can reduce overall demand for lighting and space conditioning services, while smaller dwellings, shared housing, and building lifespan extension can all reduce the overall demand for carbon-intensive building materials such as concrete and steel (Hertwich et al. 2019; Material Economics Sverige AB 2018; IEA 2019a; Pauliuk et al. 2021). Emerging strategies for materials efficiency, such as 3D printing to optimise the geometries and minimise the materials content of structural elements, may also play a key role (Favier et al. 2019). Several scenarios estimate an ‘avoid’ potential in the building sector, reducing waste in superfluous floor space, heating and IT equipment, and energy use, by between 10 and 30%, in one case even by 50% (Nadel, Steven and Ungar 2019) (see Chapter 9).

Service efficiency strategies are emerging to avoid materials demand at the product level, including dematerialisation strategies for various forms of packaging (Worrell and Van Sluisveld 2013) and the concept of “products as services,” in which product systems are designed and maintained for long lifespans to provide a marketable service (Oliva and Kallenberg 2003), thereby reducing the number of products sold and tons of materials needed to provide the same service to consumers (see Chapter 11). Successful examples of this approach have been documented for carpets (Stubbs and Cocklin 2008), copiers (Roy 2000), kitchens (Liedtke et al. 1998), vehicles (Ceschin and Vezzoli 2010; Williams 2006) and more (Roy 2000).

Shift strategies unique to the service-oriented perspective generally involve meeting service demands at much lower life-cycle energy, emissions, and resource intensities (Roy and Pal 2009), through such strategies as shifting from single-family to multi-family dwellings (reducing the materials intensity per unit floor area (De Wolf et al. 2015)), shifting from passenger cars to rail or bus (reducing fuel, vehicle manufacturing, and infrastructure requirements (Chester and Horvath 2009), shifting materials to reduce resource and emissions intensities (e.g., low-carbon concrete blends (Scrivener and Gartner 2018)) and shifting from conventional to additive manufacturing processes to reduce materials requirements and improve end-use product performance (Huang et al. 2016, 2017).

An important consideration in all ASI strategies is the potential for unintended rebound effects (Sorrell et al. 2009), which must be carefully avoided through various regulatory and behavioural measures (Santarius et al. 2016). For example, extending the lifespan of energy inefficient products may lead to net increases in emissions (Gutowski et al. 2011), whereas automated car sharing may reduce the number of cars manufactured at the expense of increased demand for passenger kilometres due to lower travel opportunity cost (Wadud et al. 2016) (see also 5.3.2).

In summary, sector specific demand side mitigation options reflect important role of socio-behavioural, technological and infrastructural factors and interdependence among them (Figure 5.7). The assessment shows by 2050 high emission reduction potential can be realised without any supply side intervention with considerable impact on electricity supply system. Integrated cross sectoral actions shown through sector coupling is also important for investment decision making and policy framing going beyond sector boundaries (*high evidence and high agreement).*

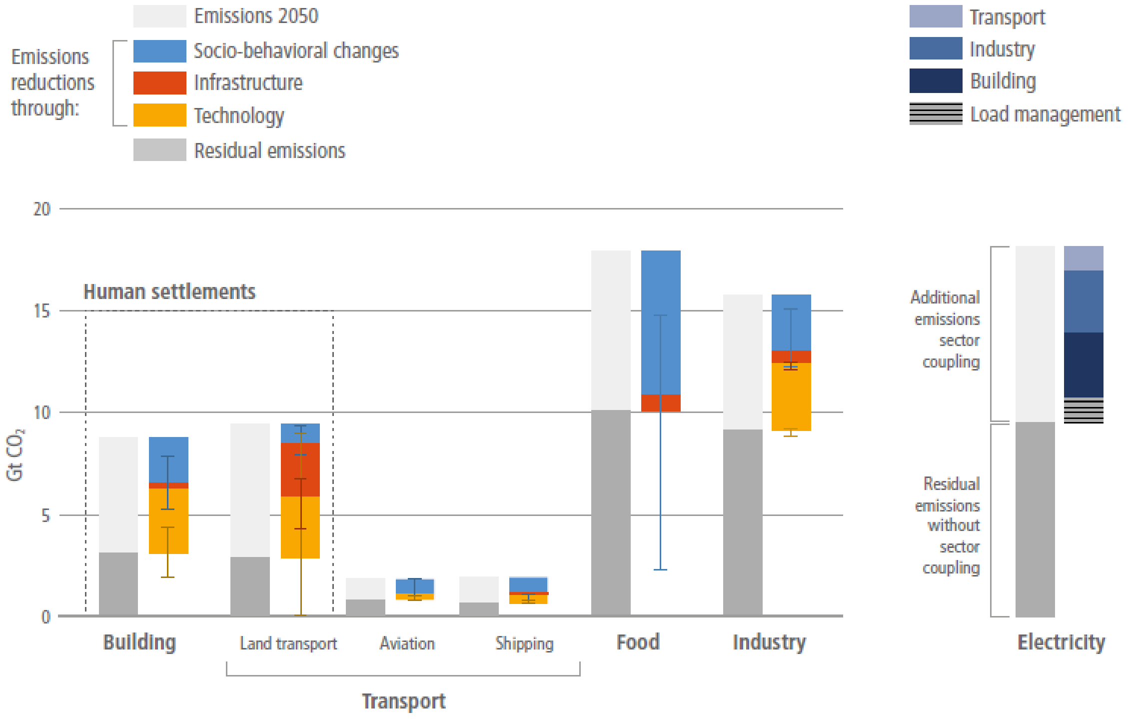


Figure 5.7 Sectoral demand-side mitigation options in three dimensions: socio-behavioural, technological and infrastructure reinforces each other and can substantially reduce emissions by 2050, 40-80% in each end-use sector (Supplementary Material II Chapter 5). Sector coupling increases efficiency and decreases overall primary energy input if electricity is based on renewable energy. Sector coupling requires increased GHG emissions from electricity system, which in turn can be reduced by socio-behavioural, infrastructural and technological demand side options. The largest socio-behavioural potential is in diet shift (food), the largest infrastructural potential is realising walkable and cyclable cities (land transport) and the largest technological potential is in making building use and industry more energy efficient. Source: (Creutzig et al. 2021b)

5.3.1.2 Consumption options to reduce GHG emissions

A systematic review of consumption-based options to reduce GHG emissions identified 6990 peer-reviewed journal papers, with 771 options that were aggregated into 61 consumption option categories ((Ivanova et al. 2020); Figure 5.8). In consistence with previous research (Herendeen and Tanaka 1976; Pachauri and Spreng 2002; Pachauri 2007; Ivanova et al. 2016), a hierarchical list of mitigation options emerges. Choosing low-carbon options, such as car-free living, plant-based diets without or very little animal products, renewable sources of electricity and heating at home as well as local holiday plans, can reduce an individual's carbon footprint by up to 9tCO_2-eq. Realising these options requires substantial policy support to overcome infrastructural, institutional and socio-behavioural lock-in (see 5.4 and 5.6).

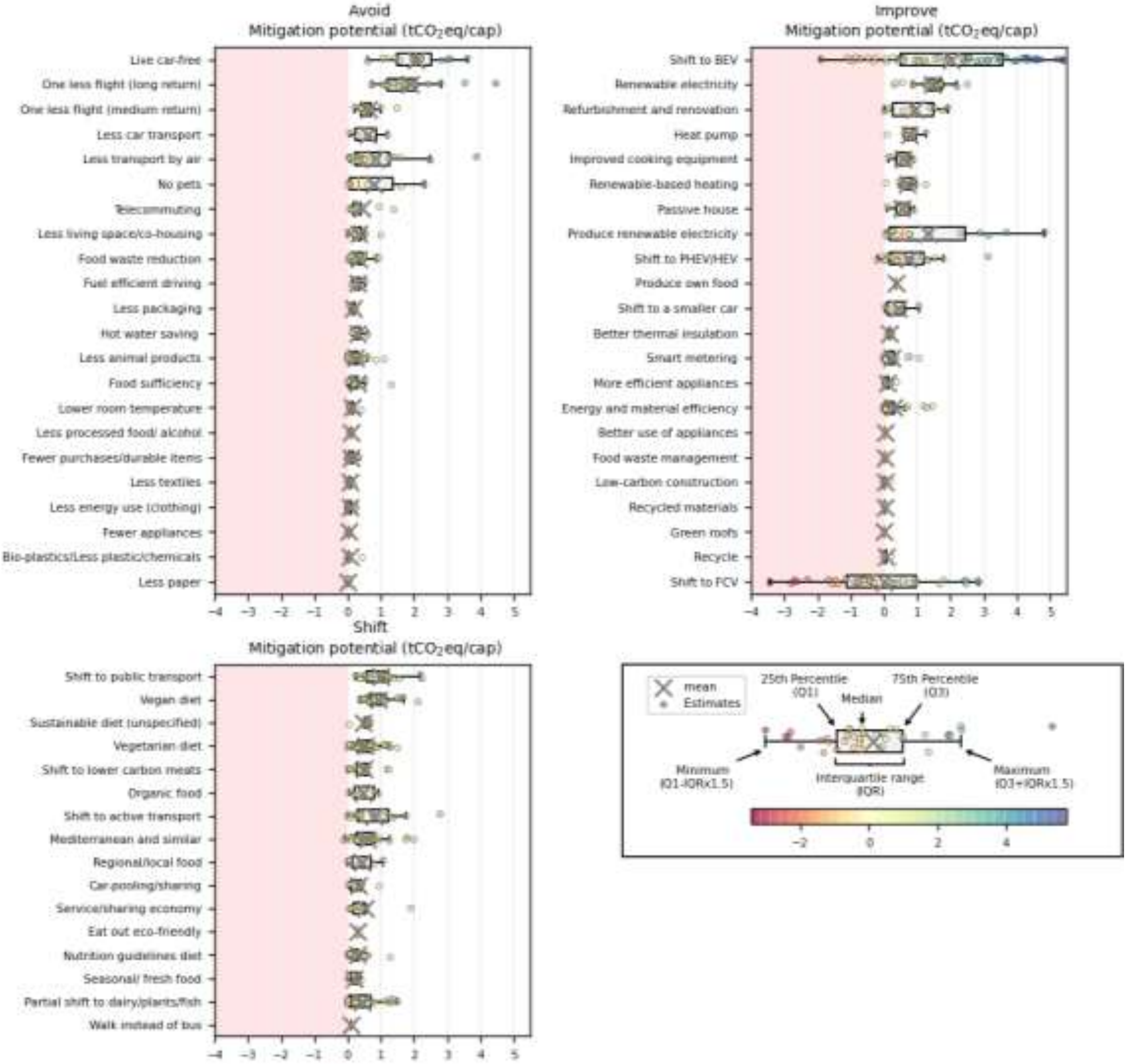


Figure 5.8 Synthesis of 60 demand side options ordered by the median GHG mitigation potential found across all estimates from the literature. The x-s are averages. The boxes represent the 25th percentile, median and 75th percentiles of study results. The whiskers or dots show the minimum and maximum mitigation potentials of each option. Negative values (in the red area) represent the potentials for backfire due to rebound, i.e. a net-increase of GHG emissions due to adopting the option. Source: (Ivanova et al. 2020)

5.3.2 Technical tools to identify Avoid-Shift-Improve options

Service delivery systems to satisfy variety of service needs (e.g., mobility, nutrition, thermal comfort, etc.) comprise a series of interlinked processes to convert primary resources (e.g. coal, minerals) into useable products (e.g. electricity, copper wires, lamps, light bulbs). It is useful to differentiate between conversion and processing steps "upstream" of end-users (mines, power plants, manufacturing facilities) and "downstream", i.e. those associated with end-users, including service levels, and direct wellbeing benefits for people (Kalt et al. 2019). Illustrative examples of such resource processing systems steps and associated conversion losses drawn from the literature are shown in Figure 5.9. in the form of resource processing cascades for energy (direct energy conversion efficiencies (De Stercke 2014; Nakićenović et al. 1993)), water use in food production systems (water use efficiency and embodied water losses in food delivery and consumption (Lundqvist et al. 2008; Sadras et al. 2011)), and materials (Ayres and Simonis 1994; Fischer-Kowalski et al. 2011) using the example of steel manufacturing, use and recycling at the global level (Allwood and Cullen 2012). Invariably, conversion losses along the entire service delivery systems are substantial, ranging from 83% (water) to 86% (energy) and 87% (steel) of primary resource inputs (TWI2050 2018). In other words, only between 14 to 17% of the harnessed primary resources remain at the level of ultimate service delivery.

Examples of conversion losses at the supply side of resource processing systems include for instance for energy electricity generation (global output/input conversion efficiency of electric plants of 45% as shown in energy balance statistics (IEA 2020b); for water embodied in food irrigation water use efficiency (some 40% (Sadras et al. 2011)) and calorific conversion efficiency (food calories out/food calories in) in meat production of 60% (Lundqvist et al. 2008), or for materials where globally only 47% or primary iron ore extracted and recovered steel scrap end up as steel in purchased products, (i.e. a loss of 57%) (Allwood and Cullen 2012).

A substantial part of losses happen at the end-use point and in final service delivery (where losses account for 47 to 60 percentage points of aggregate systems losses for steel and energy respectively, and for 23% in the case of water embodied in food, i.e. food waste). The efficiency of service delivery (for a detailed discussion cf. (Brand-Correa and Steinberger 2017)) has usually both a technological component (efficiency of end-use devices such as cars, light bulbs) and a behavioural component (i.e. how efficiently end-use devices are used, e.g. load factors, for a discussion of such behavioural efficiency improvement options see e.g. (Dietz et al. 2009; Laitner et al. 2009; Ehrhardt-Martinez 2015; Kane and Srinivas 2014; Lopes et al. 2017; Thaler 2015; Norton 2012). Using the example of mobility where service levels are usually expressed by passenger-km, the service delivery efficiency is thus a function of the fuel efficiency of the vehicle and its drivetrain (typically only about 20%-25% for internal combustion engines, but close to 100% for electric motors) plus how many passengers the vehicle actually transports (load factor, typically as low as 20%-25%, i.e. one passenger per vehicle that could seat 4-5), i.e. an aggregate end-use efficiency of between 4-6% only. Aggregated energy end-use efficiencies at the global level are estimated as low as 20% (De Stercke 2014), 13% for steel (recovered post-use scrap, Allwood and Cullen, 2012), and some 70% for food (including distribution losses and food wastes of some 30%, (Lundqvist et al. 2008).

To harness additional gain in efficiency by shifting the focus in service delivery systems to the end-user can translate into large "upstream" resource reductions. For each unit of improvement at the end-use point of the service delivery system (examples shown in Figure 5.9), primary resource inputs are reduced between a factor of 6 to 7 units (water, steel, energy) (TWI2050 2018). For example, reducing energy needs for final service delivery equivalent to 1 EJ, reduces primary energy needs by some 7 EJ. This is hence a leverage point to waste less, while maintaining or improving services (as motivated in 5.2.1).

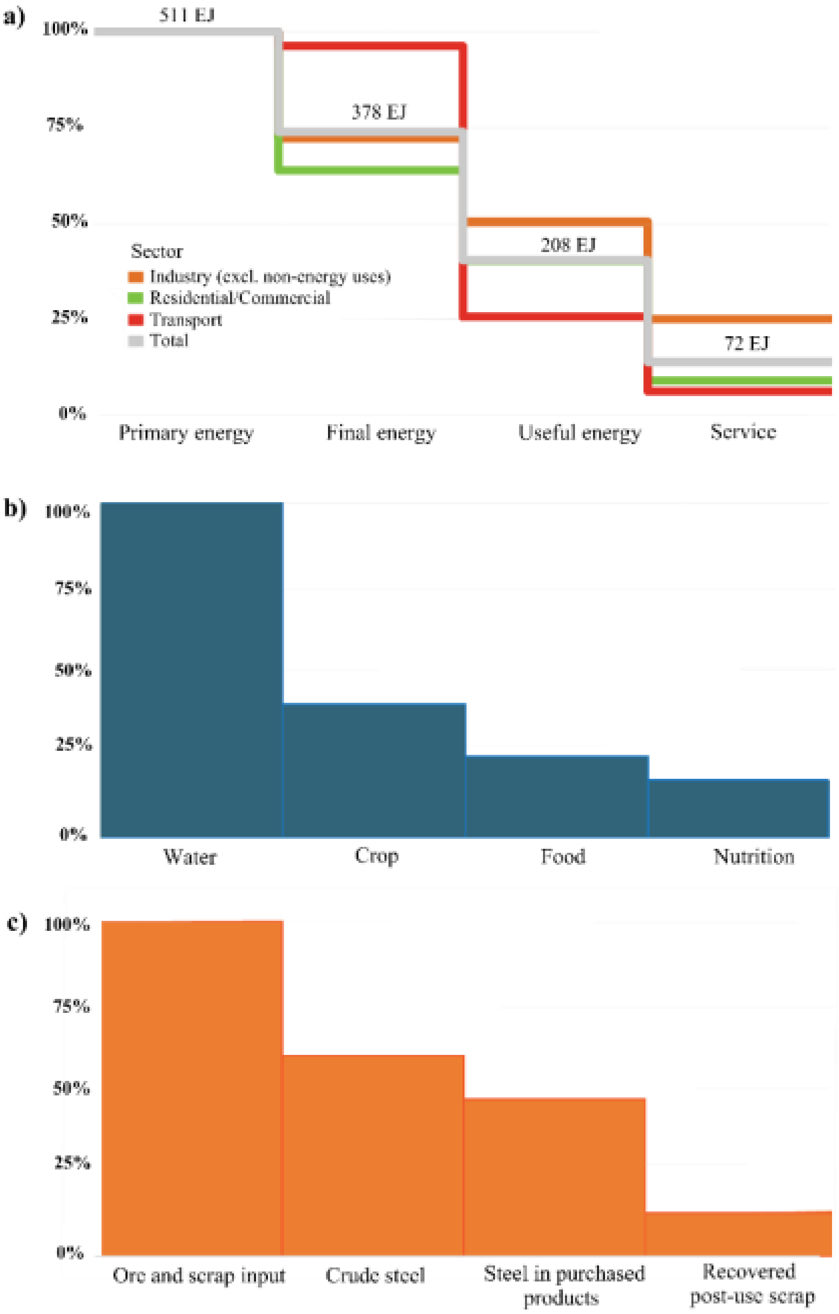


Figure 5.9 Resource processing steps and efficiency cascades (in percent of primary resource inputs [vertical axis] remaining at respective step until ultimate service delivery) for illustrative global service delivery systems for energy (top panel, disaggregated into three sectorial service types and the aggregate total), food (middle panel, water use in agriculture and food processing, delivery and use), and materials (bottom panel, example steel). The aggregate efficiencies of service delivery chains is with 13-17% low. Source: (TWI2050 2018)

There is thus *high evidence and high agreement* in the literature that the leverage effect for improvements in end-use service delivery efficiency through behavioural, technological, and market organisational innovations is very large, ranging from a factor 6-7 (resource cascades) to up to a factor 10 to 20 (exergy analysis) with the highest improvement potentials at the end-user and service provisioning levels (for systemic reviews see (Grubler et al. 2012b; Nakićenović et al. 1996; Sousa et al. 2017). Also these literature show *high agreement* that current conversion efficiencies are invariably low, particularly for those components at the end-use and service delivery back end of service provisioning systems. It also suggests that efficiencies might be actually even lower than those revealed by direct input-output resource accounting as discussed above (Figure 5.9). Illustrative exergy efficiencies of entire national or global service delivery systems range from 2.5% (USA, (Ayres 1989)) to 5% (OECD average, (Grubler et al. 2012b)) and 10% (global, Nakićenović et al., 1996) respectively. Studies that adopt more restricted systems boundaries either leaving out upstream resource processing/conversion or conversely end-use and service provision, show typical exergetic efficiencies between 15% (city of Geneva, cf. (Grubler et al. 2012a)) to below 25% (Japan, Italy, and Brazil, albeit with incomplete systems coverage that miss important conversion losses (Nakićenović et al. 1996)).

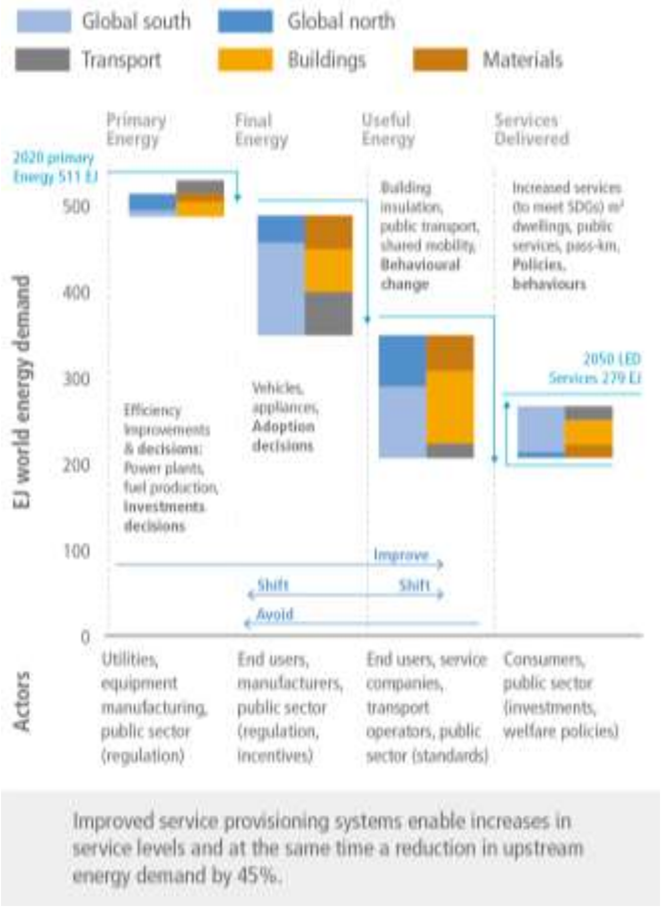


Figure 5.10 Realisable energy efficiency improvements by region and by end-use type between 2020 and 2050 in an illustrative Low Energy Demand scenario (in EJ). Data: Figure 5.9 and (Grubler et al. 2018). Efficiency improvements are decomposed by respective steps in the conversion chain from primary energy to final, and useful energy, and to service delivery and disaggregated by region (developed and developing countries) and end-use type (buildings, transport, materials). Improvements are dominated by improved efficiency in service delivery (153 EJ) and by more efficient end-use energy conversion (134 EJ). Improvements in service efficiency in transport shown here are conservative in this scenario but could be substantially higher with the full adoption of integrated urban shared mobility schemes. Increases in energy use due to increases in service levels and system effects of transport electrification (grey bars on top of first pair in the bar charts) that counterbalance some of the efficiency improvements are also shown. Examples of options for efficiency improvements and decision involved (grey text in the chart), the relative weight of generic demand-side strategies (improve, shift, avoid blue arrows), as well as prototype actors involved are also illustrated

5.3.3 Low demand scenarios

Long-term mitigation scenarios play a crucial role in climate policy design in the near term, by illuminating transition pathways, interactions between supply-side and demand-side interventions, their timing, and the scale of required investments needed to achieve mitigation goals (see Chapter 3). Historically, most long-term mitigation scenarios have taken technology-centric approaches with heavy reliance on supply-side solutions and the use of negative emissions technologies, particularly in 1.5ºC scenarios (Rogelj et al. 2018). Comparatively less attention has been paid to deep demand-side reductions incorporating lifestyle change and the cascade effects (see section 5.3.2) associated with ASI strategies. Primarily, due to limited past representation of such service-oriented interventions in long-term integrated assessment models (IAMs) and energy systems models (ESMs) (Napp et al. 2019; Grubler et al. 2018; van de Ven et al. 2018). There is ample evidence of savings from sector- or issue-specific bottom-up studies (see section 5.3.1.2). However, these savings typically get lost in the dominant narrative provided by IAMs and ESMs and in the evaluation of combinations of ASI and efficiency strategies. As a result, their interaction effects do not get equal focus alongside supply-side and negative emissions technology options (van den Berg et al. 2019; Van Vuuren et al. 2018; Samadi et al. 2017).

In response to 1.5ºC ambitions, and a growing desire to identify participatory pathways with less reliance on negative emissions technologies with high uncertainty, several recent IAM and ESM mitigation scenarios have explored the role of deep demand-side energy and resource use reductions potentials at global and regional levels. Table 5.2 summarises long-term scenarios that aimed to minimise service-level energy and resource demand as a central mitigation tenet, to specifically evaluate the role of behavioural change and ASI strategies, and/or to achieve a carbon budget with limited/no negative emissions technologies. From assessment of this emerging body of literature, several general observations arise and are presented below.

First, socio-behavioural changes within transition pathways can offer Gigaton-scale CO_2 savings potential at the global level, and therefore represent a substantial overlooked strategy in traditional mitigation scenarios. Two lifestyle change scenarios conducted with the IMAGE IAM suggested that low-cost behaviour changes such heating and cooling set-point adjustments, shorter showers, reduced appliance use, shifts to public transit, less meat intensive diets, and improved recycling can deliver an additional 1.7 Gt and 3 $GtCO_2$ savings in 2050, beyond the savings achieved in traditional technology-centric mitigation scenarios for the 2ºC and 1.5ºC ambitions, respectively (van Sluisveld et al. 2016; Van Vuuren et al. 2018). In its Sustainable Development Scenario, the IEA's behavioural change and resource efficiency wedges deliver around 3 $GtCO_2$-eq reduction in 2050, combined savings that exceed those of Solar PV that same year (IEA 2019b). In Europe, a GCAM scenario evaluating combined lifestyle changes such as teleworking, travel avoidance, dietary shifts, food waste reductions, and recycling reduced cumulative EU-27 CO_2 emissions 2011-2050 by up to 16% compared to an SSP2 baseline (van de Ven et al. 2018). Also in Europe, a multi-regional input-output analysis suggested that adoption of low-carbon consumption practices could reduce carbon footprints by 25%, or 1.4 Gt (Moran et al. 2020). A global transport scenario suggests that transport sector emission can decline from business as usual 18 $GtCO_2$-eq to 2 $GtCO_2$-eq if avoid-shift-improve strategies are deployed (Gota et al. 2019), a value considerably below the estimates provided in IAM scenarios that have no resolution in ASI strategies (compare with Chapter 10).

In light of the limited number of mitigation scenarios that represent socio-behavioural changes explicitly, there is *medium evidence* in the literature that such changes can reduce emissions at regional and global levels, but *high agreement* that such changes hold gigaton-scale CO_2 emissions reduction potentials.

Second, pursuant to the ASI principle, deep demand reductions require parallel pursuit of behavioural change and advanced energy efficient technology deployment; neither is sufficient on its own. The LED scenario (Figure 5.10) combines behavioural and technological change consistent with numerous ASI strategies that leverage digitalisation, sharing, and circular economy megatrends to deliver decent living standards while reducing global final energy demand in 2050 to 245 EJ (Grubler et al. 2018). This value is 40% lower than final energy demand in 2018 (IEA 2019b), and a lower 2050 outcome than other IAM/ESM scenarios with primarily technology-centric mitigation approaches (IEA 2017b; Teske et al. 2015). In the IEA's B2DS scenario, avoid/shift in the transport sector accounts for around 2 $GtCO_2$-eq yr^{-1} in 2060, whereas parallel vehicle efficiency improvements increase the overall mitigation wedge to 5.5 $GtCO_2$-eq yr^{-1} in 2060 (IEA 2017b).

Third, low demand scenarios can reduce both supply side capacity additions and the need for negative emissions technologies to reach emissions targets. Of the scenarios listed in Table 5.5, two (LED-MESSAGE and RegChange-IMAGE) reach 2050 emissions targets with no negative emission technologies (Grubler et al. 2018; van Sluisveld et al. 2018), whereas others report significant reductions in reliance on bioenergy with carbon capture and storage (BECCS) compared to traditional technology-centric mitigation pathways (Liu et al. 2018; Van Vuuren et al. 2018; Napp et al. 2019).

Fourth, the costs of reaching mitigation targets are generally lower when incorporating ASI strategies for deep energy and resource demand reductions. The TIAM-Grantham low demand scenarios displayed reduction in mitigation costs (0.87–2.4% of GDP), while achieving even lower cumulative emissions to 2100 (228 to ~475 $GtCO_2$) than its central demand scenario (741 to 1066 $GtCO_2$), which had a cost range of (2.4–4.1% of GDP) (Napp et al. 2019). The GCAM behavioural change scenario concluded that domestic emission savings would contribute to reduce the costs of achieving the internationally agreed climate goal of the EU by 13.5% to 30% (van de Ven et al. 2018). The AIMS lifestyle case indicated that mitigation costs, expressed as global GDP loss, would be 14% lower than the SSP2 reference scenario in 2100, for both 2ºC and 1.5ºC mitigation targets (Liu et al. 2018). These findings mirror earlier AIMS results, which indicated lower overall mitigation costs for scenarios focused on energy service demand reductions (Fujimori et al. 2014).

Based on the limited number of long-term mitigation scenarios that explicitly represent deep demand reductions enabled by ASI strategies, there is *medium evidence* but with *high agreement* that such scenarios can reduce dependence on supply-side capacity additions and negative emissions technologies with opportunity for lower overall mitigation costs.

Once the limitations within most IAMs and ESMs regarding non-inclusion of granular ASI strategy analysis are addressed it will expand and improve long-term mitigation scenarios (van den Berg et al. 2019). These include broader inclusion of mitigation costs for behavioural interventions (van Sluisveld et al. 2016), incorporation of rebound effects from avoided spending (van de Ven et al. 2018), improved representation of materials cycle to assess resource cascades (Pauliuk et al. 2017), broader coverage of behavioural change (Samadi et al. 2017), explicit representation of intersectoral linkages related to digitalisation, sharing economy, and circular economy strategies (see section 5.3.4), and institutional, political, social, entrepreneurial, and cultural factors (van Sluisveld et al. 2018). Addressing the current modelling limitations will require increased investments in data generation and collection, model development, and inter-model comparisons, with a particular focus on socio-behavioural research that has been underrepresented in mitigation research funding to date (Overland and Sovacool 2020).

Table 5.2 Summary of long-term scenarios that aimed to minimise service-level energy and resource demand

Global scenarios										
				Focused demand reduction element(s)				**Mitigation potential[iii]**		
#	**Scenario [Temp]**	**IAM/ ESM**	**Final energy**	**Scope**	**Sectors [i]**	**Key demand reduction measures considered (A, S, I) [ii]**	**Baseline scenario**	**CO_2 (Gt)**	**Final energy**	**Primary energy**
a	Lifestyle change scenario [2ºC]	IMAGE	-	Whole scenario	R, T, I	A: Set points, smaller houses, reduced shower times, wash temperatures, standby loss, reduced car travel, reduced plastics S: from cars to bikes, rail I: improved plastic recycling	2ºC technology-centric scenario in 2050	1.7	-	-
b	Sustainable Development Scenario [1.8ºC]	World Energy Model (WEM)	398 EJ in 2040	Behavioural change wedge and resource efficiency wedge	T, I	A: shift from cars to mass transit, building lifespan extension, materials efficient construction, product reuse I: improved recycling	Stated policies in 2050	3	-	-
c	Beyond 2 Degrees Scenario [1.75ºC]	ETP-TIMES	385 EJ in 2050	Transport avoid/shift wedge and material efficiency wedge	T, I	A: shorter car trips, optimised truck routing and utilisation S: shifts from cars to mass transit I: plastics and metal recycling, production yield improvements	Stated policies in 2060	2.5	-	-
d	Lifestyle change scenario [1.5ºC]	IMAGE	-	Whole scenario	R, C, T, I	A: Set points, reduced appliance use S: from cars to mass transit, less meat intensive diets, cultured meat I: best available technologies across sectors	1.5ºC technology-centric scenario in 2050	3	-	175 EJ
e	Low Energy Demand Scenario [1.5ºC]	MESSAGE	245 EJ in 2050	Whole scenario	R, C, T, I, F	A: device integration, telework, shared mobility, material efficiency, dematerialisation, reduced paper S: multi-purpose dwellings, healthier diets I: best available technologies across sectors	Final energy in 2020	-	165 EJ	-

f	Advanced Energy [R]evolution	-	279 EJ in 2050	Whole scenario	R, C, T, I	S: shifts from cars to mass transit I: best available technologies across sectors	Stated policies in 2050	-	221 EJ	-
g	Limited BECCS – lifestyle change [1.5ºC]	IMAGE	-	Whole scenario	R, C, T, F	A: Set points, reduced appliance use S: from cars to mass transit, less meat intensive diets, cultured meat I: best available technologies across sectors	SSP2 in 2050	58	-	400 EJ
h	Lifestyle scenario [1.5ºC]	AIM	425 EJ in 2100	Whole scenario	T, I, F	A: reduced transport services demand, reduced demand for industrial goods S: less meat-intensive diets	SSP2 in 2100	-	125 EJ	-
i	Transport scenario [1.5ºC]	Bottom-up construction	-	Whole scenario	T	A: multiple options S: multiple options I: multiple options		89% vs BAU: 16GtCO$_2$	-	-
j	Net Zero Emissions 2050 scenario	World Energy Model (WEM)	-	Behaviour change wedge	R, T,	A: Set points, line drying, reduced wash temperatures, telework, reduced air travel S: shifts to walking, cycling I: eco-driving	Stated policies in 2030	2	-	-
k	Decent living with minimum energy	Bottom-up construction	149 EJ in 2050	Whole scenario	R, T, I, F	A: activity levels for mobility, shelter, nutrition, etc. consistent with decent living standards S: shifts away from animal-based foods, shifts to public transit, more I: energy efficiency consistent with best available technologies	Final energy today (20XX)	-	60%	-
Regional scenarios										
l	Urban mitigation wedge	-	540 EJ in global cities in 2050	Whole scenario	R, C, T	A: reduced transport demand S: mixed-use developments I: vehicle efficiency, building codes and retrofits	Current trends to 2050	-	180 EJ	-
m	France 2072 collective society	TIMES-Fr	4.2 EJ in France in 2072	Whole scenario	R, T	A: less travel by car and plane, longer building and device lifespans, less spending S: shared housing, shifts from cars to walking, biking, mass transit	Final energy in 2014	-	1.7 EJ	-

n	EU-27 lifestyle change – enthusiastic profile	GCAM	-	Whole scenario	R, T, F	A: telework, avoid short flights, closer holidays, food waste reduction, car sharing, set points S: vegan diet, shifts to cycling and public transit I: eco-driving, composting, paper, metal, plastic, and glass recycling	SSP2, cumulative emissions 2011-2050	16%	-	-
o	Europe broader regime change scenario	IMAGE	35 EJ in EU in 2050	Whole scenario	R, T	A: reduced passenger and air travel, smaller dwellings, fewer appliances, reduced shower times, set points, avoid standby losses S: car sharing, shifts to public transit I: best available technologies	SSP2 in 2050	-	10 EJ	-
p	EU Carbon-CAP	EXIOBASE 3 MRIO	-	Whole scenario	R, T, F	90 demand-side behaviour change opportunities spanning A-S-I including changes to consumption patterns, reducing consumption, and switching to using goods with a lower-carbon production and low-carbon use phases.	Present day consumption footprint	1.4	-	-
q	France megawatt scenario	Bottom-up construction	-	Sufficiency wedge	R, C, T, I, F	A: increase building capacity utilisation, reduced appliance use, carsharing, telework, reduced goods consumption, less packaging S: shift to attached buildings; shift from cars and air to public transit and active mobility, carsharing, freight shift to rail and water, shift away from animal proteins I: reduced speed limits, vehicle efficiency, increased recycling	Business as usual in 2050 (~2300 TWh primary energy)	-	-	~1200 TWh
r	The Netherlands households energy behavioural changes	BENCH-NLD agent-based model	-	Individual energy behavioural changes and social dynamics; considering carbon pricing	R	A: reduce energy consumption through changing lifestyle, habits and consumption patterns S: to green energy provider; investment on solar PVs (prosumers) I: investment on insulation and energy-efficient appliances	SSP2 in 2030	50%	-	-

s	The Netherlands households energy behavioural changes	BENCH-NLD agent-based model	-	Individual energy behavioural changes and social dynamics	R	A: reduce energy consumption S: investment on solar PVs (prosumers) I: investment on insulation and energy-efficient appliances	SSP2 in 2050	56%	51-71%	
t	Spain households energy behavioural changes	BENCH-ESP agent-based model	-	Individual energy behavioural changes and social dynamics	R	A: reduce energy consumption S: investment on solar PVs (prosumers) I: investment on insulation and energy-efficient appliances	SSP2 in 2050	44%	16-64%	

Sources: a (van Sluisveld et al. 2016), b (IEA 2019b), c (IEA 2017b), d (Van Vuuren et al. 2018), e (Grubler et al. 2018), f (Teske et al. 2015), g (Esmeijer et al. 2018), h (Liu et al. 2018), i (Gota et al. 2019), j (IEA 2020a), k (Millward-Hopkins et al. 2020), l (Creutzig et al. 2015b), m (Millot et al. 2018), n (van de Ven et al. 2018), o (van Sluisveld et al. 2018), p (Moran et al. 2020), q (Negawatt 2018), r (Niamir et al. 2020c), s,t (Niamir et al. 2020a)

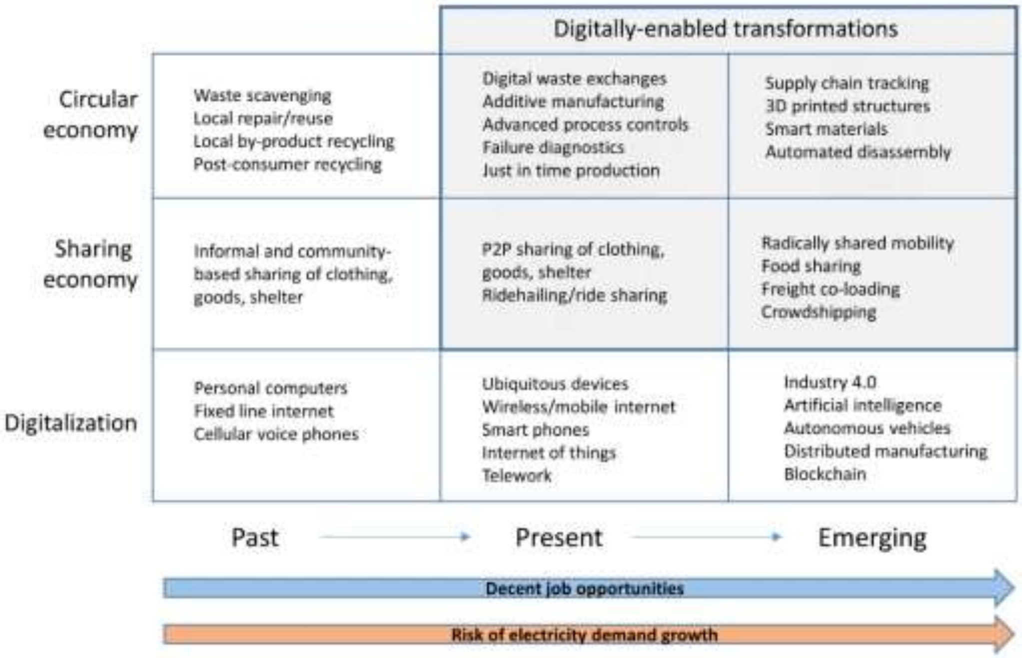
R = residential (Chapters 8, 9); C = commercial (Chapters 8, 9), T = transport (Chapters 8, 10), I = industry (Chapter 11), F = food (Chapters 6, 12),

A= avoid; S = shift, I = improve

Relative to indicated baseline scenario value in stated year

5.3.4 Transformative megatrends

The sharing economy, the circular economy, and digitalisation have all received much attention from the research, advocacy, and policy communities as potentially transformative trends for climate change mitigation (TWI2050 2019; IEA 2017a; Material Economics Sverige AB 2018). All are essentially emerging and contested concepts (Gallie 1955) that have the common goal of increasing convenience for users and rendering economic systems more resource-efficient, but which exhibit variability in the literature on their definitions and system boundaries. Historically, both sharing and circular economies have been commonplace in developing countries, where reuse, repair, and waste savaging and recycling comprise the core of informal economies facilitated by human interventions (Pacheco et al. 2012). Digitalisation is now propelling sharing and circular economy concepts in developed and developing countries alike, and the three megatrends are highly interrelated, as seen in Figure 5.11. For example, many sharing economy concepts rely on corporate or, to lesser degree, non-profit digital platforms that enable efficient information and opportunity sharing, thus making it part of the digitalisation trend. Parts of the sharing economy are also included in some circular economy approaches, as shared resource use renders utilisation of material more efficient. Digital approaches to material management also support the circular economy, such as through waste exchanges and industrial symbiosis. Digitalisation aims more broadly to deliver services in more efficient, timely, intelligent, and less resource-intensive (i.e., by moving bits and not atoms) ways, though the use of increasingly interconnected physical and digital systems in many facets of economies. With rising digitalisation also comes the risk of increased electricity use to power billions of devices and the internet infrastructure that connects them, presenting an important policy agenda for monitoring and balancing the carbon costs and benefits of digitalisation (Malmodin and Lundén 2018; TWI2050 2019). Rebound effects and instigated consumption of digitalisation are risking to lead to a net increase in GHG emissions (The Shift Project 2019). The determinants and possible scales of mitigation potentials associated with each megatrend are discussed below.



		Digitally-enabled transformations	
Circular economy	Waste scavenging Local repair/reuse Local by-product recycling Post-consumer recycling	Digital waste exchanges Additive manufacturing Advanced process controls Failure diagnostics Just in time production	Supply chain tracking 3D printed structures Smart materials Automated disassembly
Sharing economy	Informal and community-based sharing of clothing, goods, shelter	P2P sharing of clothing, goods, shelter Ridehailing/ride sharing	Radically shared mobility Food sharing Freight co-loading Crowdshipping
Digitalization	Personal computers Fixed line internet Cellular voice phones	Ubiquitous devices Wireless/mobile internet Smart phones Internet of things Telework	Industry 4.0 Artificial intelligence Autonomous vehicles Distributed manufacturing Blockchain

Figure 5.11 The growing nexus between digitalisation, the sharing economy, and the circular economy in service delivery systems. While these trends started mostly independently, rapid digitalisation is creating new synergistic opportunities with systemic potential to improve the quality of jobs, particularly in

developing economies. Widespread digitalisation may lead to net increases in electricity use, which must be monitored and managed via targeted policies

5.3.4.1 Digitalisation

In the context of service provision, there are numerous opportunities for consumers to buy, subscribe, adopt, access, install or use digital goods and services (Wilson et al. 2020b). Digitalisation has opened up new possibilities across all domains of consumer activity, from travel and retail to domestic living and energy use. Digital platforms allow surplus resources to be identified, offered , shared, transacted and exchanged (Frenken 2017). Real-time information flows on consumers' preferences and needs mean service provision can be personalised, differentiated, automated, and optimised (TWI2050 2019). Rapid innovation cycles and software upgrades drive continual improvements in performance and responsiveness to consumer behaviour. These characteristics of digitalisation enable new business models and services from shared-ridehailing (ITF 2017a) to smart heating (IEA 2017a) and from online farmers' markets (Richards and Hamilton 2018) to peer-to-peer electricity trading (Morstyn et al. 2018).

In many cases, digitalisation provides a 'radical functionality' that enables users to do or accomplish something that they could not do before (Nagy et al. 2016). Indeed the consumer appeal of digital innovations varies widely, from choice, convenience, flexibility and control to relational and social benefits (Pettifor and Wilson 2020). Reviewing over 30 digital goods and services for mobility, food buying and domestic living, Wilson et al. (2020) also found shared elements of appeal across multiple innovations including (i) making use of surplus, (ii) using not owning, (iii) being part of wider networks, and (iv) exerting greater control over service provisioning systems. Digitalisation thus creates a strong value proposition for certain consumer niches. Concurrent diffusion of many digital innovations amplifies their disruptive potential (Schuelke-Leech 2018; Wilson et al. 2019b). Besides basic mobile telephone service for communication, digital innovations have been primarily geared to population groups with high purchasing power, and too little to the needs of poor and vulnerable people.

The long-term sustainability implications of digitalised services hinge on four factors: (1) the direct energy demands of connected devices and the digital infrastructures (i.e. data centres and communication networks) that provide necessary computing, storage, and communication services (Chapter 9); (2) the systems-level energy and resource efficiencies gained through the provision of digital services; (3) the resource, material, and waste management requirements of the billions of ICT devices that comprise the world's digital systems (Belkhir and Elmeligi 2018; Malmodin and Lundén 2018) and (4) the magnitude of potential rebound effects or induced energy demands that might unleash unintended and unsustainable demand growth, such as autonomous vehicles inducing more frequent and longer journeys due to reduced travel costs (Wadud et al. 2016). Estimating the digitalisation's direct energy demand has historically been hampered by lack of consistent global data on IT device stocks, their power consumption characteristics, and usage patterns, for both consumer devices and the data centres and networks behind them. As a result, quantitative estimates vary widely, with literature values suggesting that consumer devices, data centres, and data networks account for anywhere from 5% to 12% of global electricity use (Cook et al. 2014; Gelenbe and Caseau 2015; Malmodin and Lundén 2018). Forward-looking projections have typically relied on top-down extrapolations based on growing demand for devices and internet services, leading to predictions of rapid energy demand growth (Belkhir and Elmeligi 2018; Jones 2018; Andrae and Edler 2015). However, top-down extrapolations can overlook strong countervailing effects of rapid efficiency gains in IT devices and network infrastructures that are occurring in parallel (Masanet et al. 2020; Shehabi et al. 2018; Das and Mao 2020; Malmodin 2020). Yet there is growing concern that rapid efficiency improvements might be outpaced by rising demand for digital services, particularly as data-intensive technologies such as artificial intelligence, smart and connected energy systems, distributed manufacturing systems, and autonomous vehicles promise to increase demand for data services even further in the future (Strubell et al. 2020; TWI2050 2019).

As digitalisation grows, an important policy objective is therefore to invest in data collection and monitoring systems and energy demand models of digitalised systems to guide technology and policy investment decisions for addressing potential direct energy demand growth (IEA 2017a).

However, the net systems-level energy and resource efficiencies gained through the provision of digital services could play an important role in dealing with climate change and other environmental challenges (Elliot 2011; Melville 2010; Watson et al. 2012; Gholami et al. 2013; Añón Higón et al. 2017). As shown in Figure 5.11, assessments of numerous digital service opportunities for mobility, nutrition, shelter, and education and entertainment suggest that net emissions benefits can be delivered at the systems level, although these effects are highly context-dependent. Importantly, evidence of potential negative outcomes due to rebound effects, induced demand, or life-cycle trade-offs can also be observed. For example, telework has been shown to reduce emissions where long and/or energy-intensive commutes are avoided, but can lead to net emissions increases in cases where greater non-work vehicle use occurs or only short, low-emissions commutes (e.g., via public transit) are avoided (Viana Cerqueira et al. 2020; IEA 2020a). Similarly, substitution of physical media by digital alternatives may lead to emissions increases where greater consumption is fuelled, whereas a shift to 3D printed structures may require more emissions-intensive concrete formulations leading to life-cycle emissions increases (Yao et al. 2020).

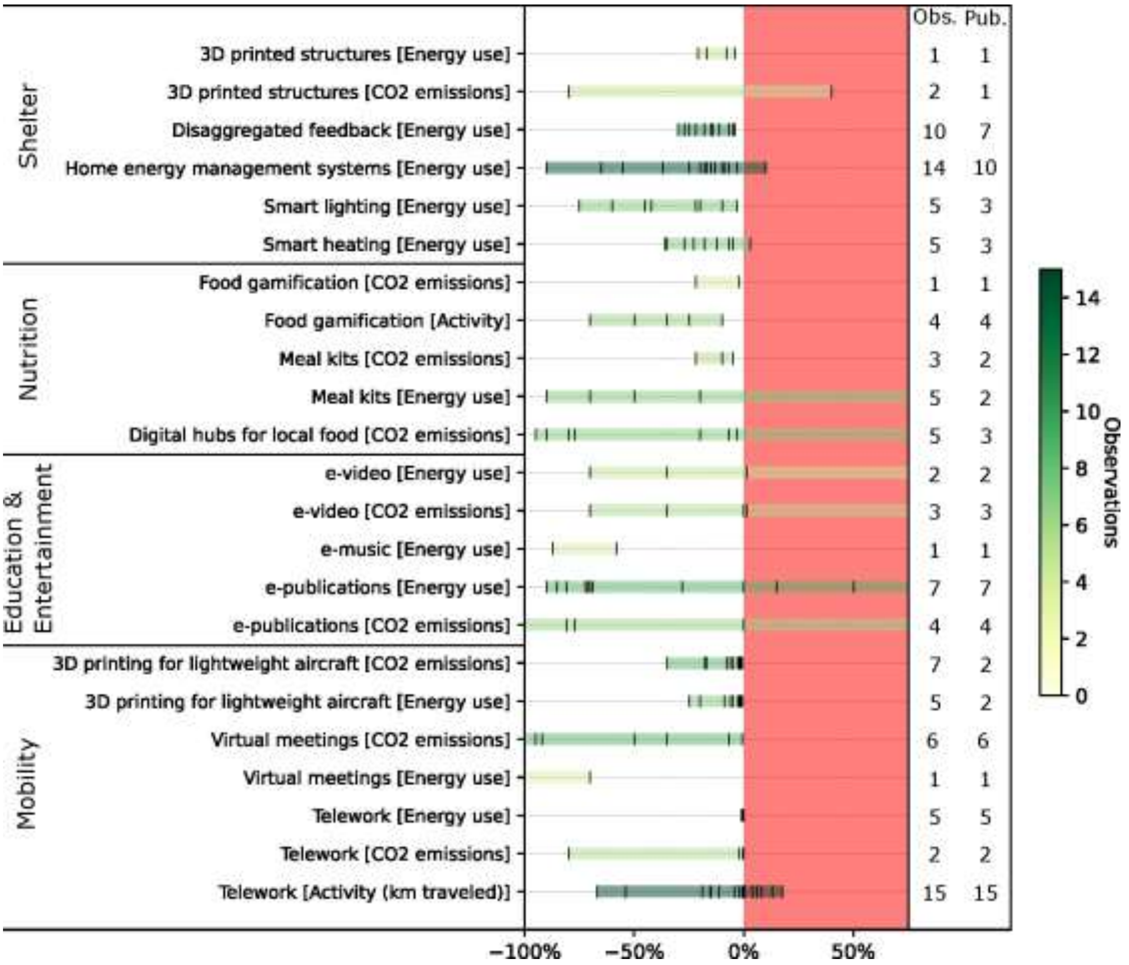


Figure 5.12 Studies assessing net changes in CO_2 emissions, energy use, and activity levels indicate significant mitigation potentials for consumer-oriented digitalisation solutions, but also risk of increased

emissions due to inefficient substitutions, induced demand, and rebound effects. Studies assessed include empirical research, attributional and consequential life-cycle assessments, and techno-economic scenarios, which are not directly comparable but useful for indicating the directionality and determinants of net emissions effects. Sources: (Hook et al. 2020; Court and Sorrell 2020; IEA 2020a; Huang et al. 2016; Gebler et al. 2014; Verhoef et al. 2018; Yao et al. 2020; Wilson et al. 2020b)

Furthermore, digitalisation, automation and artificial intelligence, as general-purpose technologies, may lead to a plethora of new products and applications that are likely to be efficient on their own but that may also lead to undesirable changes or absolute increases in demand for products (Figure 5.12). For example, last-mile delivery in logistics is both expensive and cumbersome. Battery-powered drones enable a delivery of goods at similar life-cycle emissions to delivery vans (Stolaroff et al. 2018). At the same time, drone delivery is cheaper in terms of time (immediate delivery) and monetary costs (automation saves the highest cost component: personnel) (e.g. (Sudbury and Hutchinson 2016)). As a result, demand for package delivery may increase rapidly. Similarly, automated vehicles reduce the costs of time, parking, and personnel, and therefore may dramatically increase vehicle mileage (Cohen and Cavoli 2019; Wadud et al. 2016). On-demand electric scooters offer mobility access preferable to passenger cars, but replace trips otherwise taken on public transit and can come with significant additional energy requirements for night time system rebalancing (Hollingsworth et al. 2019, ITF 2020). The energy requirements of cryptocurrencies is also a growing concern, although considerable uncertainty exists surrounding the energy use of their underlying blockchain infrastructure (Vranken 2017; Stoll et al. 2019; de Vries 2018; Masanet et al. 2019). Initial estimates of the computational intensity of artificial intelligence algorithms suggest that energy requirements may be enormous without concerted effort to improve efficiencies, especially on the computational side (Strubell et al. 2020). Efficiency gains enabled by digitalisation, in terms of reduced marginal GHG emissions or energy use per service unit may be overcompensated by activity/scale effects.

Maximising the mitigation potential of digitalisation trends involve diligent monitoring and proactive management of both direct and indirect demand effects, to ensure that a proper balance is maintained. Direct energy demand can be managed through continued investments in and incentives for energy-efficient data centres, networks, and end-use devices (Masanet et al. 2011; IEA 2017a; Avgerinou et al. 2017). Shifts to renewable power are a particularly important strategy being undertaken by data centre and network operators (Cook et al. 2014), which might be adopted across the digital device spectrum as a proactive mitigation strategy where data demands outpace feasible efficiency gains, which may be approaching limits within the next decade (Koomey et al. 2011). Most recently, data centres are being investigated as a potential resource for demand response and load balancing in renewable power grids (Zheng et al. 2020; Koronen et al. 2020). Ensuring efficiency benefits of digital services while avoiding potential rebound effects and demand surges will require early and proactive public policies to avoid excess energy use (WBGU 2019; TWI2050 2019), which will also necessitate investments in data collection and monitoring systems to ensure that net mitigation benefits are realised and that unintended consequences can be identified early and properly managed (IEA 2017a).

Within a small but growing body of literature on the net effects of digitalisation, there is *medium evidence* that digitalised consumer services can reduce overall emissions, energy use, and activity levels, with *medium agreement* on the scale of potential savings with the important caveat that induced demand and rebound effects must be managed carefully to avoid negative outcomes.

5.3.4.2 The sharing economy

Opportunities to increase service per product includes peer-to-peer based sharing of goods and services such as housing, mobility, and tools. Hence, consumable products become durable goods delivering a "product service", which potentially could provide the same level of service with fewer products

(Fischedick, M. et al. 2014).The sharing economy is an old practice of sharing assets between many without transferring ownership, which has been made new through focuses on sharing underutilised products/assets in ways that promotes flexibility and convenience, often in a highly developed context via gig economy/ online platforms. However, sharing economy offers the potential to shift from 'asset-heavy' ownership to 'asset-light' access, especially in developing countries (Retamal 2019). General conclusions on the sharing economy as a framework for climate change mitigation are challenging and are better broken down to specific subsystems (Mi and Coffman 2019).

The term sharing economy is used interchangeably with *shareconomy*, collaborative consumption, collaborative economy, the gig economy, and the mesh (Botsman and Rogers 2011; Martin 2016). The sharing economy has grown in a variety of sectors and platforms over the past years (Belk 2014a; Böcker and Meelen 2017). It defines a system that connects users/renters and owner/providers through consumer-to-consumer (C2C)/peer-to-peer (P2P) (e.g. Uber, Airbnb, couch surfing) or business-to-consumer (B2C) or business-to-business (B2B) platforms, and allowing rentals in more flexible, social interactive terms (e.g. Zipcar, WeWork) (Botsman and Rogers 2011; Schor 2014; Frenken and Schor 2017; Parente et al. 2018; Möhlmann 2015; Belk 2014a). However, there are criticisms regarding business relationship masquerading as communal sharing, so-called pseudo-sharing because these practices may not be beneficial to all parties as well as friendly to the environment and to reducing inequalities in access of products and services (Belk 2014b).

The motivation to participate in the sharing economy differs among socio-demographic groups, between users and providers and among different types of shared goods (e.g. cars, rides, accommodation, and tools). For example, empirical data analysis shows that sharing expensive goods (e.g. accommodation) is economically motivated since most of room sharing hosts pay their rent and utility bills by sharing their living spaces. Environmental motivations are important particularly for mobility, ride sharing, in which a passenger travels in a private vehicle driven by its owner, for free or for a fee, and ride hailing, which uses a third party that connects riders with taxi services in the area (Böcker and Meelen 2017). Food sharing, which is a practice where individuals or groups of people make a commitment to ensure that food is shared instead of wasted, involves highly personal interactions, especially for meal sharing, often motivated by social desires (Böcker and Meelen 2017). However, not all food sharing initiatives are based on social motivations. In fact, there are companies enjoying remarkably rapid growth and initiatives driven by economic benefits such as businesses seeking to match farmers and/or distributors to consumers for fresh produce that are still edible but contain defects in size, colour, shape and size; the so-called market for "ugly food" (Richards and Hamilton 2018). Other popular meal sharing initiatives are EatWith, Meal Sharing, Traveling Spoon, in which hosts offer affordable food and a closer look into local life to tourists. Although younger and low-income groups are more economically motivated to use and provide shared assets; younger, higher-income and higher-educated groups are less socially motivated; and women are more environmentally motivated (Böcker and Meelen 2017).

Shared mobility

Shared mobility is characterised by the sharing of an asset (e.g. a bicycle, e-scooter, vehicle), and the use of technology (i.e. apps and the Internet) to connect users and providers. It succeeded by identifying market inefficiencies and transferring control over transactions to consumers. Shared mobility reduces GHG emissions if it substitutes for more GHG intensive travel (usually private car travel) (Martin and Shaheen 2011; Shaheen and Cohen 2019; Shaheen and Chan 2016; Santos et al. 2018; Axsen and Sovacool 2019), and especially if it changes consumer behaviour in the long run "by shifting personal transportation choices from ownership to demand-fulfilment" (Mi and Coffman 2019). Demand is an important driver for energy use and emissions because decreased cost of travel time by sharing an asset (e.g. vehicle) could lead to an increase in emissions, but a high level of vehicle sharing could reduce negative impacts associated with this (Brown and Dodder 2019). One example is the megacity Kolkata, India, which has as many as twelve different modes of public transportation options that co-exist and offer means of mobility to its 14 million citizens (see Box 5.7). Most public transport modes are shared mobility options ranging from sharing between two people in a rickshaw or between a few hundred in metro or sub-urban trains. Sharing also happens informally as daily commuters avail shared taxis and neighbours borrow each other's car or bicycle for urgent or day trips.

Shared mobility is categorised into four models (Santos et al. 2018): P2P platform where individuals can rent the vehicle when not in use (Ballús-Armet et al. 2014); short term rental managed and owned by a provider (Enoch and Taylor 2006; Schaefers et al. 2016; Bardhi and Eckhardt 2012); Uber-like ridehailing services (Wallsten 2015; Angrist et al. 2017); and ride pooling where private vehicles shared by passengers to a common destination (Liyanage et al. 2019; Shaheen and Cohen 2019). The latest model – ride pooling – is promising in terms of congestion and per capita CO_2 emissions reductions and a common practice in developing countries, however is challenging in terms of waiting and travel time, comfort, and convenience, relative to private cars (Santos et al. 2018; Shaheen and Cohen 2019). The other models often yield profits to private parties, but remain mostly unrelated to reduction in CO_2 emissions (Santos et al. 2018). Shared travel models, especially Uber-like models, are criticised because of the flexibilisation of labour, especially in developing countries, in which unemployment rates and unregulated labour markets lie a foundation of precarity that lead many workers to seek out wide-ranging means towards patching together a living (Ettlinger 2017; Wells et al. 2020). Despite the advantages of the shared mobility such as convenience and affordability, consumers' perceived risk formed by possible physical injury from strangers or unexpected poor service quality (Hong et al. 2019).

The current state of shared mobility looks dismal or at least questionable (Fishman et al. 2014; Ricci 2015; Zhang et al. 2019; Zhang and Mi 2018; Martin 2016; Creutzig et al. 2019; Mi and Coffman 2019). Transport entrepreneurs and government officials often conflate 'smart' and "shared' vehicle with 'sustainable' mobility, an intellectual shortcut not withstanding scrutiny (Noy and Givoni 2018). Surveys demonstrate that users take free-floating car sharing instead of public transit, rather than to replace their private car (Herrmann et al. 2014). If substitution effects and deadheading, which is the practice of allowing employees of a common carrier to use a vehicle as a non-revenue passenger, are accounted for, flexible motor-cycle sharing in Djakarta is at best neutral to overall GHG emissions (Suatmadi et al. 2019). Around 22% of all trips travelled with Uber and Lyft would have been travelled by transit, 12% would have walked or biked, and another 12% of induced demand or passengers that would not have travelled at all (Henao and Marshall 2019). Such developments would likely increase residential energy demand, commuting distances and the conversion rate of bio-productive land into low-density residential areas.

Positive effects is realised directly in bike sharing due to its very low marginal transport emissions. For example, in 2016, bike sharing in Shanghai reduced CO emissions by 25ktCO_2 with additional benefits to air quality (Zhang and Mi 2018). However, also bike-sharing can increase emissions from motor vehicle usage when inventory management is not optimised during maintenance, collection, and redistribution of dock-less bikes (Fishman et al. 2014; Zhang et al. 2019; Mi and Coffman 2019).

Shared mobility scenarios demonstrate that GHG emission reduction is substantial when mobility systems and digitalisation is regulated. Some studies model that ride pooling with electric cars (6 to 16 seatings, which shifts the service to a more efficient transport mode (e.g., electric vehicle) and improves its carbon intensity by cutting GHG emissions by one-third (International Transport Forum 2016), and 63-82% per mile compared to a privately owned hybrid vehicle in 2030, 87 to 94% lower than a privately owned, gasoline-powered vehicle in 2014 (Greenblatt and Saxena 2015). This also realises 95% reduction in space required for public parking; total vehicle kilometres travelled would be 37% lower than the present day, although each vehicle would travel ten times the total distance of current vehicles (International Transport Forum 2016). Studies of Berlin and Lisbon demonstrate that sharing strategies could reduce the number of cars by more than 90%, also saving valuable street space for human-scale activity (Bischoff and Maciejewski 2016; Martinez and Viegas 2017; Creutzig et al. 2019). The impacts will also depend on sharing levels – concurrent or sequential – and the future modal split among public transit, automated electric vehicles fleets, and shared or pooled rides. Evidence from attributional life-cycle assessments (LCAs) of ridehailing, whether Uber-like or by taxi, suggests that the key determinants of net emissions effects are average vehicle occupancy and vehicle powertrain, with high-occupancy and electric drivetrain cars deliver the greatest emissions benefits, even rivalling traditional metro/urban rail and bus options (Figure 5.13b). It is possible that shared automated electric vehicles fleets could become widely used without many shared rides, and single or even zero occupant vehicles will continue to dominate the majority of vehicle trips. It is also feasible that shared rides could become more common, if automation makes route deviation more efficient, more cost-effective, and more convenient, increasing total travel substantially (Wadud et al. 2016). Car sharing with automated vehicles could even worsen congestion and emissions by generating additional travel demand (Rubin et al. 2016). Travel time in autonomous vehicles can be used for other activities but driving and travel costs are expected to decrease, which most likely will induce additional demand for auto travel (Moeckel and Lewis 2017) and could even create incentives for further urban sprawl. More generally, increased efficiency generated by big data and smart algorithms may generate rebound effects in demand and potentially compromise the public benefits of their efficiency promise (Gossart 2015).

In many countries, shared mobility and ride pooling is often the norm. Here the challenge is to improve service quality to keep users in shared mobility and public transport (see Box 5.7). A key barrier in cities like Nairobi is the lack of public involvement of users and sustainability experts in designing transport systems, leaving planning to transport engineers, and thus preventing inclusive shared mobility system design (Klopp 2012).

Altogether, travel behaviour, business models, and especially public policy will be key components in determining how pooling and shared automated electric vehicles impacts unfold (Shaheen and Cohen 2019). Urban-scale governance of smart mobility that prioritises public transit and the use of public spaces for human activities, manages the data as a digital sustainable commons, and Central Information Officer, as installed in Tel Aviv, manages the social and environmental risks of smart mobility and realise its benefits (Creutzig et al. 2019). Pricing of energy use and GHG emissions will be helpful to achieve these goals. The governance of shared mobility is complicated, as it involves many actors, and is key to realise wider benefits of shared mobility (Akyelken et al. 2018). New actors, networks and technologies enabling shared mobility are already fundamentally challenging how transport is governed worldwide. This is not a debate about state versus non-state actors but instead about the role the state takes within these new networks to steer, facilitate and also reject different elements of the mobility system (Docherty et al. 2018).

Shared accommodation

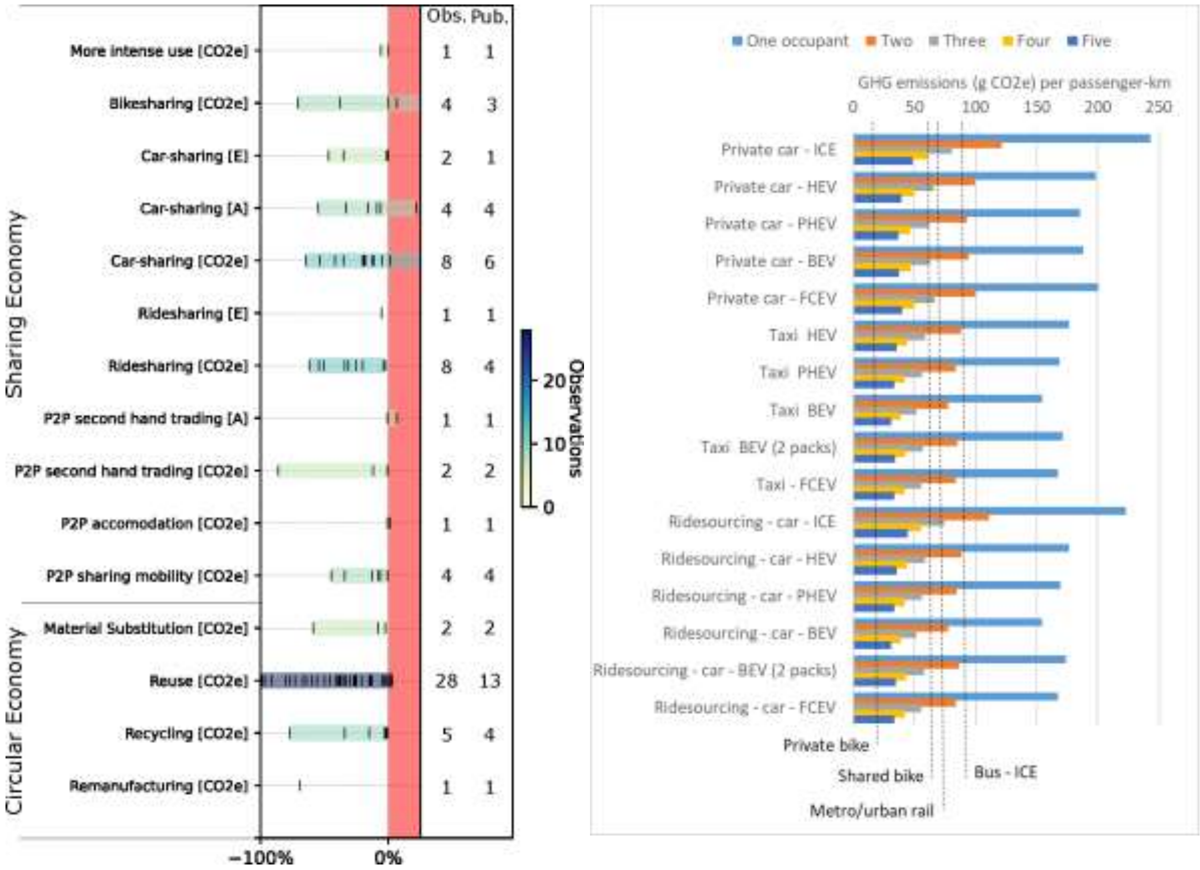
In developing countries, shared accommodation allows affordable housing for a large part of the population. For example, living arrangements are built expressly around the practice of sharing toilets, bathrooms and kitchens. While the sharing of such facilities does connote a lower level of service provision and quality of life, the variation in access to such facilities guides the housing market that provides a variety of affordable housing arrangements in response to a consumer base with very low and unreliable incomes. Thus, sharing key facilities guarantees the provision of affordable housing (Gulyani et al. 2018). In developed countries, large-scale developments are targeting students and 'young professionals' by offering shared accommodation and services. Historically shared accommodation has been part of the student life due to its flexible and affordable characteristics. However, the expansion of housing supply through densification is using shared facilities as well as an instrument to *"commercialize small housing production, while housing affordability and accessibility are threatened"* (Uyttebrouck et al. 2020).

In the European Union (EU), GHG emissions of housing person^{-1} yr^{-1} is 2.62 tCO_2-eq (Lavagna et al. 2018). Several ways of accommodation are now emerging, in which accommodation is offered to, or shared with, travellers by private people organised by business-driven or non-profit online platforms. Accommodation sharing includes P2P, ICT-enabled, short-term renting, swapping, borrowing or lending of existing privately-owned idling lodging facilities (Möhlmann 2015; Voytenko Palgan et al. 2017).

Shared accommodation service via platform economy is linked with negative sustainability effects, such as rebound effects caused by increased travel frequency (Tussyadiah and Pesonen 2016). This is particularly a problem if apartments are removed from the long-term rental markets, thus indirectly inducing constructions, with substantial GHG emissions on their own. If a host shares their accommodation with a guest, the use of some resources, such as heating and lighting, is shared, thereby leading to more efficient resource use per capita (Chenoweth 2009; Voytenko Palgan et al. 2017).

Mitigation potentials of sharing economy strategies

Sharing economy initiatives play a central role in enabling individuals to share underutilised products. In addition, different strategies present different mitigation potential. However, negative rebounds effects may occur by changing consuming patterns, e.g., if savings from sharing housing are used to finance air travel. Figure 5.13 shows that P2P second hand trading and shared mobility options has high mitigation potential, all depending on stringent public policy that reigns in run-away consumption effects. The overall literature remains limited. Therefore, the sharing economy presents a small but growing body of literature on the net effects of its strategies. Similarly to digitalisation, there is *medium evidence* that sharing economy can reduce overall emissions, energy use, and activity levels, with *medium agreement* on the scale of potential savings. Shared economy solutions relate to the "Avoid" and "Shift" strategies (see sections 5.1 and 5.3.2). On the one hand, they provide similar or improved services for wellbeing (mobility, shelter) at reduced energy and resource input, when current public policy lacks on controlling theses effects. On the other hand, shared mobility may also represent a net negative rebound effect since it has a high risk of increasing emissions by shifting activity away from public transit, lower occupancy, deadheading, and use of inefficient shared vehicles (Bonilla-Alicea et al. 2020; Merlin 2019; Jones and Leibowicz 2019).



(a) **(b)**

Figure 5.13 (a) Published estimates of the relative mitigation potential of different shared and circular economy strategies, demonstrating limited observations for many emerging strategies and wide variance in estimated benefits. Mitigation potentials are conditional on corresponding public policy and/or regulation. (b) Attributional LCA comparisons of ridesharing mobility options, which highlight the large effects of vehicle occupancy and vehicle technology on total CO_2 emissions per passenger-km and the preferability of high-occupancy and non-ICE configurations for emissions reductions compared to private cars. Also indicated are possible emissions increases associated with shared car mobility when it substitutes for non-motorised and public transit options. BEV = battery electric vehicle; FCEV = fuel cell electric vehicle; HEV = hybrid electric vehicle; ICE=internal combustion engine; PHEV = plug-in hybrid electric vehicle. Sources: (Koh 2016; Yin et al. 2017; Jacobson and King 2009; Lokhandwala and Cai 2018; Merlin 2019; Martin and Shaheen 2016; Clewlow and Mishra 2017; Gallego-Schmid et al. 2020; Coulombel et al. 2019; Yu et al. 2018; Bruck et al. 2017; Bullock et al. 2017; Bonilla-Alicea et al. 2020; Rabbitt and Ghosh 2016; Nijland and van Meerkerk 2017; Namazu and Dowlatabadi 2015; Firnkorn and Müller 2011; Baptista et al. 2014; Nußholz et al. 2019; Hopkinson et al. 2018; Ghisellini et al. 2018; Eberhardt et al. 2019b,a; Campbell 2018; Castro and Pasanen 2019; Buyle et al. 2019; Brütting et al. 2019; Brambilla et al. 2019; Nasir et al. 2017; ITF 2020, 2017b, 2018, 2017c; Yan et al. 2020; Jones and Leibowicz 2019; Wilson et al. 2020b; Zhang and Mi 2018)

The circular economy

While the demands for energy and material will increase until 2050 following the traditional linear model of production and consumption, the circular economy provides strategies for reducing the need of society for energy and materials to delivering the same level of service. Old and traditional linear throughput flow model dominates the overall wasteful development path causing serious environmental harm due to overconsumption of resources. Circular economy (CE) embodies a multitude of schools of thought with roots and relations to a number of related concepts (Blomsma and Brennan 2017; Murray et al. 2017), including cradle to cradle (McDonough and Braungart 2002), performance economy

(Stahel 2016), biomimicry (Benyus 1997) green economy (Loiseau et al. 2016) and industrial ecology (Saavedra et al. 2018). A systematic literature review identified 114 definitions of the CE (Kirchherr et al. 2017). One of the most comprehensive models is suggested by the Netherlands Environmental Assessment Agency (Potting et al. 2018), which defines ten strategies for circularity: Refuse (R0), Rethink (R1), Reduce (R2), Reuse (R3), Repair (R4), Refurbish (R5), Remanufacture (R6), Repurpose (R7), Recycle (R8), Recover energy (R9). Overall, the definition of CE is contested, with varying boundary conditions chosen; the CE overlaps both with the sharing economy and digitalisation.

In line with the principles of SDG12, responsible consumption and production, the essence of building CE is to retain as much value as possible from products and components when they reach the end of their useful life (Linder and Williander 2017; Lewandowski 2016; Lieder and Rashid 2016; Stahel 2016). This requires an integrated approach during the design phase that, for example, extends product usage and ensures recyclability after use (de Coninck et al. 2018). While traditional improve strategies tend to focus on direct energy and carbon efficiency, service-oriented strategies focus on reducing life-cycle emissions through harnessing the leverage effect (Creutzig et al. 2018). The development of closed-loop models in service-oriented business can increase resource and energy efficiency, reducing emissions and achieve climate change mitigation goals on national, regional, and global levels (Johannsdottir 2014; Korhonen et al. 2018). Key examples include remanufacturing of consumer products to extend lifespans while maintaining adequate service levels (Klausner et al. 1998), reuse of building components to reduce demand for virgin materials and construction processes (Shanks et al. 2019), and improved recycling to reduce resource pressures (IEA 2019a, 2017b).

Among the many schools of thought on the CE and climate change mitigation two different trends can be distinguished. First, there are publications, many of them non peer-reviewed, that eulogize the perceived benefits of the CE, but in many cases step short of providing a quantitative assessment. Promotion of CE from this perspective has been criticised as a greenwashing attempt by industry and manufacturers, using the concept to avoid serious regulation (Isenhour 2019). Second there are more methodologically sound publication, mostly originating in the industrial ecology field, but sometimes investigating only limited aspects of the CE (Bocken et al. 2017; Cullen 2017; Goldberg 2017). Conclusions also differ with diverging definitions of the CE. A systematic review identified 3244 peer-reviewed articles addressing CE and climate change mitigation, but only 10% of those provide meaningful insights, and most of them find only small potentials to reduce GHG emissions (Cantzler et al. 2020). Recycling is the CE category most investigated, while reuse and reduce strategies find little attention (Cantzler et al. 2020).

There are three key concerns relating to the effectiveness of the CE concept. First, many proposals and pamphlets on the CE insufficiently reflect on thermodynamic constraints that limit the potential of recycling or ignore the considerable amount of energy needed so reuse materials (Cullen 2017). Second, demand for materials and resources will likely outpace efficiency gains in supply chains, becoming a key driver of GHG emissions and other environmental problems, rendering the CE alone an insufficient strategy to reduce emissions (Bengtsson et al. 2018). In fact, the empirical literature points out that only 6.5% of all processed materials (4 Gt yr^{-1}) globally originate from recycled sources (Haas et al. 2015). The low degree of circularity is explained by the high proportion of processed materials (44%) used to provide energy thus not available for recycling; and the high rate of net additions to stocks of 17 Gt yr^{1}. Hence, strategies targeting end-of-pipe materials are limited; instead, a significant reduction of societal stock growth, and decisive eco-design is suggested to advance the CE (Haas et al. 2015). Third, cost-effectiveness underlying CE activities may concurrently also increase energy intensity and reduce labour intensity, causing systematically undesirable effects. To a large extent, the distribution of costs and benefits of material and energy use depends on institutions in order to include demand-side solutions. Thus, institutional conditions have an essential role to play in setting rules differentiating profitable from nonprofitable activities in CE (Moreau et al. 2017).

A report estimates that the CE can contribute to more than 6 $GtCO_2$ emission reductions from 2016 to 2030, including strategies such as material substitution in buildings (Blok et al. 2016). Reform of the tax system towards GHG emissions and the extraction of raw materials substituting taxes on labour is key precondition to achieve such a potential. Otherwise rebound effect will take back high share of marginal CE efforts. 50% reduction of GHG emissions in industrial processes, including the production of goods in steel, cement, plastic, paper, and aluminium from 2010 until 2050 are impossible to attain only with reuse and radical product innovation strategies, but will need to also rely on the reduction of primary input (Allwood et al. 2010).

CE strategies correspond to the “Avoid” strategy (see sections 5.1 and 5.3.2). CE strategies in industrial settings improve wellbeing mostly indirectly, via the reduction of environmental harm and climate impact. They also save monetary resources of consumers by reducing the need for consumption. It may seem counterintuitive, but reducing consumers' need for consumption of a particular product/service (e.g. reducing energy consumption) may increase a consumption of another one (e.g. travels) associated with some type of energy use. Hence, carbon emissions could rise if the rebound effect is not considered (Chitnis et al. 2013; Zink and Geyer 2017).

Looking at “Shift” strategy (see sections 5.1 and 5.3.2), the role of individuals as consumers/users has received less attention than other aspects of the CE (e.g. technological interventions as “Improve” strategy and waste minimisation as “Avoid” strategy) within mainstream debates to date. One explanation is CE has roots in the Industrial Ecology that has historically had little focus on the end-user. By shifting this perspective from the supply-side to the demand-side in the CE, users are, for the most part, discussed as social entities that now must form new relations with businesses to meet their needs. That is, as demand-side approach largely replaces the concept of a consumer with that of a user, who must either accept or reject new business models for service provision, stimulated by the pushes and pulls of prices and performance (Hobson 2019).

Relevant contribution to climate change mitigation at Giga ton scale by the CE will remain out of scope, if decision makers and industry fail to reduce primary inputs, either by restriction or taxation on GHG emissions and raw material extraction (*high confidence*). Figure 5.13 shows that total CO_2 reduction potential is higher in reusing materials in the building sector. Systemic (consequential) analysis is required to avoid the risk that scaling effects negate efficiency gains; such analysis is however hardly applied. For example, material substitution or refurbishment of buildings can increase emissions despite improving or avoiding current materials (Eberhardt et al. 2019a; Castro and Pasanen 2019) Besides, CE concepts that extend the lifetime of products and increase the fraction of recycling are useful but are both thermodynamically limited and will remain relatively small in scale as long as demand of primary materials continue to grow, and scale effects dominate. In spite of presenting a large body of literature, CE presents a small but growing body of literature on the net effects of its strategies. There is *medium evidence* that CE can reduce overall emissions, energy use, and activity levels (i.e. mostly when reusing material of building features), with *medium evidence* that sharing economy can reduce overall emissions, energy use, and activity levels, with *medium agreement* on the scale of potential savings.

5.4 Transition toward high wellbeing and low-carbon demand societies

Demand-side mitigation involves individuals (e.g. consumption choices), culture (e.g. social norms, values), corporate (e.g. investments), institutions (e.g. political agency), and infrastructure change (*high evidence, high agreement*). These five drivers of human behaviour either contribute to the status-quo of a global high-carbon, consumption, and GDP growth oriented economy or help generate the desired change to a low-carbon energy-services, wellbeing, and equity oriented economy (Yuana et al. 2020) (Figure 5.14). Each driver has novel implications for the design and implementation of demand-side mitigation policies. They show important synergies, making energy demand mitigation a dynamic problem where the packaging and/or sequencing of different policies play a role in their effectiveness, demonstrated in Sections 5.5 and 5.6. The Social Science Primer (Supplementary Material Chapter 5) describes theory and empirical insights about the interplay between individual agency, the social and physical context of demand-side decisions in the form of social roles and norms, infrastructure and technological constraints and affordances, and other formal and informal institutions. Incremental interventions on all five fronts change social practices, effecting simultaneously energy and well-being (Schot and Kanger 2018). Transformative change will require coordinated use of all five drivers, as described in Figure 5.14 and Table 5.4 using novel insights about behaviour change for policy design and implementation (*high evidence, high agreement)*. Avoid, Shift, and Improve choices will be made by individuals and households, instigated by salient and respected role models and novel social norms, but require support by adequate infrastructures designed by urban planners and building and transport professionals, corresponding investments, and a political culture supportive of mitigation action. This is particularly true for many Avoid and Shift decisions that are difficult because they carry major costs on dimensions that include sacrifices in the material consequences of changes in lifestyle but also psychological barriers of breaking routines, habits and imagining new lifestyles and the social costs of not conforming to society (Kaiser 2006). Simpler Improve decisions like energy efficiency investments on the other hand can be triggered and sustained by traditional policy instruments complemented by behavioural nudges.

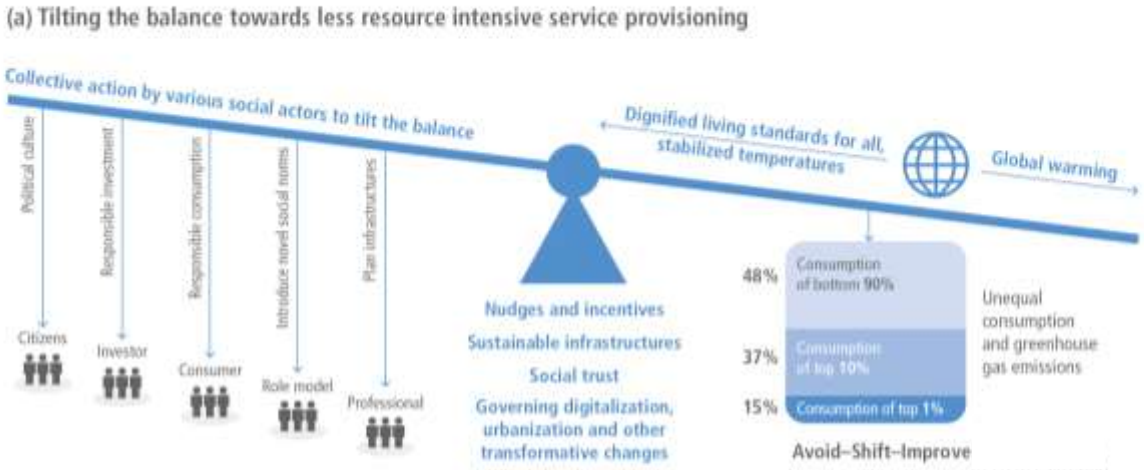


Figure 5.14 Role of people, demand-side action and consumption in reversing a planetary trajectory to a warming Earth towards effective climate change mitigation and dignified living standards for all

5.4.1 Behavioural Drivers

Behaviour change by individuals and households requires both *motivation* to change and *capacity* for change (option availability/knowledge; material/cognitive resources to initiate and maintain change) and is best seen as part of more encompassing collective action. Motivation for change for collective good comes from economic, legal, social incentives, regard for deeper intrinsic value of concern for others over extrinsic values. Capacity for change varies: people in informal settlements or rural areas are incapacitated by socio-political realities and have limited access to new energy-service options.

Motivation and effort required for behaviour change increase from Improve to Shift to Avoid decisions. 'Improve' requires changes in personal purchase decisions, 'shift' involves changes in behavioural routines/practices, 'avoid' also involves shifts in deeper values or mindsets. People set easy goals for themselves and more difficult ones for others (Attari et al. 2016) and underestimate the energy savings of behaviour changes that make a large difference (Attari et al. 2010). Most personal actions taken have small mitigation potential (recycling, ecodriving), and people refrain from options with high impact (less flying, living car free) (Dubois et al. 2019).

IPCC models of stakeholders decisions have continuously evolved. From AR1 to AR4, rational choice was the implicit assumption: agents (*homo economicus)* have perfect information and unlimited processing capacity to maximise self-focused expected utility and differ only in wealth, risk attitude, and time discount rate (Persky 1995). AR5 (Kunreuther et al. 2014) introduced a broader range of goals (material, social, and psychological) and decision processes (calculation-based, affect-based, and rule-based processes), but its perspective on decisions and action was still individual- and agency-focused and failed to address structural, cultural, and institutional constraints and the influence of physical and social context (Thaler and Sunstein 2003; Creutzig et al. 2018; Hayward and Roy 2019). AR6 in the current chapter and SScP attempt to fill this omission.

As individuals pursue a broad set of goals and use calculation-, emotion-, and rule-based processes when they make energy decisions, demand-side policies can use a broad range of behavioural tools that complement subsidies, taxes, and regulations (Chakravarty and Roy 2016; Mattauch et al. 2016; Niamir 2019) *(high evidence, high agreement*). The provision of targeted information, social advertisements, and power of role models like celebrities can be used to create better climate change knowledge and awareness (Niamir 2019; Niamir et al. 2020c,b). Behavioural interventions like communicating changes in social norms can accelerate behaviour change by creating tipping points (Nyborg et al. 2016). When changes in energy-demand decisions (such as switching to a plant-based diet, Box 5.4) are motivated by the creation and activation of a social identity consistent with this and other behaviours, positive spillover can accelerate behaviour change (Truelove et al. 2014), both within a domain or across settings, e.g., from work to home (Maki and Rothman 2017).

Box 5.4 Dietary shifts in UK society towards lower emission foods

Meat eating is declining in the UK, alongside a shift from carbon-intensive red meat towards poultry. This is due to the interaction of behavioural, socio-cultural and organisational drivers (Vinnari and Vinnari 2014). Reduced meat consumption is primarily driven by issues of personal health and animal welfare, instead of climate or environment concerns (Latvala et al. 2012; Dibb and Fitzpatrick 2014; Hartmann and Siegrist 2017; Graça et al. 2019). Social movements have promoted shifts to a vegan diet (Morris et al. 2014; Laestadius et al. 2016) yet their impact on actual behaviour is the subject of debate (Taufik et al. 2019; Harguess et al. 2020; Sahakian et al. 2020). Companies have expanded new markets in non-meat products (MINTEL 2019). Both corporate food actors and new entrants offering more innovative 'meat alternatives' view consumer preferences as an economic opportunity, and are responding by increasing the availability of meat replacement products. No significant policy change has taken place in the UK to enable dietary shift (Wellesley and Froggatt 2015). Agricultural policies serve to support meat production with large subsidies that lower production cost and effectively increase the meat intensity of diets at a population level (Simon 2003; Godfray et al. 2018). Deeper, population wide reductions in meat consumption are hampered by these lock-in mechanisms which continue to stabilise the existing meat production-consumption system. The extent to which policymakers are willing to actively stimulate reduced meat consumption thus remains an open question (Godfray et al. 2018). See more in Supplementary Material Chapter 5, SM5.6.4.

People's perceptions of climate risks, first covered in AR5, help create motivation for behaviour change, though related more proximate and personal concerns such as extreme weather and natural disasters may be more effective (Bergquist et al. 2019). 67% of individuals in 26 countries see climate change as a major threat to their country, an increase from 53% in 2013, though 29% also consider it a minor or no threat (Fagan and Huang 2019). Concern that the COVID-19 crisis may derail this momentum due to a finite pool of worry (Weber 2006) appears to be unwarranted: Americans' positions on climate change in 2020 matched high levels of concern measured in 2019 (Leiserowitz et al. 2020). Younger, female, and more educated individuals perceive climate risks to be larger (Weber 2016; Fagan and Huang 2019). Moral values and political ideology influence climate risk perception and beliefs about the outcomes and effectiveness of climate action (Maibach et al. 2011). Motivation for demand-side solutions can be increased by focusing on personal health or financial risks and benefits that clearly matter to people (Petrovic et al. 2014). Consistent with climate change as a normally distant, non-threatening, statistical issue (Gifford 2011; Fox-Glassman and Weber 2016), personal experience with climate-linked flooding or other extreme weather events increases perceptions of risk and willingness to act (Weber 2013; Atreya and Ferreira 2015; Sisco et al. 2017). Discounting the future matters (Hershfield et al. 2014): across multiple countries, individuals more focused on future outcomes more likely engage in environmental actions (Milfont et al. 2012).

There is *medium evidence and high agreement* that demographics, values, goals, personal and social norms differentially determine ASI behaviours, in the Netherlands and Spain (Abrahamse and Steg 2009; Niamir 2019; Niamir et al. 2020b), the OECD (Ameli and Brandt 2015), and 11 European countries (Mills and Schleich 2012; Roy et al. 2012). Education and income increase Shift and Improve behaviour, whereas personal norms help to increase the more difficult Avoid behaviours (Mills and Schleich 2012). Sociodemographic variables (household size and income) predict energy use, but psychological variables (perceived behavioural control, perceived responsibility) predict *changes* in energy use; younger households are more likely to adopt Improve decisions, whereas education increases Avoid decisions (Ahmad et al. 2015). In India and developing countries, Avoid decisions are made by individuals championing a cause, while Improve and Shift behaviour are increases by awareness programmes and promotional materials highlighting environmental and financial benefits (Chakravarty and Roy 2016; Roy et al. 2018a). Cleaner cookstove adoption (see Box 5.5), a widely studied Improve solution in developing countries (Nepal et al. 2010; Pant et al. 2014), goes up with income, education, and urban location; the influence of fuel availability and prices, household size and composition, and gender remains unclear, and potentially important drivers such as credit, supply-chain strengthening, and social marketing remain unstudied (Lewis and Pattanayak 2012).

Box 5.5 Socio-behavioural aspects of deploying cookstoves

Universal access to clean and modern cooking energy could cut premature death from household air pollution by two-thirds, while reducing forest degradation and deforestation and contribute to the reduction of up to 50% of CO_2 emissions from cooking (relative to baseline by 2030) (IEA 2017c; Hof et al. 2019). However, in the absence of policy reform and substantial energy investments, 2.3 billion people will have no access to clean cooking fuels such as biogas, LPG, natural gas or electricity in 2030 (IEA 2017c). Studies reveal that a combination of drivers influence adoption of new cookstove appliances including affordability, behavioural and cultural aspects (lifestyles, social norms around cooking and dietary practices), information provision, availability, aesthetic qualities of the technology, perceived health benefits and infrastructure (spatial design of households and cooking areas). The increasing efficiency *improvements* in electric cooking technologies, together with the ongoing decrease in prices of renewable energy technologies, could enable households to *shift* to electrical cooking at mass scale. The use of pressure cookers and rice cookers is now widespread in South Asia and beginning to penetrate the African market as consumer attitudes are changing towards household appliances with higher energy efficiencies (Batchelor et al. 2019). *Shifts* towards electric and LPG stoves in Bhutan (Dendup and Arimura 2019), India (Pattanayak et al. 2019), Ecuador (Martínez et al. 2017; Gould et al. 2018) and Ethiopia (Tesfamichael et al. 2021); and *improved* biomass stoves in China (Smith et al. 1993). Significant subsidy (Thinley 2019), information (Dendup and Arimura 2019), social marketing and availability of technology in the local markets are some of the key policy instruments helping to adopt ICS (Pattanayak et al. 2019). There is no one-size-fits-all solution to household air pollution – different levels of shift and improvement occur in different cultural contexts, indicating the importance of socio-cultural and behavioural aspects in shifts in cooking practices. See more in Supplementary Material Chapter 5, SM5.6.2.

There is *high agreement in the literature* that the updating of educational systems from a commercialised, individualised, entrepreneurial training model to an education cognizant of planetary health and human well-being can accelerate climate change awareness and action (Mendoza and Roa 2014; Dombrowski et al. 2016) (also see Supplementary Material Chapter 5).

There is *high evidence and high agreement* that people's core values affect climate-related decisions and climate policy support by shaping beliefs and identities (Dietz 2014; Steg 2016; Hayward and Roy 2019). People with altruistic and biospheric values are more likely to act on climate change and support climate policies than those with hedonic or egoistic values (Taylor et al. 2014), because these values are associated with higher awareness and concern about climate change, stronger belief that personal actions can help mitigating climate change, and stronger feelings of responsibility for taking climate action (Dietz 2014; Steg 2016). Research also suggest that egalitarian, individualistic, and hierarchical worldviews have their role, and that successful solutions require policy makers of all three worldviews to come together and communicate with each other (Chuang et al. 2020). Core values also influence which costs and benefits are considered (Hahnel et al. 2015; Gölz and Hahnel 2016; Steg 2016). Information provision and appeals are thus more effective when tailored to those values (Bolderdijk et al. 2013; Boomsma and Steg 2014). Awareness, personal norms, and perceived behavioural control predict willingness to change energy-related behaviour above and beyond traditional sociodemographic and economic predictors (Schwartz 1977; Ajzen 1985; Stern 2000). However, such motivation for change is often not enough, as actors also need capacity for change and help to overcome individual, institutional and market barriers (Young et al. 2010; Carrington et al. 2014; Bray et al. 2011).

Table 5.4 describes common obstacles to demand-side energy behaviour change, from loss aversion to present bias (for more detail see Supplementary Material Chapter 5). Choice architecture refers to interventions ("nudges") that shape the choice context and how choices are presented, with seemingly-irrelevant details (e.g., option order or labels) often more important than option price (Thaler and Sunstein 2009). There is *high evidence and high agreement* that choice architecture nudges shape energy decisions by capturing deciders' attention; engaging their desire to contribute to the social good; facilitating accurate assessment of risks, costs, and benefits; and making complex information more accessible (Yoeli et al. 2017; Zangheri et al. 2019). Climate-friendly choice architecture includes the setting of proper defaults, the salient positioning of green options (in stores and online), forms of framing, and communication of social norms (Johnson et al. 2012). Simplifying access to greener options (and hence lowering effort) can promote ASI changes (Mani et al. 2013). Setting effective "green" defaults may be the most effective policy to mainstream low-carbon energy choices (Sunstein and Reisch 2014), adopted in many contexts (Jachimowicz et al. 2019) and deemed acceptable in many countries (Sunstein et al. 2019). Table 5.3 lists how often different choice-architecture tools were used in many countries over the past 10 years to change ASI behaviours, and how often each tool was used to enhance an economic incentive. These tools have been tested mostly in developed countries. Reduction in energy use (typically electricity consumption) is the most widely studied behaviour (because metering is easily observable). All but one tool was applied to increase this Avoid behaviour, with demand-side reductions from 0% to up to 20%, with most values below 3% (see also meta-analyses by (Hummel and Maedche 2019; Nisa et al. 2019; van der Linden and Goldberg 2020; Stankuniene et al. 2020; Khanna et al. 2021)). Behavioural, economic, and legal instruments are most effective when applied as an internally consistent ensemble where they can reinforce each other, a concept referred to as "policy packaging" in transport policy research (Givoni 2014). A meta-analysis, combining evidence of psychological and economic studies, demonstrates that feedback, monetary incentives and social comparison operates synergistically and is together more effective than the sum of individual interventions (Khanna et al. 2021). The same meta-analysis also shows that combined with monetary incentives, nudges and choice architecture can reduce global GHG emissions from household energy use by 5-6% (Khanna et al. 2021).

Choice architecture has been depicted as an anti-democratic attempt at manipulating the behaviour of actors without their awareness or approval (Gumbert 2019). Such critiques ignore the fact that there is no neutral way to present energy-use related decisions, as every presentation format and choice environment influences choice, whether intentionally chosen or not. Educating households and policy makers about the effectiveness of choice architecture and adding these behavioural tools to existing market- and regulation-based tools in a transparent and consultative way can provide desired outcomes with increased effectiveness, while avoiding charges of manipulation or deception. People consent to choice architecture tools if their use is welfare-enhancing, policymakers are transparent about their goals and processes, public deliberation and participation is encouraged, and the choice architect is trusted (Sunstein et al. 2019).

