Frequently Asked Questions

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Chapter 1

FAQ 1.1 What is climate change mitigation?

Climate change mitigation involves implementation of actions or activities that limit emissions of greenhouse gases from entering the atmosphere and/or reduce levels of existing greenhouse gases from the atmosphere. The actions that inform mitigation vary from implementation of new and improved renewable energy technologies to enhancing energy efficiency to addressing consumer practices and behaviour. Mitigation also includes actions that facilitate removal of gases from the atmosphere by greenhouse sinks. The ultimate goal of mitigation is to prevent anthropogenic greenhouse gas emissions to interfere with the climate system, in turn reducing the rate of climate change. In the context of mitigation, a range of sources of emissions (such as land-use change) are addressed. Effective mitigation strategies require an understanding of mechanisms that underpin release of emissions.

FAQ 1.2 What human activities cause Greenhouse Gas (GHG) emissions?

Anthropogenic GHGs such as carbon dioxide (CO2), methane (CH4), nitrous oxide (N2O), and fluorinated gases (e.g. hydrofluorocarbons, perfluorocarbons, Sulphur hexafluoride) are released from various sources. CO2 makes the largest contribution to global GHG emissions; fluorinated gases (F-gases) contribute a few percent in CO2 equivalents. However, F-gases have extremely long atmospheric lifetimes, some extending to tens of thousands of years. They have also grown at the fastest rate for any GHG (440%, {2}) and now contribute a few percent in CO2 equivalents.

The largest source of CO2 is combustion of fossil fuels in energy conversion systems like boilers in electric power plants, engines in aircraft and automobiles, and in cooking and heating within homes and businesses. While most GHGs come from fossil fuel combustion, about one third come from other activities like agriculture (mainly CH4 and N2O), deforestation (mainly CO2), fossil fuel production (mainly CH4) industrial processes (mainly CO2, N2O and F-gases) and municipal waste and wastewater (mainly CH4) (See 1.3.1). In addition to these emissions, black carbon – an aerosol that is, for example, emitted during incomplete combustion of fossil fuels – contributes to warming of the Earth’s atmosphere.

FAQ 1.3 What do ‘net zero emissions’ and similar terms mean in relation to holding global temperature increase below a given level?

For the long-lived GHGs, like CO_2, N_2O, and some industrial gases (of which CO_2 dominates anthropogenic global warming), atmospheric concentrations and hence global warming will continue to increase as long as emissions exceed the processes of removal. Achieving a given long-term temperature goal thus requires (in the language of the Paris Agreement) a ‘balance between anthropogenic emissions by sources and removals by sinks of greenhouse gases.’ This relates broadly to concepts of ‘net zero emissions’ and ‘carbon (or climate) neutrality’, terms which are defined more precisely in the IPCC Glossary (Annex A in this report).

Chapter 2

FAQ 2.1 Is humanity on track to reduce emissions?

Global Greenhouse (GHG) emissions continued to rise and measured at 59±5.9 $GtCO_2eq$ in 2018 although the rate of growth has fallen compared to the previous decade. Still, emissions were higher than at any point in human history before**.** Emissions were 11% (6.0 $GtCO_2eq$) and 51% (20 $GtCO_2eq$) higher than in 2010 and 1990, respectively. Average annual GHG emissions for 2009-2018 were 56±5.6 $GtCO_2eq$ compared to 47±4.7 and 40±4.0 $GtCO_2eq$ for 2000-2009 and 1990-1999, respectively. GHG emissions growth slowed since 2010: while average annual GHG emissions growth was 2.3% between 2000 and 2010, it was only 1.3% for 2010-2018. Emissions and removals of GHGs are weighted by Global Warming Potentials with a 100-year time horizon (GWP100), using values from the Sixth Assessment Report (Section 2.2.1).

FAQ 2.2 Are there countries that have managed to economically grow and reduce emissions at the same time?

There are at least 36 countries that have sustained territorial-based CO_2 and GHG emissions reductions for more than 10 years. While total cumulative GHG reductions of these decarbonising countries are trivial compared to recent global emissions growth, some of them achieved a relative decline of up to 50% in emissions, showing what is possible even under circumstances that were only moderately favourable for climate policies (Section 2.2.3). 43 out of 166 countries have achieved absolute decoupling of consumption-based CO_2 emissions from economic growth in recent years (2010-2015)**.** A group of developed countries, such as some EU countries and the United States of America, and some developing countries, such as Cuba and Iran, have successfully achieved absolute decoupling of consumption-based CO_2 emissions and GDP growth (i.e., experienced GDP growth while their emissions have stabilised or declined). The decoupling has been achieved at various levels of per capita income and per capita emissions (Section 2.3.1).

FAQ 2.3 How much time do we have to act?