1 **Table 5.3 Inventory of behavioural interventions experimentally tested to change energy behaviours**

Intervention Category	Behavioural Tool	# of Studies	# in Developed Countries	# in Other Countries	Energy Demand Behaviour	Avoid	Shift	Improve	Enhanced Economic Incentive	Effect Size
Choice Architecture	Set Proper Default	23	23	0	Investment in energy efficiency (11) (Ebeling and Lotz 2015; Theotokis and Manganari 2015; Steffel et al. 2016) Energy use (7) (Pichert and Katsikopoulos 2008; Sunstein 2015; Fowlie et al. 2017; Jachimowicz et al. 2019) Energy source (3) (Ebeling and Lotz 2015; Hedlin, S., and Sunstein 2016; Kaiser et al. 2020) Carbon offset program (2) (Löfgren et al. 2012; Araña and León 2013)	3	20	4	8	Increased green behaviour by 4-62%
	Habit Disruption	2	2	0	Energy use (2) (Verplanken and Wood 2006; Verplanken and Roy 2016)	1	0	2	0	Behaviour change more likely after moving house; with a 3-months 'window of opportunity'

Communication Tools	Timely Feedback & Reminders	41	40	1	Energy use (41) (McCalley and Midden 2002; McMakin et al. 2002; Wood and Newborough 2003; Mack and Hallmann 2004; Matsukawa 2004; Mosler and Gutscher 2004; Karbo and Larsen 2005; Kurz et al. 2005; Ueno et al. 2005; Benders et al. 2006; Darby 2006; Hydro One 2006; Ueno et al. 2006; Abrahamse et al. 2007; Robinson 2007; Parker et al. 2008; Attari et al. 2010; Gleerup et al. 2010; Abreu et al. 2011; AECOM 2011; Carrico and Riemer 2011; Wenham et al. 2020; Grønhøj and Thøgersen 2011; Alahmad et al. 2012; Kua and Wong 2012; Peschiera and Taylor 2012; Torriti 2012; Carroll et al. 2013; Costa and Kahn 2013; Delmas et al. 2013; Houde et al. 2013; D'Oca et al. 2014; Nilsson et al. 2014; DECC 2015; Karlin et al. 2015; Lynham et al. 2016; Henry et al. 2019; Mi and Coffman 2019; Zangheri et al. 2019)	36	1	5	10	1-24% reduction in energy use
	Make Information Intuitive & Easy to Access	32	31	1	Energy use (23) (Henryson et al. 2000; Jensen 2003; Wood & Newborough 2003; Matsukawa 2004; Benders et al. 2006; Darby 2006; Nexus Energy Software 2006; Abrahamse et al. 2007; Robinson 2007; Schultz et al. 2007; Costa & Kahn 2010; Faruqui et al. 2010; Kua & Wong 2012; Peschiera & Taylor 2012; Vassileva et al. 2012; Carroll et al. 2013; K. K. Chen 2014; D'Oca et al. 2014; Jessoe & Rapson 2014; A. Nilsson et al. 2014; V. L. Chen et al. 2015; Kendel et al. 2017; M. Nilsson et al. 2018; Wong-Parodi et al. 2019; Zangheri et al. 2019) Investment in energy efficiency (1) (Larrick and Soll 2008) Carbon offset program (1) (Camilleri and Larrick 2014)	23	2	8	12	0-23% reduction in energy use
	Make Behaviour Observable & Provide Recognition	4	4	0	Energy use (3) (Schwartz et al. 2013; Yoeli et al. 2013; Delmas and Lessem 2014) Investment in energy efficiency (1) (Tonn et al. 2015)	3	0	2	1	2-20% reduction in energy use

Methods of Persuasion	Communicate a Norm	20	18	2	Energy use (20) (Mosler and Gutscher 2004; Karbo and Larsen 2005; Abrahamse et al. 2007; Schultz et al. 2007; Dünnhoff and Duscha 2008; Abreu et al. 2011; Allcott 2011; Peschiera and Taylor 2012; Smith et al. 2012; Ayres et al. 2013; Costa and Kahn 2013; Dolan and Metcalfe 2013; Allcott and Rogers 2014; Shen et al. 2016; Whitmarsh and Corner 2017; Dubois et al. 2019; Henry et al. 2019; Mi and Coffman 2019; Bonan et al. 2020)	18	1	3	5	1-12% reduction in energy use; 10-20% decay in effect per year
	Reframe Consequences in Terms People Care About	31	29	2	Energy use (17) (Darby 2006; Nexus Energy Software 2006; Costa and Kahn 2010; Azevedo et al. 2011; Geelen et al. 2012; Vassileva et al. 2012; Dolan and Metcalfe 2013; Yoeli et al. 2013; Ito et al. 2014; Petrovic et al. 2014; Asensio and Delmas 2015; Ito et al. 2015; Asensio and Delmas 2016; Student et al. 2017; Whitmarsh and Corner 2017) Investment in energy efficiency (9) (Griskevicius et al. 2010; Kaenzig and Wüstenhagen 2010; Kunreuther and Michel-Kerjan 2015; Theotokis and Manganari 2015; Hardisty et al. 2016; Ungemach et al. 2017) Mode of transportation (2) (Nepal et al. 2010; Mattauch et al. 2016) Carbon offset program (2) (Camilleri and Larrick 2014)	10	4	12	14	8 - 24% reduction in energy use
	Obtain a Commitment	4	3	1	Energy use (3) (McCalley and Midden 2002; Mosler and Gutscher 2004; Mi and Coffman 2019) Mode of transportation (1) (Matthies et al. 2006)	2	1	1	1	1 - 21% reduction in energy use

5.4.2 Socio-cultural drivers of climate mitigation

Collective behaviours and social organisation is part of everyday life, and feeling part of active collective motion renders mitigation measures efficient and pervasive (Climact 2018). Social and cultural processes play an important role in shaping what actions people take on climate mitigation, interacting with individual, structural, institutional and economic drivers (Barr and Prillwitz 2014). Just like infrastructures, social and cultural processes can 'lock-in' societies to carbon-intensive patterns of service delivery. They also offer potential levers to re-imagine normative ideas and practices in order to achieve extensive emissions cuts (*high confidence,* see Table 5.4).

In terms of cultural processes, we can distinguish two levels of analysis. Specific **meanings** (e.g. comfort, status, identity and agency) are associated with many technologies and everyday social practices that deliver energy services, from driving a car to using a cookstove (*high evidence*, *high agreement*, see section 5.5). Meanings are symbolic and influence the willingness of individuals to use existing technologies or shift to new ones (Wilhite and Ling 1995; Wilhite 2009; Sorrell 2015). Underlining their importance for climate mitigation, symbolic motives are more important predictors of technology adoption than instrumental motives (Steg 2005; Noppers et al. 2014, 2015, 2016) (see mobility case study on app-cabs in Kolkata, Box 5.7).

Narratives about climate mitigation circulate within and across societies, as recognised in SR15, and are broader than the meanings associated with specific technologies (*high evidence, high agreement).* Narratives enable people to imagine and make sense of the future through processes of interpretation, understanding, communication and social interaction (Smith et al. 2017). Stories about climate change can be utopian or dystopian (e.g. The great derangement by Amitav Ghosh) (Ghosh 2016), for example presenting apocalyptic stories and imagery to capture people's attention and evoke emotional and behavioural response (O'Neill and Smith 2014). Reading climate stories causes short-term influences on attitudes towards climate change, increasing the belief that climate change is human caused and increasing its issue priority (Schneider-Mayerson et al. 2020). Climate narratives can justify scepticism of science, drawing together coalitions of diverse actors into social movements that aim to prevent climate action (Lejano and Nero 2020). Narratives have been used by indigenous communities to imagine climate futures divergent from top-down narratives (Streeby 2018). Narratives are also used in integrated assessment and energy system models that construct climate stabilisation scenarios, for example in the choice of parameters, their interpretation and model structure (Ellenbeck and Lilliestam 2019). One important narrative choice of many models involves framing climate change as market failure (which leads to the result that carbon pricing is required). While such a choice can be justified, other model framings can be equally justified (Ellenbeck and Lilliestam 2019). This signals the role of power and agency in shaping which climate stories are told and how prevalent they are (O'Neill and Smith 2014; Schneider-Mayerson et al. 2020).

The uptake of new climate narratives is influenced by political beliefs and trust. Policy makers can enable emissions reduction by employing narratives that have broad societal appeal, encourage behavioural change and complement regulatory and fiscal measures (Terzi 2020). Justice narratives about climate mitigation have been shown in a UK study to polarise individuals along ideological lines, with lower support amongst individual with right-wing beliefs; by contrast, narratives centred on saving energy, avoiding waste and patriotic values were more widely supported across society (Whitmarsh and Corner 2017). Research is needed to assess if these findings are prevalent in other social contexts, as well the role played by social media platforms to influence emerging narratives of climate change (Pearce et al. 2019).

Trust in organisations is a key predictor of the take-up of novel energy services (Lutzenhiser 1993), particularly when financial incentives are high (Stern et al. 1985; Joskow 1995). If there is low public trust in utility companies, solutions identified include initiatives led by community-based non-profit organisations in the US (Stern et al. 1985) or public/private partnerships in Mexico (Friedmann and

Sheinbaum 1998). UK research shows that acceptance of shifts to less-resource intensive service provision (e.g. more resource efficient products, extending product lifetimes, community schemes for sharing products) varies depending on factors including trust in suppliers and manufacturers, affordability, quality and hygiene of shared products, and fair allocation of responsibilities (Cherry et al. 2018). Trust in other people plays an important role in the sharing economy (Li and Wang 2020), for example predicting shifts in transport mode, specifically car-sharing involving rides with strangers (Acheampong and Siiba 2019) (sharing economy see section 5.3.4.2).

Action on climate mitigation is influenced by our perception of what other people commonly do, think or expect, known as **social norms** *(high evidence, high agreement)* (Cialdini 2006) (see Table 5.3), even though people often do not acknowledge this (Nolan et al. 2008; Noppers et al. 2014). Providing feedback to people about how their own actions compare to others can encourage mitigation (Delmas et al. 2013), although the overall effect size is not strong (Abrahamse and Steg 2013). Socially comparative feedback seems to be more effective when people strongly identify with the reference group (De Dominicis et al. 2019). Descriptive norms (perceptions of behaviours common in others) are more strongly related to mitigation actions when injunctive norms (perceptions of whether certain behaviours are commonly approved or disapproved) are also strong, when people are not strongly personally involved with mitigation topics (Göckeritz et al. 2010), when people are currently acting inconsistently with their preferences, when norm-based interventions are supported by other interventions and when the context supports norm-congruent actions (Miller and Prentice 2016). A descriptive norm prime (“most others try to reduce energy consumption”) together with injunctive norm feedback (“you are very good in saving energy”) is a very effective combination to motivate further energy savings (Bonan et al. 2020). Second-order beliefs (perceptions on what others in the community believe) are particularly important for leveraging descriptive norms (Jachimowicz et al. 2018). Trending norms that communicate that the number of people engaging in a behaviour is increasing, even if this concerns only a minority of people, can encourage shifts to the targeted behaviour, although the effect size is relatively small (Mortensen et al. 2019).

Behavioural contagion, which describes how ideas and behaviours often spread like infectious diseases, is a major contributor to the climate crisis (Sunstein 2019). But harnessing contagion can also mitigate warming. Carbon-heavy consumption patterns have become the norm only in part because we’re not charged for environmental damage we cause (Pigou 1920). The deeper source of these patterns has been peer influence (Frank 1999), because what we do influences others. A rooftop solar installation early in the adoption cycle, for example, spawns a copycat installation in the same neighbourhood within four months, on average. With such installations thus doubling every four months, a single new order results in 32 additional installations in just two years. And contagion doesn’t stop there, since each family also influences friends and relatives in distant locations.

Harnessing contagion can also underwrite the investment necessary for climate stability. If taxed more heavily, top earners would spend less, shifting the frames of reference that shape spending of those just below, and so on—each step simultaneously reducing emissions and liberating resources for additional green investment (Frank 2020). Many resist, believing that higher taxes would make it harder to buy life’s special extras. But that belief is a cognitive illusion (Frank 2020). Acquiring special things, which are inherently in short supply, requires outbidding others who also want them. When top tax rates rise in tandem, relative bidding power is completely unchanged, so the same penthouse apartments would end up in the same hands as before. More generally, behavioural contagion is important to leverage all relevant social tipping points for stabilising Earth’s climate (Otto et al. 2020).

For new climate policies and technologies to be rapidly and extensively implemented, they must be **socially acceptable** to those directly impacted by them (*medium evidence, high agreement*). Policies that run counter to social norms or cultural meanings are less likely to be effective in reducing emissions (Demski et al. 2015; Perlaviciute et al. 2018; Roy et al. 2018b). Implementation of renewable energy technologies will be more acceptable if taking account of cultural meanings, emotional attachments and identities linked to particular landscapes and places (Devine-Wright 2009) and enabling fairness in how decisions are taken and costs and benefits distributed (Wolsink, 2007). 'Top-down' imposition of climate policies by governments can translate into local opposition when perceived to be unjust and lacking transparency (*high evidence, high agreement*). Policy makers can build trust and increase the legitimacy of new policies by implementing early and extensive **public and stakeholder participation**, avoiding 'NIMBY' (Not In My Back Yard) assumptions about objectors and adopting 'Just Transition' principles (Owens 2000; Wolsink 2007; Wüstenhagen et al. 2007; Dietz and Stern 2008; Devine-Wright 2011; Heffron and McCauley 2018). Participatory mechanisms that enable deliberation by a representative sample of the public (Climate Assembly UK 2020) can inform policy making and increase the legitimacy of new and difficult policy actions (Dryzek et al. 2019).

Collective action by citizens can work to enable or to constrain climate mitigation, by arguing for change to individual, structural, institutional and economic drivers (*high evidence*, *high agreement*). Grassroots climate and energy initiatives can reconcile lower carbon footprints with higher life satisfaction and higher incomes (Vita et al. 2020). Transition Towns and **community energy** initiatives can lead to improvements in energy efficiency, ensuring a decent standard of living and increase renewable energy uptake, while building on existing social trust, and in turn, building social trust and initiating engagement, capacity building, and social capital formation (Hicks and Ison 2018). However, more evidence is required of the impacts of community energy initiatives (Creamer et al. 2018; Bardsley et al. 2019). **Religion** plays an important role in enabling collective action on climate by providing cultural interpretations of change and institutional responses (Roy et al. 2012; Haluza-DeLay 2014; Hulme 2015). Normative interpretations of climate change for and from religious communities are found in nearly every geography, and often observe popular movements for climate action drawing on religious symbols or metaphors (Jenkins et al. 2018). This suggests the value for policy makers of involving religious constituencies in devising and delivering climate response.

Social movements can open up windows of opportunity (so called 'Overton Windows') to unlock structural change (*high evidence, high agreement)* (Szałek 2013; Piggot 2018). Ways include: a) advocating new narratives for climate mitigation (e.g. climate 'emergency'); b) criticising positive meanings associated with high emission technologies or practices (see Diet and Solar PV Case Studies, Box 5.4 and 5.6); c) showing social disapproval for high emission behaviours (e.g. through 'flight shaming'); d) advocating behaviour change (e.g. shifting to veganism or flexible diets or shifting from public transport to car sharing – see Case Study on Mobility in Kolkata, Box 5.7); e) increasing a sense of agency amongst certain social groups (e.g. young people or indigenous communities) that structural change is possible. Climate strikes have become internationally prevalent, with the September 2019 strikes involved 7.6 million participants in 183 countries (Rosane 2019; Martiskainen et al. 2020; Fisher and Nasrin 2020). Enabled by digitalisation, these have given voice to youth on climate (Lee et al. 2020) and created a new cohort of active citizens engaged in climate demonstrations (Fisher 2019). Social movements can also work to prevent policy changes, for example in France the Gilet Jaunes objected to increases in fuel costs on the grounds that they unfairly distributed the costs and benefits of price rises across social groups, for example between urban, peri-urban and rural areas (Copland 2019).

Box 5.6 Solar PV and the agency of consumers

As an innovative technology, solar PV was strongly taken up by consumers (Nemet 2019). Several key factors explain its success. First, modular design made it applicable to different scales of deployment in different geographical contexts (e.g. large-scale grid-connected projects and smaller-scale off-grid projects) and allowed its application by companies taking advantage of emerging markets (Shum and Watanabe 2009). Second, culturally, solar PV symbolised an environmentally progressive technology that was valued by users (Morris and Jungjohann 2016). Large-scale adoption led to policy change (i.e. the introduction of feed-in tariffs that guaranteed a financial return) that in turn enabled improvements to the technology by companies. Over time, this has driven large-scale reductions in cost and increase in deployment worldwide. The relative importance of drivers varied across contexts. In Japan, state subsidies were lower yet did not hinder take-up because consumer behaviour was motivated by non-cost symbolic aspects. In Germany, policy change arose from social movements that campaigned for environmental conservation and opposed nuclear power, making solar PV policies politically acceptable. In summary, the seven-decade evolution of solar PV shows an evolution in which the agency of consumers has consistently played a key role in multiple countries, such that deriving half of global electricity supply from solar is now a realistic possibility (Creutzig et al. 2017). See more in Supplementary Material Chapter 5, SM5.6.1.

5.4.3 Business and Corporate Drivers

Businesses and corporate organisations play a key role in the mitigation of global warming, through decisions to invest in researching and implementing new energy technologies and energy efficient measures, and the supply side interaction with changing consumer preferences and behaviours, e.g. via marketing. Business models and strategies work both as a barrier to and as accelerator of decarbonisation. Still existing lock-in in infrastructures and business models advantages fossil fuel industry over renewable and energy efficient end use industry (Klitkou et al. 2015). The fossil fuel energy generation and delivery system therefore epitomises a barrier to the acceptance and implementation of new and cleaner renewable energy technologies (Kariuki 2018). A small number of corporate agents also aims to derail climate change mitigation by targeted lobbying and doubt-inducing media strategies (Oreskes and Conway 2011). Corporate advertisement and brand building strategies also attempt to deflect corporate responsibility to individuals, and/or to appropriate climate care sentiments in their own brand building; climate change mitigation is uniquely framed through choice of products and consumption, avoiding the notion of the political collective action sphere (Doyle 2011; Doyle et al. 2019).

Business and corporations are also agents of change towards decarbonisation, as demonstrated in the case of PV and battery electric cars (Teece 2018). Beyond new low-carbon technologies, strong sustainability business models (SSBM) are characterised by identifying nature as the primary stakeholder, strong local anchorage, the creation of diversified income sources, and deliberate limitations on economic growth (Brozovic 2019). However, SSBM are difficult to maintain if generally traditional business models prevail, requiring short-term accounting.

Liability of fossil fuel business models and insurance against climate damages are key concerns of corporations and business. Limitations and regulation on GHG emissions will compel the demand for fossil fuel companies' products (Porter and Kramer 2006). According to a European Systemic Risk Board (ESRB 2016) report of the Advisory Scientific Committee, insurance industries are very likely to incur losses due to liability risks. The divestment movement adds additional pressure on fossil fuel related investments (Braungardt et al. 2019), even though fossil fuel financing remains resilient (Curran 2020). Companies, businesses and organisations might face liability claims for their contribution to changes especially in the carbon intensive energy sector. A late transition to a low-carbon economy would exacerbate the physical costs of climate change on governments, businesses and corporations (ESRB 2016).

Professional actors play important roles in climate mitigation. Working as building managers, landlords, energy efficiency advisers, technology installers and car dealers, they influence patterns of mobility and energy consumption (Shove 2003) by acting as 'middle actors' (Janda and Parag 2013; Parag and Janda 2014) or 'intermediaries' in the provision of building or mobility services (Grandclément et al. 2015; De Rubens et al. 2018). As influencers on the process of diffusion of innovations (Rogers 2003), professionals can enable or obstruct improvements in efficient service provision or shifts towards low-carbon technologies (LCTs) (e.g. air and ground source heat pumps, solar hot water, underfloor heating, programmable thermostats, and mechanical ventilation with heat recovery) and mobility (e.g. electric vehicles) technologies.

5.4.4 Institutional Drivers

The allocation of political power to incumbent actors and coalitions has contributed to lock-in of particular institutions, stabilising the interests of incumbents through networks that include policymakers, bureaucracies, advocacy groups and knowledge institutions (*high agreement, high evidence*). There is high evidence and high agreement in that institutions are central in addressing climate change mitigation. They shape and interact with technological systems (Unruh 2000; Foxon et al. 2004; Seto et al. 2014) and represent rules, norms and conventions that organise and structure actions (Vatn 2015) and help create new path dependency or strengthen existing path dependency (Mattioli et al. 2020) (also see case studies in Box 5.4-5.7 and Supplementary Material Chapter 5). These drive behaviour of actors through formal (e.g., laws, regulations, and standards) or informal (e.g., norms, habits, and customs) processes, and can create constraints on policy options (Breukers and Wolsink 2007). For example, 'the car dependent transport system' is maintained by interlocking elements and institutions, consisting of i) the automotive industry; ii) the provision of car infrastructure; iii) the political economy of urban sprawl; iv) the provision of public transport; v) cultures of car consumption (Mattioli et al. 2020).

Box 5.7 Shifts from private to public transport in Indian megacities

In densely populated, fast-growing megacities, policy makers face the difficult challenge of preventing widespread adoption of petrol or diesel fuelled private cars as a mode of transport. The megacity of Kolkota, with a long history of good public transport system, in India provides a useful case study. As many as twelve different modes of public transportation, each with its own system structure, actors and meanings co-exist and offers means of mobility to its 14 million citizens. Most of the public transport modes are shared mobility options ranging from sharing between two people in a rickshaw or between a few hundred in metro or sub-urban trains. Sharing also happens informally as daily commuters avail shared taxis and neighbours borrow each other's car or bicycle for urgent or day trips.

A key role is played by the state government to improve the system as whole and formalise certain semi-formal modes of transport. An important policy consideration has been to make Kolkata's mobility system more efficient (in terms of speed, reliability and avoidance of congestion) and sustainable through strengthening coordination between different mode-based regimes (Ghosh 2019) and comfortable with airconditioned space in a hot and humid climate (Roy et al. 2018b). Policy makers have introduced multiple technological, behavioural and socio-cultural measures to tackle this challenge. New buses have been purchased by public authorities (Ghosh and Schot 2019). These have been promoted to middle-class workers in terms of modernity, efficiency and comfort, and implemented using premium-fares. Digitalisation and the sharing economy has encouraged take-up of shared taxi rides ('app cabs'), being low cost and fast, but also influenced by levels of social trust involved in rides with strangers (Acheampong and Siiba 2019; Ghosh and Schot 2019). Rickshaws have been improved through use of LNG and cycling has been banned from busy roads. These measures contributed positively in bringing down the trend of greenhouse gas emissions per unit of GDP to half in one decade within the Kolkata metropolitan area, with potential for further reduction (Colenbrander et al. 2016). However, social movements have opposed some changes due to concerns about social equity, since many of the new policies cater to middle class aspirations and preferences, at the cost of low income and less privileged communities.

To conclude, urban mobility transitions in Kolkata shows interconnected policy, institutional and socio-cultural drivers for socio-technical change. Change has unfolded in complex interactions between multiple actors, sustainability values and megatrends, where direct causalities are hard to identify. However, the prominence of policy actors as change-agents is clear as they are changing multiple regimes from within. The state government initiated infrastructural change in public bus systems, coordinated with private and non-governmental actors such as auto-rickshaw operators, app-cab owners who hold crucial agency in offering public transport services in the city. The latter can directly be attributed to the global momentum of mobility-as-a-service platforms, at the intersection of digitalisation and sharing economy trends. More thoughtful action at a policy level is required to sustain and coordinate the diversity of public transport modes through infrastructure design and reflecting on the overall directionality of change (Roy et al. 2018b; Schot and Steinmueller 2018). See more in Supplementary Material Chapter 5, SM5.6.3.

Narratives for change emerge from arising political challenges eventually creating new policy instruments, platforms, insights and producing institutional innovation (*high confidence*). One important way to understand institutions is that they shape the political context for decision making, empowering some interests and reducing the influence of others (Steinmo et al. 1992; Hall 1993; Moser 2009). Establishing carbon reduction as a policy priority shared across the political spectrum (UK, Germany, India, South Africa, now increasingly in the US) and achieving robust cross-party support is an institutional stepping stone for effective climate policies. Robust climate action, institutions and governance are essential in shifting political systems toward a positive feedback loop in favour of low carbon transition in their role as mediators of internal and external interests (Aklin and Urpelainen 2013; Lockwood et al. 2017; Roberts et al. 2018; Finnegan 2019). Institutions do evolve and can be created, altered or destroyed, and changes may be triggered by crisis, struggles, leadership in the functioning of the system or as external triggers such as the threat of climate change (Nilsson et al. 2011).

5.4.5 Technological/Infrastructural Drivers

Technologies and infrastructures shape social practices and their design matters for effective mitigation measures (*high evidence, high agreement*). There are systemic interconnections between infrastructures and practices (Cass et al. 2018), and their intersection explains their relevance (Thacker et al. 2019). The design of a new electricity system to meet new emerging demand based on intermittent renewable, can lead to a change in consumption habits and the adaption of lifestyles compliant with more power supply interruption (Maïzi et al. 2017; Maïzi and Mazauric 2019). The quality of the service delivery impacts directly the potential user uptake of low-carbon technologies. In the state of Himachal Pradesh of India, shift from LPG to electricity, with induction stove, has been successful due to the availability of stable and continuous electricity which has been difficult to achieve in any other Indian state (Banerjee et al. 2016). In contrast, in South Africa, where people who were using electricity earlier are now adopting LPG to diversify the energy source for cooking due to high electricity tariff and frequent blackouts (Kimemia and Annegarn 2016) (see Box 5.5 and Supplementary Material Chapter 5).

From a welfare point of view, infrastructure investments are not constrained by revealed or stated preferences (*high evidence, high agreement*). Preferences change with social and physical environment, and infrastructure interventions can be justified by objective measures, such as public health and climate change mitigation, not only given preferences (high agreement, high evidence). Specifically, there is a case for more investment in low-carbon transport infrastructure than assumed in environmental economics as it induces low-carbon preferences (Creutzig et al. 2016a; Mattauch et al. 2016, 2018). Changes in infrastructure provision for active travel may contribute to uptake of more walking and cycling (Frank et al. 2019). These effects contribute to higher uptake of low-carbon travel options, albeit the magnitude of effects depends on design choices and context (Goodman et al. 2013, 2014; Song et al. 2017; Javaid et al. 2020). Infrastructure is thus not only required to make low-carbon travel possible, but can also be a pre-condition for the formation of low-carbon mobility preferences (also see mobility case study in Box 5.7).

The dynamic interaction of habits and infrastructures also predict CO_2-intensive choices. When people move from a city with good public transport to a car-dependent city, they are more likely to own fewer vehicles due to learned preferences for lower levels of car ownership (Weinberger and Goetzke 2010). When individuals moving to a new city with extensive public transport were given targeted material about public transport options, the modal share of public transport increased significantly (Bamberg et al. 2003). Similarly, an exogenous change to route choice in public transport makes commuters change their habitual routes (Larcom et al. 2017).

Table 5.4 Main features, insights, and policy implications of five classes of Drivers of decision and action

Driver	Why status quo bias?	What needs to change?	Driver's Policy Implications	Examples
Behavioural	Habits and routines formed under different circumstances do not get updated. Present-bias penalises upfront costs and discourages energy efficiency investments. Loss aversion magnifies the costs of change. Only personal and dreaded risks trigger action, and climate change distant and not feared.	New goals (sustainable lifestyle) New capabilities (online real-time communication) New resources (increased education) Use of full range of incentives and mechanisms to change demand-side behaviour	Policies need to be context specific and coordinate economic, legal, social, and infrastructural tools and nudges Relate climate action to salient local risks and issues.	India's new LPG scale up policy. Rooftop solar expansion in Germany (via FITs) Nuclear power in Japan and Germany post Fukushima
Socio-Cultural	Cultural norms (e.g. status, comfort, convenience) support existing behaviour. Lack of social trust reduces willingness to shift behaviour (e.g. adopt car-sharing).	Create positive meanings and norms around low-emission service delivery (e.g. mass transit). Community initiatives to build social trust and engagement, capacity	Embed policies in supportive social norms. Support collective action on climate mitigation to	Communicate descriptive norms to electricity end users. Community energy initiative RESCOOP.

Driver	Why status quo bias?	What needs to change?	Driver's Policy Implications	Examples
	Fear of social disapproval decreases willingness to adopt new behaviours. Lack of opportunities to participate in policy create reactance against 'top down' imposition. Unclear or dystopian narratives of climate response reduce willingness to change and to accept new policies and technologies.	building, and social capital formation. Climate movements that call out the insufficient, highly problematic state of delayed climate action. Public participation in policy making and technology implementation that increases trust, builds capacity and increases social acceptance. Positive narratives about possible futures that avoid emissions (e.g. emphasis upon health and slow/active travel).	create social trust and inclusion. Involve arts and humanities to create narratives for policy process	Friday For Future.
Business and Corporate	Lock-in mechanisms that make incumbent firms reluctant to change: core capabilities, sunk investments in staff and factories, stranded assets.	New companies (like Uber, car sharing companies, renewable energy start-ups) that pioneer new business models or energy service provisions.	Influence consumer behaviour via product innovation Provide capital for clean energy innovation.	Electrification of transport opens up new markets for more than a hundred million new vehicles.
Institutional	Lock-in mechanisms related to power struggles, lobbying, political economy.	New policy instruments, policy discussions, policy platforms, implementation agencies, including capacity.	Feed-in Tariffs and other regulations that turn energy consumers into prosumers.	Mobility case study, India's LPG policy sequence.
Infrastructural	various lock-in mechanisms such as sunk investments, capabilities,	many emerging technologies, which are initially often more expensive, but may	systemic governance to avoid rebound effects.	Urban walking and bike paths.

Driver	Why status quo bias?	What needs to change?	Driver's Policy Implications	Examples
	embedding in routines/lifestyles.	benefit from learning curves and scale economies that drive costs down.		Stable and continuous electricity supply fostering induction stoves.

5.5 An integrative view on transitioning

5.5.1 Demand-side transitions as multi-dimensional processes

Several integrative frameworks including social practice theory (Shove and Walker 2014; Røpke 2009), the energy cultures framework (Stephenson et al. 2015; Jürisoo et al. 2019) and socio-technical transitions theory (McMeekin and Southerton 2012; Geels et al. 2017) conceptualise demand-side transitions as multi-dimensional and interacting processes (*high evidence, high agreement*). Social practice theory emphasises interactions between artefacts, competences, and cultural meanings (Shove and Walker 2014; Røpke 2009). The energy cultures framework highlights feedbacks between materials, norms, and behavioural practices (Stephenson et al. 2015; Jürisoo et al. 2019). Socio-technical transitions theory addresses interactions between technologies, user practices, cultural meanings, business, infrastructures, and public policies (McMeekin and Southerton 2012; Geels et al. 2017) and can thus accommodate the five drivers of change and stability discussed in Section 5.4.

Section 5.4 shows with *high evidence and high agreement* that the relative influence of different drivers varies between demand-side solutions. The deployment of 'improve' options like LEDs and clean cookstoves mostly involves technological change, adoption by consumers who integrate new technologies in their daily life practices (Sanderson and Simons 2014; Franceschini and Alkemade 2016; Smith et al. 1993), and some policy change. Changes in meanings are less pertinent for those 'improve'-options that are primarily about technological substitution. Other improve-options, like clean cookstoves, involve both technological substitution and changes in cultural meanings and traditions.

Deployment of 'shift' options like enhanced public transport involves substantial behavioural change and transitions to new or expanded provisioning systems, which may include new technologies (buses, trams), infrastructures (light rail, dedicated bus lanes), institutions (operational licenses, performance contracts), financial arrangements, and new organisations (with particular responsibilities and oversight) (*high evidence, high agreement*) (Deng and Nelson 2011; Turnheim and Geels 2019). Changes in cultural meanings can facilitate 'shift' options. Shifts towards low-meat diets, for instance, are motivated by costs and by beliefs about the undesirability of meat that relate more to issues like health, nutrition and animal welfare than climate change (De Boer et al. 2014; Mylan 2018).

'Avoid' options that reduce service levels (e.g. sufficiency or downshifting) imply very substantial behavioural and cultural changes that may not resonate with mainstream consumers (Dubois et al. 2019). Other 'avoid' options like tele-working also require changes in cultural meanings and beliefs (about the importance of supervision, coaching, social contacts, or office politics), as well as changes in behaviour, institutions, and technology (including good internet connections and office space at home). Because these interconnected changes were not widespread, tele-working did not diffuse widely before the COVID-19 crisis (Hynes 2014, 2016). As preferences change, new infrastructures and social settings can also elicit new desirabilities associated with emerging low-energy demand service provisioning systems (see 5.4.5).

Demand-side transitions involve interactions between radical social or technical innovations (such as the avoid, shift, improve options discussed in Section 5.3) and existing socio-technical systems, energy cultures, and social practices (*high evidence, high agreement*) (Geels et al. 2017; Stephenson et al. 2015). Radical innovations such as tele-working, plant-based burgers, car sharing, vegetarianism, or electric vehicles initially emerge in small, peripheral niches (Kemp et al. 1998; Schot and Geels 2008), constituted by R&D projects, technological demonstration projects (Borghei and Magnusson 2016; Rosenbloom et al. 2018b), local community initiatives or grassroots projects by environmental activists (Hargreaves et al. 2013a; Hossain 2016). Such niches offer protection from mainstream selection pressures and nurture the development of radical innovations (Smith and Raven 2012). Many low-carbon niche-innovations, such as those described in Section 5.3, face uphill struggles against existing socio-technical systems, energy cultures, and social practices that are stabilised by multiple lock-in mechanisms (*high evidence, high agreement*) (Klitkou et al. 2015; Clausen et al. 2017; Ivanova et al. 2018; Seto et al. 2016). Demand-side transitions therefore do not happen easily and involve interacting processes and struggles on the behavioural, socio-cultural, institutional, business and technological dimensions (see also section 5.4).

5.5.2 Phases in transitions

Transitions often take several decades, unfolding through several phases. Although there is variability across innovations, sectors, and countries, the transitions literature distinguishes four phases, characterised by generic core processes and challenges (*high confidence*) (Rotmans et al. 2001; Markard et al. 2012; Geels et al. 2017): 1) emergence, 2) stabilisation, 3) diffusion, 4) replacement and reconfiguration. These four phases do not imply that transitions are linear, teleological processes, because set-backs or reversals may occur as a result of learning processes, conflicts, or changing coalitions (*very high confidence*) (Geels and Raven 2006; Messner 2015; Davidescu et al. 2018). There is also no guarantee that technological, social, or business model innovations progress beyond the first phase.

In the first phase, radical innovations emerge in peripheral niches, where researchers, inventors, social movement organisations or community activists dedicate time and effort to their development (*high confidence*) (Kemp et al. 1998; Schot and Geels 2008). Radical social, technical and business model innovations are initially characterised by many uncertainties about technical performance, consumer interest, institutions and cultural meanings. Learning processes are therefore essential and can be stimulated through R&D, demonstration projects, local community initiatives or grassroots projects (Rosenbloom et al. 2018b; van Mierlo and Beers 2020; Hossain 2016; Borghei and Magnusson 2016; Sengers et al. 2019). Typical challenges are fragmentation and high rates of project failure (den Hartog et al. 2018; Dana et al. 2019), limited funding (Auerswald and Branscomb 2003), limited consumer interest, and socio-cultural acceptance problems due to being perceived as strange or unfamiliar (Lounsbury and Glynn 2001) .

In the second phase, social or technical innovations are appropriated or purchased by early adopters, which increases visibility and may provide a small but steady flow of financial resources (*high evidence, high agreement*) (Zimmerman and Zeitz 2002; Dewald and Truffer 2011). Learning processes, knowledge sharing and codification activities help stabilise the innovation, leading to best practice guidelines, standards, and formalised knowledge (*high evidence, high agreement*) (Raven et al. 2008; Borghei and Magnusson 2018). User innovation may lead to the articulation of new routines and social practices, often in tandem with the integration of new technologies into people's daily lives (Nielsen et al. 2016; Schot et al. 2016). Radical innovations remain confined to niches in the second phase because adoption is limited to small, dedicated groups (Schot et al. 2016), innovations are expensive or do not appeal to wider groups, or because complementary infrastructure are missing (Markard and Hoffmann 2016).

In the third phase, radical innovations diffuse into wider communities and mainstream markets. Typical drivers are performance improvements, cost reductions, widespread consumer interest, investments in infrastructure and complementary technologies, institutional support and strong cultural appeal (*high evidence, high agreement)* (Wilson 2012; Markard and Hoffmann 2016; Raven et al. 2016; Malone et al. 2017; Kanger et al. 2019). The latter may be related to wider cultural shifts such as increased public attention to climate change and new framings like 'climate emergency' which gained traction before the Covid-19 pandemic (Bouman et al. 2020b). These concerns may not last, however, since public attention typically follows cycles (Downs 1972; Djerf-Pierre 2012).

This phase often involves multiple struggles: economic competition between low-carbon innovations and existing technologies and practices, business struggles between incumbents and new entrants (Hockerts and Wüstenhagen 2010), cultural and framing struggles in public opinion arenas (Kammermann and Dermont 2018; Hess 2019a; Rosenbloom 2018), and political struggles over adjustments in policies and institutions, which shape markets and innovations (Meadowcroft 2011; Roberts and Geels 2019). The lock-in mechanisms of existing practices and systems tend to weaken in the third phase, either because competing innovations erode their economic viability, cultural legitimacy or institutional support (Turnheim and Geels 2012; Roberts 2017; Kuokkanen et al. 2018; Leipprand and Flachsland 2018) or because exogenous shocks and pressures disrupt the status quo (Kungl and Geels 2018; Simpson 2019).

In the fourth phase, the diffusing innovations replace or substantially reconfigure existing practices and systems, which may lead to the downfall or reorientation of incumbent firms (Bergek et al. 2013; McMeekin et al. 2019). The new system becomes institutionalised and anchored in professional standards, technical capabilities, infrastructures, educational programs, regulations and institutional logics, user habits, and views of normality, which create new lock-ins (Galaskiewicz 1985; Barnes et al. 2018; Shove and Southerton 2000)

Avoid, shift and improve options vary with regard to the four transition phases. Incremental 'improve' options, such as energy-efficient appliances or stand-alone insulation measures, are not transitions but upgrades of existing technologies. They have progressed furthest since they build on existing knowledge and do not require wider changes (Geels et al. 2018). Some radical 'improve' options, which have a different technological knowledge base, are beginning to diffuse, moving from phase two to three in multiple countries. Examples are electric vehicles, light-emitting diodes, or passive house designs (Berkeley et al. 2017; Franceschini and Alkemade 2016). Many 'shift' and 'avoid/reduce' options like heat pumps, district heating, passive house designs, compact cities, less meat initiatives, flight and car use reduction have low momentum in most countries, and are mostly in the first phase of isolated initiatives and projects (Bergman 2013; Bows-Larkin 2015; Bush et al. 2016; Kivimaa and Martiskainen 2018; Hoolohan et al. 2018; Morris et al. 2014). Structural transitions in Dutch cities and Copenhagen, however, demonstrate that transitions towards low-carbon lifestyles, developed around cycling, are possible (Colville-Andersen 2018). Low-carbon demand-side transitions are often still in early phases (*high evidence, high agreement*).

5.5.3 Feasible rate of change

Transitional change is usually slow in the first and second transition phase, because experimentation, social and technological learning, and stabilisation processes take a long time, often decades, and remain restricted to small niches (*high confidence*) (Bento et al. 2018b; Bento 2013; Wilson 2012). Transitional change accelerates in the third phase, as radical innovations diffuse from initial niches into mainstream markets, propelled by the self-reinforcing mechanisms, discussed above. The rate of adoption (diffusion) of new practices, processes, artefacts, and behaviours is determined by a wide range of factors at the macro- and micro-scales, which have been identified by several decades of diffusion research in multiple disciplines (for comprehensive reviews see, e.g. (Tornatzky and Klein 1982; Ausubel 1991; Bayus 1994; Van den Bulte and Stremersch 2004; Comin and Hobijn 2003; Davis 1979; Meade and Islam 2006; Mahajan et al. 1990; Mansfield 1968; Martino et al. 1978; Peres et al. 2010; Grubler 1991; Feder and Umali 1993; Rogers 2003)).

Diffusion rates are determined by two broad categories of variables, those intrinsic to the technology/product/practice under consideration (typically performance, costs, benefits), and those intrinsic to the adoption environment (e.g., socio-economic and market characteristics).

Despite differences, the literature offers three robust conclusions on acceleration (*high evidence, high agreement*): First, size matters. Acceleration of transitions is more difficult for social, economic, or technological systems of larger size (in terms of number of users, financial investments, infrastructure, powerful industries) (Wilson 2009, Wilson 2012). Size also matters at the level of the systems component involved in a transition. Components with smaller unit-scale ("granular" and thus relatively cheap), such as light bulbs or household appliances, turn over much faster (often within a decade) than large-scale, capital-intensive lumpy technologies and infrastructures (such as transport systems) where rates of change involve typically several decades, even up to a century (Grubler 1991; Leibowicz 2018). Also, the creation of entirely new systems (diffusion) takes longer time than replacements of existing technologies/practices (substitution) (Grübler et al. 1999); and late adopters tend to adopt faster than early pioneers (Grubler 1996; Wilson 2012).

Second, complexity matters, which is often related to unit-scale (Ma et al. 2008). Acceleration is more difficult for options with higher degrees of complexity (e.g., carbon capture, transport and storage, or a hydrogen economy) representing higher technological and investment risks that can slow down change. Options with lower complexity are easier to accelerate because they involve less experimentation and debugging and require less adoption efforts and risk.

Third, agency, structure and meaning can accelerate transitions. The creation and mobilisation of actor coalitions is widely seen as important for acceleration, especially if these involve actors with technical skills, financial resources and political capital (Kern and Rogge 2016; Hess 2019b; Roberts and Geels 2019). Changes in policies and institutions can also accelerate transitions, especially if these create stable and attractive financial incentives or introduce technology-forcing standards or regulations (Brand et al. 2013; Kester et al. 2018; Roberts et al. 2018). Changes in meanings and cultural norms can also accelerate transitions, especially when they affect consumer practices, enhance social acceptance, and create legitimacy for stronger policy support (Lounsbury and Glynn 2001; Buschmann and Oels 2019; Rogers 2003). Adoption of most advanced practices can support leapfrogging polluting technologies (Box 5.8).

Box 5.8 Is leapfrogging possible?

The concept of leapfrogging emerged in development economics (Soete 1985), energy policy (Goldemberg 1991) and environmental regulation (Perkins 2003), which provides a first critical review of the concept), and refers to a development strategy that skips traditional and polluting development in favour of the most advanced concepts. For instance, in rural areas without telephone landlines or electricity access (cables), a direct shift to mobile telephony or distributed, locally-sourced energy systems is promoted, or economic development policies for pre-industrial economies forego the traditional initial emphasis of heavy industry industrialisation, instead of focusing on services like finance or tourism. Often leapfrogging is enabled by learning and innovation externalities where improved knowledge and technologies become available for late adopters at low costs. The literature highlights many cases of successful leapfrogging but also highlights limitations (for a review see Watson and Sauter (Watson and Sauter 2011); with example case studies for China e.g. Gallagher

(Gallagher 2006) or Chen and Li-Hua (Chen and Li-Hua 2011); Mexico (Gallagher and Zarsky 2007); or Japan and Korea, e.g. Cho et al. (Cho et al. 1998). Increasingly the concept is being integrated into the literature of low-carbon development, including innovation and technology transfer policies (for a review see Pigato (2020)), highlighting in particular the importance of contextual factors of successful technology transfer and leapfrogging including: domestic absorptive capacity and technological capabilities (Cirera and Maloney 2017); human capital, skills, and relevant technical know-how (Nelson and Phelps 1966); the size of the market (Keller 2004); greater openness to trade (Keller 2004; Sachs and Warner 1995); geographical proximity to investors and financing (Comin et al. 2012); environmental regulatory proximity (Dechezleprêtre et al. 2015); and stronger protection of intellectual property rights (Dechezleprêtre et al. 2013; Dussaux et al. 2017). The existence of a technological potential for leapfrogging therefore needs to be considered within a wider context of social, institutional, and economic factors that influence if leapfrogging potentials can be realised (*high evidence*, *high agreement*).

There are also some contentious topics in the debate on accelerated low-carbon transitions. First, while acceleration is desirable to mitigate climate change, there is a risk that accelerating change too much may short-cut crucial experimentation and social and technological learning in "formative phases" (Bento 2013; Bento et al. 2018b) and potentially lead to a pre-mature lock-in of solutions that later turn out to have negative impacts (Cowan 1990, 1991) (*high evidence*, *medium agreement*).

Second, there is an ongoing debate about the most powerful leverage points and policies for speeding up change in social and technological systems. Farmer et al. 2019 suggested "sensitive intervention points" for low-carbon transitions, but do not quantify the impacts on transformations. Grubler et al. 2018 proposed an end-user and efficiency-focused strategy to achieve rapid emission reductions and quantified their scenario with a leading IAM. However, discussion of the policy implications of such a strategy have only just started (Wilson et al. 2019a) suggesting an important area for future research.

The last contentious issue is if policies can/should substitute for lack of economic/social appeal of change or for technological risks. Many large-scale supply-side climate mitigation options such as CCS or nuclear power involve high technological risks, critically depend on a stable carbon price, and are controversial in terms of social and environmental impacts (cf. the reviews in (Wilson et al. 2020a; Sovacool et al. 2014) and the comprehensive discussion in (Smith et al. 2016) *(high evidence, medium agreement*). There is continuing debate if and how policies could counterbalance these impacts in order to accelerate transitions (Nordhaus 2019; Lovins 2015). Some demand-side options like large-scale public transport infrastructures such as "Hyperloop" (Decker et al. 2017) or concepts such as "Asian Super Grid" (maglev fast train coupled with superconducting electricity transmission networks) (AIGC 2017) may face similar challenges, which adds weight and robustness to those demand-side options that are more decentralised, granular in scale and provide potential tangible consumer benefits besides being low-carbon (like more efficient buildings and appliances, "soft" urban mobility options (walking and cycling), digitalisation, among others, cf. Grubler et al. 2018).

A robust conclusion from this review is that there are no generic acceleration policies that are independent from the nature of what changes, by whom and how. Greater contextualisation and granularity in policy approaches is therefore important to address the challenges of rapid transitions towards zero-carbon systems *(high evidence, high agreement*).

5.6 Governance and policy

5.6.1 Governing mitigation: participation and social trust

In demand side mitigation, governance is key to drive the multidimensional changes needed to meet service needs within a society that provide people with a decent living while increasingly reducing resource and energy input levels (Rojas-Rueda et al. 2012; Batchelor et al. 2018; OECD 2019). Impartial governance, understood as equal treatment of everyone by the rule of law, creates social trust and is thus a key enabler of inclusive and participatory demand-side climate policies (Rothstein 2011). Inclusive and broad-based participation itself also leads to greater social trust and thus is also a key enabler of demand-side climate mitigation (see Section 5.2 for details). Higher social trust and inclusive participatory processes also reduce inequality, restrain opportunistic behaviour and enhance cooperation (Drews and van den Bergh 2016; Gür 2020) (see also Section 5.2). Altogether, broad-based participatory processes are central to the successful implementation of climate policies (Rothstein and Teorell 2008; Klenert et al. 2018) (*high evidence , medium agreement)*. A culture of cooperation feeds back to increase social trust and enables action that reduce GHG emissions (Carattini et al. 2015; Carattini and Jo 2018), and requires including explicit consideration of the informal sector (Box 5.9). More equitable societies also have the institutional flexibility to allow for mitigation to advance faster, given their readiness to adopt locally appropriate mitigation policies; they also suffer less from policy lock-in (Tanner et al. 2009; Lorenz 2013; Chu 2015; Cloutier et al. 2015; Martin 2016; Seto et al. 2016; Vandeweerdt et al. 2016; Turnheim et al. 2018).

Box 5.9 The informal sector and climate mitigation

The informal economy represents a large and growing portion of socio-economic activities (Muchie et al. 2016; Mbaye and Gueye 2018), including much of the work done by women worldwide. It accounts for an estimated 61% of global employment in the world; 90% in developing countries, 67% in emerging countries, and 18% in developed countries (Berik 2018), representing roughly 30% of GDP across a range of countries (Durán Heras 2012; Narayan 2017). Due to its importance, policies which support informal-sector climate mitigation activities may be extremely efficient (Garland and Allison M. 2015; Paz et al. 2015; Satterthwaite et al. 2020). For example, environmental and energy taxes may have negative gross costs when the informal sector dominates economic activity; informal production may substitute for energy-intensive goods, with strong welfare-enhancing effects (Bento et al. 2018a). Constraints on small and informal-sector firms' ability to build climate resilience include financial and data barriers, limited access to information technology, and policy exclusion (Crick et al. 2018a,b).

Informal-sector innovation is often underrated. It gives marginalised people access to welfare-enhancing innovations, building on alternative knowledge and socially-embedded reciprocal exchange (Jaffe and Koster 2019; Sheikh 2019; Sheikh and Bhaduri 2020). Large improvements in low-emission, locally-appropriate service provision are possible by facilitating informal-sector service providers' access to low-energy technologies (while taking care not to additionally burden the unpaid and marginalised), through such means as education, participatory governance, government policies to assist the informal sector, social services, healthcare, credit provision, and removing harmful policies and regulatory silos. The importance of the informal economy, especially in low-income countries, opens many possibilities for new approaches to DSL service provision along with climate resilience (Rynikiewicz and Chetaille 2006; Backstränd et al. 2010; Porio 2011; Kriegler et al. 2014; Taylor and Peter 2014; Brown and McGranahan 2016; Chu 2016; Boran 2019; Hugo and du Plessis 2019; Satterthwaite et al. 2018; Javaid et al. 2020).

Public information and understanding of the CO_2-eq emissions implied by consumption patterns can unleash great creativity for meeting service needs fairly and with lower emissions (Darier and Schüle

1999; Sterman and Sweeney 2002; Lorenzoni et al. 2007; Billett 2010; Marres 2011; Zapico Lamela et al. 2011; Polonsky et al. 2012; Williams et al. 2019). Community-based mapping, social learning, green infrastructure development, and participatory governance facilitate such information-sharing (Tauhid and Zawani 2018; Mazeka et al. 2019; Sharifi 2020), strengthening mitigation policies (Loiter et al. 1999; Stokes and Warshaw 2017; Zhou et al. 2019).

Since informal settlements are usually dense, upgrading them supports low-carbon development pathways which leapfrog less-efficient housing, transport and other service provision, using locally-appropriate innovations (Satterthwaite et al. 2018). Examples of informal-sector mitigation include digital banking in Africa; mobility in India using recycled motors and collective transport; food production, meal provision, and reduction of food waste in Latin America (e.g. soup kitchens in Brazil, community kitchens in Lima, Peru); informal materials recycling, space heating and cooling, and illumination (Hordijk 2000; Baldez 2003; Maumbe 2006; Gutberlet 2008; Chaturvedi and Gidwani 2010; Nandy et al. 2015; Rouse and Verhoef 2016; Ackah 2017).

5.6.2 Policies to strengthen Avoid-Shift-Improve

There is high untapped potential of demand-side mitigation options if considered holistically within the domains of avoid-shift-improve (Section 5.3, Table 5.4). Within the demand-side mitigation options opportunity space, policies currently focus more on efficiency and ‘improve’ options and relatively less on ‘shift’ and ‘avoid’ options (Dubois et al. 2019; Moberg et al. 2019). Current demand side policies are fragmented, piecemeal and too weak to drive demand-side transitions commensurate with 1.5^{o}C or 2^{o}C climate goals (Wilson et al. 2012; Fawcett et al. 2019; Moberg et al. 2019; Mundaca et al. 2019) (*high evidence, high agreement)*. Policies that are aimed at behaviour and lifestyle changes carry a perception of political risks for policy makers, which may explain why policy instruments focus more on information provision and adoption of incentives than on regulation and investment (Rosenow et al. 2017; Moberg et al. 2019). Acceleration of demand-side transitions would thus require both a broadening of demand-side options and the creation of comprehensive and targeted policy mixes (Kern et al. 2017; Rosenow et al. 2017; IPCC 2018) that lower the barriers to change identified in Section 5.4, Table 5.4 and in the tables below *(high evidence, high agreement)*. Demand-side transitions in developing and emerging economies would also require stronger administrative capacity as well as technical and financial support (UN-Habitat 2013; Creutzig et al. 2016b).

Systematic categorisation of demand-side policy options in different sectors and services through the avoid-shift-improve (ASI) framework enables identification of major entry points and possible associated social struggles to overcome for the policy instruments/interventions as discussed below.

5.6.2.1 Avoid policies

There is *high evidence and agreement* that “Avoid’ policies that affect lifestyle changes offer opportunities for cost-effective reductions in energy use and emissions, but would need to overcome political sensitivities around government efforts to shape and modify individual-level behaviour (see Table 5.5) (Rosenow et al. 2017; Grubb et al. 2020). These policies include ways to help avoid travel growth through integrated city planning or building retrofits to help avoid demand for transport, heating or cooling (Bakker et al. 2014; Lucon et al. 2014; de Feijter et al. 2019), which interact with existing infrastructure. Dense pedestrianised cities and towns and medium-density transit corridors are better placed to implement policies for car reductions than ‘sprawled’ cities characterised by low-density, auto-dependent and separated land uses (Bakker et al. 2014; Seto et al. 2014; Newman and Kenworthy 2015; Newman et al. 2017).

Cities face pressing priorities like poverty reduction, meeting basic services and building human and institutional capacity. These are met with highly accessible walkable and cyclable cities, connected with public transit corridors, enabling equal accessibility for all citizens, and enabling a high level of service provisioning (UN-Habitat 2013; Colenbrander et al. 2016; Creutzig et al. 2016b). Infrastructure development costs less than for car dependent cities. However, it requires a mindset shift for urban and transport planners (*medium evidence, high agreement*).

Policies that support the avoidance of higher emission lifestyles and improve wellbeing are facilitated by the introduction of smart technologies, infrastructures and practices (Amini et al. 2019). They include regulations and measures for investment in high-quality ICT infrastructure, regulations to restrict number plates as well as company policy around flexible working conditions (Lachapelle et al. 2018; Shabanpour et al. 2018). Working-from-home arrangements may advantage certain segments of society such as male, older, higher educated and highly paid employees, potentially exacerbating existing inequalities in the labour market (Lambert et al. 2020; Bonacini et al. 2021). In the absence of distributive or other equity-based measures, the potential gains in terms of emissions reduction may therefore be counteracted by the cost of increasing inequality. This potential growth in inequality is likely to be more severe in poorer countries that will additionally suffer from a lack of international funding for achieving the SDGs (Barbier and Burgess 2020; UN 2020) (*high evidence, medium agreement*).

Table 5.5 Examples of policies to enable "avoid" options

Mitigation Option	Perceived struggles to overcome	Policy to overcome struggles (nudge/incentives)
Reduce passenger km	Overcoming existing paradigms and planning practices and car dependency (Rosenow et al. 2017; Grubb et al. 2020). Financial and capacity barrier in many developing countries.	Integrated city planning to avoid travel growth, car reduction, building retrofits to avoid heating or cooling demand (Bakker et al. 2014; Lucon et al. 2014; de Feijter et al. 2019). Public-private partnership to overcome financial barrier. (see Box 5.7) (Roy et al. 2018b).
Reduce/avoid food waste	Little visible political and social momentum to prevent food waste in the Global North.	Strengthen national nutrition guidelines for health safety, Improve education/awareness on food waste; policies to eliminate ambiguous food labelling include well-defined and clear date labelling systems for food (Wilson et al. 2017); policies to support R&D to improve packaging to extend shelf life (Thyberg and Tonjes 2016). Charging according to how much food households throw away.
Reduce size of dwellings	Size of residents/dwelling getting smaller in many countries.	Compact city design, putting a ceiling on per person property ownership.
Reduce/avoid heating, cooling and lighting in dwellings	Change in individual behaviour in dress codes and working times	Temperature set point as norm; building energy codes that set building standards; bioclimatic or/and zero emissions; cities ser building energy that incorporate features like daylighting and increased building depth, height, and compactness (Steemers 2003; Creutzig et al. 2016a).

Sharing economy for more service per product	Inclusivity and involvement of users in design. Digital divide, unequal access and unequal digital literacy (Pouri and Hilty 2018). Political or power relations among actors involved in the sharing economy (Curtis and Lehner 2019).	Discount for public parking lot space, and subsidies towards the purchase of electric vehicles providers of electric vehicle (EV) sharing services were given subsidies towards the purchase of electric vehicles (Jung and Koo 2018).

Note: Please see Section 5.3.1.1 and Table 5.1 for details on options. For direct and indirect benefits and links with wellbeing and SDG dimensions please see Section 5.2, Figure 5.6.

5.6.2.2 Shift policies

As indicated in Table 5.6, 'Shift' policies have various forms such as the demand for low carbon materials for buildings and infrastructure in manufacturing and services and shift from meat-based protein, mainly beef, to plant-based diets of other protein sources (Willett et al. 2019; Ritchie et al. 2018; Springmann et al. 2016a) (*high evidence, high agreement*). Governments also play a direct role beyond nudging citizens with information about health and wellbeing. While the effectiveness of these policies on behaviour change overall may be limited (Pearson-Stuttard et al. 2017; Shangguan et al. 2019), there is some room for policy to influence actors upstream, i.e. industry and supermarkets which may give rise to longer-term, structural change.

Table 5.6 Examples of policies to enable "shift" options

Mitigation Option	Perceived struggles to overcome	Policy to overcome struggles (nudge/incentives)
More walking, less car use, train rather air travel	Adequate infrastructure may be absent, speed a part of modern life.	Congestion charges (Pearson-Stuttard et al. 2017; Shangguan et al. 2019); deliberate urban design including cycling lanes, shared micromobility, and extensive cycling infrastructure. Fair street space allocation (Creutzig et al. 2020).
Multifamily housing,	Zonings that favour single family homes have been dominant in planning (Hagen 2016).	Taxation, relaxation of single-family zoning policies and land use regulation (Geffner 2017).
Shifting from meat to other protein	Minimal meat required for protein intake, especially in developing countries for population suffering from malnutrition and when plant-based protein is lacking(Garnett 2011; Sunguya et al. 2014; Behrens et al. 2017; Godfray et al. 2018); Dominance of market-based instruments limits governments' role to nudging citizens with information about health and wellbeing, and point-of-purchase labelling (Pearson-Stuttard et al. 2017; Shangguan et al. 2019).	Tax on meat/beef (Edjabou and Smed 2013; Säll and Gren 2015). Nationally recommended diets (NRDs) (Garnett 2011; Sunguya et al. 2014; Behrens et al. 2017; Godfray et al. 2018).

Material-efficient product design, packaging	Resistance by architects and builders who might perceive risks with lean designs. Cultural/ social norms. Policy measures not keeping up with changes on the ground such as increased consumption of packaging.	Embodied carbon standards for buildings (IEA 2019c). For packaging, policies focusing on total reduction of environmental impacts through a reduction of material used (Worrell and Van Sluisveld 2013).
Architectural design with shading and ventilation	Lack of education, awareness and capacity for new thinking, local air pollution.	Incentives for increased urban density and incentives to encourage architectural forms with lower surface-to-volume ratios and increased shading support (Creutzig et al. 2016a).

Mobility services is one of the key areas where a combination of market-based and command-and-control measures have been implemented to persuade large numbers of people to get out of their automobiles and take up public transport and cycling alternatives (Gehl et al. 2011). Congestion charges are often complemented by other measures such as company subsidies for bicycles to incentivise the shift to public mobility services. Attracting people to public transport requires sufficient spatial coverage of transport with adequate level of provision, and good quality service at affordable fares (Sims et al. 2014; Moberg et al. 2019) (*high evidence, high agreement*). Cities such as Bogota, Buenos Aires and Santiago have seen rapid growth of cycling, resulting in an 6-fold of cyclists (Pucher and Buehler 2017). Broadly, the history and type of city determines how quickly the transition to public modes of transport can be achieved. For example, cities in developed countries enjoy an advantage in that network of high-quality public transport predating the advent of automobiles, whereas cities in less developed countries are latecomers in large-scale network infrastructure (UN-Habitat 2013; Gota et al. 2019).

5.6.2.3 Improve policies

'Improve' policies focus on the efficiency and enhancement of technological performance of services (Table 5.7). In mobility services, *'improve'* policies aim at improving vehicles, comfort, fuels, transport operations and management technologies; and in building, they include policies for improving efficiency of heating systems and retrofitting existing buildings. Efficiency *improvements* in electric cooking appliances, together with the ongoing decrease in prices of renewable energy technologies, is opening policy opportunities to support households to adopt electrical cooking at mass scale (IEA 2017c; Puzzolo et al. 2019) (*medium evidence, medium agreement*). These actions towards cleaner energy for cooking often come with cooking-related reduction of GHG emissions, even though the extent of the reductions is highly dependent on context and technology and fuel pathways (Martínez et al. 2017; Mondal et al. 2018; Rosenthal et al. 2018; Serrano-Medrano et al. 2018; Hof et al. 2019) (*high evidence, high agreement*) (see Box 5.5).

Table 5.7 Examples of policies to enable "improve" options

Mitigation Option	Perceived struggles to overcome	Policy to overcome struggles (nudge/incentives)
Lightweight vehicle, hydrogen car, electric vehicles, ecodriving	Adequate infrastructure may be absent, speed a part of modern life.	Monetary incentives and traffic regulations favouring EVs; investment in public charging infrastructure; car purchase tax calculated by a combination of weight, CO_2 and NOx emissions (Haugneland and

		Kvisle 2015; Globisch et al. 2018; Gnann et al. 2018; Lieven and Rietmann 2018; Rietmann and Lieven 2019).
Use low carbon materials in dwelling design	Manufacturing and R&D costs, recycling processes and aesthetic performance (Orsini and Marrone 2019). Access to secondary materials in the building sector (Nußholz et al. 2019).	Increasing recycling of construction and demolition waste; Incentives must be available to companies in the waste collection and recovery markets to offer recovered material at higher value (Nußholz et al. 2019).
Better insulation and retrofitting	Policies to advance retrofitting and GHG emission reductions in buildings are laden with high expectations since they are core components of politically ambitious city climate targets (Haug et al. 2010). Bringing building owners to implement measures identified in auditing results Lack of incentive for building owners to invest in higher efficiency than required norms (Trencher et al. 2016).	Grants and loans through Development Banks, building and heating system labels, and technical renovation requirements to continuously raise standards (Ortiz et al. 2019; Sebi et al. 2019); disclosure of energy use, financing and technical assistance (Sebi et al. 2019).
Widen low carbon energy access	Access to finance, capacity, robust policies, affordability for poor households for off-grid solutions until recently (Rolffs et al. 2015; Fuso Nerini et al. 2018; Mulugetta et al. 2019).	Feed-in-tariffs and auctions to stimulate investment. Pay-as-you-go (PAYG) end-user financing scheme where customers pay a small up-front fee for the equipment, followed by monthly payments, using mobile payment system (Yadav et al. 2019; Rolffs et al. 2015).
Improve illumination related emission	Supply side solution for low carbon electricity provision.	Building energy codes that set building standards; grants and other incentives for R&D.
Improve efficiency of cooking appliances	Reliability of power in many countries is not guaranteed; electricity tariff is high in many countries; cooking appliances are mostly imported using scarce foreign currency.	Driven by a combination of government support for appliance purchases, shifting subsidies from kerosene or LPG to electricity; community-level consultation and awareness campaigns about the hazards associated with indoor air pollution from the use of fuelwood and kerosene, as well as education on the multiple benefits of electric cooking (Yangka and Diesendorf 2016; Martínez-Gómez et al. 2016; Martínez et al. 2017; Gould and Urpelainen 2018; Dendup and Arimura 2019; Pattanayak et al. 2019).

Shift to LED lamp	People spend increasing amounts of time indoors, with heavy dependence on and demand for artificial lighting environment (Ding et al. 2020).	Government Incentive, utility incentive (Bertoldi et al. 2020). EU bans on directional and non-directional halogen bulbs (Franceschini et al. 2018).
Solar water heating	Dominance of incumbent energy source i.e. electricity; cheap conventional energy; high initial investment costs and long payback (Joubert et al. 2016).	Subsidy for solar heaters (Li et al. 2013; Bessa and Prado 2015; Sgouridis et al. 2016).

Table 5.7 highlights the significant progress made in the uptake of the Electrical Vehicle (EV) in Europe, driven by a suite of incentives and policies. Increased activity in widening Electric Vehicle (EV) use is also occurring in developing countries. The Indian Government's commitment to reach the target of a 100% electric vehicle fleet by 2030 has stimulated investment in charging infrastructure that can facilitate diffusion of larger EVs (Dhar et al. 2017). India's large and growing two-wheeler market has benefitted from this policy drive, showing a significant potential for increasing the share of electric two-and three-wheelers in the short-term (Ahmad and Creutzig 2019). Similar opportunities exist for China where e-bikes have replaced car trips and are reported to act as intermediate links in multimodal mobility (Cherry et al. 2016).

In recent years, policy interest has arisen to address the energy access challenge in Africa using low-carbon energy technologies to meet energy for poverty reduction and climate action simultaneously (Rolffs et al. 2015; Fuso Nerini et al. 2018; Mulugetta et al. 2019). This aspiration has been bolstered on the technical front by significant advances in appliance efficiency such as light-emitting diode (LED) technology, complemented by the sharp reduction in the cost of renewable energy technologies, and largely driven by market stimulating policies and public R&D to mitigate risks (Alstone et al. 2015; Zubi et al. 2019) (*high evidence, high agreement*).

5.6.3 Policies in transition phases

Demand-side policies tend to vary for different transition phases (*high evidence, high agreement*) (Roberts and Geels 2019; Sandin et al. 2019). In the first phase, which is characterised by the emergence or introduction of radical innovations in small niches, policies focus on: a) supporting R&D and demonstration projects to enable learning and capability developments, b) nurturing the building of networks and multi-stakeholder interactions, and c) providing future orientation through visions or targets (Brown et al. 2003; López-García et al. 2019; Roesler and Hassler 2019). In the second phase, the policy emphasis shifts towards upscaling of experiments, standardisation, cost reduction, and the creation of early market niches (Borghei and Magnusson 2018; Ruggiero et al. 2018). In the third and later phases, comprehensive policy mixes are used to stimulate mass adoption, infrastructure creation, social acceptance and business investment (Fichter and Clausen 2016; Geels et al. 2018; Strauch 2020). In the third phases, transitions can also be stimulated through policies that weaken or phase-out existing regimes such as removing subsidies (for cheap petrol or fuel oil), increasing taxes on carbon-intensive products and practices, or substantially tightening regulations and standards (Kivimaa and Kern 2016; David 2017; Rogge and Johnstone 2017).

Box 5.10: Carbon pricing and fairness

Whether the public supports specific policy instruments for reducing greenhouse gas emissions is determined by cultural and political world views (Alberini et al. 2018; Cherry et al. 2017; Kotchen et al. 2017) and national position in international climate negotiations with major implications for policy design. For example, policy proposals need to circumvent "solution aversion": that is, individuals are more doubtful about the urgency of climate change mitigation if the proposed policy contradicts their political worldviews (Campbell and Kay 2014). While carbon pricing is the most efficient way to reduce emissions, a recent literature – focusing on populations in Western Europe and North America and carbon taxes – documents that efficiency feature alone is not what makes citizens like or dislike carbon pricing schemes (Kallbekken et al. 2011; Carattini et al. 2017; Klenert et al. 2018).

Citizens tend to ignore or doubt the idea that pricing carbon emissions reduces GHG emissions (Kallbekken et al. 2011; Douenne and Fabre 2019; Maestre-Andrés et al. 2019). Further, citizens have fairness concerns about carbon pricing (Büchs and Schnepf 2013; Douenne and Fabre 2019; Maestre-Andrés et al. 2019), even if higher carbon prices can be made progressive by suitable use of revenues (Rausch et al. 2011; Williams et al. 2015; Klenert and Mattauch 2016). There are also non-economic properties of policy instruments that matter for public support: Calling a carbon price a "CO_2 levy" alleviates solution aversion (Kallbekken et al. 2011; Carattini et al. 2017). It may be that the word "tax" evokes a feeling of distrust in government and may have high costs, low benefits and distributional effects (Strand 2020). Trust in politicians is correlated with higher carbon prices (Hammar and Jagers 2006; Rafaty 2018) and political campaigns for a carbon tax can lower public support for them (Anderson et al. 2019). Few developing countries have adopted carbon taxes, probably due to high costs, relatively low benefits, and distributional effects (Strand 2020).

To address these realities regarding support for carbon pricing, some studies have examined whether specific uses of the revenue can increase public support for higher carbon prices (Carattini et al. 2017; Beiser-McGrath and Bernauer 2019). Doubt about the environmental effectiveness of carbon pricing may be alleviated if revenue from carbon pricing is earmarked for specific uses (Kallbekken et al. 2011; Carattini et al. 2017) and higher carbon prices may then be supported (Beiser-McGrath and Bernauer 2019). This is especially the case for using the proceeds on "green investment" in infrastructure or energy efficiency programmes (Kotchen et al. 2017). Further, returning the revenues to individuals in a salient manner may increase public support and alleviate fairness proposals, given sufficient information (Carattini et al. 2017; Klenert et al. 2018). Perceived fairness is one of the strongest predictors of policy support (Jagers et al. 2010; Whittle et al. 2019).

5.6.4 Policy sequencing and packaging to strengthen enabling conditions

Policy coordination is critical to manage infrastructure interdependence across sectors, and to avoid trade-off effects (Raven and Verbong 2007; Hiteva and Watson 2019), specifically requiring the consideration of interactions among supply-side and demand-side measures (Kivimaa and Virkamäki 2014; Rogge and Reichardt 2016; de Coninck et al. 2018; Edmondson et al. 2019) (*high evidence, high agreement*). For example, the amount of electricity required for cooking can overwhelm the grid which can lead to failure, causing end-users to shift back to traditional biomass or fossil fuels (Ateba et al. 2018; Israel-Akinbo et al. 2018); thus grid stability policies need to be undertaken in conjunction.

Policy makers operate in a politically dynamic national and international environment, and their policies often reflect their contextual situations and constraints with regards to climate-related reforms (Levin et al. 2012; Copland 2019), including differentiation between developed and developing countries (Beer and Beer 2014; Roy et al. 2018c) *(high evidence, high agreement).* Variables such as internal political stability, equity, informality (Box 5.9), macro-economic conditions, public debt, governance of policies, global oil prices, quality of public services, and the maturity of green technologies play important roles in determining policy directions.

Sequencing policies appropriately is a success factor for climate policy regimes (*high evidence, high agreement*). In most situations policy measures require a preparatory phase that prepares the ground by lowering the costs of policies, communicating the costs and benefits to citizens, and building coalitions for policies, thus reducing political resistance (Meckling et al. 2017). This policy sequencing aims to incrementally relax or remove barriers over time to enable significant cumulative increases in policy stringency and create coalitions that support future policy development (Pahle et al. 2018). German policies into renewables began with funding for RD&D, then subsidies for demonstration projects during the 1970s and 1980s, and continued to larger-scale projects such as 'Solar Roofs' programmes in the 1990s, including the scaled-up FITs for solar power (Jacobsson and Lauber 2006). These policies led to industrial expansion in wind and solar energy systems, giving rise to powerful renewables interest coalitions that defend existing measures and lend political support for further action.

As a key contending policy instrument, carbon pricing also requires embedding into policy packages *(high evidence, medium agreement).* Pricing may be regressive and perceived as additional costs by households and industry, making investments into green infrastructure politically feasible, as examples from France and Australia show (Copland 2019; Douenne and Fabre 2020). Reforms that would push up household energy expenses are often left aside for fear of how citizens, especially the poor, would react or cope with higher bills (Martinez and Viegas 2017; Tesfamichael et al. 2021) (*high evidence, medium agreement*). This makes it important to precede carbon pricing with investments into renewable energy and low carbon transport modes (Biber et al. 2017; Tvinnereim and Mehling 2018), and especially support developing countries by building up low-carbon energy and mobility infrastructures and technologies, thus reducing resistance to carbon pricing (Creutzig 2019). Additionally, carbon pricing receives higher acceptance if fairness and distributive consideration are made explicit in revenue distribution (see Box 5.10).

The effectiveness of a policy package is determined by design decisions as well as the wider governance context that include the political environment, institutions for coordination across scales, bureaucratic traditions, and judicial functioning (Howlett and Rayner 2013; Rogge and Reichardt 2013; Rosenow et al. 2016) (*high evidence, high agreement*). Policy packages often emerge through interactions between different policy instruments as they operate in either complementary or contradictory ways, resulting from conflicting policy goals (Cunningham et al. 2013; Givoni et al. 2013). An example includes the acceleration in shift from traditional biomass to the adoption of modern cooking fuel for 80 million households in rural India over a very short period of 4 years (2016-2020), which employed a comprehensive 'policy package' including financial incentive, infrastructural support and strengthening of the supply chain to induce households to shift towards a clean cooking fuel from the use of biomass (Kumar 2019). This was operationalised by creating a LPG supply chain by linking oil and gas companies with distributors to assure availability, create infrastructure for local storage along with an improvement of the rural road network, especially in the rural context (Sankhyayan and Dasgupta 2019). State governments initiated separate policies to increase the distributorship of LPG in their states (Kumar et al. 2016). Similarly, policy actions for scaling up electric vehicles need to be well designed and coordinated where EV policy, transport policy and climate policy are used together, working on different decision points and different aspects of human behaviour (Barton and Schütte 2017). The coordination of the multiple policy actions enables co-evolution of multiple outcomes that involve shifting towards renewable energy production, improving access to charging infrastructure, carbon pricing and other GHG measures (Wolbertus et al. 2018).

Design of policy packages should consider not only policies that support low carbon transitions but also those that challenge existing carbon-intensive regimes, generating not just policy "winners" but also "losers" (Carley and Konisky 2020) (*high evidence, high agreement*). The winners include low carbon innovators and entrepreneurs, while the potential losers include incumbents with vested interests in sustaining the status quo (Mundaca et al. 2018; Monasterolo and Raberto 2019). Low carbon policy packages would benefit from looking beyond climate benefits to include non-climate benefits such as health benefits, fuel poverty reductions and environmental co-benefits (Ürge-Vorsatz et al. 2014; Sovacool et al. 2020b). The uptake of decentralised energy services using solar PV in rural areas in developing countries is one such example where successful initiatives are linked to the convergence of multiple policies that include import tariffs, research incentives for R&D, job creation programmes, policies to widen health and education services, and strategies for increased safety for women and children (Kattumuri and Kruse 2019; Gebreslassie 2020).

The energy efficient lighting transition in Europe represents a good case of the formation of policy coalitions that led to the development of policy packages. As attention for energy efficiency in Europe increased in the 1990s, policymakers attempted to stimulate energy-saving lamp diffusion through voluntary measures. But policies stimulated only limited adoption. Consumers perceived CFLs as giving 'cold' light, being unattractively shaped, taking too long to achieve full brightness, unsuitable for many fixtures, and unreliable (Wall and Crosbie 2009). Still, innovations by major CFL and LED multinationals continued. Increasing political attention to climate change and criticisms from environmental NGOs (e.g. WWF, Greenpeace) strengthened awareness about the inefficiency of incandescent light bulbs (ILBs), which led to negative socio-cultural framings that associated ILBs with energy waste (Franceschini and Alkemade 2016). The combined pressures from the lighting industry, NGOs and member states led the European Commission to introduce the 2009 ban of ILBs of more than 80W, progressing to lower-wattage bans in successive years. While the ILB ban initially mainly boosted CFL diffusion, it also stimulated LED uptake. LED prices decreased quickly by more than 85% between 2008 and 2012 (Sanderson and Simons 2014), because of scale economies, standardisation and commoditisation of LED chip technology, and improved manufacturing techniques. Because of further rapid developments to meet consumer tastes, LEDs came to be seen as the future of domestic lighting (Franceschini et al. 2018). Acknowledging these changing views, the 2016 and 2018 European bans on directional and non-directional halogen bulbs explicitly intended to further accelerate the LED transition and reduce energy consumption for residential lighting.

In summary, more equitable societies are associated with high levels of social trust and enables action that reduce GHG emissions. To this end, people play an important role in the delivery of demand-side mitigation options within which efficiency and 'improve' options dominate. Policies that are aimed at behaviour and lifestyle changes come with political risks for policy makers. However, the potential exists for broadening demand-side interventions to include 'avoid' and 'shift' policies. Longer term thinking and implementation that involves careful sequencing of policies as well as designing policy packages that address multiple co-benefits would be critical to manage interactions among supply-side and demand-side options to accelerate mitigation.

5.7 Knowledge gaps

Knowledge gap 1: Climate action as if people matter

Knowledge on climate action that starts with the social practices and how people live in various cultures, contexts and attempts to improve their wellbeing, is still in its infancy. In models, climate solutions remain supply-side oriented, and evaluated against GDP, without acknowledging the reduction in wellbeing due to climate impacts. GDP is a poor metric of human wellbeing, and climate policy evaluation requires better grounding in relation to decent living standards and or similar benchmarks. Actual solutions will invariably include demand, service provisioning and end use. Literature on how gender, informal economies, and solidarity and care frameworks translate into climate action, but also how climate action can improve the life of marginalised groups remains scarce. The working of economic systems under a wellbeing driven rather than GDP driven paradigm requires better understanding.

Knowledge gap 2: Evaluation of the digital economy

The digital economy, as well as shared and circular economy, is emerging as template for great narratives, hopes and fears. Yet, there is few systematic evaluation of what is already happening and what can govern it towards a great narrative. Research needs to better gauge energy trends for rapidly evolving systems like data centres, AI, blockchain, implication of digital divide on wellbeing. Governance decisions on AI, indirectly fostering either climate harming or climate mitigating activities remain unexplored. Better integration of mitigation models and consequential life cycle analysis is needed for assessing how digitalisation, shared economy and circular economy change material and energy demand.

Knowledge gap 3: Scenario modelling of services

Scenarios start within parameter-rich models carrying more than a decade-long legacy of supply side technologies that are not always gauged in recent technological developments. Service provisioning systems are not explicitly modelled, and diversity in concepts and patterns of lifestyles rarely considered. A new class of flexible and modular models with focus on services and activities, based on variety of data sources including big data collected and compiled is needed. There is scope for more sensitivity analysis on which socio-behavioural aspects/ organisation changes has biggest impact on energy/emissions reductions, and on the scale for take-back effects, to better guide subsequent detailed studies on mechanisms and policy responses and policy feedbacks due to interdependence on inclusion or exclusion of groups of people. Models mostly consider behavioural change free, and don't account for how savings due to "avoid" measures may be re-spent.

Knowledge gap 4: Dynamic interaction between individual, social, and structural drivers of change

Better understanding is required on: (1) More detailed causal mechanisms in the mutual interactions between individual, social, and structural drivers of change and how these vary over time, i.e. what is their relative importance in different transition phases; (2) how narratives associated with specific technologies, group identities, and climate change influence each other and interact over time to enable and constrain mitigation outcomes; (3) how social media influences the development and impacts of narratives about low carbon transitions; (4) the effects of social movements (for climate justice, youth climate activism, fossil fuel divestment, and climate action more generally) on social norms and political change, especially in less developed countries; (5) how existing provisioning systems and social practices destabilise through the weakening of various lock-in mechanisms, and resulting deliberate strategies for accelerating demand-side transitions; (6) a dynamic understanding of feasibility, which addresses the dynamic mechanisms that lower barriers or drive mitigation options over the barriers. The debate on the most powerful leverage point/s and policies for speeding up change in social and technological systems need to be resolved with more evidence. Discussion on the policy interdependence and implications of end-user and efficiency focused strategies have only just started suggesting an important area for future research.

Frequently Asked Questions (FAQs)

FAQ 5.1 What can every person do to limit warming to 1.5°C?

People act in different roles, and in each role everyone can contribute to limit global warming to 1.5°C. As citizens, we can organise and put political pressure on the system. As role models, we can be examples to others. As professionals (e.g., engineers, urban planners, teachers, researchers) we can change professional standards in consistency with decarbonisation; e.g., urban planners and architects can design physical infrastructures to facilitate low-carbon mobility and energy use by making walking and cycling safe for children. As investors, for those rich enough, we can divest from fossils and invest in carbon-neutral technologies. As consumers, especially if we belong to the top 10% of the world population in terms of income, we can limit excessive consumption, especially in mobility, and explore the good life consistent with responsible consumption.

Policy makers support individual action not only by economic incentives, such as carbon pricing, but also by interventions that understand complex decision making processes, habits, and routines. Highly relevant examples include choice architectures and nudges that set green options as default. Removing subsidies for cheap petrol, increasing taxes on carbon-intensive products, or substantially tightening regulations and standards support shifts in social norms, and thus can be effective beyond the direct economic incentive.

FAQ 5.2 How does society perceive transformative change?

Man-made global warming, together with other global trends and events, such as digitalisation and automation, and the COVID-19 pandemic, induces changes in labour markets, and bring large uncertainty and ambiguity. This makes people anxious. History and psychology reveal that societies can thrive in these circumstances if they openly embrace uncertainty on the future and try out ways to improve life. Tolerating ambiguity can be learned, e.g., by interacting with history, poetry and the arts.

As a key barrier, established meanings, values and discourses help to legitimise and normalise the status quo. For example, discourses that frame cars as status symbols that embody success, power, freedom, and autonomy help to entrench auto-mobility and hinder shifts to public transport. Discourses that portray dairy milk and animal protein healthy and natural stabilise particular diets and hinder transitions to plant-based milk. Novel narratives and inclusive processes help strategies to overcome these barriers. Case studies demonstrate that citizens support transformative changes if participatory processes enable a design that meets local interests and culture. Promising narratives specify that even as speed and capabilities differ humanity embarks on a joint journey towards wellbeing for all and a healthy planet.

FAQ 5.3 Is demand reduction compatible with economic growth?

Economic growth measured by total or individual income growth is a main driver of GHG emissions. Only a few countries with low economic growth rates have reduced both territorial and consumption-based GHG emissions from, typically by switching from fossil fuels to renewables, but until now at insufficient rates and levels for stabilising global warming at 1.5°C. High deployment of renewables and associated rapid reduction in demand and use of coal, gas, and oil can further reducing the interdependence between economic growth and GHG emissions.

There is a growing realisation that income growth is insufficient to measure national welfare and individual wellbeing. Hence, any action towards climate change mitigation is best evaluated against a broader set of indicators that represent a variety of needs to define individual wellbeing, macroeconomic stability, and planetary health. This chapter shows that many solutions that reduce primary material and fossil energy demand provide better services to help achieve wellbeing for all while reducing GHG emissions drastically.

References

Aaberge, R., and A. Brandolini, 2015: Multidimensional Poverty and Inequality. *Handbook of Income Distribution, vol. 2A,* A. Atkinson and F. Bourguignon, Eds., Vol. 2 of, Elsevier, 141–216.

Abrahamse, W., and L. Steg, 2009: How do socio-demographic and psychological factors relate to households' direct and indirect energy use and savings? *J. Econ. Psychol.*, **30**, 711–720, https://doi.org/10.1016/j.joep.2009.05.006.

——, and ——, 2013: Social influence approaches to encourage resource conservation: A meta-analysis. *Glob. Environ. Chang.*, **23**, 1773–1785, https://doi.org/10.1016/j.gloenvcha.2013.07.029.

——, ——, C. Vlek, and T. Rothengatter, 2007: The effect of tailored information, goal setting, and tailored feedback on household energy use, energy-related behaviors, and behavioral antecedents. *J. Environ. Psychol.*, **27**, 265–276, https://doi.org/10.1016/j.jenvp.2007.08.002.

Abreu, J. M., I. L. Azevedo, and F. C. Pereira, 2011: A contribution to better understand the demand for electricity in the residential sector. *ECEEE 2011 Summer Study*, 15.

Acheampong, R. A., and A. Siiba, 2019: Modelling the determinants of car-sharing adoption intentions among young adults: the role of attitude, perceived benefits, travel expectations and socio-demographic factors. *Transportation (Amst).*, **47**, 2557–2580, https://doi.org/10.1007/s11116-019-10029-3.

Ackah, M., 2017: Informal E-waste recycling in developing countries: review of metal(loid)s pollution, environmental impacts and transport pathways. *Environ. Sci. Pollut. Res.*, **24**, 24092–24101, https://doi.org/10.1007/s11356-017-0273-y.

Adger, W. N., K. Brown, J. Fairbrass, A. Jordan, J. Paavola, S. Rosendo, and G. Seyfang, 2003: Governance for Sustainability: Towards a 'Thick' Analysis of Environmental Decisionmaking. *Environ. Plan. A Econ. Sp.*, **35**, 1095–1110, https://doi.org/10.1068/a35289.

AECOM, 2011: *Energy Demand Research Project: Final Analysis*. www.ofgem.gov.uk/ofgem-publications/59105/energy-demand-research-project-final-analysis.pdf.

Ahmad, S., and F. Creutzig, 2019: Spatially contextualized analysis of energy use for commuting in India. *Environ. Res. Lett.*, **14**, 045007, https://doi.org/10.1088/1748-9326/ab011f.

——, G. Baiocchi, and F. Creutzig, 2015: CO2 Emissions from Direct Energy Use of Urban Households in India. *Environ. Sci. Technol.*, **49**, 11312–11320, https://doi.org/10.1021/es505814g.

Ahmad, S., S. Pachauri, and F. Creutzig, 2017: Synergies and trade-offs between energy-efficient urbanization and health. *Environ. Res. Lett.*, **12**, https://doi.org/10.1088/1748-9326/aa9281.

AIGC, 2017: *Asia International Grid Connection Study Group Interim Report*.

Ajzen, I., 1985: From Intentions to Actions: A Theory of Planned Behavior. *Action Control*, Springer Berlin Heidelberg, 11–39.

Aklin, M., and J. Urpelainen, 2013: Political competition, path dependence, and the strategy of sustainable energy transitions. *Am. J. Pol. Sci.*, **57**, 643–658, https://doi.org/10.1111/ajps.12002.

Akyelken, N., D. Banister, and M. Givoni, 2018: The Sustainability of Shared Mobility in London: The Dilemma for Governance. *Sustainability*, **10**, 420, https://doi.org/10.3390/su10020420.

Alahmad, M. A., P. G. Wheeler, A. Schwer, J. Eiden, and A. Brumbaugh, 2012: A Comparative Study of Three Feedback Devices for Residential Real-Time Energy Monitoring. *IEEE Trans. Ind. Electron.*, **59**, 2002–2013, https://doi.org/10.1109/TIE.2011.2165456.

Alber, G., 2009: Gender and Climate Change Policy. *Population Dynamics and Climate Change*, J.M. Guzmán, G. M artinez, G. McGranahan, D. Schensul, and C. Tacoli, Eds., United Nations Population Fund / International Institute for Environment and Development, 149–163.

Alberini, A., A. Bigano, M. Ščasný, and I. Zvěřinová, 2018: Preferences for Energy Efficiency vs. Renewables: What Is the Willingness to Pay to Reduce CO2 Emissions? *Ecol. Econ.*, **144**, 171–185, https://doi.org/10.1016/j.ecolecon.2017.08.009.

Albrecht, G., and Coauthors, 2007: Solastalgia: The Distress Caused by Environmental Change. *Australas. Psychiatry*, **15**, S95–S98, https://doi.org/10.1080/10398560701701288.

Aldaco, R., and Coauthors, 2020: Food waste management during the COVID-19 outbreak: a holistic climate, economic and nutritional approach. *Sci. Total Environ.*, **742**, 140524, https://doi.org/10.1016/j.scitotenv.2020.140524.

Alkire, S., and M. E. Santos, 2014: Measuring Acute Poverty in the Developing World: Robustness and Scope of the Multidimensional Poverty Index. *World Dev.*, **59**, 251–274, https://doi.org/10.1016/j.worlddev.2014.01.026.

——, and G. Robles, 2017: *Multidimensional Poverty Index - Summer 2017: brief methodological note and results*. 20 pp. https://ophi.org.uk/multidimensional-poverty-index-summer-2017-brief-methodological-note-and-results/.

Allcott, H., 2011: Social norms and energy conservation. *J. Public Econ.*, **95**, 1082–1095, https://doi.org/10.1016/j.jpubeco.2011.03.003.

——, and T. Rogers, 2014: The short-run and long-run effects of behavioral interventions: Experimental evidence from energy conservation. *Am. Econ. Rev.*, **104**, 3003–3037, https://doi.org/10.1257/aer.104.10.3003.

Allwood, J. M., and J. M. Cullen, 2012: *Sustainable Materials with Both Eyes Open. Future Buildings, Vehicles, Products and Equipment- Made Efficiently and Made with Less New Material*. UIT Cambridge Ltd., 356 pp.

——, ——, and R. L. Milford, 2010: Options for Achieving a 50% Cut in Industrial Carbon Emissions by 2050. *Environ. Sci. Technol.*, **44**, 1888–1894, https://doi.org/10.1021/es902909k.

Alon, T., M. Doepke, J. Olmstead-Rumsey, and M. Tertilt, 2020: *The Impact of COVID-19 on Gender Equality*.

Alstone, P., D. Gershenson, and D. M. Kammen, 2015: Decentralized energy systems for clean electricity access. *Nat. Clim. Chang.*, **5**, 305–314, https://doi.org/10.1038/nclimate2512.

Alvaredo, F., L. Chancel, T. Piketty, E. Saez, and G. Zucman, 2018: *World Inequality Report 2018*. 344 pp. www.wid.world/team (Accessed November 20, 2019).

Ameli, N., and N. Brandt, 2015: Determinants of households' investment in energy efficiency and renewables: evidence from the OECD survey on household environmental behaviour and attitudes. *Environ. Res. Lett.*, **10**, https://doi.org/10.1088/1748-9326/10/4/044015.

Amini, M. H., H. Arasteh, and P. Siano, 2019: Sustainable smart cities through the lens of complex interdependent infrastructures: Panorama and state-of-the-art. *Studies in Systems, Decision and Control*, Vol. 186 of, Springer International Publishing, 45–68.

Amis, J. M., and B. D. Janz, 2020: Leading Change in Response to COVID-19. *J. Appl. Behav. Sci.*, **56**, 272–278, https://doi.org/10.1177/0021886320936703.

Amundsen, H., F. Berglund, and H. Westskogh, 2010: Overcoming barriers to climate change adaptation-a question of multilevel governance? *Environ. Plan. C Gov. Policy*, **28**, 276–289, https://doi.org/10.1068/c0941.

Anderson, S., I. E. Marinescu, and B. Shor, 2019: Can Pigou at the Polls Stop US Melting the Poles? *SSRN Electron. J.*, https://doi.org/10.2139/ssrn.3400772.

Andrae, A., and T. Edler, 2015: On Global Electricity Usage of Communication Technology: Trends to 2030. *Challenges*, **6**, 117–157, https://doi.org/10.3390/challe6010117.

Angrist, J. D., S. Caldwell, and J. V Hall, 2017: *Uber vs. Taxi: A Driver's Eye View*. 1–75 pp.

Annecke, W., 2002: The rich get richer and the poor get renewables: the WSSD, energy and women, a malevolent perspective: Agenda: Vol 17, No 52. 8–16.

Añón Higón, D., R. Gholami, and F. Shirazi, 2017: ICT and environmental sustainability: A global perspective. *Telemat. Informatics*, **34**, 85–95, https://doi.org/10.1016/J.TELE.2017.01.001.

Anshelm, J., and M. Hultman, 2014: A green fatwā? Climate change as a threat to the masculinity of industrial modernity. *NORMA*, **9**, 84–96, https://doi.org/10.1080/18902138.2014.908627.

Araña, J., and C. León, 2013: Can Defaults Save the Climate? Evidence from a Field Experiment on Carbon Offsetting Programs. *Environ. Resour. Econ.*, **54**, 613–626.

Arrow, K., and Coauthors, 2004: Are We Consuming Too Much? *J. Econ. Perspect.*, **18**, 147–172, https://doi.org/10.1257/0895330042162377.

Arrow, K. J., P. Dasgupta, L. H. Goulder, K. J. Mumford, and K. Oleson, 2013: Sustainability and the measurement of wealth: further reflections. *Environ. Dev. Econ.*, **18**, 504–516, https://doi.org/10.1017/s1355770x13000193.

Arto, I., I. Capellán-Pérez, R. Lago, G. Bueno, and R. Bermejo, 2016: The energy requirements of a developed world. *Energy Sustain. Dev.*, **33**, 1–13.

Asensio, O. I., and M. A. Delmas, 2015: Nonprice incentives and energy conservation. *Proc. Natl. Acad. Sci. U. S. A.*, **112**, E510–515, https://doi.org/10.1073/pnas.1401880112.

——, and M. A. Delmas, 2016: The dynamics of behavior change: Evidence from energy conservation. *J. Econ. Behav. Organ.*, **126**, 196–212, https://doi.org/10.1016/j.jebo.2016.03.012.

Ateba, B. B., J. J. Prinsloo, and E. Fourie, 2018: The impact of energy fuel choice determinants on sustainable energy consumption of selected South African households. *J. Energy South. Africa*, **29**, 51–65, https://doi.org/10.17159/2413-3051/2018/v29i3a4714.

Atkinson, R., T. Dörfler, M. Hasanov, E. Rothfuß, and I. Smith, 2017: Making the case for self-organisation: Understanding how communities make sense of sustainability and climate change through collective action. *Int. J. Sustain. Soc.*, **9**, 193–209, https://doi.org/10.1504/IJSSOC.2017.088300.

Atreya, A., and S. Ferreira, 2015: Seeing is Believing? Evidence from Property Prices in Inundated Areas. *Risk Anal.*, **35**, 828–848, https://doi.org/10.1111/risa.12307.

Attari, S. Z., M. L. DeKay, C. I. Davidson, W. B. de Bruin, W. Bruine de Bruin, and W. B. de Bruin, 2010: Public perceptions of energy consumption and savings. *Proc. Natl. Acad. Sci.*, **107**, 16054–16059, https://doi.org/10.1073/pnas.1001509107.

Attari, S. Z., D. H. Krantz, and E. U. Weber, 2016: Energy conservation goals: What people adopt, what they recommend, and why. *Judgm. Decis. Mak.*, **11**, 342–351.

Auerswald, P. E., and L. M. Branscomb, 2003: Valleys of Death and Darwinian Seas : Financing the Invention to Innovation Transition in the United States. *Technology*, **28**, 227–239, https://doi.org/10.1023/A:1024980525678.

Ausubel, J. H., 1991: Rat-race dynamics and crazy companies. The diffusion of technologies and social behavior. *Technol. Forecast. Soc. Change*, **39**, 11–22, https://doi.org/10.1016/0040-1625(91)90025-B.

Avgerinou, M., P. Bertoldi, and L. Castellazzi, 2017: Trends in Data Centre Energy Consumption under the European Code of Conduct for Data Centre Energy Efficiency. *Energies*, **10**, 1–18, https://doi.org/10.3390/en10101470.

Axsen, J., and B. K. Sovacool, 2019: The roles of users in electric, shared and automated mobility transitions. *Transp. Res. Part D Transp. Environ.*, **71**, 1–21, https://doi.org/10.1016/J.TRD.2019.02.012.

Ayres, I., S. Raseman, and A. Shih, 2013: Evidence from Two Large Field Experiments that Peer

Comparison Feedback Can Reduce Residential Energy Usage. *J. Law, Econ. Organ.*, **29**, 992–1022.

Ayres, R. U., 1989: *Energy Inefficiency in the US Economy : A New Case for Conservation*. 28 pp. http://pure.iiasa.ac.at/id/eprint/3220/.

——, and U. E. Simonis, 1994: *Industrial Metabolism: Restructuring for Sustainable Development*. United Nations University Press, 376 pp.

——, and B. Warr, 2005: Accounting for growth: The role of physical work. *Struct. Chang. Econ. Dyn.*, **16**, 181–209, https://doi.org/10.1016/j.strueco.2003.10.003.

Azevedo, I. M. L., M. G. Morgan, and L. Lave, 2011: Residential and Regional Electricity Consumption in the U.S. and EU: How Much Will Higher Prices Reduce CO2 Emissions? *Electr. J.*, **24**, 21–29, https://doi.org/10.1016/j.tej.2010.12.004.

Azong, M., C. J. Kelso, and K. Naidoo, 2018: Vulnerability and resilience of female farmers in Oku, Cameroon, to Climate Change | African Sociological Review / Revue Africaine de Sociologie. *African Sociol. Rev.*, **22**.

Backstränd, K., J. Khan, A. Kronsell, E. Lövbrand, and (eds.), 2010: *Environmental Politics and Deliberative Democracy: Examining the Promise of New Modes of Governance*.

Bajželj, B., K. S. Richards, J. M. Allwood, P. Smith, J. S. Dennis, E. Curmi, and C. A. Gilligan, 2014: Importance of food-demand management for climate mitigation. *Nat. Clim. Chang.*, **4**, 924–929, https://doi.org/10.1038/nclimate2353.

Baker, L., 2018: Of embodied emissions and inequality: Rethinking energy consumption. *Energy Res. Soc. Sci.*, **36**, 52–60, https://doi.org/10.1016/j.erss.2017.09.027.

Bakker, S., M. Zuidgeest, H. de Coninck, and C. Huizenga, 2014: Transport, Development and Climate Change Mitigation: Towards an Integrated Approach. *Transp. Rev.*, **34**, 335–355, https://doi.org/10.1080/01441647.2014.903531.

Baldez, L., 2003: Women's Movements and Democratic Transition in Chile, Brazil, East Germany, and Poland. *Comp. Polit.*, **35**, 253, https://doi.org/10.2307/4150176.

Ball, R., and K. Chernova, 2008: Absolute Income, Relative Income, and Happiness. *Soc. Indic. Res.*, **88**, 497–529, https://doi.org/10.1007/s11205-007-9217-0.

Ballew, M., E. Maibach, J. Kotcher, P. Bergquist, S. Rosenthal, J. Marlon, and A. Leiserowitz, 2020: Which racial/ethnic groups care most about climate change? - Yale Program on Climate Change Communication. *Audiences, Behav. Actions Beliefs Attitude Yale Programe Clim. Chang. Commun.*,. https://climatecommunication.yale.edu/publications/race-and-climate-change/ (Accessed June 5, 2020).

Ballús-Armet, I., S. A. Shaheen, K. Clonts, and D. Weinzimmer, 2014: Peer-to-Peer Carsharing. *Transp. Res. Rec. J. Transp. Res. Board*, **2416**, 27–36, https://doi.org/10.3141/2416-04.

Baloch, M. A., Danish, S. U. Khan, and Z. Ş. Ulucak, 2020: Analyzing the relationship between poverty, income inequality, and CO2 emission in Sub-Saharan African countries. *Sci. Total Environ.*, 139867, https://doi.org/10.1016/j.scitotenv.2020.139867.

Bamberg, S., D. Rölle, and C. Weber, 2003: Does habitual car use not lead to more resistance to change of travel mode? *Transportation (Amst).*, **30**, 97–108, https://doi.org/10.1023/A:1021282523910.

Banerjee, M., R. Prasad, I. H. Rehman, and B. Gill, 2016: Induction stoves as an option for clean cooking in rural India. *Energy Policy*, **88**, 159–167, https://doi.org/10.1016/j.enpol.2015.10.021.

Baptista, P., S. Melo, and C. Rolim, 2014: Energy, Environmental and Mobility Impacts of Car-sharing Systems. Empirical Results from Lisbon, Portugal. *Procedia - Soc. Behav. Sci.*, **111**, 28–37, https://doi.org/10.1016/j.sbspro.2014.01.035.

Baranzini, A. et al., 2017: *What drives social contagion in the adoption of solar photovoltaic* *technology?* http://www.lse.ac.uk/GranthamInstitute/publication/what-drives-social-contagion-in-the-adoption-of-solar-photovoltaic-technology/ (Accessed July 4, 2019).

Barbier, E. B., and J. C. Burgess, 2020: Sustainability and development after COVID-19. *World Dev.*, **135**, 105082, https://doi.org/10.1016/j.worlddev.2020.105082.

Bardhi, F., and G. M. Eckhardt, 2012: Access-Based Consumption: The Case of Car Sharing. *J. Consum. Res.*, **39**, 881–898, https://doi.org/10.1086/666376.

Bardsley, N., and Coauthors, 2019: Domestic thermal upgrades, community action and energy saving: A three-year experimental study of prosperous households. *Energy Policy*, **127**, 475–485, https://doi.org/10.1016/j.enpol.2018.11.036.

Barnes, J., R. Durrant, F. Kern, and G. MacKerron, 2018: The institutionalisation of sustainable practices in cities: how initiatives shape local selection environments. *Environ. Innov. Soc. Transitions*, **29**, 68–80, https://doi.org/10.1016/j.eist.2018.04.003.

Barnes, M. L., and Coauthors, 2020: Social determinants of adaptive and transformative responses to climate change. *Nat. Clim. Chang.*, https://doi.org/10.1038/s41558-020-0871-4.

Barnett, J., 2003: Security and climate change. *Glob. Environ. Chang.*, **13**, 7–17, https://doi.org/10.1016/S0959-3780(02)00080-8.

Barnett, J., K. Burningham, G. Walker, and N. Cass, 2012: Imagined publics and engagement around renewable energy technologies in the UK. *Public Underst. Sci.*, **21**, 36–50, https://doi.org/10.1177/0963662510365663.

Barr, S., and J. Prillwitz, 2014: A smarter choice? exploring the behaviour change agenda for environmentally sustainable mobility. *Environ. Plan. C Gov. Policy*, **32**, 1–19, https://doi.org/10.1068/c1201.