If global CO_2 emissions continue to be released at current rates, the remaining carbon budget for keeping warming below both 1.5°C will be exhausted before 2030. Between 1850 and 2018 total cumulative CO_2 emissions from the Fossil Fuel Industry (FFI) and Agriculture, Forestry and Other Land Use (AFOLU) were 2400±390 $GtCO_2$. Of these, about 980±98 $GtCO_2$ were added to the atmosphere since 1990. 330±31 $GtCO_2$ were added since AR5 (2010). This is about the same size as the remaining carbon budget of 310±250 (390, 500) $GtCO_2$ for keeping global warming below 1.5°C and between 2-3 times smaller than the 960±250 (1140, 1390) $GtCO_2$ for keeping warming below 2°C with a probability of 67% (50%, 33%), respectively. At current rates of CO_2 emissions (43±4.1 Gt CO_2 yr^{-1}), these remaining budgets will be exhausted in 7(9,11) and 22 (27, 33) years, respectively, depending on selected probability threshold and how remaining geo-physical uncertainties unfold. Even in the case of global CO_2 emission reductions at 2% or 5% per year, the 1.5°C budget will be exhausted before 2030 highlighting the dependence of 1.5°C pathways on the availability of substantial CO_2 removal capacities (Section 2.2.1).

Chapter 3

FAQ 3.1 Is it possible to stabilize warming without net negative emissions?

Many scenarios aiming at meeting the stringent long-term climate goals that were generated by integrated assessment models (IAMs) and were used in earlier IPCC reports (AR5 and SR1.5) heavily rely on net negative CO2 emissions (NNCE) in the second half of this century. That may encourage delayed action and allow temperature limit to be temporarily exceeded (overshoot). Such scenarios are mostly accomplished through a large-scale implementation of bioenergy with carbon capture and storage (BECCS), and afforestation that face several difficulties such as underground carbon storage as well as competition with food supply and biodiversity when compared to other mitigation options such as energy end-use or non-CO2 technologies. Recently, the IAMs specifically focused on the scenarios meeting the low-temperature climate target without NNCE. The scenarios require a more rapid transformation and more emissions reductions in the near-term with significant benefits for the economy, food system, biodiversity and the environment in the long-term. The scenarios without NNCE reach net zero 5 to 10 years earlier than those with no NNCE. The rapid transformation and structural changes lead to multiple benefits such as lowering carbon price peak, saving mitigation costs throughout this century, and avoiding drastic land-use change.

FAQ 3.2 What does a net zero world look like?

Achieving net zero emissions globally requires deep emissions cuts across all sectors and regions. The distribution of the emissions reductions across sectors and time depends on several factors such as relative abatement costs, the inertia of sectors against fundamental structural changes, and the ability to reduce emissions. In general, AFOLU and energy supply sectors act as sinks and are fully decarbonized several decades earlier compared to other sectors, while the transport, buildings, and industry sectors are responsible for remaining residual emissions sources. This emphasizes the responsibility of land-based mitigation options such as afforestation and reforestation as well as BECCS for the bulk of the gross negative emissions and the importance of demand-side measures to reduce the residual emissions. The land-based mitigation options need more land for forest and bioenergy supply, which would require a consideration for the conservation of ecosystem and agricultural market stabilization.

FAQ 3.3 How plausible are high emissions scenarios and what are their roles?

The IAMs developed plausible scenarios describing what might happen to socioeconomic circumstances, greenhouse-gas emissions and climate warming in this century as Shared Socioeconomic Pathways (SSPs) and Representative Concentrations Pathways (RCPs). Among them, the SSP5 where climate condition is equivalent to RCP8.5 is the highest emissions scenario based on the high demographic growth and low economic and technological developments. The characteristics of this scenario results in nearly 5 °C of warming by the end of the century. One of the roles of this high-end scenario is to explore the possible warmest climate and associated impacts. Because of these strong trends, the high emissions scenario cannot be interpreted as the deterministic business-as-usual scenario but is still valuable as a possible outcome that may arise from such a scenario if these trends were to be realized. Recently, global CO2 emissions growth is mitigated compared to the period from 2000s and early 2010s and COVID-19 may further push down emissions. However, we cannot completely discard the possibility to go back to SSP5-baseline-like future, and it is still worth keeping these scenarios to inform policymakers about the pathway background that results in such a high rise in temperature.

Chapter 4

FAQ 4.1 What is to be done over and above countries' existing pledges under the Paris Agreement to keep global warming well below 2°C?

Accelerating mitigation is not enough; massive, deep, and rapid transformations are needed; Focusing on making transformative changes that disrupt existing developmental trends (Shifting development pathways) towards sustainability, i.e., involving substantial disruption to existing carbon intensive development trends, in particular to improve underlying enabling conditions for climate change mitigation; equity considerations and need for just transition matter; Covid-19 crisis does not fundamentally alter assessment, at least given current knowledge.

FAQ 4.2 What is to be done in the near term to accelerate mitigation and shift development pathways?

Understand how to shift development pathways; including creating new infrastructure, sustainable supply chains, institutional capacities for evidence-based and integrated decision-making, financial alignment away from incumbent high-carbon technologies towards low-carbon socially responsible investments and shifts in behaviour and norms to support cleaner consumption; adopting multi-level governance modes, tackling corruption, and improving social and political trust are also key for aligning and supporting long-term environmentally just policies and processes; take a long-term perspective on near-term decisions and actions.

FAQ 4.3 What does 'shifting development pathways to increased sustainability' (SDPS) mean, and what is the concept of SDPS doing in a report on mitigation?

Development pathways determine GHG emissions. Mitigation conceived as incremental change is not enough. Mitigation policies grafted on to existing development pathways are unlikely to be able to achieve rapid and deep emission reductions. An approach of Shifting development pathways to increased sustainability (SDPS) is complementary to accelerating mitigation. SDPS can broaden opportunities by focusing on development pathways and considering how to shift them. Decision-makers might consider a broader toolbox of enablers and levers that is available in domains that have not traditionally been thought of as climate policy. The approach helps to think about change in systems and integrated policy packages. Putting in place more supportive enabling conditions can be done in the near-term – policy, institutional capacity, multi-level governance, finance and investment, innovation and technology, and drivers of behavioural change. Such shifts are the result of decisions by a wide range of actors – social movements, governments, non-state actors, businesses, intergovernmental organisations. SDPS is not an alternative to accelerating mitigation, it is complementary – both are needed to address the climate crisis.

Chapter 5

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 organize 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 through economic incentives, such as carbon pricing, but also through 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 digitalization and automation, and the COVID-19 pandemic, induces changes in labour markets, and brings 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 legitimize and normalize 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 as healthy and natural stabilize 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, typically by switching from fossil fuels to renewables, but until now at insufficient rates and levels for stabilizing 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 reduce 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.

Chapter 6

FAQ 6.1. Will net zero energy systems be different than energy systems today?

Net-zero energy systems will be similar to those of today in the sense that they will provide many of the same services that they provide today – for example, heating and cooling homes, allowing us to travel to work or on vacation, and powering manufacturing. But future energy systems may be different in the sense that we may also demand new services, just as we now use energy for many information technology uses that we did not anticipate 50 years ago. More importantly, net-zero energy systems will be different in the way that we produce, transform, and use energy to provide these services. In the future, almost all electricity will be produced from sources that don't emit CO2, such as solar power, wind power, nuclear power, bioenergy, or hydropower; we will use electricity, hydrogen, and bioenergy in many situations where we use fossil fuels today; and energy will be used more efficiently than to today, for example, through more efficient cars, trucks, and appliances, buildings that use very little energy, and greater use of public transportation. Fundamental to all of these changes is that net-zero energy systems will use little or no fossil fuels.

FAQ 6.2. Can we power future energy systems on renewable energy alone?

Renewable energy technologies harness energy from natural sources that are continually replenished, for example, from the sun (solar energy), the wind (wind energy), plants (bioenergy), rainfall (hydropower), or even ocean waves (wave energy). The energy from these sources exceeds the world's current and future energy needs many times. But that does not mean that they will provide all energy in future net-zero energy systems. Only some of the energy from renewable sources can be captured at reasonable costs; other low- or zero-emissions options, such as nuclear power or fossil energy with carbon dioxide capture and storage (CCUS), may be more viable in some circumstances. Some countries have a lot of renewable energy, whereas others do not. Important sources such as solar energy, wind energy, and hydropower are all "intermittent", meaning that they cannot provide energy at all times. Many sources may also have other consequences, for example producing bioenergy may reduce biodiversity and increase food prices. For all of these reasons, it is unlikely that most future energy systems will rely entirely on renewable energy sources. But research is increasingly indicating that it will be viable, in many circumstances, to produce most or all electricity from renewable energy.

FAQ 6.3. What are the most important steps to decarbonize the energy system?

To reduce energy system emissions to zero, they must be eliminated across all parts of the system, and not just one or two. This means eliminating emissions when we produce electricity, drive our cars, haul freight, heat and cool buildings, power our data centers, and manufacture goods. Technologies need to be developed and deployed, and policies and regulations need to be put in place across the energy system. At the same time, some actions and parts of the energy system provide greater near-term opportunities to reduce emissions than others, even if a comprehensive approach is critical to get on a path to net-zero emissions. Key near term actions include deploying low- and zero-carbon electricity sources; halting the construction of new coal-fired power plants and retiring existing coal-fired power plants; limiting the construction of new gas-fired power plants; installing electric heaters ("heat pumps") in homes and businesses; replacing cars using gasoline with those using electricity; and installing more efficient technologies wherever possible. These should be accompanied by efforts to improve and test out options that will be important later on, including hydrogen or biofuels in cars and trucks, and fossil power plants, bioenergy power plants or refineries with CCUS.