Barton, B., and P. Schütte, 2017: Electric vehicle law and policy: A comparative analysis. *J. Energy Nat. Resour. Law*, **35**, 147–170, https://doi.org/10.1080/02646811.2017.1262087.

Bassi, A. M., and A. E. Baer, 2009: Quantifying cross-sectoral impacts of investments in climate change mitigation in Ecuador. *Energy Sustain. Dev.*, **13**, 116–123, https://doi.org/10.1016/j.esd.2009.05.003.

Batchelor, S., E. Brown, J. Leary, N. Scott, A. Alsop, and M. Leach, 2018: Solar electric cooking in Africa: Where will the transition happen first? *Energy Res. Soc. Sci.*, **40**, 257–272, https://doi.org/10.1016/j.erss.2018.01.019.

——, ——, N. Scott, and J. Leary, 2019: Two birds, one stone-reframing cooking energy policies in Africa and Asia. *Energies*, **12**, 1591, https://doi.org/10.3390/en12091591.

Bayus, B. L., 1994: Are product life cycles really getting shorter? *J. Prod. Innov. Manag.*, **11**, 300–308, https://doi.org/10.1016/0737-6782(94)90085-X.

Beaunoyer, E., S. Dupéré, and M. J. Guitton, 2020: COVID-19 and digital inequalities: Reciprocal impacts and mitigation strategies. *Comput. Human Behav.*, **111**, 106424, https://doi.org/10.1016/j.chb.2020.106424.

Beer, and C. T. Beer, 2014: Climate Justice, the Global South, and Policy Preferences of Kenyan Environmental NGOs. *Glob. South*, **8**, 84–100, https://doi.org/10.2979/globalsouth.8.2.84.

Beeson, M., 2019: *Environmental Populism : The Politics of Survival in the Anthropocene*. Palgrave Macmillan, 1–131 pp.

Behrens, P., J. C. Kiefte-De Jong, T. Bosker, J. F. D. Rodrigues, A. De Koning, and A. Tukker, 2017: Evaluating the environmental impacts of dietary recommendations. *Proc. Natl. Acad. Sci. U. S. A.*, **114**, 13412–13417, https://doi.org/10.1073/pnas.1711889114.

Beiser-McGrath, L. F., and T. Bernauer, 2019: Could revenue recycling make effective carbon taxation politically feasible? *Sci. Adv.*, **5**, https://doi.org/10.1126/sciadv.aax3323.

Belk, R., 2014a: You are what you can access: Sharing and collaborative consumption online. *J. Bus. Res.*, **67**, 1595–1600, https://doi.org/https://doi.org/10.1016/j.jbusres.2013.10.001.

——, 2014b: Sharing versus pseudo-sharing in web 2.0. *Anthropologist*, **18**, 7–23, https://doi.org/10.1080/09720073.2014.11891518.

Belkhir, L., and A. Elmeligi, 2018: Assessing ICT global emissions footprint: Trends to 2040 & recommendations. *J. Clean. Prod.*, **177**, 448–463, https://doi.org/10.1016/J.JCLEPRO.2017.12.239.

Bell, S. E., C. Daggett, and C. Labuski, 2020: Toward feminist energy systems: Why adding women and solar panels is not enough. *Energy Res. Soc. Sci.*, **68**, 101557, https://doi.org/10.1016/j.erss.2020.101557.

Benders, R. M. J., R. Kok, H. C. Moll, G. Wiersma, and K. J. Noorman, 2006: New approaches for household energy conservation—In search of personal household energy budgets and energy reduction options. *Energy Policy*, **34**, https://doi.org/10.1016/j.enpol.2005.08.005.

Benegal, S. D., 2018: The spillover of race and racial attitudes into public opinion about climate change. *Env. Polit.*, **27**, 733–756, https://doi.org/10.1080/09644016.2018.1457287.

Bengtsson, M., E. Alfredsson, M. Cohen, S. Lorek, and P. Schroeder, 2018: Transforming systems of consumption and production for achieving the sustainable development goals: moving beyond efficiency. *Sustain. Sci.*, **13**, 1533–1547, https://doi.org/10.1007/s11625-018-0582-1.

Bentley, M., 2014: An ecological public health approach to understanding the relationships between sustainable urban environments, public health and social equity. *Health Promot. Int.*, **29**, 528–537, https://doi.org/10.1093/heapro/dat028.

Bento, A. M., M. R. Jacobsen, and A. A. Liu, 2018a: Environmental policy in the presence of an informal sector. *J. Environ. Econ. Manage.*, **90**, 61–77, https://doi.org/10.1016/j.jeem.2018.03.011.

Bento, N., 2013: *New Evidence in Technology Scaling Dynamics and the Role of the Formative Phase*. 45 pp. http://pure.iiasa.ac.at/id/eprint/10752/.

——, C. Wilson, and L. D. Anadon, 2018b: Time to get ready: Conceptualizing the temporal and spatial dynamics of formative phases for energy technologies. *Energy Policy*, **119**, 282–293, https://doi.org/10.1016/j.enpol.2018.04.015.

Benyus, J., 1997: *Biomimicry: Innovation inspired by nature*. 320 pp.

van den Berg, N. J., A. F. Hof, L. Akenji, O. Y. Edelenbosch, M. A. E. van Sluisveld, V. J. Timmer, and D. P. van Vuuren, 2019: Improved modelling of lifestyle changes in Integrated Assessment Models: Cross-disciplinary insights from methodologies and theories. *Energy Strateg. Rev.*, **26**, 100420, https://doi.org/10.1016/j.esr.2019.100420.

Bergek, A., C. Berggren, T. Magnusson, and M. Hobday, 2013: Technological discontinuities and the challenge for incumbent firms: Destruction, disruption or creative accumulation? *Res. Policy*, **42**, 1210–1224, https://doi.org/10.1016/j.respol.2013.02.009.

Bergh, A., and C. Bjørnskov, 2014: Trust, welfare states and income equality: Sorting out the causality. *Eur. J. Polit. Econ.*, **35**, 183–199, https://doi.org/10.1016/j.ejpoleco.2014.06.002.

Bergman, N., 2013: Why is renewable heat in the UK underperforming? A socio-technical perspective. *Proc. Inst. Mech. Eng. Part A J. Power Energy*, **227**, 124–131, https://doi.org/10.1177/0957650912471291.

Bergquist, M., A. Nilsson, and P. Wesley Schultz, 2019: Experiencing a severe weather event increases concern about climate change. *Front. Psychol.*, **10**, 220, https://doi.org/10.3389/fpsyg.2019.00220.

Berik, G., 2018: *Toward more inclusive measures of economic well-being: Debates and practices*. 32 pp. https://www.ilo.org/wcmsp5/groups/public/---dgreports/---

cabinet/documents/publication/wcms_630602.pdf (Accessed November 28, 2019).

Berkeley, N., D. Bailey, A. Jones, and D. Jarvis, 2017: Assessing the transition towards Battery Electric Vehicles: A Multi-Level Perspective on drivers of, and barriers to, take up. *Transp. Res. Part A Policy Pract.*, **106**, 320–332, https://doi.org/10.1016/j.tra.2017.10.004.

Berry, S., D. Whaley, K. Davidson, and W. Saman, 2014: Near zero energy homes - What do users think? *Energy Policy*, **73**, 127–137, https://doi.org/10.1016/j.enpol.2014.05.011.

Bertoldi, P., M. Economidou, V. Palermo, B. Boza-Kiss, and V. Todeschi, 2020: How to finance energy renovation of residential buildings: Review of current and emerging financing instruments in the EU. *Wiley Interdiscip. Rev. Energy Environ.*, https://doi.org/10.1002/wene.384.

Bertram, C., G. Luderer, F. Creutzig, N. Bauer, F. Ueckerdt, A. Malik, and O. Edenhofer, 2020: COVID-induced low power demand and market forces starkly reduce CO2 emissions. **submitted**.

Bessa, V. M. T., and R. T. A. Prado, 2015: Reduction of carbon dioxide emissions by solar water heating systems and passive technologies in social housing. *Energy Policy*, **83**, 138–150, https://doi.org/10.1016/j.enpol.2015.04.010.

Biber, E., N. Kelsey, and J. Meckling, 2017: The Political Economy of Decarbonization: A Research Agenda. *Brooklyn Law Rev.*, **82**.

Bilal, and Coauthors, 2020: Environmental pollution and COVID-19 outbreak: insights from Germany. *Air Qual. Atmos. Heal.*, 1–10, https://doi.org/10.1007/s11869-020-00893-9.

Billett, S., 2010: Dividing climate change: global warming in the Indian mass media. *Clim. Change*, **99**, 1–16, https://doi.org/10.1007/s10584-009-9605-3.

Bischoff, J., and M. Maciejewski, 2016: Autonomous Taxicabs in Berlin – A Spatiotemporal Analysis of Service Performance. *Transp. Res. Procedia*, **19**, 176–186, https://doi.org/10.1016/J.TRPRO.2016.12.078.

Black, T., 2016: Race, gender, and climate justice: Dimensions of social and environmental inequality. *Systemic crises of global climate change: intersections of race, class and gender*, P. Godfrey and D. Torres, Eds., Routledge, 172–184.

Blok, K., J. Hoogzaad, S. Ramkumar, A. Ridley, P. Srivastav, I. Tan, W. Terlouw, and M. de Wit, 2016: *Implementing Circular Economy Globally Makes Paris Targets Achievable*. 18 pp. https://www.circularnorway.no/wp-content/uploads/2019/04/ircle-economy-ecofys-2016-implementing-circular-economy-globally-makes-paris-targets-achievable.pdf.pdf.

Blomsma, F., and G. Brennan, 2017: The Emergence of Circular Economy: A New Framing Around Prolonging Resource Productivity. *J. Ind. Ecol.*, **21**, 603–614, https://doi.org/10.1111/jiec.12603.

Bob, U., and A. Babugura, 2014: Contextualising and conceptualising gender and climate change in Africa. *Agenda*, **28**, 3–15, https://doi.org/10.1080/10130950.2014.958907.

Bocken, N. M. P., E. A. Olivetti, J. M. Cullen, J. Potting, and R. Lifset, 2017: Taking the Circularity to the Next Level: A Special Issue on the Circular Economy. *J. Ind. Ecol.*, **21**, 476–482, https://doi.org/10.1111/jiec.12606.

Böcker, L., and T. Meelen, 2017: Sharing for people, planet or profit? Analysing motivations for intended sharing economy participation. *Environ. Innov. Soc. Transitions*, **23**, 28–39, https://doi.org/10.1016/J.EIST.2016.09.004.

Bodart, M., and A. De Herde, 2002: Global energy savings in offices buildings by the use of daylighting. *Energy Build.*, **34**, 421–429, https://doi.org/10.1016/S0378-7788(01)00117-7.

De Boer, J., H. Schösler, and H. Aiking, 2014: “Meatless days” or “less but better”? Exploring strategies to adapt Western meat consumption to health and sustainability challenges. *Appetite*, **76**, 120–128, https://doi.org/10.1016/j.appet.2014.02.002.

Bolderdijk, J. W., M. Gorsira, K. Keizer, and L. Steg, 2013: Values Determine the (In)Effectiveness of

Informational Interventions in Promoting Pro-Environmental Behavior. *PLoS One*, **8**, e83911, https://doi.org/10.1371/journal.pone.0083911.

Bolsen, T., T. J. Leeper, and M. A. Shapiro, 2014: Doing What Others Do: Norms, Science, and Collective Action on Global Warming. *Am. Polit. Res.*, **42**, 65–89, https://doi.org/10.1177/1532673X13484173.

Bonacini, L., G. Gallo, and S. Scicchitano, 2021: Working from home and income inequality: risks of a 'new normal' with COVID-19. *J. Popul. Econ.*, **34**, 303–360, https://doi.org/10.1007/s00148-020-00800-7.

Bonan, J., C. Cattaneo, G. D'Adda, and M. Tavoni, 2020: The interaction of descriptive and injunctive social norms in promoting energy conservation. *Nat. Energy*, **5**, 900–909, https://doi.org/10.1038/s41560-020-00719-z.

Bongardt, D., F. Creutzig, H. Hüging, K. Sakamoto, S. Bakker, S. Gota, and S. Böhler-Baedeker, 2013: *Low-carbon Land Transport: Policy Handbook*. Routledge,.

Bonilla-Alicea, R. J., B. C. Watson, Z. Shen, L. Tamayo, and C. Telenko, 2020: Life cycle assessment to quantify the impact of technology improvements in bike-sharing systems. *J. Ind. Ecol.*, **24**, 138–148, https://doi.org/10.1111/jiec.12860.

Boomsma, C., and L. Steg, 2014: The effect of information and values on acceptability of reduced street lighting. *J. Environ. Psychol.*, **39**, 22–31, https://doi.org/10.1016/j.jenvp.2013.11.004.

Boran, I., 2019: *Political theory and global climate action : recasting the public sphere*. Routledge, 98 pp.

Borghei, B., and T. Magnusson, 2016: Niche experiments with alternative powertrain technologies: the case of electric city-buses in Europe. *Int. J. Automot. Technol. Manag.*, **16**, 274, https://doi.org/10.1504/ijatm.2016.080787.

Borghei, B. B., and T. Magnusson, 2018: Niche aggregation through cumulative learning: A study of multiple electric bus projects. *Environ. Innov. Soc. Transitions*, **28**, 108–121, https://doi.org/10.1016/j.eist.2018.01.004.

Botsman, R., and R. Rogers, 2011: *What's mine is yours: how collaborative consumption is changing the way we live*. Collins, 280 pp.

Bouman, T., L. Steg, and T. Dietz, 2020a: Insights from early COVID-19 responses about promoting sustainable action. *Nat. Sustain.*, 1–7, https://doi.org/10.1038/s41893-020-00626-x.

——, M. Verschoor, C. J. Albers, G. Böhm, S. D. Fisher, W. Poortinga, L. Whitmarsh, and L. Steg, 2020b: When worry about climate change leads to climate action: How values, worry and personal responsibility relate to various climate actions. *Glob. Environ. Chang.*, **62**, 102061, https://doi.org/https://doi.org/10.1016/j.gloenvcha.2020.102061.

Bows-Larkin, A., 2015: All adrift: aviation, shipping, and climate change policy. *Clim. Policy*, **15**, 681–702, https://doi.org/10.1080/14693062.2014.965125.

Bradshaw, S., 2018: Sex disaggregation alone will not energize equality. *Nat. Energy*, **3**, 813–815, https://doi.org/10.1038/s41560-018-0247-4.

Brambilla, G., M. Lavagna, G. Vasdravellis, and C. A. Castiglioni, 2019: Environmental benefits arising from demountable steel-concrete composite floor systems in buildings. *Resour. Conserv. Recycl.*, **141**, 133–142, https://doi.org/10.1016/j.resconrec.2018.10.014.

Brand-Correa, L. I., and J. K. Steinberger, 2017: A Framework for Decoupling Human Need Satisfaction From Energy Use. *Ecol. Econ.*, **141**, 43–52, https://doi.org/10.1016/j.ecolecon.2017.05.019.

——, J. Martin-Ortega, and J. K. Steinberger, 2018: Human Scale Energy Services: Untangling a 'golden thread.' *Energy Res. Soc. Sci.*, **38**, 178–187, https://doi.org/10.1016/j.erss.2018.01.008.

Brand, C., and B. Boardman, 2008: Taming of the few-The unequal distribution of greenhouse gas emissions from personal travel in the UK. *Energy Policy*, **36**, 224–238, https://doi.org/10.1016/j.enpol.2007.08.016.

——, and J. M. Preston, 2010: '60-20 emission'-The unequal distribution of greenhouse gas emissions from personal, non-business travel in the UK. *Transp. Policy*, **17**, 9–19, https://doi.org/10.1016/j.tranpol.2009.09.001.

——, J. Anable, and M. Tran, 2013: Accelerating the transformation to a low carbon passenger transport system: The role of car purchase taxes, feebates, road taxes and scrappage incentives in the UK. *Transp. Res. Part A Policy Pract.*, **49**, 132–148, https://doi.org/10.1016/j.tra.2013.01.010.

Braungardt, S., J. van den Bergh, and T. Dunlop, 2019: Fossil fuel divestment and climate change: Reviewing contested arguments. *Energy Res. Soc. Sci.*, **50**, 191–200, https://doi.org/10.1016/j.erss.2018.12.004.

Bray, J., N. Johns, and D. Kilburn, 2011: An Exploratory Study into the Factors Impeding Ethical Consumption. *J. Bus. Ethics*, **98**, 597–608, https://doi.org/10.1007/s10551-010-0640-9.

Breukers, S., and M. Wolsink, 2007: Wind energy policies in the Netherlands: Institutional capacity-building for ecological modernisation. *Env. Polit.*, **16**, 92–112, https://doi.org/10.1080/09644010601073838.

Brockway, P., H. Saunders, M. Heun, T. Foxon, J. Steinberger, J. Barrett, and S. Sorrell, 2017: Energy Rebound as a Potential Threat to a Low-Carbon Future: Findings from a New Exergy-Based National-Level Rebound Approach. *Energies*, **10**, 51, https://doi.org/10.3390/en10010051.

Brown, D., and G. McGranahan, 2016: The urban informal economy, local inclusion and achieving a global green transformation. *Habitat Int.*, **53**, 97–105, https://doi.org/10.1016/j.habitatint.2015.11.002.

Brown, H. S., P. Vergragt, K. Green, and L. Berchicci, 2003: Learning for sustainability transition through bounded socio-technical experiments in personal mobility. *Technol. Anal. Strateg. Manag.*, **15**, 291–316, https://doi.org/10.1080/0953732032000046024.

Brown, K. E., and R. Dodder, 2019: Energy and emissions implications of automated vehicles in the U.S. energy system. *Transp. Res. Part D Transp. Environ.*, **77**, 132–147, https://doi.org/10.1016/j.trd.2019.09.003.

Brownell, K. D., and K. E. Warner, 2009: The perils of ignoring history: Big tobacco played dirty and millions died. how similar is big food. *Milbank Q.*, **87**, 259–294, https://doi.org/10.1111/j.1468-0009.2009.00555.x.

Brozovic, D., 2019: Business model based on strong sustainability: Insights from an empirical study. *Bus. Strateg. Environ.*, **29**, 763–778, https://doi.org/10.1002/bse.2440.

Bruck, B. P., V. Incerti, M. Iori, and M. Vignoli, 2017: Minimizing CO2 emissions in a practical daily carpooling problem. *Comput. Oper. Res.*, **81**, 40–50, https://doi.org/10.1016/j.cor.2016.12.003.

Brütting, J., C. De Wolf, and C. Fivet, 2019: The reuse of load-bearing components. *IOP Conf. Ser. Earth Environ. Sci.*, **225**, https://doi.org/10.1088/1755-1315/225/1/012025.

Bryan, E., and J. A. Behrman, 2013: *Community based adaptation to climate change: A theoretical framework, overview of key issues and discussion of gender differentiated priorities and participation*. International Food Policy Research Institute (IFPRI),.

——, Q. Bernier, M. Espinal, and C. Ringler, 2018: Making climate change adaptation programmes in sub-Saharan Africa more gender responsive: insights from implementing organizations on the barriers and opportunities. *Clim. Dev.*, **10**, 417–431, https://doi.org/10.1080/17565529.2017.1301870.

Bryson, J., and P. Rauwolf, 2016: *Trust, Communication, and Inequality*. 1–7 pp.

Büchs, M., and S. V. Schnepf, 2013: Who emits most? Associations between socio-economic factors and UK households' home energy, transport, indirect and total CO2 emissions. *Ecol. Econ.*, **90**, 114–123, https://doi.org/10.1016/j.ecolecon.2013.03.007.

Buckingham, S., and R. Kulcur, 2017: It's not just the numbers: Challenging Masculinist Working Practices in Climate Change Decision-Making in UK Government and Environmental Non-Governmental Organizations. *Climate Change and Gender in Rich Countries: Work, Public Policy and Action*, M.G. Cohen, Ed., Routledge, 35–51.

Budd, L., and S. Ison, 2020: Responsible Transport: A post-COVID agenda for transport policy and practice. *Transp. Res. Interdiscip. Perspect.*, **6**, 100151, https://doi.org/10.1016/j.trip.2020.100151.

Bulkeley, H., and P. Newell, 2015: *Governing Climate Change*. Thomas G. Weiss, Ed. Routledge,.

Bullock, C., F. Brereton, and S. Bailey, 2017: The economic contribution of public bike-share to the sustainability and efficient functioning of cities. *Sustain. Cities Soc.*, **28**, 76–87, https://doi.org/10.1016/j.scs.2016.08.024.

Van den Bulte, C., and S. Stremersch, 2004: Social Contagion and Income Heterogeneity in New Product Diffusion: A Meta-Analytic Test. *Mark. Sci.*, **23**, 530–544, https://doi.org/10.1287/mksc.1040.0054.

Burke, M. J., 2020: Energy-Sufficiency for a Just Transition: A Systematic Review. *Energies*, **13**, 2444, https://doi.org/10.3390/en13102444.

——, and J. C. Stephens, 2017: Energy democracy: Goals and policy instruments for sociotechnical transitions. *Energy Res. Soc. Sci.*, **33**, 35–48, https://doi.org/10.1016/j.erss.2017.09.024.

Burstein, R., and Coauthors, 2019: Mapping 123 million neonatal, infant and child deaths between 2000 and 2017. *Nature*, **574**, 353–358, https://doi.org/10.1038/s41586-019-1545-0.

Buschmann, P., and A. Oels, 2019: The overlooked role of discourse in breaking carbon lock-in: The case of the German energy transition. *Wiley Interdiscip. Rev. Clim. Chang.*, **10**, 1–14, https://doi.org/10.1002/wcc.574.

Bush, R. E., C. S. E. Bale, and P. G. Taylor, 2016: Realising local government visions for developing district heating: Experiences from a learning country. *Energy Policy*, **98**, 84–96, https://doi.org/10.1016/j.enpol.2016.08.013.

Buyle, M., W. Galle, W. Debacker, and A. Audenaert, 2019: Sustainability assessment of circular building alternatives: Consequential LCA and LCC for internal wall assemblies as a case study in a Belgian context. *J. Clean. Prod.*, **218**, 141–156, https://doi.org/10.1016/j.jclepro.2019.01.306.

Camilleri, A. R., and R. P. Larrick, 2014: Metric and Scale Design as Choice Architecture Tools. *J. Public Policy Mark.*, **33**, 108–125, https://doi.org/10.1509/jppm.12.151.

Campbell, A., 2018: Mass timber in the circular economy: Paradigm in practice? *Proc. Inst. Civ. Eng. Eng. Sustain.*, **172**, 141–152, https://doi.org/10.1680/jensu.17.00069.

Campbell, I., A. Kalanki, and S. Sachar, 2018: *Solving the Global Cooling Challenge How to Counter the Climate Threat from Room Air Conditioners*. www.rmi.org/insight/solving_the_global_cooling_challenge. (Accessed December 9, 2020).

Campbell, T. H., and A. C. Kay, 2014: Solution aversion: On the relation between ideology and motivated disbelief. *J. Pers. Soc. Psychol.*, **107**, 809–824, https://doi.org/10.1037/a0037963.

Cantzler, J., F. Creutzig, E. Ayargarnchanakul, A. Javaid, L. Wong, and W. Haas, 2020: Saving resources and the climate? A systematic review of the circular economy and its mitigation potential. *Environ. Res. Lett.*, **15**, 123001, https://doi.org/10.1088/1748-9326/abbeb7.

Carattini, S., and A. Jo, 2018: *Trust and CO2 Emissions: Cooperation on a Global Scale*. https://www.lse.ac.uk/granthaminstitute/wp-content/uploads/2018/03/working-paper-294-Jo-Carattini-Sept-2018.pdf.

——, A. Baranzini, and J. Roca, 2015: Unconventional Determinants of Greenhouse Gas Emissions: The role of trust. *Environ. Policy Gov.*, **25**, 243–257, https://doi.org/10.1002/eet.1685.

——, ——, P. Thalmann, F. Varone, and F. Vöhringer, 2017: Green Taxes in a Post-Paris World: Are Millions of Nays Inevitable? *Environ. Resour. Econ.*, **68**, 97–128, https://doi.org/10.1007/s10640-017-0133-8.

——, S. Levin, and A. Tavoni, 2019: Cooperation in the Climate Commons. *Rev. Environ. Econ. Policy*, **13**, 227–247, https://doi.org/10.1093/reep/rez009.

Carley, S., and D. M. Konisky, 2020: The justice and equity implications of the clean energy transition. *Nat. Energy*, **5**, 569–577, https://doi.org/10.1038/s41560-020-0641-6.

Carr, E. R., and M. C. Thompson, 2014: Gender and Climate Change Adaptation in Agrarian Settings: Current Thinking, New Directions, and Research Frontiers. *Geogr. Compass*, **8**, 182–197, https://doi.org/10.1111/gec3.12121.

Carrico, A. R., and M. Riemer, 2011: Motivating energy conservation in the workplace: An evaluation of the use of group-level feedback and peer education. *J. Environ. Psychol.*, **31**, 1–13, https://doi.org/10.1016/j.jenvp.2010.11.004.

Carrington, M. J., B. A. Neville, and G. J. Whitwell, 2014: Lost in translation: Exploring the ethical consumer intention-behavior gap. *J. Bus. Res.*, **67**, 2759–2767, https://doi.org/10.1016/j.jbusres.2012.09.022.

Carroll, J., S. Lyons, and E. Denny, 2013: *Reducing Electricity Demand through Smart Metering: The Role of Improved Household Knowledge*. https://ideas.repec.org/p/tcd/tcduee/tep0313.html.

Cass, N., T. Schwanen, and E. Shove, 2018: Infrastructures, intersections and societal transformations. *Technol. Forecast. Soc. Change*, **137**, 160–167, https://doi.org/10.1016/J.TECHFORE.2018.07.039.

Castro, R., and P. Pasanen, 2019: How to design buildings with Life Cycle Assessment by accounting for the material flows in refurbishment. *IOP Conf. Ser. Earth Environ. Sci.*, **225**, https://doi.org/10.1088/1755-1315/225/1/012019.

Cazorla, M. ., and M. Toman, 2001: International Equity and Climate Change Policy. *Climate Change Economics and Policy: An RFF Anthology*, M. Toman, Ed., Routledge, 235–245.

Ceschin, F., and C. Vezzoli, 2010: The role of public policy in stimulating radical environmental impact reduction in the automotive sector: The need to focus on product-service system innovation. *Int. J. Automot. Technol. Manag.*, **10**, https://doi.org/10.1504/IJATM.2010.032631.

Chakravarty, D., and J. Roy, 2016: The global south: New estimates and insights from urban India. *Rethinking Climate and Energy Policies: New Perspectives on the Rebound Phenomenon*, Springer International Publishing, 55–72.

Chakravarty, S., and Coauthors, 2009: Sharing global CO2 emission reductions among one billion high emitters. *Proc. Natl. Acad. Sci. U. S. A.*, **106**, 11884–11888, https://doi.org/10.1073/pnas.0905232106.

Chan, S., and Coauthors, 2019: Promises and risks of nonstate action in climate and sustainability governance. *Wiley Interdiscip. Rev. Clim. Chang.*, 1–8, https://doi.org/10.1002/wcc.572.

Chancel, L., and T. Piketty, 2015: *Carbon and inequality: from Kyoto to Paris Trends in the global inequality of carbon emissions (1998-2013) & prospects for an equitable adaptation fund*. 50 pp. http://piketty.pse.ens.fr/files/ChancelPiketty2015.pdf (Accessed July 4, 2019).

Chandra, A., K. E. McNamara, P. Dargusch, A. M. Caspe, and D. Dalabajan, 2017: Gendered vulnerabilities of smallholder farmers to climate change in conflict-prone areas: A case study from Mindanao, Philippines. *J. Rural Stud.*, **50**, 45–59, https://doi.org/10.1016/j.jrurstud.2016.12.011.

Chanza, N., and A. De Wit, 2016: Enhancing climate governance through indigenous knowledge: Case in sustainability science. *S. Afr. J. Sci.*, **112**, https://doi.org/10.17159/sajs.2016/20140286.

Chapman, A., and T. Fraser, 2019: Japan's mega solar boom: quantifying social equity expectations and realities at the local scale. *Sustain. Sci.*, **14**, 355–374, https://doi.org/10.1007/s11625-018-0613-y.

Chapman, A. J., B. C. Mclellan, and T. Tezuka, 2018: Prioritizing mitigation efforts considering co-benefits, equity and energy justice: Fossil fuel to renewable energy transition pathways. *Appl. Energy*, **219**, 187–198, https://doi.org/10.1016/j.apenergy.2018.03.054.

Chaturvedi, B., and V. Gidwani, 2010: The Right to Waste: Informal Sector Recyclers and Struggles for Social Justice in Post-Reform Urban India. *India's New Economic Policy A Critical Analysis*, W. Ahmed, A. Kundu, and R. Peet, Eds., Routledge, 137–165.

Chen, D., and R. Li-Hua, 2011: Modes of technological leapfrogging: Five case studies from China. *J. Eng. Technol. Manag.*, **28**, 93–108, https://doi.org/https://doi.org/10.1016/j.jengtecman.2010.12.006.

Chen, K. K., 2014: Assessing the effects of customer innovativeness, environmental value and ecological lifestyles on residential solar power systems install intention. *Energy Policy*, **67**, 951–961, https://doi.org/10.1016/j.enpol.2013.12.005.

Chen, V. L., M. A. Delmas, W. J. Kaiser, and S. L. Locke, 2015: What can we learn from high-frequency appliance-level energy metering? Results from a field experiment. *Energy Policy*, **77**, 164–175, https://doi.org/10.1016/j.enpol.2014.11.021.

Chenoweth, J., 2009: Is tourism with a low impact on climate possible? *Worldw. Hosp. Tour. Themes*, **1**, 274–287, https://doi.org/10.1108/17554210910980611.

Cheon, A., 2020: Advocacy, social movements, and climate change. *Handbook of U.S. Environmental Policy*, D.M. Konisky, Ed., Edward Elgar Publishing, 315–327.

Cherry, C., K. Scott, J. Barrett, and N. Pidgeon, 2018: Public acceptance of resource-efficiency strategies to mitigate climate change. *Nat. Clim. Chang.*, **8**, 1007–1012, https://doi.org/10.1038/s41558-018-0298-3.

Cherry, C. R., H. Yang, L. R. Jones, and M. He, 2016: Dynamics of electric bike ownership and use in Kunming, China. *Transp. Policy*, **45**, 127–135, https://doi.org/10.1016/j.tranpol.2015.09.007.

Cherry, T. L., S. Kallbekken, and S. Kroll, 2017: Accepting market failure: Cultural worldviews and the opposition to corrective environmental policies. *J. Environ. Econ. Manage.*, **85**, 193–204, https://doi.org/10.1016/j.jeem.2017.05.004.

Chester, M. V., and A. Horvath, 2009: Environmental assessment of passenger transportation should include infrastructure and supply chains. *Environ. Res. Lett.*, **4**, https://doi.org/10.1088/1748-9326/4/2/024008.

Cheung, F., and R. E. Lucas, 2016: Income inequality is associated with stronger social comparisons: the effect of relative income on life satisfaction. 332–341.

Chevigny, P., 2003: The populism of fear: Politics of crime in the Americas. *Punishm. Soc.*, **5**, 77–96, https://doi.org/10.1177/1462474503005001293.

Chhatre, A., and A. Agrawal, 2009: Trade-offs and synergies between carbon storage and livelihood benefits from forest commons. *Proc. Natl. Acad. Sci. U. S. A.*, **106**, 17667–17670, https://doi.org/10.1073/pnas.0905308106.

Di Chiro, G., 2019: Care not growth: Imagining a subsistence economy for all. *Br. J. Polit. Int. Relations*, **21**, 303–311, https://doi.org/10.1177/1369148119836349.

Chitnis, M., S. Sorrell, A. Druckman, S. K. Firth, and T. Jackson, 2013: Turning lights into flights: Estimating direct and indirect rebound effects for UK households. *Energy Policy*, **55**, 234–250, https://doi.org/10.1016/j.enpol.2012.12.008.

Cho, D.-S., D.-J. Kim, and D. K. Rhee, 1998: Latecomer Strategies: Evidence from the Semiconductor Industry in Japan and Korea. *Organ. Sci.*, **9**, 489–505, https://doi.org/https://doi.org/10.1287/orsc.9.4.489.

Chu, E., 2016: The political economy of urban climate adaptation and development planning in Surat, India. *Environ. Plan. C Gov. Policy*, **34**, 281–298, https://doi.org/10.1177/0263774X15614174.

Chu, S., 2015: Car restraint policies and mileage in Singapore. *Transp. Res. Part A Policy Pract.*, **77**, 404–412, https://doi.org/10.1016/j.tra.2015.04.028.

Chuang, F., E. Manley, and A. Petersen, 2020: The role of worldviews in the governance of sustainable mobility. *Proc. Natl. Acad. Sci.*, **117**, 4034 LP – 4042, https://doi.org/10.1073/pnas.1916936117.

Chuku, C. A., 2010: Pursuing an integrated development and climate policy framework in Africa: Options for mainstreaming. *Mitig. Adapt. Strateg. Glob. Chang.*, **15**, 41–52, https://doi.org/10.1007/s11027-009-9203-8.

Cialdini, R. B., 2006: *Influence: The psychology of persuasion*. Herper Collins New York, 173–174 pp.

Cirera, X., and W. F. Maloney, 2017: *The Innovation Paradox: Developing-Country Capabilities and the Unrealized Promise of Technological Catch-Up*. World Bank, 186 pp.

Claeys, P., and D. Delgado Pugley, 2017: Peasant and indigenous transnational social movements engaging with climate justice. *Can. J. Dev. Stud. / Rev. Can. d'études du développement*, **38**, 325–340, https://doi.org/10.1080/02255189.2016.1235018.

Clancy, J., and M. Feenstra, 2019: *Women, Gender Equality and the Energy Transition in the EU*. http://www.europarl.europa.eu/supporting-analyses (Accessed June 19, 2020).

Clancy, J., A. Barnett, E. Cecelski, S. Pachauri, S. Dutta, S. Oparaocha, A. Kooijman, and ENERGIA, 2019: Gender in the transition to sustainable energy for all: From evidence to inclusive policies. *Energ. Int. Netw. Gend. Sustain. Energy*, 1–105.

Clausen, J., E. Göll, and V. Tappeser, 2017: Sticky Transformation – How path dependencies in socio-technical regimes are impeding the transformation to a Green Economy. *J. Innov. Manag.*, **5**, 111–138, https://doi.org/10.1007/BF00727536.

Clayton, S., 2018: The Role of Perceived Justice, Political Ideology, and Individual or Collective Framing in Support for Environmental Policies. *Soc. Justice Res.*, **31**, 219–237, https://doi.org/10.1007/s11211-018-0303-z.

——, P. Devine-Wright, P. C. Stern, L. Whitmarsh, A. Carrico, L. Steg, J. Swim, and M. Bonnes, 2015: Psychological research and global climate change. *Nat. Clim. Chang.*, **5**, 640–646, https://doi.org/10.1038/nclimate2622.

Clewlow, R. R., and G. S. Mishra, 2017: *Disruptive Transportation: The Adoption, Utilization, and Impacts of Ride-Hailing in the United States*.

Climact, 2018: *Net Zero by 2050: from whether to how*. 35 pp. https://europeanclimate.org/wp-content/uploads/2019/11/09-18-net-zero-by-2050-from-whether-to-how.pdf.

Climate Assembly UK, 2020: *The path to net zero*. https://www.climateassembly.uk/report/read/final-report-exec-summary.pdf (Accessed December 10, 2020).

Cloutier, G., F. Joerin, C. Dubois, M. Labarthe, C. Legay, and D. Viens, 2015: Planning adaptation based on local actors' knowledge and participation: a climate governance experiment. *Clim. Policy*, **15**, 458–474, https://doi.org/10.1080/14693062.2014.937388.

Coates, S. J., L. K. Andersen, and M. D. Boos, 2020: Balancing public health and private wealth: lessons on climate inaction from the COVID-19 pandemic. *Int. J. Dermatol.*, https://doi.org/10.1111/ijd.14917.

Cohen, M., 2017: Gendered Emissions: Counting Greenhouse Gas Emissions by Gender and Why it Matters. *Climate Change and its Discontents*, C. Fanelli and B. Evans, Eds.

Cohen, T., and C. Cavoli, 2019: Automated vehicles: exploring possible consequences of government (non)intervention for congestion and accessibility. *Transp. Rev.*, **39**, 129–151, https://doi.org/10.1080/01441647.2018.1524401.

Colenbrander, S., and Coauthors, 2016: Can low-carbon urban development be pro-poor? The case of Kolkata, India. *Environ. Urban.*, **29**, 139–158, https://doi.org/10.1177/0956247816677775.

Collins, C., 2019: *Can Improving Women's Representation in Environmental Governance Reduce Greenhouse Gas Emissions?* 7 pp. http://climate.org/can-improving-womens-representation-in-environmental-governance-reduce-greenhouse-gas-emissions/ (Accessed July 4, 2019).

Colville-Andersen, M., 2018: *Copenhagenize : the definitive guide to global bicycle urbanism*. Island Press, 275 pp.

Comin, D., and B. Hobijn, 2003: *Cross-country technology adoption: Making the theories face the facts*. 49 pp. http://hdl.handle.net/10419/60558.

——, M. Dmitriev, and E. Rossi-Hansberg, 2012: Heavy technology: The process of technological diffusion over time and space. *VoxEU CEPR*,. https://voxeu.org/article/heavy-technology-process-technological-diffusion-over-time-and-space (Accessed August 4, 2020).

de Coninck, H., and Coauthors, 2018: Strengthening and implementing the global response. *Global Warming of 1.5C: an IPCC special report on the impacts of global warming of 1.5C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change*, p. 132.

Cook, G., T. Dowdall, D. Pomerantz, and Y. Wang, 2014: *Clicking Clean : How Companies are Creating the Green Internet*. https://www.greenpeace.org/usa/wp-content/uploads/legacy/Global/usa/planet3/PDFs/clickingclean.pdf.

Cook, N. J., T. Grillos, and K. P. Andersson, 2019: Gender quotas increase the equality and effectiveness of climate policy interventions. *Nat. Clim. Chang.*, **9**, 330–334, https://doi.org/10.1038/s41558-019-0438-4.

Cooper, C. L., Y. Liu, and S. Y. Tarba, 2014: Resilience, HRM practices and impact on organizational performance and employee well-being. *Int. J. Hum. Resour. Manag.*, **25**, 2466–2471, https://doi.org/10.1080/09585192.2014.926688.

Copland, S., 2019: Anti-politics and Global Climate Inaction: The Case of the Australian Carbon Tax. *Crit. Sociol.*, **46**, 623–641, https://doi.org/10.1177/0896920519870230.

Costa, D. L., and M. E. Kahn, 2010: *Energy Conservation*.

Costa, D. L., and M. E. Kahn, 2013: Energy conservation "nudges" and environmentalist ideology: Evidence from a randomized residential electricity field experiment. *J. Eur. Econ. Assoc.*, **11**, 680–702, https://doi.org/10.1111/jeea.12011.

Costa, V., and A. Johnson, 2019: Global Food and Nutrition Trends: Driving Positive Momentum for Grains. *Cereal Foods World*, **64**, https://doi.org/10.1094/CFW-64-3-0032.

Coulombel, N., V. Boutueil, L. Liu, V. Viguié, and B. Yin, 2019: Substantial rebound effects in urban ridesharing: Simulating travel decisions in Paris, France. *Transp. Res. Part D Transp. Environ.*, **71**, 110–126, https://doi.org/10.1016/j.trd.2018.12.006.

Court, V., and S. Sorrell, 2020: Digitalisation of goods: A systematic review of the determinants and magnitude of the impacts on energy consumption. *Environ. Res. Lett.*, **15**, https://doi.org/10.1088/1748-9326/ab6788.

Cowan, R., 1990: Nuclear Power Reactors: A Study in Technological Lock-in. *J. Econ. Hist.*, **50**, 541–567, https://doi.org/10.1017/S0022050700037153.

——, 1991: Tortoises and hares: Choice among technologies of unknown merit. *Econ. J.*, **101**, 801–814, https://doi.org/10.1016/s0262-4079(11)61100-7.

Cramton, P., A. Ockenfels, and J. Tirole, 2017: Translating the Collective Climate Goal Into a Common Climate Commitment. *Rev. Environ. Econ. Policy*, **11**, 165–171, https://doi.org/10.1093/reep/rew015.

Crawford, N. C., 2019: *Pentagon Fuel Use, Climate Change, and the Costs of War*. 46 pp. https://watson.brown.edu/costsofwar/files/cow/imce/papers/2018/Crawford_Costs of War Es (Accessed October 31, 2019).

Creamer, E., and Coauthors, 2018: Community energy: Entanglements of community, state, and private sector. *Geogr. Compass*, **12**, https://doi.org/10.1111/gec3.12378.

Creutzig, F., 2019: The Mitigation Trinity: Coordinating Policies to Escalate Climate Mitigation. *One Earth*, **1**, 76–85, https://doi.org/10.1016/j.oneear.2019.08.007.

——, and Coauthors, 2015a: Transport: A roadblock to climate change mitigation? *Science (80-.).*, **350**, 911–912, https://doi.org/10.1126/science.aac8033.

——, G. Baiocchi, R. Bierkandt, P.-P. P. Pichler, and K. C. Seto, 2015b: Global typology of urban energy use and potentials for an urbanization mitigation wedge. *Proc. Natl. Acad. Sci.*, **112**, 6283–6288, https://doi.org/10.1073/pnas.1315545112.

——, and Coauthors, 2016a: Urban infrastructure choices structure climate solutions. *Nat. Clim. Chang.*, **6**, 1054, https://doi.org/10.1038/nclimate3169.

——, B. Fernandez, H. Haberl, R. Khosla, Y. Mulugetta, and K. C. Seto, 2016b: Beyond technology: demand-side solutions for climate change mitigation. *Annu. Rev. Environ. Resour.*, **41**, 173–198, https://doi.org/10.1146/annurev-environ-110615-085428.

——, P. Agoston, J. C. J. C. Goldschmidt, G. Luderer, G. Nemet, and R. C. R. C. Pietzcker, 2017: The underestimated potential of solar energy to mitigate climate change. *Nat. Energy*, **2**, https://doi.org/10.1038/nenergy.2017.140.

——, and Coauthors, 2018: Towards demand-side solutions for mitigating climate change. *Nat. Clim. Chang.*, **8**, 260–263, https://doi.org/10.1038/s41558-018-0121-1.

Creutzig, F., M. Franzen, R. Moeckel, D. Heinrichs, K. Nagel, S. Nieland, and H. Weisz, 2019: Leveraging Digitalization for Sustainability in Urban Transport. *Glob. Sustain.*, **2**, 1–6, https://doi.org/10.1017/sus.2019.11.

Creutzig, F., and Coauthors, 2020: Fair street space allocation: ethical principles and empirical insights. *Transp. Rev.*, **40**, 711–733, https://doi.org/10.1080/01441647.2020.1762795.

——, and Coauthors, 2021a: A typology of 100,000 publications on demand, services and social aspects of climate change mitigation. *Environ. Res. Lett.*, **submitted**.

——, and Coauthors, 2021b: Demand-side solutions to climate change mitigation consistent with high levels of wellbeing. **submitted**.

Crick, F., S. M. S. U. Eskander, S. Fankhauser, and M. Diop, 2018a: How do African SMEs respond to climate risks? Evidence from Kenya and Senegal. *World Dev.*, **108**, 157–168, https://doi.org/10.1016/j.worlddev.2018.03.015.

——, K. E. Gannon, M. Diop, and M. Sow, 2018b: Enabling private sector adaptation to climate change in sub-Saharan Africa. *Wiley Interdiscip. Rev. Clim. Chang.*, **9**, e505, https://doi.org/10.1002/wcc.505.

Cuenot, F., L. Fulton, and J. Staub, 2010: The prospect for modal shifts in passenger transport worldwide and impacts on energy use and CO2. *Energy Policy*, **41**, 98–106, https://doi.org/10.1016/j.enpol.2010.07.017.

Cullen, J., 2017: Circular economy: theoretical benchmark or perpetual motion machine? *Circ. Econ.*, **21**, 483–486, https://doi.org/10.1111/jiec.12599.

Cunningham, P., J. Edler, K. Flanagan, and P. Laredo, 2013: *Innovation policy mix and instrument interaction: a review*. 47 pp. www.nesta.org.uk/wp13-20.

Curnow, J., and A. Gross, 2016: Injustice is not an investment: student activism, climate justice, and the fossil fuel divestment campaign. *Contemporary Youth Activism: Advancing Social Justice in the United States*, S. Connor, J. and Rosen, Ed., ABC-CLIO, p. 433.

Curran, G., 2020: Divestment, energy incumbency and the global political economy of energy transition: the case of Adani's Carmichael mine in Australia. *Clim. Policy*, **20**, 949–962, https://doi.org/10.1080/14693062.2020.1756731.

Curtis, S. K., and M. Lehner, 2019: Defining the sharing economy for sustainability. *Sustain.*, **11**, https://doi.org/10.3390/su11030567.

D'Ambrosio, C., and J. R. Frick, 2012: Individual Wellbeing in a Dynamic Perspective. *Economica*, **79**, 284–302, https://doi.org/10.1111/j.1468-0335.2011.00896.x.

D'Oca, S., S. P. Corgnati, and T. Buso, 2014: Smart meters and energy savings in Italy: Determining the effectiveness of persuasive communication in dwellings. *Energy Res. Soc. Sci.*, **3**, 131–142, https://doi.org/10.1016/j.erss.2014.07.015.

Dana, L.-P., C. Gurău, F. Hoy, V. Ramadani, and T. Alexander, 2019: Success factors and challenges of grassroots innovations: Learning from failure. *Technol. Forecast. Soc. Change*, https://doi.org/10.1016/j.techfore.2019.03.009.

Dankelman, I., 2010: *Gender and climate change : an introduction*. I. Dankelman, Ed. Routledge/Earthscan, 284 pp.

Dankelman, I., and W. H. M. Jansen, 2010: Gender, Environment and Climate Change: understanding the linkages. https://doi.org/10.4324/9781849775274.

Darby, S., 2006: *The effectiveness of feedback on energy consumption a review for defra of the literature on metering, billing and direct displays*. https://www.eci.ox.ac.uk/research/energy/downloads/smart-metering-report.pdf (Accessed November 28, 2020).

Darier, É., and R. Schüle, 1999: Think globally, act locally'? Climate change and public participation in Manchester and Frankfurt. *Local Environ.*, **4**, 317–329, https://doi.org/10.1080/13549839908725602.

Dario Kenner, 2015: Inequality of overconsumption: The ecological footprint of the richest. https://whygreeneconomy.org/wp-content/uploads/2015/11/Inequality-of-overconsumption.-The-ecological-footprint-of-the-richest-Dario-Kenner.pdf (Accessed November 29, 2019).

Das, K., G. Pradhan, and S. Nonhebel, 2019: Human energy and time spent by women using cooking energy systems: A case study of Nepal. *Energy*, **182**, 493–501, https://doi.org/10.1016/j.energy.2019.06.074.

Das, S., and E. Mao, 2020: The global energy footprint of information and communication technology electronics in connected Internet-of-Things devices. *Sustain. Energy, Grids Networks*, **24**, 100408, https://doi.org/https://doi.org/10.1016/j.segan.2020.100408.

——, D. Graziano, V. K. K. Upadhyayula, E. Masanet, M. Riddle, and J. Cresko, 2016: Vehicle lightweighting energy use impacts in U.S. light-duty vehicle fleet. *Sustain. Mater. Technol.*, **8**, 5–13, https://doi.org/10.1016/j.susmat.2016.04.001.

Dasgupta, A., and P. Dasgupta, 2017: Socially Embedded Preferences, Environmental Externalities, and Reproductive Rights. *Popul. Dev. Rev.*, **43**, 405–441, https://doi.org/10.1111/padr.12090.

Dasgupta, P., D. Southerton, A. Ulph, and D. Ulph, 2016: Consumer Behaviour with Environmental and Social Externalities: Implications for Analysis and Policy. *Environ. Resour. Econ.*, **65**, 191–226, https://doi.org/10.1007/s10640-015-9911-3.

Daube, M., and D. Ulph, 2016: Moral Behaviour, Altruism and Environmental Policy. *Environ. Resour. Econ.*, **63**, 505–522, https://doi.org/10.1007/s10640-014-9836-2.

David, M., 2017: Moving beyond the heuristic of creative destruction: Targeting exnovation with policy mixes for energy transitions. *Energy Res. Soc. Sci.*, **33**, 138–146, https://doi.org/10.1016/j.erss.2017.09.023.

David Tàbara, J., and Coauthors, 2018: Positive tipping points in a rapidly warming world. *Curr. Opin. Environ. Sustain.*, **31**, 120–129, https://doi.org/10.1016/j.cosust.2018.01.012.

Davidescu, S., R. Hiteva, and T. Maltby, 2018: Two steps forward, one step back: Renewable energy transitions in Bulgaria and Romania. *Public Adm.*, **96**, 611–625, https://doi.org/10.1111/padm.12522.

Davis, S., 1979: *The Diffusion of Process Innovations*. Cambridge University Press, 193 pp.

Davis, S. J., and K. Caldeira, 2010: Consumption-based accounting of CO2 emissions. *Proc. Natl. Acad. Sci.*, **107**, 5687–5692, https://doi.org/10.1073/pnas.0906974107.

Decancq, K., A. Decoster, and E. Schokkaert, 2009: The Evolution of World Inequality in Well-being. *World Dev.*, **37**, 11–25, https://doi.org/10.1016/j.worlddev.2007.12.006.

DECC, 2015: *Smart Metering Early Learning Project: Domestic Energy Consumption Analysis*. https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/407542/2_ELP_Domestic_Energy_Consumption_Analysis_Report.pdf.

Dechezleprêtre, A., M. Glachant, and Y. Ménière, 2013: What Drives the International Transfer of Climate Change Mitigation Technologies? Empirical Evidence from Patent Data. *Environ. Resour. Econ.*, **54**, 161–178, https://doi.org/10.1007/s10640-012-9592-0.

——, E. Neumayer, and R. Perkins, 2015: Environmental regulation and the cross-border diffusion of new technology: Evidence from automobile patents. *Res. Policy*, **44**, 244–257, https://doi.org/10.1016/j.respol.2014.07.017.

Decker, K., and Coauthors, 2017: *Conceptual Feasibility Study of the Hyperloop Vehicle for Next-Generation Transport*. 22 pp. https://ntrs.nasa.gov/search.jsp?R=20170001624 (Accessed December 16, 2019).

Delhey, J., and G. Dragolov, 2014: Why Inequality Makes Europeans Less Happy: The Role of Distrust, Status Anxiety, and Perceived Conflict. *Eur. Sociol. Rev.*, **30**, 151–165, https://doi.org/10.1093/esr/jct033.

Delmas, M. A., and N. Lessem, 2014: Saving power to conserve your reputation? The effectiveness of private versus public information. *J. Environ. Econ. Manage.*, **67**, 353–370, https://doi.org/10.1016/j.jeem.2013.12.009.

Delmas, M. A., M. Fischlein, and O. I. Asensio, 2013: Information strategies and energy conservation behavior: A meta-analysis of experimental studies from 1975 to 2012. *Energy Policy*, **61**, 729–739, https://doi.org/10.1016/j.enpol.2013.05.109.

Demski, C., C. Butler, K. A. Parkhill, A. Spence, and N. F. Pidgeon, 2015: Public values for energy system change. *Glob. Environ. Chang.*, **34**, 59–69, https://doi.org/10.1016/j.gloenvcha.2015.06.014.

Dendup, N., and T. H. Arimura, 2019: Information leverage: The adoption of clean cooking fuel in Bhutan. *Energy Policy*, **125**, 181–195, https://doi.org/10.1016/j.enpol.2018.10.054.

Deng, T., and J. D. Nelson, 2011: Recent developments in bus rapid transit: A review of the literature. *Transp. Rev.*, **31**, 69–96, https://doi.org/10.1080/01441647.2010.492455.

Dengler, C., and B. Strunk, 2018: The Monetized Economy Versus Care and the Environment: Degrowth Perspectives On Reconciling an Antagonism. *Fem. Econ.*, **24**, 160–183, https://doi.org/10.1080/13545701.2017.1383620.

Devine-Wright, P., 2009: Rethinking NIMBYism: The role of place attachment and place identity in explaining place-protective action. *J. Community Appl. Soc. Psychol.*, **19**, 426–441, https://doi.org/10.1002/casp.1004.

——, 2011: Public engagement with large-scale renewable energy technologies: Breaking the cycle of

NIMBYism. *Wiley Interdiscip. Rev. Clim. Chang.*, **2**, 19–26, https://doi.org/10.1002/wcc.89.

——, L. Pinto de Carvalho, A. Di Masso, M. Lewicka, L. Manzo, and D. R. Williams, 2020: "Re-placed" - Reconsidering relationships with place and lessons from a pandemic. *J. Environ. Psychol.*, **72**, 101514, https://doi.org/10.1016/j.jenvp.2020.101514.

Dewald, U., and B. Truffer, 2011: Market formation in technological innovation systems-diffusion of photovoltaic applications in Germany. *Ind. Innov.*, **18**, 285–300, https://doi.org/10.1080/13662716.2011.561028.

Dhar, S., M. Pathak, and P. R. Shukla, 2017: Electric vehicles and India's low carbon passenger transport: a long-term co-benefits assessment. *J. Clean. Prod.*, **146**, 139–148, https://doi.org/10.1016/j.jclepro.2016.05.111.

Dibb, S., and I. Fitzpatrick, 2014: *Let's talk about meat: changing dietary behaviour for the 21st century*. 32 pp.

Diener, E., L. Tay, and S. Oishi, 2013: Rising income and the subjective well-being of nations. *J. Pers. Soc. Psychol.*, **104**, 267–276, https://doi.org/10.1037/a0030487.

Dietrich, F., and C. List, 2016: Reason-based choice and contextdependence: an explanatory framework. *Econ. Philos.*, **32**, 175–229, https://doi.org/10.1017/S0266267115000474.

Dietz, T., 2014: Understanding environmentally significant consumption. *Proc. Natl. Acad. Sci. U. S. A.*, **111**, 5067–5068, https://doi.org/10.1073/pnas.1403169111.

——, and P. C. Stern, 2008: *Public participation in environmental assessment and decision making*. National Academies Press, 1–305 pp.

——, G. T. Gardner, J. Gilligan, P. C. Stern, and M. P. Vandenbergh, 2009: Household actions can provide a behavioral wedge to rapidly reduce US carbon emissions. *Proc. Natl. Acad. Sci.*, **106**, 18452–18456, https://doi.org/10.1073/pnas.0908738106.

Diffenbaugh, N. S., and Coauthors, 2020: The COVID-19 lockdowns: a window into the Earth System. *Nat. Rev. Earth Environ.*, **1**, 470–481, https://doi.org/10.1038/s43017-020-0079-1.

Ding, Q., X. Liang, H. Chen, M. Liu, and J. Yang, 2020: Study on Policy and Standard System of LED Lighting Industry in EU. *E3S Web Conf.*, **194**, 02016, https://doi.org/10.1051/e3sconf/202019402016.

Djerf-Pierre, M., 2012: Green metacycles of attention: Reassessing the attention cycles of environmental news reporting 1961–2010. *Public Underst. Sci.*, **22**, 495–512, https://doi.org/10.1177/0963662511426819.

Docherty, I., G. Marsden, and J. Anable, 2018: The governance of smart mobility. *Transp. Res. Part A Policy Pract.*, **115**, 114–125, https://doi.org/10.1016/j.tra.2017.09.012.

Dolan, P., and R. Metcalfe, 2013: *Neighbors, Knowledge, and Nuggets: Two Natural Field Experiments on the Role of Incentives on Energy Conservation*. https://ideas.repec.org/p/cep/cepdps/dp1222.html.

Dombrowski, K., 2010: Filling the gap? An analysis of non-governmental organizations responses to participation and representation deficits in global climate governance. *Int. Environ. Agreements Polit. Law Econ.*, **10**, 397–416, https://doi.org/10.1007/s10784-010-9140-8.

Dombrowski, U., S. Ernst, and A. Reimer, 2016: A New Training for Factory Planning Engineers to Create Awareness of Climate Change. *Procedia CIRP*, **48**, 443–448, https://doi.org/10.1016/j.procir.2016.04.083.

De Dominicis, S., R. Sokoloski, C. M. Jaeger, and P. W. Schultz, 2019: Making the smart meter social promotes long-term energy conservation. *Palgrave Commun.*, **5**, 1–8, https://doi.org/10.1057/s41599-019-0254-5.

Dorling, D., 2019: *Inequality and the 1%*. Third. Verso, 272 pp.

Douenne, T., and A. Fabre, 2019: *Can We Reconcile French People with the Carbon Tax? Disentangling Beliefs from Preferences*. FAERE - French Association of Environmental and Resource Economists,.

——, and ——, 2020: French attitudes on climate change, carbon taxation and other climate policies. *Ecol. Econ.*, **169**, https://doi.org/10.1016/j.ecolecon.2019.106496.

Downs, A., 1972: Up and Down With Ecology The "Issue-Attention Cycle." *Public Interest*, 38–50.

Doyal, L., and I. Gough, 1991: Introduction. *A Theory of Human Need*, Palgrave, 1–2.

Doyle, J., 2011: Where has all the oil gone? BP branding and the discursive elimination of climate change risk. *Culture, environment and eco- politics*, N. Heffernan and D. Wragg, Eds., Cambridge Scholars Publishing, 200–225.

——, N. Farrell, and M. K. Goodman, 2019: The cultural politics of climate branding: Project Sunlight, the biopolitics of climate care and the socialisation of the everyday sustainable consumption practices of citizens-consumers. *Clim. Change*, **163**, 117–133, https://doi.org/10.1007/s10584-019-02487-6.

Drews, S., and J. C. J. M. van den Bergh, 2016: What explains public support for climate policies? A review of empirical and experimental studies. *Clim. Policy*, **16**, 855–876, https://doi.org/10.1080/14693062.2015.1058240.

Dreyfus, G., and Coauthors, 2020: *Assessment of climate and development benefits of efficient and climate-friendly cooling* . https://ccacoalition.org/en/resources/assessment-climate-and-development-benefits-efficient-and-climate-friendly-cooling (Accessed December 9, 2020).

Druckman, A., and T. Jackson, 2010: The bare necessities: How much household carbon do we really need? *Ecol. Econ.*, **69**, 1794–1804, https://doi.org/10.1016/j.ecolecon.2010.04.018.

——, I. Buck, B. Hayward, and T. Jackson, 2012: Time, gender and carbon: A study of the carbon implications of British adults' use of time. *Ecol. Econ.*, **84**, 153–163, https://doi.org/10.1016/j.ecolecon.2012.09.008.

Dryzek, J. S., and Coauthors, 2019: The crisis of democracy and the science of deliberation. *Science (80-.).*, **363**, 1144–1146, https://doi.org/10.1126/scienceaaw2694.

Dubash, N. K., 2013: The politics of climate change in india: Narratives of equity and cobenefits. *Wiley Interdiscip. Rev. Clim. Chang.*, **4**, 191–201, https://doi.org/10.1002/wcc.210.

Dubois, G., and Coauthors, 2019: It starts at home? Climate policies targeting household consumption and behavioral decisions are key to low-carbon futures. *Energy Res. Soc. Sci.*, **52**, 144–158, https://doi.org/10.1016/j.erss.2019.02.001.

Dulal, H., K. Shah, and N. Ahmad, 2009: Social Equity Considerations in the Implementation of Caribbean Climate Change Adaptation Policies. *Sustainability*, **1**, 363–383, https://doi.org/10.3390/su1030363.

Dünnhoff, E., and M. Duscha, 2008: Effiziente Beratungsbausteine zur Minderung des Stromverbrauchs in privaten Haushalten. Endbericht [Efficient building blocks for energy counseling aimed at reducing electricity consumption in private households]. *Inst. für Energie- und Umweltforsch.*,.

Durán Heras, M. A., 2012: *Unpaid Work in the Global Economy*. M.A. Durán Heras, Ed. Fundacion BBVA, 511 pp.

Dussaux, D., A. Dechezleprêtre, and M. Glachant, 2017: *Intellectual property rights protection and the international transfer of low-carbon technologies*. 48 pp. https://hal.archives-ouvertes.fr/hal-01693539.

Easterlin, R. A., L. A. McVey, M. Switek, O. Sawangfa, and J. S. Zweig, 2010: The happiness-income paradox revisited. *Proc. Natl. Acad. Sci. U. S. A.*, **107**, https://doi.org/10.1073/pnas.1015962107.

Eastin, J., 2018: Climate change and gender equality in developing states. *World Dev.*, **107**, 289–305, https://doi.org/10.1016/j.worlddev.2018.02.021.

Ebeling, F., and S. Lotz, 2015: Domestic uptake of green energy promoted by opt-out tariffs. *Nat. Clim. Chang.*, **5**, 868–871, https://doi.org/10.1038/nclimate2681.

Eberhardt, L. C. M., H. Birgisdottir, and M. Birkved, 2019a: Potential of Circular Economy in Sustainable Buildings. *IOP Conf. Ser. Mater. Sci. Eng.*, **471**, https://doi.org/10.1088/1757-899X/471/9/092051.

——, H. Birgisdóttir, and M. Birkved, 2019b: Life cycle assessment of a Danish office building designed for disassembly. *Build. Res. Inf.*, **47**, 666–680, https://doi.org/10.1080/09613218.2018.1517458.

Edjabou, L. D., and S. Smed, 2013: The effect of using consumption taxes on foods to promote climate friendly diets - The case of Denmark. *Food Policy*, **39**, 84–96, https://doi.org/10.1016/j.foodpol.2012.12.004.

Edmondson, D. L., F. Kern, and K. S. Rogge, 2019: The co-evolution of policy mixes and socio-technical systems: Towards a conceptual framework of policy mix feedback in sustainability transitions. *Res. Policy*, **48**, Article 103555, https://doi.org/10.1016/j.respol.2018.03.010.

Ehrhardt-Martinez, K., 2015: Behaviour wedge profiles for cities. *eceee 2015 Summer Study energy Effic. First fuel now*, **Panel: 3.**, 691–702.

Ehrlich, P. R., and A. H. Ehrlich, 2013: Can a collapse of global civilization be avoided? *Proc. R. Soc. B Biol. Sci.*, **280**, 1–9, https://doi.org/10.1098/rspb.2012.2845.

Elias, T., N. S. Dahmen, D. D. Morrison, D. Morrison, and D. L. Morris, 2018: Understanding Climate Change Perceptions and Attitudes Across Racial/Ethnic Groups. *Howard J. Commun.*, **30**, 38–56, https://doi.org/10.1080/10646175.2018.1439420.

Ellenbeck, S., and J. Lilliestam, 2019: How modelers construct energy costs: Discursive elements in Energy System and Integrated Assessment Models. *Energy Res. Soc. Sci.*, **47**, 69–77, https://doi.org/10.1016/j.erss.2018.08.021.

Elliot, S., 2011: Transdisciplinary Perspectives on Environmental Sustainability: A Resource Base and Framework for IT-Enabled Business Transformation. *MIS Q.*, **35**, 197, https://doi.org/10.2307/23043495.

Elnakat, A., and J. D. Gomez, 2015: Energy engenderment: An industrialized perspective assessing the importance of engaging women in residential energy consumption management. *Energy Policy*, **82**, 166–177, https://doi.org/10.1016/j.enpol.2015.03.014.

Enoch, M. P., and J. Taylor, 2006: A worldwide review of support mechanisms for car clubs. *Transp. Policy*, **13**, 434–443, https://doi.org/10.1016/J.TRANPOL.2006.04.001.

Erb, K.-H., C. Lauk, T. Kastner, A. Mayer, M. C. Theurl, and Helmut Haberl, 2016: Exploring the biophysical option space for feeding the world without deforestation. *Nat. Clim. Chang.*, **48**, 829–834, https://doi.org/https://doi.org/10.1038/ncomms11382.

Ergas, C., and R. York, 2012: Women's status and carbon dioxide emissions: A quantitative cross-national analysis. *Soc. Sci. Res.*, **41**, 965–976, https://doi.org/10.1016/j.ssresearch.2012.03.008.

ESRB, 2016: *Too late, too sudden: Transition to a low-carbon economy and systemic risk*.

Ettlinger, N., 2017: Open innovation and its discontents. *Geoforum*, **80**, 61–71, https://doi.org/10.1016/j.geoforum.2017.01.011.

Eurostat, 2018: Glossary: Material deprivation. *Eurostat Stat. Explain.*, 1–2. https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Glossary:Material_deprivation_rate (Accessed February 21, 2019).

Fagan, M., and C. Huang, 2019: How people worldwide view climate change | Pew Research Center.

Pew Res. Cent.,. https://www.pewresearch.org/fact-tank/2019/04/18/a-look-at-how-people-around-the-world-view-climate-change/ (Accessed November 30, 2019).

Fairbrother, M., I. Johansson Sevä, and J. Kulin, 2019: Political trust and the relationship between climate change beliefs and support for fossil fuel taxes: Evidence from a survey of 23 European countries. *Glob. Environ. Chang.*, **59**, https://doi.org/10.1016/j.gloenvcha.2019.102003.

Fanning, A. L., and D. W. O'Neill, 2019: The Wellbeing–Consumption paradox: Happiness, health, income, and carbon emissions in growing versus non-growing economies. *J. Clean. Prod.*, **212**, 810–821, https://doi.org/10.1016/j.jclepro.2018.11.223.

FAO, 2014: *Food Wastage Footprint: Full cost-accounting*. 98 pp. http://www.fao.org/publications/card/en/c/5e7c4154-2b97-4ea5-83a7-be9604925a24/.

——, 2018: *FAO Agricultural Outlook 2018-2027*. OECD, 108 pp.

Farmer, J. D., and Coauthors, 2019: Sensitive intervention points in the post-carbon transition. *Science (80-.).*, **364**, 132–134, https://doi.org/10.1126/science.aaw7287.

Faruqui, A., S. Sergici, and A. Sharif, 2010: The impact of informational feedback on energy consumption-A survey of the experimental evidence. *Energy*, **35**, 1598–1608, https://doi.org/10.1016/j.energy.2009.07.042.

Favier, A., K. Scrivener, and G. Habert, 2019: Decarbonizing the cement and concrete sector: integration of the full value chain to reach net zero emissions in Europe. *IOP Conf. Ser. Earth Environ. Sci.*, **225**, 012009, https://doi.org/10.1088/1755-1315/225/1/012009.

Fawcett, T., J. Rosenow, and P. Bertoldi, 2019: Energy efficiency obligation schemes: their future in the EU. *Energy Effic.*, **12**, 57–71, https://doi.org/10.1007/s12053-018-9657-1.

Feder, G., and D. L. Umali, 1993: The adoption of agricultural innovations: A review. *Technol. Forecast. Soc. Change*, **43**, 215–239, https://doi.org/https://doi.org/10.1016/0040-1625(93)90053-A.

Fedrigo, D., J. Hontelez, A. Tukker, M. J. Cohen, K. Hubacek, O. Mont, D. Fedrigo, and J. Hontelez, 2010: Sustainable Consumption and Production. *J. Ind. Ecol.*, **14**, 10–12, https://doi.org/https://doi.org/10.1111/j.1530-9290.2009.00214.x.

de Feijter, F. J., B. J. M. van Vliet, and Y. Chen, 2019: Household inclusion in the governance of housing retrofitting: Analysing Chinese and Dutch systems of energy retrofit provision. *Energy Res. Soc. Sci.*, **53**, 10–22, https://doi.org/10.1016/j.erss.2019.02.006.

Fell, M. J., 2017: Energy services : A conceptual review. *Energy Res. Soc. Sci.*, **27**, 129–140, https://doi.org/10.1016/j.erss.2017.02.010.

Fernström Nåtby, K., and H. Rönnerfalk, 2018: Gender Equality and CO2-Emissions: A Panel Data Study. Lund University, Department of Economics, Sweden, 40 pp. https://lup.lub.lu.se/student-papers/search/publication/8934039 (Accessed July 4, 2019).

Fichter, K., and J. Clausen, 2016: Diffusion Dynamics of Sustainable Innovation - Insights on Diffusion Patterns Based on the Analysis of 100 Sustainable Product and Service Innovations. *J. Innov. Manag.*, **4**, 30–67, https://doi.org/10.24840/2183-0606_004.002_0004.

Figge, F., W. Young, and R. Barkemeyer, 2014: Sufficiency or efficiency to achieve lower resource consumption and emissions? the role of the rebound effect. *J. Clean. Prod.*, **69**, 216–224, https://doi.org/10.1016/j.jclepro.2014.01.031.

Finnegan, J., 2019: *Institutions, climate change, and the foundations of long-term policymaking*. www.cccep.ac.uk.

Fioramonti, L., L. Coscieme, and L. F. Mortensen, 2019: From gross domestic product to wellbeing: How alternative indicators can help connect the new economy with the Sustainable Development Goals. *Anthr. Rev.*, **6**, 207–222, https://doi.org/10.1177/2053019619869947.

Firnkorn, J., and M. Müller, 2011: What will be the environmental effects of new free-floating car-sharing systems? The case of car2go in Ulm. *Ecol. Econ.*, **70**, 1519–1528, https://doi.org/10.1016/j.ecolecon.2011.03.014.

Fischedick, M., J., and Coauthors, 2014: Chapter 10 Industry. *Climate Change 2014: Mitigation of Climate Change. Contri- bution of Working Group III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change*, O. Edenhofer et al., Eds., Cambridge University Press, 739–810.

Fischedick, M., and Coauthors, 2014: Industry. *Climate Change 2014: Mitigation of Climate Change. Contribution of Working Group III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change*, O. Edenhofer et al., Eds., Cambridge University Press, 739–810.

Fischer-Kowalski, M., and Coauthors, 2011: Methodology and indicators of economy-wide material flow accounting: State of the art and reliability across sources. *J. Ind. Ecol.*, **15**, 855–876, https://doi.org/10.1111/j.1530-9290.2011.00366.x.

Fisher, D. R., 2019: The broader importance of #FridaysForFuture. *Nat. Clim. Chang.*, **9**, 430–431, https://doi.org/10.1038/s41558-019-0484-y.

——, and S. Nasrin, 2020: Climate activism and its effects. *Wiley Interdiscip. Rev. Clim. Chang.*, https://doi.org/10.1002/wcc.683.

Fishman, E., S. Washington, and N. Haworth, 2014: Bike share’s impact on car use: Evidence from the United States, Great Britain, and Australia. *Transp. Res. Part D Transp. Environ.*, **31**, 13–20, https://doi.org/10.1016/j.trd.2014.05.013.

Flatø, M., R. Muttarak, and A. Pelser, 2017: Women, Weather, and Woes: The Triangular Dynamics of Female-Headed Households, Economic Vulnerability, and Climate Variability in South Africa. *World Dev.*, **90**, 41–62, https://doi.org/10.1016/j.worlddev.2016.08.015.

Fleurbaey, M., and K. Tadenuma, 2014: Universal Social Orderings: An Integrated Theory of Policy Evaluation, Inter-Society Comparisons, and Interpersonal Comparisons. *Rev. Econ. Stud.*, **81**, 1071–1101, https://doi.org/10.1093/restud/rdu006.

Flyvbjerg, B., 2020: The law of regression to the tail: How to survive Covid-19, the climate crisis, and other disasters. *Environ. Sci. Policy*, **114**, 614–618, https://doi.org/10.1016/j.envsci.2020.08.013.

Fortnam, M., and Coauthors, 2019: The Gendered Nature of Ecosystem Services. *Ecol. Econ.*, **159**, 312–325, https://doi.org/10.1016/j.ecolecon.2018.12.018.

Fowlie, M., C. Wolfram, C. A. Spurlock, A. Todd, P. Baylis, and P. Cappers, 2017: Default Effects and Follow-On Behavior: Evidence From An Electricity Pricing Program. *Abdul Latif Jameel Poverty Action Lab*,. https://www.povertyactionlab.org/evaluation/default-effects-and-follow-behavior-evidence-electricity-pricing-program.

Fox-Glassman, K. T., and E. U. Weber, 2016: What makes risk acceptable? Revisiting the 1978 psychological dimensions of perceptions of technological risks. *J. Math. Psychol.*, **75**, 157–169, https://doi.org/10.1016/j.jmp.2016.05.003.

Foxon, T., Z. Makuch, M. Mata, and P. Pearson, 2004: *Governance for Industrial Transformation*. 96–112 pp.

Franceschini, S., and F. Alkemade, 2016: Non-disruptive regime changes—The case of competing energy efficient lighting trajectories. *Environ. Innov. Soc. Transitions*, **21**, 56–68, https://doi.org/10.1016/j.eist.2016.04.003.

——, M. Borup, and J. Rosales-Carreón, 2018: Future indoor light and associated energy consumption based on professionals’ visions: A practice- and network-oriented analysis. *Technol. Forecast. Soc. Change*, **129**, 1–11, https://doi.org/10.1016/j.techfore.2018.01.013.

Frank, L. D., A. Hong, and V. D. Ngo, 2019: Causal evaluation of urban greenway retrofit: A longitudinal study on physical activity and sedentary behavior. *Prev. Med. (Baltim).*, **123**, 109–

116, https://doi.org/10.1016/j.ypmed.2019.01.011.

Frank, R. H., 1999: *Luxury Fever : Weighing the Cost of Excess*. Princeton University Press,.

——, 2020: *Under the Influence: Putting Peer Pressure to Work*. Princeton University Press,.

Frank, S., 2017: Reducing greenhouse gas emissions in agriculture without compromising food security? *Environ. Res. Lett.*, **12**, https://doi.org/10.1088/1748-9326/aa8c83.

Fraune, C., and M. Knodt, 2018: Sustainable energy transformations in an age of populism, post-truth politics, and local resistance. *Energy Res. Soc. Sci.*, **43**, 1–7, https://doi.org/10.1016/j.erss.2018.05.029.

Frenken, K., 2017: Political economies and environmental futures for the sharing economy. *Philos. Trans. R. Soc. A Math. Phys. Eng. Sci.*, **375**, https://doi.org/10.1098/rsta.2016.0367.

——, and J. Schor, 2017: Putting the sharing economy into perspective. *Environ. Innov. Soc. Transitions*, **23**, 3–10, https://doi.org/10.1016/j.eist.2017.01.003.

Friedmann, R., and C. Sheinbaum, 1998: Mexican electric end-use efficiency: Experiences to date. *Annu. Rev. Energy Environ.*, **23**, 225–252, https://doi.org/10.1146/annurev.energy.23.1.225.

Fritze, J. C. G., G. A. Blashki, S. Burke, and J. Wiseman, 2008: Hope, despair and transformation: Climate change and the promotion of mental health and wellbeing. *Int. J. Ment. Health Syst.*, **2**, 13, https://doi.org/10.1186/1752-4458-2-13.

Frongillo, E. A., H. T. Nguyen, M. D. Smith, and A. Coleman-Jensen, 2019: Food Insecurity Is More Strongly Associated with Poor Subjective Well-Being in More-Developed Countries than in Less-Developed Countries. *J. Nutr.*, **149**, 330–335, https://doi.org/10.1093/jn/nxy261.

Frye, I., and Coauthors, 2018: *Decent Standard of Living Index: Final Report*. 1–69 pp. http://spii.org.za/wp-content/uploads/2018/11/DSL-Report-SD-v3.doc.pdf (Accessed November 30, 2019).

Fujimori, S., M. Kainuma, T. Masui, T. Hasegawa, and H. Dai, 2014: The effectiveness of energy service demand reduction: A scenario analysis of global climate change mitigation. *Energy Policy*, **75**, https://doi.org/10.1016/j.enpol.2014.09.015.

Fulton, L., P. Cazzola, and F. Cuenot, 2009: IEA Mobility Model (MoMo) and its use in the ETP 2008. *Energy Policy*, **37**, 3758–3768, https://doi.org/10.1016/j.enpol.2009.07.065.

Fumo, N., 2014: A review on the basics of building energy estimation. *Renew. Sustain. Energy Rev.*, **31**, 53–60, https://doi.org/10.1016/j.rser.2013.11.040.

Fuso Nerini, F., and Coauthors, 2018: Mapping synergies and trade-offs between energy and the Sustainable Development Goals. *Nat. Energy*, **3**, 10–15, https://doi.org/10.1038/s41560-017-0036-5.

Gach, E., 2019: Normative Shifts in the Global Conception of Climate Change: The Growth of Climate Justice. *Soc. Sci.*, **8**, 24, https://doi.org/10.3390/socsci8010024.

Galaskiewicz, J., 1985: Professional Networks and the Institutionalization of a Single Mind Set. *Am. Sociol. Rev.*, **50**, 639–658, https://doi.org/10.2307/2095379.

Gallagher, K. P., and L. Zarsky, 2007: *The enclave economy : foreign investment and sustainable development in Mexico's Silicon Valley*. R. Gottlieb and H.R. Luce, Eds. Massachusetts Institute of Technology, 214 pp.

Gallagher, K. S., 2006: Limits to leapfrogging in energy technologies? Evidence from the Chinese automobile industry. *Energy Policy*, **34**, 383–394, https://doi.org/10.1016/j.enpol.2004.06.005.

Gallego-Schmid, A., H. M. Chen, M. Sharmina, and J. M. F. Mendoza, 2020: Links between circular economy and climate change mitigation in the built environment. *J. Clean. Prod.*, **260**, 121115, https://doi.org/10.1016/j.jclepro.2020.121115.

Gallie, W. B., 1955: Essentially Contested Concepts. *Proc. Aristot. Soc.*, **56**, 167–198, https://doi.org/10.2307/4544562.

Ganglmair-Wooliscroft, A., and B. Wooliscroft, 2019: Well-Being and Everyday Ethical Consumption. *J. Happiness Stud.*, **20**, 141–163, https://doi.org/10.1007/s10902-017-9944-0.

Garg, A., 2011: Pro-equity Effects of Ancillary Benefits of Climate Change Policies: A Case Study of Human Health Impacts of Outdoor Air Pollution in New Delhi. *World Dev.*, **39**, 1002–1025, https://doi.org/10.1016/j.worlddev.2010.01.003.

Garland, and Allison M., 2015: *Urban Opportunities: Perspectives on Climate Change , Resilience , Inclusion , and the Informal Economy*. Wilson Center, USAID, 1–181 pp.

Garnett, T., 2011: Where are the best opportunities for reducing greenhouse gas emissions in the food system (including the food chain)? *Food Policy*, **36**, https://doi.org/10.1016/j.foodpol.2010.10.010.

Gebler, M., A. J. M. Schoot Uiterkamp, and C. Visser, 2014: A global sustainability perspective on 3D printing technologies. *Energy Policy*, **74**, https://doi.org/10.1016/j.enpol.2014.08.033.

Gebreslassie, M. G., 2020: Solar home systems in Ethiopia: Sustainability challenges and policy directions. *Sustain. Energy Technol. Assessments*, **42**, https://doi.org/10.1016/j.seta.2020.100880.

Geelen, D. V, D. V Keyson, S. U. Boess, and J. C. Brezet, 2012: Exploring the use of a game to stimulate energy saving in households. *J. Des. Res.*, **10**.

Geels, F., and R. Raven, 2006: Non-linearity and expectations in niche-development trajectories: Ups and downs in Dutch biogas development (1973-2003). *Technol. Anal. Strateg. Manag.*, **18**, 375–392, https://doi.org/10.1080/09537320600777143.

Geels, F. W., B. K. Sovacool, T. Schwanen, and S. Sorrell, 2017: Accelerating innovation is as important as climate policy. *Science (80-.).*, **357**, 1242–1244, https://doi.org/10.1126/science.aao3760.

Geels, F. W., T. Schwanen, S. Sorrell, K. Jenkins, and B. K. Sovacool, 2018: Reducing energy demand through low carbon innovation: A sociotechnical transitions perspective and thirteen research debates. *Energy Res. Soc. Sci.*, **40**, 23–35, https://doi.org/10.1016/j.erss.2017.11.003.

Geerts, R. J., 2017: Towards a Qualitative Assessment of Energy Practices: Illich and Borgmann on Energy in Society. *Philos. Technol.*, **30**, 521–540, https://doi.org/10.1007/s13347-017-0262-6.

Geffner, T., 2017: Land Use Zoning in America: The Case for Inclusionary Policy. *Anthós*, **8**, https://doi.org/10.15760/anthos.2017.49.

Gehl, J., B. B. Svarre, and J. Risom, 2011: Cities for People. *Plan. News*, **37**, 6–8.

Gelenbe, E., and Y. Caseau, 2015: The impact of information technology on energy consumption and carbon emissions. *Ubiquity*, **1530–2180**, 1–15, https://doi.org/10.1145/2755977.

Ghisellini, P., M. Ripa, and S. Ulgiati, 2018: Exploring environmental and economic costs and benefits of a circular economy approach to the construction and demolition sector. A literature review. *J. Clean. Prod.*, **178**, 618–643, https://doi.org/10.1016/j.jclepro.2017.11.207.

Gholami, R., A. B. Sulaiman, T. Ramayah, and A. Molla, 2013: Senior managers’ perception on green information systems (IS) adoption and environmental performance: Results from a field survey. *Inf. Manag.*, **50**, 431–438, https://doi.org/10.1016/J.IM.2013.01.004.

Ghosh, A., 2016: *The great derangement*. University of Chicago Press,.

Ghosh, B., 2019: Transformation beyond experimentation Sustainability transitions in megacities. University of Sussex, 246 pp. http://sro.sussex.ac.uk/id/eprint/82511/ (Accessed December 10, 2019).

——, and J. Schot, 2019: Towards a novel regime change framework: Studying mobility transitions in public transport regimes in an Indian megacity. *Energy Res. Soc. Sci.*, **51**, 82–95, https://doi.org/10.1016/J.ERSS.2018.12.001.

Gifford, R., 2011: The Dragons of Inaction: Psychological Barriers That Limit Climate Change Mitigation and Adaptation. *Am. Psychol.*, **66**, 290–302, https://doi.org/10.1037/a0023566.

Girod, B., and P. De Haan, 2010: More or Better? A Model for Changes in Household Greenhouse Gas Emissions due to Higher Income. *J. Ind. Ecol.*, **14**, 31–49, https://doi.org/10.1111/j.1530-9290.2009.00202.x.

Givoni, M., 2014: Addressing transport policy challenges through policy-packaging. *Transp. Res. Part A Policy Pract.*, **60**, 1–8, https://doi.org/10.1016/j.tra.2013.10.012.

——, J. Macmillen, D. Banister, and E. Feitelson, 2013: From Policy Measures to Policy Packages. *Transp. Rev.*, **33**, 1–20, https://doi.org/10.1080/01441647.2012.744779.

Gleerup, M., A. Larsen, S. Leth-Petersen, and M. Togeby, 2010: The effect of feedback by text message (SMS) and email on household electricity consumption: Experimental evidence. *Energy J.*, **31**, 113–132, https://doi.org/10.5547/ISSN0195-6574-EJ-Vol31-No3-6.

Glemarec, Y., F. Bayat-Renoux, and O. Waissbein, 2016: Removing barriers to women entrepreneurs' engagement in decentralized sustainable energy solutions for the poor. *AIMS Energy*, **4**, 136–172, https://doi.org/10.3934/energy.2016.1.136.

Globisch, J., P. Plötz, E. Dütschke, and M. Wietschel, 2018: *Consumer evaluation of public charging infrastructure for electric vehicles*. http://nbn-resolving.de/urn:nbn:de:0011-n-497713-14.

Gnann, T., S. Funke, N. Jakobsson, P. Plötz, F. Sprei, and A. Bennehag, 2018: Fast charging infrastructure for electric vehicles: Today's situation and future needs. *Transp. Res. Part D Transp. Environ.*, **62**, 314–329, https://doi.org/10.1016/j.trd.2018.03.004.

Göckeritz, S., P. W. Schultz, T. Rendon, R. B. Cialdini, N. J. Goldstein, and V. Griskevicius, 2010: Descriptive mormative belief and conservative behaviour: The moderating roles of personal involvement and injunctive normative belief. *Eur. J. Soc. Psychol.*, **40**, 514–523, https://doi.org/10.1002/ejsp.643.

Godfray, H. C. J., and T. Garnett, 2014: Food security and sustainable intensification. *Philos. Trans. R. Soc. London B Biol. Sci.*, **369**, 20120273, https://doi.org/10.1098/rstb.2012.0273.

Godfray, H. C. J., and Coauthors, 2018: Meat consumption, health, and the environment. *Science (80-.).*, **361**, https://doi.org/10.1126/science.aam5324.

Godfrey, P., and D. Torres, 2016: *Systemic Crises of Global Climate Change: Intersection of race, class and gender*. P. Godfrey and D. Torres, Eds. Routledge,.

Goldberg, T., 2017: What about the Circularity of Hazardous Materials? *J. Ind. Ecol.*, **21**, 491–493, https://doi.org/10.1111/jiec.12585.

Goldemberg, J., 1991: Leapfrogging: A New Energy Policy for Developing Countries. *WEC J.*, 27–30.

——, T. B. Johansson, A. K. N. Reddy, and R. H. Williams, 1985: Basic needs and much more with one kilowatt per capita (energy). *Ambio*, **14**, 190–200, https://doi.org/10.2307/4313148.

——, ——, ——, and ——, 1988: *Energy for a sustainable world*.

Goldstein, B., D. Gounaridis, and J. P. Newell, 2020: The carbon footprint of household energy use in the United States. *Proc. Natl. Acad. Sci.*, **117**, 19122–19130, https://doi.org/10.1073/pnas.1922205117.

Goldthau, A., 2014: Rethinking the governance of energy infrastructure: Scale, decentralization and polycentrism. *Energy Res. Soc. Sci.*, **1**, 134–140, https://doi.org/10.1016/j.erss.2014.02.009.

Golley, J., and X. Meng, 2012: Income inequality and carbon dioxide emissions: The case of Chinese urban households. *Energy Econ.*, **34**, 1864–1872, https://doi.org/10.1016/J.ENECO.2012.07.025.

Gölz, S., and U. J. J. Hahnel, 2016: What motivates people to use energy feedback systems? A multiple goal approach to predict long-term usage behaviour in daily life. *Energy Res. Soc. Sci.*, **21**, 155–166, https://doi.org/10.1016/j.erss.2016.07.006.

Goodman, A., S. Sahlqvist, and D. Ogilvie, 2013: Who uses new walking and cycling infrastructure and how? Longitudinal results from the UK iConnect study. *Prev. Med. (Baltim).*, **57**, 518–524, https://doi.org/10.1016/j.ypmed.2013.07.007.

——, ——, and ——, 2014: New walking and cycling routes and increased physical activity: One- and 2-year findings from the UK iConnect study. *Am. J. Public Health*, **104**, 38–46, https://doi.org/10.2105/AJPH.2014.302059.

Goodman, J., 2009: From global justice to climate justice? Justice ecologism in an era of global warming. *New Polit. Sci.*, **31**, 499–514, https://doi.org/10.1080/07393140903322570.

Goodrich, C. G., P. B. Udas, and H. Larrington-Spencer, 2019: Conceptualizing gendered vulnerability to climate change in the Hindu Kush Himalaya: Contextual conditions and drivers of change. *Environ. Dev.*, **31**, 9–18, https://doi.org/10.1016/j.envdev.2018.11.003.

Gore, T., 2015: *Extreme Carbon Inequality: Why the Paris climate deal must put the poorest, lowest emitting and most vulnerable people first*. Oxfam International, 14 pp. https://oxfamilibrary.openrepository.com/handle/10546/582545 (Accessed September 12, 2019).

Gori-Maia, A., 2013: Relative Income, Inequality and Subjective Wellbeing: Evidence for Brazil. *Soc. Indic. Res.*, **113**, 1193–1204, https://doi.org/10.1007/s11205-012-0135-4.

Gossart, C., 2015: Rebound Effects and ICT: A Review of the Literature. *ICT Innovations for Sustainability*, L.M. Hilty and B. Aebischer, Eds., Springer, 435–448.

Gössling, S., 2019: Celebrities, air travel, and social norms. *Ann. Tour. Res.*, **79**, 102775, https://doi.org/10.1016/j.annals.2019.102775.

——, and A. Humpe, 2020: The global scale, distribution and growth of aviation: Implications for climate change. *Glob. Environ. Chang.*, **65**, 102194, https://doi.org/10.1016/j.gloenvcha.2020.102194.

Gota, S., C. Huizenga, K. Peet, N. Medimorec, and S. Bakker, 2019: Decarbonising transport to achieve Paris Agreement targets. *Energy Effic.*, **12**, 363–386, https://doi.org/10.1007/s12053-018-9671-3.

Gough, I., 2015: Climate change and sustainable welfare: the centrality of human needs. *Cambridge J. Econ.*, **39**, 1191–1214, https://doi.org/10.1093/cje/bev039.

Gough, I., 2017: *Heat, Greed and Human Need: Climate Change, Capitalism and Sustainable Wellbeing*. Elgar, 283 pp.

Gould, C. F., and J. Urpelainen, 2018: LPG as a clean cooking fuel: Adoption, use, and impact in rural India. *Energy Policy*, **122**, 395–408, https://doi.org/10.1016/j.enpol.2018.07.042.

——, S. Schlesinger, A. O. Toasa, M. Thurber, W. F. Waters, J. P. Graham, and D. W. Jack, 2018: Government policy, clean fuel access, and persistent fuel stacking in Ecuador. *Energy Sustain. Dev.*, **46**, 111–122, https://doi.org/10.1016/j.esd.2018.05.009.

Graça, J., C. A. Godinho, and M. Truninger, 2019: Reducing meat consumption and following plant-based diets: Current evidence and future directions to inform integrated transitions. *Trends Food Sci. Technol.*, **91**, 380–390, https://doi.org/10.1016/j.tifs.2019.07.046.

Grady-Benson, J., and B. Sarathy, 2016: Fossil fuel divestment in US higher education: student-led organising for climate justice. *Local Environ.*, **21**, 661–681, https://doi.org/10.1080/13549839.2015.1009825.

Gramkow, C., and A. Anger-Kraavi, 2019: Developing Green: A Case for the Brazilian Manufacturing Industry. *Sustainability*, **11**, 6783, https://doi.org/10.3390/su11236783.

Grandclément, C., A. Karvonen, and S. Guy, 2015: Negotiating comfort in low energy housing: The politics of intermediation. *Energy Policy*, **84**, 213–222, https://doi.org/10.1016/j.enpol.2014.11.034.

Green, D., and G. Raygorodetsky, 2010: Indigenous knowledge of a changing climate. *Clim. Change*, **100**, 239–242, https://doi.org/10.1007/s10584-010-9804-y.

Greenblatt, J. B., and S. Saxena, 2015: Autonomous taxis could greatly reduce greenhouse-gas emissions of US light-duty vehicles. *Nat. Clim. Chang.*, **5**, 860–863, https://doi.org/10.1038/nclimate2685.

Di Gregorio, M., and Coauthors, 2019: Multi-level governance and power in climate change policy networks. *Glob. Environ. Chang.*, **54**, 64–77, https://doi.org/10.1016/j.gloenvcha.2018.10.003.

Grinblatt, M., M. Keloharju, and S. Ikaheimo, 2008: Social Influence and Consumption: Evidence from the Automobile Purchases of Neighbors. *Rev. Econ. Stat.*, **90**, 735–753, https://doi.org/10.2139/ssrn.995855.

Grinde, B., R. B. Nes, I. F. MacDonald, and D. S. Wilson, 2018: Quality of Life in Intentional Communities. *Soc. Indic. Res.*, **137**, 625–640, https://doi.org/10.1007/s11205-017-1615-3.

Griskevicius, V., J. M. Tybur, and B. den Bergh, 2010: Going green to be seen: Status, reputation, and conspicuous conservation. *J. Pers. Soc. Psychol.*, **98**, 392–404, https://doi.org/10.1037/a0017346.

Grønhøj, A., and J. Thøgersen, 2011: Feedback on household electricity consumption: learning and social influence processes. *Int. J. Consum. Stud.*, **35**, 138–145, https://doi.org/10.1111/j.1470-6431.2010.00967.x.

Grubb, M., D. Crawford-Brown, K. Neuhoff, K. Schanes, S. Hawkins, and A. Poncia, 2020: Consumption-oriented policy instruments for fostering greenhouse gas mitigation. *Clim. Policy*, **20**, S58–S73, https://doi.org/10.1080/14693062.2020.1730151.

Grubler, A., 1991: Energy in the 21st century: From resource to environmental and lifestyle constraints. *Entropie Rev. Sci. Tech. Thermodyn.*, **164**, 29–33.

——, 1996: Time for a change: on the patterns of diffusion of innovation. *Daedalus*, **125**, 19–42.

——, and Coauthors, 2012a: Chapter 24 - Policies for the Energy Technology Innovation System (ETIS). *Global Energy Assessment - Toward a Sustainable Future*, 1665–1744.

——, T. B. Johansson, L. Mundaca, N. Nakicenovic, S. Pachauri, K. Riahi, H.-H. Rogner, and L. Strupeit, 2012b: Chapter 1 - Energy Primer. *Global Energy Assessment - Toward a Sustainable Future*, 99–150.

——, and Coauthors, 2018: A low energy demand scenario for meeting the 1.5° C target and sustainable development goals without negative emission technologies. *Nat. Energy*, **3**, 515–527, https://doi.org/10.1038/s41560-018-0172-6.

Grübler, A., N. Nakićenović, and D. G. Victor, 1999: Dynamics of energy technologies and global change. *Energy Policy*, **27**, 247–280, https://doi.org/10.1016/S0301-4215(98)00067-6.

Grunewald, N., S. Klasen, I. Martinez-Zarzoso, and C. Muris, 2011: *Income Inequality and Carbon Emissions*.

——, ——, I. Martínez-Zarzoso, C. Muris, N. Grunewald, S. Klasen, I. Martínez-Zarzoso, and C. Muris, 2017: The Trade-off Between Income Inequality and Carbon Dioxide Emissions. *Ecol. Econ.*, **142**, 249–256, https://doi.org/10.1016/j.ecolecon.2017.06.034.

Gulyani, S., D. Talukdar, and E. M. Bassett, 2018: A sharing economy? Unpacking demand and living conditions in the urban housing market in Kenya. *World Dev.*, **109**, 57–72, https://doi.org/10.1016/j.worlddev.2018.04.007.

Gumbert, T., 2019: Anti-Democratic Tenets? Behavioural-Economic Imaginaries of a Future Food System. *Polit. Gov.*, **7**, https://doi.org/10.17645/pag.v7i4.2216.

Gunders, D., J. Bloom, J. Berkenkamp, D. Hoover, A. Spacht, and M. Mourad, 2017: Wasted: How America is Losing up to 40% of its Food from Farm to Fork to Landfill. *NRDC*,.

Gür, N., 2020: Does social trust promote behaviour aimed at mitigating climate change? *Econ. Aff.*, **40**, 36–49, https://doi.org/10.1111/ecaf.12384.

Guruswamy, L., 2010: Energy Justice and Sustainable Development. *Colo. J. Int. Environ. Law Policy*,.

——, 2016: *International energy and poverty : The emerging contours*. Routledge, 329 pp.

——, 2020: Global Energy Poverty: the Relevance of Faith and Reason by Lakshman Guruswamy :: SSRN. *Belmont Law Rev.*, **7**, 199–244.

Gutberlet, J., 2008: Organized and informal recycling: social movements contributing to sustainability. *Waste Management and the Environment IV*, M. Zamorano, C.A. Brebbia, A.G. Kungolos, and V. Popov, Eds., WITPress, 223–232.

Gutowski, T. G., S. Sahni, A. Boustani, and S. C. Graves, 2011: Remanufacturing and Energy Savings. *Environ. Sci. Technol.*, **45**, 4540–4547, https://doi.org/10.1021/es102598b.

——, J. M. Allwood, C. Herrmann, and S. Sahni, 2013: A Global Assessment of Manufacturing: Economic Development, Energy Use, Carbon Emissions, and the Potential for Energy Efficiency and Materials Recycling. *Annu. Rev. Environ. Resour.*, **38**, 81–106, https://doi.org/10.1146/annurev-environ-041112-110510.

Haas, W., F. Krausmann, D. Wiedenhofer, and M. Heinz, 2015: How Circular is the Global Economy?: An Assessment of Material Flows, Waste Production, and Recycling in the European Union and the World in 2005. *J. Ind. Ecol.*, **19**, 765–777, https://doi.org/10.1111/jiec.12244.

Haberl, H., D. Wiedenhofer, K. H. Erb, C. Görg, and F. Krausmann, 2017: The Material Stock–Flow–Service Nexus: A New Approach for Tackling the Decoupling Conundrum. *Sustainability*, **9**, 1049, https://doi.org/10.3390/su9071049.

——, ——, S. Pauliuk, F. Krausmann, D. B. Müller, and M. Fischer-Kowalski, 2019: Contributions of sociometabolic research to sustainability science. *Nat. Sustain.*, **2**, 173–184, https://doi.org/10.1038/s41893-019-0225-2.

——, and Coauthors, 2020: A systematic review of the evidence on decoupling of GDP, resource use and GHG emissions, part II: Synthesizing the insights. *Environ. Res. Lett.*, **15**, https://doi.org/10.1088/1748-9326/ab842a.

Habtezion, S., 2013: *Gender and Climate Change Asia and the Pacific*. 1–6 pp. http://www.undp.org/content/dam/undp/library/gender/Gender and Environment/PB1-AP-Overview-Gender-and-climate-change.pdf.

Hagen, B., 2016: The role of planning in minimizing the negative impacts of global climate change. *Urban Plan.*, **1**, 13–24, https://doi.org/10.17645/up.v1i3.671.

Hahnel, U. J. J., O. Arnold, M. Waschto, L. Korcaj, K. Hillmann, D. Roser, and H. Spada, 2015: The power of putting a label on it: green labels weigh heavier than contradicting product information for consumers' purchase decisions and post-purchase behavior. *Front. Psychol.*, **6**, 1392, https://doi.org/10.3389/fpsyg.2015.01392.

Hailemariam, A., R. Dzhumashev, and M. Shahbaz, 2019: Carbon emissions, income inequality and economic development. *Empir. Econ.*, article 57, https://doi.org/10.1007/s00181-019-01664-x.

Hall, P. A., 1993: Policy Paradigms, Social Learning, and the State: The Case of Economic Policymaking in Britain. *Comp. Polit.*, **25**, 275, https://doi.org/10.2307/422246.

Haluza-DeLay, R., 2014: Religion and climate change: varieties in viewpoints and practices. *Wiley Interdiscip. Rev. Clim. Chang.*, **5**, 261–279, https://doi.org/10.1002/wcc.268.

Hammar, H., and S. C. Jagers, 2006: Can trust in politicians explain individuals' support for climate policy? The case of CO2 tax. *Clim. Policy*, **5**, 613–625, https://doi.org/10.1080/14693062.2006.9685582.

——, and ——, 2007: What is a fair CO2 tax increase? On fair emission reductions in the transport sector. *Ecol. Econ.*, **61**, 377–387, https://doi.org/10.1016/j.ecolecon.2006.03.004.