Chapter 7

FAQ 7.1 Why is the Agriculture, Forestry and Other Land Use (AFOLU) sector unique when considering Greenhouse Gas (GHG) mitigation?

There are three principle reasons that make AFOLU unique in terms of mitigation;

1. In contrast to other sectors, AFOLU can facilitate mitigation through several different pathways. Specifically, AFOLU can (a) reduce emissions as a sector in its own right, (b) remove meaningful quantities of carbon from the atmosphere and relatively cheaply, and (c) provide raw materials to enable mitigation within other sectors, such as energy, industry or the built environment.
2. The emissions profile of AFOLU differs from other sectors, with a greater proportion of non-CO_2 gasses (N_2O and CH_4) arising from AFOLU. The impacts of mitigation efforts within AFOLU can vary according to which gasses are targeted, as a result of the differing atmospheric lifetime of the gasses and differing global temperature responses to the accumulation of the specific gasses in the atmosphere. This makes reporting aggregated AFOLU emissions, estimating relative mitigation potential and forming mitigation pathways for meeting climate objectives challenging (see Box 2.2 and Appendix A.B.10 on GHG emission metrics).
3. AFOLU is inextricably linked with some of the most serious challenges that are suggested to have ever faced humanity, such as large-scale biodiversity loss, environmental degradation and the associated consequences. As AFOLU concerns land management and utilizes a considerable portion of the Earth's terrestrial area, the sector greatly influences soil, water and air quality, biological and social diversity, the provision of natural habitats, and ecosystem functioning, consequently impacting many SDGs. In addition to tackling climate change, AFOLU mitigation measures have capacity, where appropriately implemented, to help address some of these wider challenges, as well as contributing to climate change adaptation.

FAQ 7.2 What AFOLU measures have the greatest economic mitigation potential?

Mitigation measures in forests and other ecosystems provide the largest share of economic (up to USD100/tCO_2 yr^{-1}) mitigation potential, followed by agriculture and demand-side measures. Reduced conversion (protection), enhanced management, and restoration of forests, wetlands, savannas and grasslands have the potential to reduce emissions and/or sequester carbon by 6.1 (±2.9) $GtCO_2eq$ yr^{-1}, with measures that 'protect' having the highest mitigation densities (mitigation per area). Agriculture provides the second largest share of mitigation, with 3.9 ± 0.2 $GtCO_2$-eq yr^{-1} potential, from soil carbon management in croplands and grasslands, agroforestry, biochar, rice cultivation, and livestock and nutrient management. Demand-side measures including shifting to healthy diets and reducing food waste, can provide 1.9 $GtCO_2$-eq yr^{-1} potential (accounting only for diverted agricultural production and excluding land-use change). Demand-side measures reduce agricultural land needs and land competition and can complement or enable supply-side measures such as reduced deforestation and reforestation.

FAQ 7.3 What are potential impacts of large-scale establishment of dedicated bioenergy plantations and crops and why is it so controversial?

The potential of bioenergy with carbon capture and storage (BECCS) remains a focus of debate. BECCS involves sequestering carbon through plant growth and capturing the carbon generated when the crops are burned for power or fuel. While these processes in isolation appear to create a carbon-negative outcome, BECCS requires cropland, water and energy which can create adverse side-effects at scale. Controversy has arisen because some of the models calculating the energy mix required to keep the temperature to 1.5°C have included BECCS at very large scales as a means of both providing energy and removing carbon to offset emissions from industry, power, transport or heat. For example, studies have calculated that for BECCS to achieve 11.5 $GtCO_2$-eq per year of carbon removal in 2100, as envisaged in one scenario, 380-700 Mha or 25-46% of all the world's arable and cropland would be needed. In such a situation, competition for agricultural land could threaten food production and food security. More recently however, the scenarios for BECCS have become much more realistic. However, where bioenergy is part of the full agriculture or wood chain, from sustainably managed forest or specialized plantations, it will deliver positive GHG balances. Progress is important because if BECCS is not a feasible option at a large scale then deeper transformation will be required in other areas, or ambitious climate targets will have to be given up altogether.

Chapter 8

FAQ 8.1 Why are urban areas important to global climate change mitigation?

The world is rapidly urbanizing and this will likely lead to an increasing share of global GHG emissions. The trends and potentials associated with this phenomenon render urban emissions reduction crucial to global climate change mitigation. Indeed, over half of the world's population currently reside in urban areas—a number forecasted to increase to nearly 70% by 2050. Furthermore, urban areas take up a growing proportion of national and global emissions, estimated to be between 45–87% today, depending on emissions scope. This range is projected to grow in the coming decades; in 2100, some scenarios show urban share as high as 100%, with 65% being at the minimum for any scenario. One study of 84 cities found that urban areas that utilize energy-efficiency in transport, commercial buildings, and building heating/cooling could reduce urban emissions by 36–54%—significant considering the global urban emissions share. Furthermore, subnational governments (e.g., those governing cities, towns, villages) are uniquely situated to influence other levels of governance and stakeholders by upscaling effective mitigation efforts and promoting technology transfer through such means as urban mitigation experimentation, participation in transnational municipal networks and international organisations, and other enabling strategies. Urban areas can also act as points of intervention to amplify synergies and co-benefits for accomplishing the SDGs.

FAQ 8.2 What are the most impactful options cities can take to mitigate urban emissions, and how can these be best implemented?

There is a wide array of GHG mitigation options available to urban areas that help break—or prevent—the cycle of urban carbon lock-in. These options have the greatest mitigation impact when urban actors employ them across sectors, operate within an urban systems framework, offer "enabling conditions" (e.g., supportive policy instruments and institutions, financing, etc.), and continually innovate over time. Cross-sector integration might include updating building and zoning regulations while promoting renewable-energy based decentralization of energy systems and promoting compact urban development that is coupled with land use mix and transit-oriented development.

The optimal mitigation options and their implementation will depend on the governance and developmental context of the urban area (e.g., new, emerging, or established urban areas). In emerging and yet-to-be-built urban areas, carbon lock-in in can be avoided by deploying low- and negative-carbon infrastructure and urban form. For existing cities, electrification of the grid and transport, and implementing energy efficiency across sectors, are highly transformative mitigation options. Figure 8.22 illustrates those strategies with the largest mitigation potential common to all cities, regardless of development status; these include low-carbon energy use, nature-based solutions, and enabling consumer behaviour change through incentivizing/increasing accessibility to consumption and material choices with a smaller carbon footprint (e.g., through low-impact dietary choices, offering walking and cycling, expanding recycling and its accessibility, etc.). In general, electrification of urban services and ensuring that sources of electricity are from renewable energy are among the most impactful options that cities can take to reduce urban emissions. Without such urban-scale changes, pro-environmental behaviour can reduce individual footprints significantly.

FAQ 8.3 How do we estimate global emissions from cities, and how reliable are the estimates?

Broadly, there are two different approaches used to estimate emissions from cities globally: top-down and bottom-up. The top-down approach starts from atmospheric observations and attempts to allocate those to urban areas through atmospheric modelling. This approach estimates direct (scope 1) emissions only. The second approach estimates emissions from GHG emitting activities in a given urban area via a combination of local activity data or direct measurement such as stack monitoring, traffic data, energy consumption information, and building attributes. Activity data is combined with CO2 emission factors to estimate emissions. These estimates can also be achieved via downscaling from national or regional estimates. The emissions may include solely direct emissions (scope 1), or also factor in indirect emissions (i.e., from purchased electricity consumption – or scope 2) or all remaining emissions, like those from the urban supply chain (scope 3). Some researchers also take a hybrid approach. No approach has systematically accounted for all cities worldwide. Rather, they have been applied to subsets of global cities and often include the largest cities globally. These continue to support the conclusion that cities account for an average share of about 70% of global CO2 emissions and 60% of global GHG emissions, including CO2 and CH4—numbers that are projected to increase into 2050 and 2100. However, these estimates and the urban share depends upon how one defines the emissions (i.e., the scope and city boundary). Uncertainty remains for both the top-down and bottom-up approaches (10–20%). Individual self-reported inventories from cities have shown chronic underestimation when compared to atmospherically-calibrated estimates.

Chapter 9

FAQ 9.1 To which Greenhouse Gas (GHG) emissions do buildings contribute?

There are three categories of GHG emissions from buildings:

i. direct emissions, which are defined as all on-site fossil fuel or biomass-based combustion activities (i.e. use of biomass for cooking, or gas for heating and hot water) and F-gas emissions (i.e. use of heating and cooling systems, aerosols, fire extinguishers, soundproof)

ii. indirect emissions which occur off-site and are related to heat and electricity production

iii. embodied emissions which are related to construction material and goods used in buildings

In terms of gases, GHG emissions from buildings include carbon dioxide, (CO_2), methane (CH_4), nitrous oxide (N_2O) and fluorinated gas (F-gas). However, data on CH_4 and N_2O and F-gas are scarce.

FAQ 9.2: How important are the co-benefits and trade-offs of mitigation actions in buildings?