Hans, A., S. Hazra, S. Das, and A. Patel, 2019: Encountering Gendered Spaces in Climate Change Policy in India: Migration and Adaptation. *J. Migr. Aff.*, **II**, 1–24, https://doi.org/10.36931/jma.2019.2.1.1-24.

Hao, Y., H. Chen, and Q. Zhang, 2016: Will income inequality affect environmental quality? Analysis based on China's provincial panel data. *Ecol. Indic.*, **67**, 533–542, https://doi.org/10.1016/j.ecolind.2016.03.025.

Haque, K. N. H., F. A. Chowdhury, and K. R. Khatun, 2015: Participatory environmental governance and climate change adaptation: Mainstreaming of tidal river management in South-West Bangladesh. *Land and Disaster Management Strategies in Asia*, Springer India, 189–208.

Hardisty, D., Y. Shim, D. Sun, and D. Griffin, 2016: Encouraging Energy Efficiency: Product Labels Activate Temporal Tradeoffs. *NA - Adv. Consum. Res.*, **44**, 15–20.

Harguess, J. M., N. C. Crespo, and M. Y. Hong, 2020: Strategies to reduce meat consumption: A systematic literature review of experimental studies. *Appetite*, **144**, 104478, https://doi.org/10.1016/j.appet.2019.104478.

Harring, N., and S. C. Jagers, 2013: Should We Trust in Values? Explaining Public Support for Pro-Environmental Taxes. *Sustainability*, **5**, 210–227, https://doi.org/10.3390/su5010210.

Harriss, R., and B. Shui, 2010: Consumption, not CO 2 emissions: Reframing perspectives on climate change and sustainability. *Environment*, **52**, 8–15, https://doi.org/10.1080/00139157.2010.522461.

Hartmann, C., and M. Siegrist, 2017: Consumer perception and behaviour regarding sustainable protein consumption: A systematic review. *Trends Food Sci. Technol.*, **61**, 11–25, https://doi.org/10.1016/j.tifs.2016.12.006.

den Hartog, H., F. Sengers, Y. Xu, L. Xie, P. Jiang, and M. de Jong, 2018: Low-carbon promises and realities: Lessons from three socio-technical experiments in Shanghai. *J. Clean. Prod.*, **181**, 692–702, https://doi.org/10.1016/j.jclepro.2018.02.003.

Haug, C., and Coauthors, 2010: Navigating the dilemmas of climate policy in Europe: Evidence from policy evaluation studies. *Clim. Change*, **101**, 427–445, https://doi.org/10.1007/s10584-009-9682-3.

Haugneland, P., and H. H. Kvisle, 2015: Norwegian electric car user experience. *Int. J. Automot. Technol. Manag.*, **15**, 194–221, https://doi.org/10.1504/IJATM.2015.068548.

Hausknost, D., W. Haas, S. Hielscher, M. Schäfer, M. Leitner, I. Kunze, and S. Mandl, 2018: Investigating patterns of local climate governance: How low-carbon municipalities and intentional communities intervene in social practices. *Environ. Policy Gov.*, **28**, 371–382, https://doi.org/10.1002/eet.1804.

Hayward, B., and J. Roy, 2019: Sustainable Living: Bridging the North-South Divide in Lifestyles and Consumption Debates. *Annu. Rev. Environ. Resour.*, **44**, 1–9, https://doi.org/https://doi.org/10.1146/annurev-environ-101718-033119.

Healy, N., and J. Barry, 2017: Politicizing energy justice and energy system transitions: Fossil fuel divestment and a "just transition." *Energy Policy*, **108**, 451–459, https://doi.org/10.1016/j.enpol.2017.06.014.

Hedlin, S., and Sunstein, C. R., 2016: Does active choosing promote green energy use: Experimental evidence. *Ecol. LQ*, **43**.

Heffron, R. J., and D. McCauley, 2018: What is the 'Just Transition'? *Geoforum*, **88**, 74–77, https://doi.org/10.1016/j.geoforum.2017.11.016.

Helferty, A., and A. Clarke, 2009: Student-led campus climate change initiatives in Canada. *Int. J. Sustain. High. Educ.*, **10**, 287–300, https://doi.org/10.1108/14676370910972594.

Helliwell, J., H. Huang, and S. Wang, 2016: New Evidence on Trust and Well-being. *Natl. Bur. Econ. Res.*, https://doi.org/10.3386/w22450.

Helliwell, J. F., and H. Huang, 2008: How's Your Government? International Evidence Linking Good Government and Well-Being. *Br. J. Polit. Sci.*, **38**, 595–619, https://doi.org/10.1017/S0007123408000306.

——, ——, S. Grover, and S. Wang, 2018: Empirical linkages between good governance and national well-being. *J. Comp. Econ.*, **46**, 1332–1346, https://doi.org/10.1016/j.jce.2018.01.004.

Henao, A., and W. E. Marshall, 2019: The impact of ride hailing on parking (and vice versa). *J. Transp. Land Use*, **12**, https://doi.org/10.5198/jtlu.2019.1392.

Henry, M. L., P. J. Ferraro, and A. Kontoleon, 2019: The behavioural effect of electronic home energy reports: Evidence from a randomised field trial in the United States. *Energy Policy*, **132**, 1256–1261, https://doi.org/10.1016/j.enpol.2019.06.039.

Henryson, J., T. Håkansson, and J. Pyrko, 2000: Energy efficiency in buildings through information – Swedish perspective. *Energy Policy*, **28**, 169–180, https://doi.org/10.1016/S0301-4215(00)00004-5.

Hepburn, C., and Coauthors, 2020: Will COVID-19 fiscal recovery packages accelerate or retard progress on climate change? *Oxford Rev. Econ. Policy*, **36**, S359–S381, https://doi.org/10.1093/oxrep/graa015.

Herendeen, R., and J. Tanaka, 1976: Energy cost of living. *Energy*, **1**, 165–178, https://doi.org/10.1016/0360-5442(76)90015-3.

Herrmann, S., F. Schulte, and S. Voß, 2014: Increasing acceptance of free-floating car sharing systems using smart relocation strategies: A survey based study of car2go hamburg. *Lecture Notes in Computer Science*, Vol. 8760 of, 151–162.

Hershfield, H. E., H. M. Bang, and E. U. Weber, 2014: National Differences in Environmental Concern and Performance Are Predicted by Country Age. *Psychol. Sci.*, **25**, 152–160, https://doi.org/10.1177/0956797613501522.

Hertwich, E. G., and G. P. Peters, 2009: Carbon footprint of nations: A global, trade-linked analysis. *Environ. Sci. Technol.*, **43**, 6414–6420, https://doi.org/10.1021/es803496a.

Hertwich, E. G., and Coauthors, 2019: Material efficiency strategies to reducing greenhouse gas emissions associated with buildings, vehicles, and electronics—a review. *Environ. Res. Lett.*, **14**, 043004, https://doi.org/10.1088/1748-9326/ab0fe3.

Hess, D. J., 2019a: Coalitions, framing, and the politics of energy transitions: Local democracy and community choice in California. *Energy Res. Soc. Sci.*, **50**, 38–50, https://doi.org/10.1016/j.erss.2018.11.013.

——, 2019b: Cooler coalitions for a warmer planet: A review of political strategies for accelerating energy transitions. *Energy Res. Soc. Sci.*, **57**, 101246, https://doi.org/10.1016/j.erss.2019.101246.

Heun, M. K., and P. E. Brockway, 2019: Meeting 2030 primary energy and economic growth goals: Mission impossible? *Appl. Energy*, **251**, 112697, https://doi.org/10.1016/j.apenergy.2019.01.255.

Hicks, J., and N. Ison, 2018: An exploration of the boundaries of 'community' in community renewable energy projects: Navigating between motivations and context. *Energy Policy*, **113**, 523–534, https://doi.org/10.1016/j.enpol.2017.10.031.

Hidalgo, D., and C. Huizenga, 2013: Implementation of sustainable urban transport in Latin America. *Res. Transp. Econ.*, **40**, 66–77, https://doi.org/https://doi.org/10.1016/j.retrec.2012.06.034.

Hilson, C., 2019: Climate Populism, Courts, and Science. *J. Environ. Law*, **31**, 395–398, https://doi.org/10.1093/jel/eqz021.

Himmelweit, S., 2002: Making visible the hidden economy: The case for gender-impact analysis of economic policy. *Fem. Econ.*, **8**, 49–70, https://doi.org/10.1080/13545700110104864.

Hiteva, R., and J. Watson, 2019: Governance of interactions between infrastructure sectors: The making of smart grids in the UK. *Environ. Innov. Soc. Transitions*, **32**, 140–152, https://doi.org/10.1016/j.eist.2019.02.006.

Hobbs, J. E., 2020: Food supply chains during the COVID-19 pandemic. *Can. J. Agric. Econ. Can. d'agroeconomie*, **68**, 171–176, https://doi.org/10.1111/cjag.12237.

Hobson, K., 2019: 'Small stories of closing loops': social circularity and the everyday circular economy. *Clim. Change*, https://doi.org/10.1007/s10584-019-02480-z.

Hockerts, K., and R. Wüstenhagen, 2010: Greening Goliaths versus emerging Davids: Theorizing about the role of incumbents and new entrants in sustainable entrepreneurship. *J. Bus. Ventur.*, **25**, 481–492, https://doi.org/10.1016/j.jbusvent.2009.07.005.

Hof, A. F., A. G. Dagnachew, P. L. Lucas, and D. P. van Vuuren, 2019: *Towards Universal Access to Clean Cooking Solutions in Sub-Saharan Africa: An integrated assessment of the cost, health and environmental implications of policies and targets*. 60 pp. https://www.pbl.nl/sites/default/files/downloads/pbl-2019-clean-cooking-solutions-sub-saharan-africa_3421_0.pdf.

Hofstad, H., and T. Vedeld, 2020: *Urban climate governance and co-creation In Cape Town, Copenhagen, Gothenburg and Oslo*. H. Hofstad and T. Verkild?, Eds. Norwegian Institute for Urban and Regional Research, 115 pp. http://3.121.66.0/handle/20.500.12199/3126 (Accessed June 12, 2020).

Hollingsworth, J., B. Copeland, and J. X. Johnson, 2019: Are e-scooters polluters? The environmental impacts of shared dockless electric scooters. *Environ. Res. Lett.*, **14**, https://doi.org/10.1088/1748-9326/ab2da8.

Hong, J. H., B. C. Kim, and K. S. Park, 2019: Optimal risk management for the sharing economy with stranger danger and service quality. *Eur. J. Oper. Res.*, **279**, 1024–1035, https://doi.org/10.1016/j.ejor.2019.06.020.

Hook, A., V. Court, B. K. Sovacool, and S. Sorrell, 2020: A systematic review of the energy and climate impacts of teleworking. *Environ. Res. Lett.*, **15**, https://doi.org/10.1088/1748-9326/ab8a84.

Hoolohan, C., C. McLachlan, and S. Mander, 2018: Food related routines and energy policy: A focus group study examining potential for change in the United Kingdom. *Energy Res. Soc. Sci.*, **39**, 93–102, https://doi.org/10.1016/j.erss.2017.10.050.

Hopkinson, P., H. M. Chen, K. Zhou, Y. Wang, and D. Lam, 2018: Recovery and reuse of structural products from end-of-life buildings. *Proc. Inst. Civ. Eng. Eng. Sustain.*, **172**, 119–128, https://doi.org/10.1680/jensu.18.00007.

Hordijk, M. A., 2000: Of Dreams and Deeds: the role of local initiatives for community-based environmental management in Lima, Peru. http://dare.uva.nl (Accessed December 9, 2019).

Horen Greenford, D., T. Crownshaw, C. Lesk, K. Stadler, and H. D. Matthews, 2020: Shifting economic activity to services has limited potential to reduce global environmental impacts due to the household consumption of labour. *Environ. Res. Lett.*, **15**.

Hossain, M., 2016: Grassroots innovation : A systematic review of two decades of research. *J. Clean. Prod.*, **137**, 973–981, https://doi.org/10.1016/j.jclepro.2016.07.140.

Houde, S., A. Todd, A. Sudarshan, J. A. Flora, and K. C. Armel, 2013: Real-time Feedback and Electricity Consumption: A Field Experiment Assessing the Potential for Savings and Persistence. *Energy J.*, **0**, https://doi.org/10.5547/01956574.34.1.4.

Howlett, M., and J. Rayner, 2013: Patching vs packaging in policy formulation: Assessing policy portfolio design. *Polit. Gov.*, **1**, 170–182, https://doi.org/10.12924/pag2013.01020170.

Huang, H., D. Roland-Holst, C. Springer, J. Lin, W. Cai, and C. Wang, 2019: Emissions trading systems and social equity: A CGE assessment for China. *Appl. Energy*, **235**, 1254–1265, https://doi.org/10.1016/j.apenergy.2018.11.056.

Huang, R., M. Riddle, D. Graziano, J. Warren, S. Das, S. Nimbalkar, J. Cresko, and E. Masanet, 2016: Energy and emissions saving potential of additive manufacturing: the case of lightweight aircraft components. *J. Clean. Prod.*, **135**, 1559–1570, https://doi.org/10.1016/j.jclepro.2015.04.109.

——, M. E. Riddle, D. Graziano, S. Das, S. Nimbalkar, J. Cresko, and E. Masanet, 2017: Environmental and Economic Implications of Distributed Additive Manufacturing: The Case of Injection Mold Tooling. *J. Ind. Ecol.*, **21**, S130–S143, https://doi.org/10.1111/jiec.12641.

Hubacek, K., G. Baiocchi, K. Feng, L. Sun, and J. Xue, 2017: Global carbon inequality. *Energy, Ecol. Environ.*, **2**, 361–369, https://doi.org/10.1007/s40974-017-0072-9.

Huber, J., W. K. Viscusi, and J. Bell, 2020: Dynamic relationships between social norms and pro-environmental behavior: evidence from household recycling. *Behav. Public Policy*, **4**, 1–25, https://doi.org/10.1017/bpp.2017.13.

Hübler, M., 2017: The inequality-emissions nexus in the context of trade and development: A quantile regression approach. *Ecol. Econ.*, **134**, 174–185, https://doi.org/10.1016/j.ecolecon.2016.12.015.

Hugo, J., and C. du Plessis, 2019: A quantitative analysis of interstitial spaces to improve climate change resilience in Southern African cities. *Clim. Dev.*, 1–9, https://doi.org/10.1080/17565529.2019.1664379.

Hulme, M., 2015: Varieties of religious engagement with climate change. *Climate Change*, W. Jenkins, M.E. Tucker, and J. Grim, Eds., Routledge, p. 239.

Hummel, D., and A. Maedche, 2019: How effective is nudging? A quantitative review on the effect sizes and limits of empirical nudging studies. *J. Behav. Exp. Econ.* , **80**, 47–58, https://doi.org/10.1016/j.socec.2019.03.005.

Hunsberger, C., and Coauthors, 2017: Climate change mitigation, land grabbing and conflict: towards a landscape-based and collaborative action research agenda. *Can. J. Dev. Stud.*, **38**, 305–324, https://doi.org/10.1080/02255189.2016.1250617.

Huyer, S., and S. Partey, 2020: Weathering the storm or storming the norms? Moving gender equality forward in climate-resilient agriculture: Introduction to the Special Issue on Gender Equality in Climate-Smart Agriculture: Approaches and Opportunities. *Clim. Change*, **158**, 1–12, https://doi.org/10.1007/s10584-019-02612-5.

Hydro One, 2006: The Impact of Real-Time Feedback on Residential Energy Consumption: The Hydro One pilot. Summary. *Conduct. by Dean Mt. Univ. Ontario, Canada*, 4. https://www.reducemyenergy.com/PDF/Summary Results Hydro One Pilot - Real-Time Feedback.pdf (Accessed June 14, 2020).

Hynes, M., 2014: Telework Isn't Working: A Policy Review. *Econ. Soc. Rev. (Irel).*, **45**, 579–602.

Hynes, M., 2016: Developing (tele)work? A multi-level sociotechnical perspective of telework in Ireland. *Res. Transp. Econ.*, **57**, 21–31, https://doi.org/10.1016/j.retrec.2016.06.008.

IEA, 2016: *Energy Technology Perspectives 2016*. OECD, 418 pp.

——, 2017a: *Digitalization & Energy*. OECD, 185 pp.

——, 2017b: *Energy Technology Perspectives 2017: Catalysing Energy Technology Transformations*. OECD, 443 pp.

——, 2017c: *Energy Access Outlook 2017: From Poverty to Prosperity*.

——, 2018: *The Future of Cooling: Opportunities for energy-efficient air conditioning*. OECD, 92 pp.

——, 2019a: *Material efficiency in clean energy transitions*. OECD, 162 pp.

——, 2019b: *World Energy Outlook 2019*. OECD,.

——, 2019c: *SDG7: Data and Projections Access to affordable, reliable, sustainable and modern energy for all*. https://www.iea.org/reports/sdg7-data-and-projections (Accessed December 6, 2019).

——, 2020a: *World Energy Outlook 2020*. OECD,.

——, 2020b: *World Energy Balances: Overview*. https://www.iea.org/reports/world-energy-balances-overview.

ILO, 2020: *Policy Brief The COVID-19 response: Getting gender equality right for a better future for women at work*.

Inderberg, T. H., S. H. Eriksen, K. L. O'Brien, and L. Sygna, 2015: *Climate change adaptation and development : transforming paradigms and practices*. L. Inderberg, T.H., Eriksen, S., O'Brien, K., and Sygna, Ed. Routledge/Taylor & Francis Group, 296 pp.

International Transport Forum, 2016: *Shared mobility: innovation for liveable cities*. 56 pp.

IPCC, 2007: *Climate change 2007: Mitigation. Contribution of Working Group III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*. B. Metz, O.R. Davidson, P.R. Bosch, R. Dave, and L.A. Meyer, Eds. Cambridge University Press, 1–861 pp.

——, 2014a: Summary for Policymakers. *Climate Change 2014: Mitigation of Climate Change. Contribution of Working Group III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change*, B. Metz, O.R. Davidson, P.R. Bosch, R. Dave, and L.A. Meyer, Eds., Cambridge University Press, p. 24.

——, 2014b: *Climate change 2014 : mitigation of climate change : Working Group III contribution to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change*. O. Edenhofer et al., Eds. Cambridge University Press,.

——, 2018: *Global Warming of 1.5°C. An IPCC Special Report on the impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change,*. V. Masson-Delmotte et al., Eds. in press pp.

Isenhour, C., 2019: A consuming globalism: On power and the post-Paris Agreement politics of climate and consumption. *Power and Politics in in Sustainable Consumption Research and Practice*.

Isenhour, C., and M. Ardenfors, 2009: Gender and sustainable consumption: Policy implications. *Int. J. Innov. Sustain. Dev.*, **4**, 135–149, https://doi.org/10.1504/IJISD.2009.028068.

Israel-Akinbo, S., J. Snowball, and G. Fraser, 2018: The energy transition patterns of low-income households in South Africa: An evaluation of energy programme and policy. *J. Energy South. Africa*, **29**, 75–85, https://doi.org/10.17159/2413-3051/2017/v29i3a3310.

ISSC, IDS, and UNESCO, 2016: *World Social Science Report 2016, Challenging Inequalities; Pathways to a Just World*. UNESCO Publishing, 359 pp.

ITF, 2017a: *Transition to Shared Mobility: How large cities can deliver inclusive transport services*.

——, 2017b: *Shared Mobility Simulations for Helsinki*. 95 pp.

——, 2017c: *Shared Mobility Simulations for Auckland*. 91 pp.

——, 2018: *Shared Mobility Simulations for Dublin. Case-specific policy analysis*. 97 pp.

——, 2020: *Shared Mobility Simulations for Lyon*. 91 pp.

Ito, K., and Coauthors, 2014: *The Persistence of Intrinsic and Extrinsic Motivation: Experimental Evidence from Energy Demand **. http://www.abef.jp/archive/event/2014/pdf_abst/PR0005.pdf (Accessed November 28, 2020).

——, T. Ida, and M. Tanaka, 2015: *The Persistence of Moral Suasion and Economic Incentives: Field Experimental Evidence from Energy Demand*. 36 pp.

Ivanova, D., K. Stadler, K. Steen-Olsen, R. Wood, G. Vita, A. Tukker, and E. G. Hertwich, 2016: Environmental Impact Assessment of Household Consumption. *J. Ind. Ecol.*, **20**, 526–536, https://doi.org/10.1111/jiec.12371.

——, G. Vita, R. Wood, C. Lausselet, A. Dumitru, K. Krause, I. Macsinga, and E. G. Hertwich, 2018: Carbon mitigation in domains of high consumer lock-in. *Glob. Environ. Chang.*, **52**, 117–130, https://doi.org/10.1016/j.gloenvcha.2018.06.006.

——, J. Barrett, D. Wiedenhofer, B. Macura, M. Callaghan, and F. Creutzig, 2020: Quantifying the potential for climate change mitigation of consumption options. *Environ. Res. Lett.*, **15**, 093001, https://doi.org/10.1088/1748-9326/ab8589.

Ivarsflaten, E., and K. Strømsnes, 2013: Inequality, Diversity and Social Trust in Norwegian Communities. *J. Elections, Public Opin. Parties*, **23**, 322–342, https://doi.org/10.1080/17457289.2013.808643.

Jachimowicz, J. M., O. P. Hauser, J. D. O'Brien, E. Sherman, and A. D. Galinsky, 2018: The critical role of second-order normative beliefs in predicting energy conservation. *Nat. Hum. Behav.*, **2**, 757–764, https://doi.org/10.1038/s41562-018-0434-0.

Jachimowicz, J. M., S. Duncan, E. U. Weber, and E. J. Johnson, 2019: When and why defaults influence decisions: a meta-analysis of default effects. *Behav. Public Policy*, **3**, 159–186, https://doi.org/10.1017/bpp.2018.43.

Jackson, T., 2008: Live Better by Consuming Less?: Is There a "Double Dividend" in Sustainable Consumption? *J. Ind. Ecol.*, **9**, 19–36, https://doi.org/10.1162/1088198054084734.

——, 2009: *Prosperity without growth ? The transition to a sustainable economy*. Sustainable Development Commission, 133 pp.

——, and N. Marks, 1999: Consumption, sustainable welfare and human needs - With reference to UK expenditure patterns between 1954 and 1994. *Ecol. Econ.*, **28**, 421–441, https://doi.org/10.1016/S0921-8009(98)00108-6.

——, and E. Papathanasopoulou, 2008: Luxury or "lock-in"? An exploration of unsustainable consumption in the UK: 1968 to 2000. *Ecol. Econ.*, **68**, 80–95, https://doi.org/10.1016/j.ecolecon.2008.01.026.

——, and P. A. Victor, 2016: Does slow growth lead to rising inequality? Some theoretical reflections and numerical simulations. *Ecol. Econ.*, **121**, 206–219, https://doi.org/10.1016/j.ecolecon.2015.03.019.

Jacobsen, G. D., M. J. Kotchen, and M. P. Vandenbergh, 2012: The behavioral response to voluntary provision of an environmental public good: Evidence from residential electricity demand. *Eur. Econ. Rev.*, **56**, 946–960, https://doi.org/10.1016/j.euroecorev.2012.02.008.

Jacobson, S. H., and D. M. King, 2009: Fuel saving and ridesharing in the US: Motivations, limitations, and opportunities. *Transp. Res. Part D Transp. Environ.*, **14**, 14–21, https://doi.org/10.1016/j.trd.2008.10.001.

Jacobsson, S., and V. Lauber, 2006: The politics and policy of energy system transformation--explaining the {German} diffusion of renewable energy technology. *Energy Policy*, **34**, 256–276.

Jaffe, R., and M. Koster, 2019: The Myth of Formality in the Global North: Informality-as-Innovation in Dutch Governance. *Int. J. Urban Reg. Res.*, **43**, 563–568, https://doi.org/10.1111/1468-2427.12706.

Jafry, T., K. Helwig, and M. Mikulewicz, 2019: *Handbook of climate justice*. Routledge, 542 pp.

Jagers, S. C., Å. Löfgren, and J. Stripple, 2010: Attitudes to personal carbon allowances: Political trust, fairness and ideology. *Clim. Policy*, **10**, 410–431, https://doi.org/10.3763/cpol.2009.0673.

Janda, K. B., and Y. Parag, 2013: A middle-out approach for improving energy performance in buildings. *Build. Res. Inf.*, **41**, 39–50, https://doi.org/10.1080/09613218.2013.743396.

Javaid, A., S. Bamberg, and F. Creutzig, 2020: Determinants of low-carbon transport mode adoption: Systematic review of reviews. *Environ. Res. Lett*, **15**, 103002.

Jenkins, W., E. Berry, and L. B. Kreider, 2018: Religion and Climate Change. *Annu. Rev. Environ. Resour.*, **43**, 85–108, https://doi.org/https://doi.org/10.1146/annurev-environ-102017-025855.

Jensen, O. M., 2003: Visualisation turns down energy demand. *summer study of the European Council for an energy efficient economy*, Stockholm, 451–454 https://www.eceee.org/library/conference_proceedings/eceee_Summer_Studies/2003/Panel_2/2155jensen/.

Jessoe, K., and D. Rapson, 2014: Knowledge is (Less) power: Experimental evidence from residential energy use. *Am. Econ. Rev.*, **104**, 1417–1438, https://doi.org/10.1257/aer.104.4.1417.

Jodoin, S., S. Duyck, and K. Lofts, 2015: Public Participation and Climate Governance: An Introduction. *Rev. Eur. Comp. Int. Environ. Law*, **24**, 117–122, https://doi.org/10.1111/reel.12126.

Johannsdottir, L., 2014: Transforming the linear insurance business model to a closed-loop insurance model: A case study of Nordic non-life insurers. *J. Clean. Prod.*, **83**, 341–355, https://doi.org/10.1016/j.jclepro.2014.07.010.

Johansson, T., A. Patwardhan, N. Nakićenović, and GEA, 2012: *Global Energy Assessment - Toward a Sustainable Future*.

Johnson, C., 2020: Is demand side response a woman's work? Domestic labour and electricity shifting in low income homes in the United Kingdom. *Energy Res. Soc. Sci.*, **68**, https://doi.org/10.1016/j.erss.2020.101558.

Johnson, E. J., and Coauthors, 2012: Beyond nudges: Tools of a choice architecture. *Mark. Lett.*, **23**, 487–504, https://doi.org/10.1007/s11002-012-9186-1.

Jokinen, M., S. Sarkki, and H. I. Heikkinen, 2016: The Well-being effects of localized multi-level environmental governance: Case of Kilpisjärvi. *Nord. Geogr. Publ.*, **45**, 19–36.

Jones, E. C., and B. D. Leibowicz, 2019: Contributions of shared autonomous vehicles to climate change mitigation. *Transp. Res. Part D Transp. Environ.*, **72**, 279–298, https://doi.org/10.1016/j.trd.2019.05.005.

Jones, N., 2018: How to stop data centres from gobbling up the world's electricity. *Nature*, https://doi.org/10.1038/d41586-018-06610-y.

Jordahl, H., 2011: Inequality and Trust. *SSRN Electron. J.*, https://doi.org/10.2139/ssrn.1012786.

Jorgenson, A., J. Schor, and X. Huang, 2017: Income Inequality and Carbon Emissions in the United States: A State-level Analysis, 1997–2012. *Ecol. Econ.*, **134**, 40–48, https://doi.org/10.1016/j.ecolecon.2016.12.016.

Jorgenson, A. K., J. B. Schor, K. W. Knight, and X. Huang, 2016: Domestic Inequality and Carbon Emissions in Comparative Perspective. *Sociol. Forum*, **31**, 770–786, https://doi.org/10.1111/socf.12272.

——, and Coauthors, 2019: Social science perspectives on drivers of and responses to global climate change. *WIREs Clim. Chang.*, **10**, 1–17, https://doi.org/10.1002/wcc.554.

Joskow, P. L., 1995: Utility-Subsidized Energy-Efficiency Programs. *Annu. Rev. Energy Environ.*, **20**, 526–534, https://doi.org/10.1146/annurev.eg.20.110195.002522.

Joubert, E. C., S. Hess, and J. L. Van Niekerk, 2016: Large-scale solar water heating in South Africa: Status, barriers and recommendations. *Renew. Energy*, **97**, 809–822, https://doi.org/10.1016/j.renene.2016.06.029.

Jung, J., and Y. Koo, 2018: Analyzing the effects of car sharing services on the reduction of greenhouse gas (GHG) emissions. *Sustainability*, **10**, https://doi.org/10.3390/su10020539.

Jürisoo, M., N. Serenje, F. Mwila, F. Lambe, and M. Osborne, 2019: Old habits die hard: Using the energy cultures framework to understand drivers of household-level energy transitions in urban Zambia. *Energy Res. Soc. Sci.*, **53**, 59–67, https://doi.org/10.1016/j.erss.2019.03.001.

Jylhä, K. M., C. Cantal, N. Akrami, and T. L. Milfont, 2016: Denial of anthropogenic climate change: Social dominance orientation helps explain the conservative male effect in Brazil and Sweden. *Pers. Individ. Dif.*, **98**, 184–187, https://doi.org/10.1016/j.paid.2016.04.020.

Kaenzig, J., and R. Wüstenhagen, 2010: The Effect of Life Cycle Cost Information on Consumer Investment Decisions Regarding Eco-Innovation. *J. Ind. Ecol.*, **14**, 121–136, https://doi.org/10.1111/j.1530-9290.2009.00195.x.

Kahneman, D., and A. Deaton, 2010: High income improves evaluation of life but not emotional well-being. *Proc. Natl. Acad. Sci. U. S. A.*, **107**, 16489–16493, https://doi.org/10.1073/pnas.1011492107.

Kaiser, F. G., 2006: A general measure of ecological behavior. *J. Appl. Soc. Psychol.*, **28**, 395–422, https://doi.org/10.1111/j.1559-1816.1998.tb01712.x.

Kaiser, M., M. Bernauer, C. R. Sunstein, and L. A. Reisch, 2020: The power of green defaults: the impact of regional variation of opt-out tariffs on green energy demand in Germany. *Ecol. Econ.*, **174**, 106685, https://doi.org/10.1016/j.ecolecon.2020.106685.

Kallbekken, S., S. Kroll, and T. L. Cherry, 2011: Do you not like Pigou, or do you not understand him? Tax aversion and revenue recycling in the lab. *J. Environ. Econ. Manage.*, **62**, 53–64, https://doi.org/10.1016/j.jeem.2010.10.006.

Kallis, G., C. Kerschner, and J. Martinez-Alier, 2012: The economics of degrowth. *Ecol. Econ.*, **84**, 172–180, https://doi.org/10.1016/j.ecolecon.2012.08.017.

Kalt, G., D. Wiedenhofer, C. Görg, and H. Haberl, 2019: Conceptualizing energy services: A review of energy and well-being along the Energy Service Cascade. *Energy Res. Soc. Sci.*, **53**, 47–58, https://doi.org/10.1016/j.erss.2019.02.026.

Kammermann, L., and C. Dermont, 2018: How beliefs of the political elite and citizens on climate change influence support for Swiss energy transition policy. *Energy Res. Soc. Sci.*, **43**, 48–60, https://doi.org/10.1016/j.erss.2018.05.010.

Kane, R., and N. Srinivas, 2014: Unlocking the Potential of Behavioral Energy Efficiency: Methodology for Calculating Technical, Economic, and Achievable Savings Potential. *ACEEE 2014: The Next Generation: Reaching for High Energy Savings*, 5-198-5–209.

Kanger, L., F. W. Geels, B. Sovacool, and J. Schot, 2019: Technological diffusion as a process of societal embedding: Lessons from historical automobile transitions for future electric mobility. *Transp. Res. Part D Transp. Environ.*, **71**, 47–66, https://doi.org/10.1016/j.trd.2018.11.012.

Karbo, P., and T. F. Larsen, 2005: Use of online measurement data for electricity savings in Denmark. *2005 summer study of the European Council for an energy efficient economy*, Stockholm, 161–164.

Kariuki, D., 2018: Barriers to Renewable Energy Technologies Development. *Energy Today*,. https://www.energytoday.net/economics-policy/barriers-renewable-energy-technologies-development/ (Accessed December 2, 2020).

Karlin, B., J. F. Zinger, and R. Ford, 2015: The effects of feedback on energy conservation: A meta-analysis. *Psychol. Bull.*, **141**, 1205–1227, https://doi.org/10.1037/a0039650.

Kartha, S., E. Kemp-Benedic, E. Ghosh, and A. Nazareth, 2020: *The carbon inequality era*. 51 pp.

Kattumuri, R., and T. Kruse, 2019: Renewable technologies in Karnataka, India: jobs potential and co-benefits. *Clim. Dev.*, **11**, 124–137, https://doi.org/10.1080/17565529.2017.1410085.

Kavitha, N. V., N. Gandhimathi, and S. Gandhimathi, 2020: Do carbon emissions and economic growth decouple in India? An empirical analysis based on Tapio decoupling model. *Stud. Indian Place Names*, **40**, 146–152.

Keller, W., 2004: International Technology Diffusion. *J. Econ. Lit.*, **42**, 752–782, https://doi.org/DOI: 10.1257/0022051042177685.

Kemp, R., J. Schot, and R. Hoogma, 1998: Regime shifts to sustainability through processes of niche formation: The approach of strategic niche management. *Technol. Anal. Strateg. Manag.*, **10**, 175–195, https://doi.org/10.1080/09537329808524310.

Kendel, A., N. Lazaric, and K. Maréchal, 2017: What do people 'learn by looking' at direct feedback on their energy consumption? Results of a field study in Southern France. *Energy Policy*, **108**, 593–605, https://doi.org/10.1016/j.enpol.2017.06.020.

Kenner, D., 2019: *Carbon Inequality: The Role of the Richest in Climate Change - 1st Edi*. Routledge,.

Kern, F., and K. S. Rogge, 2016: The pace of governed energy transitions: Agency, international dynamics and the global Paris agreement accelerating decarbonisation processes? *Energy Res. Soc. Sci.*, **22**, 13–17, https://doi.org/10.1016/j.erss.2016.08.016.

Kern, F., P. Kivimaa, and M. Martiskainen, 2017: Policy packaging or policy patching? The development of complex energy efficiency policy mixes. *Energy Res. Soc. Sci.*, **23**, 11–25, https://doi.org/10.1016/j.erss.2016.11.002.

Kern, K., and H. Bulkeley, 2009: Cities, Europeanization and Multi-level Governance: Governing Climate Change through Transnational Municipal Networks. *JCMS*, **47**, 309–332.

Keskitalo, E. C. H., 2010: *Developing Adaptation Policy and Practice in Europe: Multi-level Governance of Climate Change*. C.H. Keskitalo, Ed. Springer,.

Kester, J., L. Noel, G. Zarazua de Rubens, and B. K. Sovacool, 2018: Policy mechanisms to accelerate electric vehicle adoption: A qualitative review from the Nordic region. *Renew. Sustain. Energy Rev.*, **94**, 719–731, https://doi.org/10.1016/j.rser.2018.05.067.

Ketlhoilwe, M. J., 2013: Improving resilience to protect women against adverse effects of climate change. *Clim. Dev.*, **5**, 153–159, https://doi.org/10.1080/17565529.2013.789788.

Khanna, T., and Coauthors, 2021: Reducing carbon emissions of households through monetary incentives and behavioural interventions: a meta-analysis. *Environ. Res. Lett.*, **submitted**.

Kikstra, J. S., and Coauthors, 2021: Maintaining energy demand shifts induced by COVID-19 reduces mitigation challenges. *Nat. Clim. Chang.*, **submitted**.

Kim, B. F., and Coauthors, 2020: Country-specific dietary shifts to mitigate climate and water crises. *Glob. Environ. Chang.*, **62**, 101926, https://doi.org/10.1016/j.gloenvcha.2019.05.010.

Kimemia, D., and H. Annegarn, 2016: Domestic LPG interventions in South Africa: Challenges and lessons. *Energy Policy*, **93**, 150–156, https://doi.org/10.1016/j.enpol.2016.03.005.

King, D. A., M. J. Smart, and M. Manville, 2019: The Poverty of the Carless: Toward Universal Auto Access. *J. Plan. Educ. Res.*, 0739456X1882325, https://doi.org/10.1177/0739456X18823252.

Kirchherr, J., D. Reike, and M. Hekkert, 2017: Conceptualizing the circular economy: An analysis of 114 definitions. *Resour. Conserv. Recycl.*, **127**, 221–232.

Kitou, E., and A. Horvath, 2003: Energy-related emissions from telework. *Environ. Sci. Technol.*, **37**, 3467–3475, https://doi.org/10.1021/es025849p.

Kivimaa, P., and V. Virkamäki, 2014: Policy mixes, policy interplay and low carbon transitions: The case of passenger transport in Finland. *Environ. Policy Gov.*, **24**, 28–41, https://doi.org/10.1002/eet.1629.

——, and F. Kern, 2016: Creative destruction or mere niche support? Innovation policy mixes for sustainability transitions. *Res. Policy*, **45**, 205–217, https://doi.org/10.1016/j.respol.2015.09.008.

——, and M. Martiskainen, 2018: Energy Research & Social Science Dynamics of policy change and intermediation : The arduous transition towards low-energy homes in the United Kingdom. *Energy Res. Soc. Sci.*, **44**, 83–99, https://doi.org/10.1016/j.erss.2018.04.032.

Klasen, S., 2018: Inequality and Greenhouse Gas Emissions. *J. Income Distrib.*, **26**, 1–14.

Klausbruckner, C., H. Annegarn, L. R. F. Henneman, and P. Rafaj, 2016: A policy review of synergies and trade-offs in South African climate change mitigation and air pollution control strategies. *Environ. Sci. Policy*, **57**, 70–78, https://doi.org/10.1016/j.envsci.2015.12.001.

Klausner, M., W. M. Grimm, and C. Hendrickson, 1998: Reuse of Electric Motors in Consumer Products. *J. Ind. Ecol.*, **2**, 89–102, https://doi.org/10.1162/jiec.1998.2.2.89.

Klemeš, J. J., Y. Van Fan, R. R. Tan, and P. Jiang, 2020: Minimising the present and future plastic waste, energy and environmental footprints related to COVID-19. *Renew. Sustain. Energy Rev.*, **127**, 109883, https://doi.org/10.1016/j.rser.2020.109883.

Klenert, D., and L. Mattauch, 2016: How to make a carbon tax reform progressive: The role of subsistence consumption. *Econ. Lett.*, **138**, 100–103, https://doi.org/10.1016/j.econlet.2015.11.019.

——, ——, E. Combet, O. Edenhofer, C. Hepburn, R. Rafaty, and N. Stern, 2018: Making carbon pricing work for citizens. *Nat. Clim. Chang.*, **8**, 669–677, https://doi.org/10.1038/s41558-018-0201-2.

——, F. Funke, L. Mattauch, and B. O'Callaghan, 2020: Five Lessons from COVID-19 for Advancing Climate Change Mitigation. *SSRN Electron. J.*, **76**, 751–778, https://doi.org/10.2139/ssrn.3622201.

Klinsky, S., and H. Winkler, 2014: Equity, sustainable development and climate policy. *Clim. Policy*, **14**, 1–7, https://doi.org/10.1080/14693062.2014.859352.

——, and Coauthors, 2016: Why equity is fundamental in climate change policy research. *Glob. Environ. Chang.*, https://doi.org/10.1016/j.gloenvcha.2016.08.002.

Klitkou, A., S. Bolwig, T. Hansen, and N. Wessberg, 2015: The role of lock-in mechanisms in transition processes: The case of energy for road transport. *Environ. Innov. Soc. Transitions*, **16**, 22–37, https://doi.org/10.1016/j.eist.2015.07.005.

Klopp, J. M., 2012: Towards a Political Economy of Transportation Policy and Practice in Nairobi. *Urban Forum*, **23**, 1–21, https://doi.org/10.1007/s12132-011-9116-y.

Koh, H., 2016: A new app to save food at the 11th Hour. *Eco-Business*, November 15.

Komiyama, H., 2014: *Beyond the limits to growth: New ideas from Japan*. H. Komiyama, Ed. Springer Japan, 1–12 pp.

Konrad, K., 2016: Ups and downs of alternative fuels. *Nat. Publ. Gr.*, **1**, 1–2, https://doi.org/10.1038/nenergy.2016.22.

Koomey, J. G., S. Berard, M. Sanchez, and H. Wong, 2011: Implications of historical trends in the electrical efficiency of computing. *IEEE Ann. Hist. Comput.*, https://doi.org/10.1109/MAHC.2010.28.

Korhonen, J., A. Honkasalo, and J. Seppälä, 2018: Circular Economy: The Concept and its Limitations. *Ecol. Econ.*, **143**, 37–46, https://doi.org/https://doi.org/10.1016/j.ecolecon.2017.06.041.

Koronen, C., M. Åhman, and L. J. Nilsson, 2020: Data centres in future European energy systems—energy efficiency, integration and policy. *Energy Effic.*, **13**, https://doi.org/10.1007/s12053-019-09833-8.

Kotchen, M. J., Z. M. Turk, and A. A. Leiserowitz, 2017: Public willingness to pay for a US carbon tax and preferences for spending the revenue. *Environ. Res. Lett*, **12**, 94012, https://doi.org/10.1088/1748-9326/aa822a.

Kragten, N., and J. Rözer, 2017: The Income Inequality Hypothesis Revisited: Assessing the Hypothesis Using Four Methodological Approaches. *Soc. Indic. Res.*, **131**, 1015–1033, https://doi.org/10.1007/s11205-016-1283-8.

Krausmann, F., S. Gingrich, N. Eisenmenger, K. H. Erb, H. Haberl, and M. Fischer-Kowalski, 2009: Growth in global materials use, GDP and population during the 20th century. *Ecol. Econ.*, **68**, 2696–2705, https://doi.org/10.1016/j.ecolecon.2009.05.007.

Krieger, N., 2020: ENOUGH: COVID-19, Structural Racism, Police Brutality, Plutocracy, Climate Change—and Time for Health Justice, Democratic Governance, and an Equitable, Sustainable Future. *Am. J. Public Health*, **110**, 1620–1623, https://doi.org/10.2105/ajph.2020.305886.

Kriegler, E., J. Edmonds, S. Hallegatte, K. L. Ebi, T. Kram, K. Riahi, H. Winkler, and D. P. van Vuuren, 2014: A new scenario framework for climate change research: The concept of shared climate policy assumptions. *Clim. Change*, **122**, 401–414, https://doi.org/10.1007/s10584-013-0971-5.

Kronsell, A., 2017: The contribution of feminist perspectives to climate governance. *Understanding Climate Change through Gender Relations*, S. Buckingham and V. Le Masson, Eds., Routledge, 104–120.

Kua, H. W., and S. E. Wong, 2012: Lessons for integrated household energy conservation policies from an intervention study in Singapore. *Energy Policy*, **47**, 49–56, https://doi.org/10.1016/j.enpol.2012.04.009.

Kulin, J., and I. Johansson Sevä, 2019: The Role of Government in Protecting the Environment: Quality of Government and the Translation of Normative Views about Government Responsibility into Spending Preferences. *Int. J. Sociol.*, **49**, 110–129, https://doi.org/10.1080/00207659.2019.1582964.

Kumar, P., R. K. Rao, and N. H. Reddy, 2016: Sustained uptake of LPG as cleaner cooking fuel in rural India: Role of affordability, accessibility, and awareness. *World Dev. Perspect.*, **4**, 33–37, https://doi.org/10.1016/j.wdp.2016.12.001.

Kumar, S. V., 2019: *Rural roads and the SDGs*.

Kungl, G., and F. W. Geels, 2018: Sequence and alignment of external pressures in industry destabilisation: Understanding the downfall of incumbent utilities in the German energy transition (1998–2015). *Environ. Innov. Soc. Transitions*, **26**, 78–100, https://doi.org/https://doi.org/10.1016/j.eist.2017.05.003.

Kunreuther, H., and E. Michel-Kerjan, 2015: Demand for fixed-price multi-year contracts: Experimental evidence from insurance decisions. *J. Risk Uncertain.*, **51**, 171–194, https://doi.org/10.1007%2Fs11166-015-9225-4.

Kunreuther, H., and Coauthors, 2014: Integrated Risk and Uncertainty Assessment of Climate Change Response Policies. *Climate Change 2014: Mitigation of Climate Change. Contribution of Working Group III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change*, O. Edenhofer et al., Eds., Cambridge University Press Cambridge, UK, and New York, 151–206.

Kuokkanen, A., A. Nurmi, M. Mikkilä, M. Kuisma, H. Kahiluoto, and L. Linnanen, 2018: Agency in regime destabilization through the selection environment: The Finnish food system's sustainability transition. *Res. Policy*, **47**, 1513–1522, https://doi.org/10.1016/j.respol.2018.05.006.

Kurz, T., N. Donaghue, and I. Walker, 2005: Utilizing a social-ecological framework to promote water and energy conservation: A field experiment. *J. Appl. Soc. Psychol.*, **35**, 1281–1300, https://doi.org/10.1111/j.1559-1816.2005.tb02171.x.

Lachapelle, U., G. A. Tanguay, and L. Neumark-Gaudet, 2018: Telecommuting and sustainable travel: Reduction of overall travel time, increases in non-motorised travel and congestion relief? *Urban Stud.*, **55**, 2226–2244, https://doi.org/10.1177/0042098017708985.

Laestadius, L. I., R. A. Neff, C. L. Barry, and S. Frattaroli, 2016: No Meat, Less Meat, or Better Meat: Understanding NGO Messaging Choices Intended to Alter Meat Consumption in Light of Climate Change. *Environ. Commun.*, **10**, 84–103, https://doi.org/10.1080/17524032.2014.981561.

Laitner, J. A. "Skip," K. Ehrhardt-Martinez, and V. McKinney, 2009: Examining the scale of the

Behaviour Energy Efficiency Continuum. *Proc. 2009 ECEEE Summer Study*, **Panel 1. T**, 217–223.

Lamb, W. F., and N. D. Rao, 2015: Human development in a climate-constrained world: What the past says about the future. *Glob. Environ. Chang.*, **33**, 14–22, https://doi.org/10.1016/j.gloenvcha.2015.03.010.

——, and J. K. Steinberger, 2017: Human well-being and climate change mitigation. *Wiley Interdiscip. Rev. Clim. Chang.*, **8**, https://doi.org/10.1002/wcc.485.

Lamb, W. F., J. K. Steinberger, A. Bows-Larkin, G. P. Peters, J. T. Roberts, and F. R. Wood, 2014: Transitions in pathways of human development and carbon emissions. *Environ. Res. Lett.*, **9**, https://doi.org/10.1088/1748-9326/9/1/014011.

Lambert, H., and Coauthors, 2020: COVID-19 as a global challenge: towards an inclusive and sustainable future. *Lancet Planet. Heal.*, **4**, e312–e314, https://doi.org/10.1016/S2542-5196(20)30168-6.

Lange, A., C. Vogt, and A. Ziegler, 2007: On the importance of equity in international climate policy: An empirical analysis. *Energy Econ.*, **29**, 545–562, https://doi.org/10.1016/j.eneco.2006.09.002.

Larcom, S., F. Rauch, and T. Willems, 2017: The Benefits of Forced Experimentation: Striking Evidence from the London Underground Network. *Q. J. Econ.*, **132**, 2019–2055, https://doi.org/10.1093/qje/qjx020.

Larrick, R. P., and J. B. Soll, 2008: The MPG illusion. *Science (80-.).*, **320**, 1593–1594, https://doi.org/10.1126/science.1154983.

Larson, A. M., D. Solis, A. E. Duchelle, S. Atmadja, I. A. P. Resosudarmo, T. Dokken, and M. Komalasari, 2018: Gender lessons for climate initiatives: A comparative study of REDD+ impacts on subjective wellbeing. *World Dev.*, **108**, 86–102, https://doi.org/10.1016/j.worlddev.2018.02.027.

Latvala, T., M. Niva, J. Mäkelä, E. Pouta, J. Heikkilä, J. Kotro, and S. Forsman-Hugg, 2012: Diversifying meat consumption patterns: Consumers' self-reported past behaviour and intentions for change. *Meat Sci.*, **92**, 71–77, https://doi.org/10.1016/j.meatsci.2012.04.014.

Lavagna, M., C. Baldassarri, A. Campioli, S. Giorgi, A. Dalla Valle, V. Castellani, and S. Sala, 2018: Benchmarks for environmental impact of housing in Europe: Definition of archetypes and LCA of the residential building stock. *Build. Environ.*, **145**, 260–275, https://doi.org/10.1016/j.buildenv.2018.09.008.

Lazarus, M., and H. van Asselt, 2018: Fossil fuel supply and climate policy: exploring the road less taken. *Clim. Change*, **150**, https://doi.org/10.1007/s10584-018-2266-3.

Leach, M., H. MacGregor, I. Scoones, and A. Wilkinson, 2021: Post-pandemic transformations: How and why COVID-19 requires us to rethink development. *World Dev.*, **138**, 105233, https://doi.org/10.1016/j.worlddev.2020.105233.

Lee, E., N.-K. Park, and J. H. Han, 2013: Gender Difference in Environmental Attitude and Behaviors in Adoption of Energy-Efficient Lighting at Home. *J. Sustain. Dev.*, **6**, https://doi.org/10.5539/jsd.v6n9p36.

Lee, K., N. Gjersoe, S. O'Neill, and J. Barnett, 2020: Youth perceptions of climate change: A narrative synthesis. *Wiley Interdiscip. Rev. Clim. Chang.*, **11**, 1–24, https://doi.org/10.1002/wcc.641.

Lee, S., and E. Zusman, 2019: Participatory climate governance in Southeast Asia: Lessons learned from gender-responsive climate mitigation. *Routledge Handbook of Climate Justice*, T. Jafry, Ed., Routledge, 393–404.

Lee, T., and C. Koski, 2015: Multilevel governance and urban climate change mitigation. *Environ. Plan. C Gov. Policy*, **33**, 1501–1517, https://doi.org/10.1177/0263774X15614700.

Leemans, R., A. Van Amstel, C. Battjes, E. Kreileman, and S. Toet, 1996: The land cover and carbon cycle consequences of large-scale utilizations of biomass as an energy source. *Glob. Environ. Chang.*, **6**, 335–357, https://doi.org/10.1016/S0959-3780(96)00028-3.

Leibowicz, B. D., 2018: Policy recommendations for a transition to sustainable mobility based on historical diffusion dynamics of transport systems. *Energy Policy*, **119**, 357–366, https://doi.org/10.1016/j.enpol.2018.04.066.

Leipprand, A., and C. Flachsland, 2018: Energy Research & Social Science Regime destabilization in energy transitions : The German debate on the future of coal. *Energy Res. Soc. Sci.*, **40**, 190–204, https://doi.org/10.1016/j.erss.2018.02.004.

Leiserowitz, A., and K. Akerlof, 2010: *Race, ethnicity and public responses to climate change*. http://environment.yale.edu/uploads/RaceEthnicity2010.pdf (Accessed June 5, 2020).

——, E. Maibach, S. Rosenthal, J. Kotcher, P. Bergquist, M. T. Ballew, M. Goldberg, and A. Gustafson, 2020: Climate change in the American mind: November 2019. https://doi.org/10.31234/osf.io/z3wtx.

Lejano, R. P., and S. J. Nero, 2020: *The Power of Narrative: Climate Skepticism and the Deconstruction of Science*. Oxford University Press,.

Lepeley, M.-T., 2017: Bhutan's Gross National Happiness: An Approach to Human Centred Sustainable Development. *South Asian J. Hum. Resour. Manag.*, **4**, 174–184, https://doi.org/10.1177/2322093717731634.

Levin-Waldman, O. M., 2012: *Income inequality and disparities in civic participation in the New York City Metro Area*. 22–29 pp.

Levin, K., B. Cashore, S. Bernstein, and G. Auld, 2012: Overcoming the tragedy of super wicked problems: Constraining our future selves to ameliorate global climate change. *Policy Sci.*, **45**, 123–152, https://doi.org/10.1007/s11077-012-9151-0.

Lewandowski, M., 2016: Designing the business models for circular economy-towards the conceptual framework. *Sustain.*, **8**, 1–28, https://doi.org/10.3390/su8010043.

Lewis, J. J., and S. K. Pattanayak, 2012: Who Adopts Improved Fuels and Cookstoves? A Systematic Review. *Environ. Health Perspect.*, **120**, 637–645, https://doi.org/10.1289/ehp.1104194.

Li, J., J. Zhang, D. Zhang, and Q. Ji, 2019: Does gender inequality affect household green consumption behaviour in China? *Energy Policy*, **135**, 111071, https://doi.org/10.1016/j.enpol.2019.111071.

Li, L., and W. Wang, 2020: The effects of online trust-building mechanisms on trust in the sharing economy: The perspective of providers. *Sustainability*, **12**, https://doi.org/10.3390/su12051717.

Li, W., T. H. Rubin, and P. A. Onyina, 2013: Comparing solar water heater popularization policies in China, Israel and Australia: The roles of governments in adopting green innovations. *Sustain. Dev.*, **21**, 160–170, https://doi.org/10.1002/sd.1547.

Liao, L., M. E. Warner, and G. C. Homsy, 2019: Sustainability's forgotten third E: what influences local government actions on social equity? *Local Environ.*, **24**, 1197–1208, https://doi.org/10.1080/13549839.2019.1683725.

Lidskog, R., and I. Elander, 2009: Addressing climate change democratically. Multi-level governance, transnational networks and governmental structures. *Sustain. Dev.*, **18**, n/a-n/a, https://doi.org/10.1002/sd.395.

Lieder, M., and A. Rashid, 2016: Towards circular economy implementation: a comprehensive review in context of manufacturing industry. *J. Clean. Prod.*, **115**, 36–51, https://doi.org/https://doi.org/10.1016/j.jclepro.2015.12.042.

Liedtke, C., H. Rohn, M. Kuhndt, and R. Nickel, 1998: Applying Material Flow Accounting: Ecoauditing and Resource Management at the Kambium Furniture Workshop. *J. Ind. Ecol.*, **2**, 131–147, https://doi.org/10.1162/jiec.1998.2.3.131.

Lieven, T., and N. Rietmann, 2018: Do policy measures in fact promote electric mobility? A study across 20 countries. *Transport and the City*, S. Ricci and C.A. Brebbia, Eds., Edward Elgar Publications, 41–50.

van der Linden, S., and M. H. Goldberg, 2020: Alternative meta-analysis of behavioral interventions to promote action on climate change yields different conclusions. *Nat. Commun.*, **11**, 3915, https://doi.org/10.1038/s41467-020-17613-7.

Linder, M., and M. Williander, 2017: Circular Business Model Innovation: Inherent Uncertainties. *Bus. Strateg. Environ.*, **26**, 182–196, https://doi.org/10.1002/bse.1906.

Liu, C. J., and F. Hao, 2020: The impact of social and ecological factors on environmentally responsible behavior. *J. Clean. Prod.*, **254**, 120173, https://doi.org/10.1016/j.jclepro.2020.120173.

Liu, J. Y., S. Fujimori, K. Takahashi, T. Hasegawa, X. Su, and T. Masui, 2018: Socioeconomic factors and future challenges of the goal of limiting the increase in global average temperature to 1.5 °C. *Carbon Manag.*, **9**, 447–457, https://doi.org/10.1080/17583004.2018.1477374.

Liu, Q., S. Wang, W. Zhang, J. Li, and Y. Kong, 2019: Examining the effects of income inequality on CO2 emissions: Evidence from non-spatial and spatial perspectives. *Appl. Energy*, **236**, 163–171, https://doi.org/10.1016/J.APENERGY.2018.11.082.

Liyanage, S., H. Dia, R. Abduljabbar, S. Bagloee, S. Liyanage, H. Dia, R. Abduljabbar, and S. A. Bagloee, 2019: Flexible Mobility On-Demand: An Environmental Scan. *Sustainability*, **11**, 1262, https://doi.org/10.3390/su11051262.

Lockwood, M., 2018: Right-wing populism and the climate change agenda: exploring the linkages. *Env. Polit.*, https://doi.org/10.1080/09644016.2018.1458411.

——, C. Kuzemko, C. Mitchell, and R. Hoggett, 2017: Historical institutionalism and the politics of sustainable energy transitions: A research agenda. *Environ. Plan. C Gov. Policy*, **35**, 312–333, https://doi.org/10.1177/0263774X16660561.

Löfgren, Å., P. Martinsson, M. Hennlock, and T. Sterner, 2012: Are experienced people affected by a pre-set default option—Results from a field experiment. *J. Environ. Econ. Manage.*, **63**, 66–72.

Loiseau, E., and Coauthors, 2016: Green economy and related concepts: An overview. *J. Clean. Prod.*, **139**, 361–371, https://doi.org/https://doi.org/10.1016/j.jclepro.2016.08.024.

Loiter, J. M., V. Norberg-Bohm, J. M. Loiter, and V. Norberg-Bohm, 1999: Energy policy : the international journal of the political, economic, planning, environmental and social aspects of energy. *Energy Policy*, **27**, 85–97.

Lokhandwala, M., and H. Cai, 2018: Dynamic ride sharing using traditional taxis and shared autonomous taxis: A case study of NYC. *Transp. Res. Part C Emerg. Technol.*, **97**, 45–60, https://doi.org/10.1016/j.trc.2018.10.007.

Lopes, M. A. R., C. H. Antunes, A. Reis, and N. Martins, 2017: Estimating energy savings from behaviours using building performance simulations. *Build. Res. Inf.*, **45**, 303–319, https://doi.org/10.1080/09613218.2016.1140000.

López-García, D., L. Calvet-Mir, M. Di Masso, and J. Espluga, 2019: Multi-actor networks and innovation niches: university training for local Agroecological Dynamization. *Agric. Human Values*, **36**, 567–579, https://doi.org/10.1007/s10460-018-9863-7.

Lorenz, D. F., 2013: The diversity of resilience: contributions from a social science perspective. *Nat. Hazards*, **67**, 7–24, https://doi.org/10.1007/s11069-010-9654-y.

Lorenzoni, I., S. Nicholson-Cole, and L. Whitmarsh, 2007: Barriers perceived to engaging with climate change among the UK public and their policy implications. *Glob. Environ. Chang.*, **17**, 445–459, https://doi.org/10.1016/J.GLOENVCHA.2007.01.004.

Lounsbury, M., and M. A. Glynn, 2001: Cultural entrepreneurship: Stories, legitimacy, and the acquisition of resources. *Strateg. Manag. J.*, **22**, 545–564, https://doi.org/10.1002/smj.188.

Lovins, A., 2015: The nuclear distraction - Bulletin of the Atomic Scientists.

Lucon, O., and Coauthors, 2014: Buildings. *Climate Change 2014: Mitigation of Climate Change. Contribution of Working Group III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change*, O. Edenhofer et al., Eds., 671–738.

Lundqvist, J., C. de Fraiture, and D. Molden, 2008: *Saving Water: From Field to Fork – Curbing Losses and Wastage in the Food Chain*. 36 pp. http://www.siwi.org/publications/.

Luttmer, E. F. P., 2005: Neighbors as Negatives: Relative Earnings and Well-Being. *Q. J. Econ.*, **120**, 963–1002, https://doi.org/10.1093/qje/120.3.963.

Lutzenhiser, L., 1993: Social and behavioral aspects of energy use contents introduction. *Annu. Rev. Energy Env.*, **18**, 247–289.

Lynch, M. J., M. A. Long, P. B. Stretesky, and K. L. Barrett, 2019: Measuring the Ecological Impact of the Wealthy: Excessive Consumption, Ecological Disorganization, Green Crime, and Justice. *Soc. Curr.*, **6**, 377–395, https://doi.org/10.1177/2329496519847491.

Lynham, J., K. Nitta, T. Saijo, and N. Tarui, 2016: Why does real-time information reduce energy consumption? *Energy Econ.*, **54**, 173–181, https://doi.org/10.1016/j.eneco.2015.11.007.

Ma, T., A. Grubler, N. Nakicenovic, and W. B. Arthur, 2008: *Technologies as agents of change: A simulation model of the evolving complexity of the global energy system*. http://pure.iiasa.ac.at/id/eprint/8762/.

Macgregor, S., 2014: Only Resist: Feminist Ecological Citizenship and the Post-politics of Climate Change. *Hypatia*, **29**, 617–633, https://doi.org/10.1111/hypa.12065.

Mack, B., and S. Hallmann, 2004: Strom sparen in Lummerlund—eine Interventionsstudie in einer Passiv- und Niedrigenergiehaussiedlung. [Conserving electricity in Lummerlund. An intervention study in a passive and low energy house residential area]. *Umweltpsychologie*, **8**, 12–29.

Maestre-Andrés, S., S. Drews, and J. van den Bergh, 2019: Perceived fairness and public acceptability of carbon pricing: a review of the literature. *Clim. Policy*, **19**, 1186–1204, https://doi.org/10.1080/14693062.2019.1639490.

Mahajan, V., E. Muller, and F. M. Bass, 1990: New product diffusion models in marketing: A review and directions for research. *J. Mark.*, **54**, 1–26, https://doi.org/10.2307/1252170.

Mahler, D. G., C. Lakner, R. A. C. Aguilar, and H. Wu, 2020: Updated estimates of the impact of COVID-19 on global poverty. *World Bank Blog*,. https://scholar-google-com.ezproxy.library.yorku.ca/scholar?hl=en&as_sdt=0,5&cluster=5715007817648070731 (Accessed November 26, 2020).

Maibach, E. W., A. Leiserowitz, C. Roser-Renouf, and C. K. Mertz, 2011: Identifying Like-Minded Audiences for Global Warming Public Engagement Campaigns: An Audience Segmentation Analysis and Tool Development. *PLoS One*, **6**, e17571, https://doi.org/10.1371/journal.pone.0017571.

Maïzi, N., and V. Mazauric, 2019: From centralized to decentralized power systems: The shift on finitude constraints. *Energy Procedia*, **158**, 4262–4267, https://doi.org/10.1016/j.egypro.2019.01.800.

Maïzi, N., V. Mazauric, E. Assoumou, S. Bouckaert, V. Krakowski, X. Li, and P. Wang, 2017: Maximizing intermittency in 100% renewable and reliable power systems: A holistic approach applied to Reunion Island in 2030. *Appl. Energy*, **227**, 332–341, https://doi.org/10.1016/j.apenergy.2017.08.058.

Maki, A., and A. J. Rothman, 2017: Understanding proenvironmental intentions and behaviors: The importance of considering both the behavior setting and the type of behavior. *J. Soc. Psychol.*, **157**, 517–531, https://doi.org/10.1080/00224545.2016.1215968.

Malmodin, J., 2020: The power consumption of mobile and fixed network data services - The case of streaming video and downloading large files. *Proceedings of the Electronics Goes Green 2020+ Conference, Berlin, September 1*, 87–96.

——, and D. Lundén, 2018: The energy and carbon footprint of the global ICT and E & M sectors 2010-2015. *Sustain.*, https://doi.org/10.3390/su10093027.

Malone, E., N. E. Hultman, K. L. Anderson, and V. Romeiro, 2017: Energy Research & Social Science Stories about ourselves : How national narratives in fl uence the di ff usion of large-scale energy technologies. **31**, 70–76, https://doi.org/10.1016/j.erss.2017.05.035.

Mani, A., S. Mullainathan, E. Shafir, and J. Zhao, 2013: Poverty impedes cognitive function. *Science (80-.).*, **341**, 976–980, https://doi.org/10.1126/science.1238041.

Mansfield, E., 1968: *The Economics of Technological Change*. W.W. Norton & Co., 150 pp.

Manzanedo, R. D., and P. Manning, 2020: COVID-19: Lessons for the climate change emergency. *Sci. Total Environ.*, **742**, 140563, https://doi.org/10.1016/j.scitotenv.2020.140563.

Mardani, A., D. Streimikiene, F. Cavallaro, N. Loganathan, and M. Khoshnoudi, 2019: Carbon dioxide (CO2) emissions and economic growth: A systematic review of two decades of research from 1995 to 2017. *Sci. Total Environ.*, **649**, 31–49, https://doi.org/10.1016/j.scitotenv.2018.08.229.

Markard, J., and V. H. Hoffmann, 2016: Analysis of complementarities: Framework and examples from the energy transition. *Technol. Forecast. Soc. Chang.*, **111**, 63–75, https://doi.org/10.1016/j.techfore.2016.06.008.

——, R. Raven, and B. Truffer, 2012: Sustainability transitions : An emerging field of research and its prospects. *Res. Policy*, **41**, 955–967, https://doi.org/10.1016/j.respol.2012.02.013.

Marquardt, J., 2017: Conceptualizing power in multi-level climate governance. *J. Clean. Prod.*, **154**, 167–175, https://doi.org/10.1016/j.jclepro.2017.03.176.

Marres, N., 2011: The costs of public involvement: everyday devices of carbon accounting and the materialization of participation. *Econ. Soc.*, **40**, 510–533, https://doi.org/10.1080/03085147.2011.602294.

Martin, C. J., 2016: The sharing economy: A pathway to sustainability or a nightmarish form of neoliberal capitalism? *Ecol. Econ.*, **121**, 149–159, https://doi.org/https://doi.org/10.1016/j.ecolecon.2015.11.027.

Martin, E., and S. Shaheen, 2016: *Impacts of car2go on Vehicle Ownership, Modal Shift, Vehicle Miles Traveled, and Greenhouse Gas Emissions: An Analysis of Five North American Cities*. 0–25 pp. http://innovativemobility.org/wp-content/uploads/2016/07/Impactsofcar2go_FiveCities_2016.pdf.

Martin, E. W., and S. A. Shaheen, 2011: Greenhouse gas emission impacts of carsharing in North America. *IEEE Trans. Intell. Transp. Syst.*, **12**, 1074–1086, https://doi.org/10.1109/TITS.2011.2158539.

Martínez-Gómez, J., D. Ibarra, S. Villacis, P. Cuji, and P. R. Cruz, 2016: Analysis of LPG, electric and induction cookers during cooking typical Ecuadorian dishes into the national efficient cooking program. *Food Policy*, **59**, 88–102, https://doi.org/10.1016/j.foodpol.2015.12.010.

Martínez, J., J. Martí-Herrero, S. Villacís, A. J. J. Riofrio, and D. Vaca, 2017: Analysis of energy, CO2 emissions and economy of the technological migration for clean cooking in Ecuador. *Energy Policy*, **107**, 182–187, https://doi.org/10.1016/j.enpol.2017.04.033.

Martinez, L. M., and J. M. Viegas, 2017: Assessing the impacts of deploying a shared self-driving urban mobility system: An agent-based model applied to the city of Lisbon, Portugal. *Int. J. Transp. Sci. Technol.*, **6**, 13–27, https://doi.org/10.1016/J.IJTST.2017.05.005.

Martino, J. P., K.-L. Chen, and R. C. Lenz, 1978: *Predicting the Diffusion Rate of Industrial Innovations*.

Martiskainen, M., S. Axon, B. K. Sovacool, S. Sareen, D. Furszyfer Del Rio, and K. Axon, 2020: Contextualizing climate justice activism: Knowledge, emotions, motivations, and actions among climate strikers in six cities. *Glob. Environ. Chang.*, **65**, 102180, https://doi.org/10.1016/j.gloenvcha.2020.102180.

Masanet, E., A. Shehabi, N. Lei, H. Vranken, J. Koomey, and J. Malmodin, 2019: Implausible projections overestimate near-term Bitcoin CO2 emissions. *Nat. Clim. Chang.*, https://doi.org/10.1038/s41558-019-0535-4.

——, ——, ——, S. Smith, and J. Koomey, 2020: Recalibrating global data center energy-use estimates: Growth in energy use has slowed owing to efficiency gains that smart policies can help maintain in the near term. *Science (80-.).*, **367**, https://doi.org/10.1126/science.aba3758.

Masanet, E. R., R. E. Brown, A. Shehabi, J. G. Koomey, and B. Nordman, 2011: Estimating the energy use and efficiency potential of U.S. data centers. *Proc. IEEE*, **99**, 1440–1453, https://doi.org/10.1109/JPROC.2011.2155610.

Mastrucci, A., and N. D. Rao, 2017: Decent housing in the developing world: Reducing life-cycle energy requirements. *Energy Build.*, **152**, 629–642, https://doi.org/10.1016/j.enbuild.2017.07.072.

——, and ——, 2019: Bridging India’s housing gap: lowering costs and CO2 emissions. *Build. Res. Inf.*, **47**, 8–23, https://doi.org/10.1080/09613218.2018.1483634.

Material Economics Sverige AB, 2018: *The Circular Economy: a Powerful Force for Climate Mitigation*. 176 pp. https://materialeconomics.com/publications/the-circular-economy.

Matsukawa, I., 2004: The Effects of Information on Residential Demand for Electricity. *Energy J.*, **25**, 17, https://doi.org/10.5547/issn0195-6574-ej-vol25-no1-2.nadel.

Mattauch, L., and C. Hepburn, 2016: Climate Policy When Preferences Are Endogenous-and Sometimes They Are. *Midwest Stud. Philos.*, **40**, 76–95, https://doi.org/10.1111/misp.12048.

——, M. Ridgway, and F. Creutzig, 2016: Happy or liberal? Making sense of behavior in transport policy design. *Transp. Res. Part D Transp. Environ.*, **45**, 64–83, https://doi.org/10.1016/j.trd.2015.08.006.

——, C. Hepburn, and N. Stern, 2018: *Pigou Pushes Preferences: Decarbonisation and Endoge-nous Values*. http://www.lse.ac.uk/GranthamInstitute/wp-content/uploads/2018/12/working-paper-314-Mattauch-et-al.pdf (Accessed July 4, 2019).

Matthies, E., C. A. Klockner, and C. L. Preissner, 2006: Applying a Modified Moral Decision Making Model to Change Habitual Car Use: How Can Commitment be Effective? *Appl. Psychol.*, **55**, 91–106, https://doi.org/10.1111/j.1464-0597.2006.00237.x.

Mattioli, G., 2016: Transport needs in a climate-constrained world. A novel framework to reconcile social and environmental sustainability in transport. *Energy Res. Soc. Sci.*, **18**, 118–128, https://doi.org/10.1016/j.erss.2016.03.025.

——, C. Roberts, J. K. Steinberger, and A. Brown, 2020: The political economy of car dependence: A systems of provision approach. *Energy Res. Soc. Sci.*, **66**, https://doi.org/10.1016/j.erss.2020.101486.

Maumbe, B. M., 2006: Digital Financial Service Delivery to Poor Communities in South Africa : A Preliminary Assessment. *Int. Rev. Bus. Res. Pap.*, **2**, 72–79.

Max-Neef, M., 1995: Economic growth and quality of life: a threshold hypothesis. *Ecol. Econ.*, **15**, 115–118, https://doi.org/https://doi.org/10.1016/0921-8009(95)00064-X.

Max-Neef, M., A. Elizalde, and Martín Hopenhayn, 1989: *Human scale development: An option for the future*. 5–80 pp.

Mazeka, B., C. Sutherland, S. Buthelezi, and D. Khumalo, 2019: Community-Based Mapping Methodology for Climate Change Adaptation: A Case Study of Quarry Road West Informal Settlement, Durban, South Africa. *The Geography of Climate Change Adaptation in Urban Africa*, Springer International Publishing, 57–88.

Mazur, A., and E. Rosa, 1974: Energy and life-style. *Science (80-.).*, **186**, 607–610, https://doi.org/10.1126/science.186.4164.607.

Mazzucato, M., 2018: *The value of everything : making and taking in the global economy.* Allen Lane,.

Mbaye, A. A., and F. Gueye, 2018: The Competitiveness Challenge of the Formal Sector in Francophone Africa: Understanding the Role of the Informal Sector and the Business Environment. *Africa's Competitiveness in the Global Economy*, Springer International Publishing, 25–51.

Mbow, C., and Coauthors, 2019: Food security. *Climate Change and Land: an IPCC special report on climate change, desertification, land degradation, sustainable land management, food security, and greenhouse gas fluxes in terrestrial ecosystems*, p. 437.

McCalley, L. T., and C. J. H. Midden, 2002: Energy conservation through product-integrated feedback: The roles of goal-setting and social orientation. *J. Econ. Psychol.*, **23**, 589–603, https://doi.org/10.1016/S0167-4870(02)00119-8.

McCright, A. M., and R. E. Dunlap, 2011: Cool dudes: The denial of climate change among conservative white males in the United States. *Glob. Environ. Chang.*, **21**, 1163–1172, https://doi.org/10.1016/j.gloenvcha.2011.06.003.

——, and C. Xiao, 2014: Gender and Environmental Concern: Insights from Recent Work and for Future Research. *Soc. Nat. Resour.*, **27**, 1109–1113, https://doi.org/10.1080/08941920.2014.918235.

McCubbin, L. D., H. I. McCubbin, W. Zhang, L. Kehl, and I. Strom, 2013: Relational Well-being: An Indigenous Perspective and Measure. *Fam. Relat.*, **62**, 354–365, https://doi.org/10.1111/fare.12007.

McDonough, W., and M. Braungart, 2002: *Cradle to cradle: remaking the way we make things*. North Point Press, 193 pp.

McGregor, J. A., and N. Pouw, 2017: Towards an economics of well-being. *Cambridge J. Econ.*, **41**, 1123–1142, https://doi.org/10.1093/cje/bew044.

McLaren, H. J., K. R. Wong, K. N. Nguyen, and K. N. D. Mahamadachchi, 2020: Covid-19 and women's triple burden: Vignettes from Sri Lanka, Malaysia, Vietnam and Australia. *Soc. Sci.*, **9**, 87, https://doi.org/10.3390/SOCSCI9050087.

McMakin, A. H., E. L. Malone, and R. E. Lundgren, 2002: Motivating Residents to Conserve Energy without Financial Incentives. *Environ. Behav.*, **34**, 848–863, https://doi.org/10.1177/001391602237252.

McMeekin, A., and D. Southerton, 2012: Sustainability transitions and final consumption: Practices and socio-technical systems. *Technol. Anal. Strateg. Manag.*, **24**, 345–361, https://doi.org/10.1080/09537325.2012.663960.

——, F. W. Geels, and M. Hodson, 2019: Mapping the winds of whole system reconfiguration: Analysing low-carbon transformations across production, distribution and consumption in the UK electricity system (1990-2016). *Res. Policy*, **48**, 1216–1231, https://doi.org/10.1016/j.respol.2018.12.007.

Meade, N., and T. Islam, 2006: Modelling and forecasting the diffusion of innovation - A 25-year review. *Int. J. Forecast.*, **22**, 519–545, https://doi.org/10.1016/j.ijforecast.2006.01.005.

Meadowcroft, J., 2011: Environmental Innovation and Societal Transitions Engaging with the politics of sustainability transitions. *Environ. Innov. Soc. Transitions*, **1**, 70–75, https://doi.org/10.1016/j.eist.2011.02.003.

Mearns, R., and A. Norton, 2009: *Social dimensions of climate change : equity and vulnerability in a warming world*. World Bank, 319 pp.

Meckling, J., T. Sterner, and G. Wagner, 2017: Policy sequencing toward decarbonization. *Nat. Energy*, **2**, 918–922, https://doi.org/10.1038/s41560-017-0025-8.

Medina, M. A. P., and A. G. Toledo-Bruno, 2016: Ecological footprint of university students: Does gender matter? *Autumn 2016 Glob. J. Environ. Sci. Manag.*, **2**, 339–344, https://doi.org/10.22034/gjesm.2016.02.04.003.

Méjean, A., C. Guivarch, J. Lefèvre, and M. Hamdi-Cherif, 2019: The transition in energy demand sectors to limit global warming to 1.5 °C. *Energy Effic.*, **12**, 441–462, https://doi.org/10.1007/s12053-018-9682-0.

Mekuriaw, A., 2017: Towards a methodological approach to document and analyze local knowledge of climate change: with evidence from Rift Balley and Blue Nile Basins, Ethiopia. *Climate Change Adaptation in Africa: Fostering Resilience and Capacity to Adapt*, W. Leal Filho, S. Belay, J. Kalangu, W. Menas, P. Munishi, and K. Musiyiwa, Eds., Springer, 689–710.

Mekuriaw Bizuneh, A., 2013: *Climate Variability and Change in the Rift Valley and Blue Nile Basin ... - Abate Mekuriaw Bizuneh - Google Books*. Logos Verlag,.

Melville, N. P., 2010: Information Systems Innovation for Environmental Sustainability. *MIS Q.*, **34**, 1–21, https://doi.org/10.2307/20721412.

Mendoza, M. E. B., and O. G. M. Roa, 2014: Educomunicación y medio ambiente: en la búsqueda y construcción de fisuras. *Rev. Investig. Agrar. y Ambient.*, **5**, https://doi.org/10.22490/21456453.960.

Mercure, J. F., and Coauthors, 2018: Environmental impact assessment for climate change policy with the simulation-based integrated assessment model E3ME-FTT-GENIE. *Energy Strateg. Rev.*, **20**, 195–208, https://doi.org/10.1016/j.esr.2018.03.003.

Merlin, L. A., 2019: Transportation Sustainability Follows From More People in Fewer Vehicles, Not Necessarily Automation. *J. Am. Plan. Assoc.*, **85**, 501–510, https://doi.org/10.1080/01944363.2019.1637770.

Messner, D., 2015: A social contract for low carbon and sustainable development: Reflections on non-linear dynamics of social realignments and technological innovations in transformation processes. *Technol. Forecast. Soc. Chang.*, **98**, 260–270, https://doi.org/10.1016/j.techfore.2015.05.013.

Mi, Z., and D. M. Coffman, 2019: The sharing economy promotes sustainable societies. *Nat. Commun.*, **10**, 5–7, https://doi.org/10.1038/s41467-019-09260-4.

van Mierlo, B., and P. J. Beers, 2020: Understanding and governing learning in sustainability transitions: A review. *Environ. Innov. Soc. Transitions*, **34**, 255–269, https://doi.org/https://doi.org/10.1016/j.eist.2018.08.002.

Mikucka, M., F. Sarracino, and J. K. Dubrow, 2017: When Does Economic Growth Improve Life Satisfaction? Multilevel Analysis of the Roles of Social Trust and Income Inequality in 46 Countries, 1981–2012. *World Dev.*, **93**, 447–459, https://doi.org/10.1016/j.worlddev.2017.01.002.

Milfont, T. L., J. Wilson, and P. Diniz, 2012: Time perspective and environmental engagement: A meta-analysis. *Int. J. Psychol.*, **47**, 325–334, https://doi.org/10.1080/00207594.2011.647029.

Milkoreit, M., 2017: Imaginary politics: Climate change and making the future. *Elementa*, **5**, https://doi.org/10.1525/elementa.249.

Miller, D. T., and D. A. Prentice, 2016: Changing Norms to Change Behavior. *Annu. Rev. Psychol.*, **67**, 339–361, https://doi.org/10.1146/annurev-psych-010814-015013.

Millot, A., R. Doudard, T. Le Gallic, F. Briens, E. Assoumou, and N. Maïzi, 2018: France 2072: Lifestyles at the core of carbon neutrality challenges. *Limiting Global Warming to Well Below 2 °C: Energy System Modelling and Policy Development. Lecture Notes in Energy 54*, G. Giannakidis, K.B. Karlsson, M. Labriet, and B. Gallachóir, Eds., Vol. 64 of, Springer Verlag, 173–

190.

Mills, B., and J. Schleich, 2012: Residential energy-efficient technology adoption, energy conservation, knowledge, and attitudes: An analysis of European countries. *Energy Policy*, **49**, 616–628, https://doi.org/10.1016/J.ENPOL.2012.07.008.

Millward-Hopkins, J., J. K. Steinberger, N. D. Rao, and Y. Oswald, 2020: Providing decent living with minimum energy: A global scenario. *Glob. Environ. Chang.*, **65**, 102168, https://doi.org/10.1016/j.gloenvcha.2020.102168.

MINTEL, 2019: MINTEL Global New Products Database. *Mintel Glob. New Prod. database*,. https://www.mintel.com/global-new-products-database/features (Accessed November 27, 2020).

Mitchell, J. K., 2015: Governance of megacity disaster risks: Confronting the contradictionshapte. *Risk Governance: The Articulation of Hazard, Politics and Ecology*, U. Fra.Paleo, Ed., Springer Netherlands, 413–439.

——, 2019: Growing the Constituency: A Twenty-First Century Challenge. *Disaster Research and the Second Environmental Crisis*, J. Kendra, S.G. Knowles, and T. Wachtendorf, Eds., Springer , 161–188.

Moberg, K. R., C. Aall, F. Dorner, E. Reimerson, J. P. Ceron, B. Sköld, B. K. Sovacool, and V. Piana, 2019: Mobility, food and housing: responsibility, individual consumption and demand-side policies in European deep decarbonisation pathways. *Energy Effic.*, **12**, 497–519, https://doi.org/10.1007/s12053-018-9708-7.

Moeckel, R., and R. Lewis, 2017: Two decades of smart growth in Maryland (U.S.A): impact assessment and future directions of a national leader. *Urban, Plan. Transp. Res.*, **5**, 22–37, https://doi.org/10.1080/21650020.2017.1304240.

Möhlmann, M., 2015: Collaborative consumption: determinants of satisfaction and the likelihood of using a sharing economy option again. *J. Consum. Behav.*, **14**, 193–207, https://doi.org/10.1002/cb.1512.

Mokhtarian, P. L., 2002: Telecommunications and travel: The case for complementarity. *J. Ind. Ecol.*, **6**, 43–57, https://doi.org/10.1162/108819802763471771.

Monasterolo, I., and M. Raberto, 2019: The impact of phasing out fossil fuel subsidies on the low-carbon transition. *Energy Policy*, **124**, 355–370, https://doi.org/10.1016/j.enpol.2018.08.051.

Mondal, M. A. H., E. Bryan, C. Ringler, D. Mekonnen, and M. Rosegrant, 2018: Ethiopian energy status and demand scenarios: Prospects to improve energy efficiency and mitigate GHG emissions. *Energy*, **149**, 161–172, https://doi.org/10.1016/j.energy.2018.02.067.

Mont, O., Y. V. Palgan, K. Bradley, and L. Zvolska, 2020: A decade of the sharing economy: Concepts, users, business and governance perspectives. *J. Clean. Prod.*, **269**, 122215, https://doi.org/10.1016/j.jclepro.2020.122215.

Moore, F. C., and D. B. Diaz, 2015: Temperature impacts on economic growth warrant stringent mitigation policy. *Nat. Clim. Chang.*, **5**, 127–131, https://doi.org/10.1038/nclimate2481.

Moran, D., R. Wood, E. Hertwich, K. Mattson, J. F. D. Rodriguez, K. Schanes, and J. Barrett, 2020: Quantifying the potential for consumer-oriented policy to reduce European and foreign carbon emissions. *Clim. Policy*, **20**, https://doi.org/10.1080/14693062.2018.1551186.

Moreau, V., M. Sahakian, P. van Griethuysen, and F. Vuille, 2017: Coming Full Circle: Why Social and Institutional Dimensions Matter for the Circular Economy. *J. Ind. Ecol.*, **21**, 497–506, https://doi.org/10.1111/jiec.12598.

Morello Frosch, R., M. Pastor, J. Sadd, and S. Shonkoff, 2009: *The Climate Gap: Inequalities in How Climate Change Hurts Americans & How to Close the Gap*. https://dornsife.usc.edu/pere/climategap/ (Accessed December 3, 2020).

Morris, C., and A. Jungjohann, 2016: *Energy democracy: Germany's Energiewende to renewables*.

Springer,.

Morris, C., J. Kirwan, and R. Lally, 2014: Less Meat Initiatives : An Initial Exploration of a Diet-focused Social Innovation in Transitions to a More Sustainable Regime of Meat Provisioning. *Int. J. Sociol. Agric. Food*, **21**, 189–208.

Morstyn, T., N. Farrell, S. J. Darby, and M. D. McCulloch, 2018: Using peer-to-peer energy-trading platforms to incentivize prosumers to form federated power plants. *Nat. Energy*, **3**, https://doi.org/10.1038/s41560-017-0075-y.

Mortensen, C. R., R. Neel, R. B. Cialdini, C. M. Jaeger, R. P. Jacobson, and M. M. Ringel, 2019: Trending Norms: A Lever for Encouraging Behaviors Performed by the Minority. *Soc. Psychol. Personal. Sci.*, **10**, 201–210, https://doi.org/10.1177/1948550617734615.

Moser, S. C., 2009: Communicating Climate Change and Motivating Civic Action: Renewing, Activating, and Building Democracies. *Changing Climates in North American Politics: Institutions, Policymaking, and Multilevel Governance*, H. Selin and S.D. VanDeveer, Eds., The MIT Press, 283–302.

Mosler, H. J., and H. Gutscher, 2004: Die Förderung von Energiesparverhalten durch Kombination von instruierter Selbstverbreitung mit Interventionsinstrumenten. [Promoting Energy Conserving Behaviour by Combining Instructed Self-Diffusion with Intervention Instruments]. *Umweltpsychologie*, **8**, 50–65.

Muchie, M., S. Bhaduri, A. Baskaran, and F. A. Sheikh, 2016: *Informal Sector Innovations: Insights from the Global South*. M. Muchie, S. Bhaduri, A. Baskaran, and F.A. Sheikh, Eds. Routledge,.

Mulder, L. B., E. Van Dijk, D. De Cremer, and H. A. M. Wilke, 2006: Undermining trust and cooperation: The paradox of sanctioning systems in social dilemmas. *J. Exp. Soc. Psychol.*, **42**, 147–162, https://doi.org/10.1016/j.jesp.2005.03.002.

Muller, A., and Coauthors, 2017: Strategies for feeding the world more sustainably with organic agriculture. *Nat. Commun.*, **8**, https://doi.org/10.1038/s41467-017-01410-w.

Mulugetta, Y., E. Ben Hagan, and D. Kammen, 2019: *Energy access for sustainable development*. Institute of Physics Publishing,.

Mundaca, L., H. Busch, and S. Schwer, 2018: 'Successful' low-carbon energy transitions at the community level? An energy justice perspective. *Appl. Energy*, **218**, 292–303, https://doi.org/10.1016/j.apenergy.2018.02.146.

——, D. Ürge-Vorsatz, and C. Wilson, 2019: Demand-side approaches for limiting global warming to 1.5 °C. *Energy Effic.*, **12**, 343–362, https://doi.org/10.1007/s12053-018-9722-9.

Murray, A., K. Skene, and K. Haynes, 2017: The Circular Economy: An Interdisciplinary Exploration of the Concept and Application in a Global Context. *J. Bus. Ethics*, **140**, 369–380, https://doi.org/10.1007/s10551-015-2693-2.

Muttitt, G., and S. Kartha, 2020: Equity, climate justice and fossil fuel extraction: principles for a managed phase out. *Clim. Policy*, 1–19, https://doi.org/10.1080/14693062.2020.1763900.

Mylan, J., 2018: Sustainable consumption in everyday life: A qualitative study of UK consumer experiences of meat reduction. *Sustainability*, **10**, 2307, https://doi.org/10.3390/su10072307.

Myrick, J. G., and S. Evans Comfort, 2019: The Pope May Not Be Enough: How Emotions, Populist Beliefs, and Perceptions of an Elite Messenger Interact to Influence Responses to Climate Change Messaging. *Mass Commun. Soc.*, 1–21, https://doi.org/10.1080/15205436.2019.1639758.

Nabi, A. A., & Zubair, A. Shahid, & Khurram, A. Mubashir, A. Ali, A. Iqbal, and K. Zaman, 2020: Relationship between population growth, price level, poverty incidence, and carbon emissions in a panel of 98 countries. *Environ. Sci. Pollut. Res.*, **27**, 31778–31792, https://doi.org/10.1007/s11356-020-08465-1.

Nadel, Steven, and L. Ungar, 2019: *Halfway there: Energy efficiency can cut energy use and* *greenhouse gas emissions in half by 2050*. 70 pp. https://www.aceee.org/sites/default/files/publications/researchreports/u1907.pdf.

Nagel, J., 2015: *Gender and climate change : Impacts, science, policy*. Routledge, 249 pp.

Nagy, D., J. Schuessler, and A. Dubinsky, 2016: Defining and identifying disruptive innovations. *Ind. Mark. Manag.*, **57**, https://doi.org/10.1016/j.indmarman.2015.11.017.

Nakićenović, N., and Coauthors, 1993: Long term strategies for mitigating global warming. *Energy*, **18**, 401–609, https://doi.org/10.1016/0360-5442(93)90019-A.

——, A. Grubler, H. Ishitani, T. Johansson, G. Marland, J. R. Moreira, and Rogn, 1996: Energy Primer. *Climate Change 1995: Impacts, Adaptations and Mitigation of Climate Change: Scientific-Technical Analyses. Contribution of Working Group II to the Second Assessment Report of the Intergovernmental Panel on Climate Change,* R.T. Watson, M.C. Zinyowera, and R.H. Moss, Eds., Cambridge University Press, 75–94.

Namazu, M., and H. Dowlatabadi, 2015: Characterizing the GHG emission impacts of carsharing: A case of Vancouver. *Environ. Res. Lett.*, **10**, https://doi.org/10.1088/1748-9326/10/12/124017.

Nandi, S., J. Sarkis, A. A. Hervani, and M. M. Helms, 2020: Redesigning Supply Chains using Blockchain-Enabled Circular Economy and COVID-19 Experiences. *Sustain. Prod. Consum.*, **27**, 10–22, https://doi.org/10.1016/j.spc.2020.10.019.

Nandy, B., G. Sharma, S. Garg, S. Kumari, T. George, Y. Sunanda, and B. Sinha, 2015: Recovery of consumer waste in India - A mass flow analysis for paper, plastic and glass and the contribution of households and the informal sector. *Resour. Conserv. Recycl.*, **101**, 167–181, https://doi.org/10.1016/j.resconrec.2015.05.012.

Nannestad, P., G. T. Svendsen, P. T. Dinesen, and K. M. Sønderskov, 2014: Do Institutions or Culture Determine the Level of Social Trust? The Natural Experiment of Migration from Non-western to Western Countries. *J. Ethn. Migr. Stud.*, **40**, 544–565, https://doi.org/10.1080/1369183X.2013.830499.

Napp, T. A., S. Few, A. Sood, D. Bernie, A. Hawkes, and A. Gambhir, 2019: The role of advanced demand-sector technologies and energy demand reduction in achieving ambitious carbon budgets. *Appl. Energy*, https://doi.org/10.1016/j.apenergy.2019.01.033.

Narayan, L., 2017: contextualizing unpaid care work and women empowerment. *Int. J. Appl. Res.*, **3**, 654–659.

Nasir, M. H. A., A. Genovese, A. A. Acquaye, S. C. L. Koh, and F. Yamoah, 2017: Comparing linear and circular supply chains: A case study from the construction industry. *Int. J. Prod. Econ.*, **183**, 443–457, https://doi.org/10.1016/j.ijpe.2016.06.008.

Navroz, D., 2019: *India in a Warming World: Integrating Climate Change and Development - Google Books*. N. Dubash, Ed. Oxford University Press,.

Nayak, B. P., C. Werthmann, and V. Aggarwal, 2015: Trust and cooperation among urban poor for transition to cleaner and modern cooking fuel. *Environ. Innov. Soc. Transitions*, **14**, 116–127, https://doi.org/10.1016/j.eist.2014.09.002.

Negawatt, A., 2018: *négaWatt scenario 2017-2050: A blueprint for a succesful energy transition in France*. https://negawatt.org/IMG/pdf/181128_negawatt-scenario_eng_12p.pdf.

Nelson, E. J., and Coauthors, 2013: Climate change's impact on key ecosystem services and the human well-being they support in the US. *Front. Ecol. Environ.*, **11**, 483–893, https://doi.org/10.1890/120312.

Nelson, R., and E. S. Phelps, 1966: Investment in Humans, Technological Diffusion, and Economic Growth. *Am. Econ. Rev.*, **56**, 69–75, https://doi.org/10.1016/b978-0-12-554002-5.50015-7.

Nemet, G. F., 2019: *How solar energy became cheap : A model for low-carbon innovation*. Routledge,.

Nepal, M., A. Nepal, and K. Grimsrud, 2010: Unbelievable but improved cookstoves are not helpful in reducing firewood demand in Nepal. *Environ. Dev. Econ.*, **16**, 1–23, https://doi.org/10.1017/S1355770X10000409.

Newman, P., and J. R. Kenworthy, 2015: *The End of Automobile Dependence: How Cities are Moving Beyond Car-based Planning*. Island Press, Ed. 320 pp.

——, T. Beatley, and H. Boyer, 2017: *Resilient Cities: Overcoming Fossil Fuel Dependence*. 2nd ed. Island Press, 264 pp.

Nexus Energy Software, 2006: *California Bill Analysis Pilot Final Report A Research Project Conducted as Part of the California Statewide Pricing Pilot (R) 02.06.001*. http://www.calmac.org/publications/ca_bill_analysis_pilot_final_04-06es.pdf (Accessed June 14, 2020).

Ng, W., and E. Diener, 2019: Affluence and Subjective Well-Being: Does Income Inequality Moderate their Associations? *Appl. Res. Qual. Life*, **14**, 155–170, https://doi.org/10.1007/s11482-017-9585-9.

Ngamaba, K. H., M. Panagioti, and C. J. Armitage, 2018: Income inequality and subjective well-being: a systematic review and meta-analysis. *Qual. Life Res.*, **27**, 577–596, https://doi.org/10.1007/s11136-017-1719-x.

Niamir, L., 2019: Behavioural Climate Change Mitigation: from individual energy choices to demand-side potential. University of Twente, 267 pp.

——, T. Filatova, A. Voinov, and H. Bressers, 2018: Transition to low-carbon economy: Assessing cumulative impacts of individual behavioral changes. *Energy Policy*, **118**, 325–345, https://doi.org/10.1016/j.enpol.2018.03.045.

——, O. Ivanova, and T. Filatova, 2020a: Economy-wide impacts of behavioral climate change mitigation: Linking agent-based and computable general equilibrium models. *Environ. Model. Softw.*, **134**, 104839, https://doi.org/10.1016/j.envsoft.2020.104839.

——, ——, ——, A. Voinov, and H. Bressers, 2020b: Demand-side solutions for climate mitigation: Bottom-up drivers of household energy behavior change in the Netherlands and Spain. *Energy Res. Soc. Sci.*, **62**, 101356, https://doi.org/https://doi.org/10.1016/j.erss.2019.101356.

——, G. Kiesewetter, F. Wagner, W. Schöpp, T. Filatova, A. Voinov, and H. Bressers, 2020c: Assessing the macroeconomic impacts of individual behavioral changes on carbon emissions. *Clim. Change*, **158**, 141–160, https://doi.org/https://doi.org/10.1007/s10584-019-02566-8.

Nielsen, K. R., L. A. Reisch, and J. Thøgersen, 2016: Sustainable user innovation from a policy perspective: a systematic literature review. *J. Clean. Prod.*, **133**, 65–77, https://doi.org/10.1016/j.jclepro.2016.05.092.

Nijland, H., and J. van Meerkerk, 2017: Mobility and environmental impacts of car sharing in the Netherlands. *Environ. Innov. Soc. Transitions*, **23**, 84–91, https://doi.org/10.1016/j.eist.2017.02.001.

Nilsson, A., C. J. Bergstad, L. Thuvander, D. Andersson, K. Andersson, and P. Meiling, 2014: Effects of continuous feedback on households' electricity consumption: Potentials and barriers. *Appl. Energy*, **122**, 17–23, https://doi.org/10.1016/j.apenergy.2014.01.060.

Nilsson, M., L. J. Nilsson, R. Hildingsson, J. Stripple, and P. O. Eikeland, 2011: The missing link: Bringing institutions and politics into energy future studies. *Futures*, **43**, 1117–1128, https://doi.org/10.1016/j.futures.2011.07.010.

——, and Coauthors, 2018: Mapping interactions between the sustainable development goals: lessons learned and ways forward. *Sustain. Sci.*, **13**, 1489–1503, https://doi.org/10.1007/s11625-018-0604-z.

Nisa, C. F., J. J. Bélanger, B. M. Schumpe, and D. G. Faller, 2019: Meta-analysis of randomised controlled trials testing behavioural interventions to promote household action on climate change. *Nat. Commun.*, **10**, 4545, https://doi.org/10.1038/s41467-019-12457-2.

Nolan, J. M., P. W. Schultz, R. B. Cialdini, N. J. Goldstein, and V. Griskevicius, 2008: Normative social influence is underdetected. *Personal. Soc. Psychol. Bull.*, **34**, 913–923, https://doi.org/10.1177/0146167208316691.

Noppers, E. H., K. Keizer, J. W. Bolderdijk, and L. Steg, 2014: The adoption of sustainable innovations: Driven by symbolic and environmental motives. *Glob. Environ. Chang.*, **25**, 52–62, https://doi.org/10.1016/j.gloenvcha.2014.01.012.

——, ——, M. Bockarjova, and L. Steg, 2015: The adoption of sustainable innovations: The role of instrumental, environmental, and symbolic attributes for earlier and later adopters. *J. Environ. Psychol.*, **44**, 74–84, https://doi.org/10.1016/j.jenvp.2015.09.002.

——, ——, M. Milovanovic, and L. Steg, 2016: The importance of instrumental, symbolic, and environmental attributes for the adoption of smart energy systems. *Energy Policy*, **98**, 12–18, https://doi.org/10.1016/j.enpol.2016.08.007.

Nordhaus, T., 2019: The Empty Radicalism of the Climate Apocalypse. *Issues Sci. Technol.*, **35**, 69–78.

Norouzi, N., G. Zarazua de Rubens, S. Choubanpishehzafar, and P. Enevoldsen, 2020: When pandemics impact economies and climate change: Exploring the impacts of COVID-19 on oil and electricity demand in China. *Energy Res. Soc. Sci.*, **68**, 101654, https://doi.org/10.1016/j.erss.2020.101654.

Norton, B., 2012: No Title. *Sav. Waste Energy Use Waste Anal. by End-Use*,. https://opiniondynamics.com/wp-content/uploads/2013/02/Opinion-Dynamics_Saving-Waste-Energy-Use-and-Waste-Analysis-By-End-Use.pdf (Accessed August 4, 2020).

Noy, K., and M. Givoni, 2018: Is ‘Smart Mobility’ Sustainable? Examining the Views and Beliefs of Transport’s Technological Entrepreneurs. *Sustainability*, **10**, 422, https://doi.org/10.3390/su10020422.

Nußholz, J. L. K., F. Nygaard Rasmussen, and L. Milios, 2019: Circular building materials: Carbon saving potential and the role of business model innovation and public policy. *Resour. Conserv. Recycl.*, **141**, 308–316, https://doi.org/10.1016/j.resconrec.2018.10.036.

Nyborg, K., and M. Rege, 2003: On social norms: the evolution of considerate smoking behavior. *J. Econ. Behav. Organ.*, **52**, 323–340, https://doi.org/10.1016/S0167-2681(03)00031-3.

——, and Coauthors, 2016: Social norms as solutions. *Science (80-.).*, **354**, 42–43, https://doi.org/10.1126/science.aaf8317.