Mitigation actions in buildings generate multiple co-benefits (e.g., health benefits due to the improved indoor and outdoor conditions, productivity gains in non-residential buildings, creation of new jobs particularly at the local level, improvements in social wellbeing etc.) beyond their direct impact on reducing energy consumption and GHG emissions. Most studies agree that the value of these multiple benefits is greater than the value of energy savings and their inclusion in economic evaluation of mitigation actions may substantially improve their cost-effectiveness. On the other hand, the buildings sector in several cases is characterized by strong rebound effects, which may lower the economic performance of mitigation actions. All these are characterized by several uncertainties as mitigation actions will be implemented in a changing climate. Climate change impacts can increase energy consumption, which may lead to higher GHG emissions and greater need for mitigation. Also, increased storms and rainfall under future climate may impact building materials and components that would need to be renovated, resulting in increased energy consumption and household expenditure for producing and installing the new components and renovations.

FAQ 9.3: Which are the needed and most effective policies and measures to decarbonize the building sector?

Several barriers (information, financing, markets, behavioural, etc.) still prevents the decarbonisation of buildings stock, despite the several co-benefits, including large energy savings. Solutions include investments in technological solutions (e.g. insulation, efficient equipment and on-site renewables) and lifestyle changes. In addition, the concept of sufficiency shall be promoted and implemented through policies and information, as technological solutions will be not enough to decarbonise the building sector. Due to the different types of buildings, occupants and development stages, there is not a single policy that alone will reach the decarbonisation target. There are a range of policy instruments, ranging from regulatory measures such as building energy code for NZEBs and appliance standards, to market-based instruments (carbon tax, personal carbon allowance, renewable portfolio standards, etc.), and information. Financing (grants, loans, performance base incentives, pays as you save, etc.) is another key enabler for energy efficiency technologies and on-site renewables. Finally, effective governance and strong institutional capacity are key to having an effective and successful implementation of policies and financing.

Chapter 10

FAQ 10.1 How important is electro-mobility in decarbonising transport and are there major constraints in battery minerals?

- Electro-mobility is the biggest change in transport since AR5. It is providing a mechanism for the major source of transport GHG - cars, motorbikes, buses and trucks - to be reduced or removed entirely. The extent of decarbonization depends on how much the power system is decarbonized though life cycle analyses and shows that Lithium Ion Battery-powered vehicles are significantly more efficient and lower carbon than Internal Combustion Engines. They also can be powered by home or business renewable power before or in parallel to the transition to grid-based renewable power.
- Electro-mobility is happening rapidly in micro-mobility (e-autorickshaws, e-scooters, e-bikes) and in transit systems, especially buses. All these, including private vehicles, can be used in grid stabilization by their batteries being plugged in when not in use or recharging.
- The state-of-the-art Lithium Ion Batteries (LIBs) available in 2020 are superior to alternative cell technologies in terms of battery life, energy density, specific energy and cost. The expected further improvements in LIBs suggest these chemistries will remain superior to alternative battery technologies in the medium-term, and therefore LIBs will continue to dominate the electric vehicle market.
- Dependence on LIB metals will remain and this is a concern for some from the perspective of resource availability and costs. However, the demand for such metals is much lower than the reserves available, with many new mines starting up in response to the new market, and therefore resource concerns may be overstated.
- Recycling batteries will significantly reduce long-term resource requirements. The main challenge to recycling is a lack of standardisation of battery designs and no focus on recyclability which make it difficult and expensive to recycle LIBs.
- The most significant enabling condition in electro-mobility is to provide electric recharging opportunities and a strategy to show they can be helping the grid.

FAQ 10.2 How hard is it to decarbonise heavy vehicles in transport like long haul trucks, ships and planes?

- Unlike light vehicles, there are few obvious solutions to decarbonizing heavy vehicles other than by increased efficiency which so far has not prevented these large vehicles from becoming the fastest growing source of GHG globally. These vehicles need drop-in fuels that can be fitted to the present propulsion systems and so far, none of these - hydrogen fuel cells, biofuels or synthetic fuels - have become commercial like LIB electric vehicles.
- Hydrogen Fuel Cell Vehicles may be a solution for long haul trucks after 2030.
- Electric propulsion using hydrogen fuel cells or Li-ion batteries are unlikely to help with aviation and shipping as the large long-lived vessels and aircraft need drop-in liquid fuels for most major long-distance functions.
- Biofuels may be a solution but as is shown in chapters 2, 6 and 12 there are multiple issues constraining biofuels as more than a niche fuel in certain places.
- Synthetic fuels made by CO_2 capture and subsequent refining to a jet fuel or marine fuel can be a very good solution as it is zero carbon, involves much less contrails-based climate impacts and low local air pollution. However, it requires significant R&D and demonstration as shown by new commitments in Switzerland.

FAQ 10.3 How can governments, communities and individuals reduce demand and be more efficient in consuming transport energy?

- Cities can reduce their transport fuel by around 25% through combinations of more compact land use and less car dependent transport infrastructure.
- Covid-based lockdowns have confirmed the value in two new technologies reducing the need for high energy-travel: ICT replacing significant numbers of work and personal journeys; and, electric micro-mobility enabling much greater localized travel. These changes may not last and impacts on productivity and health are still to be fully evaluated.
- More traditional programs for reducing unnecessary high-energy travel through behaviour change programs, taxes on fuel, parking and vehicles, subsidies on alternatives, continue to be evaluated with mixed results due to the dominance of time savings in most transport issues.
- Creative solutions involving shared communities that set new cultural means of reducing fossil fuel consumption especially in transport, are setting out how climate change mitigation can be achieved.

Chapter 11

FAQ 11.1 What are the key options to reduce industrial emissions?

To decarbonize industry requires that we pursue several options simultaneously. These include energy efficiency, materials demand management, improving materials efficiency, more circular material flows, electrification, as well as Carbon Capture and Utilization (CCU) and Carbon Capture and Storage (CCS). Renewable energy and feedstock resources are sufficient to meet future demand for fossil free industrial production, especially if we can reduce the need for resource extraction and energy intensive primary processing. Recycling is an option to achieve this. It includes chemical recycling of plastics, i.e., breaking them down to produce new monomer building blocks, potentially based on biogenic carbon and hydrogen instead of fossil feedstock. Hydrogen can also be used as a reduction agent instead of coke in ironmaking. Process emissions from cement production can be captured and stored or used as feedstock for chemicals and materials. Electricity and hydrogen needs can be very large but the potential for renewable electricity is not a limiting factor.

FAQ 11.2 Isn´t industrial decarbonisation very costly? Will it not conflict with sustainable development?

The answer is both yes and no to both questions. In most cases and in early stages of deployment, it will make the production of primary basic materials such as cement, steel, or polyethylene more expensive. However, demand management, materials efficiency and more circular material flows can dampen the effect of such cost increases. In addition, the cost of energy intensive materials is typically a very small part of the total price of products, such as appliances, a bottle of soda, or a building, so the effect on consumers is very small. Getting actors to pay more for zero emission materials is a challenge in supply chains with a strong focus on cutting costs, but it is not a significant problem for the broader economy. Reduced demand for services such as square meters of living space or kilometers of car travel is an option where material living standards are already high. If material living standards are very low, increased material use is often needed for more sustainable development. The options of materials and energy efficiency, and more circular material flows, generally have synergies with sustainable development. Increased use of electricity, hydrogen, CCU and CCS may have both positive and negative implications for sustainable development.

FAQ 11.3 What needs to happen for a low carbon industry transition?

Broad and sequential policy strategies for industrial development that pursue several mitigation options at the same time are more likely to reduce emissions cost effectively. Options such as materials and energy efficiency, albeit important, are not in themselves enough to reach zero emissions. Less electricity will be needed if electrification is pursued in parallel with options that reduce the need for the energy intensive virgin materials production. Based on shared visions or pathways for a zero-emission industry, industrial policy needs to support development of new technologies and solutions as well as market creation for low and zero emission materials and products. This implies coordination across policy domains including research and innovation, waste and recycling, product standards, digitization, taxes, regional development, infrastructure, public procurement, permit procedures and more to make sustainable transition to carbon neutral industry worldwide.

Chapter 12

FAQ 12.1 How could new technologies to remove carbon dioxide from the atmosphere contribute to climate change mitigation?

Limiting warming to 1.5°C -2°C and achieving net-zero emissions will require efforts to draw CO2 out of the atmosphere (carbon dioxide removal, CDR).

There are a number of CDR methods, each with different removal potentials, costs and side effects. Some biological methods used for CDR like afforestation/reforestation or wetland restoration have long been practiced. Given an expected scale of deployment, these methods could result in side effects such as biodiversity loss or food price increases. It is therefore prudent to develop new technological approaches to CDR, including Direct Air Carbon Capture and Storage (DACCS), Enhanced Mineral Weathering or Ocean Alkalinity Enhancement. Biological CDR methods are generally less expensive but more vulnerable to reversal than technological approaches.

DACCS uses chemicals that bind to CO2 directly from the air; the CO2 is then removed from the sorbent and stored underground or mineralized. Enhanced Mineral Weathering involves the mining of rocks containing minerals that naturally absorb CO2 from the atmosphere over geological timescales, which are crushed to increase the surface area and spread on soils (or elsewhere) where they absorb atmospheric CO2. Ocean Alkalinity Enhancement involves the extraction, processing, and dissolution of minerals and addition to the ocean where it enhances sequestration of CO2 as bicarbonate and carbonate ions in the ocean.