O’Connor, N., 2017: Three connections between rising economic inequality and the rise of populism. *Irish Stud. Int. Aff.*, **28**, 29–43, https://doi.org/10.3318/isia.2017.28.5.

O’Neill, D. W., A. L. Fanning, W. F. Lamb, J. K. Steinberger, D. W. O’Neill, A. L. Fanning, W. F. Lamb, and J. K. Steinberger, 2018: A good life for all within planetary boundaries. *Nat. Sustain.*, **1**, 88–95, https://doi.org/10.1038/s41893-018-0021-4.

O’Neill, S. J., and N. Smith, 2014: Climate change and visual imagery. *Wiley Interdiscip. Rev. Clim. Chang.*, **5**, 73–87, https://doi.org/10.1002/wcc.249.

OECD, 2019: *Accelerating Climate Action: Refocusing Policies through a Well-being Lens*. 193 pp.

Oishi, S., K. Kushlev, and U. Schimmack, 2018: Progressive taxation, income inequality, and happiness. *Am. Psychol.*, **73**, 157–168, https://doi.org/10.1037/amp0000166.

Okereke, C., 2018: Equity and Justice in Polycentric Climate Governance. *Governing Climate Change*, A. Jordan, D. Huitema, H. Van Asselt, and J. Forster, Eds., Cambridge University Press, 320–337.

Okvat, H. A., and A. J. Zautra, 2011: Community Gardening: A Parsimonious Path to Individual, Community, and Environmental Resilience. *Am. J. Community Psychol.*, **47**, 374–387, https://doi.org/10.1007/s10464-010-9404-z.

Olatunji, O. O., O. O. Ayo, S. Akinlabi, F. Ishola, N. Madushele, and P. A. Adedeji, 2019: Competitive advantage of carbon efficient supply chain in manufacturing industry. *J. Clean. Prod.*, **238**, 117937, https://doi.org/10.1016/j.jclepro.2019.117937.

Oliva, R., and R. Kallenberg, 2003: Managing the transition from products to services. *Int. J. Serv. Ind. Manag.*, **14**, 160–172, https://doi.org/10.1108/09564230310474138.

Olsson, L., and Coauthors, 2019: Climate change and land. Chapter 4: Land Degradation. *IPCC Spec. Rep. Glob. Warm. 1.5 °C*, 186.

Onyige, C. D., 2017: Women, indigenous knowledge and climate change in Nigeria. *Osun Sociol. Rev.*, **4**.

Oparaocha, S., and S. Dutta, 2011: Gender and energy for sustainable development. *Curr. Opin. Environ. Sustain.*, **3**, 265–271, https://doi.org/10.1016/j.cosust.2011.07.003.

Oreskes, N., and E. M. Conway, 2011: *Merchants of Doubt: How a Handful of Scientists Obscured the Truth on Issues from Tobacco Smoke to Global Warming*. 1st ed. Bloomsbury Press,.

Orsini, F., and P. Marrone, 2019: Approaches for a low-carbon production of building materials: A review. *J. Clean. Prod.*, **241**, https://doi.org/10.1016/j.jclepro.2019.118380.

Ortega-Ruiz, G., A. Mena-Nieto, and J. E. García-Ramos, 2020: Is India on the right pathway to reduce CO2 emissions? Decomposing an enlarged Kaya identity using the LMDI method for the period 1990–2016. *Sci. Total Environ.*, **737**, 139638, https://doi.org/10.1016/j.scitotenv.2020.139638.

Ortiz, J., N. Casquero-Modrego, and J. Salom, 2019: Health and related economic effects of residential energy retrofitting in Spain. *Energy Policy*, **130**, 375–388, https://doi.org/10.1016/j.enpol.2019.04.013.

Orviska, M., A. Caplanova, and J. Hudson, 2014: The Impact of Democracy on Well-being. *Soc. Indic. Res.*, **115**, 493–508, https://doi.org/10.1007/s11205-012-9997-8.

Osuoka, A., and A. Haruna, 2019: *Boiling Over: Global Warming, Hunger and Violence in the Lake Chad Basin*. http://saction.org/books/boiling_over.pdf (Accessed July 4, 2019).

Oswald, Y., A. Owen, and J. K. Steinberger, 2020: Large inequality in international and intranational energy footprints between income groups and across consumption categories. *Nat. Energy*, **5**, 231–239, https://doi.org/10.1038/s41560-020-0579-8.

Ott, J. C., 2011: Government and Happiness in 130 Nations: Good Governance Fosters Higher Level and More Equality of Happiness. *Soc. Indic. Res.*, **102**, 3–22, https://doi.org/10.1007/s11205-010-9719-z.

Otto, I. M., K. M. Kim, N. Dubrovsky, and W. Lucht, 2019: Shift the focus from the super-poor to the super-rich. *Nat. Clim. Chang.*, **9**, 82–84, https://doi.org/10.1038/s41558-019-0402-3.

——, and Coauthors, 2020: Social tipping dynamics for stabilizing Earth’s climate by 2050. *Proc. Natl. Acad. Sci. U. S. A.*, **117**, 2354–2365, https://doi.org/10.1073/pnas.1900577117.

Overland, I., and B. K. Sovacool, 2020: The misallocation of climate research funding. *Energy Res. Soc. Sci.*, **62**, 101349, https://doi.org/10.1016/j.erss.2019.101349.

Owens, S., 2000: ‘Engaging the Public’: Information and Deliberation in Environmental Policy. *Environ. Plan. A Econ. Sp.*, **32**, 1141–1148, https://doi.org/10.1068/a3330.

Özcan, B., and C. Bjørnskov, 2011: Social trust and human development. *J. Socio. Econ.*, **40**, 753–762, https://doi.org/10.1016/j.socec.2011.08.007.

Ozturk, I., 2010: A literature survey on energy-growth nexus. *Energy Policy*, **38**, 340–349, https://doi.org/10.1016/j.enpol.2009.09.024.

Pachauri, S., 2007: *An energy analysis of household consumption: Changing patterns of direct and* *indirect use in India*. 1st ed. Springer Netherlands, 1–12 pp.

——, and D. Spreng, 2002: Direct and indirect energy requirements of households in India. *Energy Policy*, **30**, 511–523, https://doi.org/10.1016/S0301-4215(01)00119-7.

Pacheco, E. B. A. V., L. M. Ronchetti, and E. Masanet, 2012: An overview of plastic recycling in Rio de Janeiro. *Resour. Conserv. Recycl.*, https://doi.org/10.1016/j.resconrec.2011.12.010.

Pagliano, L., and S. Erba, 2019: Energy sufficiency in (strongly intertwined) building and city design - Examples for temperate and Mediterranean climates. *Eceee Summer Study Proc.*, **2019-June**, 1505–1514.

Pahle, M., D. Burtraw, C. Flachsland, N. Kelsey, E. Biber, J. Meckling, O. Edenhofer, and J. Zysman, 2018: Sequencing to ratchet up climate policy stringency. *Nat. Clim. Chang.*, **8**, 861–867, https://doi.org/10.1038/s41558-018-0287-6.

Pan, X., H. Wang, Z. Wang, L. L. Lin, Q. Zhang, X. Zheng, and W. Chen, 2019: Carbon Palma Ratio : A new indicator for measuring the distribution inequality of carbon emissions among individuals. *J. Clean. Prod.*, **241**, 118418, https://doi.org/10.1016/j.jclepro.2019.118418.

Pant, K. P., S. K. Pattanayak, and M. B. M. Thakuri, 2014: Climate change, cookstoves and coughs and colds: Thinking global acting locally in rural Nepal. *Environment and Development Economics: Essays in Honour of Sir Partha Dasgupta*, S. Barrett, K.-G. Mäler, and E.S. Maskin, Eds., Oxford University Press, 145–168.

Papa, R., A. Galderisi, M. C. Vigo Majello, and E. Saretta, 2015: Smart and Resilient Cities. A Systemic Approach for Developing Cross-sectoral Strategies in the Face of Climate Change - CNR Solar. *TeMA J. L. Use, Mobil. Environ.*, **8**, 19–49.

Parag, Y., and K. B. Janda, 2014: More than filler: Middle actors and socio-technical change in the energy system from the "middle-out." *Energy Res. Soc. Sci.*, **3**, 102–112, https://doi.org/10.1016/j.erss.2014.07.011.

Parente, R. C., J.-M. G. Geleilate, and K. Rong, 2018: The Sharing Economy Globalization Phenomenon: A Research Agenda. *J. Int. Manag.*, **24**, 52–64, https://doi.org/10.1016/J.INTMAN.2017.10.001.

Parker, D. S., D. Hoak, and J. Cummings, 2008: *Pilot Evaluation of Energy Savings from Residential Energy Demand Feedback Devices*. 1219080, FSEC–CR–1742–08 pp.

Parker, S., and M. I. Bhatti, 2020: Dynamics and drivers of per capita CO2 emissions in Asia. *Energy Econ.*, **89**, 104798, https://doi.org/10.1016/j.eneco.2020.104798.

Pascale, A., S. Chakravarty, P. Lant, S. Smart, and C. Greig, 2020: The rise of (sub)nations? Sub-national human development, climate targets, and carbon dioxide emissions in 163 countries. *Energy Res. Soc. Sci.*, **68**, 101546, https://doi.org/10.1016/j.erss.2020.101546.

Patel, J. A., F. B. H. Nielsen, A. A. Badiani, S. Assi, V. A. Unadkat, B. Patel, R. Ravindrane, and H. Wardle, 2020: Poverty, inequality and COVID-19: the forgotten vulnerable. *Public Health*, **183**, 110–111, https://doi.org/10.1016/j.puhe.2020.05.006.

Patra, S. K., M. Muchie, S. K. Patra, and M. Muchie, 2017: Science, technology and innovation in BRICS countries: Introduction to the special issue. *African J. Sci. Technol. Innov. Dev.*, **9**, 499–501, https://doi.org/10.1080/20421338.2017.1380586.

Pattanayak, S. K., and Coauthors, 2019: Experimental evidence on promotion of electric and improved biomass cookstoves. *Proc. Natl. Acad. Sci. U. S. A.*, **116**, 13282–13287, https://doi.org/10.1073/pnas.1808827116.

Patterson, J. J., and D. Huitema, 2019: Institutional innovation in urban governance: The case of climate change adaptation. *J. Environ. Plan. Manag.*, **62**, 374–398, https://doi.org/10.1080/09640568.2018.1510767.

Pauliuk, S., A. Arvesen, K. Stadler, and E. G. Hertwich, 2017: Industrial ecology in integrated assessment models. *Nat. Clim. Chang.*, https://doi.org/10.1038/nclimate3148.

——, N. Heeren, P. Berrill, T. Fishman, A. Nistad, Q. Tu, P. Wolfram, and E. Hertwich, 2021: Global Scenarios of Resource and Emissions Savings from Systemic Material Efficiency in Buildings and Cars. *Nat. Commun.*, **submitted**, https://doi.org/https://doi.org/10.21203/rs.3.rs-93217/v1.

Paz, M., A. Avendaño, A. Caballero, V. Gozalo, and M. Paz, 2015: *Joining the dots of informality and climate change: a discussion paper for practitioners*. 1–40 pp. www.kas.de/energie-klima-lateinamerika/ (Accessed June 11, 2020).

Pearce, W., S. Niederer, S. M. Özkula, and N. Sánchez Querubín, 2019: The social media life of climate change: Platforms, publics, and future imaginaries. *Wiley Interdiscip. Rev. Clim. Chang.*, **10**, https://doi.org/10.1002/wcc.569.

Pearse, R., 2017: Gender and climate change. *Wiley Interdiscip. Rev. Clim. Chang.*, **8**, e451, https://doi.org/10.1002/wcc.451.

Pearson-Stuttard, J., and Coauthors, 2017: Comparing effectiveness of mass media campaigns with price reductions targeting fruit and vegetable intake on US cardiovascular disease mortality and race disparities. *Am. J. Clin. Nutr.*, **106**, 199–206, https://doi.org/10.3945/ajcn.

Pearson, A. R., M. T. Ballew, S. Naiman, J. P. Schuldt, A. R. Pearson, M. T. Ballew, S. Naiman, and J. P. Schuldt, 2017: Race, Class, Gender and Climate Change Communication. *Oxford Research Encyclopedia of Climate Science*, Oxford University Press.

Pecl, G. T., and Coauthors, 2017: Biodiversity redistribution under climate change: Impacts on ecosystems and human well-being. *Science (80-.).*, **355**, https://doi.org/10.1126/science.aai9214.

Perch, L., 2011: *Mitigation of what and by what? Adaptation by whom and for whom? Dilemmas in delivering for the poor and the vulnerable in international climate policy*. www.ipc-undp.org (Accessed October 2, 2020).

Peres, R., E. Muller, and V. Mahajan, 2010: Innovation diffusion and new product growth models: A critical review and research directions. *Int. J. Res. Mark.*, **27**, 91–106, https://doi.org/10.1016/j.ijresmar.2009.12.012.

Perez, C., E. M. Jones, P. Kristjanson, L. Cramer, P. K. Thornton, W. Förch, and C. Barahona, 2015: How resilient are farming households and communities to a changing climate in Africa? A gender-based perspective. *Glob. Environ. Chang.*, **34**, 95–107, https://doi.org/10.1016/j.gloenvcha.2015.06.003.

Perkins, P. E. (Ellie., 2019: Climate justice, commons, and degrowth. *Ecol. Econ.*, **160**, 183–190, https://doi.org/10.1016/j.ecolecon.2019.02.005.

Perkins, R., 2003: Environmental leapfrogging in developing countries: A critical assessment and reconstruction. *Nat. Resour. Forum*, **27**, 177–188, https://doi.org/10.1111/1477-8947.00053.

Perlaviciute, G., G. Schuitema, P. Devine-Wright, and B. Ram, 2018: At the heart of a sustainable energy transition: The public acceptability of energy projects. *IEEE Power Energy Mag.*, **16**, 49–55, https://doi.org/10.1109/MPE.2017.2759918.

Permana, A. S., N. A. Aziz, and H. C. Siong, 2015: Is mom energy efficient? A study of gender, household energy consumption and family decision making in Indonesia. *Energy Res. Soc. Sci.*, **6**, 78–86, https://doi.org/10.1016/j.erss.2014.12.007.

Persky, J., 1995: Retrospectives: The Ethology of Homo Economicus. *J. Econ. Perspect.*, **9**, 221–231.

Peschiera, G., and J. E. Taylor, 2012: The impact of peer network position on electricity consumption in building occupant networks utilizing energy feedback systems. *Energy Build.*, **49**, 584–590, https://doi.org/10.1016/j.enbuild.2012.03.011.

Peters, M., and Coauthors, 2012: Tropical Forage-based Systems to Mitigate Greenhouse Gas Emissions. *Eco-Efficiency: From Vision to Reality*, C.H. Hershey, Ed., Cali, Colombia: International Center for Tropical Agriculture (CIAT).

Petheram, L., N. Stacey, and A. Fleming, 2015: Future sea changes: Indigenous women's preferences for adaptation to climate change on South Goulburn Island, Northern Territory (Australia). *Clim. Dev.*, **7**, 339–352, https://doi.org/10.1080/17565529.2014.951019.

Petrovic, N., J. Madrigano, and L. Zaval, 2014: Motivating mitigation: when health matters more than climate change. *Clim. Change*, **126**, 245–254, https://doi.org/10.1007/s10584-014-1192-2.

Pettifor, H., and C. Wilson, 2020: Low carbon innovations for mobility, food, homes and energy: A synthesis of consumer attributes. *Renew. Sustain. Energy Rev.*, **130**, https://doi.org/10.1016/j.rser.2020.109954.

Phan, M. B., 2008: We're All in This Together: Context, Contacts, and Social Trust in Canada. *Anal. Soc. Issues Public Policy*, **8**, 23–51, https://doi.org/10.1111/j.1530-2415.2008.00151.x.

Phillips, C. A., and Coauthors, 2020: Compound climate risks in the COVID-19 pandemic. *Nat. Clim. Chang.*, **10**, 586–588, https://doi.org/10.1038/s41558-020-0804-2.

Phuong, L. T. H., G. R. Biesbroek, and A. E. J. Wals, 2017: The interplay between social learning and adaptive capacity in climate change adaptation: A systematic review. *NJAS - Wageningen J. Life Sci.*, **82**, 1–9, https://doi.org/10.1016/j.njas.2017.05.001.

Pichert, D., and K. V. Katsikopoulos, 2008: Green defaults: Information presentation and pro-environmental behaviour. *J. Environ. Psychol.*, **28**, 63–73, https://doi.org/10.1016/j.jenvp.2007.09.004.

Pichler, P. P., I. S. Jaccard, U. Weisz, and H. Weisz, 2019: International comparison of health care carbon footprints. *Environ. Res. Lett.*, **14**, 064004, https://doi.org/10.1088/1748-9326/ab19e1.

Pigato, M. A., S. J. Black, D. Dussaux, Z. Mao, M. McKenna, R. Rafaty, and S. Touboul, 2020: *Technology Transfer and Innovation for Low-Carbon Development*. World Bank, 192 pp.

Piggot, G., 2018: The influence of social movements on policies that constrain fossil fuel supply. *Clim. Policy*, **18**, 942–954, https://doi.org/10.1080/14693062.2017.1394255.

——, M. Boyland, A. Down, and A. R. Torre, 2019: *Realizing a just and equitable transition away from fossil fuels*.

Pigou, A., 1920: *The Economics of Welfare*. Macmillan,.

Piketty, T., … L. C.-. eu/en/news/carbon-and-inequality-from-kyoto, and undefined 2015, Carbon and inequality: from Kyoto to Paris. *ledevoir.com*,.

Pizzigati, S., 2018: Can an Unequal Earth Beat Climate Change? *Inequality.org*,. https://inequality.org/great-divide/can-an-unequal-earth-beat-climate-change/ (Accessed July 4, 2019).

Polonsky, M. J., A. Vocino, S. L. Grau, R. Garma, and A. S. Ferdous, 2012: The impact of general and carbon-related environmental knowledge on attitudes and behaviour of US consumers. *J. Mark. Manag.*, **28**, 238–263, https://doi.org/10.1080/0267257X.2012.659279.

Porio, E., 2011: Vulnerability, adaptation, and resilience to floods and climate change-related risks among marginal, riverine communities in Metro Manila. *Asian J. Soc. Sci.*, **39**, 425–445, https://doi.org/10.1163/156853111X597260.

Porter, G., 2016: Mobilities in rural Africa: New connections, new challenges. *Ann. Am. Assoc. Geogr.*, **106**, 434–441, https://doi.org/10.1080/00045608.2015.1100056.

Porter, M. E., and M. R. Kramer, 2006: Strategy & Society: The link between competitive advantage and corporate social responsibility. *Harv. Bus. Rev.*, **84**, 78–92.

——, S. Stern, and M. Green, 2017: *Social Progress Index 2017*.

Potting, J., A. Hanemaaijer, R. Delahaye, J. Ganzevles, R. Hoekstra, and J. Lijzen, 2018: *Circular Economy : What We Want To Know and Can Measure*. 20 pp.

Pouri, M. J., and L. M. Hilty, 2018: Conceptualizing the Digital Sharing Economy in the Context of Sustainability. *Sustainability*, **10**, 4453, https://doi.org/10.3390/su10124453.

Powless, B., 2012: An Indigenous Movement to Confront Climate Change. *Globalizations*, **9**, 411–424, https://doi.org/10.1080/14747731.2012.680736.

Prata, J. C., A. L. P. Silva, T. R. Walker, A. C. Duarte, and T. Rocha-Santos, 2020: COVID-19 Pandemic Repercussions on the Use and Management of Plastics. *Environ. Sci. Technol.*, **54**, 7760–7765, https://doi.org/10.1021/acs.est.0c02178.

Prideaux, B., M. Thompson, and A. Pabel, 2020: Lessons from COVID-19 can prepare global tourism for the economic transformation needed to combat climate change. *Tour. Geogr.*, **22**, 667–678, https://doi.org/10.1080/14616688.2020.1762117.

Princen, T., 2003: Principles for Sustainability: From Cooperation and Efficiency to Sufficiency. *Glob. Environ. Polit.*, **3**, 33–50, https://doi.org/10.1162/152638003763336374.

Pucher, J., and R. Buehler, 2017: Cycling towards a more sustainable transport future. *Transp. Rev.*, **37**, 689–694, https://doi.org/10.1080/01441647.2017.1340234.

Puzzolo, E., H. Zerriffi, E. Carter, H. Clemens, H. Stokes, P. Jagger, J. Rosenthal, and H. Petach, 2019: Supply Considerations for Scaling Up Clean Cooking Fuels for Household Energy in Low- and Middle-Income Countries. *GeoHealth*, 2019GH000208, https://doi.org/10.1029/2019GH000208.

Quandt, A., 2019: Variability in perceptions of household livelihood resilience and drought at the intersection of gender and ethnicity. *Clim. Change*, **152**, 1–15, https://doi.org/10.1007/s10584-018-2343-7.

Quayson, M., C. Bai, and V. Osei, 2020: Digital Inclusion for Resilient Post-COVID-19 Supply Chains: Smallholder Farmer Perspectives. *IEEE Eng. Manag. Rev.*, **48**, 104–110, https://doi.org/10.1109/EMR.2020.3006259.

Le Quéré, C., and Coauthors, 2019: Drivers of declining CO 2 emissions in 18 developed economies. *Nat. Clim. Chang.*, **9**, 213–217, https://doi.org/10.1038/s41558-019-0419-7.

——, and Coauthors, 2020: Temporary reduction in daily global CO2 emissions during the COVID-19 forced confinement. *Nat. Clim. Chang.*, **10**, 647–653, https://doi.org/10.1038/s41558-020-0797-x.

Rabbitt, N., and B. Ghosh, 2016: Economic and environmental impacts of organised Car Sharing Services: A case study of Ireland. *Res. Transp. Econ.*, **57**, 3–12, https://doi.org/10.1016/j.retrec.2016.10.001.

Rafaty, R., 2018: Perceptions of corruption, political distrust, and the weakening of climate policy. *Glob. Environ. Polit.*, **18**, 106–129, https://doi.org/10.1162/glep_a_00471.

Ramaswami, A., and Coauthors, 2017: Urban cross-sector actions for carbon mitigation with local health co-benefits in China. *Nat. Clim. Chang.*, **7**, 736–742, https://doi.org/10.1038/nclimate3373.

Rao, N., E. T. Lawson, W. N. Raditloaneng, D. Solomon, and M. N. Angula, 2019a: Gendered vulnerabilities to climate change: insights from the semi-arid regions of Africa and Asia. *Clim. Dev.*, **11**, 14–26, https://doi.org/10.1080/17565529.2017.1372266.

Rao, N. D., and P. Baer, 2012: “Decent Living” Emissions: A Conceptual Framework. *Sustainability*, **4**, 656–681, https://doi.org/10.3390/su4040656.

Rao, N. D., and S. Pachauri, 2017: Energy access and living standards: some observations on recent trends. *Environ. Res. Lett.*, **12**, 025011, https://doi.org/10.1088/1748-9326/aa5b0d.

Rao, N. D., and J. Min, 2018a: Decent Living Standards: Material Prerequisites for Human Wellbeing. *Soc. Indic. Res.*, **138**, 225–244, https://doi.org/10.1007/s11205-017-1650-0.

——, and ——, 2018b: Less global inequality can improve climate outcomes. *Wiley Interdiscip. Rev. Clim. Chang.*, **9**, https://doi.org/10.1002/wcc.513.

——, K. Riahi, and A. Grubler, 2014: Climate impacts of poverty eradication. *Nat. Clim. Chang.*, **4**, 749–751, https://doi.org/10.1038/nclimate2340.

——, J. Min, and A. Mastrucci, 2019b: Energy requirements for decent living in India, Brazil and South Africa. *Nat. Energy*, **4**, 1025–1032, https://doi.org/10.1038/s41560-019-0497-9.

Räty, R., and A. Carlsson-Kanyama, 2009: *Comparing energy use by gender, age and income in some European countries*. 40 pp. pp. https://www.compromisorse.com/upload/estudios/000/101/foir2800.pdf (Accessed September 12, 2019).

Räty, R., and A. Carlsson-Kanyama, 2010: Energy consumption by gender in some European countries. *Energy Policy*, **38**, 646–649, https://doi.org/https://doi.org/10.1016/j.enpol.2009.08.010.

Rausch, S., G. E. Metcalf, and J. M. Reilly, 2011: Distributional impacts of carbon pricing: A general equilibrium approach with micro-data for households. *Energy Econ.*, **33**, https://doi.org/10.1016/j.eneco.2011.07.023.

Raven, R., and G. Verbong, 2007: Multi-regime interactions in the dutch energy sector: The case of combined heat and power technologies in the Netherlands 1970-2000. *Technol. Anal. Strateg. Manag.*, **19**, 491–507, https://doi.org/10.1080/09537320701403441.

——, F. Kern, B. Verhees, and A. Smith, 2016: Niche construction and empowerment through socio-political work. A meta-analysis of six low-carbon technology cases. *Environ. Innov. Soc. Transitions*, **18**, 164–180, https://doi.org/10.1016/j.eist.2015.02.002.

Raven, R. P. J. M., E. Heiskanen, M. Hodson, and B. Brohmann, 2008: The Contribution of Local Experiments and Negotiation Processes to Field-Level Learning in Emerging (Niche) Technologies Meta-Analysis of 27 New Energy Projects in Europe. *Bull. Sci. Technol. Soc.*, **28**, 464–477, https://doi.org/10.1177/0270467608317523.

Reckien, D., F. Creutzig, B. Fernandez, S. Lwasa, M. Tovar-Restrepo, D. Mcevoy, and D. Satterthwaite, 2017: Climate change, equity and the Sustainable Development Goals: an urban perspective. *Environ. Urban.*, **29**, 159–182, https://doi.org/10.1177/0956247816677778.

Requena, F., 2016: Rural–Urban Living and Level of Economic Development as Factors in Subjective Well-Being. *Soc. Indic. Res.*, **128**, 693–708, https://doi.org/10.1007/s11205-015-1051-1.

Resurrección, B. P., 2013: Persistent women and environment linkages in climate change and sustainable development agendas. *Womens. Stud. Int. Forum*, **40**, 33–43, https://doi.org/10.1016/j.wsif.2013.03.011.

Retamal, M., 2019: Collaborative consumption practices in Southeast Asian cities: Prospects for growth and sustainability. *J. Clean. Prod.*, **222**, 143–152, https://doi.org/https://doi.org/10.1016/j.jclepro.2019.02.267.

Reusser, D., T. Lissner, P. Pradhan, A. Holsten, D. Rybski, and J. P. Kropp, 2013: Relating climate compatible development and human livelihood. *Energy Procedia*, Vol. 40 of, Elsevier Ltd, 192–201.

Reyes-García, V., R. Babigumira, A. Pyhälä, S. Wunder, F. Zorondo-Rodríguez, and A. Angelsen, 2016: Subjective Wellbeing and Income: Empirical Patterns in the Rural Developing World. *J. Happiness Stud.*, **17**, 773–791, https://doi.org/10.1007/s10902-014-9608-2.

Ricci, M., 2015: Bike sharing: A review of evidence on impacts and processes of implementation and operation. *Res. Transp. Bus. Manag.*, **15**, 28–38, https://doi.org/10.1016/j.rtbm.2015.03.003.

Richards, M., 2003: *Poverty reduction, equity and climate change: challenges for global governance*. https://www.odi.org/sites/odi.org.uk/files/odi-assets/publications-opinion-files/2792.pdf (Accessed December 17, 2019).

Richards, T. J., and S. F. Hamilton, 2018: Food waste in the sharing economy. *Food Policy*, **75**, 109–123, https://doi.org/https://doi.org/10.1016/j.foodpol.2018.01.008.

Rietmann, N., and T. Lieven, 2019: How policy measures succeeded to promote electric mobility – Worldwide review and outlook. *J. Clean. Prod.*, **206**, 66–75, https://doi.org/10.1016/j.jclepro.2018.09.121.

Ritchie, H., D. S. Reay, and P. Higgins, 2018: Potential of Meat Substitutes for Climate Change Mitigation and Improved Human Health in High-Income Markets. *Front. Sustain. Food Syst.*, **2**, 16, https://doi.org/10.3389/fsufs.2018.00016.

Roberts, C., and F. W. Geels, 2019: Conditions for politically accelerated transitions: Historical institutionalism, the multi-level perspective, and two historical case studies in transport and agriculture. *Technol. Forecast. Soc. Chang.*, **140**, 221–240, https://doi.org/10.1016/j.techfore.2018.11.019.

——, ——, M. Lockwood, P. Newell, H. Schmitz, B. Turnheim, and A. Jordan, 2018: The politics of accelerating low-carbon transitions: Towards a new research agenda. *Energy Res. Soc. Sci.*, **44**, 304–311, https://doi.org/10.1016/j.erss.2018.06.001.

Roberts, J. C. D., 2017: Discursive destabilisation of socio-technical regimes: Negative storylines and the discursive vulnerability of historical American railroads. *Energy Res. Soc. Sci.*, **31**, 86–99, https://doi.org/10.1016/j.erss.2017.05.031.

Robinson, J., 2007: The effect of Electricity-Use Feedback on Residential Consumption: A Case Study of Customers with Smart Meters in Milton, Ontario. University of Waterloo, .

Roesler, T., and M. Hassler, 2019: Creating niches – The role of policy for the implementation of bioenergy village cooperatives in Germany. *Energy Policy*, **124**, 95–101, https://doi.org/10.1016/j.enpol.2018.07.012.

Rogelj, J., and Coauthors, 2018: Mitigation pathways compatible with 1.5°C in the context of sustainable development. *Global Warming of 1.5 °C an IPCC special report on the impacts of global warming of 1.5 °C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change*.

Rogelj, J., P. M. Forster, E. Kriegler, C. J. Smith, and R. Séférian, 2019: Estimating and tracking the remaining carbon budget for stringent climate targets. *Nature*, **571**, 335–342, https://doi.org/10.1038/s41586-019-1368-z.

Rogers, E. M., 2003: *Diffusion of Innovations*. Fifth edit. Free Press of Glencoe and Macmillan, 576 pp.

Rogge, K. S., and K. Reichardt, 2013: *Towards a more comprehensive policy mix conceptualization for environmental technological change: A literature synthesis*. 67 pp. http://hdl.handle.net/10419/77924www.econstor.eu.

Rogge, K. S., and K. Reichardt, 2016: Policy mixes for sustainability transitions: An extended concept and framework for analysis. *Res. Policy*, **45**, 1620–1635, https://doi.org/10.1016/j.respol.2016.04.004.

——, and P. Johnstone, 2017: Exploring the role of phase-out policies for low-carbon energy transitions: The case of the German Energiewende. *Energy Res. Soc. Sci.*, **33**, 128–137, https://doi.org/10.1016/j.erss.2017.10.004.

Rojas-Rueda, D., A. de Nazelle, O. Teixidó, and M. J. Nieuwenhuijsen, 2012: Replacing car trips by increasing bike and public transport in the greater Barcelona metropolitan area: A health impact assessment study. *Environ. Int.*, **49**, 100–109, https://doi.org/10.1016/j.envint.2012.08.009.

Rolffs, P., D. Ockwell, and R. Byrne, 2015: Beyond technology and finance: pay-as-you-go sustainable energy access and theories of social change. *Environ. Plan. A*, **47**, 2609–2627, https://doi.org/10.1177/0308518X15615368.

Røpke, I., 2009: Theories of practice - New inspiration for ecological economic studies on consumption. *Ecol. Econ.*, **68**, 2490–2497, https://doi.org/10.1016/j.ecolecon.2009.05.015.

Rosane, O., 2019: 7.6 Million Join Week of Global Climate Strikes - EcoWatch. *EcoWatch*,. https://www.ecowatch.com/global-climate-strikes-week-2640790405.html (Accessed December 1, 2020).

Rosenbloom, D., 2018: Framing low-carbon pathways: A discursive analysis of contending storylines surrounding the phase-out of coal-fired power in Ontario. *Environ. Innov. Soc. Transitions*, **27**, 129–145, https://doi.org/10.1016/j.eist.2017.11.003.

——, B. Haley, and J. Meadowcroft, 2018a: Critical choices and the politics of decarbonization pathways : Exploring branching points surrounding low-carbon transitions in Canadian electricity systems Energy Research & Social Science Critical choices and the politics of decarbonization pathways : . *Energy Res. Soc. Sci.*, **37**, 22–36, https://doi.org/10.1016/j.erss.2017.09.022.

——, J. Meadowcroft, S. Sheppard, S. Burch, and S. Williams, 2018b: Transition Experiments: Opening Up Low-Carbon Transition Pathways for Canada through Innovation and Learning. *Can. Public Policy*, **44**, 1–6, https://doi.org/10.3138/cpp.2018-020.

Rosenow, J., T. Fawcett, N. Eyre, and V. Oikonomou, 2016: Energy efficiency and the policy mix. *Build. Res. Inf.*, **44**, 562–574, https://doi.org/10.1080/09613218.2016.1138803.

——, F. Kern, and K. Rogge, 2017: The need for comprehensive and well targeted instrument mixes to stimulate energy transitions: The case of energy efficiency policy. *Energy Res. Soc. Sci.*, **33**, 95–104, https://doi.org/10.1016/j.erss.2017.09.013.

Rosenthal, J., A. Quinn, A. P. Grieshop, A. Pillarisetti, and R. I. Glass, 2018: Clean cooking and the SDGs: Integrated analytical approaches to guide energy interventions for health and environment goals. *Energy Sustain. Dev.*, **42**, 152–159, https://doi.org/10.1016/j.esd.2017.11.003.

Roser, M., E. Ortiz-Ospina, H. Ritchie, J. Hassel, and D. Gavrilov, 2019: Our world in data. *Univ. Oxford*,. https://ourworldindata.org/grapher/interpersonal-trust-vs-income-inequality.

Rothstein, B., 2011: *The Quality of Government: Corruption, Social Trust, and Inequality in International Perspective*. University of Chicago Press,.

——, and E. M. Uslaner, 2005: All for All: Equality, Corruption, and Social Trust. *World Polit.*, **58**, 41–72, https://doi.org/10.1353/wp.2006.0022.

——, and Stolle, 2008: The State and social capital: an institutional theory of generalized governance. *Comp. Polit.*, 441–459.

Rothstein, B., and J. Teorell, 2008: What Is Quality of Government? A Theory of Impartial Government Institutions. *Governance*, **21**, 165–190, https://doi.org/10.1111/j.1468-0491.2008.00391.x.

Rotmans, J., R. Kemp, and M. Van Asselt, 2001: More evolution than revolution: Transition management in public policy. *Foresight*, **3**, 15–31, https://doi.org/10.1108/14636680110803003.

Rouse, M., and G. Verhoef, 2016: Mobile banking in Africa: The current state of play. *The Book of Payments: Historical and Contemporary Views on the Cashless Society*, B. Batiz-Lazo and L. Efthymiou, Eds., Palgrave Macmillan, 233–257.

Roy, B., and A. Schaffartzik, 2020: Talk renewables, walk coal: The paradox of India's energy transition. *Ecol. Econ.*, **180**, 106871, https://doi.org/10.1016/j.ecolecon.2020.106871.

Roy, J., and S. Pal, 2009: Lifestyles and climate change: link awaiting activation. *Curr. Opin. Environ. Sustain.*, **1**, 192–200, https://doi.org/https://doi.org/10.1016/j.cosust.2009.10.009.

——, A. M. Dowd, A. Muller, S. Pal, N. Prata, and S. Lemmet, 2012: Chapter 21- Lifestyles, well-being and energy. *Global Energy Assessment—Toward a Sustainable Future*, Cambridge University Press, 1527–1548.

Roy, J., and Coauthors, 2018a: Sustainable Development, Poverty Eradication and Reducing Inequalities. *Global Warming of 1.5 °C an IPCC special report on the impacts of global warming of 1.5 °C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change*, P. Zhai et al., Eds., 445–538.

Roy, J., D. Chakravarty, S. Dasgupta, D. Chakraborty, S. Pal, and D. Ghosh, 2018b: Where is the hope? Blending modern urban lifestyle with cultural practices in India. *Curr. Opin. Environ. Sustain.*, **31**, 96–103, https://doi.org/10.1016/j.cosust.2018.01.010.

——, S. Dasgupta, D. Ghosh, N. Das, D. Chakravarty, D. Chakraborty, and S. De, 2018c: Governing National Actions for Global Climate Change Stabilization: Examples from India. *Climate Change Governance and Adaptation*, A. Barua, V. Narain, and S. Vij, Eds., CRC Press, 137–159.

Roy, R., 2000: Sustainable product-service systems. *Futures*, **32**, 289–299, https://doi.org/10.1016/S0016-3287(99)00098-1.

De Rubens, Z. G., L. Noel, and B. K. Sovacool, 2018: Dismissive and deceptive car dealerships create barriers to electric vehicle adoption at the point of sale. *Nat. Energy*, **3**, 501–507, https://doi.org/10.1038/s41560-018-0152-x.

Rubin, E. S., M. L. Azevedo, P. Jaramillo, and S. Yeh, 2016: A review of learning rates for electricity supply technologies. *Energy Policy*, **86**, 198–218, https://doi.org/10.1016/j.enpol.2015.06.011.

Ruggiero, S., M. Martiskainen, and T. Onkila, 2018: Understanding the scaling-up of community energy niches through strategic niche management theory: Insights from Finland. *J. Clean. Prod.*, **170**, 581–590, https://doi.org/10.1016/j.jclepro.2017.09.144.

Ryan, R. M., and E. L. Deci, 2001: On happiness and human potentials: a review of research on hedonic and eudaimonic well-being. *Annu. Rev. Psychol.*, **52**, 141–166, https://doi.org/10.1146/annurev.psych.52.1.141.

Rynikiewicz, C., and A. Chetaille, 2006: Poverty reduction, climate change mitigation and adaptation : The need for intermediate public policies harnessing technology appropriation. *The future of science, technology and innovation : 40th anniversary conference, SPRU*, 11 https://pdfs.semanticscholar.org/c59f/90000428a5c81e12daf3b9a7a96983996813.pdf?_ga=2.171553252.57338894.1575697081-1617201598.1561360840 (Accessed November 30, 2019).

S. D'alessandro, André Cieplinski, Tiziano Distefano, and Pietro Guarnieri, 2019: Societal transition for a sustainable economy. *Agrochimica*, 293–336.

Saavedra, Y. Y. M. B., D. R. D. Iritani, … A. P.-J. of C., U. 2018, A. L. R. Pavan, and A. R. Ometto, 2018: Theoretical contribution of industrial ecology to circular economy. *J. Clean. Prod.*, **170**, 1514–1522, https://doi.org/10.1016/J.JCLEPRO.2017.09.260.

Sachs, J. D., and A. M. Warner, 1995: *Natural Resource Abundance and Economic Growth*. 47 pp. https://www.nber.org/papers/w5398.

Sadras, V. O., P. Grassini, and P. Steduto, 2011: *Status of water use efficiency of main crops: SOLAW Background Thematic Report-TR07*. 41 pp. http://www.fao.org/fileadmin/templates/solaw/files/thematic_reports/TR_07_web.pdf.

Sager, L., 2017: Income inequality and carbon consumption: evidence from environmental Engel curves - Grantham Research Institute on climate change and the environment. http://www.lse.ac.uk/GranthamInstitute/publication/income-inequality-and-carbon-consumption-evidence-from-environmental-engel-curves/ (Accessed July 4, 2019).

Sahakian, M., 2018: Toward a more solidaristic sharing economy. *Social Change and the Coming of Post-Consumer Society*, M.J. Cohen, H.S. Brown, and P.J. Vergragt, Eds., Routledge, 43–60.

——, L. Godin, and I. Courtin, 2020: Promoting 'pro', 'low', and 'no' meat consumption in Switzerland: The role of emotions in practices. *Appetite*, **150**, 104637, https://doi.org/10.1016/j.appet.2020.104637.

Salas, R. N., and A. K. Jha, 2019: Climate change threatens the achievement of effective universal healthcare. *BMJ*, **366**, https://doi.org/10.1136/bmj.l5302.

Salehi, S., Z. Pazuki Nejad, H. Mahmoudi, and A. Knierim, 2015: Gender, responsible citizenship and global climate change. *Womens. Stud. Int. Forum*, **50**, 30–36, https://doi.org/10.1016/j.wsif.2015.02.015.

Salick, J., and N. Ross, 2009: Traditional peoples and climate change. *Glob. Environ. Chang.*, **19**, 137–139, https://doi.org/10.1016/j.gloenvcha.2009.01.004.

Säll, S., and I. M. Gren, 2015: Effects of an environmental tax on meat and dairy consumption in Sweden. *Food Policy*, **55**, 41–53, https://doi.org/10.1016/j.foodpol.2015.05.008.

Samadi, S., M. C. Gröne, U. Schneidewind, H. J. Luhmann, J. Venjakob, and B. Best, 2017: Sufficiency in energy scenario studies: Taking the potential benefits of lifestyle changes into account. *Technol. Forecast. Soc. Change*, **124**, 126–134, https://doi.org/10.1016/j.techfore.2016.09.013.

Sanderson, S. W., and K. L. Simons, 2014: Light emitting diodes and the lighting revolution: The Emergence of a solid-state lighting industry. *Res. Policy*, **43**, 1730–1746, https://doi.org/10.1016/j.respol.2014.07.011.

Sandin, S., L. Neij, and P. Mickwitz, 2019: Transition governance for energy efficiency - insights from a systematic review of Swedish policy evaluation practices. *Energy. Sustain. Soc.*, **9**, 17, https://doi.org/10.1186/s13705-019-0203-6.

Sankhyayan, P., and S. Dasgupta, 2019: ‘Availability’ and/or ‘Affordability’:What matters in household energy access in India? *Energy Policy*, **131**, 131–143, https://doi.org/10.1016/j.enpol.2019.04.019.

Santarius, T., H. J. Walnum, and C. Aall, 2016: *Rethinking climate and energy policies: New perspectives on the rebound phenomenon*.

Santos, G., Santos, and Georgina, 2018: Sustainability and Shared Mobility Models. *Sustainability*, **10**, 3194, https://doi.org/10.3390/su10093194.

Satterthwaite, D., D. Archer, S. Colenbrander, D. Dodman, J. Hardoy, and S. Patel, 2018: *Responding to climate change in cities and in their informal settlements and economies*. 61 pp. https://citiesipcc.org/wp-content/uploads/2018/03/Informality-background-paper-for-IPCC-Cities.pdf (Accessed November 30, 2019).

——, ——, ——, ——, ——, D. Mitlin, and S. Patel, 2020: Building Resilience to Climate Change in Informal Settlements. *One Earth*, **2**, 143–156, https://doi.org/10.1016/j.oneear.2020.02.002.

Schaefers, T., S. J. Lawson, and M. Kukar-Kinney, 2016: How the burdens of ownership promote consumer usage of access-based services. *Mark. Lett.*, **27**, 569–577, https://doi.org/10.1007/s11002-015-9366-x.

Schäfer, A. W., and S. Yeh, 2020: A holistic analysis of passenger travel energy and greenhouse gas intensities. *Nat. Sustain.*, **3**, https://doi.org/10.1038/s41893-020-0514-9.

Schanes, K., K. Dobernig, and B. Gözet, 2018: Food waste matters - A systematic review of household food waste practices and their policy implications. *J. Clean. Prod.*, **182**, 978–991, https://doi.org/10.1016/J.JCLEPRO.2018.02.030.

Scheffran, J., E. Marmer, and P. Sow, 2012: Migration as a contribution to resilience and innovation in climate adaptation: Social networks and co-development in Northwest Africa. *Appl. Geogr.*, **33**, 119–127, https://doi.org/10.1016/j.apgeog.2011.10.002.

Scherer, L., P. Behrens, A. de Koning, R. Heijungs, B. Sprecher, and A. Tukker, 2018: Trade-offs between social and environmental Sustainable Development Goals. *Environ. Sci. Policy*, **90**, 65–72, https://doi.org/10.1016/j.envsci.2018.10.002.

Schipper, L., 1989: Linking Life-Styles And Energy Use: A Matter Of Time. *Annu. Rev. Energy Environ.*, **14**, 273–320, https://doi.org/10.1146/annurev.energy.14.1.273.

Schlosberg, D., and L. B. Collins, 2014: From environmental to climate justice: climate change and the discourse of environmental justice. *Wiley Interdiscip. Rev. Clim. Chang.*, **5**, 359–374, https://doi.org/10.1002/wcc.275.

Schneider-Mayerson, M., A. Gustafson, A. Leiserowitz, M. H. Goldberg, S. A. Rosenthal, and M. Ballew, 2020: Environmental Literature as Persuasion: An Experimental Test of the Effects of Reading Climate Fiction. *Environ. Commun.*, https://doi.org/10.1080/17524032.2020.1814377.

Schneider, S. M., 2016: Income Inequality and Subjective Wellbeing: Trends, Challenges, and Research Directions. *J. Happiness Stud.*, **17**, 1719–1739, https://doi.org/10.1007/s10902-015-9655-3.

Schor, J., 2014: *Debating the Sharing Economy*. 15 pp. https://www.greattransition.org/publication/debating-the-sharing-economy.

Schot, J., and F. W. Geels, 2008: Strategic niche management and sustainable innovation journeys: Theory, findings, research agenda, and policy. *Technol. Anal. Strateg. Manag.*, **20**, 537–554, https://doi.org/10.1080/09537320802292651.

——, and L. Kanger, 2018: Deep transitions: Emergence, acceleration, stabilization and directionality. *Res. Policy*, **47**, 1045–1059, https://doi.org/10.1016/j.respol.2018.03.009.

——, and W. E. Steinmueller, 2018: Three frames for innovation policy: R&D, systems of innovation and transformative change. *Res. Policy*, **47**, 1554–1567, https://doi.org/10.1016/j.respol.2018.08.011.

——, L. Kanger, and G. Verbong, 2016: The roles of users in shaping transitions to new energy systems. *Nat. Energy*, **1**, 1–7, https://doi.org/10.1038/NENERGY.2016.54.

Schröder, M., 2018: Income Inequality and Life Satisfaction: Unrelated Between Countries, Associated Within Countries Over Time. *J. Happiness Stud.*, **19**, 1021–1043, https://doi.org/10.1007/s10902-017-9860-3.

Schroeder, P., 2013: Assessing effectiveness of governance approaches for sustainable consumption and production in China. https://doi.org/10.1016/j.jclepro.2013.05.039.

Schuelke-Leech, B. A., 2018: A model for understanding the orders of magnitude of disruptive technologies. *Technol. Forecast. Soc. Change*, **129**, https://doi.org/10.1016/j.techfore.2017.09.033.

Schuldt, J. P., and A. R. Pearson, 2016: The role of race and ethnicity in climate change polarization: evidence from a U.S. national survey experiment. *Clim. Change*, **136**, 495–505, https://doi.org/10.1007/s10584-016-1631-3.

Schultz, P. W., J. M. Nolan, R. B. Cialdini, N. J. Goldstein, and V. Griskevicius, 2007: The Constructive, Destructive, and Reconstructive Power of Social Norms. *Psychol. Sci.*, **18**, 429–434, https://doi.org/10.1111/j.1467-9280.2007.01917.x.

Schumacher, I., 2015: The endogenous formation of an environmental culture. *Eur. Econ. Rev.*, **76**, 200–221, https://doi.org/10.1016/j.euroecorev.2015.03.002.

Schwartz, D., B. Fischhoff, T. Krishnamurti, and F. Sowell, 2013: The Hawthorne effect and energy awareness. *Proc. Natl. Acad. Sci. U. S. A.*, **110**, 15242–15246, https://doi.org/10.1073/pnas.1301687110.

Schwartz, S. H., 1977: Normative influences on altruism. *Adv. Exp. Soc. Psychol.*, **10**, 221–279, https://doi.org/10.1016/S0065-2601(08)60358-5.

Scrivener, K. L., and E. M. Gartner, 2018: Eco-efficient cements: Potential economically viable solutions for a low-CO2 cement-based materials industry. *Cem. Concr. Res.*, **114**, 2–26, https://doi.org/10.1016/J.CEMCONRES.2018.03.015.

Sebi, C., S. Nadel, B. Schlomann, and J. Steinbach, 2019: Policy strategies for achieving large long-term savings from retrofitting existing buildings. *Energy Effic.*, **12**, 89–105, https://doi.org/10.1007/s12053-018-9661-5.

Sen, A., 1985: Well-being, agency and freedom: The Dewey Lectures 1984. *J. Philos.*, **82**, 169–221, https://doi.org/10.2307/2026184.

Sen, B., 2017: *How States can boost renewables, with benefits for all*. www.ips-dc.org (Accessed June 9, 2020).

Sengers, F., A. J. Wieczorek, and R. Raven, 2019: Experimenting for sustainability transitions: A systematic literature review. *Technol. Forecast. Soc. Chang.*, **145**, 153–164, https://doi.org/10.1016/j.techfore.2016.08.031.

Serrano-Medrano, M., C. García-Bustamante, V. M. Berrueta, R. Martínez-Bravo, V. M. Ruiz-García, A. Ghilardi, and O. Masera, 2018: Promoting LPG, clean woodburning cookstoves or both? Climate change mitigation implications of integrated household energy transition scenarios in rural Mexico. *Environ. Res. Lett.*, **13**, https://doi.org/10.1088/1748-9326/aad5b8.

Serrao-Neumann, S., F. Crick, B. Harman, G. Schuch, and D. L. Choy, 2015: Maximising synergies between disaster risk reduction and climate change adaptation: Potential enablers for improved planning outcomes. *Environ. Sci. Policy*, **50**, 46–61, https://doi.org/10.1016/j.envsci.2015.01.017.

Seto, K. C., and Coauthors, 2014: Human Settlements, Infrastructure, and Spatial Planning. *Climate Change 2014: Mitigation of Climate Change. Contribution of Working Group III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change*, Cambridge University Press Cambridge, UK, and New York, 67–76.

Seto, K. C., S. J. Davis, R. B. Mitchell, E. C. Stokes, G. Unruh, D. Urge-Vorsatz, and D. Ürge-Vorsatz, 2016: Carbon Lock-In: Types, Causes, and Policy Implications. *Annu. Rev. Environ. Resour.*, **41**, 425–452, https://doi.org/10.1146/annurev-environ-110615-085934.

Sgouridis, S., A. Abdullah, S. Griffiths, D. Saygin, N. Wagner, D. Gielen, H. Reinisch, and D. McQueen, 2016: RE-mapping the UAE's energy transition: An economy-wide assessment of renewable energy options and their policy implications. *Renew. Sustain. Energy Rev.*, **55**, 1166–1180, https://doi.org/10.1016/j.rser.2015.05.039.

Shabanpour, R., N. Golshani, M. Tayarani, J. Auld, and A. (Kouros) Mohammadian, 2018: Analysis of telecommuting behavior and impacts on travel demand and the environment. *Transp. Res. Part D Transp. Environ.*, **62**, 563–576, https://doi.org/10.1016/j.trd.2018.04.003.

Shaheen, S., and N. Chan, 2016: Mobility and the Sharing Economy: Potential to Facilitate the First- and Last-Mile Public Transit Connections. *Built Environ.*, **42**, 573–588, https://doi.org/10.2148/benv.42.4.573.

——, and A. Cohen, 2019: Shared ride services in North America: definitions, impacts, and the future of pooling. *Transp. Rev.*, **39**, 427–442, https://doi.org/10.1080/01441647.2018.1497728.

Shangguan, S., and Coauthors, 2019: A Meta-Analysis of Food Labeling Effects on Consumer Diet Behaviors and Industry Practices. *Am. J. Prev. Med.*, **56**, 300–314, https://doi.org/10.1016/j.amepre.2018.09.024.

Shanks, W., C. F. Dunant, M. P. Drewniok, R. C. Lupton, A. Serrenho, and J. M. Allwood, 2019: How much cement can we do without? Lessons from cement material flows in the UK. *Resour. Conserv. Recycl.*, **141**, 441–454, https://doi.org/10.1016/J.RESCONREC.2018.11.002.

Sharifi, A., 2020: Trade-offs and conflicts between urban climate change mitigation and adaptation measures: A literature review. *J. Clean. Prod.*, **276**, 122813, https://doi.org/10.1016/j.jclepro.2020.122813.

Shaw, C., S. Hales, P. Howden-Chapman, and R. Edwards, 2014: Health co-benefits of climate change mitigation policies in the transport sector. *Nat. Clim. Chang.*, **4**, 427–433, https://doi.org/10.1038/nclimate2247.

Shehabi, A., S. J. Smith, E. Masanet, and J. Koomey, 2018: Data center growth in the United States: decoupling the demand for services from electricity use. *Environ. Res. Lett.*, **13**, 124030, https://doi.org/10.1088/1748-9326/aaec9c.

Sheikh, F. A., 2019: Undervaluation of informal sector innovations: Making a case for revisiting methodology. *African J. Sci. Technol. Innov. Dev.*, **11**, 505–512, https://doi.org/10.1080/20421338.2018.1532630.

——, and S. Bhaduri, 2020: Grassroots innovations in the informal economy: insights from value theory. *Oxford Dev. Stud.*, **48**, 85–99, https://doi.org/10.1080/13600818.2020.1717453.

Shelley, S., 2017: *More and better jobs in a low carbon future: provocations and possibilities Stream: "A volatile political economy: Work, climate change and labour: labour process perspectives."*

Shen, M., R. Young, and Q. Cui, 2016: The normative feedback approach for energy conservation behavior in the military community. *Energy Policy*, **98**, 19–32, https://doi.org/10.1016/j.enpol.2016.08.014.

Shi, X., 2019: Inequality of opportunity in energy consumption in China. *Energy Policy*, **124**, 371–382, https://doi.org/10.1016/j.enpol.2018.09.029.

Shields, L. (Liam P., 2016: *Just enough : sufficiency as a demand of justice*. Edinburgh University Press, 224 pp.

Shonkoff, S. B., R. Morello-Frosch, M. Pastor, and J. Sadd, 2011: The climate gap: Environmental health and equity implications of climate change and mitigation policies in California-a review of the literature. *Clim. Change*, **109**, 485–503, https://doi.org/10.1007/s10584-011-0310-7.

Shove, E., 2003: *Comfort, Cleanliness and Convenience: The Social Organization of Normality*. 1st ed. E. Shove, Ed. Berg Publishers/Bloomsbury, 240 pp.

Shove, E., and D. Southerton, 2000: Defrosting the freezer: From Novelty to convenience. A Narrative of Normalization. *J. Mater. Cult.*, **5**, 301–319, https://doi.org/10.1177/135918350000500303.

——, and G. Walker, 2014: What Is Energy For? Social Practice and Energy Demand. *Theory, Cult. Soc.*, **31**, 41–58, https://doi.org/10.1177/0263276414536746.

Shuai, C., X. Chen, Y. Wu, Y. Zhang, and Y. Tan, 2019: A three-step strategy for decoupling economic growth from carbon emission: Empirical evidences from 133 countries. *Sci. Total Environ.*, **646**, 524–543, https://doi.org/10.1016/j.scitotenv.2018.07.045.

Shum, K. L., and C. Watanabe, 2009: An innovation management approach for renewable energy deployment-the case of solar photovoltaic (PV) technology. *Energy Policy*, **37**, 3535–3544, https://doi.org/10.1016/j.enpol.2009.04.007.

Simon, D. R., 2003: *Meatonomics : how the rigged economics of meat and dairy make you consume too much-- and how to eat better, live longer, and spend smarter*. Conari Press, 289 pp.

Simon, F., 2020: Expert: 'Lack of trust' hampers energy efficiency services industry. *Euractiv*, June 16.

Simpson, N. P., 2019: Accommodating landscape-scale shocks: Lessons on transition from Cape Town and Puerto Rico. *Geoforum*, **102**, 226–229, https://doi.org/https://doi.org/10.1016/j.geoforum.2018.12.005.

Sims, R., and Coauthors, 2014: Chapter 8: Transport. *Climate Change 2014: Mitigation of Climate Change. Contribution of Working Group III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change*, Cambridge University Press.

Singer, M., 2018: *Climate change and social inequality : the health and social costs of global warming*. Earthscan, 247 pp.

Sinha, A., 2016: Trilateral association between SO2/NO2 emission, inequality in energy intensity, and economic growth: A case of Indian cities. *Atmos. Pollut. Res.*, **7**, 647–658, https://doi.org/10.1016/j.apr.2016.02.010.

Sirgy, M. J., 2012: *The psychology of quality of life: Hedonic well-being, life satisfaction, and eudaimonia*. Second. Springer Netherlands, 622 pp.

Sisco, M. R., V. Bosetti, and E. U. Weber, 2017: When do extreme weather events generate attention to climate change? *Clim. Change*, **143**, 227–241, https://doi.org/10.1007/s10584-017-1984-2.

Slocum, R., 2018: Climate Politics and Race in the Pacific Northwest. *Soc. Sci.*, **7**, 192, https://doi.org/10.3390/socsci7100192.

van Sluisveld, M. A. E., S. H. Martínez, V. Daioglou, and D. P. van Vuuren, 2016: Exploring the implications of lifestyle change in 2°C mitigation scenarios using the IMAGE integrated assessment model. *Technol. Forecast. Soc. Change*, **102**, 309–319, https://doi.org/10.1016/j.techfore.2015.08.013.

——, A. F. Hof, S. Carrara, F. W. Geels, M. Nilsson, K. Rogge, B. Turnheim, and D. P. van Vuuren, 2018: Aligning integrated assessment modelling with socio-technical transition insights: An application to low-carbon energy scenario analysis in Europe. *Technol. Forecast. Soc. Change*, https://doi.org/10.1016/j.techfore.2017.10.024.

Smetschka, B., D. Wiedenhofer, C. Egger, E. Haselsteiner, D. Moran, and V. Gaube, 2019: Time Matters: The Carbon Footprint of Everyday Activities in Austria. *Ecol. Econ.*, **164**, 106357, https://doi.org/10.1016/j.ecolecon.2019.106357.

Smil, V., 2017: *Energy and civilization : a history*. MIT Press, 552 pp.

Smit, B., and O. Pilifosova, 2001: Adaptation to Climate Change in the Context of Sustainable Development and Equity. France, 879–912.

Smith, A., and R. Raven, 2012: What is protective space? Reconsidering niches in transitions to sustainability. *Res. Policy*, **41**, 1025–1036, https://doi.org/10.1016/j.respol.2011.12.012.

Smith, E. K., and A. Mayer, 2018: A social trap for the climate? Collective action, trust and climate change risk perception in 35 countries. *Glob. Environ. Chang.*, **49**, 140–153, https://doi.org/10.1016/j.gloenvcha.2018.02.014.

Smith, J., and Coauthors, 2017: Gathering around stories: Interdisciplinary experiments in support of energy system transitions. *Energy Res. Soc. Sci.*, **31**, 284–294, https://doi.org/10.1016/j.erss.2017.06.026.

Smith, K. R., G. U. Shuhua, H. Kun, and Q. Daxiong, 1993: One hundred million improved cookstoves in China: How was it done? *World Dev.*, **21**, 941–961, https://doi.org/10.1016/0305-750X(93)90053-C.

Smith, K. R., and Coauthors, 2012: Chapter 4 - Energy and Health. *Global Energy Assessment - Toward a Sustainable Future*, 255–324.

Smith, P., and Coauthors, 2014: Agriculture, Forestry and Other Land Use (AFOLU). *Cimate Change 2014: Mitigation of Climate Change. Contribution of Working Group III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change*, O. Edenhofer, R. Pichs-Madruga, and Y. Soukuba, Eds., Cambridge University Press, 881–922.

Smith, P., and Coauthors, 2016: Biophysical and economic limits to negative CO2 emissions. *Nat. Clim. Chang.*, **6**, 42–50, https://doi.org/10.1038/nclimate2870.

Smith, P. (Philip D., and N. C. Howe, 2015: *Climate change as social drama: global warming in the public sphere*. Cambridge University Press, 242 pp.

Smith, T., M. Noble, S. Noble, G. Wright, D. McLennan, and E. Plunkett, 2015: *The English Indices of Deprivation 2015*. 126 pp.

Smith, T. S. J., and L. Reid, 2018: Which ‘being’ in wellbeing? Ontology, wellness and the geographies of happiness. *Prog. Hum. Geogr.*, **42**, 807–829, https://doi.org/10.1177/0309132517717100.

Soete, L., 1985: International diffusion of technology, industrial development and technological leapfrogging. *World Dev.*, **13**, 409–422, https://doi.org/https://doi.org/10.1016/0305-750X(85)90138-X.

Soliev, I., and I. Theesfeld, 2020: Benefit sharing for solving transboundary commons dilemma in central Asia. *Int. J. Commons*, **14**, 61–77, https://doi.org/10.5334/ijc.955.

Song, Y., J. Preston, and D. Ogilvie, 2017: New walking and cycling infrastructure and modal shift in the UK: A quasi-experimental panel study. *Transp. Res. Part A Policy Pract.*, **95**, 320–333, https://doi.org/https://doi.org/10.1016/j.tra.2016.11.017.

Sorrell, S., 2015: Reducing energy demand: A review of issues, challenges and approaches. *Renew. Sustain. Energy Rev.*, **47**, 74–82, https://doi.org/10.1016/J.RSER.2015.03.002.

——, J. Dimitropoulos, and M. Sommerville, 2009: Empirical estimates of the direct rebound effect: A review. *Energy Policy*, **37**, 1356–1371, https://doi.org/10.1016/J.ENPOL.2008.11.026.

Sousa, T., P. E. Brockway, J. M. Cullen, S. T. Henriques, J. Miller, A. C. Serrenho, and T. Domingos, 2017: The Need for Robust, Consistent Methods in Societal Exergy Accounting. *Ecol. Econ.*, **141**, 11–21, https://doi.org/10.1016/j.ecolecon.2017.05.020.

Sovacool, B. K., and I. M. Drupady, 2016: *Energy access, poverty, and development : the governance of small-scale renewable energy in developing Asia*. Routledge, 328 pp.

——, A. Gilbert, and D. Nugent, 2014: An international comparative assessment of construction cost overruns for electricity infrastructure. *Energy Res. Soc. Sci.*, **3**, 152–160, https://doi.org/10.1016/j.erss.2014.07.016.

Sovacool, B. K., and Coauthors, 2015: Integrating social science in energy research. *Energy Res. Soc. Sci.*, **6**, 95–99, https://doi.org/10.1016/j.erss.2014.12.005.

Sovacool, B. K., D. Furszyfer Del Rio, and S. Griffiths, 2020a: Contextualizing the Covid-19 pandemic for a carbon-constrained world: Insights for sustainability transitions, energy justice, and research methodology. *Energy Res. Soc. Sci.*, **68**, 101701, https://doi.org/10.1016/j.erss.2020.101701.

——, M. Martiskainen, A. Hook, and L. Baker, 2020b: Beyond cost and carbon: The multidimensional co-benefits of low carbon transitions in Europe. *Ecol. Econ.*, **169**, https://doi.org/10.1016/j.ecolecon.2019.106529.

Spangenberg, J., 2014: Institutional change for strong sustainable consumption: Sustainable consumption and the degrowth economy. *Sustain. Sci. Pract. Policy*, **10**, 62–77, https://doi.org/10.1080/15487733.2014.11908125.

Spangenberg, J. H., and S. Germany, 2016: Sufficiency , Degrowth and Sustainable Consumption. *Sustainable Consumption and Social Justice in a Constrained World SCORAI Europe Workshop Proceedings*, Budapest, Hungary, Sustainable Consumption Transitions Series, Issue 6., 25–33.

Spangenberg, J. H., and S. Lorek, 2019: Sufficiency and consumer behaviour: From theory to policy. *Energy Policy*, **129**, 1070–1079, https://doi.org/10.1016/j.enpol.2019.03.013.

Spengler, L., 2016: Two types of ‘enough’: sufficiency as minimum and maximum. *Env. Polit.*, **25**, 921–940, https://doi.org/10.1080/09644016.2016.1164355.

Speranza, C. I., B. Kiteme, P. Ambenje, U. Wiesmann, and S. Makali, 2010: Indigenous knowledge related to climate variability and change: Insights from droughts in semi-arid areas of former Makueni District, Kenya. *Clim. Change*, **100**, 295–315, https://doi.org/10.1007/s10584-009-9713-0.

Springmann, M., and Coauthors, 2016: Global and regional health effects of future food production under climate change: A modelling study. *Lancet*, **387**, 1937–1946, https://doi.org/10.1016/S0140-6736(15)01156-3.

——, and Coauthors, 2018: Options for keeping the food system within environmental limits. *Nature*, **562**, 519–525, https://doi.org/10.1038/s41586-018-0594-0.

Stahel, W., 2016: The circular economy. *Nature*, **531**, 435–438, https://doi.org/10.1038/531435a.

Stankuniene, G., D. Streimikiene, and G. L. Kyriakopoulos, 2020: Systematic Literature Review on Behavioral Barriers of Climate Change Mitigation in Households. *Sustainability*, **12**, 7369, https://doi.org/10.3390/SU12187369.

Stark, C., 2020: Covid-19 recovery and climate change. *IPPR Progress. Rev.*, **27**, 132–139, https://doi.org/10.1111/newe.12207.

Von Stechow, C., and Coauthors, 2016: 2 °C and SDGs: united they stand, divided they fall? *Environ. Res. Lett.*, **11**, 034022, https://doi.org/10.1088/1748-9326/11/3/034022.

Steckel, J. C., R. J. Brecha, M. Jakob, J. Stre, and G. Luderer, 2013: Development without energy ? Assessing future scenarios of energy consumption in developing countries. *Ecol. Econ.*, **90**, 53–67, https://doi.org/10.1016/j.ecolecon.2013.02.006.

Steemers, K., 2003: Energy and the city: density, buildings and transport. *Energy Build.*, **35**, 3–14, https://doi.org/https://doi.org/10.1016/S0378-7788(02)00075-0.

Steffel, M., E. F. Williams, and R. Pogacar, 2016: Ethically Deployed Defaults: Transparency and Consumer Protection through Disclosure and Preference Articulation. *J. Mark. Res.*, **53**, 865–880, https://doi.org/10.1509/jmr.14.0421.

Steffen, W., J. Rockström, K. Richardson, T. M. Lenton, C. Folke, and D. Liverman, 2018: Trajectories of the Earth System in the Anthropocene. *Proc. Natl. Acad. Sci.*, 1–8, https://doi.org/10.1073/pnas.1810141115.

Steg, L., 2005: Car use: Lust and must. Instrumental, symbolic and affective motives for car use. *Transp. Res. Part A Policy Pract.*, **39**, 147–162, https://doi.org/10.1016/j.tra.2004.07.001.

——, 2016: Values, Norms, and Intrinsic Motivation to Act Proenvironmentally. *Annu. Rev. Environ. Resour.*, **41**, 277–292, https://doi.org/10.1146/annurev-environ-110615-085947.

Steijn, S., and B. Lancee, 2011: *Does Income Inequality Negatively Affect General Trust?* www.gini-research.org. (Accessed November 30, 2019).

Stein, R. (ed. ., 2004: *New Perspectives on Environmental Justice: Gender, Sexuality, and Activism*. Rutgers University Press,.

Steinberger, J. K., J. Timmons Roberts, G. P. Peters, G. Baiocchi, J. T. Roberts, G. P. Peters, and G. Baiocchi, 2012: Pathways of human development and carbon emissions embodied in trade. *Nat. Clim. Chang.*, **2**, 81–85, https://doi.org/10.1038/nclimate1371.

Steinberger, J. K. ., and J. T. Roberts, 2010: From constraint to sufficiency: The decoupling of energy and carbon from human needs, 1975–2005. *Ecol. Econ.*, **70**, 425–433, https://doi.org/10.1016/j.ecolecon.2010.09.014.

Steinmo, S., K. A. Thelen, and F. Longstreth, 1992: *Structuring politics : historical institutionalism in comparative analysis*. Cambridge University Press, 257 pp.

Stephenson, J., and Coauthors, 2015: The energy cultures framework: Exploring the role of norms, practices and material culture in shaping energy behaviour in New Zealand. *Energy Res. Soc. Sci.*, **7**, 117–123, https://doi.org/10.1016/j.erss.2015.03.005.

De Stercke, S., 2014: *Dynamics of Energy Systems: a Useful Perspective*. 68 pp. http://pure.iiasa.ac.at/id/eprint/11254/1/IR-14-013.pdf.

Sterman, J. D., and L. B. Sweeney, 2002: Cloudy skies: assessing public understanding of global warming. *Syst. Dyn. Rev.*, **18**, 207–240, https://doi.org/10.1002/sdr.242.

Stern, P. C., 2000: New Environmental Theories: Toward a Coherent Theory of Environmentally Significant Behavior. *J. Soc. Issues*, **56**, 407–424, https://doi.org/10.1111/0022-4537.00175.

——, and Coauthors, 1985: The effectiveness of incentives for residential energy conservation. *Evol. Rev.*, **10**, 147–176.

Stiglitz, J., 2012: *The Price of Inequality: How Today's Divided Society Endangers Our Future*. W. W. Norton & Company,.

Stokes, L. C., and C. Warshaw, 2017: Renewable energy policy design and framing influence public support in the United States. *Nat. Energy*, **2**, 17107, https://doi.org/10.1038/nenergy.2017.107.

Stolaroff, J. K., C. Samaras, E. R. O'Neill, A. Lubers, A. S. Mitchell, and D. Ceperley, 2018: Energy use and life cycle greenhouse gas emissions of drones for commercial package delivery. *Nat. Commun.*, **9**, 409, https://doi.org/10.1038/s41467-017-02411-5.

Stoll, C., L. Klaaßen, and U. Gallersdörfer, 2019: The Carbon Footprint of Bitcoin. *Joule*, **3**, https://doi.org/10.1016/j.joule.2019.05.012.

Stone, A. A., S. Schneider, A. Krueger, J. E. Schwartz, and A. Deaton, 2018: Experiential Wellbeing Data from the American Time Use Survey: Comparisons with Other Methods and Analytic Illustrations with Age and Income. *Soc. Indic. Res.*, **136**, 359–378, https://doi.org/10.1007/s11205-016-1532-x.

Strand, J., 2020: *Supporting Carbon Tax Implementation in Developing Countries through Results-Based Payments for Emissions Reductions*.

Stratford, B., 2020: The Threat of Rent Extraction in a Resource-constrained Future. *Ecol. Econ.*, **169**, 106524, https://doi.org/10.1016/j.ecolecon.2019.106524.

Strauch, Y., 2020: Beyond the low-carbon niche: Global tipping points in the rise of wind, solar, and electric vehicles to regime scale systems. *Energy Res. Soc. Sci.*, **62**, https://doi.org/10.1016/j.erss.2019.101364.

Streeby, S., 2018: *Imagining the Future of Climate Change World-Making through Science Fiction and Activism*. University of California Press,.

Strubell, E., A. Ganesh, and A. McCallum, 2020: Energy and policy considerations for deep learning in NLP. *ACL 2019 - 57th Annual Meeting of the Association for Computational Linguistics, Proceedings of the Conference*, Association for Computational Linguistics (ACL), 3645–3650.

Stubbs, W., and C. Cocklin, 2008: An ecological modernist interpretation of sustainability: The Case of Interface Inc. *Bus. Strateg. Environ.*, **17**, 512–523, https://doi.org/10.1002/bse.544.

Stuber, J., S. Galea, and B. G. Link, 2008: Smoking and the emergence of a stigmatized social status. *Soc. Sci. Med.*, **67**, 420–430, https://doi.org/10.1016/j.socscimed.2008.03.010.

Student, J., E. Papyrakis, and P. van Beukering, 2017: Buildings behaving badly: a behavioral experiment on how different motivational frames influence residential energy label adoption in the Netherlands. *J. Hous. Built Environ.*, **32**, 107–132, https://doi.org/10.1007/s10901-016-9500-y.

Sturm, S., 2007: The Architecture of Inclusion: Interdisciplinary Insights on Pursuing Institutional Citizenship. *Harvard J. Law Gend.*, **30**, 409–419.

Suatmadi, A. Y., F. Creutzig, and I. M. Otto, 2019: On-demand motorcycle taxis improve mobility, not sustainability. *Case Stud. Transp. Policy*, **7**, 218–229, https://doi.org/10.1016/J.CSTP.2019.04.005.

Sudbury, A. W., and E. B. Hutchinson, 2016: A Cost Analysis Of Amazon Prime Air (Drone Delivery). *J. Econ. Educ.*, **16**, 1–12.

Sulemana, I., L. McCann, and Harvey S. James, 2016: Perceived environmental quality and subjective well-being: are African countries different from developed countries? *Int. J. Happiness Dev.*, **3**, 64, https://doi.org/10.1504/ijhd.2016.076209.

Sumner, A., C. Hoy, and E. Ortiz-Juarez, 2020: *Estimates of the impact of COVID-19 on global poverty*.

Sunderland, L., A. Jahn, M. Hogan, J. Rosenow, R. Cowart, L. Sunderland, A. Hogan, and J. Cowart, 2020: *Equity in the energy transition Who pays and who benefits?*

Sunguya, B. F., K. I. C. Ong, S. Dhakal, L. B. Mlunde, A. Shibanuma, J. Yasuoka, and M. Jimba, 2014: Strong nutrition governance is a key to addressing nutrition transition in low and middle-income countries: Review of countries' nutrition policies. *Nutr. J.*, **13**, https://doi.org/10.1186/1475-2891-13-65.

Sunstein, C. R., 2015: Do People Like Nudges? *SSRN Electron. J.*, https://doi.org/10.2139/ssrn.2604084.

Sunstein, C. R., 2019: *Conformity*. New York University Press, 176 pp.

——, and L. A. Reisch, 2014: Automatically Green: Behavioral Economics and Environmental Protection. *Harvard Environ. Law Rev.*, **38**, 127–158, https://doi.org/10.2139/ssrn.2245657.

——, ——, and M. Kaiser, 2019: Trusting nudges? Lessons from an international survey. *J. Eur. Public Policy*, **26**, 1417–1443, https://doi.org/10.1080/13501763.2018.1531912.

Swyngedouw, E., 2011: Climate Change as Post-Political and Post-Democratic Populism. *Politik im Klimawandel*, Nomos Verlagsgesellschaft mbH & Co. KG, 65–81.

Szałek, B. Z., 2013: Some praxiological reflections on the so-called 'overton window of political possibilities', 'framing' and related problems. *Real. Polit. Estim. - Comments - Forecast.*, 237–257.

Tanner, T., T. Mitchell, E. Polack, and B. Guenther, 2009: Urban Governance for Adaptation: Assessing Climate Change Resilience in Ten Asian Cities. *IDS Work. Pap.*, **2009**, 1–47, https://doi.org/10.1111/j.2040-0209.2009.00315_1.x.

Taufik, D., M. C. D. Verain, E. P. Bouwman, and M. J. Reinders, 2019: Determinants of real-life behavioural interventions to stimulate more plant-based and less animal-based diets: A systematic review. *Trends Food Sci. Technol.*, **93**, 281–303, https://doi.org/10.1016/j.tifs.2019.09.019.

Tauhid, F. A., and H. Zawani, 2018: Mitigating climate change related floods in urban poor areas: Green infrastructure approach. *J. Reg. City Plan.*, **29**, 98–112, https://doi.org/10.5614/jrcp.2018.29.2.2.

Taylor, A., and C. Peter, 2014: *Strengthening Climate Resilience in African Cities A Framework for Working with Informality*. Climate and Development Knowledge Network (CDKN), 20 pp. https://cdkn.org/wp-content/uploads/2014/05/CDKN_ACC_WP_final_web-res.pdf.

Taylor, A. L., S. Dessai, and W. Bruine de Bruin, 2014: Public perception of climate risk and adaptation in the UK: A review of the literature. *Clim. Risk Manag.*, **4**, 1–16, https://doi.org/10.1016/j.crm.2014.09.001.

Teame, G. T., and A. T. Habte, 2020: To cite this article: Ghirmai Tesfamariam Economic Growth and Carbon Dioxide Emissions in East African Countries: A Pooled Mean Group Approach. *Int. J. Bus. Econ. Res.*, **9**, 160–169, https://doi.org/10.11648/j.ijber.20200904.11.

Teece, D. J., 2018: Tesla and the Reshaping of the Auto Industry. *Manag. Organ. Rev.*, **14**, 501–512, https://doi.org/10.1017/mor.2018.33.

Temper, L., and Coauthors, 2020: Movements shaping climate futures: A systematic mapping of protests against fossil fuel and low-carbon energy projects . *Environ. Res. Lett*, **15**, 123004, https://doi.org/10.1088/1748-9326/abc197.

Temple, J., 2020: Why we need broader coalitions to combat environmental racism and climate change | MIT Technology Review. *MIT Technol. Rev.*,. https://www.technologyreview.com/2020/06/11/1003162/a-green-new-deal-architect-explains-how-the-protests-and-climate-crisis-are-connected/ (Accessed June 19, 2020).

Terry, G., 2009: No climate justice without gender justice: an overview of the issues. *Gend. Dev.*, **17**, 5–18, https://doi.org/10.1080/13552070802696839.

Terzi, A., 2020: Crafting an effective narrative on the green transition. *Energy Policy*, **147**, https://doi.org/10.1016/j.enpol.2020.111883.

Tesfamichael, M., Y. Mulugetta, A. D. Beyene, and S. Sebsibie, 2021: Counting the cost: Coping with tariff increases amidst power supply shortfalls in urban households in Ethiopia. *Energy Res. Soc. Sci.*, **71**, 101860, https://doi.org/10.1016/j.erss.2020.101860.

Teske, S., and Coauthors, 2015: *Energy [R] Evolution: A sustainable world energy outlook 2015*.

https://elib.dlr.de/98314/.

Thacker, S., and Coauthors, 2019: Infrastructure for sustainable development. *Nat. Sustain.*, **2**, 324–331, https://doi.org/10.1038/s41893-019-0256-8.

Thaler, R., and C. Sunstein, 2009: Nudge: Improving decisions about health, wealth, and happiness.

Thaler, R. H., 2015: *Misbehaving : the making of behavioral economics*. W.W. Norton & Co., 415 pp.

——, and C. R. Sunstein, 2003: Libertarian Paternalism. *Am. Econ. Rev.*, **93**, 175–179, https://doi.org/10.2307/3132220.

The Shift Project, 2019: *Lean ICT: towards digital sobriety*. 90 pp. https://theshiftproject.org/wp-content/uploads/2019/03/Lean-ICT-Report_The-Shift-Project_2019.pdf.

Theotokis, A., and E. Manganari, 2015: The Impact of Choice Architecture on Sustainable Consumer Behavior: The Role of Guilt. *J. Bus. Ethics*, **131**, 423–437, https://doi.org/10.1007/s10551-014-2287-4.

Thomas, D. S. G., and C. Twyman, 2005: Equity and justice in climate change adaptation amongst natural-resource-dependent societies. *Glob. Environ. Chang.*, **15**, 115–124, https://doi.org/10.1016/j.gloenvcha.2004.10.001.

Thoyre, A., 2020: Home climate change mitigation practices as gendered labor. *Womens. Stud. Int. Forum*, **78**, 102314, https://doi.org/10.1016/j.wsif.2019.102314.

Thyberg, K. L., and D. J. Tonjes, 2016: Drivers of food waste and their implications for sustainable policy development. *Resour. Conserv. Recycl.*, **106**, 110–123, https://doi.org/10.1016/j.resconrec.2015.11.016.

Tiba, S., and A. Omri, 2017: Literature survey on the relationships between energy, environment and economic growth. *Renew. Sustain. Energy Rev.*, **69**, 1129–1146, https://doi.org/10.1016/j.rser.2016.09.113.

Timko, M. T., 2019: A World Without Waste. *IEEE Eng. Manag. Rev.*, **47**, 106–109, https://doi.org/10.1109/EMR.2019.2900636.

Tokuda, Y., S. Fujii, and T. Inoguchi, 2017: Individual and Country-Level Effects of Social Trust on Happiness: The Asia Barometer Survey. Springer, Singapore, 123–139.

Tonn, B. E., and Coauthors, 2015: *Weatherization Works II - Summary of Findings from the ARRA Period Evaluation of the U.S. Department of Energy's Weatherization Assistance Program*. 1223654, ORNL/TM–2015/139 pp.

Tornatzky, L. G., and K. J. Klein, 1982: Innovation Charactersitic and Innovation Adoption-Implementation : Meta Analysis of the Finding. *IEEE Trans. Eng. Manag.*, **EM-29**, 28–45, https://doi.org/10.1109/TEM.1982.6447463.

Toroitich, I. K., and G. Kerber, 2014: Diakonia, Sustainability, and Climate Change. 288–301, https://doi.org/10.1111/erev.12106.

Torriti, J., 2012: Price-based demand side management: Assessing the impacts of time-of-use tariffs on residential electricity demand and peak shifting in Northern Italy. *Energy*, **44**, 576–583.

Toth, G., and C. Szigeti, 2016: The historical ecological footprint: From over-population to over-consumption. *Ecol. Indic.*, **60**, 283–291, https://doi.org/10.1016/j.ecolind.2015.06.040.

Toulouse, E., M. Sahakian, and S. Lorek, 2019: Energy sufficiency: how can research better help and inform policy-making? *ECEEE Summer Study Proceedings* https://www.eceee.org/library/conference_proceedings/eceee_Summer_Studies/2019/2-whats-next-in-energy-policy/energy-sufficiency-how-can-research-better-help-and-inform-policy-making/ (Accessed September 14, 2020).

Townsend, P., 1979: *Poverty in the United Kingdom: A Survey of Household Resources and Standards of Living. Peter Townsend*. Penguin Books Ltd, 1216 pp.

Trencher, G., V. Castán Broto, T. Takagi, Z. Sprigings, Y. Nishida, and M. Yarime, 2016: Innovative policy practices to advance building energy efficiency and retrofitting: Approaches, impacts and challenges in ten C40 cities. *Environ. Sci. Policy*, **66**, 353–365, https://doi.org/10.1016/j.envsci.2016.06.021.

Truelove, H. B., A. R. Carrico, E. U. Weber, K. T. Raimi, and M. P. Vandenbergh, 2014: Positive and negative spillover of pro-environmental behavior: An integrative review and theoretical framework. *Glob. Environ. Chang.*, **29**, 127–138, https://doi.org/10.1016/j.gloenvcha.2014.09.004.

Tschakert, P., and Coauthors, 2017: Climate change and loss, as if people mattered: values, places, and experiences. *Wiley Interdiscip. Rev. Clim. Chang.*, **8**, e476, https://doi.org/10.1002/wcc.476.

Tu, Y., and C. K. Hsee, 2018: Hedonomics: On Subtle Yet Significant Determinants of Happiness. *Handbook of Well-being*, E. Diener, S. Oishi, and L. Tay, Eds., DEF Publishers.

Turnheim, B., and F. W. Geels, 2012: Regime destabilisation as the flipside of energy transitions: Lessons from the history of the British coal industry (1913-1997). *Energy Policy*, **50**, 35–49, https://doi.org/10.1016/j.enpol.2012.04.060.

Turnheim, B., and F. W. Geels, 2019: Incumbent actors, guided search paths, and landmark projects in infra-system transitions: Re-thinking Strategic Niche Management with a case study of French tramway diffusion (1971–2016). *Res. Policy*, **48**, 1412–1428, https://doi.org/10.1016/j.respol.2019.02.002.

——, P. Kivimaa, and F. (Frans) Berkhout, 2018: *Innovating Climate Governance: Moving Beyond Experiments*. B. Turnheim, P. Kivimaa, and F. Berkhout, Eds. Cambridge University Press, 250 pp.

Tussyadiah, I. P., and J. Pesonen, 2016: Impacts of Peer-to-Peer Accommodation Use on Travel Patterns. *J. Travel Res.*, **55**, 1022–1040, https://doi.org/10.1177/0047287515608505.

Tvinnereim, E., and M. Mehling, 2018: Carbon pricing and deep decarbonisation. *Energy Policy*, **121**, 185–189, https://doi.org/10.1016/j.enpol.2018.06.020.

——, K. Fløttum, Ø. Gjerstad, M. P. Johannesson, and Å. D. Nordø, 2017: Citizens' preferences for tackling climate change. Quantitative and qualitative analyses of their freely formulated solutions. *Glob. Environ. Chang.*, **46**, 34–41, https://doi.org/10.1016/j.gloenvcha.2017.06.005.

TWI2050, 2018: *Transformations to Achieve the Sustainable Development Goals - Report prepared by The World in 2050 initiative*. 154 pp.

——, 2019: *The Digital Revolution and Sustainable Development: Opportunities and Challenges*. 100 pp.

Ueno, T., R. Inada, O. Saeki, and K. Tsuji, 2005: Effectiveness of displaying energy consumption data in residential houses – Analysis on how the residents respond. *2005 summer study of the European Council for an energy efficient economy*, Stockholm https://www.eceee.org/library/conference_proceedings/eceee_Summer_Studies/2005c/Panel_6/6100ueno/.

——, F. Sano, O. Saeki, and K. Tsuji, 2006: Effectiveness of an energy-consumption information system on energy savings in residential houses based on monitored data. *Appl. Energy*, **83**, 166–183.

Ulph, A., and D. Ulph, 2018: Environmental policy when consumers value conformity. *J. Environ. Econ. Manage.*, https://doi.org/10.1016/j.jeem.2018.09.001.

UN-Habitat, 2013: *Planning and design for sustainable urban mobility: Global report on human settlements 2013*. United Nations Human Settlements Programme (, 348 pp.

UN, 2020: *Shared Responsibility, Global Solidarity: Responding to the socio-economic impacts of COVID-19*. https://www.imf.org/en/News/Articles/2020/03/27/sp032720-opening-remarks-at-press-briefing-following-imfc-conference-call (Accessed December 7, 2020).

UNEP, 2010: *ABC of SCP: Clarifying Concepts on Sustainable Consumption and Production*.

——, 2013: *Women and natural resources : unlocking the peacebuilding potential*. UNEP, 1–70 pp.

UNESC, 2017: *Report of the Inter-agency and Expert Group on Sustainable Development Goal Indicators*. 49 pp. http://unstats.un.org/sdgs/iaeg-sdgs/.

UNFCCC, 2015: *Paris Agreement*. https://unfccc.int/files/essential_background/convention/application/pdf/english_paris_agreement.pdf (Accessed December 4, 2020).

——, 2016: *Report of the Conference of the Parties on its twenty-second session, held in Marrakech from 7 to 18 November 2016*. https://unfccc.int/resource/docs/2016/cop22/eng/10a02.pdf (Accessed December 4, 2020).

Ungemach, C., A. R. Camilleri, E. J. Johnson, R. P. Larrick, and E. U. Weber, 2017: Translated Attributes as Choice Architecture: Aligning Objectives and Choices Through Decision Signposts. *Manage. Sci.*, **65**, 1975–2471, https://doi.org/10.1287/mnsc.2016.2703.

United Nations, 2015: *Transforming Our World: The 2030 Agenda for Sustainable Development*. 41 pp. https://sustainabledevelopment.un.org/post2015/transformingourworld.

Unruh, G. C., 2000: Understanding carbon lock-in. *Energy Policy*, **28**, 817–830, https://doi.org/10.1016/S0301-4215(00)00070-7.

Ürge-Vorsatz, D., S. T. Herrero, N. K. Dubash, and F. Lecocq, 2014: Measuring the co-benefits of climate change mitigation. *Annu. Rev. Environ. Resour.*, **39**, 549–582, https://doi.org/10.1146/annurev-environ-031312-125456.

Uyttebrouck, C., E. van Bueren, and J. Teller, 2020: Shared housing for students and young professionals: evolution of a market in need of regulation. *J. Hous. Built Environ.*, https://doi.org/10.1007/s10901-020-09778-w.

Uzar, U., and K. Eyuboglu, 2019: The nexus between income inequality and CO2 emissions in Turkey. *J. Clean. Prod.*, **227**, 149–157, https://doi.org/10.1016/j.jclepro.2019.04.169.

Vandeweerdt, C., B. Kerremans, and A. Cohn, 2016: Climate voting in the US Congress: the power of public concern. *Env. Polit.*, **25**, 268–288, https://doi.org/10.1080/09644016.2016.1116651.

Vassileva, I., M. Odlare, F. Wallin, and E. Dahlquist, 2012: The impact of consumers' feedback preferences on domestic electricity consumption. *Appl. Energy*, **93**, 575–582.

Vatn, A., 2015: *Environmental governance : institutions, policies and actions*. Edward Elgar Publications,.

van de Ven, D. J., M. González-Eguino, and I. Arto, 2018: The potential of behavioural change for climate change mitigation: a case study for the European Union. *Mitig. Adapt. Strateg. Glob. Chang.*, **23**, 835–886, https://doi.org/10.1007/s11027-017-9763-y.

Verhoef, L. A., B. W. Budde, C. Chockalingam, B. García Nodar, and A. J. M. van Wijk, 2018: The effect of additive manufacturing on global energy demand: An assessment using a bottom-up approach. *Energy Policy*, **112**, https://doi.org/10.1016/j.enpol.2017.10.034.

Verplanken, B., and W. Wood, 2006: Interventions to break and create consumer habits. *J. Public Policy Mark.*, **25**, 90–103, https://doi.org/10.1509/jppm.25.1.90.

——, and D. Roy, 2016: Empowering interventions to promote sustainable lifestyles: Testing the habit discontinuity hypothesis in a field experiment. *J. Environ. Psychol.*, **45**, 127–134, https://doi.org/10.1016/j.jenvp.2015.11.008.

Viana Cerqueira, E. D., B. Motte-baumvol, L. B. Chevallier, and O. Bonin, 2020: Does working from home reduce CO2 emissions? An analysis of travel patterns as dictated by workplaces. *Transp. Res. Part D Transp. Environ.*, **83**, 2020, https://doi.org/10.1016/j.trd.2020.102338.

Victor, P., 2019: *Managing Without Growth—Slower by Design, Not Disaster*. 2nd ed. CUSP, 413 pp.

La Viña, A. G., J. M. Tan, T. I. M. Guanzon, M. J. Caleda, and L. Ang, 2018: Navigating a trilemma: Energy security, equity, and sustainability in the Philippines' low-carbon transition. *Energy Res. Soc. Sci.*, **35**, 37–47, https://doi.org/10.1016/j.erss.2017.10.039.

Vinnari, M., and E. Vinnari, 2014: A Framework for Sustainability Transition: The Case of Plant-Based Diets. *J. Agric. Environ. Ethics*, **27**, 369–396, https://doi.org/10.1007/s10806-013-9468-5.

Vinyeta, K., K. Whyte, and K. Lynn, 2016: *Climate Change Through an Intersectional Lens: Gendered Vulnerability and Resilience in Indigenous Communities in the United States*. https://www.researchgate.net/publication/291523872_Climate_change_through_an_intersectional_lens_Gendered_vulnerability_and_resilience_in_indigenous_communities_in_the_United_States (Accessed July 4, 2019).

Vita, G., E. G. Hertwich, K. Stadler, and R. Wood, 2019a: Connecting global emissions to fundamental human needs and their satisfaction. *Environ. Res. Lett.*, **14**, 014002, https://doi.org/10.1088/1748-9326/aae6e0.

——, J. R. Lundström, E. G. Hertwich, J. Quist, D. Ivanova, K. Stadler, and R. Wood, 2019b: The Environmental Impact of Green Consumption and Sufficiency Lifestyles Scenarios in Europe: Connecting Local Sustainability Visions to Global Consequences. *Ecol. Econ.*, **164**, 106322, https://doi.org/10.1016/j.ecolecon.2019.05.002.

——, and Coauthors, 2020: Happier with less? Members of European environmental grassroots initiatives reconcile lower carbon footprints with higher life satisfaction and income increases. *Energy Res. Soc. Sci.*, **60**, https://doi.org/10.1016/j.erss.2019.101329.

Van Vossole, J., 2012: Global Climate Governance: A Legitimation Crisis: Capitalism, Power, and Alienation from Marxist and Polanyian Perspectives. *Rev. (Fernand Braudel Center)*, **35**, 1–27.

Voytenko Palgan, Y., L. Zvolska, and O. Mont, 2017: Sustainability framings of accommodation sharing. *Environ. Innov. Soc. Transitions*, **23**, 70–83, https://doi.org/10.1016/J.EIST.2016.12.002.

Vranken, H., 2017: Sustainability of bitcoin and blockchains. *Curr. Opin. Environ. Sustain.*, **28**, 1–9, https://doi.org/10.1016/j.cosust.2017.04.011.

de Vries, A., 2018: Bitcoin's Growing Energy Problem. *Joule*, **2**, 801–805, https://doi.org/10.1016/j.joule.2018.04.016.

Van Vuuren, D. P., and Coauthors, 2018: Alternative pathways to the 1.5 °C target reduce the need for negative emission technologies. *Nat. Clim. Chang.*, **8**, 391–397, https://doi.org/10.1038/s41558-018-0119-8.

Wachsmuth, J., and V. Duscha, 2019: Achievability of the Paris targets in the EU—the role of demand-side-driven mitigation in different types of scenarios. *Energy Effic.*, **12**, 403–421, https://doi.org/10.1007/s12053-018-9670-4.

Wadud, Z., D. MacKenzie, and P. Leiby, 2016: Help or hindrance? The travel, energy and carbon impacts of highly automated vehicles. *Transp. Res. Part A Policy Pract.*, **86**, 1–18, https://doi.org/https://doi.org/10.1016/j.tra.2015.12.001.

Waisman, H., and Coauthors, 2019: Greenhouse gas emission development strategies. *Nat. Clim. Chang.*, **9**, https://doi.org/10.1038/s41558-019-0442-8.

Walker, G., N. Simcock, and R. Day, 2016: Necessary energy uses and a minimum standard of living in the United Kingdom: Energy justice or escalating expectations? *Energy Res. Soc. Sci.*, **18**, 129–138, https://doi.org/10.1016/j.erss.2016.02.007.

Wall, R., and T. Crosbie, 2009: Potential for reducing electricity demand for lighting in households: An exploratory socio-technical study. *Energy Policy*, **37**, 1021–1031, https://doi.org/10.1016/j.enpol.2008.10.045.

Wallace-Wells, D., 2019: Rhiana Gunn-Wright on the Rapid Evolution of Climate Policy. *Intelligencer*, September 20.

Waller, L., T. Rayner, J. Chilvers, C. A. Gough, I. Lorenzoni, A. Jordan, and N. Vaughan, 2020: Contested framings of greenhouse gas removal and its feasibility: Social and political dimensions. *WIREs Clim. Chang.*, **11**, https://doi.org/10.1002/wcc.649.

Wallsten, S., 2015: *The Competitive Effects of the Sharing Economy: How is Uber Changing Taxis?* 1–22 pp. https://techpolicyinstitute.org/wp-content/uploads/2015/06/the-competitive-effects-of-the-2007713.pdf (Accessed July 14, 2019).

Walsh, E., 2016: Why We Need Intersectionality to Understand Climate Change. *intercontinentalcry.org*,. https://intercontinentalcry.org/need-intersectionality-understand-climate-change/ (Accessed December 3, 2020).

Wang, D., T. Schwanen, and Z. Mao, 2019: Does exposure to richer and poorer neighborhoods influence wellbeing? *Cities*, **95**, https://doi.org/10.1016/j.cities.2019.102408.

Wang, R., V. Assenova, and E. Hertwich, 2021: Empirical Explanations of Carbon Mitigation during Periods of Economic Growth. **submitted**, https://doi.org/10.31235/osf.io/ph9ye.

Ward, J. D., P. C. Sutton, A. D. Werner, R. Costanza, S. H. Mohr, and C. T. Simmons, 2016: Is Decoupling GDP Growth from Environmental Impact Possible? *PLoS One*, **11**, e0164733, https://doi.org/10.1371/journal.pone.0164733.

Watson, J., and R. Sauter, 2011: Sustainable innovation through leapfrogging: A review of the evidence. *Int. J. Technol. Glob.*, **5**, 170–189, https://doi.org/https://doi.org/10.1504/IJTG.2011.039763.

Watson, R. T., J. Corbett, M. C. Boudreau, and J. Webster, 2012: An information strategy for environmental sustainability. *Commun. ACM*, **55**, 28, https://doi.org/10.1145/2209249.2209261.

WBGU, 2019: *Digital Momentum for the UN Sustainability Agenda in the 21st Century*. 1–28 pp. https://www.wbgu.de/fileadmin/user_upload/wbgu/publikationen/politikpapiere/pp10_2019/pdf/WBGU_PP10_EN.pdf (Accessed July 14, 2019).

Weber, E. U., 2006: Experience-based and description-based perceptions of long-term risk: Why global warming does not scare us (yet). *Clim. Change*, **77**, 103–120, https://doi.org/10.1007/s10584-006-9060-3.

Weber, E. U., 2013: Psychology: Seeing is believing. *Nat. Clim. Chang.*, **3**, https://doi.org/10.1038/nclimate1845.

Weber, E. U., 2016: What shapes perceptions of climate change? New research since 2010. *Wiley Interdiscip. Rev. Clim. Chang.*, **7**, 125–134, https://doi.org/10.1002/wcc.377.

Weinberger, R., and F. Goetzke, 2010: Unpacking Preference: How Previous Experience Affects Auto Ownership in the United States. *Urban Stud.*, **47**, 2111–2128, https://doi.org/10.1177/0042098009357354.

von Weizsäcker, C. C., 1971: Notes on endogenous change of tastes. *J. Econ. Theory*, **3**, 345–372, https://doi.org/10.1016/0022-0531(71)90037-8.

Wellesley, L., and A. Froggatt, 2015: *Changing Climate, Changing Diets: Pathways to Lower Meat Consumptiontle*. https://www.chathamhouse.org/publication/changing-climate-changing-diets.

Wells, P., X. Wang, L. Wang, H. Liu, and R. Orsato, 2020: More friends than foes? The impact of automobility-as-a-service on the incumbent automotive industry. *Technol. Forecast. Soc. Change*, **154**, 119975, https://doi.org/10.1016/j.techfore.2020.119975.

Wenham, C., J. Smith, and R. Morgan, 2020: COVID-19: the gendered impacts of the outbreak. *Lancet*, **395**, 846–848, https://doi.org/10.1016/S0140-6736(20)30526-2.

Wester, P., A. Mishra, A. Mukherji, and A. B. Shrestha, 2019: *The Hindu Kush Himalaya Assessment - Mountains, Climate Change, Sustainability and People*. Springer,.

White, R., 2011: Climate change, uncertain futures and the sociology of youth. *Youth Stud. Aust.*, **30**, 13–19.

White, S. C., 2017: Relational wellbeing: re-centring the politics of happiness, policy and the self. *Policy Polit.*, **45**, 121–136, https://doi.org/10.1332/030557317X14866576265970.

Whiting, K., L. G. Carmona, L. Brand-Correa, and E. Simpson, 2020: Illumination as a material service: A comparison between Ancient Rome and early 19th century London. *Ecol. Econ.*, **169**, 106502, https://doi.org/10.1016/j.ecolecon.2019.106502.

Whitmarsh, L., and A. Corner, 2017: Tools for a new climate conversation: A mixed-methods study of language for public engagement across the political spectrum. *Glob. Environ. Chang.*, **42**, 122–135, https://doi.org/10.1016/j.gloenvcha.2016.12.008.

Whittle, C., L. Whitmarsh, P. Hagger, P. Morgan, and G. Parkhurst, 2019: User decision-making in transitions to electrified, autonomous, shared or reduced mobility. *Transp. Res. Part D Transp. Environ.*, **71**, 302–319, https://doi.org/10.1016/j.trd.2018.12.014.

Whyte, K., 2017: Indigenous climate change studies: Indigenizing futures, decolonizing the anthropocene. *Engl. Lang. Notes*, **55**, 153–162, https://doi.org/10.1215/00138282-55.1-2.153.

Whyte, K. P., 2014: A concern about shifting interactions between indigenous and non-indigenous parties in US climate adaptation contexts. *Interdiscip. Environ. Rev.*, **15**, 114, https://doi.org/10.1504/IER.2014.063658.

Whyte, K. P., 2018: Indigenous science (fiction) for the Anthropocene: Ancestral dystopias and fantasies of climate change crises. *Environ. Plan. E Nat. Sp.*, **1**, 224–242, https://doi.org/10.1177/2514848618777621.

Wickramasinghe, A., 2015: Energy for rural women: beyond energy access. *International Energy and Poverty: The emerging contours*, L. Guruswamy, Ed., Routledge, 231–244.

Wiedenhofer, D., D. Guan, Z. Liu, J. Meng, N. Zhang, and Y.-M. Wei, 2017: Unequal household carbon footprints in China. *Nat. Clim. Chang.*, **7**, 75–80, https://doi.org/10.1038/nclimate3165.

Wiedenhofer, D., B. Smetschka, L. Akenji, M. Jalas, and H. Haberl, 2018: Household time use, carbon footprints, and urban form: a review of the potential contributions of everyday living to the 1.5 °C climate target. *Curr. Opin. Environ. Sustain.*, **30**, 7–17, https://doi.org/10.1016/j.cosust.2018.02.007.

——, and Coauthors, 2020: A systematic review of the evidence on decoupling of GDP, resource use and GHG emissions, part I: Bibliometric and conceptual mapping. *Environ. Res. Lett.*, **15**, 063002, https://doi.org/10.1088/1748-9326/ab842a.

Wiedmann, T., and J. Minx, 2008: A Definition of "Carbon Footprint." *Ecological Economics Research Trends*, C.C. Pertsova, Ed., Nova Science Publishers.

——, M. Lenzen, L. T. Keyßer, and J. K. Steinberger, 2020: Scientists' warning on affluence. *Nat. Commun.*, **11**, 1–10, https://doi.org/10.1038/s41467-020-16941-y.

Wildcat, D. R., 2014: Introduction: Climate change and indigenous peoples of the USA. *Climate Change and Indigenous Peoples in the United States: Impacts, Experiences and Actions*, Springer International Publishing, 1–7.

Wilhite, H., 2009: The conditioning of comfort. *Build. Res. Inf.*, **37**, 84–88, https://doi.org/10.1080/09613210802559943.

——, and R. Ling, 1995: Measured energy savings from a more informative energy bill. *Energy Build.*, **22**, 145–155, https://doi.org/10.1016/0378-7788(94)00912-4.

Wilkinson, R., and K. Pickett, 2009: *The Spirit Level: Why Greater Equality Makes Societies Stronger*. Bloomsbury Press,.

——, and ——, 2019: *The Inner Level: How More Equal Societies Reduce Stress, Restore Sanity and Improve Everyone's Well-Being*. Penguin,.

Wilkinson, R., K. Pickett, and R. De Vogli, 2010: Equality, sustainability, and quality of life. *BMJ*, **341**, 1138–1140, https://doi.org/10.1136/bmj.c5816.

Wilkinson, R. G., 2005: *The impact of inequality*. The New Press,.

Willett, W., and et al., 2018: Food in the Anthropocene: the EAT-Lancet Commission on healthy diets from sustainable food systems. https://doi.org/10.1016/S0140.

Williams, A., 2006: Product-service systems in the automotive industry: The case of micro-factory retailing. *J. Clean. Prod.*, **14**, https://doi.org/10.1016/j.jclepro.2004.09.003.

Williams, D. S., M. Máñez Costa, C. Sutherland, L. Celliers, and J. Scheffran, 2019: Vulnerability of informal settlements in the context of rapid urbanization and climate change. *Environ. Urban.*, **31**, 157–176, https://doi.org/10.1177/0956247818819694.

Williams, M., and B. Jaftha, 2020: Attitudes, beliefs and readiness to act on climate change: A preregistered replication. *Ecopsychology*,.

Williams, R. C., and Coauthors, 2015: The Initial Incidence of a Carbon Tax Across Income Groups. *Natl. Tax J.*, **68**, 195–214.

Wilson, C., 2009: *Meta-analysis of unit and industry level scaling dynamics in energy technologies and climate change mitigation scenarios*. 119 pp.

——, 2012: Up-scaling , formative phases , and learning in the historical diffusion of energy technologies. *Energy Policy*, **50**, 81–94, https://doi.org/10.1016/j.enpol.2012.04.077.

——, A. Grubler, K. S. Gallagher, and G. F. Nemet, 2012: Marginalization of end-use technologies in energy innovation for climate protection. *Nat. Clim. Chang.*, **2**, 780–788, https://doi.org/10.1038/nclimate1576.

——, N. Bento, B. Boza-Kiss, and A. Grubler, 2019a: Near-term actions for transforming energy-service efficiency to limit global warming to 1.5 °C. *eceee 2019 Summer Study on energy efficiency: Is efficient sufficient?*, Belambra Presqu’île de Giens, France, France, eceee.

——, H. Pettifor, E. Cassar, L. Kerr, and M. Wilson, 2019b: The potential contribution of disruptive low-carbon innovations to 1.5 °C climate mitigation. *Energy Effic.*, **12**, https://doi.org/10.1007/s12053-018-9679-8.

Wilson, C., A. Grubler, N. Bento, S. Healey, S. De Stercke, and C. Zimm, 2020a: Granular technologies to accelerate decarbonization. *Science (80-.).*, **368**, 36–39, https://doi.org/10.1126/science.aaz8060.

Wilson, C., L. Kerr, F. Sprei, E. Vrain, and M. Wilson, 2020b: Potential Climate Benefits of Digital Consumer Innovations. *Annu. Rev. Environ. Resour.*, **45**, https://doi.org/10.1146/annurev-environ-012320-082424.

Wilson, J. R., and Coauthors, 2018: Adaptive comanagement to achieve climate-ready fisheries. *Conserv. Lett.*, **11**, e12452, https://doi.org/10.1111/conl.12452.

Wilson, N. L. W., B. J. Rickard, R. Saputo, and S.-T. Ho, 2017: Food waste: The role of date labels, package size, and product category. *Food Qual. Prefer.*, **55**, 35–44, https://doi.org/10.1016/J.FOODQUAL.2016.08.004.

Wise, R. M., I. Fazey, M. Stafford Smith, S. E. Park, H. C. Eakin, E. R. M. Archer Van Garderen, and B. Campbell, 2014: Reconceptualising adaptation to climate change as part of pathways of change and response. *Glob. Environ. Chang.*, **28**, 325–336, https://doi.org/10.1016/j.gloenvcha.2013.12.002.

Wolbertus, R., M. Kroesen, R. van den Hoed, and C. G. Chorus, 2018: Policy effects on charging behaviour of electric vehicle owners and on purchase intentions of prospective owners: Natural and stated choice experiments. *Transp. Res. Part D Transp. Environ.*, **62**, 283–297, https://doi.org/10.1016/j.trd.2018.03.012.

De Wolf, C., F. Yang, D. Cox, A. Charlson, A. S. Hattan, and J. Ochsendorf, 2015: Material quantities and embodied carbon dioxide in structures. *Proc. Inst. Civ. Eng. - Eng. Sustain.*, **169**, 150–161, https://doi.org/10.1680/ensu.15.00033.

Wolfram, P., T. Wiedmann, and M. Diesendorf, 2016: Carbon footprint scenarios for renewable electricity in Australia. *J. Clean. Prod.*, **124**, 236–245, https://doi.org/10.1016/j.jclepro.2016.02.080.

Wolsink, M., 2007: Wind power implementation: The nature of public attitudes: Equity and fairness instead of "backyard motives." *Renew. Sustain. Energy Rev.*, **11**, 1188–1207, https://doi.org/10.1016/j.rser.2005.10.005.

Women's Budget Group, 2020: *Creating and Caring Economy: A Call to Action*. https://wbg.org.uk/wp-content/uploads/2020/09/CGEE-Creating-a-Caring-Economy-A-Call-to-Action-WBG.pdf (Accessed October 2, 2020).

Wong-Parodi, G., T. Krishnamurti, J. Gluck, and Y. Agarwal, 2019: Encouraging energy conservation at work: A field study testing social norm feedback and awareness of monitoring. *Energy Policy*, **130**, 197–205.

Wood, G., and M. Newborough, 2003: Dynamic energy-consumption indicators for domestic appliances: Environment, behaviour and design. *Energy Build.*, **35**, 821–841, https://doi.org/10.1016/S0378-7788(02)00241-4.

World Bank, 2019: CO2 emissions (metric tons per capita). *World Bank Data*,. https://data.worldbank.org/indicator/EN.ATM.CO2E.PC (Accessed December 11, 2019).

Worrell, E., and M. A. E. Van Sluisveld, 2013: Material efficiency in Dutch packaging policy. *Philos. Trans. R. Soc. A Math. Phys. Eng. Sci.*, **371**, https://doi.org/10.1098/rsta.2011.0570.

Wu, S., X. Zheng, and C. Wei, 2017: Measurement of inequality using household energy consumption data in rural China. *Nat. Energy*, **2**, 795–803, https://doi.org/10.1038/s41560-017-0003-1.

Wu, X. D., J. L. Guo, J. Meng, and G. Q. Chen, 2019: Energy use by globalized economy: Total-consumption-based perspective via multi-region input-output accounting. *Sci. Total Environ.*, **662**, 65–76, https://doi.org/10.1016/j.scitotenv.2019.01.108.

Wüstenhagen, R., M. Wolsink, and M. J. Bürer, 2007: Social acceptance of renewable energy innovation: An introduction to the concept. *Energy Policy*, **35**, 2683–2691, https://doi.org/10.1016/j.enpol.2006.12.001.

Xie, B., M. J. Hurlstone, and I. Walker, 2018: Correct me if I'm wrong: groups outperform individuals in the climate stabilization task. *Front. Psychol.*, 17–28, https://doi.org/10.3389/fpsyg.2018.02274.

Yadav, P., A. P. Heynen, and D. Palit, 2019: Pay-As-You-Go financing: A model for viable and widespread deployment of solar home systems in rural India. *Energy Sustain. Dev.*, **48**, 139–153, https://doi.org/10.1016/j.esd.2018.12.005.

Yamamura, E., 2014: Trust in government and its effect on preferences for income redistribution and perceived tax burden. *Econ. Gov.*, **15**, 71–100, https://doi.org/10.1007/s10101-013-0134-1.

Yamin, F., A. Rahman, and S. Huq, 2005: Vulnerability, Adaptation and Climate Disasters: A Conceptual Overview. *IDS Bull.*, **36**, 1–14, https://doi.org/10.1111/j.1759-5436.2005.tb00231.x.

Yan, L., X. Luo, R. Zhu, P. Santi, H. Wang, D. Wang, S. Zhang, and C. Ratti, 2020: Quantifying and analyzing traffic emission reductions from ridesharing: A case study of Shanghai. *Transp. Res. Part D Transp. Environ.*, **89**, 102629, https://doi.org/10.1016/j.trd.2020.102629.

Yangka, D., and M. Diesendorf, 2016: Modeling the benefits of electric cooking in Bhutan: A long term perspective. *Renew. Sustain. Energy Rev.*, **59**, 494–503, https://doi.org/10.1016/j.rser.2015.12.265.

Yao, Y., M. Hu, F. Di Maio, and S. Cucurachi, 2020: Life cycle assessment of 3D printing geo-polymer concrete: An ex-ante study. *J. Ind. Ecol.*, **24**, https://doi.org/10.1111/jiec.12930.

Yellowfly, C. L., 1992: An alternative strategy for resource development : a Gitksan Wet'suwet'en proposal. https://doi.org/10.14288/1.0086566.

Yin, B., L. Liu, N. Coulombel, and V. Viguié, 2017: Evaluation of ridesharing impacts using an integrated transport land-use model: A case study for the Paris region. *Transp. Res. Procedia*, **27**, 824–831, https://doi.org/10.1016/j.trpro.2017.12.083.

Yoeli, E., M. Hoffman, D. G. Rand, and M. A. Nowak, 2013: Powering up with indirect reciprocity in a large-scale field experiment. *Proc. Natl. Acad. Sci. U. S. A.*, **110**, 10424–10429, https://doi.org/10.1073/pnas.1301210110.

——, and Coauthors, 2017: Behavioral science tools to strengthen energy & environmental policy. *Behav. Sci. Policy*, **3**, 68–79, https://doi.org/10.1353/bsp.2017.0006.

You, J., 2012: Social Trust: Fairness Matters More Than Homogeneity. *Polit. Psychol.*, **33**, 701–721, https://doi.org/10.1111/j.1467-9221.2012.00893.x.

Young, W., K. Hwang, S. McDonald, and C. J. Oates, 2010: Sustainable consumption: green consumer behaviour when purchasing products. *Sustain. Dev.*, **18**, 20–31, https://doi.org/10.1002/sd.394.

Yu, A., Y. Wei, W. Chen, N. Peng, and L. Peng, 2018: Life cycle environmental impacts and carbon emissions: A case study of electric and gasoline vehicles in China. *Transp. Res. Part D Transp. Environ.*, **65**, 409–420, https://doi.org/10.1016/j.trd.2018.09.009.

Yuana, S. L., F. Sengers, W. Boon, M. A. Hajer, and R. Raven, 2020: A dramaturgy of critical moments in transition: Understanding the dynamics of conflict in socio-political change. *Environ. Innov. Soc. Transitions*, **37**, 156–170, https://doi.org/10.1016/j.eist.2020.08.009.

Yumashev, A., B. Ślusarczyk, S. Kondrashev, and A. Mikhaylov, 2020: Global Indicators of Sustainable Development: Evaluation of the Influence of the Human Development Index on Consumption and Quality of Energy. *Energies*, **13**, 2768, https://doi.org/10.3390/en13112768.

Zangheri, Serrenho, and Bertoldi, 2019: Energy Savings from Feedback Systems: A Meta-Studies' Review. *Energies*, **12**, 3788, https://doi.org/10.3390/en12193788.

Zapico Lamela, J. L., M. Turpeinen, and M. Guath, 2011: Kilograms or cups of tea: comparing footprints for better CO2 understanding. *PsychNology*, **9**, 43–54.

Zhang, Y., and Z. Mi, 2018: Environmental benefits of bike sharing: A big data-based analysis. *Appl. Energy*, **220**, 296–301, https://doi.org/10.1016/j.apenergy.2018.03.101.

——, D. Lin, and Z. Mi, 2019: Electric fence planning for dockless bike-sharing services. *J. Clean. Prod.*, **206**, 383–393, https://doi.org/10.1016/j.jclepro.2018.09.215.

Zheng, J., A. A. Chien, and S. Suh, 2020: Mitigating Curtailment and Carbon Emissions through Load Migration between Data Centers. *Joule*, **4**, https://doi.org/10.1016/j.joule.2020.08.001.

Zhou, S., D. Noonan, S. Zhou, and D. S. Noonan, 2019: Justice Implications of Clean Energy Policies and Programs in the United States: A Theoretical and Empirical Exploration. *Sustainability*, **11**, 807, https://doi.org/10.3390/su11030807.

Zimm, C., 2019: Methodological issues in measuring international inequality in technology ownership and infrastructure service use. *Dev. Stud. Res.*, **6**, 92–105, https://doi.org/10.1080/21665095.2019.1605533.

Zimmerman, M. A., and G. J. Zeitz, 2002: Beyond Survival : Achieving New Venture Growth by Building Legitimacy. *Acad. Manag.*, **27**, 414–431, https://doi.org/10.5465/amr.2002.7389921.

Zink, T., and R. Geyer, 2017: Circular Economy Rebound. *J. Ind. Ecol.*, **21**, 593–602, https://doi.org/10.1111/jiec.12545.

de Zoysa, U., 2011: Millennium consumption goals: A fair proposal from the poor to the rich. *Sustain. Sci. Pract. Policy*, **7**, 1–5, https://doi.org/10.1080/15487733.2011.11908060.

Zubi, G., G. V. Fracastoro, J. M. Lujano-Rojas, K. El Bakari, and D. Andrews, 2019: The unlocked potential of solar home systems; an effective way to overcome domestic energy poverty in developing regions. *Renew. Energy*, **132**, 1425–1435, https://doi.org/10.1016/j.renene.2018.08.093.

Supplementary Material Chapter 5: Social Science Primer

Supplementary Material of Chapter 5 (Social Science Primer) aims to present multiple fundamental frameworks and concepts that help explain the variety in social aspects of demand side responses to climate mitigation. It does not aim to resolve any debates about the diversity in perspectives and approaches on this topic in the literature. Instead its goal is to describe more fully some common concepts and terminologies that are mentioned in this first-ever full chapter (Chapter 5) in an IPCC report on demand-side, energy-service, and social aspects of mitigation. Chapter 5 uses social science perspectives to examine societal level challenges and opportunities for mitigation options that involve end-users, with an eye on policy relevant insights about the drivers' processes and potential of demand-side solutions. Glossary definitions provide insufficient background information for new concepts used in this IPCC report to present social science perspectives. This primer is not meant to be complete and comprehensive, but is an easily accessible short handbook and a living document in the IPCC process.

There has been continuous advancement in the way demand-side choice processes have been viewed and modelled in the IPCC and energy and carbon mitigation policy community. From AR1 to AR4, rational decision making as defined by microeconomics was the implicit assumption, where homogeneous individual agents maximise self-focused utility/ expected utility, with the only consequential variations of this *homo economicus* relating to income, wealth, risk attitude, and time discount rate (Persky 1995). AR5 (Kunreuther et al. 2014) introduced a broader range of goals that are held by *homo sapiens* (material goals like those of *homo economicus*, but also self- and other-regarding social goals, and psychological goals such as confidence and feeling in control). It also considered a broader range of decision processes (calculation-based, but also affect-based, and role- and rule-based processes) designed to allow timely decisions within a context of bounded rationality as the result of attentional and processing limitations. AR5's perspective on decisions and action, like the rational choice perspective, remained individual- and agency-focused and thus did not explicitly address the role of structural, cultural, and institutional constraints and the pervasive influence of physical and social context, beyond simple choice-architecture interventions that modify the context or format in which choice alternatives are presented (Thaler and Sunstein 2003).

AR5 (Kunreuther et. al 2014) reviewed how experts and the general population differed in their responses to risky and uncertain climate information and the importance for experts/scientists/policy makers to understand and predict the public's reaction in order to communicate climate risks and uncertainties effectively. Its introduction of a broader range of goals and decision processes than those of *homo economicus* has important implications for IPCC scenarios by introducing additional uncertainty about the effects of climate change (e.g., temperature increases or extreme weather) on human behaviour and hence future GHG emissions (Beckage et al. 2018). At the same time, an agency-based framework that includes the many influences on individual decisions that go beyond rational choice and rational expectations (e.g., responses to extreme events, perceived behavioural control, and perceived social norms) explains many anomalies observed by ecologists in the field (Schlüter et al. 2017; Beckage et al. 2018) and generates a broader set of demand-side policy options and more effective ways of implementing them.

Given the focus in AR6 on assessing growing social inequity but need for participation in managing the global common good, the need for increased used of energy and materials to bridge the gap in wellbeing in some parts of the world while there is co-existing reality of wasteful consumption and production systems, while at the same time the need for accelerated emissions reduction and socio-economic transitions, this Social Science Primer strives to provide frameworks for understanding the challenges of systemic change, emergent transition phases and patterns, and what determines technological choice. So it is not just about socio-technical relations alone, but also includes social groups, justice, wellbeing, normative goals for growth in terms of desirability and sufficiency and effective policy frameworks as important factors in mitigation, drawing from various domains of social science. The **societal perspective** in Chapter 5 of AR6 very broadly focuses on human society and human agency, where political power structures, infrastructure, and technology interact to deliver services that provide dignified living for all, irrespective of geographical location, which is compatible with cosmopolitan justice theories.

The following figure (Figure SM5.15) summarises key results of papers in the social science literature with the highest topic score (highest amount of references to key social science topics) and/or highest citation count, organised by mitigation sector. It builds on 34 search queries on demand-side climate change mitigation and 99,065 unique papers, which were fed into a machine learning algorithms to identify 60 topic models (vectors of 10 co-occuring key words) (Creutzig et al. 2021a). Expert judgement identified the 24 topics models most relevant to demand-side climate change mitigation (see also Figure 5.2). In a next step, the key papers from the topic models were summarised, selected from the ten most cited of each topic model with topic score > 0.1, and the 10 with highest topic score, finding a wide array from insights, ranging from the importance of consumption-based carbon footprints, to sectoral interventions, to policy instruments, and the key insight that demand and supply are interdependent and require joint consideration. Figure SM5.1 further condenses these insights into headline statements in a clustered summary.

Heat and demand for thermal comfort can be met with distributed renewables, thermal storage, and passive housing.	**Communities** can instigate local energy and retrofitting projects, and create trust, but operate in the context of broader governance.	**Buildings'** GHG emissions can be reduced by retrofitting, adequate floor space, re-use of buildings, and efficiency technologies.	With international trade, not only territorial but also consumption-based **GHG emission** footprintsrequire policy attention.
Cities are places of visioning, where collective action instigate changes in infrastructure to low-carbon service provisioning.	**Rural households** are often vulnerable and require information and credit to adapt to climate change	In **social housing**, gender and care of the elderly, for example, in face of heat waves are key and require good housing stock and management.	Direct environmental **taxes**, if sufficiently high, are highly effective and fair, if complemented with impartial redistribution of revenue.
Energy demand is growing inter alia because of increasing floor and higher need for cooling.	**Governance** operates on multiple scales and includes many actors, all of relevance for climate change mitigation.	**Sustainability** encompasses holistic goal thinking, drawing bridges between social and physical sciences.	Cost savings motivate reducing energy and material use, but current **cost-benefit** analysis under-values uncertain environmenal damages
Policy instrument deployment is seen as evolutionary trajectories, requiring adapting policy packages and intelligent sequencing.	Absolute decoupling between **GDP** and GHG emissions has not (yet) been observed at appropriate scale.	**Low-carbon development** builds on complemetary demand and supply side policies and decisions.	High-growth in **tourism** and aviation endangers climate stabilization, with COVID-19 opening the opportunity to rethink tourism.
Connected, mixed-use, and medium-density cities with public **transport** systems and cycling infrastrure avoid the necessity of car use.	Rapid substitution of coal and gas by renewable **electricity** is key, especially for emerging economies, and to also realize low-carbon sector coupling.	A small price elasticity effect on demand can generate wider change in consumption via behavioral contagion and resulting **new social norms**.	Reducing **waste** and re-using it for new purposes are central tenets of a (still speculative) circular economy.
Changing people's mode and distance, e.g. by enabling active **travel**, and by reducing luxury air travel and luxury cars supports decarbonization.	Attitudes, perceived behavioral control, and charging station unavailability are key constraint for adoption of electric **vehicles**.	Farm-system solutions, reducing food mileage, and especially **dietary** shift can reduce GHG emissions dramatically and improve health.	Changing **consumption** to low-GHG emissions high-wellbeing options build on behavioral change, new social norms, structures and incentives.

Figure SM5.15 Cluster-oriented summary of key messages drawn from academic publications in social science literature. Source: (Creutzig et al. 2021a)

Low-carbon ways of producing the services that are necessary for everyone's wellbeing are the foundation of the post-carbon societal transition. Advancing this transition depends not just on progress indicators that measure wellbeing, equity, and sufficiency in relation to emissions and ecological health, but also on technological innovations, evolving social norms, policy frameworks, and global networking to share successful ways of building global socioeconomic equity while reducing global emissions. The tight links between equity, wellbeing for all, and emissions reductions are demonstrated in growing interdisciplinary literatures, (also outlined in AR6 Chapter 5, Section 5. 2). This Social Science Primer provides the theoretical underpinnings for these concepts, drawing from various social sciences (see also (Creutzig et al. 2018; Hayward and Roy 2019; Jorgenson et al. 2019; Hess and Sovacool 2020)).

From an economics perspective, for example, expanding concepts of value to include nonmarketed social and ecological factors, unpaid work, and informal-sector production makes possible a broader participation and more inclusive view of economic activity and its total benefits and costs. Individual and collective choices, including not only what to consume but how best to foster local contexts for wellbeing, are reflected in new literatures on relative provisioning, sufficiency, decent standards of living for all, and the costs of socioeconomic inequality. Sufficiency in economics (also discussed in AR6 Chapter 9 of this reports, GEA 2012 chapter 21 on lifestyles, wellbeing and energy) expresses the idea that ecological limits necessitate restraint to prevent overconsumption; short and longterm risks including those related to climate change can only be mitigated by going beyond cooperation and efficiency to sufficiency (Princen 2003; Mongsawad 2012; Bierwirth and Thomas 2019; Fawcett and Darby 2019; Hayward and Roy 2019; Monyei et al. 2019). Behavioural changes that reduce energy consumption can lead to rebound and spillover effects that can partially counter the benefits, or enhance welfare depending on the context (Chakravarty et al. 2013; Brockway et al. 2017; Van Lange et al. 2018; Rogelj et al. 2018; Shao et al. 2019; Yan et al. 2019; Court and Sorrell 2020; Saunders et al. 2021). Intersectional inequities related to geography, gender, race, Indigeneity, ethnicity and other factors interrupt the fair distribution of income, resources, energy access and emissions, further restricting the margin of manoeuvre for climate action and the urgency of operationalising sufficiency norms. One way to foster this is through multi-dimensional affordability, which includes not only economic affordability but also social, motivational, and institutional/environmental affordability, as part of consumption choice processes-all influenced by policies (Spangenberg and Lorek 2019). Information for consumers, communities and policy-makers about the equity and emissions implications of their decisions, such as that provided by the Ecological Footprint (Kopp and Dorn 2018; Lin et al. 2018; Yunani et al. 2020) and the Carbon Footprint (Wiedmann and Minx 2008), can facilitate multi-dimensional choice processes (Beattie and Sale 2009; González-García et al. 2018; Wood et al. 2020). Empirical social sciences research is addressing earlier discrepancies in methods and challenges in estimating these indicators across global supply chains, income levels, energy technologies, time frames, and systems boundaries (Matthews et al. 2008; Chen et al. 2016; Kanemoto et al. 2016; Bello et al. 2018; Fenner et al. 2018; Lenzen et al. 2018; Pichler et al. 2019; Zheng and Suh 2019). Decent Living Standards (DLS) is another way to express the socio-political goal of prioritising necessities over luxuries while limiting emissions (Dearby 2007; Gorge et al. 2014; Rao and Pachauri 2017; Otto et al. 2019; Rao et al. 2019; Millward-Hopkins et al. 2020). Like the early footprint indicators, DLS omits intermediate service provision and some important components of wellbeing such as collective, land-based cultural values (Ikuenobe 2016; Bullock et al. 2018; Choy 2018; Richardson et al. 2019; Raymond et al. 2019) in its focus on material prerequisites of wellbeing (Rao and Min 2018). Socially-determined and contextual measures of value and individual/collective wellbeing also interrelate with social norms regarding acceptable or expected consumption levels, as shown in Figure SM5.16. This has implications for emissions, since appropriate modes of service provision within different cultural contexts, and in situations of changing social norms and preferences, can facilitate the effective decoupling of service provision from energy use (Jackson 2005; Akenji 2014; Komiyama 2014; Brand-Correa and Steinberger 2017; Mastrucci and Rao 2017; O'Neill et al. 2018; Rao and Min 2018a; Mastrucci and Rao 2019; Vita et al. 2019a, 2020; Wiedenhofer et al. 2020).

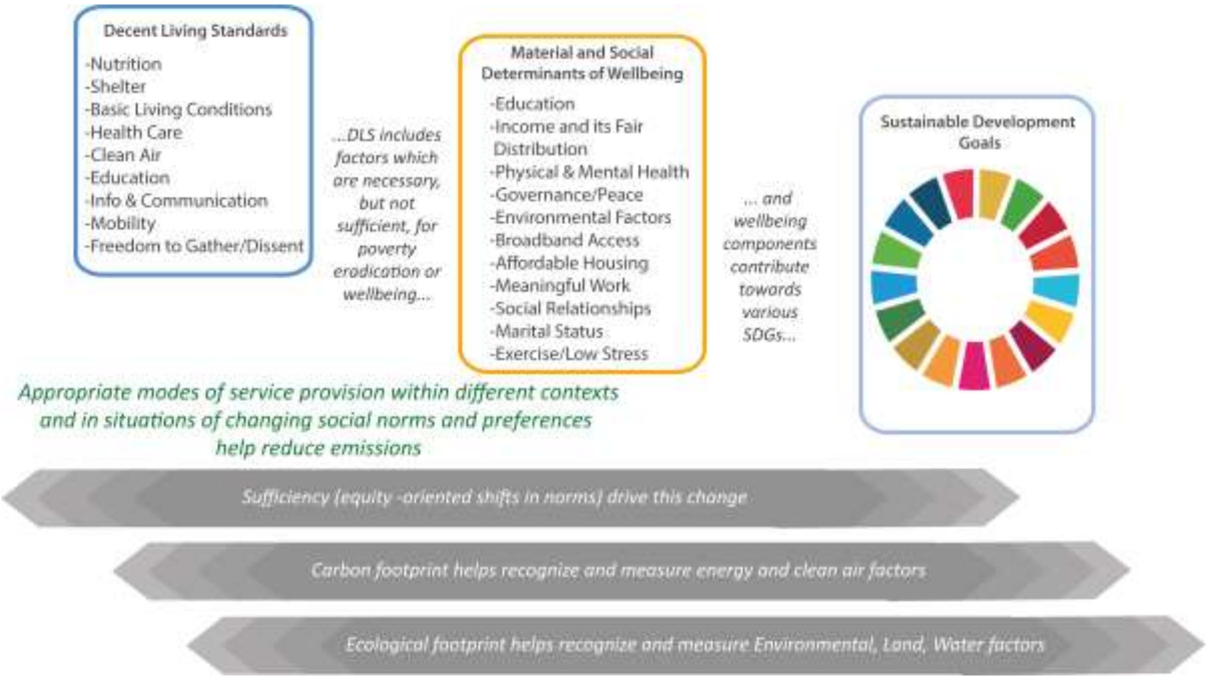


Figure SM5.16 The relationships among indicators of Decent Living Standards, Wellbeing, Footprints, Sufficiency and the Sustainable Development Goals

Demand-side contributions to mitigation – or those related to what consumers choose to buy-are more promising than Supply-side contributions – or those related to what producers choose to offer for sale, exactly because they allow consumers/users to select the best way to further their own wellbeing, making trade-offs across sectors and technologies as best suits their needs and contexts (Creutzig et al. 2021b).

There are multiple components of systemic change, and one way to dynamically represent change in the demand for GHG-emission-intensive products and services is to map it across the key concepts of agency, structure, meaning, relations, and norms (Sovacool and Hess 2017, Hess and Sovacool 2020). This involves the potential of individuals to change their consumption patterns and to act collectively in driving institutional change (agency), the redesign of infrastructures and technologies to foster low-carbon consumption patterns (structure), and the (re)establishment of cultures and social norms in alignment with consumption patterns that have few associated GHG emissions (meaning). Even a broad set of individual-based decision factors accounts at best for 30-40% of the variance in climate action, suggesting that behavioural change is not only a function of individual agency but also depends on other enabling factors, such as infrastructures, social norms, and professional roles (Bamberg et al. 2007b; Whitmarsh et al. 2017). Chapter 5 reflects this more inclusive view of different disciplinary and philosophical perspectives on individual and collective energy decisions (Grubb 2014; Riahi et al. 2015; Grubler et al. 2018; Mundaca et al. 2019; Creutzig et al. 2018, 2016). It broadens the individually-focused agency framework of micro- and behavioural economics and psychology by also including considerations of structure and meaning, i.e., the hardware and software of the social, cultural, and physical context studied by disciplines like geography, ecology, sociology, urban planning, and anthropology.

Disciplines vary in their approaches and research questions on demand side issues. For example, psychologists and behavioural economists focus on emotional factors and cognitive biases in decision making (Poortinga et al. 2019; Mills and Schleich 2012; Niamir et al. 2020a; Bamberg et al. 2007a); economists elaborate on how, under rational decision-making, carbon pricing and other fiscal instruments can trigger change in demand (Ameli and Brandt 2015) and help transitions to low carbon futures (Roy et al. 2013); normative economics focuses on enabling conditions for sustainable human development; sociologists emphasise every-day practices, structural issues, and socio-economic inequality; anthropologists address the role of culture in energy consumption; urban planners take the role of infrastructures as an entry point; and studies in technological innovation consider socio-technical transitions and the norms, rules and pace of adoption that support dominant technologies. Political scientists consider the roles of ideology, democracy, institutions, and politics in shaping societal transformation. Generally, social sciences share a focus on interpersonal and collective outcomes–how people shape their cultures and livelihoods together. Social practice theory emphasises interactions between artefacts, competences, and cultural meanings (Shove and Walker 2014; Røpke 2009). The energy cultures framework highlights feedbacks between materials, norms, and behavioural practices (Stephenson et al. 2015; Jürisoo et al. 2019). Socio-technical transitions theory addresses interactions between technologies, user practices, cultural meanings, business, infrastructures, and public policies (McMeekin and Southerton 2012; Geels et al. 2017a) and thus accommodates the five drivers of change and stability discussed in Section 5.4 and 5.5 in chapter 5 of WGIII of AR6.

This primer provides additional information about key concepts and processes described in AR6 Chapter 5. Section SM5.1 elaborates on key concepts from Section 5.2 of Chapter 5: well-being, equity, and decent living standards. Sections SM2-4 then provide background information on the five drivers of change introduced in Section 5.4 of Chapter 5, divided into the three categories shown in: Individual concepts and processes provide background on the behavioural drivers of change; social concepts and processes elaborate on the socio-cultural drivers of change; and structure elaborates on the business, technology, and institutional drivers of change (see (United Nations Environment Programme 2020)) (Figure SM5.17). Section SM5.5 provides additional background on transitions and Section SM5.6 provides several case studies as illustrative examples drawn from both developed and developing countries of social processes in various contexts of technology uptake, service provisioning and shifts in choices.

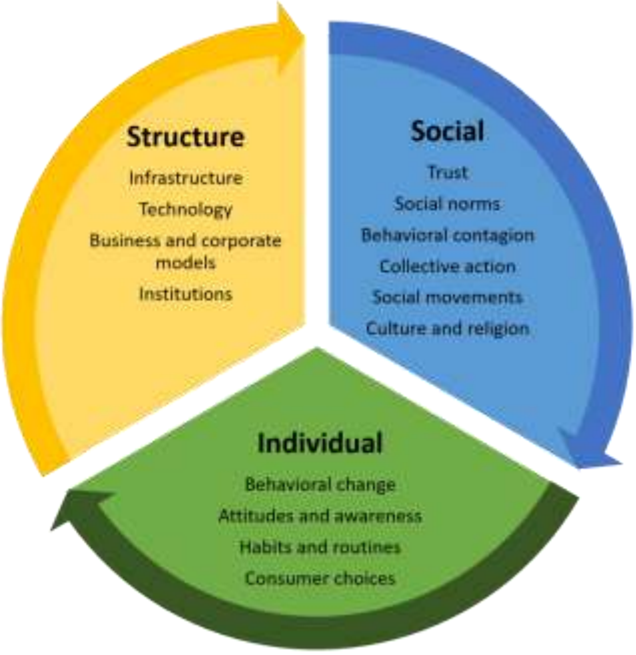


Figure SM5.17 Drivers of change: Perspectives and underlying concepts and processes

SM 5.1 Wellbeing, equity, decent living standards

Wellbeing for all is a cornerstone of sustainable development (Princen 2003; Dasgupta and Dasgupta 2017) and directly underpins the Sustainable Development Goals (SDGs). A focus on human wellbeing improves upon GDP, which is an inadequate and incomplete goal for socio-economic activities (Faber et al. 2012; Zimmerer 2012; Arrow et al. 2013; Dasgupta 2013; Griggs et al. 2013; Hobson 2013; Dasgupta 2014; Gabriel and Bond 2019; Hayward and Roy 2019). Human wellbeing is a description of the state of individuals' life situation in multiple dimensions that captures their life circumstances (Mcgillivray and Clarke 2006). Constituents of well-being include health, happiness, meaningful work and social relationships, freedom and liberty, while determinants are the inputs that enable wellbeing such as food, shelter, water, access to knowledge and information (Dasgupta 2001). A well-being focus emphasises equity and universal need satisfaction, compatible with SDG progress (Lamb and Steinberger 2017). GDP is dominating the current economic wellbeing driven development literature, assuming that welfare is still predominantly associated with increased levels of consumption of products and services (Roy et al. 2012). However, GDP only measures economic activity and neglects inequality and services delivered by current capital stocks (Haberl et al. 2019); it is therefore, a poor proxy for societal well-being (Ward et al. 2016). Instead, several new indices have emerged to measure well-being (i.e. Human Development Index, OECD better life initiative, QoL Index, Gallup Health, Well-Being Index, Gross National Happiness, Happy Planet Index) but finding a single measure represents a challenge due the lack of data (Sugiawan and Managi 2019). Economic growth in equitable societies is associated with lower emissions than in inequitable societies (McGee and Greiner 2018), and income inequality is associated with higher global emissions (Ravallion et al. 1997; McGee and Greiner 2018; Rao and Min 2018b; Diffenbaugh and Burke 2019; Fremstad and Paul 2019; Liu and Hao 2020). Relatively slight increases in energy consumption and carbon emissions produce great increases in human development and wellbeing in less-developed countries, and the amount of energy needed for a high global level of human development is dropping (Steinberger and Roberts 2010).

Policies designed to foster higher well-being for all via climate mitigation include reducing emissions through wider participation in climate action, building more effective governance for improved mitigation, and including social trust, greater equity, and informal-sector support as integral parts of climate policies. Better education, health care, valuing of social diversity, and reduced poverty – characteristics of more equal societies–all lead to resilience, innovation, and readiness to adopt progressive and locally-appropriate mitigation policies, whether high-tech or low-tech, centralised or decentralised (Martin 2016; Chu 2015; Cloutier et al. 2015; Vandeweerdt et al. 2016; Mitchell 2015; Tanner et al. 2009; Turnheim et al. 2018; Lorenz 2013). There is less policy lock-in in more equitable societies (Seto et al. 2016). International communication, networking, and global connections among citizens are more prevalent in more equitable societies, and these help spread promising mitigation approaches (Scheffran et al. 2012). Climate-related injustices are addressed where equity is prioritised (Klinsky and Winkler 2014). Thus, there is high confidence in the literature that addressing inequities in income, wealth, and DLS not only raises overall wellbeing and furthers the SDGs but also improves the effectiveness of climate change mitigation policies.

Recently, measures such as inclusive wealth (the sum of capital assets that form the productive base of an economy) are proposed as an indicator to replace GDP for measuring well-being (Arrow et al. 2013; Dasgupta et al. 2015; UNEP 2018; Sugiawan and Managi 2019). Another measure for considering aspects of social progress beyond economic activity is the recently established social progress index (SPI), a composite index based on a dashboard of outcome-oriented indicators of fulfilment of basic human needs and foundations of well-being (Haberl et al. 2019) considering opportunities such as nutrition, shelter, water, safety, access to knowledge and information, health, education, freedom, rights and environmental quality. All of these considerations have been fully or partially reflected in the

United Nation's Sustainable Development Goals (SDGs), politically agreed upon goals of human wellbeing and planetary stability for the year 2030.

Decent Living Standards (DLS) is a tool for assessing wellbeing for all as need satisfiers. It is defined as the minimum set of inputs required for a decent human livelihood, anywhere in the world (Doyal and Gough 1991; Neri 2002; Adema 2006; Antony and Visweswara Rao 2007; Saramet 2007; Acs and Turner 2008; Rao and Baer 2012; Frye 2013; Saramet et al. 2009; Brand-Correa and Steinberger 2017; Rao and Min 2018c) (see also Chapter 9.1). The DLS goes beyond existing multidimensional poverty indicators by addressing living conditions and social participation, and offers a normative basis to assess environmental impacts and climate change (Rao and Min 2018c). It is based on human needs theory, which argues that material dimensions of well-being correlate with needs satisfaction, but only up to a threshold, after which additional needs satisfier use does not result in significant improvements in needs satisfaction (Frank 2010; Stiglitz 2012; Oishi et al. 2018; Xie et al. 2018; Wilkinson and Pickett 2009, 2019a; Doyal and Gough 1991). It is also closely related to eudaimonic wellbeing approaches focused on realising human potential, not just seeking pleasure and avoiding pain (Lamb and Steinberger 2017). DLS services include adequate nutrition, shelter, hygiene, clothing, healthcare, mobility, education, communication, and information access.

Services are activities that help satisfy human wants or needs. While they usually involve interactions between producers and consumers, services are less tangible and less storable than goods, and may involve personal relationships(Arent et al. 2015; Millonig and Haustein 2020).Wellbeing needs are met through services. Provision of services associated with low-energy demand is a key component of current and future efforts to reduce carbon emissions. Services can be provided in various culturally-appropriate ways, with diverse climate implications. People demand services for dignified survival, sustenance, mobility, communication, comfort and material wellbeing (Nakićenović et al. 1996; Johansson et al. 2012; Creutzig et al. 2018). Access to services is fundamental, rather than only physical resources (biomass, energy, materials, etc.) and technologies (e.g. cars, appliances). Two key concepts for evaluating the efficiency of service provision systems are: resource cascades and exergy(Grubler et al. 2012). These concepts provide powerful analytical lenses through which to identify and substantially reduce energy and resource waste in service provision systems both for decent living standards (see section .in the main chapter) and higher wellbeing levels 5.3.3

Equity and ASI framework. Mitigation, equity and wellbeing go hand in hand. Both distributive justice and procedural justice are important in mitigation action (Roy et al. 2018a). Given the current level of inequity both within and between countries in access to services needed for dignified living for effective policy/mitigation action while increase in current overall service provision in considered at the same time how irresponsible consumption, waste reduction can also be avoided is gaining attention in the literature to tilt the balance towards sustainable future (more in sections 5.2 and 5.4 of Chapter 5 of WGIII, AR6). The options for avoid (A), shift (S) and improve (I) in relatively adequately currently provided service access is also considered. ASI add wider range of perspective and options. Inclusion of various social categories/groups is also attached importance keeping in view the role of trust in collective action for governing mitigation action. Endogenous Preference Framing is one of the corner stone of the chapter 5. People drive social change by making choice of actions with varying outcome.

SM 5.2 Individual perspectives

SM 5.2.1 Agency

Agency is defined as the capacity to act, both individually and collectively, as shaped by different physical, social, historical, cultural, and other contexts. Using their agency, people engage in existing social practices, and also may step outside routines and engage in new behaviours. Agency is realised through different social roles for action, which include as citizen, role model, community member, worker, investor, professional, household member, consumer, etc. In the demand-side mitigation options space, agency is expressed by actors (individuals and households) who differ in motivations and goals, and in their capacities for change as shaped by different physical, social, historical, and cultural contexts.

SM 5.2.2 Behaviour change

Decisions or action that directly or indirectly reduce energy demand can be motivated by market- and non-market forces, and can be either legally vs. socially vs. ethically binding. It has long been thought useful to conceive of consumers as "rational actors," attentive to incentives, including all relevant costs and benefits (Becker 2013). If the price of certain goods increases, people will buy less of them. Under this framework, moral commitments, and social norms, may or may not matter (Becker and Murphy 2000). If they do, it is because violations of a social norm operate as a kind of "tax", leading a consumers to take steps to avoid such violations. The large point is that demand-side behaviour is above all reflection of what consumers perceive as costs and benefits. If, for example, consumers believe that it is in their interest to engage in consumption patterns that lead to a high-carbon economy, then a high-carbon economy is much more likely. A transition to a low-carbon economy will require a significant shift in incentives. This understanding of consumer behaviour has clear implications for policy – suggesting, for example, that appropriate taxes or subsidies can lead to major reductions in greenhouse gas emissions. But it misses important features of human judgment and decision making (Kahneman 2011; Thaler 2015), with relevant implications for environmental policy (Sunstein and Reisch 2014; Creutzig et al. 2016). For example, people may show "status quo bias," which means that they might continue to do what they have been doing, even if it would be in their interest to change (Samuelson and Zeckhauser 1988). Consumers may show "present bias," in the sense that they might focus on the short-term, even if it would be in their interest to consider the long-term (O'Donoghue and Rabin 2015). Whether consumers are responsive to incentives depends on whether those incentives are salient (Gabaix and Laibson 2018). Some characteristics of activities and products are "shrouded," even though they matter to consumer's wellbeing, and consumer may not pay a great deal of attention to them. In addition, norms matter, and can greatly affect behaviour (Lessig 1995). To influence consumer demand, policymakers have an assortment of tools, including prohibitions, mandates, taxes, fees, subsidies, and "nudges" (Thaler and Sunstein 2009), defined to include such choice-preserving interventions as information, warnings, reminders, uses of social norms, and default rules, such as automatic enrolment in "green energy," such as wind or solar (Ebeling and Lotz 2015). It would make little sense to say, in the abstract, that one tool is better than another; the choice of tool depends on its effects on wellbeing in the relevant context. In principle, a carbon tax has many advantages over any other approach, because it forces consumers to bear the cost of their activities (Nordhaus 2013). But automatic enrolment in green energy might be a useful complement to a carbon tax, especially if that tax is too low. Responses and actions by these actors interact in complex ways that differ from the more linear integration in conventional (integrated assessment) models or macroeconomic computable general equilibrium models. Novel ways of capturing these influence and feedback processes (Stern 2016; Niamir et al. 2018, 2020b) that include complex adaptive systems models (Levin et al. 2013) or agent-based models (Lamperti et al. 2018) allow for emergence of tipping points or other nonlinear change dynamics that may be necessary to bring about behaviour change on energy at the speed and scale required (Nyborg et al. 2016). Correctly understanding the roles, goals, and needs of these different actors, their perceptions and decision processes (Kunreuther et al. 2014), and the feedback between their actions is imperative in designing effective policies and decision support systems (Roelich and Giesekam 2019).

SM 5.2.3 Consumer decisions

On a global scale, households influence, directly and indirectly, 72% of GHG emissions (Hertwich and Peters 2009; Roy et al. 2012). Energy use is disproportionally dominated by electricity in developed countries, and most cities in the developing countries, whereas non electric cooking fuels constitute the largest share of energy use in rural areas of developing countries; energy use for mobility is significant and rising most rapidly (Ahmad et al. 2015). Demand side solutions require both the motivation to change and the capacity for change, in the form of availability and knowledge about change options and the resources to consider, initiate and maintain change. Existing willingness to change (to lower carbon sources of energy (Shift) or energy efficient devices (Improve) or to reduce energy use (Avoid)) is motivated by different factors in different demographics and geographies. For some, perceptions of climate risks and concerns about the environment and future generations trigger action. For others, prices drive energy decisions and subsidies of carbon energy can be problematic, as they set up cultural norms and individual habits, a path-dependence of sorts that requires additional interventions to be overcome. Individuals' perceptions of climate risks, first covered in AR5, continue to be studied as a perhaps necessary if not sufficient condition for behaviour change.

Core Human Value. Social change is a complex process that tries to integrate value and interest of people. Much of human behaviour is goal directed and core values reflect the general goals that people strive for. Four classes of values are most relevant to understand climate actions, and people differ in the extent to which they hold these values and goals: hedonic values (with the goal to seek pleasure, convenience and comfort), egoistic values (with the goal to safeguard personal resources), altruistic values (with the goal to protect the wellbeing of other people) and biospheric values (with the goal to protect nature and the environment (Steg et al. 2014).

Group differences in climate risk perception and motivation to act suggest the need for segmentation in information or climate action campaigns, with age, education, core values, political ideology, and personal experience being important segmentation variables. Such segmentation is not always easily accomplished; however, information relevant for different segments (e.g., metrics that allow individuals reduce their energy consumption for different reasons) can be provided in the same display. The fuel-economy sticker issued by the US Environmental Protection Agency in 2013 displays a car's energy requirements in monetary terms for buyers interested in financial savings, in technical terms for buyers interested in car performance, or in GHG ratings for buyers interested in climate impacts. These multiple ratings are almost perfectly correlated and their high-density display on a single label could be seen as confusing. However, consumers selectively attend to the information that conforms to their motivation (Ungemach et al. 2017). The full EPA fuel-economy label resulted in the highest willingness-to-pay for fuel economy, suggesting that duplication of information in slightly different formats is a communication asset rather than liability (Kormos and Sussman 2018).

Professional actors play important roles in climate mitigation. Working as building managers, landlords, energy efficiency advisers, technology installers and car dealers, they influence patterns of mobility and energy consumption (Shove 2003) by acting as 'middle actors' (Janda and Parag 2013; Parag and Janda 2014) or 'intermediaries' in the provision of building or mobility services (Grandclément et al. 2015; De Rubens et al. 2018). As influencers on the process of diffusion of innovations (Rogers 2003), professionals can enable or obstruct improvements in efficient service provision or shifts towards low-carbon technologies (LCTs) (e.g. air and ground source heat pumps, solar hot water, underfloor heating, programmable thermostats, and mechanical ventilation with heat recovery) and mobility (e.g. electric vehicles) technologies.

SM 5.3 Social perspectives

SM 5.3.1 Lifestyles

'Lifestyle' means a coherent pattern of behaviours and cognitions consistent with certain situational factors (Axsen et al. 2012; Hedlund-de Witt 2012). Behaviours include actions, activities, technology adoption, and consumption choices. Cognitions include values, worldviews, concerns and beliefs. Lifestyles typically apply to individuals, but can also be used to describe households. Lifestyles also depend on situational factors, which shape the accessibility of certain behaviours or the achievability of certain cognitive goals. Geography, infrastructure, and culture are all examples of situational factors relevant to lifestyles. Behaviours, cognitions and situational factors are common elements of lifestyle, but are emphasised differently depending on the perspective taken. Three common perspectives emphasise patterned behaviour, cognitive direction, or reflexive identity.

A *patterned* view sees lifestyle as manifest in routine, habitual patterns of behaviour (Darnton et al. 2011). These behavioural patterns are situational, in that they may vary between home, work, travel, leisure and other domains of everyday life (Barr et al. 2011). This patterned view lends itself to the identification of lifestyles through consumption activity and other observable behaviours (Schipper 1989). Put simply, lifestyle describes "*how people spend their money and their time*" (Mowen and Minor 1998).

A *cognitive* view similarly sees lifestyle as a regular pattern of behaviour, but rather than being primarily situational, it is led by intentions and so is directed towards an overarching goal (Jensen 2009). Intentions can be antecedent to specific choices such as where to live (Frenkel et al. 2013), or can be linked to broader cognitive constructs such as values or worldviews (Hedlund-de Witt 2012). This cognitive view is consistent with the idea of individuals pursuing a 'low-carbon lifestyle' to reduce their impact on climate change.

A *reflexive* view sees lifestyle as a way for individuals to organise and express their self-identity through their behaviour, while the behaviours then reflexively help constitute an individual's identity. This reflexive view is associated with the work of the sociologist, Anthony Giddens, who defined lifestyles as "*routines that include the presentation of self, consumption, interaction and setting*" (Giddens 1991).

Despite differences in emphasis, all three of these views recognise that lifestyle is shaped by context and so is both dynamic and plural. As examples, lifestyles change when people migrate from the countryside into cities (Chen et al. 2019), or when there is easier access to certain infrastructures like bike lanes or bus routes (Etminani-Ghasrodashti et al. 2018).

In the context of climate change, lifestyle is used both *descriptively* to identify clusters of low-carbon behaviours and quantify their emissions impact, and *normatively* to explore individuals' efforts to reduce their carbon footprint. As lifestyles are situational as well as behavioural and cognitive, these efforts can be strongly shaped by public policy and infrastructure. In all these applications, lifestyle can sometimes be used interchangeably with behaviour. This is not appropriate as behaviours are discrete actions, whereas lifestyles comprise coherent sets of actions linked in a consistent way to cognitions and identity (Lawson and Todd 2002).

Lifestyles can be identified and measured using both qualitative and quantitative methods. Qualitative methods explore self-identity, situational influences, and the dynamics of how lifestyles are expressed. Common qualitative methods used to research lifestyles include interviews (Barr et al. 2011) and narratives (Hagbert and Bradley 2017). Quantitative methods link lifestyles to outcomes and impacts, and identify segments and variation in a population. Common quantitative methods include cluster analysis, factor analysis (Kuan et al. 2019), hierarchical tree analysis (Baiocchi et al. 2015), and decision tree analysis (Le Gallic et al. 2018). These methods identify groups of individuals, who share similar sets of cognitions and behaviours in certain contexts. Quantitative methods are commonly applied to survey datasets, which combine information on behaviours with self-reported cognitions. Examples of datasets include national social surveys, household expenditure surveys, and time use surveys. These allow lifestyle groups or types to be identified in a population, and linked to sociodemographic, geographic or other widely-available indicators. For example, a recent study in France used census, housing, travel and household budget surveys to identify lifestyles grouped along eight dimensions: cohabitation, relationship with technology, mobility practices, attitude to work, dwelling location, living standard, leisure practices and demographics (Millot et al. 2018).

Measuring lifestyles is useful for different reasons. First, lifestyles can be tested as predictors or explanations of an outcome of interest such as risk of dementia (Lourida et al. 2019), food preferences (Nie and Zepeda 2011), or propensity to buy an electric vehicle (Axsen et al. 2012). The outcome of interest varies widely across research fields. Second, lifestyles can descriptively characterise common patterns of behaviour in specific domains or ‘sites of practice’ like shopping, food, domestic living, or energy and water consumption (Barr and Gilg 2006). This allows the relationship between lifestyles and situational factors to be explored in more depth. Third, lifestyles can explain variation between households in a population. This captures an important dimension of heterogeneity which can then be applied in modelling and scenario studies of how lifestyles may change into the future (Le Gallic et al. 2018; van den Berg et al. 2019). Fourth, lifestyles can also explain variation between populations in different countries or cultures. Data from the periodic World Values Survey reveals systematic differences in lifestyles between regions with certain cultural characteristics such as pragmatism or respect for tradition. Variation can also be situational. For example, housing-related lifestyles were found to be similar across different European countries whereas food-related lifestyles were not (Thøgersen 2017a, 2018).

Pro-environmental, green, sustainable, or ‘low-carbon’ lifestyles have two different interpretations, broadly distinguished by intention and impact (van den Berg et al. 2019). Emphasising intentions, a green lifestyle has been defined as “*a collection of practices by which people today try to address an interrelated set of environmental problems*” (Lorenzen 2012). Applied to climate change, 'low-carbon' lifestyles can be identified by the values, intentions or goals of individuals seeking to reduce their carbon footprint. Emphasising impacts, low-carbon lifestyles can also be identified by reductions in energy and material use or other consumption-based reductions in greenhouse gas emissions (Le Gallic et al. 2018).

These two interpretations of low-carbon lifestyles can be in tension as low-carbon intentions do not always translate into low-carbon impacts (e.g., a globetrotting IPCC scientist), and low-carbon impacts may not be the result of low-carbon intentions (e.g., a low income household living in fuel poverty). Such tensions between cognitions, behaviours and impacts on emissions are almost always evident in population-level analyses of low-carbon lifestyles. This reinforces that lifestyles are situational as well as cognitive and behavioural, and that lifestyles are multiple and reflexively constructed so can never offer a single unifying explanation for an individual's impact on emissions.

Research focused on very specific low-carbon lifestyle groups characterised by self-sufficiency, frugality or voluntary simplicity can avoid these tensions between intention and impact (Lorenzen 2012; Hagbert and Bradley 2017). Here the challenge is in scaling or replicating this type of intentional low-carbon lifestyle more widely. Conversely, research focused on resource-efficient consumption across the population as a whole is more widely applicable but is also more uncertain and contingent in terms of its emissions impact (Vita et al. 2019b). Low-carbon lifestyles can be defined broadly or situationally. Studies taking a broad view seek to generalise low-carbon lifestyles that are consistent across multiple domains of everyday life. Such studies inform social marketing and educational campaigns to encourage more sustainable lifestyles (Darnton et al. 2011; DEFRA 2011). Other studies test whether low-carbon lifestyles are generalisable explanations for technology adoption decisions in multiple domains, such as electric vehicles, solar panels and green electricity tariffs (Axsen et al. 2012). Recognising the importance of situational factors, many studies focus on low-carbon lifestyles in a specific domain of resource-intensive activity. This includes domestic energy use and waste generation (Tudor et al. 2016), dwelling location and type (Frenkel et al. 2013; Thøgersen 2017b), mobility and travel (Lanzendorf 2002; Thøgersen 2018), leisure and tourism (Barr et al. 2011), and food (Thøgersen 2017a; Hur et al. 2010). Some studies find that much of the variation in energy or resource consumption can be explained by domain-specific lifestyle factors (Sanquist et al. 2012). However it is hard to generalise insights across domains as relationships between low-carbon lifestyles and emissions tend to be heterogeneous as well as situational or context-dependent.

In addition to heterogeneity and the tension between intention and impact, a third limitation of low-carbon lifestyles research is its concentration in technophile and/or environmentally-conscious population segments in the global North. Available studies in emerging economies tend to place less emphasis on intentions, and more emphasis on demographic, social or institutional factors which shape emissions-intensive lifestyles such as migration from countryside to cities (Chen et al. 2019) or literacy, theft and corruption (George-Ufot et al. 2017).

The 'consumer lifestyle approach' assigns upstream or indirect emissions to the final consumption of energy, materials, food or other resources by individuals and households (Ding et al. 2017; Chen et al. 2019). Similar to consumption-based accounting, this approach typically finds that over three quarters of emissions are attributable to the consumption activities which constitute lifestyles (Bin and Dowlatabadi 2005). Lifestyle change is therefore a potential means of delivering significant emission reductions.

Scenario and modelling studies confirm this potential by taking examples of low-carbon behaviours and scaling them up to the population level to determine aggregate system outcomes (van Sluisveld et al. 2016; Van Vuuren et al. 2018). Common examples of low-carbon behaviours amenable to modelling analysis include reducing meat in diets, substituting driving for active travel modes or public transport, and turning thermostats down. Scenario narratives that describe why such behaviours become more common tend to emphasise the spread of green values, environmental consciousness, or awareness of climate risks. This implies an intentional understanding of lifestyle change, and deemphasises the influence of situational factors.

Differences underlying lifestyle choices influence efforts to meet targets for emissions reduction. A combined assessment of costs, lifestyles and technologies in France up to the year 2072 showed that an individualistic lifestyle with high take-up of digital technologies led to increased GDP but not carbon neutrality, in contrast to a society characterised by more collective lifestyles that resulted in less growth but greater emissions reductions (Millot et al. 2018). Voluntary lifestyle change typically focuses on relatively low impact behaviours (e.g. switching off lights at home, recycling) in a piecemeal manner instead of high impact behaviours (e.g. adopting a low meat diet or long-haul flights (Nash et al. 2019; Dubois et al. 2019). Changes in social, technological or demographic factors can also be enshrined in scenario narratives of future lifestyle change. Examples include a shift in consumption culture from owning goods to using services including through sharing economies (Vita et al. 2019b), and a demographic shift from rural to urban, from physical to virtual work, and from analogue to digital (Millot et al. 2018; Le Gallic et al. 2018). Such studies in the controlled environment of a simulation model show significant emission reduction potentials from low-carbon lifestyle change. This is not just limited to the direct impact of lifestyle change on emissions, but also to the indirect impact of reducing the speed of required transformation upstream in energy and land-use systems (Grubler et al. 2018).

Turning scenarios into reality is inevitably more complex and contingent. There is good evidence that interventions targeting specific behaviours can be effective, particularly if they combine different mechanisms such as price, norms, information, competences, and infrastructure (Stern et al. 2016). Robust principles for designing effective interventions for low-carbon behaviour change also benefit from a large body of evidence from public health (Michie et al. 2011). However interventions targeting low-carbon lifestyles in general rather than specific low-carbon behaviours are harder to define beyond general informational, educational, and marketing strategies (Haq et al. 2008). The signal of low-carbon lifestyle change is also difficult to detect amidst the noise of a continually changing technological, social and demographic landscape. This is particularly the case in emerging economies with rapidly changing income distributions, urban settlements, and living standards (Hubacek et al. 2007; Chen et al. 2019).

SM 5.3.2 Education

Modifying climate change awareness and perception help the dynamics of this radical shift (Halady and Rao 2010; Dombrowski et al. 2016; Odjugo and Ovuyovwiroye 2013; Niamir et al. 2020a). This requires a complete remodelling of educational methods, where the barriers to be tackled include not only a lack of funding, but the conservative environment of the educational system itself (Ferrer-Balas et al. 2009; Fisher and McAdams 2015; Velazquez et al. 2006; Leal Filho et al. 2018).

Traditional education is still structured on mercantilist and neoliberal ideologies and delivered in politicised educational institutions where environmental issues are invisible most of the time (Mendoza and Roa 2014). This situation calls for a move away from this commercial, individualised and entrepreneurial training model towards the commitment to education for solidarity and care that was highlighted by (Anderson et al. 2019) in the specific context of food, but that can be applied to the climate crisis. Even if the role of universities in climate change education has been acknowledged as extremely important there is few investment to embed climate change education in a higher education context. When achieved, there is a variety of approaches and it is difficult to identify a clear pattern at the country or even university level (Molthan-Hill et al. 2019). This is why there is a need to achieve or/and reinforce a culture of climate awareness through new educational forms based on a convergence between education and communication (educommunication) (Rodrigo-Cano et al. 2019) could be used as a base for action and social and environmental intervention unlike communication and disinformation campaigns that use the environment to convey a commercial message (Delmas and Burbano 2011; Megias-Delagado et al. 2018).

SM 5.3.3 Religion

As a central component of many cultures, religion interacts with climate change in numerous and diverse ways (Jenkins et al. 2018). Some religious identities are associated with the denial of climate change, notably White US Evangelical Christians (Smith and Leiserowitz 2013). Different religions interpret climate change in different ways, but nearly all contain elements related to the protection of divine creation, including the environment. Faith groups are both social institutions and sites of collection action on climate change (Haluza-DeLay 2014). They can draw on shared symbols, identities and narratives to promote collective action on climate change (Bomberg and Hague 2018; Roy et al. 2012). Pope Francis' encyclical (2015) reframes climate action from being an economic and technological issue to one of moral stewardship of public goods. Understanding religion helps in understanding attitude towards climate change across communities and traditions (Jenkins et al. 2018). However, further research is required to capture the heterogeneous practices of diverse faith groups globally in relation to climate mitigation (Haluza-DeLay 2014).

Religious groups can communicate with social groups not necessarily involved in climate change action. However, most educational programs that train clergy remain silent on climate change or ecological issues; in North America only 24% of program included instructions (Heistein et al. 2017). Joint programs between academia and clergy has potential to bring climate action to communities that otherwise lack resources to interact with non-subsistence issues and to connect climate change mitigation with local contexts.

SM 5.3.4 Civil society, NGOs, and social movements

People, governed by values and social norms, make individual decisions on how to live, eat, travel, etc.: what they need in life, why and how they need it, and (within their means) what forms of consumption they choose. Collectively, the same values and social norms affect voting, politics, private sector and informal sector decision-making and policy, with the potential to induce even faster change (Adger 2003).

Collective action by individuals as part of formal social movements or informal 'lifestyle movements' (Haenfler et al. 2012) can significantly impact climate mitigation. Both AR5 and SR15 reports recognised the role of collective action as part of cultural shifts in consumption patterns and dietary change. Collective action has the potential to both enable and constrain societal shifts in emissions reduction. Movements that shift social norms can produce 'tipping points' towards lifestyles with reduced emissions, for example veganism (Cherry 2006). On the other hand, landscape conservation groups have opposed the deployment of onshore wind turbines in several European countries (McLaren Loring 2007; Toke et al. 2008).

SM 5.3.5 Meaning

A people-centred view of mitigation recognises that individuals and groups make sense of climate change through meanings, not just information processing (Jerome 1990). Meanings associated with climate mitigation are not neutral, but part of an active process of constructing possible futures in which some actors have more influence over shared narratives than others. Meanings are associated with climate mitigation at different levels – from an individual person's values or identity (e.g. choosing to describe oneself to others as a vegan), to the symbolism associated with low-carbon technologies (e.g. how cook stoves or solar panels confer status on their owners), to the level of collective imaginary futures at community, city, national or global levels (e.g. stories about smart urban futures or environmental catastrophes).

SR15 recognised that narratives and storytelling can enable the imagining of novel visions of place-based 1.5°C futures, creating space for agency, deliberation and the co-construction of meaning around desirable pathways of transition (Veland et al. 2018). Stories about climate change are ways of collectively making sense of uncertain futures, involving processes of interpretation and understanding through communication and social interaction (Smith et al. 2017). Culture – including religious beliefs - is central to climate mitigation, influencing how individuals perceive demand for services in relation to emissions and their expectations about what is both possible and desirable (Moezzi et al. 2017; Batel 2018).

Collective narratives about climate change refer to imaginary futures that can be either utopian or dystopian (e.g. Amitav Ghosh 2016), often presenting apocalyptic stories and imagery in an effort to capture attention and evoke emotional and behavioural response (O'Neill and Smith 2014). The idea of the Anthropocene has gained traction as a way of imagining a new era of human-environment relations characterised by unprecedented human influence over natural ecosystems, and to mobilise a sense of grief at the potential for mass extinction of species, including humanity (James Lovelock 2007; Head 2016; Heise 2017). In turn, epistemic evolution, the increasing dependency of global society in further developments in knowledge and technology to continue surviving in the Anthropocene, mirrors a narrative of opportunity (Renn 2018).

While climate stories themselves do not have agency in driving societal transformations, they can open up new ways of involving people in conversations about systemic changes that can provide motivation and confidence for people to participate in more inclusive ways (Smith et al. 2017). Science fiction has afforded indigenous communities a creative means to imagine climate futures divergent from conventional top-down narratives (Streeby 2018), signalling the role of power in shaping which climate stories are told and how prevalent they are (O'Neill and Smith 2014). Further research is required to study the impact of social media platforms on emerging narratives of climate change within societies and local communities (Pearce et al. 2019).

SM 5.3.6 Discourse and narratives

Meanings play a number of roles, both enabling and constraining action on mitigation (Buschmann and Oels 2019). At the societal level, imaginaries about the cities or homes of the future play important roles in enabling innovation by attracting attention, legitimating certain technology choices, rejecting or undermining others and attracting investment e.g. (Tozer and Klenk 2019). These imaginaries have been shown to be important in the innovation of wind and solar energy, biopower, nuclear energy and smart meters (Sovacool et al. 2018). Analysis of shifts in discourse over time has revealed 'turning points' that facilitate change in systems of energy provision, providing the basis for new narratives to emerge and to become legitimate (Buschmann and Oels 2019).

One aspect of current unsustainable societies is the prevalence of common sense assumptions about systems of provision that effectively lock-in (Unruh 2002) social actors to certain patterns of thinking or behaviour, limiting awareness and take up of alternatives (e.g. assuming that domestic heating must come from household boilers instead of district heating systems) (Owens and Driffill 2008). Political beliefs play an important role in influencing the uptake of narratives. 'Climate justice' narratives polarise individuals along ideological lines, while narratives that centre on saving energy, avoiding waste and embedding the uptake of low carbon energy in patriotic values were more widely supported (Whitmarsh and Corner 2017).

Climate policies need to go beyond an emphasis upon the rational provision of information and the functional attributes of new services, to place greater emphasis on symbolic meanings and emotions as a means to encourage social change. Presenting narrative meanings instead of factual information can lead to greater public engagement and pro-environmental action on climate change through arousing emotional responses (Morris et al. 2019).

SM 5.3.7 Meanings of technology

At the design stage, expectations of potential users of energy technologies and services (e.g. cookstoves, meters, thermostats) are scripted into the appearance and functionalities of those devices. Experts and designers hold common assumptions that public users are characterised by deficits of knowledge, competence and interest in energy systems (Burningham et al. 2015; Skjølsvold and Lindkvist 2015; Owens and Driffill 2008). These assumptions shape pathways of technology development and deployment (Marvin et al. 1999) leading to smart technologies with passive roles for users rather than smart users playing more active roles in systems of provision, distribution, storage and consumption (Goulden et al. 2014).

Contrasting meanings signal more active roles, including 'prosumers' who act as producers as well as consumers in decentralised energy systems (Espe et al. 2018), 'energy citizens' who are motivated by altruistic and environmental concerns, not only self-interest (Devine-Wright 2007; Ryghaug et al. 2018) and collectives such as 'clean energy communities'(Gui and MacGill 2018) engaged in peer-to-peer trading of energy services (Fell et al. 2019). Policy has an important role to play in communicating which of these expectations are preferred pathways of low carbon transition.

Meanings shape the willingness of individuals to use existing technologies or adopt new ones. Individuals develop attachments to material possessions (Belk 1988), which symbolise consumer-related identities (Dittmar 2008). Use of private cars for commuting is influenced by emotional and symbolic assumptions about driving (e.g. ideas of status, freedom and independence) as much as instrumental motives (Steg 2005). When new technologies are installed (e.g. feedback displays, smart meters), they become ‘domesticated’ into pre-existing daily routines (Monreal et al. 2016; Shove and Southerton 2000) that can involve negotiation and sometimes conflict within households (Hargreaves et al. 2013). Smart meters raise concerns about reduced autonomy and independence (Wilson et al. 2017). Failure of policy to recognise these emotional and symbolic processes can lead to overestimates of technology potentials, including emissions reduction.

When energy technologies are resisted by the public, meanings about objectors influence the responses of policy makers and energy companies. ‘NIMBY’ (Not In My Back Yard) is both a label used to describe objectors and an explanation for why protests over the siting of low carbon energy technologies take place (Burningham 2000). The concept suggests that objectors are characterised by ignorance, irrationality and selfishness (Devine-Wright 2005; Wolsink 2007; Burningham et al. 2015). When developers hold these views, it leads to strategies of community engagement that prioritise the provision of factual information and financial incentives as well as the avoidance of ‘angry’ crowds (Barnett et al. 2012; Walker et al. 2010). Engagement that overlooks technology meanings can produce unintended consequences, prolonging social conflict and reducing trust (Devine-Wright 2011; Wolsink 2007). Adopting alternative meanings of communities, e.g. viewing them as repositories of expertise and local knowledge, and enabling genuine participation and benefit sharing can reduce conflict and increase acceptance (Bell et al. 2013; Walker and Baxter 2017).

SM 5.3.8 Meanings of place and landscape

Renewable energy resources are widely dispersed across geographical areas, leading to consequences for patterns of development in rural areas (Pasqualetti 2000). ‘Energy landscapes’ refer to ways that meanings associated with rural areas evolve as land use changes from conventional agriculture to technological systems of heat and power generation and new ‘energy crops’ (Pasqualetti and Stremke 2018). Since landscapes are important symbols of cultural and social identity (Woods 2003; Short 2002), changes to their meaning influence the acceptability of technology siting (Devine-Wright 2009).

Locations perceived as pristine and natural are considered less suitable for the siting of large scale energy infrastructures such as wind turbines and power lines (Wolsink 2010). Objections are often based on fears that technologies will ‘industrialise’ or ‘urbanise’ rural areas and are opposed by individuals with strong emotional attachments to those places (Devine-Wright and Howes 2010). Novel wave and tidal energy technologies have been positively associated with place attachments and public support, in part due to the ways they enhance a sense of local distinctiveness (Devine-Wright 2011).

SM 5.3.9 Social norms

Human behaviour is affected by the social environment, and in particular by what people commonly do or what other people think and expect (Cialdini 2006), even though people often do not acknowledge this (Nolan et al. 2008; Noppers et al. 2014); social influence seems more influential in some countries than others (Pettifor et al. 2017). Specifically, injunctive norms reflect perceptions of which behaviour is commonly approved or disapproved, and guide behaviour, as people are motivated to gain social approval and avoid social disapproval. Injunctive norms are related to a wide range of mitigation behaviours, including limited meat consumption, limited car use, the use of energy-saving light bulbs (Harland et al. 1999), energy use (Farrow et al. 2017) and recycling (Geiger et al. 2019), although the effects are not always strong (Gardner and Abraham 2008; Farrow et al. 2017).

Descriptive norms refer to behaviour commonly shown by others, and affect behaviour because it provides information about which behaviour is most sensible in a given situation. Descriptive norms (or peer effects) are related to different mitigation behaviours, including household energy savings (Nolan et al. 2008), car use (Gardner and Abraham 2008), energy use (Farrow et al., 2019), the adoption of electric vehicles and participation in smart energy systems (Noppers et al. 2019), and recycling (Geiger et al. 2019). Similarly, descriptive norm information or socially comparative feedback (in which case one's own performance is compared to the performance of others) can encourage mitigation actions, although the overall effect size is not strong (Abrahamse and Steg 2013). A study in Uganda suggests that peer effects mostly affect attitudes towards cookstoves, but not the actual purchase of cookstoves (Beltramo et al. 2015). Socially comparative feedback seems more effective when people more strongly identify with the reference group (De Dominicis et al. 2019). Descriptive norms are more strongly related to mitigation actions when injunctive norms are strong too, when people are not strongly personally involved with mitigation topics (Göckeritz et al. 2010), when people are currently acting inconsistent with their preferences, when norm-based interventions are supported by other interventions and when the context support norm-congruent actions (Miller and Prentice 2016). Weak descriptive norms, in which case people think others do not act on climate change, may inhibit mitigation actions (Schultz et al. 2007). Yet, trending norms that communicate that the number of people engaging in a behaviour is increasing, even if this concerns only a minority of people, can encourage the targeted behaviour, although the effect size is relatively small (Mortensen et al. 2019).

Human behaviour and choices are a function of personal and social norms and the content of norms depends on the context (Sunstein 1996; Thaler and Sunstein 2009; Niamir 2019). Climate change challenges pose major collective action problems, where a group benefits from a certain action, but no individual has sufficient incentive to act alone (Nyborg et al. 2016; Niamir 2019). Here, formal institutions (e.g., laws and regulations) are not always able to impose collectively desirable outcomes. Instead, informal institutions, such as social norms, can play a crucial role. If conditions are right, policy can support social norm changes, helping address global problems (Nyborg et al. 2016; Niamir 2019). Sunstein (Sunstein 1996) appraise people's choices and preferences in terms of *intrinsic value, reputational effects*, and *effects on self-conception*. Law and regulations potentially play an important role, by which the function of law in expressing social values with the goal of shifting social norms. There can be a serious obstacle to freedom in the fact that individual choices are a function of social norms, social meanings, and social roles, which individuals may deplore, and over which individuals have little or no control (Sunstein 1996). Here collective action and movements may be necessary to enable people to change norms that they do not like (Bamberg et al. 2015; Sunstein and Reisch 2014; Niamir et al. 2020a). Some norms are obstacles to human well-being and autonomy. It is appropriate for law to alter norms if they diminish well-being and autonomy (Thaler and Sunstein 2009; Sunstein 1996).

Being part of a group or organisation that values the environment and advocates mitigation actions promotes mitigation actions (Ruepert et al. 2017; Sloot et al. 2018), particularly when individuals strongly identify with the peer group (Biddau et al. 2016; Fielding and Hornsey 2016; Jans et al. 2018) or have strong ties with this group (Weenig and Midden 1991). When people feel strongly connected to a group, they may come to adopt the goals of the group as their own goals (Jans et al. 2018). Similarly, block leader approaches in which change is initiated from the bottom-up are effective in promoting mitigation behaviours (Abrahamse and Steg 2013); local ambassadors are more successful at convincing others when they already adopted the promoted behaviour or programmes themselves as this increases their credibility (Kraft-Todd et al. 2018).

SM 5.4 Structural perspectives

Sociological and historical analyses of energy demand (Royston et al. 2018) deduce that patterns and dynamics of consumption are shaped by shifting configurations of infrastructures, technologies and collective conventions (Frantzeskaki and Loorbach 2008). When the aim is to reverse the current growing trend in demand, it is imperative to effectively activate and combine the three leverage points underlying structures (rules, organisations and infrastructures) to trigger social consistent with mitigation targets. If these leverage points are activated separately there is a high probability that path dependencies and behavioural lock-ins cannot be overcome; if they are activated together but independently, they can cause unwanted bounce effects or induce unexpected trends. There is a high probability that the ex-ante design of a relevant combination of infrastructures, organisations and rules, together with collective change of behaviours and adapted governance, will enable a real change in demand-side mitigation. Past lessons are helpful to fine-tune the required combination.

SM 5.4.1 Infrastructures and technologies

Infrastructures, defined in relation to organised practices (Star and Ruhleder 1996), should not be treated as independent systems, levers and drivers of change as it is often the case, but rather as systemic interconnections between infrastructures and practices (Cass et al. 2018). Indeed, the ways in which infrastructures intersect explain their potential influence (Thacker et al. 2019). For instance, the introduction of cycling lanes is embedded within multiple systems in flux, including the staged societal transformations with specific forms of governance and intervention associated with each phase of cycling lane history a study (Oldenziel et al. 2016). Similar results can be derived from an analysis of district heating systems (Hawkey 2012) or at urban level (Bulkeley et al. 2014). In the power sector, huge investments in electricity generation are foreseen, due to both the strong growth in emerging countries and a shift in usage towards “decarbonable” sources. Therefore, there is a need for the transformation of networks because of urban concentration and more dispersed electricity generation resulting from the rise of renewables. It implies that a compromise has to be found between two transition options: the design of a new electricity system to maintain its qualities of supply and sustain its current levels of reliability; a change in consumption habits and the adaption of lifestyles compliant with more power supply interruption (Maïzi and Mazauric 2019; Maïzi et al. 2017). This illustrates the multiple-level relationships between infrastructures, technology choices, economic development and individual choices.

Disciplines identify different drivers of technology adoption. Using rational choice models, mainstream economists propose relative costs and performance of new technologies compared to existing ones as the main driver of adoption (Nelson et al. 2004). Adding to this, evolutionary economists and innovation scholars suggest that technological development experiences positive feedbacks and increasing returns to adoption (like scale economies, learning-by-using, network externalities, informational increasing returns, and technological interrelatedness) that improve a technology’s price/performance characteristics as more people adopt (Arthur 1989; Creutzig et al. 2017). Psychologists argue that adoption decisions are shaped by people’s attitudes and beliefs with regard to instrumental considerations (perceived usefulness and ease of use) and wider norms and values (Davis 1989; Ajzen 1991). These disciplines conceptualise adoption as one-off purchase decisions, which is particularly useful with regard to ‘improve’ options that do not require wider changes in lifestyles and user routines.

Offering a broader and more longitudinal view, sociologists of innovation and social practice theorists focus on the co-evolution of technologies with lifestyles, social practices and user routines (Hand et al. 2005; Gram-Hanssen 2008; McMeekin and Southerton 2012; Hyysalo et al. 2013; Shove et al. 2014), which is particularly relevant for ‘shift’ and ‘avoid/reduce/ options. On the one hand, new technologies are not just purchased, but also integrated into daily life routines and user practices, which involves several activities (Shove and Southerton 2000; Monreal et al. 2016): a) cognitive activities involve the learning of new skills and competencies, b) interpretive and sense-making activities imbue new technologies with meanings, c) practical activities involve adjustments in everyday routines and material contexts. On the other hand, users do not just adopt new technologies, but can also actively contribute to development and innovation processes by: a) providing feedback to engineers about how technologies function in real-world user contexts (Heiskanen and Lovio 2010; Schot et al. 2016; Sopjani et al. 2019), b) tinkering themselves with the technology (Hyysalo et al. 2013; Nielsen et al. 2016), c) developing new organisational templates and business models (Truffer 2003; Ornetzeder and Rohracher 2013; De Vries et al. 2016).

Moving beyond adoption, sociologists of innovation have shown that new technologies need to be embedded in multiple contexts (Ó Tuama 2015; Kanger et al. 2019; Mylan et al. 2019), which involve not just user environments but also: a) business environments, including the development of business models, supply chains, repair facilities and infrastructures (Markard 2011; van Waes et al. 2018), b) civil society, including discourses, narratives, and public debates that shape cultural legitimacy and societal acceptance of new technologies (Geels and Verhees 2011; Rosenbloom et al. 2016), and c) institutional environments, including safety regulations, reliability standards and performance requirements (Reddy et al. 1991; Bohnsack et al. 2016; Andrews-Speed 2016).

SM 5.4.2 Institutions

Policymaking is a political process in that policies are conceived and implemented by governments and their policy coalitions with particular political priorities and values, and within a wider socio-economic context (Eyre and Killip 2019). Government policy contributes to shaping demand for energy services, travel and mobility, and given range of energy-using activities, the policy agenda involves reaching out to a wide range of actors that includes practitioners and the general public. Doing this effectively will require a systematic deployment of effective regulatory and enforcement framework, consisting of regulations, market-based instruments, and information based instruments to voluntary agreements at various governance levels to address a wide range of stakeholders and their concerns (Park 2015; Mundaca and Markandya 2016).

The function of institutions in shaping policies and the interaction of various policy instruments is critical for the transition to a low carbon economy (O'riordan and Jordan 1999). One important characteristic of institutions, understood as 'rules of the game in society', consists of formal rules such as laws and regulations and informal norms or conventions that set the incentive structure for decision making (Vatn 2015). For example, Feed-in Tariffs and similar regulations set rules that enable citizens to participate in energy transitions as energy prosumers (Inderberg et al. 2018) (see also 5.4.4.3). The literature around policy processes and implementation with respect to demand and services relates that timing and policy choice is dynamic. At certain times there may be 'policy windows' for ambitious climate change policies, but such windows may also close unpredictably (Carter and Jacobs 2014). Another way to understand institutions is that they shape the political context for decision making, empowering some interests and reducing the influence of others (Steinmo et al. 1992; Hall 1993; Moser 2009). An example of this is the fossil fuel subsidy that advantages incumbent actors in this sector over those from the renewable, leaving individuals or businesses who wish to invest in green energy, receiving much less support (Lockwood 2015; Healy and Barry 2017; Rentschler and Bazilian 2017).

In some countries, establishing carbon reduction as a policy priority is shared across the political spectrum (UK, Germany, India, South Africa), but even then much of the consensus has remained in single issue areas of intervention such as expansion of renewable energy; and rarely around structural change in areas such as sustainable prosperity in a circular economy (Jackson 2017) or sufficiency (Darby and Fawcett 2018; Thomas et al. 2019). These are both politically contentious and suffer from institutional inertia where the tendency is that institutions move slowly and resist change in challenges that call for structural and system-wide change (Munck af Rosenschöld et al. 2014).

SM 5.5 Transition

SM 5.5.1 Transition perspectives

The literature offers several integrative frameworks. Social practice theory emphasises interactions between artefacts, competences, and cultural meanings (Shove and Walker 2014; Røpke 2009). The energy cultures framework highlights feedbacks between materials, norms, and behavioural practices (Stephenson et al. 2015; Jürisoo et al. 2019) highlights. And socio-technical transitions theory, which spans both provisioning systems and use contexts, addresses interactions between technologies, user practices, cultural meanings, business, infrastructures, and public policies (McMeekin and Southerton 2012; Geels et al. 2017b).

Cultural meanings and discourses shape the beliefs, preferences and motivations of various actors and what they consider to be desirable, legitimate or acceptable (Stryker 1994; Phillips et al. 2004). Structural elements such as regulations, institutions, technologies and infrastructures provide the more tangible contexts within which actors act (Currie and Spyridonidis 2016; Solér et al. 2020). Actors like households, firms, civil society organisations, and policymakers reproduce or transform cultural and structural contexts through storytelling, political lobbying, innovation activities and infrastructure building (Lounsbury and Glynn 2001; Dolata 2009; Battilana et al. 2009).

The energy cultures framework and socio-technical transitions theory both understand demand-side transitions as involving interactions between: 1) radical social or technical innovations, which deviate in one more dimensions from dominant configurations, 2) relatively stable dominant energy cultures or socio-technical systems, 3) external influences such as shocks or gradually increasing pressures.

Radical demand-side innovations like new technologies, new business models or alternative behavioural practices initially emerge in small, peripheral niches (Kemp et al. 1998; Schot and Geels 2008). These projects and initiatives offer protection from mainstream selection pressures and nurture the development of radical innovations (Smith and Raven 2012). Dominant energy cultures, social practices or socio-technical systems resist radical change, because they are stabilised by multiple lock-in mechanisms (Klitkou et al. 2015; Clausen et al. 2017; Ivanova et al. 2018; Seto et al. 2016).

SM 5.5.2 Lock-in mechanisms of existing systems and practices

Although there are many demand-side mitigation options, low-carbon transitions do not happen easily because multiple lock-in mechanisms stabilise existing systems of service provision and social practices and thus hinder major change (Clausen et al. 2017; Ivanova et al. 2018; Seto et al. 2016; Klitkou et al. 2015). Existing activities and demand patterns are often stabilised by behavioural lock-in mechanisms identified by psychological and economic literature: a) routines and habits tend to be repeated over time as ‘normal’ dietary, heating or travel patterns (Barnes et al. 2004; Maréchal 2010; Kurz et al. 2015; Hoolohan et al. 2018); b) preferences and attitudes can orient people positively towards existing practices over alternatives, e.g. private car travel over public transport (Sheller 2004); and c) cost-benefit calculations make people purchase technologies that are more practical or cheaper than alternatives (e.g. cars over public transport in rural areas; petrol cars over electric cars).

Structural elements of existing systems and practices are also stabilised by lock-in mechanisms as sociological, political science and innovation literature have demonstrated. Institutional lock-in mechanisms can stabilise existing policies that support existing technologies and demand patterns: a) policy networks facilitate interactions between policymakers, specialists, and established business interests and tend to shape policymaking towards status quo protection or incremental reform rather than more radical policy change (Walker 2000; Knox-Hayes 2012; Geels 2014; Normann 2017; Roberts and Geels 2019); b) existing policy paradigms shape how policymakers frame problems and think about solutions (Kern et al. 2014; Rosenbloom 2018; Schmidt et al. 2019; Buschmann and Oels 2019), often leading to a focus on upstream technologies, market-based instruments, and hands-off policy styles (Whittle et al. 2019), c) incumbent firms use corporate political strategies and resistance tactics to delay or water down strong climate policies (Kolk and Pinkse 2007; Smink et al. 2015; Ferguson et al. 2016; Supran and Oreskes 2017; Geels 2014). Technological lock-in mechanisms such as core competencies and sunk investments in factories and employees generate vested interests and technological regimes that incumbent firms will try to protect through incremental innovation (Berkhout 2002; Raven and Verbong 2004; Vanloqueren and Baret 2009). Infrastructural lock-in mechanisms such as capital-intensity, asset durability, obduracy, and systemic interrelatedness (van der Vleuten 2004; Markard 2011) means that infrastructure-related technologies and practices are difficult to change. Existing roads, petrol stations and land-use patterns stabilise car-based mobility patterns (Seto et al. 2016), while gas infrastructures stabilise home-based boiler heating practices (Gross and Hanna 2019).

Existing meanings may also lock-in existing systems and practices. Discourse and cultural studies literature have found that established meanings, values and discourses help legitimise and normalise the status quo (Bosman et al. 2014; Buschmann and Oels 2019). For example, discourses that frame cars as status symbols that embody success, power, freedom, and autonomy help entrench auto-mobility and hinder shifts to public transport (Stephenson et al. 2015). Discourses that portray dairy milk as healthy and natural stabilise particular diets and hinder transitions to plant-based milk (Mylan et al. 2019). Most people and communities hold a plurality of cultural values; environmental protection and climate mitigation is only one value cluster amongst others such as efficiency, security and stability, social justice and fairness, autonomy and freedom, and improved quality of life (Plumecocq et al. 2018; Demski et al. 2015).

SM 5.5.3 Phases in transitions

The transitions literature distinguishes four phases, characterised by generic core processes (Rotmans et al. 2001; Markard et al. 2012; Geels et al. 2017a). These four phases do not imply that transitions are linear, teleological processes, because set-backs or reversals may occur as a result of learning processes, conflicts, or changing coalitions (Geels and Raven 2006; Messner 2015; Davidescu et al. 2018).

The emergence of radical innovations in the first phase is characterised by open-ended learning processes and the building of social networks to nurture and support the innovations (Kemp et al. 1998; Schot and Geels 2008). Radical innovations are characterised by many uncertainties about technical performance, consumer interest, and social acceptance. Research, development and demonstration projects, local community initiatives or grassroots projects, therefore, act as carriers of early niches to enable learning about these dimensions (Rosenbloom et al. 2018b; van Mierlo and Beers 2020; Hossain 2016; Borghei and Magnusson 2016; Sengers et al. 2019). Learning processes and network building are also important for the transfer of established technologies, like improved cookstoves, to developing countries, because new-to-the-country innovations require contextualisation, adaptation, capability building, and the creation of local supply chains and innovation systems (Ockwell and Byrne 2016; Tigabu et al. 2017; Watson et al. 2015). Typical challenges of radical innovations in the first phase are fragmentation and high rates of project failure (den Hartog et al. 2018; Dana et al. 2019), limited funding (Auerswald and Branscomb 2003), limited market demand, and social acceptance problems due to being perceived as strange or unfamiliar (Lounsbury and Glynn 2001).

In the second phase, innovations find a foothold in small market niches, where early adopters provide a small but steady flow of financial resources (Zimmerman and Zeitz 2002; Dewald and Truffer 2011). Learning processes, knowledge sharing and codification activities help stabilise the innovation, leading to best practice guidelines, design standards, and formalised technical knowledge (Raven et al. 2008; Borghei and Magnusson 2018). Supporting social networks also expand and roles become more formalised, resulting in the creation of engineering communities, industry associations or 'intermediary actors' like energy or innovation agencies (Mignon and Kanda 2018; Kivimaa et al. 2019). User innovation may lead to the articulation of new routines, functionalities, and practices, as people integrate new technologies into their daily lives (Nielsen et al. 2016; Schot et al. 2016). Radical innovations remain confined to small niches in the second phase because they tend to be more expensive than existing technologies, complementary infrastructure may be missing (Markard and Hoffmann 2016), market demand is limited to small, dedicated groups (Schot et al. 2016).

In the third phase, radical innovations diffuse into wider communities and mainstream markets. Typical drivers are performance improvements, cost reductions, strong cultural appeal, widespread consumer interest, investments in infrastructure and complementary technologies, and institutional support (Wilson 2012; Markard and Hoffmann 2016; Raven et al. 2016; Malone et al. 2017; Kanger et al. 2019). The third phase often involves multiple struggles between diffusing innovations and associated actors and the existing system and incumbent actors, for instance, economic competition in markets, business struggles between incumbents and new entrants (Hockerts and Wüstenhagen 2010), discursive and framing struggles in civil society arenas, which affect cultural meanings and public opinion about low-carbon transitions (Kammermann and Dermont 2018; Hess 2019; Rosenbloom 2018), political struggles over adjustments in policies and institutions, which shape markets and innovations (Meadowcroft 2011; Roberts and Geels 2019). These struggles may erode and weaken the technological, institutional and cultural lock-in mechanisms that stabilise existing systems (Turnheim and Geels 2012; Roberts 2017; Kuokkanen et al. 2018; Leipprand and Flachsland 2018).

In the fourth phase, the diffusing innovations replace or substantially reconfigure the existing system, which may lead to the downfall or reorientation of incumbent firms (Bergek et al. 2013; McMeekin et al. 2019). The new system becomes institutionalised and anchored in professional standards, technical capabilities, infrastructures, educational programs, regulations and institutional logics, user habits, and views of normality, which create new lock-ins (Galaskiewicz 1985; Barnes et al. 2018; Shove and Southerton 2000).

SM 5.5.4 Rates of change, acceleration

Rates of change are usually slow in the first and second transition phase, because experimentation, social and technological learning, the creation of standards, and the reduction of uncertainty take a long time, often decades (Bento et al. 2018; Bento 2013; Wilson 2012). Rates of change increase in the third phase, as radical innovations diffuse from initial niches into mainstream markets, propelled by the self-reinforcing mechanisms, discussed above. The rate of adoption (diffusion) of new practices, processes, artefacts, and behaviours is determined by a wide range of factors at the macro- and micro-scales, which have been identified by several decades of diffusion research in multiple disciplines (for comprehensive reviews see, e.g., Tornatzky and Klein, 1982; Feder & Umali, 1993;). (Ausubel 1991; Bayus 1994; Van den Bulte and Stremersch 2004; Comin and Hobijn 2003, 2010; Davis 1979; Meade and Islam 2006; Mahajan et al. 1990; Mansfield 1968; Martino et al. 1978; Peres et al. 2010; Rogers 2003; Grubler 1991).

Diffusion rates are determined by two broad categories of variables, those intrinsic to the technology/product/practice under consideration (typically performance, costs, benefits), and those intrinsic to the adoption environment (e.g., socio-economic and market characteristics).

The literature on systems or macro-determinants of diffusion (technology growth and behavioural change) rates comprises three streams: historical energy transition research (e.g., Fouquet 2008; Geels 2002), systems theories of technological change (Grübler et al. 1999), as well as the recent literature on scaling(-up) dynamics of technologies (Wilson 2009) which has also been applied for validation of climate mitigation scenarios (Wilson et al. 2013). Common to them all is the recognition of the importance of scale, or market size, as well as time and place as determinants of rates of change. Three main conclusions emerge from this literature. Ceteris paribus, a) larger systems take more time to evolve, grow, and change compared to smaller ones; b) the creation of entirely new systems (diffusion) takes longer time than replacements of existing technologies/practices (substitution); and c) late adopters tend to adopt faster than early pioneers.

The micro-level literature on technology- (or product-) specific rates of adoption is vast (for reviews see, (Tornatzky and Klein 1982; Grübler et al. 1999; Peres et al. 2010; Rogers 2003)) and has identified three clusters of variables: a) relative advantage; b) adoption effort required and complexity; and c) compatibility, observability, and trialability. All variables, except adoption effort, are positively correlated with (rapid) rates of change.

The acceleration of transitions is a complex issue, because of the multitude and combination of both macro- (societal, economic, markets) and micro- (e.g., firm- or consumer-) level determinants. A recent debate (Sovacool 2016) vs. (Grubler et al. 2016) led to a special journal issue on the duration and acceleration of energy transitions from a variety of (opposing) perspectives, which ranged from political urgency and malleability (Bromley, 2016) to inertia in large-techno-economic systems (Smil 2016); for a summary of the debate cf. (Sovacool and Geels 2016).

SM 5.5.5 Feasibility and barriers of demand-side transitions

While demand-side solutions have very high mitigation potential, the widespread diffusion and transitioning of many options is challenging. Table SM5.8 provides a high-level assessment of feasibility barriers for avoid, shift and improve options on behavioural, technological, business, institutional and socio-cultural dimensions. This assessment shows that improve options, which are mostly about technical component substitutions that do not require wider changes, face low to medium feasibility barriers. related to higher costs (especially if new technologies also require new infrastructures), limited consumer interest, and some industry reluctance. Shift options, which involve different ways of fulfilling desired services, face medium to large feasibility barriers, due to substantial required changes in behavioural routines, technologies, institutions, and investments. Avoid options, which involve deep changes in lifestyles and social practices, face large feasibility barriers in behavioural routines, institutions and cultural meanings, small to medium technical barriers and variable economic barriers.

There is variability within this high-level assessment of feasibility and speed of transition. Some improve options may diffuse rapidly (e.g. LED lightbulbs), but other improve options, such as improved cooking stoves remain at low levels due to mismatch with cultural practices or cost barriers. Avoid and shift options often require longer time scales, especially if new infrastructures, such as tram lines or building retrofits, are involved. Sometimes they unfold rapidly, however. For example, digital service provision models ranging from communication to entertainment, retail, or banking via integrated digital platforms (typically via smartphone apps) diffused quickly, replacing conventional analogue and/or physical service provisioning systems (home entertainment systems, bank offices, or shops (TWI2050 2019)).

Demand-side transitions thus face the dilemma that improve options are in some cases more feasible, but only exploit part of the solution space, because they are less deep. Shift and avoid options have higher mitigation potential, but face larger feasibility barriers, for instance for living car-free and restricting long-haul flights (Dubois et al. 2019). While the diffusion of most demand-side options is likely to be slow without stronger policies, this dilemma means that the diffusion of shift and avoid options would particularly benefit from stronger policy support that also address social norms. Importantly, feasibility barriers are not fixed or static, but malleable and evolving over time. Obstacles and feasibility barriers are high in early transition phases. But over time, the various barriers decrease as a result of technical and social learning processes, network building, scale economies, cultural debates and institutional adjustments.

Table SM5.8 Assessment of feasibility/barriers for the diffusion of demand-side mitigation options

	Behavioural	Technology, infrastructure	Business	Institutional	Socio-cultural
Improve options: Electric vehicles, light-weight vehicles, wood as building material, solar thermal devices, insulation, energy-efficient appliances and light bulbs, low carbon fabrics, improved clean cookstoves	**Small-medium** -Small change in behavioural routines -Costs or lack of interest may hold back purchase	**Small-medium** -Most component substitutions are technically feasible. -Some options require infrastructure change (e.g. recharging)	**Medium** -More expensive than existing technologies (although learning curves reduce costs) -Infrastructure change would increase costs - Incumbent firms may delay reorientation to new technical capabilities.	**Small** -No major institutional change needed (as existing systems mostly remain intact) -Diffusion slow without policy support and financing models	**Small** - No major cultural change needed
Shift options: **Shift from cars to public transport or cycling, less material-intensive construction, district heating, passive house, smaller devices, circular economy, shift towards from meat to other protein sources**	**Medium-large** -Medium change in behavioural routines -Not widespread consumer interest	**Small-Medium** -Increased use of existing or new technologies -New provisioning systems and sometimes new infrastructures	**Medium-large** - Investments in technologies, supply chains, business models, infrastructure - Resistance from incumbent industries	**Medium-large** -Medium institutional change (new agencies, responsibilities) -Large policy change (new goals, programs, instruments) - Substantial political resistance and struggle	**Medium-large** - Large scale cultural change for some shif options (e.g. less meat)
Avoid options: Integrated transport and land-use planning, tele-working, compact	**Large** -Large change in	**Small-medium** -Limited technical change (except	**Variable** High costs for some options (e.g. compact cities), low	**Large** -Large institutional change (e.g. overcoming	**Large** -Large cultural change in many options

cities, smaller apartments, shared common spaces, multi-generational housing, change dress codes, change work times, change temperature settings, consume less goods, keep calories in line with health guidelines, daylighting	behavioural routines -Small to limited consumer interest	for some options) -Mostly using existing or proven technologies	costs for others (e.g. change dress codes)	silo-problem, new agencies) -Large policy change for some options (e.g. compact cities, tele-working)	(e.g. smaller apartments, consume less in some contexts)

SM 5.6 Case studies

SM 5.6.1 Consumer-led innovation in solar photovoltaics (CS1)

Although solar PV has attained massive scale as an energy supply technology, its success in becoming a low-cost mitigation option is attributable in large part to the collective agency of energy consumers who embraced the unique services that PV's modularity provides. These bottom-up socio-cultural forces catalysed a supportive policy environment, which enabled improvements in the technology by innovative firms. PV's technological evolution can be summarised as the result of distinct contributions by the US, Japan, Germany, Australia, and China—in that sequence over seven decades (Nemet 2019) (Figure SM5.18).

Since its first commercial application in 1958, PV has provided distinct energy services to a sequence of increasingly large consumer niche markets with high but decreasing willingness to pay (Dracker and De Laquil III 1996; Jacobsson and Lauber 2006). Modularity is among PV's most consequential attributes; the smallest electronics application to utility-scale spans nine orders of magnitude (Shum and Watanabe 2009). Nearly every scale in between has been applied to provide needed services—often serving not a policy-driven market but one arising from idiosyncratic consumer needs, for which PV was well suited. In the 1950s, the US Navy bought cells for early satellites from an electronics entrepreneur who had been selling solar-power radios (NRC 1972; Perlin 1999). In India in early days activist entrepreneurs marketed solar-powered lanterns in rural areas with unreliable electricity (Roy 1997; Roy and Jana 1998). Off-grid housing, water pumps in Mali, and electronics provided important consumer niche markets (Perlin 2013). It has played a substantial role in reducing poverty in China (Zhang et al. 2020).

Institutionally, the most important policy for the improvements observed in PV was Germany's Erneuerbare-Energie Gesetz (EEG) passed in 2000, guaranteeing prices paid to prosumers (i.e. citizens acting as both producers and consumers) of renewable electricity for 20 years (RESA 2001). The EEG quadrupled the size of the German solar market in one year and stimulated corporate actors to invest in designing PV-specific production equipment that was crucial for subsequent improvements and cost reductions accomplished by Chinese producers (Palz 2010; Wu and Mathews 2012). In India in 1982 the Department of Non-conventional Energy Sources was set up which eventually got transformed into Ministry of Non-conventional Energy Sources (MNES) in 1992 and in 2006 to MNRE in 2006. Indian Renewable Energy Development Agency (IREDA) was established in 1987 to finance renewable energy projects (Bhattacharya and Jana 2009).

The EEG adopted the policy innovation of guaranteed long term contracts that California regulators had designed to provide grid access to small energy producers in the 1980s (CPUC 1983; Hirsch 1999). It also adopted the Japanese innovations of a declining subsidy and the first national rooftop top solar program in 1995 (Kimura and Suzuki 2006). The adoption behaviour of the 200,000 Japanese households who installed PV in the next ten years showed the world that consumer demand for PV energy services was strong (Shimamoto 2014). The Japanese subsidy was far less generous than the subsequent German program and surveys of adopters indicate that environmental values were a stronger driver than economics (Kimura and Suzuki 2006). Corporate actors, in the form of Japanese electronic conglomerates, became the world's largest PV producers using experience incorporating PV's unique attributes, scale and mobility, into consumer products, like watches, calculators, and electronic toys (Honda 2008).

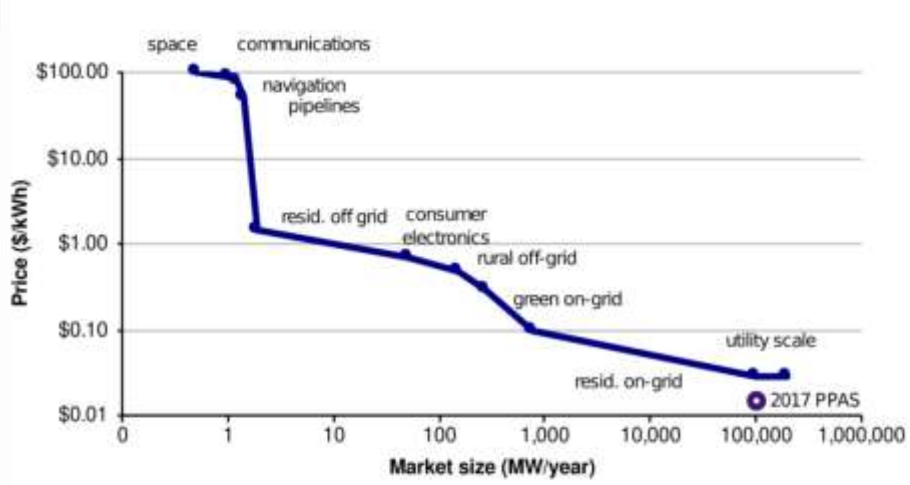


Figure SM5.18 Technological learning curve of photovoltaic solar energy. Prices decline with production and associated innovation and economics of scale. As granular technology that can be matched to diverse settings, technological learning is faster than in most other technologies. Source:(Nemet 2019)

The EEG only became politically feasible in Germany because of an environmental activist social movement, originating in the 1968 student protests, advocating a shift to consumer-led green energy production (Morris and Jungjohann 2016). PV had the potential to avoid: environmental damage, oil dependence, hegemony of electric utilities, nuclear power, and later climate change. PV thus attained meaning beyond its technical elegance; its main advocate in the German Parliament, Hermann Scheer emphasised the importance of its "emancipatory motivation" (Palz 2010). In 1998, when a policy window opened, broad social acceptability existed, cities had de-risked the technology, and policy implementation details had been worked leading to a cascade of technology adoption, performance improvement, and cost reductions that set the stage for broader systemic change (Lauber and Jacobsson 2016).

Today's massive utility-scale PV projects are now a factor of 10,000 cheaper than the first PV cells in satellites. They are also inextricably linked to a seven-decade evolution in which the agency of consumers has consistently played a key role in multiple countries, such that deriving half of global electricity supply from solar is now a realistic possibility (Creutzig et al. 2017).

SM 5.6.2 Energy services for cooking - Improve cookstoves and shift to new forms of energy (CS2)

The majority of households in developing countries use traditional solid biomass fuel through inefficient and incomplete combustion for cooking and heating (Bhattacharya and Cropper 2010; Nepal et al. 2010; Bonjour et al. 2013; IEA 2017; Wester et al. 2019). This has been a major concern for deforestation (Kissinger et al. 2012) and for health, gender relations, and economic livelihood (Batchelor et al. 2019). For example, about 85% of the fine particulate matter (PM2.5) emission in Africa in 2018 came from the burning of biomass indoors (IEA 2019).

Cleaner and safer cooking solutions in South Asia and Africa can obtain a range of benefits: reduce firewood collection from the forest (Pattanayak et al. 2004); reduce the burden on women (Hazra et al. 2014); deliver better health (Pant 2008; Bikram and Thakuri 2009); higher labour productivity (Kalyanaratne 2014) for the users and reduce emissions of greenhouse gases (Zhang et al. 2013; Somanathan and Bluffstone 2015). Studies have shown that net reduction in emission for the switch from biomass as a cooking fuel to LPG has clear climate and non-climate benefits (Anenberg et al. 2017; Singh et al. 2017; Ghilardi et al. 2018; Goldemberg et al. 2018). In India during 2001 and 2011 increase in LPG use has led to a net emissions (Kyoto and non-Kyoto Gases) reduction of 6.73 MtCO$_2$-eq (0.94 MtCO$_2$-eq in rural area and 5.79 MtCO$_2$-eq in urban area) with fuel wood displaced 7.2 million tons (0.99 million tons in rural area and 6.19 million tons in urban area)(Singh et al. 2017).

To improve the affordability of the cleaner fuel and cook stove choice, actors at the households level need motivation through pricing policy like subsidies and installation cost waiver (Troncoso and Soares da Silva 2017; Dickinson et al. 2018; Sankhyayan and Dasgupta 2019). The decision towards actual transition to a cleaner cooking fuel and technology is often governed by other demand-side drivers/barriers like lifestyle and socio-cultural norms and practices.

The useful energy demand for cooking is a crucial component of the choice between various cooking technology options and has been the subject of numerous studies (Balmer 2007; Nerini et al. 2016). Daioglo et al. (Daioglou et al. 2012) conclude that a mean of 3 MJ cap^{-1} day^{-1} (range 0.77 to 7.22) of useful energy is required for cooking (equivalent to 125 kWh month^{-1} for a household of 5. Accommodating cooking energy services in off-grid electrification technologies, Zubi et al. (Zubi et al. 2017) estimate that a three litre multi-cooker needs just 0.6 kWh day^{-1} to cook lunch and dinner for a household of six, which is equivalent to 0.36 MJ cap^{-1} day^{-1} . Similarly, according to Batchelor et al. (Batchelor et al. 2018) 0.2 kWh could be enough to cook rice for a household of four in a rice cooker.

Shifts towards electric and LPG stoves in Bhutan (Dendup and Arimura 2019), India (Pattanayak et al. 2019), Ecuador (Gould et al. 2018; Martínez et al. 2017) and Ethiopia (Tesfamichael et al. 2021); are taking over now compared to past trend towards *improved* biomass stoves in China (Smith et al. 1993). Significant subsidy (Litzow et al. 2019), information (Dendup and Arimura 2019), social marketing and availability of technology in the local markets are some of the key instruments helping to adopt ICS (Pattanayak et al. 2019), through supply chain creation availability was scaled up enormously in India (Sankhyayan and Dasgupta 2019). Shift in use of energy efficient cooking appliances like pressure cookers and rice cookers is now almost universal in South Asia and beginning to penetrate the African market as consumer attitudes are changing towards household cooking appliances with higher energy efficiencies (Batchelor et al. 2019).

There is substantial evidence that more awareness programs are needed to break the behavioural barriers towards usage of modern cooking fuel (Giri and Aadil 2018). While designing ICS, along with technical aspects like energy efficiency, emission mitigation, and improving health outcomes researchers are also needed to factor in functionality, asthetics and consumers' need and preference. A tailoring in the technology is also needed based on the region, climate and culture (Bielecki and Wingenbach 2014). Many of the families who are first time users of LPG often find safety issues as a barrier to use it. Studies from Senegal and Mexico shows that even though households are complaining of smoke and itchy and watery eyes during cooking with solid fuels, and are aware of the health benefits of using LPG or other efficient technology, they still find traditional cooking practices using solid fuels to be more desirable (Pine et al. 2011; Hooper et al. 2018). Many country-specific studies have also shown that the types of diet, modes of cooking and types of utensils, vessels used have an impact on the choice of cooking fuel and technology (Ravindranath and Ramakrishna 1997; Atanassov 2010; Mukhopadhyay et al. 2012; Bielecki and Wingenbach 2014; Troncoso et al. 2019) the perception of food tastes (Mukhopadhyay et al. 2012; Wiedinmyer et al. 2017; Hooper et al. 2018), differences in the housing-style and location of the cooking area-indoor or outdoor (Chattopadhyay et al. 2017) delays transition to a cleaner fuel or new technology . In Mozambique the dissemination of solar cookstove has seen limited success as its design failed to capture end-user need of cooking process like boiling, steaming or frying and how the food is prepared like standing versus sitting (Otte 2014).

Universal access to clean and modern cooking energy could cut premature death from HAP by two-third relative to baseline in 2030 while reducing forest degradation and deforestation and contribute to the reduction of up to 50% of CO_2 emissions from cooking relative to baseline by 2030 (Hof et al. 2019; IEA 2017). However, in the absence of policy reform and substantial energy investments, 2.3 billion people will have no access to clean cooking fuels such as biogas, LPG, natural gas or electricity in 2030 (IEA 2017). The increasing efficiency *improvements* in electric cooking technologies, together with the ongoing decrease in prices of renewable energy technologies, could enable households to shift to electrical cooking at mass scale (Figure SM5.19a).

SM 5.6.3 Shift in mobility service provision through public transport in Kolkata (CS3)

In densely populated cities in India, mobility is still predominantly dependent on public transport, walking and cycling modes (Tiwari et al. 2016). There is an increasing shift of narratives towards comfortable, affordable public transport systems in public policy, which is translated into infrastructure investments, procurement of equipment, road safety legislation, and even public consultations on mobility in smart cities (Roy et al. 2018b; Ghosh and Arora 2019). This transition in mobility systems in historically public transport dominated cities like Kolkata and Mumbai is happening through ‘fit and conform’ strategies, but also by ‘stretch and transform strategy’ in new cities like Ahmedabad, Bangalore, Pune (Ghosh et al. 2018; Roy et al. 2018b; Ghosh and Schot 2019).

In the megacity Kolkata, as many as twelve different modes of public transportation ‘regimes’ - each with its own system, structure, network of actors and meanings - co-exist and offer means of mobility to its 14 million citizens. Most public transport modes are shared mobility options ranging from sharing between two people in a rickshaw or between a few hundred in metro or sub-urban trains. Sharing also happens as daily commuters avail shared taxis organised by organically formed local taxi associations and neighbours borrow each other’s car or bicycle for urgent or day trips. However, there are also formal efforts by several actors and initiatives to transform the existing systems in sustainable directions. Many factors have contributed to transformative changes in Kolkata’s public transport regimes, including socio-cultural awareness generated through mass-media like television and newspaper reports, research and communication by NGOs on the detrimental effects of existing standards of fuel and equipment, environmental campaigns by civil society organisations involving school children, students and the elderly. There were efforts to improve efficiency in managing fleets and service provision through smart, real time and integrated display and fare collection system etc. A crucial driver of this policy has been to discourage users to shift their demand from public to private mobility and new meaning to buses, autorickshaws were getting added continuously. Many of these changes were driven by new policy at national and urban levels, for instance the National Urban Renewal Mission (2005) (Ministry of Housing and Urban Affairs 2005), National Urban Transport Policy (2006) (Ministry Of Urban Transport 2006) and Kolkata’s comprehensive urban mobility plan (2008) (IDFC 2008).

A key role is played by the state government to improve the system as whole and formalise certain semi-formal modes of transport. An important policy consideration has been to make Kolkata’s mobility system more efficient (in terms of speed, reliability and avoidance of congestion) and sustainable through strengthening coordination between different mode-based regimes as each of these regimes are transformed individually and collectively over the past 10 years (Ghosh 2019). Such transformations within the regimes arose from a broad range of drivers such as need for new infrastructure, increased fuel efficiency, digitalisation of operation, and pollution mitigation. Many of these interventions were to address wider sustainability challenges such as increasing demand for individual mobility, high concentration of pollutants in the air, lack of affordability etc. Each of Kolkata's diverse public transport regimes have changed along different pathways in the past decade owing partly to new standards and regulations, but also to new values, beliefs and expectations-(cognitive and normative meanings. Four distinctive regime level change processes are: improvements and new meaning to public buses, greening and formalisation of auto-rickshaws, the institutional and socio-cultural support to the emergence of 'app-cab' niche, a cycling ban policy in major arterial roads of Kolkata.

Each of Kolkata's diverse public transport regimes have changed along different pathways in the past decade owing partly to new standards and regulations, but also to new values, beliefs and expectations (cognitive and normative meanings). Four distinctive regime level change processes are elaborated here: 1) improvements and new meaning to public buses; 2) greening and formalisation of auto-rickshaws; 3) the institutional and socio-cultural support to the emergence of 'app-cab' niche; 4) a cycling ban policy in major arterial roads of Kolkata.

Public Buses attracting the middle class: Supported by the National Urban Renewal Mission in 2010, the West Bengal government rolled out 1200 new fuel efficient, low floor buses with an aim to provide 'modern and efficient bus service to the urban middle-class citizens of Kolkata, who will be willing to pay a premium fare for a comfortable and reliable bus service'(Ghosh and Schot 2019). Several changes in the state bus regime followed this effort to improve public bus infrastructure to match the demands for a new urban lifestyle. There were efforts to improve efficiency in managing fleets and service provision through smart, real time and integrated display and fare collection system etc. A crucial driver of this policy has been to discourage users to shift their demand from public to private mobility. The primary focus on these strategies have been to cater to their preferences for safety, reliability and comfort. A way to incentivise the middle class, urban population of Kolkata to keep using public buses was through transforming the socio-cultural meaning of the public bus regime by rebranding and advancing a new image of the bus as a comfortable and efficient mode of transport.

Auto-rickshaws and new meanings: While the transformation of the public bus was triggered by social pressures like affordability, safety and reliability, transformation in the auto-rickshaw regime started off in response to the environmental challenges from the unsustainable fuel used in these vehicles. Emissions from auto-rickshaws operated with a cheap toxic mixture of petrol, kerosene and naphtha accounted for 60% of the city's air pollution. Since 2009, new legislation has mandated the use of single mode liquified petroleum gas (LPG). This improvement in fuel infrastructure coupled with consequent initiatives by the state government to formally recognise and integrate auto-rickshaws as part of the public transport portfolio of the city, resulted in a transformation of the socio-cultural meaning of auto-rickshaws from one considered to be noisy, polluting, unregulated and informal paratransit mode into an environment-friendly, fast and efficient mode of shared mobility.

Emergence of 'app-cab' niche: Public buses started attracting middle classes, Autorickshaws got new meaning and with digitalisation Taxi services got transformed. The existing social norm of sharing public transport modes coupled with a rapid uptake of smartphones facilitated the emergence of 'app-cabs' in Kolkata (Ghosh 2019). Since 2014, the global mobility platform, Uber and the Indian app-cab company, Ola started operating services in Kolkata, gaining quick momentum in shifting the demand of users from yellow taxis to app-based taxi services. Both Uber and Ola have 'pool' (ride-sharing) options which are considerably cheaper than booking the entire car. Commuters could even buy a monthly pass for cheaper daily access. Owing to these facilities, transparency of payment and safety promises, shifts have taken place in the expectations and routines of commuters from “car is the only comfortable way of travelling” to “sharing a cab is much faster and efficient” (Ghosh and Schot 2019). Such deeper shifts in the beliefs of the more affluent urban population are crucial for transitioning towards sustainable mobility in coherence with emerging lifestyle preferences in megacities like Kolkata. However, there is also a change in behaviour of the urban middle-class, who are willing to replace their bus, metro or auto-rickshaw rides with app-cabs because of additional benefits like door to door service.

Cycling ban policy: While the effect on social justice, equity and inclusion is clear in the cases of the bus, auto-rickshaw or app-cabs, some recent policy actions in Kolkata are directly related to socio-economic exclusion. Since 2014, Kolkata police have banned cycling in many major arterial roads as a traffic management strategy under the pressure of congestion and to avoid road accidents in over crowded narrow streets. Civil society activists and NGOs have protested against the ban on grounds of environmental impacts and injustice against the poor. The ban was partially retracted in 2016 (Ghosh 2019). Scholars have argued that such policy measures exacerbate inequalities by disadvantaging the urban poor, and hence are undesirable, even though it might seem to be a congestion mitigation strategy in the short term (Raven et al. 2017; Sur 2017). The agency of political actors in implementing regulatory policies in individual bus, auto or taxi regimes is important, but not enough to maintain the existing sustainable practices of shared mobility. The transformation processes in state bus and auto-rickshaw regimes highlight that policies need to align with specific user demands (for safety, reliability, comfort) and focus on changing deeper beliefs and practices across multiple mobility regimes in the city. The emergence of the app-cab service suggests the role of digitalisation beyond policies and markets to renew the taxi regime, following the existing ride sharing culture that already exists in Kolkata. The cycling ban case highlights the exclusionary effects of policy, which the agency of civil society actors in social movements can hold into account in a democratic context.

To conclude, more thoughtful action at a policy level is required to sustain and coordinate the diversity of public transport modes through infrastructure design and reflecting on the overall directionality of change (Roy et al. 2018b; Schot and Steinmueller 2018). The case of urban mobility transitions in Kolkata shows interconnected policy, institutional, socio-cultural and behavioural drivers for socio-technical change. Change has unfolded in complex interactions between multiple actors, sustainability values and megatrends, where direct causalities are hard to identify. However, the prominence of policy actors as change-agents is clear as they are changing multiple regimes from within. The state government initiated infrastructural change in public bus systems, coordinated with private and non-governmental actors such as auto-rickshaw operators and app-cab owners who hold crucial agency in offering public transport services in the city. The latter can directly be attributed to the global momentum of mobility-as-a-service platforms, at the intersection of digitalisation and sharing economy trends. However, sensitivity of the policy actors in the developing countries to local needs and capabilities are important, instead of chasing global trends, especially if such trends increase inequality at the cost of improved standard of living for a selected section of people. It is a fact that many of these policy changes cater to middle class aspirations and preferences, at the cost of lower income and less privileged communities (Figure SM5.19b).

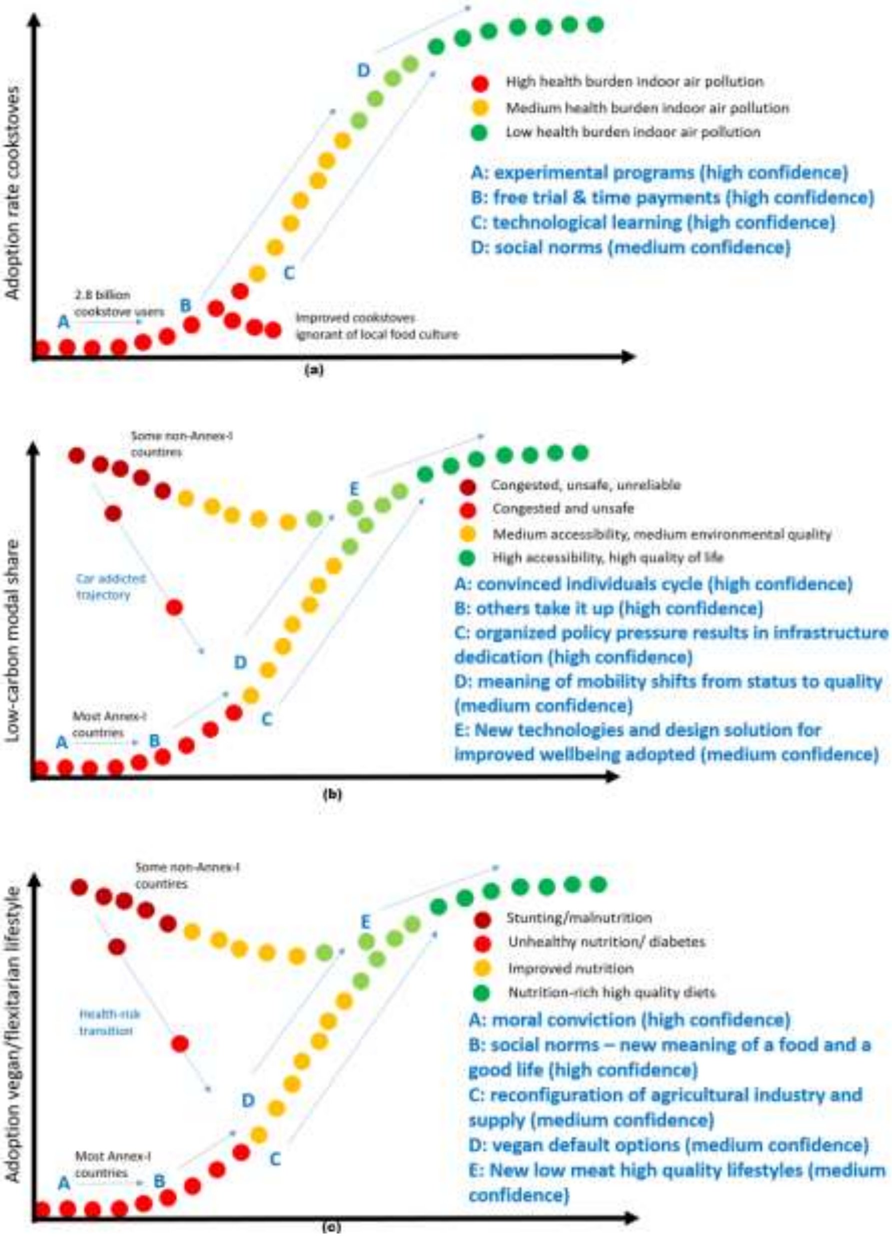


Figure SM5.19 Examplary transition dynamics for the cases of improved cookstoves, modal shifts, and diet shift

SM 5.6.4 Dietary change and reduced meat consumption (CS4)

UK per capita meat consumption increased from 69.2 kg yr^{-1} in 1961 to 85.7 kg yr^{-1} in 2006, and then declined to 78.6 kg yr^{-1} in 2015 (= 8.3%), followed by a small increase in 2016 and decline in 2017 (see Figure SM5.20). Despite ups and downs, the trend since 2006 is downward. Another long-term trend is a relative shift from carbon-intensive red meat towards poultry. Research indicates that this shift away from meat consumption is likely to have resulted from interactions between several actors and multiple dimensions (Vinnari and Vinnari 2014).

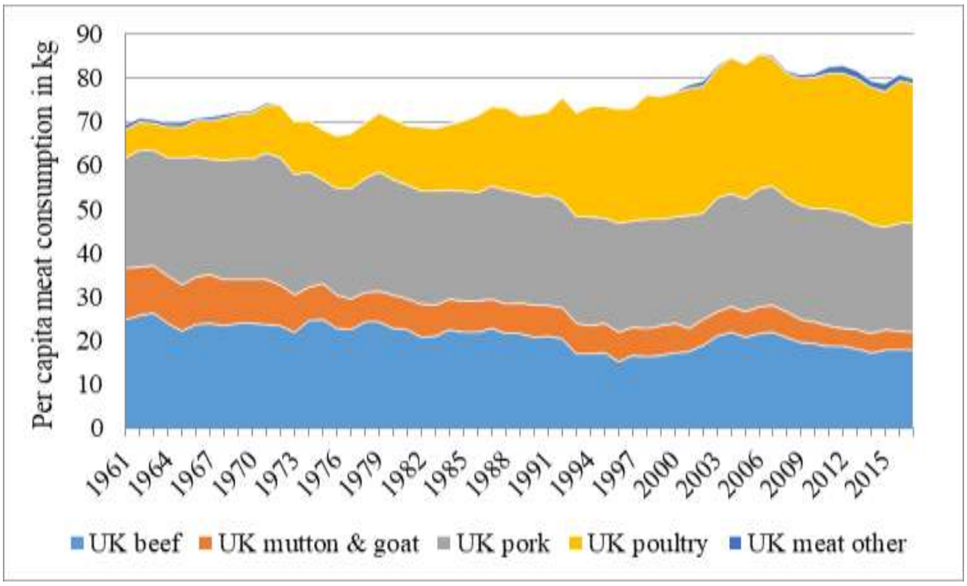


Figure SM5.20 UK per capita meat consumption (kgs; constructed from FAO Food Balances database)

A substantial body of literature indicates that self-reported consumer motivations for shifting away from meat are primarily linked to concerns for personal health. Food safety, cost, and animal welfare, are also important, with concerns about climate change less so (Latvala et al. 2012; Dibb and Fitzpatrick 2014; Hartmann and Siegrist 2017; Graça et al. 2019). However, there is little evidence to link these motivations to actual behaviour change (Bianchi et al. 2018; Graça et al. 2019). This can be attributed to lock-in mechanisms, such as established habits of food provision; skills deficits in preparing non-meat meals (Pohjolainen et al. 2015); positive socio-cultural meanings attached to meat eating, including vitality and sociality (Mylan 2018) and limitations in the availability of non-meat options when eating out of the home (Graça et al. 2019).

NGO campaigns that aim to change public discourses and attitudes toward meat production and consumption (Laestadius et al. 2016), have gained prominence in UK over the past decade, drawing attention to issues including health, climate change and animal welfare. There has also been a proliferation of behaviour change initiatives led by social movements including ‘meat-free-Mondays’ and ‘Veganuary’ which, in addition to information provision, aim to encourage behaviour change by providing practical guidance and creating normative pressures (Morris et al. 2014). The effectiveness of these civic-led interventions, and accompanying attempts to ‘nudge’ consumers toward meat reduction by altering the visual appeal, position, or size of meat offerings at the point of purchase, is being debated in the literature (Garnett et al. 2015; Godfray et al. 2018; Taufik et al. 2019; Harguess et al. 2020; Sahakian et al. 2020).

Companies have started to respond to the growing demand for ‘meat free’ products, with 16% of new UK food products launched in 2018 presenting ‘non animal’ claims – a doubling since 2015 (MINTEL 2019). These ‘meat alternatives’ vary in material form, with more ‘radical’ products such as cultured meat, or algae and insect-based proteins, facing substantial structural barriers (technological, organisational, institutional), which presently hinder their widespread diffusion (van der Weele et al. 2019). Nevertheless, it is clear that both corporate food actors and new entrants offering more innovative ‘meat alternatives’ view consumer preferences as an economic opportunity, and are responding by increasing the availability of meat replacement products. Farmers and meat industry actors have opposed these developments through political lobbying, which in 2019 led the European Parliament’s agriculture committee to prohibit these new companies from using the terms “burger” or “sausage” to describe products that do not contain meat.

Policy support for meat alternatives or behavioural change has remained limited in the UK, where reduced meat consumption is low on the political agenda (Wellesley and Froggatt 2015). The extent to which policymakers are willing to actively stimulate reduced meat consumption thus remains an open question(Godfray et al. 2018). Agricultural policies in the UK serve to support meat production with large subsidies that lower production cost and effectively increase the meat intensity of diets at a population level (Simon 2003; Godfray et al. 2018). Deeper, population wide reductions in meat consumption are hampered by these lock-in mechanisms which continue to stabilise the existing meat production-consumption system.

To conclude, analysis of the dynamics across the UK food provisioning system which have accompanied the observed decline in UK meat consumption, indicates that this has resulted from interaction between multiple behavioural, socio-cultural, and corporate drivers (Figure SM5.19c).

References

Abrahamse, W., and L. Steg, 2013: Social influence approaches to encourage resource conservation: A meta-analysis. *Glob. Environ. Chang.*, **23**, 1773–1785, https://doi.org/10.1016/j.gloenvcha.2013.07.029. http://dx.doi.org/10.1016/j.gloenvcha.2013.07.029.

Acs, G., and M. A. Turner, 2008: *Making Work Pay Enough A Decent Standard of Living for Working Families*. 21 pp. http://www.urban.org/url.cfm?ID=411711 (Accessed November 4, 2019).

Adema, W., 2006: *Social Assistance Policy Development and the Provision of a Decent Level of Income in Selected OECD Countries*.

Adger, W. N., 2003: Social capital, collective action, and adaptation to climate change. *Econ. Geogr.*, **79**, 387–404, https://doi.org/10.1111/j.1944-8287.2003.tb00220.x.

Ahmad, S., G. Baiocchi, and F. Creutzig, 2015: CO2 Emissions from Direct Energy Use of Urban Households in India. *Environ. Sci. Technol.*, **49**, 11312–11320, https://doi.org/10.1021/es505814g. http://pubs.acs.org/doi/10.1021/es505814g (Accessed July 14, 2019).

Ajzen, I., 1991: The theory of planned behavior. *Organ. Behav. Hum. Decis. Process.*, **50**, 179–211, https://doi.org/10.1016/0749-5978(91)90020-T. http://www.sciencedirect.com/science/article/pii/074959789190020T.

Akenji, L., 2014: Consumer scapegoatism and limits to green consumerism. *J. Clean. Prod.*, **63**, 13–23, https://doi.org/10.1016/j.jclepro.2013.05.022. http://www.sciencedirect.com/science/article/pii/S0959652613003405.

Ameli, N., and N. Brandt, 2015: Determinants of households' investment in energy efficiency and renewables: evidence from the OECD survey on household environmental behaviour and attitudes. *Environ. Res. Lett.*, **10**, https://doi.org/10.1088/1748-9326/10/4/044015. http://stacks.iop.org/1748-9326/10/i=4/a=044015?key=crossref.ae009172dc54584c33c31a029ea1b7a2 (Accessed May 9, 2019).

Anderson, C. R., R. Binimelis, M. P. Pimbert, and M. G. Rivera-Ferre, 2019: Introduction to the symposium on critical adult education in food movements: learning for transformation in and beyond food movements—the why, where, how and the what next? *Agriculture and Human Values*.

Andrews-Speed, P., 2016: Applying institutional theory to the low-carbon energy transition. *Energy Res. Soc. Sci.*, **13**, 216–225, https://doi.org/10.1016/j.erss.2015.12.011.

Anenberg, S. C., D. K. Henze, F. Lacey, A. Irfan, P. Kinney, G. Kleiman, and A. Pillarisetti, 2017: Air pollution-related health and climate benefits of clean cookstove programs in Mozambique. *Environ. Res. Lett.*, **12**, 025006, https://doi.org/10.1088/1748-9326/aa5557. https://iopscience.iop.org/article/10.1088/1748-9326/aa5557 (Accessed December 3, 2020).

Antony, G. M., and K. Visweswara Rao, 2007: A composite index to explain variations in poverty, health, nutritional status and standard of living: Use of multivariate statistical methods. *Public Health*, **121**, 578–587, https://doi.org/10.1016/j.puhe.2006.10.018.

Arent, D. J., and Coauthors, 2015: Key economic sectors and services. *Climate Change 2014 Impacts, Adaptation and Vulnerability: Part A: Global and Sectoral Aspects*, Cambridge University Press, 659–708 https://research.vu.nl/en/publications/key-economic-sectors-and-services (Accessed

August 28, 2020).

Arrow, K. J., P. Dasgupta, L. H. Goulder, K. J. Mumford, and K. Oleson, 2013: Sustainability and the measurement of wealth: further reflections. *Environ. Dev. Econ.*, **18**, 504–516, https://doi.org/10.1017/s1355770x13000193.

Arthur, B., 1989: Competing technologies, increasing returns, and lock-in by historical events. *Econ. J.*, **99**, 116–131, https://doi.org/10.2307/2234208.

Atanassov, B., 2010: Socio-cultural dimensions in household cooking energy choice: Implications for energy transition in Catembe, Mozambique. Department of Human Geography, Stockholm University, 95 pp. www.humangeo.su.se.

Auerswald, P. E., and L. M. Branscomb, 2003: Valleys of Death and Darwinian Seas : Financing the Invention to Innovation Transition in the United States. *Technology*, **28**, 227–239, https://doi.org/10.1023/A:1024980525678.

Ausubel, J. H., 1991: Rat-race dynamics and crazy companies. The diffusion of technologies and social behavior. *Technol. Forecast. Soc. Change*, **39**, 11–22, https://doi.org/10.1016/0040-1625(91)90025-B.

Axsen, J., J. TyreeHageman, and A. Lentz, 2012: Lifestyle practices and pro-environmental technology. *Ecol. Econ.*, **82**, 64–74, https://doi.org/10.1016/j.ecolecon.2012.07.013. file:///C:/Users/gyma/OneDrive - Loughborough University/Lifestyle_Lowcarbon/Lifestyle_references/Axsen (2012) Lifestyle Practices.pdf.

Baiocchi, G., F. Creutzig, J. Minx, and P.-P. Pichler, 2015: A spatial typology of human settlements and their CO 2 emissions in England. *Glob. Environ. Chang.*, **34**, 13–21.

Balmer, M., 2007: Energy poverty and cooking energy requirements: The forgotten issue in South African energy policy? *J. Energy South. Africa*, **18**, 4–9, https://doi.org/10.17159/2413-3051/2007/v18i3a3380.

Bamberg, S., M. Hunecke, and A. Blöbaum, 2007a: Social context, personal norms and the use of public transportation: Two field studies. *J. Environ. Psychol.*, **27**, 190–203, https://doi.org/10.1016/J.JENVP.2007.04.001. https://www.sciencedirect.com/science/article/abs/pii/S0272494407000357 (Accessed June 17, 2019).

——, G. Möser, and G. M. Mo¨ser, 2007b: Twenty years after Hines, Hungerford, and Tomera: A new meta-analysis of psycho-social determinants of pro-environmental behaviour. *J. Environ. Psychol.*, **27**, 14–25, https://doi.org/10.1016/j.jenvp.2006.12.002. www.elsevier.com/locate/jep (Accessed December 13, 2019).

——, J. Rees, and S. Seebauer, 2015: Collective climate action: Determinants of participation intention in community-based pro-environmental initiatives. *J. Environ. Psychol.*, **43**, 155–165, https://doi.org/10.1016/j.jenvp.2015.06.006.

Barnes, J., R. Durrant, F. Kern, and G. MacKerron, 2018: The institutionalisation of sustainable practices in cities: how initiatives shape local selection environments. *Environ. Innov. Soc. Transitions*, **29**, 68–80, https://doi.org/10.1016/j.eist.2018.04.003.

Barnes, W., M. Gartland, and M. Stack, 2004: Old habits die hard: Path dependency and behavioral lock-in. *J. Econ. Issues*, **38**, 371–377, https://doi.org/10.1080/00213624.2004.11506696.

Barnett, J., K. Burningham, G. Walker, and N. Cass, 2012: Imagined publics and engagement around renewable energy technologies in the UK. *Public Underst. Sci.*, **21**, 36–50, https://doi.org/10.1177/0963662510365663.

Barr, S., and A. Gilg, 2006: Sustainable lifestyles: Framing environmental action in and around the home. *Geoforum*, **37**, 906–920, https://doi.org/10.1016/j.geoforum.2006.05.002. file:///C:/Users/gyma/AppData/Local/Mendeley Ltd./Mendeley Desktop/Downloaded/Barr, Gilg - 2006 - Sustainable lifestyles Framing environmental action in and around the home.pdf.

——, G. Shaw, and T. Coles, 2011: Sustainable lifestyles: Sites, practices, and policy. *Environ. Plan. A*, **43**, 3011–3029, https://doi.org/10.1068/a43529. file:///C:/Users/gyma/OneDrive - Loughborough University/Lifestyle_Lowcarbon/Lifestyle_references/Barr (2011-J), Sustainable Lifestyles - Sites of Practice.pdf.

Batchelor, S., E. Brown, J. Leary, N. Scott, A. Alsop, and M. Leach, 2018: Solar electric cooking in Africa: Where will the transition happen first? *Energy Res. Soc. Sci.*, **40**, 257–272, https://doi.org/10.1016/j.erss.2018.01.019.

——, ——, N. Scott, and J. Leary, 2019: Two birds, one stone-reframing cooking energy policies in Africa and Asia. *Energies*, **12**, 1591, https://doi.org/10.3390/en12091591.

Batel, S., 2018: A critical discussion of research on the social acceptance of renewable energy generation and associated infrastructures and an agenda for the future. *J. Environ. Policy Plan.*, **20**, 356–369, https://doi.org/10.1080/1523908X.2017.1417120.

Battilana, J., B. Leca, and E. Boxenbaum, 2009: 2 How Actors Change Institutions: Towards a Theory of Institutional Entrepreneurship. *Acad. Manag. Ann.*, **3**, 65–107, https://doi.org/10.1080/19416520903053598.

Bayus, B. L., 1994: Are product life cycles really getting shorter? *J. Prod. Innov. Manag.*, **11**, 300–308, https://doi.org/10.1016/0737-6782(94)90085-X.

Beattie, G., and L. Sale, 2009: Explicit and Implicit Attitudes to Low and High Carbon Footprint Products. *Int. J. Environ. Cult. Econ. Soc. Sustain. Annu. Rev.*, **5**, 191–206, https://doi.org/10.18848/1832-2077/cgp/v05i04/54652.

Beckage, B., and Coauthors, 2018: Linking models of human behaviour and climate alters projected climate change. *Nat. Clim. Chang.*, **8**, 79–84, https://doi.org/10.1038/s41558-017-0031-7. www.nature.com/natureclimatechange79.

Becker, G. S., 2013: *The Economic Approach to Human Behavior*. University of Chicago Press, 314 pp.

Becker, G. S., and K. M. Murphy, 2000: Fad, fashion and norm. *Social economics : Market behavior in a social environment*, G.S. Becker and K.M. Murphy, Eds., Belknap Press of Harvard University Press, p. 170.

Belk, R. W., 1988: Possessions and the Extended Self. *J. Consum. Res.*, **15**, 139–168, https://doi.org/10.1086/209154. https://www.jstor.org/stable/2489522?seq=6#metadata_info_tab_contents.

Bell, D., T. Gray, C. Haggett, and J. Swaffield, 2013: Re-visiting the “social gap”: Public opinion and relations of power in the local politics of wind energy. *Env. Polit.*, **22**, 115–135, https://doi.org/10.1080/09644016.2013.755793.

Bello, M. O., S. A. Solarin, and Y. Y. Yen, 2018: The impact of electricity consumption on CO2 emission, carbon footprint, water footprint and ecological footprint: The role of hydropower in an emerging economy. *J. Environ. Manage.*, **219**, 218–230, https://doi.org/10.1016/j.jenvman.2018.04.101.

Beltramo, T., G. Blalock, D. I. Levine, and A. M. Simons, 2015: Does peer use influence adoption of efficient cookstoves? Evidence from a randomized controlled trial in uganda. *J. Health Commun.*,

20, 55–66, https://doi.org/10.1080/10810730.2014.994244.

Bento, N., 2013: *New Evidence in Technology Scaling Dynamics and the Role of the Formative Phase*. 45 pp. http://pure.iiasa.ac.at/id/eprint/10752/.

——, C. Wilson, and L. D. Anadon, 2018: Time to get ready: Conceptualizing the temporal and spatial dynamics of formative phases for energy technologies. *Energy Policy*, **119**, 282–293, https://doi.org/10.1016/j.enpol.2018.04.015. https://doi.org/10.1016/j.enpol.2018.04.015.

van den Berg, N. J., A. F. Hof, L. Akenji, O. Y. Edelenbosch, M. A. E. van Sluisveld, V. J. Timmer, and D. P. van Vuuren, 2019: Improved modelling of lifestyle changes in Integrated Assessment Models: Cross-disciplinary insights from methodologies and theories. *Energy Strateg. Rev.*, **26**, 100420, https://doi.org/10.1016/j.esr.2019.100420.

Bergek, A., C. Berggren, T. Magnusson, and M. Hobday, 2013: Technological discontinuities and the challenge for incumbent firms: Destruction, disruption or creative accumulation? *Res. Policy*, **42**, 1210–1224, https://doi.org/10.1016/j.respol.2013.02.009.

Berkhout, F., 2002: Technological regimes, path dependency and the environment. *Glob. Environ. Chang.*, **12**, 1–4, https://doi.org/10.1016/s0959-3780(01)00025-5.

Bhattacharya, S., and M. L. Cropper, 2010: *Options for Energy Efficiency in India and Barriers to Their Adoption A Scoping Study Options for Energy Efficiency in India and Barriers to Their Adoption*. Resources for the Future (RfF) Press, 38 pp. https://media.rff.org/documents/RFF-DP-10-20.pdf.

Bhattacharya, S. C., and C. Jana, 2009: Renewable energy in India: Historical developments and prospects. *Energy*, **34**, 981–991, https://doi.org/10.1016/j.energy.2008.10.017.

Bianchi, F., E. Garnett, C. Dorsel, P. Aveyard, and S. A. Jebb, 2018: Restructuring physical micro-environments to reduce the demand for meat: a systematic review and qualitative comparative analysis. *Lancet Planet. Heal.*, **2**, e384–e397, https://doi.org/10.1016/S2542-5196(18)30188-8. www.thelancet.com/ (Accessed December 5, 2020).

Biddau, F., A. Armenti, and P. Cottone, 2016: Socio-psychological aspects of grassroots participation in the transition movement: An Italian case study. *J. Soc. Polit. Psychol.*, **4**, 142–165, https://doi.org/10.5964/jspp.v4i1.518.

Bielecki, C., and G. Wingenbach, 2014: Rethinking improved cookstove diffusion programs: A case study of social perceptions and cooking choices in rural Guatemala. *Energy Policy*, **66**, 350–358, https://doi.org/10.1016/j.enpol.2013.10.082.

Bierwirth, A., and S. Thomas, 2019: *Estimating the sufficiency potential in buildings: the space between under-dimensioned and oversized*. https://ec.europa.eu/eurostat/ (Accessed December 18, 2020).

Bikram, M., and M. Thakuri, 2009: *Revisiting the Need of Improved Stoves: Estimating Health, Time and Carbon Benefits*. 46 pp. www.sandeeonline.org.

Bin, S., and H. Dowlatabadi, 2005: Consumer lifestyle approach to US energy use and the related CO2 emissions. *Energy Policy*, **33**, 197–208, https://doi.org/10.1016/S0301-4215(03)00210-6. https://www.sciencedirect.com/science/article/pii/S0301421503002106 (Accessed July 4, 2019).

Bohnsack, R., J. Pinkse, and A. Waelpoel, 2016: The institutional evolution process of the global solar industry: The role of public and private actors in creating institutional shifts. *Environ. Innov. Soc. Transitions*, **20**, 16–32, https://doi.org/10.1016/j.eist.2015.10.006.

Bomberg, E., and A. Hague, 2018: Faith-based climate action in Christian congregations: mobilisation and spiritual resources. *Local Environ.*, **23**, 582–596, https://doi.org/10.1080/13549839.2018.1449822.

https://www.tandfonline.com/doi/full/10.1080/13549839.2018.1449822 (Accessed December 13, 2019).

Bonjour, S., and Coauthors, 2013: Solid fuel use for household cooking: Country and regional estimates for 1980-2010. *Environ. Health Perspect.*, **121**, 784–790, https://doi.org/10.1289/ehp.1205987.

Borghei, B., and T. Magnusson, 2016: Niche experiments with alternative powertrain technologies: the case of electric city-buses in Europe. *Int. J. Automot. Technol. Manag.*, **16**, 274, https://doi.org/10.1504/ijatm.2016.080787.

Borghei, B. B., and T. Magnusson, 2018: Niche aggregation through cumulative learning: A study of multiple electric bus projects. *Environ. Innov. Soc. Transitions*, **28**, 108–121, https://doi.org/10.1016/j.eist.2018.01.004. https://doi.org/10.1016/j.eist.2018.01.004 (Accessed December 13, 2019).

Bosman, R., D. Loorbach, N. Frantzeskaki, and T. Pistorius, 2014: Discursive regime dynamics in the Dutch energy transition. *Environ. Innov. Soc. Transitions*, **13**, 45–59, https://doi.org/10.1016/j.eist.2014.07.003.

Brand-Correa, L. I., and J. K. Steinberger, 2017: A Framework for Decoupling Human Need Satisfaction From Energy Use. *Ecol. Econ.*, **141**, 43–52, https://doi.org/10.1016/j.ecolecon.2017.05.019. https://www.sciencedirect.com/science/article/pii/S0921800916308448 (Accessed March 24, 2019).

Brockway, P., H. Saunders, M. Heun, T. Foxon, J. Steinberger, J. Barrett, and S. Sorrell, 2017: Energy Rebound as a Potential Threat to a Low-Carbon Future: Findings from a New Exergy-Based National-Level Rebound Approach. *Energies*, **10**, 51, https://doi.org/10.3390/en10010051. http://www.mdpi.com/1996-1073/10/1/51 (Accessed June 11, 2020).

Bulkeley, H., V. Castán Broto, and A. Maassen, 2014: Low-carbon Transitions and the Reconfiguration of Urban Infrastructure. *Urban Stud.*, **51**, 1471–1486, https://doi.org/10.1177/0042098013500089. https://journals.sagepub.com/doi/abs/10.1177/0042098013500089?journalCode=usja.

Bullock, C., D. Joyce, and M. Collier, 2018: An exploration of the relationships between cultural ecosystem services, socio-cultural values and well-being. *Ecosyst. Serv.*, **31**, 142–152, https://doi.org/10.1016/j.ecoser.2018.02.020.

Van den Bulte, C., and S. Stremersch, 2004: Social Contagion and Income Heterogeneity in New Product Diffusion: A Meta-Analytic Test. *Mark. Sci.*, **23**, 530–544, https://doi.org/10.1287/mksc.1040.0054.

Burningham, K., 2000: Using the language of NIMBY: A topic for research, not an activity for researchers. *Local Environ.*, **5**, 55–67, https://doi.org/10.1080/135498300113264. https://www.tandfonline.com/doi/abs/10.1080/135498300113264.

——, J. Barnett, and G. Walker, 2015: An Array of Deficits: Unpacking NIMBY Discourses in Wind Energy Developers' Conceptualizations of Their Local Opponents. *Soc. Nat. Resour.*, **28**, 246–260, https://doi.org/10.1080/08941920.2014.933923. https://www.tandfonline.com/doi/full/10.1080/08941920.2014.933923.

Buschmann, P., and A. Oels, 2019: The overlooked role of discourse in breaking carbon lock-in: The case of the German energy transition. *Wiley Interdiscip. Rev. Clim. Chang.*, **10**, 1–14, https://doi.org/10.1002/wcc.574.

Carter, N., and M. Jacobs, 2014: Explaining radical policy change: The case of climate change and energy policy under the British labour government 2006-10. *Public Adm.*, **92**, 125–141, https://doi.org/10.1111/padm.12046.

Cass, N., T. Schwanen, and E. Shove, 2018: Infrastructures, intersections and societal transformations. *Technol. Forecast. Soc. Change*, **137**, 160–167, https://doi.org/10.1016/J.TECHFORE.2018.07.039.

Chakravarty, D., S. Dasgupta, and J. Roy, 2013: Rebound effect: How much to worry? *Curr. Opin. Environ. Sustain.*, **5**, 216–228, https://doi.org/http://dx.doi.org/10.1016/j.cosust.2013.03.001.

Chattopadhyay, M., T. H. Arimura, H. Katayama, S. Mari, and H. Yokoo, 2017: Cooking Fuel Choices—Analysis of Socio-economic and Demographic Factors in Rural India. *Environ. Sci.*, **30**, 131–140, https://doi.org/10.11353/sesj.30.131.

Chen, C., G. Liu, F. Meng, Y. Hao, Y. Zhang, and M. Casazza, 2019: Energy consumption and carbon footprint accounting of urban and rural residents in Beijing through Consumer Lifestyle Approach. *Ecol. Indic.*, **98**, 575–586, https://doi.org/10.1016/j.ecolind.2018.11.049. https://doi.org/10.1016/j.ecolind.2018.11.049.

Chen, G., T. Wiedmann, M. Hadjikakou, and H. Rowley, 2016: City Carbon Footprint Networks. *Energies*, **9**, 602, https://doi.org/10.3390/en9080602. http://www.mdpi.com/1996-1073/9/8/602 (Accessed December 18, 2020).

Cherry, E., 2006: Veganism as a Cultural Movement: A Relational Approach. *Soc. Mov. Stud.*, **5**, 155–170, https://doi.org/10.1080/14742830600807543.

Choy, Y. K., 2018: Cost-benefit Analysis, Values, Wellbeing and Ethics: An Indigenous Worldview Analysis. *Ecol. Econ.*, **145**, 1–9, https://doi.org/10.1016/j.ecolecon.2017.08.005.

Chu, S., 2015: Car restraint policies and mileage in Singapore. *Transp. Res. Part A Policy Pract.*, **77**, 404–412, https://doi.org/10.1016/j.tra.2015.04.028.

Cialdini, R. B., 2006: *Influence: The psychology of persuasion*. Herper Collins New York, 173–174 pp.

Clausen, J., E. Göll, and V. Tappeser, 2017: Sticky Transformation – How path dependencies in socio-technical regimes are impeding the transformation to a Green Economy. *J. Innov. Manag.*, **5**, 111–138, https://doi.org/10.1007/BF00727536. https://search.proquest.com/docview/1957730369?accountid=13031%0Ahttp://sfx.nelliportaali.fi/nelli28b?url_ver=Z39.88-2004&rft_val_fmt=info:ofi/fmt:kev:mtx:journal&genre=article&sid=ProQ:ProQ%3Aabiglobal&atitle=Sticky+Transformation+–+How+path+dependencies.

Cloutier, G., F. Joerin, C. Dubois, M. Labarthe, C. Legay, and D. Viens, 2015: Planning adaptation based on local actors' knowledge and participation: a climate governance experiment. *Clim. Policy*, **15**, 458–474, https://doi.org/10.1080/14693062.2014.937388.

Comin, D., and B. Hobijn, 2003: *Cross-country technology adoption: Making the theories face the facts*. 49 pp. http://hdl.handle.net/10419/60558.

——, and ——, 2010: An exploration of technology diffusion. *Am. Econ. Rev.*, **100**, 2031–2059, https://doi.org/10.1257/aer.100.5.2031.

Court, V., and S. Sorrell, 2020: Digitalisation of goods: A systematic review of the determinants and magnitude of the impacts on energy consumption. *Environ. Res. Lett.*, **15**, https://doi.org/10.1088/1748-9326/ab6788.

CPUC, 1983: Approval of Interim Standard Offer No.4 for PG&E, SCE, and SDG&E based on the results of a Negotiating Conference. *Decision*, **83-09–054**.

Creutzig, F., B. Fernandez, H. Haberl, R. Khosla, Y. Mulugetta, and K. C. Seto, 2016: Beyond technology: demand-side solutions for climate change mitigation. *Annu. Rev. Environ. Resour.*, **41**, 173–198, https://doi.org/10.1146/annurev-environ-110615-085428. http://www.annualreviews.org/doi/abs/10.1146/annurev-environ-110615-085428 (Accessed December 6, 2019).

——, P. Agoston, J. C. J. C. Goldschmidt, G. Luderer, G. Nemet, and R. C. R. C. Pietzcker, 2017: The underestimated potential of solar energy to mitigate climate change. *Nat. Energy*, **2**, https://doi.org/10.1038/nenergy.2017.140.

——, and Coauthors, 2018: Towards demand-side solutions for mitigating climate change. *Nat. Clim. Chang.*, **8**, 260–263, https://doi.org/10.1038/s41558-018-0121-1. http://www.nature.com/articles/s41558-018-0121-1 (Accessed February 9, 2019).

——, and Coauthors, 2021a: A typology of 100,000 publications on demand, services and social aspects of climate change mitigation. *Environ. Res. Lett.*, **submitted**.

——, and Coauthors, 2021b: Demand-side solutions to climate change mitigation consistent with high levels of wellbeing. **submitted**.

Currie, G., and D. Spyridonidis, 2016: Interpretation of Multiple Institutional Logics on the Ground: Actors' Position, their Agency and Situational Constraints in Professionalized Contexts. *Organ. Stud.*, **37**, 77–97, https://doi.org/10.1177/0170840615604503.

Daioglou, V., B. J. van Ruijven, and D. P. van Vuuren, 2012: Model projections for household energy use in developing countries. *Energy*, **37**, 601–615, https://doi.org/10.1016/j.energy.2011.10.044.

Dana, L.-P., C. Gurău, F. Hoy, V. Ramadani, and T. Alexander, 2019: Success factors and challenges of grassroots innovations: Learning from failure. *Technol. Forecast. Soc. Change*, https://doi.org/10.1016/j.techfore.2019.03.009. https://linkinghub.elsevier.com/retrieve/pii/S0040162517314002.

Darby, S., and T. Fawcett, 2018: *Energy sufficiency: an introduction Concept paper*. https://www.energysufficiency.org/static/media/uploads/site-8/library/papers/sufficiency-introduction-final-oct2018.pdf (Accessed December 16, 2019).

Darnton, A., B. Verplanken, P. White, and L. Whitmarsh, 2011: *Habits , Routines and Sustainable Lifestyles Summary Report A research report completed for the Department for Environment , Food*. 71 pp. file:///C:/Users/gyma/OneDrive - Loughborough University/Lifestyle_Lowcarbon/Lifestyle_references/Darnton etal (2011) Habits, Routines and Sustainable Lifestyles A summary report to DEFRA.pdf.

Dasgupta, A., and P. Dasgupta, 2017: Socially Embedded Preferences, Environmental Externalities, and Reproductive Rights. *Popul. Dev. Rev.*, **43**, 405–441, https://doi.org/10.1111/padr.12090. https://doi.org/10.1111/padr.12090.

Dasgupta, P., 2001: *Human Well-Being and the Natural Environment*. Oxford University Press, 328 pp.

——, 2013: The Nature of Economic Development and the Economic Development of Nature. *Econ. Polit. Wkly.*, **48**. https://www.epw.in/journal/2013/51/special-articles/nature-economic-development-and-economic-development-nature.html.

——, 2014: Pricing climate change. *Polit. Philos. Econ.*, **13**, 394–416, https://doi.org/10.1177/1470594X14541521.

Dasgupta, P., and Coauthors, 2015: How to measure sustainable progress. *Science (80-.).*, **350**, 748–748, https://doi.org/10.1126/science.350.6262.748.

Davidescu, S., R. Hiteva, and T. Maltby, 2018: Two steps forward, one step back: Renewable energy transitions in Bulgaria and Romania. *Public Adm.*, **96**, 611–625, https://doi.org/10.1111/padm.12522.

Davis, F. D., 1989: Perceived Usefulness, Perceived Ease Of Use, And User Acceptance of Information Technology. *MIS Q.*, **13**, 319–340, https://doi.org/10.2307/249008.

Davis, S., 1979: *The Diffusion of Process Innovations*. Cambridge University Press, 193 pp.

Dearby, S., 2007: *Enough is as good as a feast: sufficiency as policy*.

DEFRA, 2011: *Sustainable Lifestyles Framework*. 33 pp. file:///C:/Users/gyma/OneDrive - Loughborough University/Lifestyle_Lowcarbon/Lifestyle_references/DEFRA (2011)Sustainable_lifestyles_framework.pdf.

Delmas, M. A., and V. C. Burbano, 2011: The Drivers of Greenwashing. *Calif. Manage. Rev.*, **54**, https://doi.org/10.1525/cmr.2011.54.1.64. https://www0.gsb.columbia.edu/mygsb/faculty/research/pubfiles/14016/cmr5401_04_printversion_delmasburbano.pdf (Accessed December 3, 2019).

Demski, C., C. Butler, K. A. Parkhill, A. Spence, and N. F. Pidgeon, 2015: Public values for energy system change. *Glob. Environ. Chang.*, **34**, 59–69, https://doi.org/10.1016/j.gloenvcha.2015.06.014.

Dendup, N., and T. H. Arimura, 2019: Information leverage: The adoption of clean cooking fuel in Bhutan. *Energy Policy*, **125**, 181–195, https://doi.org/10.1016/j.enpol.2018.10.054.

Devine-Wright, P., 2005: Beyond NIMBYism: Towards an integrated framework for understanding public perceptions of wind energy. *Wind Energy*, **8**, 125–139, https://doi.org/10.1002/we.124.

——, 2007: Energy citizenship: psychological aspects of evolution in sustainable energy technologies. *Governing Technology for Sustainability*, M. Joseph, Ed., Earthscan, p. 24.

——, 2009: Rethinking NIMBYism: The role of place attachment and place identity in explaining place-protective action. *J. Community Appl. Soc. Psychol.*, **19**, 426–441, https://doi.org/10.1002/casp.1004.

——, 2011: Public engagement with large-scale renewable energy technologies: Breaking the cycle of NIMBYism. *Wiley Interdiscip. Rev. Clim. Chang.*, **2**, 19–26, https://doi.org/10.1002/wcc.89.

——, and Y. Howes, 2010: Disruption to place attachment and the protection of restorative environments: A wind energy case study. *J. Environ. Psychol.*, **30**, 271–280, https://doi.org/10.1016/j.jenvp.2010.01.008. https://psycnet.apa.org/record/2010-04048-001.

Dewald, U., and B. Truffer, 2011: Market formation in technological innovation systems-diffusion of photovoltaic applications in Germany. *Ind. Innov.*, **18**, 285–300, https://doi.org/10.1080/13662716.2011.561028.

Dibb, S., and I. Fitzpatrick, 2014: *Let's talk about meat: changing dietary behaviour for the 21st century*. 32 pp.

Dickinson, K. L., and Coauthors, 2018: Prices, peers, and perceptions (P3): Study protocol for improved biomass cookstove project in northern Ghana. *BMC Public Health*, **18**, 1209, https://doi.org/10.1186/s12889-018-6116-z. https://bmcpublichealth.biomedcentral.com/articles/10.1186/s12889-018-6116-z (Accessed June 6, 2020).

Diffenbaugh, N. S., and M. Burke, 2019: Global warming has increased global economic inequality. *Proc. Natl. Acad. Sci. U. S. A.*, **116**, 9808–9813, https://doi.org/10.1073/pnas.1816020116.

http://www.ncbi.nlm.nih.gov/pubmed/31010922 (Accessed July 4, 2019).

Ding, Q., W. Cai, C. Wang, and M. Sanwal, 2017: The relationships between household consumption activities and energy consumption in china— An input-output analysis from the lifestyle perspective. *Appl. Energy*, **207**, 520–532, https://doi.org/10.1016/j.apenergy.2017.06.003. https://doi.org/10.1016/j.apenergy.2017.06.003.

Dittmar, H., 2008: *Consumer culture, identity and well-being : the search for the "good life" and the "body perfect."* Psychology Press, 271 pp.

Dolata, U., 2009: Technological innovations and sectoral change. Transformative capacity, adaptability, patterns of change: An analytical framework. *Res. Policy*, **38**, 1066–1076, https://doi.org/10.1016/j.respol.2009.03.006.

Dombrowski, U., S. Ernst, and A. Reimer, 2016: A New Training for Factory Planning Engineers to Create Awareness of Climate Change. *Procedia CIRP*, **48**, 443–448, https://doi.org/10.1016/j.procir.2016.04.083. https://www.sciencedirect.com/science/article/pii/S2212827116302700 (Accessed May 5, 2019).

De Dominicis, S., R. Sokoloski, C. M. Jaeger, and P. W. Schultz, 2019: Making the smart meter social promotes long-term energy conservation. *Palgrave Commun.*, **5**, 1–8, https://doi.org/10.1057/s41599-019-0254-5. http://dx.doi.org/10.1057/s41599-019-0254-5.

Doyal, L., and I. Gough, 1991: Introduction. *A Theory of Human Need*, Palgrave, 1–2.

Dracker, R., and P. De Laquil III, 1996: Progress Commercializing Solar-Electric Power Systems. *Annu. Rev. Energy Environ.*, **21**, 371–402, https://doi.org/10.1146/annurev.energy.21.1.371. http://www.annualreviews.org/doi/10.1146/annurev.energy.21.1.371 (Accessed December 13, 2019).

Dubois, G., and Coauthors, 2019: It starts at home? Climate policies targeting household consumption and behavioral decisions are key to low-carbon futures. *Energy Res. Soc. Sci.*, **52**, 144–158, https://doi.org/10.1016/j.erss.2019.02.001. http://www.sciencedirect.com/science/article/pii/S2214629618310314 (Accessed December 6, 2019).

Ebeling, F., and S. Lotz, 2015: Domestic uptake of green energy promoted by opt-out tariffs. *Nat. Clim. Chang.*, **5**, 868–871, https://doi.org/10.1038/nclimate2681. https://www.nature.com/articles/nclimate2681 (Accessed December 26, 2019).

Espe, E., V. Potdar, and E. Chang, 2018: Prosumer communities and relationships in smart grids: A literature review, evolution and future directions. *Energies*, **11**, https://doi.org/10.3390/en11102528.

Etminani-Ghasrodashti, R., M. Paydar, and A. Ardeshiri, 2018: Recreational cycling in a coastal city: Investigating lifestyle, attitudes and built environment in cycling behavior. *Sustain. Cities Soc.*, **39**, 241–251, https://doi.org/10.1016/j.scs.2018.02.037. https://doi.org/10.1016/j.scs.2018.02.037.

Eyre, N., and G. Killip, 2019: *Shifting the focus: energy demand in a net-zero carbon UK*. https://www.creds.ac.uk/publications/shifting-the-focus-energy-demand-in-a-net-zero-carbon-uk/ (Accessed December 16, 2019).

Faber, J., and Coauthors, 2012: *Behavioural Climate Change Mitigation Options and Their Appropriate Inclusion in Quantitative Longer Term Policy Scenarios*. CE Delft, 87 pp. http://publications.europa.eu/resource/cellar/d9f5683a-b330-47c4-beac-d4d4f5dec681.0001.07/DOC_1.

Farrow, K., G. Grolleau, and L. Ibanez, 2017: Social Norms and Pro-environmental Behavior: A Review of the Evidence. *Ecol. Econ.*, **140**, 1–13, https://doi.org/10.1016/j.ecolecon.2017.04.017. http://dx.doi.org/10.1016/j.ecolecon.2017.04.017 (Accessed June 5, 2020).

Fawcett, T., and S. Darby, 2019: *Energy sufficiency in policy and practice: the question of needs and wants*. 2–226 pp. http://www.oxfordlearnersdictionaries.com/definition/english/sufficiency (Accessed December 21, 2020).

Fell, M. J., A. Schneiders, and D. Shipworth, 2019: Consumer Demand for Blockchain-Enabled Peer-to-Peer Electricity Trading in the United Kingdom: An Online Survey Experiment. *Energies*, **12**, 3913, https://doi.org/10.3390/en12203913.

Fenner, A. E., C. J. Kibert, J. Woo, S. Morque, M. Razkenari, H. Hakim, and X. Lu, 2018: The carbon footprint of buildings: A review of methodologies and applications. *Renew. Sustain. Energy Rev.*, **94**, 1142–1152, https://doi.org/10.1016/j.rser.2018.07.012.

Ferguson, J., T. R. Sales de Aguiar, and A. Fearfull, 2016: Corporate response to climate change: language, power and symbolic construction,. *Accounting, Audit. Account. J.*, **29**, 278–304, https://doi.org/http://dx.doi.org/10.1108/MRR-09-2015-0216.

Ferrer-Balas, D., H. Buckland, and M. de Mingo, 2009: Explorations on the University's role in society for sustainable development through a systems transition approach. Case-study of the Technical University of Catalonia (UPC). *J. Clean. Prod.*, **17**, 1075–1085, https://doi.org/10.1016/J.JCLEPRO.2008.11.006. https://www.sciencedirect.com/science/article/pii/S0959652608002849?via%3Dihub (Accessed May 5, 2019).

Fielding, K. S., and M. J. Hornsey, 2016: A social identity analysis of climate change and environmental attitudes and behaviors: Insights and opportunities. *Front. Psychol.*, **7**, 1–12, https://doi.org/10.3389/fpsyg.2016.00121.

Fisher, P. B., and E. McAdams, 2015: Gaps in sustainability education. *Int. J. Sustain. High. Educ.*, **16**, 407–423, https://doi.org/10.1108/IJSHE-08-2013-0106. http://www.emeraldinsight.com/doi/10.1108/IJSHE-08-2013-0106 (Accessed May 4, 2019).

Fouquet, R., 2008: *Heat, power and light: revolutions in energy services*. Edward Elgar Publishing, 470 pp.

Frank, R. H., 1999: *Luxury Fever : Weighing the Cost of Excess*. Princeton University Press, https://press.princeton.edu/books/paperback/9780691146935/luxury-fever (Accessed July 5, 2019).

Frantzeskaki, N., and D. Loorbach, 2008: Infrastructures in transition role and response of infrastructures in societal transitions. *2008 1st International Conference on Infrastructure Systems and Services: Building Networks for a Brighter Future, INFRA 2008*.

Fremstad, A., and M. Paul, 2019: The Impact of a Carbon Tax on Inequality. *Ecol. Econ.*, **163**, 88–97, https://doi.org/10.1016/j.ecolecon.2019.04.016.

Frenkel, A., E. Bendit, and S. Kaplan, 2013: The linkage between the lifestyle of knowledge-workers and their intra-metropolitan residential choice: A clustering approach based on self-organizing maps. *Comput. Environ. Urban Syst.*, **39**, 151–161, https://doi.org/10.1016/j.compenvurbsys.2012.09.001. http://dx.doi.org/10.1016/j.compenvurbsys.2012.09.001.

Frye, I., 2013: *Towards a Decent Living Level*. 18 pp. https://dslnow.net/wp-content/uploads/2019/06/Policy-Brief-2.pdf (Accessed November 4, 2019).

Gabaix, X., and D. Laibson, 2018: Shrouded attributes, consumer myopia and information suppression in competitive markets. *Handbook of Behavioral Industrial Organization*, Edward Elgar Publishing.

Gabriel, C. A., and C. Bond, 2019: Need, Entitlement and Desert: A Distributive Justice Framework for Consumption Degrowth. *Ecol. Econ.*, **156**, 327–336, https://doi.org/10.1016/j.ecolecon.2018.10.006.

Galaskiewicz, J., 1985: Professional Networks and the Institutionalization of a Single Mind Set. *Am. Sociol. Rev.*, **50**, 639–658, https://doi.org/10.2307/2095379.

Le Gallic, T., E. Assoumou, and N. Maïzi, 2018: Investigating long-term lifestyle changes: A methodological proposal based on a statistical model. *Sustain. Dev.*, **26**, 159–171, https://doi.org/10.1002/sd.1727. file:///C:/Users/gyma/OneDrive - Loughborough University/Lifestyle_Lowcarbon/Lifestyle_references/Le Gallic (2018) Investigating long-term lifestyle changes.pdf.

Gardner, B., and C. Abraham, 2008: Psychological correlates of car use: A meta-analysis. *Transp. Res. Part F Traffic Psychol. Behav.*, **11**, 300–311, https://doi.org/10.1016/j.trf.2008.01.004.

Garnett, T., S. Mathewson, P. Angelides, F. Borthwick, and C. House, 2015: *Policies and actions to shift eating patterns: What works?* 85 pp. https://www.fcrn.org.uk/sites/default/files/fcrn_chatham_house_0.pdf (Accessed December 10, 2019).

Geels, F., and R. Raven, 2006: Non-linearity and expectations in niche-development trajectories: Ups and downs in Dutch biogas development (1973-2003). *Technol. Anal. Strateg. Manag.*, **18**, 375–392, https://doi.org/10.1080/09537320600777143.

Geels, F. W., 2002: Technological transitions as evolutionary reconfiguration processes: A multi-level perspective and a case-study. *Res. Policy*, **31**, 1257–1274, https://doi.org/10.1016/S0048-7333(02)00062-8.

Geels, F. W., and B. Verhees, 2011: Cultural legitimacy and framing struggles in innovation journeys: A cultural-performative perspective and a case study of Dutch nuclear energy (1945-1986). *Technol. Forecast. Soc. Change*, **78**, 910–930, https://doi.org/10.1016/j.techfore.2010.12.004.

Geels, F. W., B. K. Sovacool, T. Schwanen, and S. Sorrell, 2017a: Accelerating innovation is as important as climate policy. *Science (80-.).*, **357**, 1242–1244, https://doi.org/10.1126/science.aao3760.

Geels, F. W., B. K. Sovacool, T. Schwanen, and S. Sorrell, 2017b: Sociotechnical transitions for deep decarbonization. *Science (80-.).*, **357**, 1242–1244, https://doi.org/10.1126/science.aao3760.

Geels, F. W. F. W., 2014: Regime Resistance against Low-Carbon Transitions: Introducing Politics and Power into the Multi-Level Perspective. *Theory, Cult. Soc.*, **31**, 21–40, https://doi.org/10.1177/0263276414531627.

Geiger, J. L., L. Steg, E. van der Werff, and A. B. Ünal, 2019: A meta-analysis of factors related to recycling. *J. Environ. Psychol.*, **64**, 78–97, https://doi.org/10.1016/j.jenvp.2019.05.004.

George-Ufot, G., Y. Qu, and I. J. Orji, 2017: Sustainable lifestyle factors influencing industries' electric consumption patterns using Fuzzy logic and DEMATEL: The Nigerian perspective. *J. Clean. Prod.*, **162**, 624–634, https://doi.org/10.1016/j.jclepro.2017.05.188. http://dx.doi.org/10.1016/j.jclepro.2017.05.188.

Ghilardi, A., A. Tarter, and R. Bailis, 2018: Potential environmental benefits from woodfuel transitions in Haiti: Geospatial scenarios to 2027. *Environ. Res. Lett.*, **13**, 35007, https://doi.org/10.1088/1748-9326/aaa846. https://doi.org/10.1088/1748-9326/aaa846 (Accessed December 3, 2020).

Ghosh, A., 2016: *The great derangement*. University of Chicago Press,.

Ghosh, B., 2019: Transformation beyond experimentation Sustainability transitions in megacities. University of Sussex, 246 pp. http://sro.sussex.ac.uk/id/eprint/82511/ (Accessed December 10, 2019).

——, and S. Arora, 2019: *Smart as Democratically Transformative? An Analysis of "Smart City" Sociotechnical Imaginary in India*. ESRC Steps Centre, https://opendocs.ids.ac.uk/opendocs/handle/20.500.12413/14670 (Accessed December 3, 2020).

——, and J. Schot, 2019: Towards a novel regime change framework: Studying mobility transitions in public transport regimes in an Indian megacity. *Energy Res. Soc. Sci.*, **51**, 82–95, https://doi.org/10.1016/J.ERSS.2018.12.001.

Ghosh, D., F. Sengers, A. J. Wieczorek, B. Ghosh, J. Roy, and R. Raven, 2018: Urban mobility experiments in India and Thailand. *The Experimental City*, J. Evans, A. Karvonen, and R. Raven, Eds., Routledge, 122–136 https://www.taylorfrancis.com/books/e/9781315719825/chapters/10.4324/9781315719825-9 (Accessed December 3, 2020).

Giddens, A., 1991: *Modernity and self-identity: Self and society in the late modern age*. Stanford University Press, 70–108 pp. http://www.sup.org/books/title/?id=2660 (Accessed December 21, 2019).

Giri, A., and A. Aadil, 2018: *Pradhan Mantri Ujjwala Yojana: A demand-side diagnostic study of LPG refills Policy brief www.microsave.net*. www.microsave.net (Accessed December 3, 2020).

Göckeritz, S., P. W. Schultz, T. Rendon, R. B. Cialdini, N. J. Goldstein, and V. Griskevicius, 2010: Descriptive mormative belief and conservative behaviour: The moderating roles of personal involvement and injunctive normative belief. *Eur. J. Soc. Psychol.*, **40**, 514–523, https://doi.org/10.1002/ejsp.643.

Godfray, H. C. J., and Coauthors, 2018: Meat consumption, health, and the environment. *Science (80-.).*, **361**, https://doi.org/10.1126/science.aam5324. www.fao.org/faostat/en/?#data.] (Accessed August 27, 2020).

Goldemberg, J., J. Martinez-Gomez, A. Sagar, and K. R. Smith, 2018: Household air pollution, health, and climate change: Cleaning the air. *Environ. Res. Lett.*, **13**, 030201, https://doi.org/10.1088/1748-9326/aaa49d. https://doi.org/10.1088/1748-9326/aaa49d (Accessed December 3, 2020).

González-García, S., X. Esteve-Llorens, M. T. Moreira, and G. Feijoo, 2018: Carbon footprint and nutritional quality of different human dietary choices. *Sci. Total Environ.*, **644**, 77–94, https://doi.org/10.1016/j.scitotenv.2018.06.339.

Gorge, H., M. Herbert, N. Özçağlar-Toulouse, and I. Robert, 2014: What Do We Really Need? Questioning Consumption Through Sufficiency. *J. Macromarketing*, **35**, 11–22, https://doi.org/10.1177/0276146714553935. http://journals.sagepub.com/doi/10.1177/0276146714553935 (Accessed December 21, 2020).

Gould, C. F., S. Schlesinger, A. O. Toasa, M. Thurber, W. F. Waters, J. P. Graham, and D. W. Jack, 2018: Government policy, clean fuel access, and persistent fuel stacking in Ecuador. *Energy Sustain. Dev.*, **46**, 111–122, https://doi.org/10.1016/j.esd.2018.05.009.

Goulden, M., B. Bedwell, S. Rennick-Egglestone, T. Rodden, and A. Spence, 2014: Smart grids, smart users? the role of the user in demand side management. *Energy Res. Soc. Sci.*, **2**, 21–29, https://doi.org/10.1016/j.erss.2014.04.008.

Graça, J., C. A. Godinho, and M. Truninger, 2019: Reducing meat consumption and following plant-based diets: Current evidence and future directions to inform integrated transitions. *Trends Food Sci. Technol.*, **91**, 380–390, https://doi.org/10.1016/j.tifs.2019.07.046.

Gram-Hanssen, K., 2008: Consuming technologies - developing routines. *J. Clean. Prod.*, **16**, 1181–1189, https://doi.org/10.1016/j.jclepro.2007.08.006.

Grandclément, C., A. Karvonen, and S. Guy, 2015: Negotiating comfort in low energy housing: The politics of intermediation. *Energy Policy*, **84**, 213–222, https://doi.org/10.1016/j.enpol.2014.11.034.

Griggs, D., and Coauthors, 2013: Sustainable development goals for people and planet. *Nature*, **495**, 305–307, https://doi.org/https://doi.org/10.1038/495305a. http://www.nature.com/articles/495305a.

Gross, R., and R. Hanna, 2019: Path dependency in provision of domestic heating. *Nat. Energy*, **4**, 358–364, https://doi.org/10.1038/s41560-019-0383-5.

Grubb, M., 2014: *Energy, Climate Change and the Three Domains of Sustainable Development*. Routledge, http://www.routledge.com/books/details/9780415518826/ (Accessed December 6, 2019).

Grubler, A., 1991: Energy in the 21st century: From resource to environmental and lifestyle constraints. *Entropie Rev. Sci. Tech. Thermodyn.*, **164**, 29–33. http://pure.iiasa.ac.at/12424.

——, T. B. Johansson, L. Mundaca, N. Nakicenovic, S. Pachauri, K. Riahi, H.-H. Rogner, and L. Strupeit, 2012: Chapter 1 - Energy Primer. *Global Energy Assessment - Toward a Sustainable Future*, 99–150 http://www.globalenergyassessment.org.

——, C. Wilson, and G. Nemet, 2016: Apples, oranges, and consistent comparisons of the temporal dynamics of energy transitions. *Energy Res. Soc. Sci.*, **22**, 18–25, https://doi.org/10.1016/j.erss.2016.08.015. http://dx.doi.org/10.1016/j.erss.2016.08.015.

——, and Coauthors, 2018: A low energy demand scenario for meeting the 1.5° C target and sustainable development goals without negative emission technologies. *Nat. Energy*, **3**, 515–527, https://doi.org/10.1038/s41560-018-0172-6. https://www.nature.com/articles/s41560-018-0172-6.

Grübler, A., N. Nakićenović, and D. G. Victor, 1999: Dynamics of energy technologies and global change. *Energy Policy*, **27**, 247–280, https://doi.org/10.1016/S0301-4215(98)00067-6.

Gui, E. M., and I. MacGill, 2018: Typology of future clean energy communities: An exploratory structure, opportunities, and challenges. *Energy Res. Soc. Sci.*, **35**, 94–107, https://doi.org/10.1016/j.erss.2017.10.019.

Haberl, H., D. Wiedenhofer, S. Pauliuk, F. Krausmann, D. B. Müller, and M. Fischer-Kowalski, 2019: Contributions of sociometabolic research to sustainability science. *Nat. Sustain.*, **2**, 173–184, https://doi.org/10.1038/s41893-019-0225-2. http://www.nature.com/articles/s41893-019-0225-2.

Haenfler, R., B. Johnson, and E. Jones, 2012: Lifestyle Movements: Exploring the Intersection of Lifestyle and Social Movements. *Soc. Mov. Stud.*, **11**, 1–20, https://doi.org/10.1080/14742837.2012.640535. http://www.tandfonline.com/doi/abs/10.1080/14742837.2012.640535.

Hagbert, P., and K. Bradley, 2017: Transitions on the home front: A story of sustainable living beyond eco-efficiency. *Energy Res. Soc. Sci.*, **31**, 240–248, https://doi.org/10.1016/j.erss.2017.05.002. file:///C:/Users/gyma/OneDrive - Loughborough University/Lifestyle_Lowcarbon/Lifestyle_references/Hagbert & Bradley (2017) Transitions on the home front A story of sustainable living beyond eco-efficiency.pdf.

Halady, I. R., and P. H. Rao, 2010: Does awareness to climate change lead to behavioral change? *Int. J. Clim. Chang. Strateg. Manag.*, **2**, 6–22, https://doi.org/10.1108/17568691011020229.

Hall, P. A., 1993: Policy Paradigms, Social Learning, and the State: The Case of Economic Policymaking in Britain. *Comp. Polit.*, **25**, 275, https://doi.org/10.2307/422246. https://www.jstor.org/stable/422246?origin=crossref (Accessed December 16, 2019).

Haluza-DeLay, R., 2014: Religion and climate change: varieties in viewpoints and practices. *Wiley Interdiscip. Rev. Clim. Chang.*, **5**, 261–279, https://doi.org/10.1002/wcc.268. http://doi.wiley.com/10.1002/wcc.268 (Accessed December 14, 2019).

Hand, M., E. Shove, and D. Southerton, 2005: Explaining showering: A discussion of the material, conventional, and temporal dimensions of practice. *Sociol. Res. Online*, **10**, https://doi.org/10.5153/sro.1100.

Haq, G., J. Whitelegg, S. Cinderby, and A. Owen, 2008: The use of personalised social marketing to foster voluntary behavioural change for sustainable travel and lifestyles. *Local Environ.*, **13**, 549–569, https://doi.org/10.1080/13549830802260092. file:///C:/Users/gyma/OneDrive - Loughborough University/Lifestyle_Lowcarbon/Lifestyle_references/Haq (2008) The use of personalised social marketing to foster volunary behavioural change for sustainable travel and lifestyles.pdf.

Hargreaves, T., M. Nye, and J. Burgess, 2013: Keeping energy visible? Exploring how householders interact with feedback from smart energy monitors in the longer term. *Energy Policy*, **52**, 126–134, https://doi.org/10.1016/J.ENPOL.2012.03.027. https://www.sciencedirect.com/science/article/pii/S0301421512002327?via%3Dihub (Accessed December 12, 2019).

Harguess, J. M., N. C. Crespo, and M. Y. Hong, 2020: Strategies to reduce meat consumption: A systematic literature review of experimental studies. *Appetite*, **144**, 104478, https://doi.org/10.1016/j.appet.2019.104478.

Harland, P., H. Staats, and H. A. M. Wilke, 1999: Explaining proenvironmental intention and behavior by personal norms and the theory of planned behavior. *J. Appl. Soc. Psychol.*, **29**, 2505–2528, https://doi.org/10.1111/j.1559-1816.1999.tb00123.x.

Hartmann, C., and M. Siegrist, 2017: Consumer perception and behaviour regarding sustainable protein consumption: A systematic review. *Trends Food Sci. Technol.*, **61**, 11–25, https://doi.org/10.1016/j.tifs.2016.12.006.

den Hartog, H., F. Sengers, Y. Xu, L. Xie, P. Jiang, and M. de Jong, 2018: Low-carbon promises and realities: Lessons from three socio-technical experiments in Shanghai. *J. Clean. Prod.*, **181**, 692–702, https://doi.org/10.1016/j.jclepro.2018.02.003.

Hawkey, D. J. C., 2012: District heating in the UK: A Technological Innovation Systems analysis. *Environ. Innov. Soc. Transitions*, **5**, 19–32, https://doi.org/10.1016/j.eist.2012.10.005. https://www.sciencedirect.com/science/article/pii/S2210422412000524?via%3Dihub (Accessed May 9, 2019).

Hayward, B., and J. Roy, 2019: Sustainable Living: Bridging the North-South Divide in Lifestyles and Consumption Debates. *Annu. Rev. Environ. Resour.*, **44**, 1–9, https://doi.org/https://doi.org/10.1146/annurev-environ-101718-033119.

https://www.annualreviews.org/doi/10.1146/annurev-environ-101718-033119 (Accessed November 20, 2019).

Hazra, S., Lewis Jessica, Das Ipsita, and Kumar Singha Ashok, 2014: *Adoption and use of improved stoves and biogas plants in rural India*. South Asian Network for Development and Environmental Economics., 22 pp. http://www.sandeeonline.org/uploads/documents/publication/1037_PUB_Working_Paper_86_Somnath.pdf.

Head, L., 2016: *Hope and grief in the anthropocene: Re-conceptualising human-nature relations*. Routledge,.

Healy, N., and J. Barry, 2017: Politicizing energy justice and energy system transitions: Fossil fuel divestment and a "just transition." *Energy Policy*, **108**, 451–459, https://doi.org/10.1016/j.enpol.2017.06.014.

Hedlund-de Witt, A., 2012: Exploring worldviews and their relationships to sustainable lifestyles: Towards a new conceptual and methodological approach. *Ecol. Econ.*, **84**, 74–83, https://doi.org/10.1016/j.ecolecon.2012.09.009. http://dx.doi.org/10.1016/j.ecolecon.2012.09.009.

Heise, U. K., 2017: *Imagining Extinction: The cultural meanings of endangered species*. University of Chicago Press,.

Heiskanen, E., and R. Lovio, 2010: User−Producer Interaction in Housing Energy Innovations. *J. Ind. Ecol.*, **14**, 91–102, https://doi.org/10.1111/j.1530-9290.2009.00196.x.

Heistein, A., D. Gladstein, S. Lyons, K. Wolberger, P. Friedland, and S. Weingarten, 2017: *Report on Ecologically Informed Theological Education*. www.interfaithsustain.com (Accessed December 26, 2019).

Hertwich, E. G., and G. P. Peters, 2009: Carbon footprint of nations: A global, trade-linked analysis. *Environ. Sci. Technol.*, **43**, 6414–6420, https://doi.org/10.1021/es803496a.

Hess, D. J., 2019: Coalitions, framing, and the politics of energy transitions: Local democracy and community choice in California. *Energy Res. Soc. Sci.*, **50**, 38–50, https://doi.org/10.1016/j.erss.2018.11.013.

——, and B. K. Sovacool, 2020: Sociotechnical matters: Reviewing and integrating science and technology studies with energy social science. *Energy Res. Soc. Sci.*, **65**, 101462, https://doi.org/10.1016/j.erss.2020.101462.

Hirsch, R. F., 1999: *Power loss: the origins of deregulation and restructuring in the American electric utility system*. MIT Press, 406 pp.

Hobson, K., 2013: "Weak" or "strong" sustainable consumption? Efficiency, degrowth, and the 10 Year Framework of Programmes. *Environ. Plan. C Gov. Policy*, **20**, 1082–1098, https://doi.org/10.1068/cl2279. http://www.rona.unep.org/.

Hockerts, K., and R. Wüstenhagen, 2010: Greening Goliaths versus emerging Davids: Theorizing about the role of incumbents and new entrants in sustainable entrepreneurship. *J. Bus. Ventur.*, **25**, 481–492, https://doi.org/10.1016/j.jbusvent.2009.07.005.

Hof, A. F., A. G. Dagnachew, P. L. Lucas, and D. P. van Vuuren, 2019: *Towards Universal Access to Clean Cooking Solutions in Sub-Saharan Africa: An integrated assessment of the cost, health and environmental implications of policies and targets*. 60 pp. https://www.pbl.nl/sites/default/files/downloads/pbl-2019-clean-cooking-solutions-sub-saharan-africa_3421_0.pdf.

Honda, J., 2008: History of Photovoltaic Industry Development in Japan. *Proceedings of ISES World Congress 2007,* Springer, 118–123.

Hoolohan, C., C. McLachlan, and S. Mander, 2018: Food related routines and energy policy: A focus group study examining potential for change in the United Kingdom. *Energy Res. Soc. Sci.*, **39**, 93–102, https://doi.org/10.1016/j.erss.2017.10.050.

Hooper, L. G., Y. Dieye, A. Ndiaye, A. Diallo, C. S. Sack, V. S. Fan, K. M. Neuzil, and J. R. Ortiz, 2018: Traditional cooking practices and preferences for stove features among women in rural Senegal: Informing improved cookstove design and interventions. *PLoS One*, **13**, e0206822, https://doi.org/10.1371/journal.pone.0206822. https://dx.plos.org/10.1371/journal.pone.0206822 (Accessed June 6, 2020).

Hossain, M., 2016: Grassroots innovation : A systematic review of two decades of research. *J. Clean. Prod.*, **137**, 973–981, https://doi.org/10.1016/j.jclepro.2016.07.140.

Hubacek, K., D. Guan, and A. Barua, 2007: Changing lifestyles and consumption patterns in developing countries: A scenario analysis for China and India. *Futures*, **39**, 1084–1096, https://doi.org/10.1016/j.futures.2007.03.010.

Hur, W. M., H. K. Kim, and J. K. Park, 2010: Food- and situation-specific lifestyle segmentation of kitchen appliance market. *Br. Food J.*, **112**, 294–305, https://doi.org/10.1108/00070701011029165. file:///C:/Users/gyma/OneDrive - Loughborough University/Lifestyle_Lowcarbon/Lifestyle_references/Hur (2010) Food and situation specific lifestyle segmentation of kitchen appliance market.pdf.

Hyysalo, S., J. K. Juntunen, and S. Freeman, 2013: User innovation in sustainable home energy technologies. *Energy Policy*, **55**, 490–500, https://doi.org/10.1016/j.enpol.2012.12.038.

IDFC, 2008: *Comprehensive Mobility Plan for Kolkata Metropolitan Area*. https://pdfslide.net/documents/comprehensive-mobility-plan-for-kolkata-metropolitan-area.html (Accessed December 21, 2020).

IEA, 2017: *Energy Access Outlook 2017: From Poverty to Prosperity*.

——, 2019: *World Energy Outlook 2019*. OECD, https://www.oecd-ilibrary.org/energy/world-energy-outlook-2019_caf32f3b-en (Accessed December 5, 2019).

Ikuenobe, P. A., 2016: The Communal Basis for Moral Dignity: An African Perspective. *Philos. Pap.*, **45**, 437–469, https://doi.org/10.1080/05568641.2016.1245833. https://www.tandfonline.com/action/journalInformation?journalCode=rppa20 (Accessed December 18, 2020).

Inderberg, T. H. J., K. Tews, and B. Turner, 2018: *Is there a Prosumer Pathway? Exploring household solar energy development in Germany, Norway, and the United Kingdom*. http://dro.dur.ac.uk/25205/1/25205.pdf (Accessed December 16, 2019).

Ivanova, D., G. Vita, R. Wood, C. Lausselet, A. Dumitru, K. Krause, I. Macsinga, and E. G. Hertwich, 2018: Carbon mitigation in domains of high consumer lock-in. *Glob. Environ. Chang.*, **52**, 117–130, https://doi.org/10.1016/j.gloenvcha.2018.06.006. https://doi.org/10.1016/j.gloenvcha.2018.06.006.

Jackson, T., 2005: Live better by consuming less? Is there a "double dividend" in sustainable consumption? *Journal of Industrial Ecology*, Vol. 9 of, 19–36.

——, 2017: *Prosperity without growth : foundations for the economy of tomorrow*. Routledge, 310 pp.

Jacobsson, S., and V. Lauber, 2006: The politics and policy of energy system transformation--

explaining the {German} diffusion of renewable energy technology. *Energy Policy*, **34**, 256–276.

James Lovelock, 2007: *Revenge of Gaia*. Penguin,.

Janda, K. B., and Y. Parag, 2013: A middle-out approach for improving energy performance in buildings. *Build. Res. Inf.*, **41**, 39–50, https://doi.org/10.1080/09613218.2013.743396. http://www.tandfonline.com/doi/abs/10.1080/09613218.2013.743396 (Accessed December 14, 2019).

Jans, L., T. Bouman, and K. Fielding, 2018: A part of the energy "in crowd": Changing people's energy behavior via group-based approaches. *IEEE Power Energy Mag.*, **16**, 35–41, https://doi.org/10.1109/MPE.2017.2759883.

Jenkins, W., E. Berry, and L. B. Kreider, 2018: Religion and Climate Change. *Annu. Rev. Environ. Resour.*, **43**, 85–108, https://doi.org/https://doi.org/10.1146/annurev-environ-102017-025855. https://www.annualreviews.org/doi/abs/10.1146/annurev-environ-102017-025855.

Jensen, M., 2009: Lifestyle: Suggesting mechanisms and a definition from a cognitive science perspective. *Environ. Dev. Sustain.*, **11**, 215–228, https://doi.org/10.1007/s10668-007-9105-4. file:///C:/Users/gyma/OneDrive - Loughborough University/Lifestyle_Lowcarbon/Lifestyle_references/Jensen (2009) Lifestyle Suggesting mechanism and a definition from a cognitive science perspective.pdf.

Jerome, B., 1990: *Acts of Meaning*. Harvard University Press,.

Johansson, T., A. Patwardhan, N. Nakićenović, and GEA, 2012: *Global Energy Assessment - Toward a Sustainable Future*. http://www.globalenergyassessment.org (Accessed July 11, 2019).

Jorgenson, A. K., and Coauthors, 2019: Social science perspectives on drivers of and responses to global climate change. *WIREs Clim. Chang.*, **10**, 1–17, https://doi.org/10.1002/wcc.554. http://doi.wiley.com/10.1002/wcc.554 (Accessed November 13, 2020).

Jürisoo, M., N. Serenje, F. Mwila, F. Lambe, and M. Osborne, 2019: Old habits die hard: Using the energy cultures framework to understand drivers of household-level energy transitions in urban Zambia. *Energy Res. Soc. Sci.*, **53**, 59–67, https://doi.org/10.1016/j.erss.2019.03.001. https://doi.org/10.1016/j.erss.2019.03.001.

Kahneman, D., 2011: *Thinking, Fast and Slow*. Macmillan and Co.,.

Kalyanaratne, A., 2014: *Housing and Labor Productivity of Female Tea Pluckers in Sri Lanka*. 38 pp. http://www.sandeeonline.org/uploads/documents/publication/1038_PUB_Working_Paper_87_Ajantha.pdf.

Kammermann, L., and C. Dermont, 2018: How beliefs of the political elite and citizens on climate change influence support for Swiss energy transition policy. *Energy Res. Soc. Sci.*, **43**, 48–60, https://doi.org/10.1016/j.erss.2018.05.010.

Kanemoto, K., D. Moran, and E. G. Hertwich, 2016: Mapping the Carbon Footprint of Nations. *Environ. Sci. Technol.*, **50**, 10512–10517, https://doi.org/10.1021/acs.est.6b03227. https://pubs.acs.org/sharingguidelines (Accessed December 18, 2020).

Kanger, L., F. W. Geels, B. Sovacool, and J. Schot, 2019: Technological diffusion as a process of societal embedding: Lessons from historical automobile transitions for future electric mobility. *Transp. Res. Part D Transp. Environ.*, **71**, 47–66, https://doi.org/10.1016/j.trd.2018.11.012.

Kemp, R., J. Schot, and R. Hoogma, 1998: Regime shifts to sustainability through processes of niche formation: The approach of strategic niche management. *Technol. Anal. Strateg. Manag.*, **10**, 175–195, https://doi.org/10.1080/09537329808524310.

Kern, F., C. Kuzemco, and C. Mitchell, 2014: Measuring and Explaining Policy Paradigm Change. *Policy Polit.*, **42**, 513–530.

Kimura, O., and T. Suzuki, 2006: *30 years of solar energy development in Japan: co-evolution process of technology, policies, and the market*. 25 pp.

Kissinger, G., M. Herold, and V. De Sy, 2012: *Drivers of Deforestation and Forest Degradation: A Synthesis Report for REDD+ Policymakers*. 48 pp. https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/65505/6316-drivers-deforestation-report.pdf.

Kivimaa, P., W. Boon, S. Hyysalo, and L. Klerkx, 2019: Towards a typology of intermediaries in sustainability transitions : A systematic review and a research agenda. *Res. Policy*, **48**, 1062–1075, https://doi.org/10.1016/j.respol.2018.10.006.

Klinsky, S., and H. Winkler, 2014: Equity, sustainable development and climate policy. *Clim. Policy*, **14**, 1–7, https://doi.org/10.1080/14693062.2014.859352.

Klitkou, A., S. Bolwig, T. Hansen, and N. Wessberg, 2015: The role of lock-in mechanisms in transition processes: The case of energy for road transport. *Environ. Innov. Soc. Transitions*, **16**, 22–37, https://doi.org/10.1016/j.eist.2015.07.005.

Knox-Hayes, J., 2012: Negotiating climate legislation: Policy path dependence and coalition stabilization. *Regul. Gov.*, **6**, 545–567, https://doi.org/10.1111/j.1748-5991.2012.01138.x.

Kolk, A., and J. Pinkse, 2007: Multinationals' Political Activities on Climate Change. *Bus. Soc.*, **46**, 201–228, https://doi.org/10.1177/0007650307301383.

Komiyama, H., 2014: *Beyond the limits to growth: New ideas from Japan*. H. Komiyama, Ed. Springer Japan, 1–12 pp.

Konrad, K., 2016: Ups and downs of alternative fuels. *Nat. Publ. Gr.*, **1**, 1–2, https://doi.org/10.1038/nenergy.2016.22.

Kopp, T., and F. Dorn, 2018: Social Equity and Ecological Sustainability - Can the Two Be Achieved Together? *SSRN Electron. J.*, https://doi.org/10.2139/ssrn.3294285. https://papers.ssrn.com/abstract=3294285 (Accessed December 18, 2020).

Kraft-Todd, G. T., B. Bollinger, K. Gillingham, S. Lamp, and D. G. Rand, 2018: Credibility-enhancing displays promote the provision of non-normative public goods. *Nature*, **563**, 245–248, https://doi.org/10.1038/s41586-018-0647-4. http://dx.doi.org/10.1038/s41586-018-0647-4.

Kuan, G., Y. C. Kueh, N. Abdullah, and E. L. M. Tai, 2019: Psychometric properties of the health-promoting lifestyle profile II: Cross-cultural validation of the Malay language version. *BMC Public Health*, **19**, 1–10, https://doi.org/10.1186/s12889-019-7109-2. file:///C:/Users/gyma/OneDrive - Loughborough University/Lifestyle_Lowcarbon/Lifestyle_references/Kuan etal (2019) Psychometric properties of the health promoting lifestyle profile II Malaysian.pdf.

Kunreuther, H., and Coauthors, 2014: Integrated Risk and Uncertainty Assessment of Climate Change Response Policies. *Climate Change 2014: Mitigation of Climate Change. Contribution of Working Group III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change*, O. Edenhofer et al., Eds., Cambridge University Press Cambridge, UK, and New York, 151–206.

Kuokkanen, A., A. Nurmi, M. Mikkilä, M. Kuisma, H. Kahiluoto, and L. Linnanen, 2018: Agency in regime destabilization through the selection environment: The Finnish food system's sustainability transition. *Res. Policy*, **47**, 1513–1522, https://doi.org/10.1016/j.respol.2018.05.006.

Kurz, T., B. Gardner, B. Verplanken, and C. Abraham, 2015: Habitual behaviors or patterns of practice? Explaining and changing repetitive climate-relevant actions. *Wiley Interdiscip. Rev. Clim. Chang.*, **6**, 113–128, https://doi.org/10.1002/wcc.327.

Laestadius, L. I., R. A. Neff, C. L. Barry, and S. Frattaroli, 2016: No Meat, Less Meat, or Better Meat: Understanding NGO Messaging Choices Intended to Alter Meat Consumption in Light of Climate Change. *Environ. Commun.*, **10**, 84–103, https://doi.org/10.1080/17524032.2014.981561. https://www.tandfonline.com/doi/abs/10.1080/17524032.2014.981561 (Accessed December 5, 2020).

Lamb, W. F., and J. K. Steinberger, 2017: Human well-being and climate change mitigation. *Wiley Interdiscip. Rev. Clim. Chang.*, **8**, https://doi.org/10.1002/wcc.485.

Lamperti, F., G. Dosi, M. Napoletano, A. Roventini, and A. Sapio, 2018: *A Service of zbw Leibniz-Informationszentrum Wirtschaft Leibniz Information Centre for Economics*. http://hdl.handle.net/10419/174562 (Accessed December 6, 2019).

Van Lange, P. A. M., J. Joireman, and M. Milinski, 2018: Climate Change: What Psychology Can Offer in Terms of Insights and Solutions. *Curr. Dir. Psychol. Sci.*, **27**, 269–274, https://doi.org/10.1177/0963721417753945. http://journals.sagepub.com/doi/10.1177/0963721417753945 (Accessed July 4, 2019).

Lanzendorf, M., 2002: Mobility styles and travel behavior: Application of a lifestyle approach to leisure travel. *Transp. Res. Rec.*, 163–173, https://doi.org/10.3141/1807-20. file:///C:/Users/gyma/OneDrive - Loughborough University/Lifestyle_Lowcarbon/Lifestyle_references/Lanzendorf (2002) Mobility styles and travel behavior Application of a lifestyle approach.pdf.

Latvala, T., M. Niva, J. Mäkelä, E. Pouta, J. Heikkilä, J. Kotro, and S. Forsman-Hugg, 2012: Diversifying meat consumption patterns: Consumers' self-reported past behaviour and intentions for change. *Meat Sci.*, **92**, 71–77, https://doi.org/10.1016/j.meatsci.2012.04.014.

Lauber, V., and S. Jacobsson, 2016: The politics and economics of constructing, contesting and restricting socio-political space for renewables – The German Renewable Energy Act. *Environ. Innov. Soc. Transitions*, **18**, 147–163.

Lawson, R., and S. Todd, 2002: Consumer lifestyles: A social stratification perspective. *Mark. Theory*, **2**, 295–307, https://doi.org/10.1177/1470593102002003278. file:///C:/Users/gyma/AppData/Local/Mendeley Ltd./Mendeley Desktop/Downloaded/Lawson, Todd - 2002 - Consumer lifestyles A social stratification perspective.pdf.

Leal Filho, W., and Coauthors, 2018: The role of transformation in learning and education for sustainability. *J. Clean. Prod.*, **199**, 286–295, https://doi.org/10.1016/J.JCLEPRO.2018.07.017. https://www.sciencedirect.com/science/article/pii/S095965261831984X (Accessed May 5, 2019).

Leipprand, A., and C. Flachsland, 2018: Energy Research & Social Science Regime destabilization in energy transitions : The German debate on the future of coal. *Energy Res. Soc. Sci.*, **40**, 190–204, https://doi.org/10.1016/j.erss.2018.02.004.

Lenzen, M., Y. Y. Sun, F. Faturay, Y. P. Ting, A. Geschke, and A. Malik, 2018: The carbon footprint of global tourism. *Nat. Clim. Chang.*, **8**, 522–528, https://doi.org/10.1038/s41558-018-0141-x. https://doi.org/10.1038/s41558-018-0141-x (Accessed December 18, 2020).

Lessig, L., 1995: The regulation of social meaning. *Univ. Chicago Law Rev.*, **62**, 943–1045.

Levin, S., and Coauthors, 2013: Social-ecological systems as complex adaptive systems: modeling and policy implications. *Environ. Dev. Econ.*, **18**, 111–132, https://doi.org/10.1017/S1355770X12000460. https://www.cambridge.org/core/product/identifier/S1355770X12000460/type/journal_article (Accessed May 10, 2019).

Lin, D., and Coauthors, 2018: Ecological Footprint Accounting for Countries: Updates and Results of the National Footprint Accounts, 2012–2018. *Resources*, **7**, 58, https://doi.org/10.3390/resources7030058. http://www.mdpi.com/2079-9276/7/3/58 (Accessed December 18, 2020).

Litzow, E. L., S. K. Pattanayak, and T. Thinley, 2019: Returns to rural electrification: Evidence from Bhutan. *World Dev.*, **121**, 75–96, https://doi.org/10.1016/j.worlddev.2019.04.002.

Liu, C. J., and F. Hao, 2020: The impact of social and ecological factors on environmentally responsible behavior. *J. Clean. Prod.*, **254**, 120173, https://doi.org/10.1016/j.jclepro.2020.120173.

Lockwood, M., 2015: Fossil Fuel Subsidy Reform, Rent Management and Political Fragmentation in Developing Countries. *New Polit. Econ.*, **20**, 475–494, https://doi.org/10.1080/13563467.2014.923826. http://www.tandfonline.com/doi/full/10.1080/13563467.2014.923826 (Accessed December 16, 2019).

Lorenz, D. F., 2013: The diversity of resilience: contributions from a social science perspective. *Nat. Hazards*, **67**, 7–24, https://doi.org/10.1007/s11069-010-9654-y. https://www.researchgate.net/publication/226113579 (Accessed November 5, 2019).

Lorenzen, J. A., 2012: Going Green: The Process of Lifestyle Change. *Sociol. Forum*, **27**, 94–116, https://doi.org/10.1111/j.1573-7861.2011.01303.x. file:///C:/Users/gyma/OneDrive - Loughborough University/Lifestyle_Lowcarbon/Lifestyle_references/Lorenzen (2012) Going green The process of lifestyle change.pdf.

Lounsbury, M., and M. A. Glynn, 2001: Cultural entrepreneurship: Stories, legitimacy, and the acquisition of resources. *Strateg. Manag. J.*, **22**, 545–564, https://doi.org/10.1002/smj.188.

Lourida, I., E. Hannon, T. J. Littlejohns, K. M. Langa, E. Hyppönen, E. Kuźma, and D. J. Llewellyn, 2019: Association of Lifestyle and Genetic Risk with Incidence of Dementia. *JAMA - J. Am. Med. Assoc.*, **322**, 430–437, https://doi.org/10.1001/jama.2019.9879. file:///C:/Users/gyma/OneDrive - Loughborough University/Lifestyle_Lowcarbon/Lifestyle_references/Lourida etal (2019) Lifestyle and genetic risk with incidence of dementia.pdf.

Mahajan, V., E. Muller, and F. M. Bass, 1990: New product diffusion models in marketing: A review and directions for research. *J. Mark.*, **54**, 1–26, https://doi.org/10.2307/1252170.

Maïzi, N., and V. Mazauric, 2019: From centralized to decentralized power systems: The shift on finitude constraints. *Energy Procedia*, **158**, 4262–4267, https://doi.org/10.1016/j.egypro.2019.01.800.

Maïzi, N., V. Mazauric, E. Assoumou, S. Bouckaert, V. Krakowski, X. Li, and P. Wang, 2017: Maximizing intermittency in 100% renewable and reliable power systems: A holistic approach applied to Reunion Island in 2030. *Appl. Energy*, **227**, 332–341, https://doi.org/10.1016/j.apenergy.2017.08.058.

Malone, E., N. E. Hultman, K. L. Anderson, and V. Romeiro, 2017: Energy Research & Social Science Stories about ourselves : How national narratives in fl uence the di ff usion of large-scale energy technologies. **31**, 70–76, https://doi.org/10.1016/j.erss.2017.05.035.

Mansfield, E., 1968: *The Economics of Technological Change*. W.W. Norton & Co., 150 pp.

Maréchal, K., 2010: Not irrational but habitual: The importance of “behavioural lock-in” in energy consumption. *Ecol. Econ.*, **69**, 1104–1114, https://doi.org/10.1016/j.ecolecon.2009.12.004.

Markard, J., 2011: Transformation of Infrastructures: Sector Characteristics and Implications for Fundamental Change. *J. Infrastruct. Syst.*, **17**, 107–117, https://doi.org/10.1061/(asce)is.1943-555x.0000056.

——, and V. H. Hoffmann, 2016: Analysis of complementarities: Framework and examples from the energy transition. *Technol. Forecast. Soc. Chang.*, **111**, 63–75, https://doi.org/10.1016/j.techfore.2016.06.008.

——, R. Raven, and B. Truffer, 2012: Sustainability transitions : An emerging field of research and its prospects. *Res. Policy*, **41**, 955–967, https://doi.org/10.1016/j.respol.2012.02.013.

Martin, C. J., 2016: The sharing economy: A pathway to sustainability or a nightmarish form of neoliberal capitalism? *Ecol. Econ.*, **121**, 149–159, https://doi.org/https://doi.org/10.1016/j.ecolecon.2015.11.027.

Martínez, J., J. Martí-Herrero, S. Villacís, A. J. J. Riofrio, and D. Vaca, 2017: Analysis of energy, CO2 emissions and economy of the technological migration for clean cooking in Ecuador. *Energy Policy*, **107**, 182–187, https://doi.org/10.1016/j.enpol.2017.04.033.

Martino, J. P., K.-L. Chen, and R. C. Lenz, 1978: *Predicting the Diffusion Rate of Industrial Innovations*.

Marvin, S., H. Chappells, and S. Guy, 1999: *Pathways of smart metering development: shaping environmental innovation*. 109–126 pp. www.elsevier.com/locate/compenvurbsys.

Mastrucci, A., and N. D. Rao, 2017: Decent housing in the developing world: Reducing life-cycle energy requirements. *Energy Build.*, **152**, 629–642, https://doi.org/10.1016/j.enbuild.2017.07.072.

——, and ——, 2019: Bridging India's housing gap: lowering costs and CO2 emissions. *Build. Res. Inf.*, **47**, 8–23, https://doi.org/10.1080/09613218.2018.1483634. https://www.tandfonline.com/doi/full/10.1080/09613218.2018.1483634 (Accessed November 27, 2020).

Matthews, H. S., C. L. Weber, and C. Hendrickson, 2008: Estimating Carbon Footprints with Input-Output Models. *Input-Output & Environment*, Seville, Spain www.eiolca.net.

McGee, J. A., and P. T. Greiner, 2018: Can Reducing Income Inequality Decouple Economic Growth from CO 2 Emissions? *Socius Sociol. Res. a Dyn. World*, **4**, 1–11, https://doi.org/10.1177/2378023118772716. http://journals.sagepub.com/doi/10.1177/2378023118772716 (Accessed July 4, 2019).

Mcgillivray, M., and M. Clarke, 2006: *Understanding Human Well-being*. M. McGillivray and M. Clarke, Eds. United Nations University Press, 377 pp.

McLaren Loring, J., 2007: Wind energy planning in England, Wales and Denmark: Factors influencing project success. *Energy Policy*, **35**, 2648–2660, https://doi.org/10.1016/j.enpol.2006.10.008.

McMeekin, A., and D. Southerton, 2012: Sustainability transitions and final consumption: Practices and socio-technical systems. *Technol. Anal. Strateg. Manag.*, **24**, 345–361, https://doi.org/10.1080/09537325.2012.663960.

——, F. W. Geels, and M. Hodson, 2019: Mapping the winds of whole system reconfiguration: Analysing low-carbon transformations across production, distribution and consumption in the UK electricity system (1990-2016). *Res. Policy*, **48**, 1216–1231, https://doi.org/10.1016/j.respol.2018.12.007.

Meade, N., and T. Islam, 2006: Modelling and forecasting the diffusion of innovation - A 25-year review. *Int. J. Forecast.*, **22**, 519–545, https://doi.org/10.1016/j.ijforecast.2006.01.005.

Meadowcroft, J., 2011: Environmental Innovation and Societal Transitions Engaging with the politics of sustainability transitions. *Environ. Innov. Soc. Transitions*, **1**, 70–75, https://doi.org/10.1016/j.eist.2011.02.003.

Megias-Delagado, M., C. Baldallo-González, and P. Maraver-López, 2018: Validity of advertising as a resource in Environmental Education. *Rev. Mediterránea Comun.*, **9**, 203–2015, https://doi.org/10.14198/MEDCOM2018.9.2.11. http://rua.ua.es/dspace/handle/10045/76267 (Accessed December 3, 2019).

Mendoza, M. E. B., and O. G. M. Roa, 2014: Educomunicación y medio ambiente: en la búsqueda y construcción de fisuras. *Rev. Investig. Agrar. y Ambient.*, **5**, https://doi.org/10.22490/21456453.960. http://hemeroteca.unad.edu.co/index.php/riaa/article/view/960.

Messner, D., 2015: A social contract for low carbon and sustainable development: Reflections on non-linear dynamics of social realignments and technological innovations in transformation processes. *Technol. Forecast. Soc. Chang.*, **98**, 260–270, https://doi.org/10.1016/j.techfore.2015.05.013.

Michie, S., M. M. van Stralen, and R. West, 2011: The behaviour change wheel: A new method for characterising and designing behaviour change interventions. *Implement. Sci.*, **6**, 42, https://doi.org/10.1186/1748-5908-6-42. http://implementationscience.biomedcentral.com/articles/10.1186/1748-5908-6-42 (Accessed December 21, 2019).

van Mierlo, B., and P. J. Beers, 2020: Understanding and governing learning in sustainability transitions: A review. *Environ. Innov. Soc. Transitions*, **34**, 255–269, https://doi.org/https://doi.org/10.1016/j.eist.2018.08.002. http://www.sciencedirect.com/science/article/pii/S2210422417301983.

Mignon, I., and W. Kanda, 2018: A typology of intermediary organizations and their impact on sustainability transition policies. *Environ. Innov. Soc. Transitions*, **29**, 100–113, https://doi.org/10.1016/j.eist.2018.07.001.

Miller, D. T., and D. A. Prentice, 2016: Changing Norms to Change Behavior. *Annu. Rev. Psychol.*, **67**, 339–361, https://doi.org/10.1146/annurev-psych-010814-015013.

Millonig, A., and S. Haustein, 2020: Human factors of digitalized mobility forms and services. *Eur. Transp. Res. Rev.*, **12**, https://doi.org/10.1186/s12544-020-00435-5.

Millot, A., R. Doudard, T. Le Gallic, F. Briens, E. Assoumou, and N. Maïzi, 2018: France 2072: Lifestyles at the core of carbon neutrality challenges. *Limiting Global Warming to Well Below 2 °C: Energy System Modelling and Policy Development. Lecture Notes in Energy 54*, G. Giannakidis, K.B. Karlsson, M. Labriet, and B. Gallachóir, Eds., Vol. 64 of, Springer Verlag, 173–190 http://link.springer.com/10.1007/978-3-319-74424-7_11 (Accessed April 9, 2019).

Mills, B., and J. Schleich, 2012: Residential energy-efficient technology adoption, energy conservation, knowledge, and attitudes: An analysis of European countries. *Energy Policy*, **49**, 616–628, https://doi.org/10.1016/J.ENPOL.2012.07.008. https://www.sciencedirect.com/science/article/pii/S0301421512005897 (Accessed May 9, 2019).

Millward-Hopkins, J., J. K. Steinberger, N. D. Rao, and Y. Oswald, 2020: Providing decent living with minimum energy: A global scenario. *Glob. Environ. Chang.*, **65**, 102168, https://doi.org/10.1016/j.gloenvcha.2020.102168. https://linkinghub.elsevier.com/retrieve/pii/S0959378020307512.

Ministry of Housing and Urban Affairs, 2005: Jawaharlal Nehru National Urban Renewal Mission. https://www.prsindia.org/theprsblog/status-jawaharlal-nehru-national-urban-renewal-mission (Accessed December 21, 2020).

Ministry Of Urban Transport, 2006: *National Urban Transport Policy*. 22 pp. http://urbantransport.kar.gov.in/National Urban TransportPolicy.pdf (Accessed December 21, 2020).

MINTEL, 2019: MINTEL Global New Products Database. *Mintel Glob. New Prod. database*,. https://www.mintel.com/global-new-products-database/features (Accessed November 27, 2020).

Moezzi, M., K. B. Janda, and S. Rotmann, 2017: Using stories, narratives, and storytelling in energy and climate change research. *Energy Res. Soc. Sci.*, **31**, 1–10, https://doi.org/10.1016/j.erss.2017.06.034.

Molthan-Hill, P., N. Worsfold, G. J. Nagy, W. Leal Filho, and M. Mifsud, 2019: Climate change education for universities: A conceptual framework from an international study. *J. Clean. Prod.*, **226**, 1092–1101, https://doi.org/10.1016/j.jclepro.2019.04.053.

Mongsawad, P., 2012: The philosophy of the sufficiency economy: a contribution to the theory of development. *Asia-Pacific Dev. J.*, **17**, 123–143, https://doi.org/10.18356/02bd5fb3-en.

Monreal, A. C., A. McMeekin, and D. Southerton, 2016: Beyond acquisition: Exploring energy consumption through the appreciation and appropriation of domestic lighting in the UK. *Sustain. Prod. Consum.*, **7**, 37–48, https://doi.org/10.1016/j.spc.2016.02.002.

Monyei, C. G., K. E. H. Jenkins, C. G. Monyei, O. C. Aholu, K. O. Akpeji, O. Oladeji, and S. Viriri, 2019: Response to Todd, De Groot, Mose, McCauley and Heffron’s critique of “Examining energy sufficiency and energy mobility in the global south through the energy justice framework.” *Energy Policy*, **133**, 110917, https://doi.org/10.1016/j.enpol.2019.110917.

Morris, B. S., P. Chrysochou, J. D. Christensen, J. L. Orquin, J. Barraza, P. J. Zak, and P. Mitkidis, 2019: Stories vs. facts: triggering emotion and action-taking on climate change. *Clim. Change*, **154**, 19–36, https://doi.org/10.1007/s10584-019-02425-6.

Morris, C., and A. Jungjohann, 2016: *Energy democracy: Germany’s Energiewende to renewables*. Springer,.

Morris, C., J. Kirwan, and R. Lally, 2014: Less Meat Initiatives : An Initial Exploration of a Diet-focused Social Innovation in Transitions to a More Sustainable Regime of Meat Provisioning. *Int. J. Sociol. Agric. Food*, **21**, 189–208.

Mortensen, C. R., R. Neel, R. B. Cialdini, C. M. Jaeger, R. P. Jacobson, and M. M. Ringel, 2019: Trending Norms: A Lever for Encouraging Behaviors Performed by the Minority. *Soc. Psychol. Personal. Sci.*, **10**, 201–210, https://doi.org/10.1177/1948550617734615.

Moser, S. C., 2009: Communicating Climate Change and Motivating Civic Action: Renewing, Activating, and Building Democracies. *Changing Climates in North American Politics: Institutions, Policymaking, and Multilevel Governance*, H. Selin and S.D. VanDeveer, Eds., The MIT Press, 283–302.

Mowen, J. C., and M. Minor, 1998: *Consumer behavior*. Prentice-Hall, 696 pp.

Mukhopadhyay, R., and Coauthors, 2012: Cooking practices, air quality, and the acceptability of advanced cookstoves in Haryana, India: an exploratory study to inform large-scale interventions. *Glob. Health Action*, **5**, 19016, https://doi.org/10.3402/gha.v5i0.19016. https://www.tandfonline.com/doi/full/10.3402/gha.v5i0.19016 (Accessed June 6, 2020).

Munck af Rosenschöld, J., J. G. Rozema, and L. A. Frye-Levine, 2014: Institutional inertia and climate change: a review of the new institutionalist literature. *Wiley Interdiscip. Rev. Clim. Chang.*, **5**, 639–648, https://doi.org/10.1002/wcc.292. http://doi.wiley.com/10.1002/wcc.292 (Accessed December 16, 2019).

Mundaca, L., and A. Markandya, 2016: Assessing regional progress towards a 'Green Energy Economy.' *Appl. Energy*, **179**, 1372–1394, https://doi.org/10.1016/j.apenergy.2015.10.098.

——, D. Ürge-Vorsatz, and C. Wilson, 2019: Demand-side approaches for limiting global warming to 1.5 °C. *Energy Effic.*, **12**, 343–362, https://doi.org/10.1007/s12053-018-9722-9.

Mylan, J., 2018: Sustainable consumption in everyday life: A qualitative study of UK consumer experiences of meat reduction. *Sustainability*, **10**, 2307, https://doi.org/10.3390/su10072307. http://www.mdpi.com/2071-1050/10/7/2307 (Accessed December 10, 2019).

——, C. Morris, E. Beech, and F. W. Geels, 2019: Rage against the regime: Niche-regime interactions in the societal embedding of plant-based milk. *Environ. Innov. Soc. Transitions*, **31**, 233–247, https://doi.org/10.1016/j.eist.2018.11.001.

Nakićenović, N., A. Grubler, H. Ishitani, T. Johansson, G. Marland, J. R. Moreira, and Rogn, 1996: Energy Primer. *Climate Change 1995: Impacts, Adaptations and Mitigation of Climate Change: Scientific-Technical Analyses. Contribution of Working Group II to the Second Assessment Report of the Intergovernmental Panel on Climate Change*, R.T. Watson, M.C. Zinyowera, and R.H. Moss, Eds., Cambridge University Press, 75–94.

Nash, N., and Coauthors, 2019: Reflecting on behavioral spillover in context: How do behavioral motivations and awareness catalyze other environmentally responsible actions in Brazil, China, and Denmark? *Front. Psychol.*, **10**, https://doi.org/10.3389/fpsyg.2019.00788.

Nelson, R. R., A. Peterhansl, and B. Sampat, 2004: Why and how innovations get adopted: A tale of four models. *Ind. Corp. Chang.*, **13**, 679–699, https://doi.org/10.1093/icc/dth027.

Nemet, G. F., 2019: *How solar energy became cheap : A model for low-carbon innovation*. Routledge, https://www.routledge.com/How-Solar-Energy-Became-Cheap-A-Model-for-Low-Carbon-Innovation-1st-Edition/Nemet/p/book/9780367136598 (Accessed December 13, 2019).

Nepal, M., A. Nepal, and K. Grimsrud, 2010: Unbelievable but improved cookstoves are not helpful in reducing firewood demand in Nepal. *Environ. Dev. Econ.*, **16**, 1–23, https://doi.org/10.1017/S1355770X10000409. https://www.cambridge.org/core/journals/environment-and-development-economics/article/unbelievable-but-improved-cookstoves-are-not-helpful-in-reducing-firewood-demand-in-nepal/D33A679A604A0297308B72B275165B68 (Accessed June 2, 2019).

Neri, M. C., 2002: *Decent Work and the Informal Sector in Brazil*. 115 pp.

Nerini, F. F., O. Broad, D. Mentis, M. Welsch, M. Bazilian, and M. Howells, 2016: A cost comparison of technology approaches for improving access to electricity services. *Energy*, **95**, 255–265, https://doi.org/10.1016/j.energy.2015.11.068.

Niamir, L., 2019: Behavioural Climate Change Mitigation: from individual energy choices to demand-side potential. University of Twente, 267 pp. https://research.utwente.nl/en/publications/behavioural-climate-change-mitigation-from-individual-energy-choi (Accessed February 1, 2019).

——, T. Filatova, A. Voinov, and H. Bressers, 2018: Transition to low-carbon economy: Assessing cumulative impacts of individual behavioral changes. *Energy Policy*, **118**, 325–345, https://doi.org/10.1016/j.enpol.2018.03.045.

http://www.sciencedirect.com/science/article/pii/S0301421518301782 (Accessed July 14, 2019).

——, O. Ivanova, T. Filatova, A. Voinov, and H. Bressers, 2020a: Demand-side solutions for climate mitigation: Bottom-up drivers of household energy behavior change in the Netherlands and Spain. *Energy Res. Soc. Sci.*, **62**, 101356, https://doi.org/https://doi.org/10.1016/j.erss.2019.101356. http://www.sciencedirect.com/science/article/pii/S2214629619304797.

——, G. Kiesewetter, F. Wagner, W. Schöpp, T. Filatova, A. Voinov, and H. Bressers, 2020b: Assessing the macroeconomic impacts of individual behavioral changes on carbon emissions. *Clim. Change*, **158**, 141–160, https://doi.org/https://doi.org/10.1007/s10584-019-02566-8. https://link.springer.com/article/10.1007/s10584-019-02566-8.

Nie, C., and L. Zepeda, 2011: Lifestyle segmentation of US food shoppers to examine organic and local food consumption. *Appetite*, **57**, 28–37, https://doi.org/10.1016/j.appet.2011.03.012. http://dx.doi.org/10.1016/j.appet.2011.03.012.

Nielsen, K. R., L. A. Reisch, and J. Thøgersen, 2016: Sustainable user innovation from a policy perspective: a systematic literature review. *J. Clean. Prod.*, **133**, 65–77, https://doi.org/10.1016/j.jclepro.2016.05.092.

Nolan, J. M., P. W. Schultz, R. B. Cialdini, N. J. Goldstein, and V. Griskevicius, 2008: Normative social influence is underdetected. *Personal. Soc. Psychol. Bull.*, **34**, 913–923, https://doi.org/10.1177/0146167208316691.

Noppers, E., K. Keizer, M. Milovanovic, and L. Steg, 2019: The role of adoption norms and perceived product attributes in the adoption of Dutch electric vehicles and smart energy systems. *Energy Res. Soc. Sci.*, **57**, 101237, https://doi.org/10.1016/j.erss.2019.101237. https://doi.org/10.1016/j.erss.2019.101237.

Noppers, E. H., K. Keizer, J. W. Bolderdijk, and L. Steg, 2014: The adoption of sustainable innovations: Driven by symbolic and environmental motives. *Glob. Environ. Chang.*, **25**, 52–62, https://doi.org/10.1016/j.gloenvcha.2014.01.012.

Nordhaus, W. D., 2013: *The Climate casino : Risk, uncertainty, and economics for a warming world*. Yale University Press, 378 pp.

Normann, H. E., 2017: Policy networks in energy transitions: The cases of carbon capture and storage and offshore wind in Norway. *Technol. Forecast. Soc. Change*, **118**, 80–93, https://doi.org/10.1016/j.techfore.2017.02.004.

NRC, 1972: *Solar Cells: Outlook for Improved Efficiency*. The National Academies Press, https://www.nap.edu/catalog/20589/solar-cells-outlook-for-improved-efficiency.

Nyborg, K., and Coauthors, 2016: Social norms as solutions. *Science (80-.).*, **354**, 42–43, https://doi.org/10.1126/science.aaf8317. https://science.sciencemag.org/content/354/6308/42 (Accessed July 4, 2019).

O'Donoghue, T., and M. Rabin, 2015: Present bias: Lessons learned and to be learned. *Am. Econ. Rev.*, **105**, 273–279, https://doi.org/10.1257/aer.p20151085.

O'Neill, D. W., A. L. Fanning, W. F. Lamb, J. K. Steinberger, D. W. O'Neill, A. L. Fanning, W. F. Lamb, and J. K. Steinberger, 2018: A good life for all within planetary boundaries. *Nat. Sustain.*, **1**, 88–95, https://doi.org/10.1038/s41893-018-0021-4. http://www.nature.com/articles/s41893-018-0021-4 (Accessed July 11, 2019).

O'Neill, S. J., and N. Smith, 2014: Climate change and visual imagery. *Wiley Interdiscip. Rev. Clim. Chang.*, **5**, 73–87, https://doi.org/10.1002/wcc.249.

O’riordan, T., and A. Jordan, 1999: *Institutions, climate change and cultural theory: towards a common analytical framework*. 81–93 pp.

Ó Tuama, D., 2015: Ripples through the city: Understanding the processes set in motion through embedding a public bike sharing scheme in a city. *Res. Transp. Bus. Manag.*, **15**, 15–27, https://doi.org/10.1016/j.rtbm.2015.03.002.

Ockwell, D., and R. Byrne, 2016: Improving technology transfer through national systems of innovation: climate relevant innovation-system builders (CRIBs). *Clim. Policy*, **16**, 836–854, https://doi.org/10.1080/14693062.2015.1052958.

Odjugo, and P. A. Ovuyovwiroye, 2013: Analysis of climate change awareness in Nigeria. *Sci. Res. Essays*, **8**, 1203–1211, https://doi.org/10.5897/SRE11.2018. http://www.academicjournals.org/journal/SRE/article-abstract/429A10A28192.

Oishi, S., K. Kushlev, and U. Schimmack, 2018: Progressive taxation, income inequality, and happiness. *Am. Psychol.*, **73**, 157–168, https://doi.org/10.1037/amp0000166. http://www.ncbi.nlm.nih.gov/pubmed/29369661 (Accessed July 4, 2019).

Oldenziel, R., M. Emanuel, A. de la Bruheze, and F. Veraart, 2016: *Cycling Cities: The European Experience: Hundred Years of Policy and Practice*. R. Oldenziel, M. Emanuel, A. De La Bruheze, and F. Veraart, Eds. Foundation for the History of Technology and Rachel Carson Center for Environment and Society, 256 pp. http://www.diva-portal.org/smash/record.jsf?pid=diva2%3A974202&dswid=5210 (Accessed May 9, 2019).

Ornetzeder, M., and H. Rohracher, 2013: Of solar collectors, wind power, and car sharing: Comparing and understanding successful cases of grassroots innovations. *Glob. Environ. Chang.*, **23**, 856–867, https://doi.org/10.1016/j.gloenvcha.2012.12.007.

Otte, P. P., 2014: Solar cooking in Mozambique-an investigation of end-user’s needs for the design of solar cookers. *Energy Policy*, **74**, 366–375, https://doi.org/10.1016/j.enpol.2014.06.032.

Otto, S., G. W. Evans, M. J. Moon, and F. G. Kaiser, 2019: The development of children’s environmental attitude and behavior. *Glob. Environ. Chang.*, **58**, 101947, https://doi.org/10.1016/j.gloenvcha.2019.101947.

Owens, S., and L. Driffill, 2008: How to change attitudes and behaviours in the context of energy. *Energy Policy*, **36**, 4412–4418, https://doi.org/10.1016/j.enpol.2008.09.031.

Palz, W., 2010: *Power for the world: the emergence of electricity from the sun*. Pan Stanford Publishing,.

Pant, K. P., 2008: *Estimating Health Benefits when Behaviors are Endogenous: A Case of Indoor Air Pollution in Rural Nepal*. 59 pp. www.sandeeonline.org.

Parag, Y., and K. B. Janda, 2014: More than filler: Middle actors and socio-technical change in the energy system from the “middle-out.” *Energy Res. Soc. Sci.*, **3**, 102–112, https://doi.org/10.1016/j.erss.2014.07.011.

Park, S., 2015: State renewable energy governance: Policy instruments, markets, or citizens. *Rev. Policy Res.*, **32**, 273–296, https://doi.org/10.1111/ropr.12126.

Pasqualetti, M., and S. Stremke, 2018: Energy landscapes in a crowded world: A first typology of origins and expressions. *Energy Res. Soc. Sci.*, **36**, 94–105, https://doi.org/10.1016/j.erss.2017.09.030.

Pasqualetti, M. J., 2000: Morality, Space, and the Power of Wind-Energy Landscapes. *Geogr. Rev.*, **90**, 381–394, https://doi.org/10.1111/j.1931-0846.2000.tb00343.x.

Pattanayak, S., E. Sills, and R. Kramer, 2004: Seeing the forest for the fuel. *Environ. Dev. Econ.*, **9**, 155–179, https://doi.org/10.1017/S1355770X03001220.

Pattanayak, S. K., and Coauthors, 2019: Experimental evidence on promotion of electric and improved biomass cookstoves. *Proc. Natl. Acad. Sci. U. S. A.*, **116**, 13282–13287, https://doi.org/10.1073/pnas.1808827116.

Pearce, W., S. Niederer, S. M. Özkula, and N. Sánchez Querubín, 2019: The social media life of climate change: Platforms, publics, and future imaginaries. *Wiley Interdiscip. Rev. Clim. Chang.*, **10**, https://doi.org/10.1002/wcc.569.

Peres, R., E. Muller, and V. Mahajan, 2010: Innovation diffusion and new product growth models: A critical review and research directions. *Int. J. Res. Mark.*, **27**, 91–106, https://doi.org/10.1016/j.ijresmar.2009.12.012.

Perlin, J., 1999: *From Space to Earth: the Story of Solar Electricity*. AATEC Publications,.

——, 2013: *Let it shine: the 6,000-year story of solar energy*. 519 pp.

Persky, J., 1995: Retrospectives: The Ethology of Homo Economicus. *J. Econ. Perspect.*, **9**, 221–231. https://www.jstor.org/stable/2138175 (Accessed May 10, 2019).

Pettifor, H., C. Wilson, J. Axsen, W. Abrahamse, and J. Anable, 2017: Social influence in the global diffusion of alternative fuel vehicles – A meta-analysis. *J. Transp. Geogr.*, **62**, 247–261, https://doi.org/10.1016/j.jtrangeo.2017.06.009.

Phillips, N., T. B. Lawrence, and C. Hardy, 2004: Discourse and institutions. *Acad. Manag. Rev.*, **29**, 636–652, https://doi.org/10.5465/amr.2004.14497617.

Pichler, P. P., I. S. Jaccard, U. Weisz, and H. Weisz, 2019: International comparison of health care carbon footprints. *Environ. Res. Lett.*, **14**, 064004, https://doi.org/10.1088/1748-9326/ab19e1. https://doi.org/10.1088/1748-9326/ab19e1 (Accessed October 19, 2020).

Pine, K., R. Edwards, O. Masera, A. Schilmann, A. Marrón-Mares, and H. Riojas-Rodríguez, 2011: Adoption and use of improved biomass stoves in Rural Mexico. *Energy Sustain. Dev.*, **15**, 176–183, https://doi.org/10.1016/j.esd.2011.04.001.

Plumecocq, G., T. Debril, M. Duru, M. B. Magrini, J. P. Sarthou, and O. Therond, 2018: The plurality of values in sustainable agriculture models: Diverse lock-in and coevolution patterns. *Ecol. Soc.*, **23**, 21, https://doi.org/10.5751/ES-09881-230121.

Pohjolainen, P., M. Vinnari, and P. Jokinen, 2015: Consumers' perceived barriers to following a plant-based diet. *Br. Food J.*, **117**, 1150–1167, https://doi.org/10.1108/BFJ-09-2013-0252.

Poortinga, W., L. Whitmarsh, L. Steg, G. Böhm, and S. Fisher, 2019: Climate change perceptions and their individual-level determinants: A cross-European analysis. *Glob. Environ. Chang.*, **55**, 25–35, https://doi.org/10.1016/J.GLOENVCHA.2019.01.007. https://www.sciencedirect.com/science/article/abs/pii/S0959378018305107?via%3Dihub (Accessed June 17, 2019).

Princen, T., 2003: Principles for Sustainability: From Cooperation and Efficiency to Sufficiency. *Glob. Environ. Polit.*, **3**, 33–50, https://doi.org/10.1162/152638003763336374. https://www-mitpressjournals-org.ezproxy.library.yorku.ca/doix/abs/10.1162/152638003763336374 (Accessed December 18, 2020).

Rao, N. D., and P. Baer, 2012: "Decent Living" Emissions: A Conceptual Framework. *Sustainability*, **4**, 656–681, https://doi.org/10.3390/su4040656. http://www.mdpi.com/2071-1050/4/4/656 (Accessed February 9, 2019).

Rao, N. D., and S. Pachauri, 2017: Energy access and living standards: some observations on recent trends. *Environ. Res. Lett.*, **12**, 025011, https://doi.org/10.1088/1748-9326/aa5b0d. https://doi.org/10.1088/1748-9326/aa5b0d (Accessed July 4, 2019).

Rao, N. D., and J. Min, 2018a: Less global inequality can improve climate outcomes. *Wiley Interdiscip. Rev. Clim. Chang.*, **9**, https://doi.org/10.1002/wcc.513. https://onlinelibrary.wiley.com/doi/abs/10.1002/wcc.513 (Accessed July 4, 2019).

Rao, N. D., and J. Min, 2018b: *Is less global inequality good for climate change?*

Rao, N. D., and J. Min, 2018c: Decent Living Standards: Material Prerequisites for Human Wellbeing. *Soc. Indic. Res.*, **138**, 225–244, https://doi.org/10.1007/s11205-017-1650-0. https://link.springer.com/article/10.1007%2Fs11205-017-1650-0 (Accessed July 4, 2019).

——, ——, and A. Mastrucci, 2019: Energy for decent living. *Nat. Energy*,.

Ravallion, M., M. Heil, J. Jalan, and W. Bank, 1997: *A less poor world, but a hotter one? Carbon emissions, economic growth and income inequality*.

Raven, R., and G. Verbong, 2004: Ruling out innovations – technological regimes, rules and failures: The cases of heat pump power generation and bio-gas production in The Netherlands. *Innovation*, **6**, 178–198, https://doi.org/10.5172/impp.2004.6.2.178.

——, F. Kern, B. Verhees, and A. Smith, 2016: Niche construction and empowerment through socio-political work. A meta-analysis of six low-carbon technology cases. *Environ. Innov. Soc. Transitions*, **18**, 164–180, https://doi.org/10.1016/j.eist.2015.02.002.

——, and Coauthors, 2017: Unpacking sustainabilities in diverse transition contexts: solar photovoltaic and urban mobility experiments in India and Thailand. *Sustain. Sci.*, **12**, 579–596, https://doi.org/10.1007/s11625-017-0438-0.

Raven, R. P. J. M., E. Heiskanen, M. Hodson, and B. Brohmann, 2008: The Contribution of Local Experiments and Negotiation Processes to Field-Level Learning in Emerging (Niche) Technologies Meta-Analysis of 27 New Energy Projects in Europe. *Bull. Sci. Technol. Soc.*, **28**, 464–477, https://doi.org/10.1177/0270467608317523.

Ravindranath, N. H., and J. Ramakrishna, 1997: Energy options for cooking in India. *Energy Policy*, **25**, 63–75, https://doi.org/10.1016/S0301-4215(96)00105-X.

Raymond, C. M., J. O. Kenter, C. J. van Riper, A. Rawluk, and D. Kendal, 2019: Editorial overview: theoretical traditions in social values for sustainability. *Sustain. Sci.*, **14**, 1173–1185, https://doi.org/10.1007/s11625-019-00723-7. https://doi.org/10.1007/s11625-019-00723-7 (Accessed December 18, 2020).

Reddy, N. M., J. D. Aram, and L. H. Lynn, 1991: The institutional domain of technology diffusion. *J. Prod. Innov. Manag.*, **8**, 295–304, https://doi.org/10.1016/0737-6782(91)90050-9.

Renn, J., 2018: The Evolution of Knowledge: Rethinking Science in the Anthropocene in. *HoST - J. Hist. Sci. Technol.*, **12**, 1–22, https://doi.org/10.2478/host-2018-0001.

Rentschler, J., and M. Bazilian, 2017: Reforming fossil fuel subsidies: drivers, barriers and the state of progress. *Clim. Policy*, **17**, 891–914, https://doi.org/10.1080/14693062.2016.1169393. https://www.tandfonline.com/doi/full/10.1080/14693062.2016.1169393 (Accessed December 16, 2019).

RESA, 2001: Act on Granting Priority to Renewable Energy Sources (Renewable Energy Sources Act, Germany, 2000). *Sol. Energy*, **70**, 489–504, https://doi.org/10.1016/s0038-092x(00)00144-4.

Riahi, K., and Coauthors, 2015: Locked into Copenhagen pledges — Implications of short-term emission targets for the cost and feasibility of long-term climate goals. *Technol. Forecast. Soc. Change*, **90**, 8–23, https://doi.org/10.1016/j.techfore.2013.09.016. https://www.sciencedirect.com/science/article/pii/S0040162513002539 (Accessed December 6, 2019).

Richardson, E., E. Hughes, S. Mclennan, and L. Meo-Sewabu, 2019: Indigenous Well-Being and Development: Connections to Large-Scale Mining and Tourism in the Pacific. *Contemp. Pac.*, **31**, 1–34, https://doi.org/10.1353/cp.2019.0004.

Roberts, C., and F. W. Geels, 2019: Conditions for politically accelerated transitions: Historical institutionalism, the multi-level perspective, and two historical case studies in transport and agriculture. *Technol. Forecast. Soc. Chang.*, **140**, 221–240, https://doi.org/10.1016/j.techfore.2018.11.019.

Roberts, J. C. D., 2017: Discursive destabilisation of socio-technical regimes: Negative storylines and the discursive vulnerability of historical American railroads. *Energy Res. Soc. Sci.*, **31**, 86–99, https://doi.org/10.1016/j.erss.2017.05.031.

Rodrigo-Cano, D., M. J. Picó, and G. Dimuro, 2019: The Sustainable Development Goals as a base for the action and social and environmental intervention. *J. Adm. Sci. Econ.*, **9**, https://doi.org/10.17163/ret.n17.2019.02.

Roelich, K., and J. Giesekam, 2019: Decision making under uncertainty in climate change mitigation: introducing multiple actor motivations, agency and influence. *Clim. Policy*, **19**, 175–188, https://doi.org/10.1080/14693062.2018.1479238. https://www.tandfonline.com/doi/full/10.1080/14693062.2018.1479238 (Accessed June 1, 2019).

Rogelj, J., and Coauthors, 2018: Mitigation pathways compatible with 1.5°C in the context of sustainable development. *Global Warming of 1.5 °C an IPCC special report on the impacts of global warming of 1.5 °C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change* http://www.ipcc.ch/report/sr15/.

Rogers, E. M., 2003: *Diffusion of Innovations*. Fifth edit. Free Press of Glencoe and Macmillan, 576 pp.

Røpke, I., 2009: Theories of practice - New inspiration for ecological economic studies on consumption. *Ecol. Econ.*, **68**, 2490–2497, https://doi.org/10.1016/j.ecolecon.2009.05.015.

Rosenbloom, D., 2018: Framing low-carbon pathways: A discursive analysis of contending storylines surrounding the phase-out of coal-fired power in Ontario. *Environ. Innov. Soc. Transitions*, **27**, 129–145, https://doi.org/10.1016/j.eist.2017.11.003. https://www.sciencedirect.com/science/article/pii/S2210422417300977.

——, H. Berton, and J. Meadowcroft, 2016: Framing the sun: A discursive approach to understanding multi-dimensional interactions within socio-technical transitions through the case of solar electricity in Ontario, Canada. *Res. Policy*, **45**, 1275–1290, https://doi.org/10.1016/j.respol.2016.03.012.

——, B. Haley, and J. Meadowcroft, 2018a: Critical choices and the politics of decarbonization pathways : Exploring branching points surrounding low-carbon transitions in Canadian electricity systems Energy Research & Social Science Critical choices and the politics of decarbonization pathways : . *Energy Res. Soc. Sci.*, **37**, 22–36, https://doi.org/10.1016/j.erss.2017.09.022. http://dx.doi.org/10.1016/j.erss.2017.09.022.

——, J. Meadowcroft, S. Sheppard, S. Burch, and S. Williams, 2018b: Transition Experiments: Opening Up Low-Carbon Transition Pathways for Canada through Innovation and Learning. *Can.*

Public Policy, **44**, 1–6, https://doi.org/10.3138/cpp.2018-020.

Rotmans, J., R. Kemp, and M. Van Asselt, 2001: More evolution than revolution: Transition management in public policy. *Foresight*, **3**, 15–31, https://doi.org/10.1108/14636680110803003.

Roy, J., 1997: Socio economic Evaluation of the Solar Lantern Programme in rural India. *J. Sol. Energy Soc. India*, **8**, 27–35.

——, and S. Jana, 1998: Solar lanterns for rural households. *Energy*, **23**, 67–68, https://doi.org/10.1016/S0360-5442(97)00067-4.

——, A. M. Dowd, A. Muller, S. Pal, N. Prata, and S. Lemmet, 2012: Chapter 21- Lifestyles, well-being and energy. *Global Energy Assessment—Toward a Sustainable Future*, Cambridge University Press, 1527–1548 http://www.iiasa.ac.at/web/home/research/Flagship-Projects/Global-Energy-Assessment/Chapters_Home.en.html.

——, D. Ghosh, A. Ghosh, and S. Dasgupta, 2013: Fiscal instruments: Crucial role in financing low carbon transition in energy systems. *Curr. Opin. Environ. Sustain.*, **5**, 261–269, https://doi.org/10.1016/j.cosust.2013.05.003.

Roy, J., and Coauthors, 2018a: Sustainable Development, Poverty Eradication and Reducing Inequalities. *Global Warming of 1.5 °C an IPCC special report on the impacts of global warming of 1.5 °C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change*, P. Zhai et al., Eds., 445–538.

Roy, J., D. Chakravarty, S. Dasgupta, D. Chakraborty, S. Pal, and D. Ghosh, 2018b: Where is the hope? Blending modern urban lifestyle with cultural practices in India. *Curr. Opin. Environ. Sustain.*, **31**, 96–103, https://doi.org/10.1016/j.cosust.2018.01.010. https://www.sciencedirect.com/science/article/pii/S1877343517300696 (Accessed September 11, 2019).

Royston, S., J. Selby, and E. Shove, 2018: Invisible energy policies: A new agenda for energy demand reduction. *Energy Policy*, **123**, 127–135, https://doi.org/10.1016/J.ENPOL.2018.08.052. https://www.sciencedirect.com/science/article/pii/S0301421518305810 (Accessed April 12, 2019).

De Rubens, Z. G., L. Noel, and B. K. Sovacool, 2018: Dismissive and deceptive car dealerships create barriers to electric vehicle adoption at the point of sale. *Nat. Energy*, **3**, 501–507, https://doi.org/10.1038/s41560-018-0152-x. https://doi.org/10.1038/s41560-018-0152-x (Accessed December 14, 2019).

Ruepert, A. M., K. Keizer, and L. Steg, 2017: The relationship between Corporate Environmental Responsibility, employees' biospheric values and pro-environmental behaviour at work. *J. Environ. Psychol.*, **54**, 65–78, https://doi.org/10.1016/j.jenvp.2017.10.006. https://doi.org/10.1016/j.jenvp.2017.10.006.

Ryghaug, M., T. M. Skjølsvold, and S. Heidenreich, 2018: Creating energy citizenship through material participation. *Soc. Stud. Sci.*, **48**, 283–303, https://doi.org/10.1177/0306312718770286. https://doi.org/10.1177/0306312718770286 (Accessed December 14, 2019).

Sahakian, M., L. Godin, and I. Courtin, 2020: Promoting 'pro', 'low', and 'no' meat consumption in Switzerland: The role of emotions in practices. *Appetite*, **150**, 104637, https://doi.org/10.1016/j.appet.2020.104637.

Samuelson, W., and R. Zeckhauser, 1988: Status quo bias in decision making. *J. Risk Uncertain.*, **1**, 7–59, https://doi.org/10.1007/BF00055564.

Sankhyayan, P., and S. Dasgupta, 2019: ‘Availability’ and/or ‘Affordability’:What matters in household energy access in India? *Energy Policy*, **131**, 131–143, https://doi.org/10.1016/j.enpol.2019.04.019.

Sanquist, T. F., H. Orr, B. Shui, and A. C. Bittner, 2012: Lifestyle factors in U.S. residential electricity consumption. *Energy Policy*, **42**, 354–364, https://doi.org/10.1016/j.enpol.2011.11.092. http://www.sciencedirect.com/science/article/pii/S0301421511009906.

Saramet, O., 2007: The Right to a Decent Living Standard or the Right to a Sufficient Living Standard. *Ann. Univ. Apulensis Ser. Jurisprudentia*, **10**. https://heinonline.org/HOL/Page?handle=hein.journals/auaplsj10&id=363&div=52&collection=journals (Accessed November 4, 2019).

Saramet, O., C. G. Matei, and A. Toma-Bianov, 2009: *Aspects regarding the right to a decent living standard*. https://go-gale-com.ezproxy.library.yorku.ca/ps/retrieve.do?tabID=T002&resultListType=RESULT_LIST&searchResultsType=SingleTab&searchType=AdvancedSearchForm&currentPosition=5&docId=GALE%7CA224712328&docType=Report&sort=Relevance&contentSegment=ZONE-MOD1&pr (Accessed December 16, 2019).

Saunders, H., and Coauthors, 2021: Energy Efficiency : What has it Delivered in the Last 40 years ? *Annu. Rev. Energy Environ.*,.

Scheffran, J., E. Marmer, and P. Sow, 2012: Migration as a contribution to resilience and innovation in climate adaptation: Social networks and co-development in Northwest Africa. *Appl. Geogr.*, **33**, 119–127, https://doi.org/10.1016/j.apgeog.2011.10.002.

Schipper, L., 1989: Linking Life-Styles And Energy Use: A Matter Of Time. *Annu. Rev. Energy Environ.*, **14**, 273–320, https://doi.org/10.1146/annurev.energy.14.1.273.

Schlüter, M., and Coauthors, 2017: A framework for mapping and comparing behavioural theories in models of social-ecological systems. *Ecol. Econ.*, **131**, 21–35, https://doi.org/10.1016/j.ecolecon.2016.08.008. https://www.sciencedirect.com/science/article/pii/S0921800915306133 (Accessed May 9, 2019).

Schmidt, T. S., N. Schmid, and S. Sewerin, 2019: Policy Goals, Partisanship and Paradigmatic Change in Energy Policy – Analyzing Parliamentary Discourse in Germany over 30 Years. *Clim. Policy*, 1–16, https://doi.org/10.1080/14693062.2019.1594667.

Schot, J., and F. W. Geels, 2008: Strategic niche management and sustainable innovation journeys: Theory, findings, research agenda, and policy. *Technol. Anal. Strateg. Manag.*, **20**, 537–554, https://doi.org/10.1080/09537320802292651.

——, and W. E. Steinmueller, 2018: Three frames for innovation policy: R&D, systems of innovation and transformative change. *Res. Policy*, **47**, 1554–1567, https://doi.org/10.1016/j.respol.2018.08.011.

——, L. Kanger, and G. Verbong, 2016: The roles of users in shaping transitions to new energy systems. *Nat. Energy*, **1**, 1–7, https://doi.org/10.1038/NENERGY.2016.54.

Schultz, P. W., J. M. Nolan, R. B. Cialdini, N. J. Goldstein, and V. Griskevicius, 2007: The Constructive, Destructive, and Reconstructive Power of Social Norms. *Psychol. Sci.*, **18**, 429–434, https://doi.org/10.1111/j.1467-9280.2007.01917.x. http://journals.sagepub.com/doi/10.1111/j.1467-9280.2007.01917.x (Accessed July 4, 2019).

Sengers, F., A. J. Wieczorek, and R. Raven, 2019: Experimenting for sustainability transitions: A systematic literature review. *Technol. Forecast. Soc. Chang.*, **145**, 153–164, https://doi.org/10.1016/j.techfore.2016.08.031.

Seto, K. C., S. J. Davis, R. B. Mitchell, E. C. Stokes, G. Unruh, D. Urge-Vorsatz, and D. Ürge-Vorsatz, 2016: Carbon Lock-In: Types, Causes, and Policy Implications. *Annu. Rev. Environ. Resour.*, **41**, 425–452, https://doi.org/10.1146/annurev-environ-110615-085934. www.annualreviews.org (Accessed November 5, 2019).

Shao, S., L. Guo, M. Yu, L. Yang, and D. Guan, 2019: Does the rebound effect matter in energy import-dependent mega-cities? Evidence from Shanghai (China). *Appl. Energy*, **241**, 212–228, https://doi.org/10.1016/j.apenergy.2019.03.007.

Sheller, M., 2004: Automotive Emotions: Feeling the Car. *Theory, Cult. Soc.*, **21**, 221–242, https://doi.org/10.1177/0263276404046068. https://doi.org/10.1177/0263276404046068.

Shimamoto, M., 2014: *Keikaku no sohatsu: Sunshine keikaku to taiyoko hatsuden (National project management: the development of photovoltaicpower generation system under the Sunshine Project)*. Yuhikaku (in Japanese),.

Short, L., 2002: Wind Power and English Landscape Identity. *Wind Power in View*, M.J. Pasqualetti, P. Gipe, and R.W. Righter, Eds., Elsevier, 43–58.

Shove, E., 2003: *Comfort, Cleanliness and Convenience: The Social Organization of Normality*. 1st ed. E. Shove, Ed. Berg Publishers/Bloomsbury, 240 pp.

Shove, E., and D. Southerton, 2000: Defrosting the freezer: From Novelty to convenience. A Narrative of Normalization. *J. Mater. Cult.*, **5**, 301–319, https://doi.org/10.1177/135918350000500303.

——, and G. Walker, 2014: What Is Energy For? Social Practice and Energy Demand. *Theory, Cult. Soc.*, **31**, 41–58, https://doi.org/10.1177/0263276414536746. http://journals.sagepub.com/doi/10.1177/0263276414536746 (Accessed May 9, 2019).

——, ——, and S. Brown, 2014: Material culture, room temperature and the social organisation of thermal energy. *J. Mater. Cult.*, **19**, 113–124, https://doi.org/10.1177/1359183514525084.

Shum, K. L., and C. Watanabe, 2009: An innovation management approach for renewable energy deployment-the case of solar photovoltaic (PV) technology. *Energy Policy*, **37**, 3535–3544, https://doi.org/10.1016/j.enpol.2009.04.007.

Simon, D. R., 2003: *Meatonomics : how the rigged economics of meat and dairy make you consume too much-- and how to eat better, live longer, and spend smarter*. Conari Press, 289 pp. https://www.goodreads.com/book/show/17864234-meatonomics (Accessed December 10, 2019).

Singh, D., S. Pachauri, and H. Zerriffi, 2017: Environmental payoffs of LPG cooking in India. *Environ. Res. Lett.*, **12**, 115003, https://doi.org/10.1088/1748-9326/aa909d. https://doi.org/10.1088/1748-9326/aa909d (Accessed December 3, 2020).

Skjølsvold, T. M., and C. Lindkvist, 2015: Ambivalence, designing users and user imaginaries in the European smart grid: Insights from an interdisciplinary demonstration project. *Energy Res. Soc. Sci.*, **9**, 43–50, https://doi.org/10.1016/j.erss.2015.08.026.

Sloot, D., L. Jans, and L. Steg, 2018: Can community energy initiatives motivate sustainable energy behaviours? The role of initiative involvement and personal pro-environmental motivation. *J. Environ. Psychol.*, **57**, 99–106, https://doi.org/10.1016/j.jenvp.2018.06.007. https://doi.org/10.1016/j.jenvp.2018.06.007.

van Sluisveld, M. A. E., S. H. Martínez, V. Daioglou, and D. P. van Vuuren, 2016: Exploring the implications of lifestyle change in 2°C mitigation scenarios using the IMAGE integrated assessment model. *Technol. Forecast. Soc. Change*, **102**, 309–319, https://doi.org/10.1016/j.techfore.2015.08.013.

Smil, V., 2016: Examining energy transitions: A dozen insights based on performance. *Energy Res. Soc. Sci.*, **22**, 194–197, https://doi.org/10.1016/j.erss.2016.08.017. http://dx.doi.org/10.1016/j.erss.2016.08.017.

Smink, M. M., M. P. Hekkert, and S. O. Negro, 2015: Keeping sustainable innovation on a leash? Exploring incumbents' institutional strategies. *Bus. Strateg. Environ.*, **24**, 86–101, https://doi.org/10.1002/bse.1808.

Smith, A., and R. Raven, 2012: What is protective space? Reconsidering niches in transitions to sustainability. *Res. Policy*, **41**, 1025–1036, https://doi.org/10.1016/j.respol.2011.12.012. https://econpapers.repec.org/RePEc:eee:respol:v:41:y:2012:i:6:p:1025-1036 (Accessed November 20, 2020).

Smith, J., and Coauthors, 2017: Gathering around stories: Interdisciplinary experiments in support of energy system transitions. *Energy Res. Soc. Sci.*, **31**, 284–294, https://doi.org/10.1016/j.erss.2017.06.026.

Smith, K. R., G. U. Shuhua, H. Kun, and Q. Daxiong, 1993: One hundred million improved cookstoves in China: How was it done? *World Dev.*, **21**, 941–961, https://doi.org/10.1016/0305-750X(93)90053-C.

Smith, N., and A. Leiserowitz, 2013: American evangelicals and global warming. *Glob. Environ. Chang.*, **23**, 1009–1017, https://doi.org/10.1016/j.gloenvcha.2013.04.001.

Solér, C., B. Koroschetz, and E. Salminen, 2020: An infrastructural perspective on sustainable consumption - Activating and obligating sustainable consumption through infrastructures. *J. Clean. Prod.*, **243**, https://doi.org/10.1016/j.jclepro.2019.118601.

Somanathan, E., and R. Bluffstone, 2015: *Biogas: Clean Energy Access with Low-Cost Mitigation of Climate Change | SpringerLink*. http://econ.worldbank.org.

Sopjani, L., J. J. Stier, S. Ritzén, M. Hesselgren, and P. Georén, 2019: Involving users and user roles in the transition to sustainable mobility systems: The case of light electric vehicle sharing in Sweden. *Transp. Res. Part D Transp. Environ.*, **71**, 207–221, https://doi.org/10.1016/j.trd.2018.12.011. https://www.sciencedirect.com/science/article/pii/S1361920918303006 (Accessed July 13, 2019).

Sovacool, B. K., 2016: How long will it take? Conceptualizing the temporal dynamics of energy transitions. *Energy Res. Soc. Sci.*, **13**, 202–215, https://doi.org/10.1016/j.erss.2015.12.020. http://dx.doi.org/10.1016/j.erss.2015.12.020.

——, and F. W. Geels, 2016: Further reflections on the temporality of energy transitions: A response to critics. *Energy Res. Soc. Sci.*, **22**, 232–237, https://doi.org/10.1016/j.erss.2016.08.013. http://dx.doi.org/10.1016/j.erss.2016.08.013.

Sovacool, B. K., and D. J. Hess, 2017: Ordering theories: Typologies and conceptual frameworks for sociotechnical change. *Soc. Stud. Sci.*, **47**, 703–750, https://doi.org/10.1177/0306312717709363. http://journals.sagepub.com/doi/pdf/10.1177/0306312717709363.

Sovacool, B. K., J. Kester, L. Noel, and G. Z. de Rubens, 2018: The demographics of decarbonizing transport: The influence of gender, education, occupation, age, and household size on electric mobility preferences in the Nordic region. *Glob. Environ. Chang.*, **52**, 86–100, https://doi.org/10.1016/j.gloenvcha.2018.06.008.

Spangenberg, J. H., and S. Lorek, 2019: Sufficiency and consumer behaviour: From theory to policy. *Energy Policy*, **129**, 1070–1079, https://doi.org/10.1016/j.enpol.2019.03.013.

Star, S. L., and K. Ruhleder, 1996: Steps Toward an Ecology of Infrastructure: Design and Access for Large Information Spaces. *Inf. Syst. Res.*, **7**, 111–134, https://doi.org/10.1287/isre.7.1.111. http://pubsonline.informs.org/doi/abs/10.1287/isre.7.1.111 (Accessed May 9, 2019).

Steg, L., 2005: Car use: Lust and must. Instrumental, symbolic and affective motives for car use. *Transp. Res. Part A Policy Pract.*, **39**, 147–162, https://doi.org/10.1016/j.tra.2004.07.001.

——, G. Perlaviciute, E. van der Werff, and J. Lurvink, 2014: The Significance of Hedonic Values for Environmentally Relevant Attitudes, Preferences, and Actions. *Environ. Behav.*, **46**, 163–192, https://doi.org/10.1177/0013916512454730. http://journals.sagepub.com/doi/10.1177/0013916512454730 (Accessed June 15, 2020).

Steinberger, J. K. ., and J. T. Roberts, 2010: From constraint to sufficiency: The decoupling of energy and carbon from human needs, 1975–2005. *Ecol. Econ.*, **70**, 425–433, https://doi.org/10.1016/j.ecolecon.2010.09.014.

Steinmo, S., K. A. Thelen, and F. Longstreth, 1992: *Structuring politics : historical institutionalism in comparative analysis*. Cambridge University Press, 257 pp.

Stephenson, J., and Coauthors, 2015: The energy cultures framework: Exploring the role of norms, practices and material culture in shaping energy behaviour in New Zealand. *Energy Res. Soc. Sci.*, **7**, 117–123, https://doi.org/10.1016/j.erss.2015.03.005.

Stern, N., 2016: Economics: Current climate models are grossly misleading. *Nature*, **530**, 407–409, https://doi.org/10.1038/530407a. http://www.nature.com/articles/530407a (Accessed May 27, 2019).

Stern, P. C., B. K. Sovacool, and T. Dietz, 2016: Towards a science of climate and energy choices. *Nat. Clim. Chang.*, **6**, 547–555, https://doi.org/10.1038/nclimate3027. http://www.nature.com/articles/nclimate3027 (Accessed June 17, 2019).

Stiglitz, J., 2012: *The Price of Inequality: How Today's Divided Society Endangers Our Future*. W. W. Norton & Company,.

Streeby, S., 2018: *Imagining the Future of Climate Change World-Making through Science Fiction and Activism*. University of California Press,.

Stryker, R., 1994: Rules, Resources, and Legitimacy Processes: Some Implications for Social Conflict, Order, and Change. *Am. J. Sociol.*, **99**, 847–910.

Sugiawan, Y., and S. Managi, 2019: New evidence of energy-growth nexus from inclusive wealth. *Renew. Sustain. Energy Rev.*, **103**, 40–48, https://doi.org/10.1016/j.rser.2018.12.044.

Sunstein, C. R., 1996: Social norms and social roles. *Columbia Law Rev.*, **96**, 903, https://doi.org/10.2307/1123430. https://chicagounbound.uchicago.edu/cgi/viewcontent.cgi?article=12456&context=journal_articles (Accessed December 13, 2019).

——, and L. A. Reisch, 2014: Automatically Green: Behavioral Economics and Environmental Protection. *Harvard Environ. Law Rev.*, **38**, 127–158, https://doi.org/10.2139/ssrn.2245657.

Supran, G., and N. Oreskes, 2017: Assessing ExxonMobil's climate change communications. *Environ. Res. Lett.*, **12**.

Sur, M., 2017: Mobility and art: Life cycle. *Transfers*, **7**, 130–136, https://doi.org/10.3167/TRANS.2017.070110.

Tanner, T., T. Mitchell, E. Polack, and B. Guenther, 2009: Urban Governance for Adaptation: Assessing Climate Change Resilience in Ten Asian Cities. *IDS Work. Pap.*, **2009**, 1–47, https://doi.org/10.1111/j.2040-0209.2009.00315_1.x. http://doi.wiley.com/10.1111/j.2040-0209.2009.00315_1.x (Accessed November 6, 2019).

Taufik, D., M. C. D. Verain, E. P. Bouwman, and M. J. Reinders, 2019: Determinants of real-life behavioural interventions to stimulate more plant-based and less animal-based diets: A systematic review. *Trends Food Sci. Technol.*, **93**, 281–303, https://doi.org/10.1016/j.tifs.2019.09.019.

Thacker, S., and Coauthors, 2019: Infrastructure for sustainable development. *Nat. Sustain.*, **2**, 324–331, https://doi.org/10.1038/s41893-019-0256-8. http://www.nature.com/articles/s41893-019-0256-8 (Accessed November 28, 2019).

Thaler, R., and C. Sunstein, 2009: Nudge: Improving decisions about health, wealth, and happiness. https://scholar.google.com/scholar_lookup?title=Nudge:+Improving+decisions+about+health,+wealth,+and+happiness&author=RH+Thaler&author=CR+Sunstein&publication_year=2008& (Accessed July 5, 2019).

Thaler, R. H., 2015: *Misbehaving : the making of behavioral economics*. W.W. Norton & Co., 415 pp.

——, and C. R. Sunstein, 2003: Libertarian Paternalism. *Am. Econ. Rev.*, **93**, 175–179, https://doi.org/10.2307/3132220.

Thøgersen, J., 2017a: Sustainable food consumption in the nexus between national context and private lifestyle: A multi-level study. *Food Qual. Prefer.*, **55**, 16–25, https://doi.org/10.1016/j.foodqual.2016.08.006. file:///C:/Users/gyma/AppData/Local/Mendeley Ltd./Mendeley Desktop/Downloaded/Thøgersen - 2017 - Sustainable food consumption in the nexus between national context and private lifestyle A multi-level study.pdf.

——, 2017b: Housing-related lifestyle and energy saving: A multi-level approach. *Energy Policy*, **102**, 73–87, https://doi.org/10.1016/j.enpol.2016.12.015. http://dx.doi.org/10.1016/j.enpol.2016.12.015.

——, 2018: Transport-related lifestyle and environmentally-friendly travel mode choices: A multi-level approach. *Transp. Res. Part A Policy Pract.*, **107**, 166–186, https://doi.org/10.1016/j.tra.2017.11.015. https://doi.org/10.1016/j.tra.2017.11.015.

Thomas, S., J. Thema, L. A. Brischke, L. Leuser, M. Kopatz, and M. Spitzner, 2019: Energy sufficiency policy for residential electricity use and per-capita dwelling size. *Energy Effic.*, **12**, 1123–1149, https://doi.org/10.1007/s12053-018-9727-4.

Tigabu, A., F. Berkhout, and P. van Beukering, 2017: Development aid and the diffusion of technology: Improved cookstoves in Kenya and Rwanda. *Energy Policy*, **102**, 593–601, https://doi.org/10.1016/j.enpol.2016.12.039.

Tiwari, G., D. Jain, and K. Ramachandra Rao, 2016: Impact of public transport and non-motorized transport infrastructure on travel mode shares, energy, emissions and safety: Case of Indian cities. *Transp. Res. Part D Transp. Environ.*, **44**, 277–291, https://doi.org/10.1016/j.trd.2015.11.004.

Toke, D., S. Breukers, and M. Wolsink, 2008: Wind power deployment outcomes: How can we account for the differences? *Renew. Sustain. Energy Rev.*, **12**, 1129–1147, https://doi.org/10.1016/j.rser.2006.10.021.

Tornatzky, L. G., and K. J. Klein, 1982: Innovation Charactersitic and Innovation Adoption-Implementation : Meta Analysis of the Finding. *IEEE Trans. Eng. Manag.*, **EM-29**, 28–45, https://doi.org/10.1109/TEM.1982.6447463.

Tozer, L., and N. Klenk, 2019: Urban configurations of carbon neutrality: Insights from the Carbon Neutral Cities Alliance. *Environ. Plan. C Polit. Sp.*, **37**, 539–557, https://doi.org/10.1177/2399654418784949.

Troncoso, K., and A. Soares da Silva, 2017: LPG fuel subsidies in Latin America and the use of solid fuels to cook. *Energy Policy*, **107**, 188–196, https://doi.org/10.1016/j.enpol.2017.04.046.

Troncoso, K., P. Segurado, M. Aguilar, and A. Soares da Silva, 2019: Adoption of LPG for cooking in two rural communities of Chiapas, Mexico. *Energy Policy*, **133**, 110925, https://doi.org/10.1016/j.enpol.2019.110925.

Truffer, B., 2003: User-led innovation processes: The development of professional car sharing by environmentally concerned citizens. *Innovation,* **16**, 139–154, https://doi.org/10.1080/13511610304517. http://www.tandfonline.com/doi/abs/10.1080/13511610304517.

Tudor, T., C. Holt, N. Freestone, G. Bhaskaran, M. Suresh, and S. Banga, 2016: Sustainability practices and lifestyle groups in a rapidly emerging economy: a case study of Chennai, India. *Int. J. Environ. Sustain. Dev.,* **15**, 337–351, https://doi.org/10.1504/IJESD.2016.079475. file:///C:/Users/gyma/OneDrive - Loughborough University/Lifestyle_Lowcarbon/Lifestyle_references/Tudor et al (2016) Sustainability_practices_and_lifestyle_groups_in_a_rapidly_emerging_economy_a_case_study_of_Chennai_India.pdf.

Turnheim, B., and F. W. Geels, 2012: Regime destabilisation as the flipside of energy transitions: Lessons from the history of the British coal industry (1913-1997). *Energy Policy*, **50**, 35–49, https://doi.org/10.1016/j.enpol.2012.04.060.

Turnheim, B., P. Kivimaa, and F. (Frans) Berkhout, 2018: *Innovating Climate Governance: Moving Beyond Experiments*. B. Turnheim, P. Kivimaa, and F. Berkhout, Eds. Cambridge University Press, 250 pp. https://www.cambridge.org/gb/academic/subjects/earth-and-environmental-science/environmental-policy-economics-and-law/innovating-climate-governance-moving-beyond-experiments?format=HB%0Ahttps://inogov.eu/blog-innovating-climate-change-moving-beyond-experi (Accessed December 6, 2019).

TWI2050, 2019: *The Digital Revolution and Sustainable Development: Opportunities and Challenges*. 100 pp. http://pure.iiasa.ac.at/id/eprint/15913/1/TWI2050-for-web.pdf.

UNEP, 2018: *Inclusive wealth report 2018: measuring progress towards sustainability*. 14 pp.

Ungemach, C., A. R. Camilleri, E. J. Johnson, R. P. Larrick, and E. U. Weber, 2017: Translated Attributes as Choice Architecture: Aligning Objectives and Choices Through Decision Signposts. *Manage. Sci.*, **65**, 1975–2471, https://doi.org/10.1287/mnsc.2016.2703.

United Nations Environment Programme, 2020: *Emissions Gap Report 2020*. 128 pp. https://www.unenvironment.org/emissions-gap-report-2020.

Unruh, G. C., 2002: Escaping carbon lock-in. *Energy Policy*, **30**, 317–325, https://doi.org/10.1016/S0301-4215(01)00098-2.

Vandeweerdt, C., B. Kerremans, and A. Cohn, 2016: Climate voting in the US Congress: the power of public concern. *Env. Polit.*, **25**, 268–288, https://doi.org/10.1080/09644016.2016.1116651.

Vanloqueren, G., and P. V. Baret, 2009: How agricultural research systems shape a technological regime that develops genetic engineering but locks out agroecological innovations. *Res. Policy*, **38**, 971–983, https://doi.org/10.4324/9781315666396.

Vatn, A., 2015: *Environmental governance : institutions, policies and actions*. Edward Elgar Publications,.

Veland, S., and Coauthors, 2018: Narrative matters for sustainability: the transformative role of storytelling in realizing 1.5°C futures. *Curr. Opin. Environ. Sustain.*, **31**, 41–47, https://doi.org/10.1016/j.cosust.2017.12.005.

Velazquez, L., N. Munguia, A. Platt, and J. Taddei, 2006: Sustainable university: what can be the matter? *J. Clean. Prod.*, **14**, 810–819, https://doi.org/10.1016/j.jclepro.2005.12.008. https://www.sciencedirect.com/science/article/pii/S0959652606000199?via%3Dihub (Accessed May 5, 2019).

Vinnari, M., and E. Vinnari, 2014: A Framework for Sustainability Transition: The Case of Plant-Based Diets. *J. Agric. Environ. Ethics*, **27**, 369–396, https://doi.org/10.1007/s10806-013-9468-5.

Vita, G., E. G. Hertwich, K. Stadler, and R. Wood, 2019a: Connecting global emissions to fundamental human needs and their satisfaction. *Environ. Res. Lett.*, **14**, 014002, https://doi.org/10.1088/1748-9326/aae6e0. https://doi.org/10.1088/1748-9326/aae6e0 (Accessed November 10, 2020).

——, J. R. Lundström, E. G. Hertwich, J. Quist, D. Ivanova, K. Stadler, and R. Wood, 2019b: The Environmental Impact of Green Consumption and Sufficiency Lifestyles Scenarios in Europe: Connecting Local Sustainability Visions to Global Consequences. *Ecol. Econ.*, **164**, 106322, https://doi.org/10.1016/j.ecolecon.2019.05.002. https://doi.org/10.1016/j.ecolecon.2019.05.002.

——, and Coauthors, 2020: Happier with less? Members of European environmental grassroots initiatives reconcile lower carbon footprints with higher life satisfaction and income increases. *Energy Res. Soc. Sci.*, **60**, https://doi.org/10.1016/j.erss.2019.101329.

van der Vleuten, E., 2004: Infrastructures and societal change. A view from the large technical systems field. *Technol. Anal. Strateg. Manag.*, **16**, 395–414, https://doi.org/10.1080/0953732042000251160.

De Vries, G. W., W. P. C. Boon, and A. Peine, 2016: User-led innovation in civic energy communities. *Environ. Innov. Soc. Transitions*, **19**, 51–65, https://doi.org/10.1016/j.eist.2015.09.001.

Van Vuuren, D. P., and Coauthors, 2018: Alternative pathways to the 1.5 °C target reduce the need for negative emission technologies. *Nat. Clim. Chang.*, **8**, 391–397, https://doi.org/10.1038/s41558-018-0119-8. http://www.nature.com/articles/s41558-018-0119-8 (Accessed February 9, 2019).

van Waes, A., J. Farla, K. Frenken, J. P. J. de Jong, and R. Raven, 2018: Business model innovation and socio-technical transitions. A new prospective framework with an application to bike sharing. *J. Clean. Prod.*, **195**, 1300–1312, https://doi.org/10.1016/j.jclepro.2018.05.223.

Walker, C., and J. Baxter, 2017: “It’s easy to throw rocks at a corporation”: wind energy development and distributive justice in Canada. *J. Environ. Policy Plan.*, **19**, 754–768, https://doi.org/10.1080/1523908X.2016.1267614.

Walker, G., P. Devine-Wright, S. Hunter, H. High, and B. Evans, 2010: Trust and community: Exploring the meanings, contexts and dynamics of community renewable energy. *Energy Policy*, **38**, 2655–2663, https://doi.org/10.1016/j.enpol.2009.05.055.

Walker, W., 2000: Entrapment in large technology systems: institutional commitment and power relations. *Res. Policy*, **29**, 833–846, https://doi.org/10.1016/s0048-7333(00)00108-6.

Ward, J. D., P. C. Sutton, A. D. Werner, R. Costanza, S. H. Mohr, and C. T. Simmons, 2016: Is Decoupling GDP Growth from Environmental Impact Possible? *PLoS One*, **11**, e0164733, https://doi.org/10.1371/journal.pone.0164733.

Watson, J., R. Byrne, D. Ockwell, and M. Stua, 2015: Lessons from China: building technological capabilities for low carbon technology transfer and development. *Clim. Change*, **131**, 387–399, https://doi.org/10.1007/s10584-014-1124-1.

van der Weele, C., P. Feindt, A. Jan van der Goot, B. van Mierlo, and M. van Boekel, 2019: Meat alternatives: an integrative comparison. *Trends Food Sci. Technol.*, **88**, 505–512, https://doi.org/10.1016/J.TIFS.2019.04.018. https://www.sciencedirect.com/science/article/pii/S0924224418308409 (Accessed December 10, 2019).

Weenig, M. W. H., and C. J. H. Midden, 1991: Communication Network Influences on Information Diffusion and Persuasion. *J. Pers. Soc. Psychol.*, **61**, 734–742, https://doi.org/10.1037/0022-3514.61.5.734.

Wellesley, L., and A. Froggatt, 2015: *Changing Climate, Changing Diets: Pathways to Lower Meat Consumptiontle*. https://www.chathamhouse.org/publication/changing-climate-changing-diets.

Wester, P., A. Mishra, A. Mukherji, and A. B. Shrestha, 2019: *The Hindu Kush Himalaya Assessment - Mountains, Climate Change, Sustainability and People*. Springer, https://www.springer.com/gp/book/9783319922874 (Accessed December 10, 2019).

Whitmarsh, L., and A. Corner, 2017: Tools for a new climate conversation: A mixed-methods study of language for public engagement across the political spectrum. *Glob. Environ. Chang.*, **42**, 122–135, https://doi.org/10.1016/j.gloenvcha.2016.12.008.

——, S. Capstick, and N. Nash, 2017: Who is reducing their material consumption and why? A cross-cultural analysis of dematerialization behaviours. *Philos. Trans. R. Soc. A Math. Phys. Eng. Sci.*, **375**, https://doi.org/10.1098/rsta.2016.0376.

Whittle, C., L. Whitmarsh, P. Hagger, P. Morgan, and G. Parkhurst, 2019: User decision-making in transitions to electrified, autonomous, shared or reduced mobility. *Transp. Res. Part D Transp. Environ.*, **71**, 302–319, https://doi.org/10.1016/j.trd.2018.12.014.

Wiedenhofer, D., and Coauthors, 2020: A systematic review of the evidence on decoupling of GDP, resource use and GHG emissions, part I: Bibliometric and conceptual mapping. *Environ. Res. Lett.*, **15**, 063002, https://doi.org/10.1088/1748-9326/ab842a.

Wiedinmyer, C., K. Dickinson, R. Piedrahita, E. Kanyomse, E. Coffey, M. Hannigan, R. Alirigia, and A. Oduro, 2017: Rural-urban differences in cooking practices and exposures in Northern Ghana. *Environ. Res. Lett.*, **12**, https://doi.org/10.1088/1748-9326/aa7036.

Wiedmann, T., and J. Minx, 2008: A Definition of "Carbon Footprint." *Ecological Economics Research Trends*, C.C. Pertsova, Ed., Nova Science Publishers.

Wilkinson, R., and K. Pickett, 2009: *The Spirit Level: Why Greater Equality Makes Societies Stronger*. Bloomsbury Press,.

——, and ——, 2019: *The Inner Level: How More Equal Societies Reduce Stress, Restore Sanity and Improve Everyone's Well-Being*. Penguin,.

Wilson, C., 2009: *Meta-analysis of unit and industry level scaling dynamics in energy technologies and climate change mitigation scenarios*. 119 pp.

——, 2012: Up-scaling , formative phases , and learning in the historical diffusion of energy technologies. *Energy Policy*, **50**, 81–94, https://doi.org/10.1016/j.enpol.2012.04.077.

Wilson, C., A. Grubler, N. Bauer, V. Krey, and K. Riahi, 2013: Future capacity growth of energy technologies: Are scenarios consistent with historical evidence? *Clim. Change*, **118**, 381–395, https://doi.org/10.1007/s10584-012-0618-y.

Wilson, C., T. Hargreaves, and R. Hauxwell-Baldwin, 2017: Benefits and risks of smart home technologies. *Energy Policy*, **103**, 72–83, https://doi.org/10.1016/j.enpol.2016.12.047.

Wolsink, M., 2007: Wind power implementation: The nature of public attitudes: Equity and fairness instead of "backyard motives." *Renew. Sustain. Energy Rev.*, **11**, 1188–1207, https://doi.org/10.1016/j.rser.2005.10.005.

——, 2010: Near-shore wind power-Protected seascapes, environmentalists' attitudes, and the technocratic planning perspective. *Land use policy*, **27**, 195–203, https://doi.org/10.1016/j.landusepol.2009.04.004. https://www.sciencedirect.com/science/article/abs/pii/S0264837709000544.

Wood, R., K. Neuhoff, D. Moran, M. Simas, M. Grubb, and K. Stadler, 2020: The structure, drivers and policy implications of the European carbon footprint. *Clim. Policy*, **20**, S39–S57, https://doi.org/10.1080/14693062.2019.1639489. https://www.tandfonline.com/doi/full/10.1080/14693062.2019.1639489 (Accessed December 18, 2020).

Woods, M., 2003: Conflicting environmental visions of the rural: Windfarm development in mid Wales. *Sociol. Ruralis*, **43**, 271–288, https://doi.org/10.1111/1467-9523.00245.

Wu, C. Y., and J. A. Mathews, 2012: Knowledge flows in the solar photovoltaic industry: Insights from patenting by Taiwan, Korea, and China. *Res. Policy*, **41**, 524–540, https://doi.org/10.1016/j.respol.2011.10.007.

Xie, B., M. J. Hurlstone, and I. Walker, 2018: Correct me if I'm wrong: groups outperform individuals in the climate stabilization task. *Front. Psychol.*, 17–28, https://doi.org/10.3389/fpsyg.2018.02274.

Yan, Z., X. Ouyang, and K. Du, 2019: Economy-wide estimates of energy rebound effect: Evidence from China's provinces. *Energy Econ.*, **83**, 389–401, https://doi.org/10.1016/j.eneco.2019.07.027.

Yunani, A., J. Dalle, and S. Maulida, 2020: Can life quality dimensions alter ecological footprint for sustainability of asean countries? Role of per capita income, happiness and human development. *J. Secur. Sustain. Issues*, **10**, https://doi.org/10.9770/jssi.2020.10.Oct(18). http://doi.org/10.9770/jssi.2020.10.Oct (Accessed December 18, 2020).

Zhang, H., K. Wu, Y. Qiu, G. Chan, S. Wang, D. Zhou, and X. Ren, 2020: Solar photovoltaic interventions have reduced rural poverty in China. *Nat. Commun.*, **11**, https://doi.org/10.1038/s41467-020-15826-4. http://dx.doi.org/10.1038/s41467-020-15826-4.

Zhang, L. X., C. B. Wang, and B. Song, 2013: Carbon emission reduction potential of a typical household biogas system in rural China. *J. Clean. Prod.*, **47**, 415–421, https://doi.org/10.1016/j.jclepro.2012.06.021.

Zheng, J., and S. Suh, 2019: Strategies to reduce the global carbon footprint of plastics. *Nat. Clim. Chang.*, **9**, 374–378, https://doi.org/10.1038/s41558-019-0459-z. https://doi.org/10.1038/s41558-019-0459-z (Accessed December 18, 2020).

Zimmerer, K. S., 2012: The Indigenous Andean Concept of Kawsay, the Politics of Knowledge and Development, and the Borderlands of Environmental Sustainability in Latin America. *PMLA*, **127**, 600–606, https://doi.org/doi.org/10.1632/pmla.2012.127.3.600. www.geog.psu.edu/people/.

Zimmerman, M. A., and G. J. Zeitz, 2002: Beyond Survival : Achieving New Venture Growth by Building Legitimacy. *Acad. Manag.*, **27**, 414–431, https://doi.org/10.5465/amr.2002.7389921.

Zubi, G., F. Spertino, M. Carvalho, R. S. Adhikari, and T. Khatib, 2017: Development and assessment of a solar home system to cover cooking and lighting needs in developing regions as a better alternative for existing practices. *Sol. Energy*, **155**, 7–17, https://doi.org/10.1016/j.solener.2017.05.077.

Supplementary Material II Chapter 5

Table SM5.1 Climate change mitigation potentials classified in socio-behavioural, infrastructural, and technological options.

Sector	Gt CO_2 in 2050	Mitigation Strategy	Changes in CO_2 for SIT	References
Building **(total mitigation potential: 64.4%, 5.7 GtCO$_2$)**	**8.8**	**Socio-behavioural:** Sufficiency	10-40% **[median: 25%]**	(IEA 2020a; Ürge-Vorsatz et al. 2020; Niamir et al. 2020b; Ahl et al. 2019; Institute for Global Environmental Strategies et al. 2019; Climact 2018; Virage-énergie Nord-Pas de Calais 2016) see also Chapter 9
		Infrastructure: Architectural design	**[median: 5%]**	(IEA 2020a; Climact 2018; Mastrucci and Rao 2019; Niamir et al. 2020a; Mata et al. 2018; Institute for Global Environmental Strategies et al. 2019) see also Chapter 9
		Technology: Efficiency	30-70% **[median: 50%]**	(IEA 2020a; Climact 2018; Institute for Global Environmental Strategies et al. 2019; Ellsworth-Krebs et al. 2019; Mata et al. 2020) see also Chapter 9
Land Transport **(total mitigation potential: 44.2%, 6.5 GtCO$_2$)**	**9.5**	**Socio-behavioural:** Teleworking, Walking/Cycling	1-15% **[median: 10%]**	(Brand et al. 2020; Creutzig 2015; Creutzig et al. 2016; Ivanova et al. 2020; Riggs 2020) see also 5.3.3, 5.3.4 and Chapter 10
		Infrastructure: Services (urban design, compact city, public transport, shared mobility)	20-50% **[median: 30%]**	(ITF 2020a, 2019; International Transport Forum 2016; ITF 2017a,b,c,d; Creutzig et al. 2016; ITF 2020b) see also 5.3.3, 5.3.4 and Chapter 10
		Technology: Vehicle technology	-50-100% **[median: 50%]**	(Plötz et al. 2017; EEA 2018; Hill et al. 2019; Khalili et al. 2019) see also Chapter 10
Aviation **(total mitigation potential: 55%, 0.99 GtCO$_2$)**	**1.8**	**Socio-behavioural: Less/avoided flights**	**0-47% [median: 40%]**	(IATA 2020; Schäfer et al. 2019; Gössling and Humpe 2020) see also Chapter 10
		Infrastructure	**[median: 0%]**	
		Technology	**10-30% [median: 25%]**	(IATA 2020; Schäfer et al. 2019; Gössling and Humpe 2020) see also Chapter 10

Shipping **(total mitigation potential: 64.4%, 1.2 $GtCO_2$)**	**1.9**	**Socio-behavioural: Reduce demand**	**40-60% [median: 40%]**	(Bouman et al. 2017; McKinnon 2018; ITF 2018) see also Chapter 10
		Infrastructure	**[median: 1%]**	
		Technology	**30-50% [median: 40%]**	(Bouman et al. 2017; McKinnon 2018; ITF 2018) see also Chapter 10
Food **(total mitigation potential: 44.2%, 7.9 $GtCO_2$)**	**18**	**Socio-behavioural: Diet shifts, avoid food waste**	**18-87% [median: 40%]**	(Poore and Nemecek 2018; Schanes et al. 2018; Springmann et al. 2018; Willett et al. 2019; Parodi et al. 2018; Semba et al. 2020; IPCC 2019) see also Chapter 7
		Infrastructure: Choice architectures	**[median: 7%]**	
		Technology	**[median: 0%]**	
Industry **(total mitigation potential: 42%, 6.2 $GtCO_2$)**	**15.8**	**Socio-behavioural: Materials efficient services**	**3-22% [median: 17%]**	(IEA 2020a,b, 2019; Material Economics 2018; Ellen MacArthur Foundation 2019) see also Chapter 11
		Infrastructure: Reuse and recycling	**[median: 5%]**	(IEA 2020a,b, 2019; Material Economics 2018; Ellen MacArthur Foundation 2019) see also Chapter 11
		Technology: Efficiency	**25-28% [median: 26%]**	(IEA 2020a,b; Material Economics 2018) see also Chapter 11

Table SM5.2: Electricity sector demand-side mitigation potential

Sector	Gt CO_2 in 2050	Mitigation Strategy	Changes in Gt CO_2	References
Electricity	**18.2 (without sector coupling)**	**Sector coupling additional emissions**	**+8.3**	(BloombergNEF 2020)
		Building sector demand reduction (indirect emissions)	**-3.3**	(IEA 2020a,c) see also Chapter 9
		Transport sector demand reduction (indirect emissions)	**-1**	(IEA 2020a,d)
		Industry sector demand reduction (indirect emissions)	**-3**	(IEA 2020a, 2019, 2020b)
		Load management	**-1**	(IRENA 2018; Eurelectric 2017) see also Chapter 6

References

Ahl, A., G. Accawi, B. Hudey, M. Lapsa, and T. Nichols, 2019: Occupant Behavior for Energy Conservation in Commercial Buildings: Lessons Learned from Competition at the Oak Ridge National Laboratory. *Sustainability*, **11**, 3297, https://doi.org/10.3390/su11123297. https://www.mdpi.com/2071-1050/11/12/3297.

BloombergNEF, 2020: *Sector Coupling in Europe: Powering Decarbonisation*. https://www.eaton.com/za/en-gb/company/news-insights/energy-transition/sector-coupling.html (Accessed December 23, 2020).

Bouman, E. A., E. Lindstad, A. I. Rialland, and A. H. Strømman, 2017: State-of-the-art technologies, measures, and potential for reducing GHG emissions from shipping – A review. *Transp. Res. Part D Transp. Environ.*, **52**, 408–421, https://doi.org/10.1016/j.trd.2017.03.022.

Brand, C., E. Dons, and Anaya-Boig, 2020: The climate change mitigation effects of active travel. **Submitted**, https://doi.org/10.21203/rs.3.rs-39219/v1. https://www.researchsquare.com/article/rs-39219/v1.

Climact, 2018: *Net Zero by 2050: from whether to how*. 35 pp. https://europeanclimate.org/wp-content/uploads/2019/11/09-18-net-zero-by-2050-from-whether-to-how.pdf.

Creutzig, F., 2015: Towards typologies of urban climate and global environmental change. *Environ. Res. Lett.*, **10**, 101001, https://doi.org/10.1088/1748-9326/10/10/101001. http://stacks.iop.org/1748-9326/10/i=10/a=101001.

——, and Coauthors, 2016: Urban infrastructure choices structure climate solutions. *Nat. Clim. Chang.*, **6**, 1054, https://doi.org/10.1038/nclimate3169. https://www.nature.com/articles/nclimate3169 (Accessed July 8, 2019).

——, and Coauthors, 2021: Demand-side solutions to climate change mitigation consistent with high levels of wellbeing. **submitted**.

EEA, 2018: *Electric vehicles from life cycle and circular economy perspectives*. https://www.eea.europa.eu/publications/electric-vehicles-from-life-cycle (Accessed December 23, 2020).

Ellen MacArthur Foundation, 2019: *Completing the Picture: How the Circular Economy Tackles Climate Change*. https://www.ellenmacarthurfoundation.org/assets/downloads/Completing_The_Picture_How_The_Circular_Economy-_Tackles_Climate_Change_V3_26_September.pdf (Accessed December 23, 2020).

Ellsworth-Krebs, K., L. Reid, and C. J. Hunter, 2019: Home Comfort and "Peak Household": Implications for Energy Demand. *Housing, Theory Soc.*, https://doi.org/10.1080/14036096.2019.1694579. https://www.tandfonline.com/doi/abs/10.1080/14036096.2019.1694579 (Accessed December 23, 2020).

Eurelectric, 2017: *European Commission legislative proposal to amend the Energy Efficiency Directive*. 16 pp. https://www.eurelectric.org/media/2433/eurelectric_positionpaper_eed_final-2017-030-0240-01-e.pdf (Accessed December 23, 2020).

Gössling, S., and A. Humpe, 2020: The global scale, distribution and growth of aviation: Implications for climate change. *Glob. Environ. Chang.*, **65**, 102194, https://doi.org/10.1016/j.gloenvcha.2020.102194.

Hill, G., O. Heidrich, F. Creutzig, and P. Blythe, 2019: The role of electric vehicles in near-term mitigation pathways and achieving the UK's carbon budget. *Appl. Energy*, **251**, 113111, https://doi.org/10.1016/j.apenergy.2019.04.107.

IATA, 2020: *IATA Annual Review 2020*. 56 pp. https://www.iata.org/en/publications/annual-review/.

IEA, 2019: *Material efficiency in clean energy transitions*. OECD, 162 pp. https://www.oecd-ilibrary.org/energy/material-efficiency-in-clean-energy-transitions_aeaaccd8-en (Accessed May 10, 2019).

——, 2020a: *World Energy Outlook 2020*. OECD, https://www.iea.org/reports/world-energy-outlook-2020 (Accessed November 27, 2020).

——, 2020b: *Tracking Industry 2020*. https://www.iea.org/reports/tracking-industry-2020 (Accessed December 23, 2020).

——, 2020c: *Tracking Buildings 2020*. https://www.iea.org/reports/tracking-buildings-2020 (Accessed December 23, 2020).

——, 2020d: *Tracking Transport 2020* . https://www.iea.org/reports/tracking-transport-2020 (Accessed December 23, 2020).

Institute for Global Environmental Strategies, Aalto University, and D-mat ltd, 2019: *1.5-Degree Lifestyles: Targets and Options for Reducing Lifestyle Carbon Footprints*. Institute for Global Environmental Strategies, 49 pp. https://www.iges.or.jp/en/publication_documents/pub/technicalreport/en/6719/15_Degree_Lifestyles_MainReport.pdf.

International Transport Forum, 2016: *Shared mobility: innovation for liveable cities*. 56 pp. https://www.itf-oecd.org/sites/default/files/docs/shared-mobility-liveable-cities.pdf (Accessed July 14, 2019).

IPCC, 2019: *Climate Change and Land: an IPCC special report on climate change, desertification, land degradation, sustainable land management, food security, and greenhouse gas fluxes in terrestrial ecosystem*. 906 pp. https://www.ipcc.ch/srccl/download/.

IRENA, 2018: *Renewable Power Generation Costs in 2017*. International Renewable Energy Agency, 160 pp. www.irena.org (Accessed December 18, 2019).

ITF, 2017a: *Shared Mobility Simulations for Auckland*. 91 pp.

——, 2017b: *Transition to Shared Mobility: How large cities can deliver inclusive transport services*.

——, 2017c: *Transition to Shared Mobility*. 2009–2009 pp.

——, 2017d: *Shared Mobility Simulations for Helsinki*. 95 pp.

——, 2018: *Decarbonising Maritime Transport: Pathways to zero-carbon shipping by 2035*. 86 pp. https://www.itf-oecd.org/decarbonising-maritime-transport (Accessed December 23, 2020).

——, 2019: *ITF Transport Outlook 2019*. OECD Publishing, 200 pp. https://www.oecd-ilibrary.org/transport/itf-transport-outlook-2019_transp_outlook-en-2019-en (Accessed November 27, 2020).

——, 2020a: *Shared Mobility Simulations for Lyon*. 91 pp.

——, 2020b: *Good to Go? Assessing the Environmental Performance of New Mobility*. https://www.itf-oecd.org/good-go-assessing-environmental-performance-new-mobility.

Ivanova, D., J. Barrett, D. Wiedenhofer, B. Macura, M. Callaghan, and F. Creutzig, 2020: Quantifying the potential for climate change mitigation of consumption options. *Environ. Res. Lett.*, **15**, 093001, https://doi.org/10.1088/1748-9326/ab8589. https://doi.org/10.1088/1748-9326/ab8589 (Accessed October 5, 2020).

Khalili, S., E. Rantanen, D. Bogdanov, and C. Breyer, 2019: Global Transportation Demand Development with Impacts on the Energy Demand and Greenhouse Gas Emissions in a Climate-Constrained World. *Energies*, **12**, 3870, https://doi.org/10.3390/en12203870. https://www.mdpi.com/1996-1073/12/20/3870 (Accessed December 23, 2020).

Mastrucci, A., and N. D. Rao, 2019: Bridging India's housing gap: lowering costs and CO2 emissions. *Build. Res. Inf.*, **47**, 8–23, https://doi.org/10.1080/09613218.2018.1483634. https://www.tandfonline.com/doi/full/10.1080/09613218.2018.1483634 (Accessed November 27, 2020).

Mata, A. K. Korpal, S. H. Cheng, J. P. Jiménez Navarro, F. Filippidou, J. Reyna, and R. Wang, 2020: A map of roadmaps for zero and low energy and carbon buildings worldwide. *Environ. Res. Lett.*, **15**, 113003, https://doi.org/10.1088/1748-9326/abb69f. https://doi.org/10.1088/1748-9326/abb69f (Accessed December 23, 2020).

Mata, É., A. S. Kalagasidis, and F. Johnsson, 2018: Contributions of building retrofitting in five member states to EU targets for energy savings. *Renew. Sustain. Energy Rev.*, **93**, 759–774, https://doi.org/10.1016/j.rser.2018.05.014.

Material Economics, 2018: *The Circular Economy: a Powerful Force for Climate Mitigation*. 176 pp. https://materialeconomics.com/publications/the-circular-economy-a-powerful-force-for-climate-mitigation-1.

McKinnon, A., 2018: *Decarbonizing Logistics: Distributing Goods in a Low Carbon World*. Kogan Page, https://www.koganpage.com/product/decarbonising-logistics-9780749483807 (Accessed December 23, 2020).

Niamir, L., O. Ivanova, and T. Filatova, 2020a: Economy-wide impacts of behavioral climate change mitigation: Linking agent-based and computable general equilibrium models. *Environ. Model. Softw.*, **134**, 104839, https://doi.org/10.1016/j.envsoft.2020.104839.

——, ——, ——, A. Voinov, and H. Bressers, 2020b: Demand-side solutions for climate mitigation: Bottom-up drivers of household energy behavior change in the Netherlands and Spain. *Energy Res. Soc. Sci.*, **62**, 101356, https://doi.org/https://doi.org/10.1016/j.erss.2019.101356. http://www.sciencedirect.com/science/article/pii/S2214629619304797.

Parodi, A., and Coauthors, 2018: The potential of future foods for sustainable and healthy diets. *Nat. Sustain.*, **1**, 782–789, https://doi.org/10.1038/s41893-018-0189-7. https://doi.org/10.1038/s41893-018-0189-7.

Plötz, P., S. A. Funke, P. Jochem, and M. Wietschel, 2017: CO2 Mitigation Potential of Plug-in Hybrid Electric Vehicles larger than expected. *Sci. Rep.*, **7**, 16493, https://doi.org/10.1038/s41598-017-16684-9. https://doi.org/10.1038/s41598-017-16684-9.

Poore, J., and T. Nemecek, 2018: Reducing food's environmental impacts through producers and consumers. *Science (80-.).*, **360**, 987 LP – 992, https://doi.org/10.1126/science.aaq0216. http://science.sciencemag.org/content/360/6392/987.abstract.

Riggs, W., 2020: Telework and Sustainable Travel During the COVID-19 Era. *SSRN Electron. J.*, **submitted**, https://doi.org/10.2139/ssrn.3638885. https://papers.ssrn.com/abstract=3638885 (Accessed December 23, 2020).

Schäfer, A. W., and Coauthors, 2019: Technological, economic and environmental prospects of all-electric aircraft. *Nat. Energy*, **4**, 160–166, https://doi.org/10.1038/s41560-018-0294-x. https://doi.org/10.1038/s41560-018-0294-x.

Schanes, K., K. Dobernig, and B. Gözet, 2018: Food waste matters - A systematic review of household food waste practices and their policy implications. *J. Clean. Prod.*, **182**, 978–991, https://doi.org/10.1016/J.JCLEPRO.2018.02.030. https://www.sciencedirect.com/science/article/pii/S0959652618303366 (Accessed May 10, 2019).

Semba, R. D., S. de Pee, B. Kim, S. McKenzie, K. Nachman, and M. W. Bloem, 2020: Adoption of the 'planetary health diet' has different impacts on countries' greenhouse gas emissions. *Nat. Food*, **1**, 481–484, https://doi.org/10.1038/s43016-020-0128-4. https://doi.org/10.1038/s43016-020-0128-4.

Springmann, M., K. Wiebe, D. Mason-D'Croz, T. B. Sulser, M. Rayner, and P. Scarborough, 2018: Health and nutritional aspects of sustainable diet strategies and their association with environmental impacts: a global modelling analysis with country-level detail. *Lancet Planet. Heal.*, **2**, e451–e461, https://doi.org/10.1016/S2542-5196(18)30206-7.

Ürge-Vorsatz, D., R. Khosla, R. Bernhardt, Y. C. Chan, D. Vérez, S. Hu, and L. F. Cabeza, 2020: Advances Toward a Net-Zero Global Building Sector. *Annu. Rev. Environ. Resour.*, **45**, 227–269, https://doi.org/10.1146/annurev-environ-012420-045843. https://doi.org/10.1146/annurev-environ-012420-045843.

Virage-énergie Nord-Pas de Calais, 2016: *Mieux vivre en Nord-Pas de Calais*. 294 pp. http://www.virage-energie.org/wp-content/uploads/2016/01/Virage-énergie-NPdC_Rapport-complet-étude-mieux-vivre_mars2016-1.pdf.

Willett, W., and Coauthors, 2019: Food in the Anthropocene: the EAT–Lancet Commission on healthy diets from sustainable food systems. *Lancet*, **393**, 447–492, https://doi.org/10.1016/S0140-6736(18)31788-4. http://www.thelancet.com/article/S0140673618317884/fulltext (Accessed December 6, 2019).