FAQ 12.2 Why is it important to assess mitigation measures from a systemic perspective, rather than only looking at their potential to reduce Greenhouse Gas (GHG) emissions?

Mitigation measures do not only reduce GHGs, but have wider impacts. They can result in decreases or increases in GHG emissions in another sector or part of the value chain to where they are applied. They can have wider environmental (e.g. air and water pollution, biodiversity), social (e.g. employment creation, health) and economic (e.g. growth, investment) co-benefits or adverse side effects. Mitigation and adaptation can also be linked. Taking these considerations into account can help to enhance the benefits of mitigation action, and avoid unintended consequences, as well as provide a stronger case for achieving political and societal support and raising the finances required for implementation.

FAQ 12.3 Why do we need a holistic systems approach for assessing GHG emissions and mitigation opportunities from food systems?

Activities associated with the food system caused about one-third of total anthropogenic GHG emissions in 2015, distributed across all sectors. Agriculture and fisheries produce crops and animal-source food, which are partly processed in the food industry, packed, distributed, retailed, cooked, and finally eaten. Each step is associated with resource use, waste generation, and GHG emissions.

A holistic systems approach helps identify critical areas as well as novel and alternative approaches to mitigation on both supply side and demand side of the food system. But complex co-impacts need to be considered and mitigation measures tailored to the specific context. International cooperation and governance of global food trade can support both mitigation and adaptation.

There is large scope for emissions reduction in both cropland and grazing production, and also in food processing, storage and distribution. Emerging options such as plant-based alternatives to animal food products and food from cellular agriculture are receiving increasing attention, but their mitigation potential is still uncertain and depends on the GHG intensity of associated energy systems due to relatively high energy needs. Diet changes can reduce GHG emissions and also improve health in groups with excess consumption of calories and animal food products, which is mainly prevalent in developed countries. Reductions in food loss and waste can help reduce GHG emissions further.

Recommendations of buying local food and avoiding packaging can contribute to reducing GHG emissions but should not be generalized as trade-offs exist with food waste, GHG footprint at farm gate, and accessibility to diverse healthy diets.

Chapter 13

FAQ 13.1 What policies and strategies can be applied to combat climate change?

Policy instruments to reduce greenhouses gas emissions include economic instruments, regulatory instruments and other approaches.

Economic policy instruments directly influence prices to achieve emission reductions through taxes, permit trading, offset systems, subsidies, and border tax adjustments. Taxes for carbon intensive products and services increase their cost and trigger improved efficiency or reduced consumption. Fuel taxes increase cost of fuel use, indirectly reducing greenhouse gas emissions. Subsidies for mitigation support low-carbon technologies by reducing their cost for consumers.

Regulatory instruments establish specific technology or performance requirements. Technology standards specify pollution abatement technologies, production methods or goods. Performance standards are more flexible; they set carbon intensity objectives not directly linked to specific technologies. Regulatory instruments may also target related parameters, such as energy efficiency, rather than emissions.

Other instruments include information programs, government provision of goods, services and infrastructure, divestment strategies, and voluntary agreements between governments and private firms.

These instruments may directly target GHG emission reduction, or may target other multiple objectives, such as urbanization or energy security, with the effect of reducing emissions. Climate policymaking should account for both direct instruments and those aimed at multiple objectives. In practice, climate mitigation policy instruments operate in combination with other policy tools, requiring attention to the interaction effects between instruments. See also FAQ 13.2 and 13.3.

FAQ 13.2 What roles do different levels of government institutions play in climate mitigation, and how can they be effective?

Climate governance is constrained and enabled by countries' political systems, material endowments and culture, which leads to a variety of country specific approaches to climate mitigation.

National institutions set emission reduction targets, enable coordination between different actors and agencies, and strengthen accountability through improved transparency, monitoring mechanisms and stakeholder involvement. Countries have followed different approaches in developing institutions and governance for climate mitigation. Some focus on greenhouse gases emissions by adopting comprehensive climate laws and creating dedicated ministries and institutions focused on climate change. Others consider climate change among broader scope of policy objectives, such as poverty alleviation, economic development and co-benefits of climate actions, with the involvement of existing agencies and ministries.

Sub-national institutions, including at the urban scale, also play crucial roles in climate mitigation. They often lack national support, funding, and capacity. Despite this, subnational actors have created new entities or re-purposed existing offices to focus on climate change. An important issue for sub-national action is adequate coordination with climate action at other scales. Climate action at the sub-national level has a greater chance of being implemented when linked to existing local issues such as travel congestion alleviation, or air pollution control. See also FAQ 13.3.

FAQ 13.3 How can actions at the sub-national level contribute to climate mitigation?

Sub-national actors (e.g. individuals, organizations, jurisdictions and networks at regional, local and city levels) often have remit over areas salient to climate mitigation, such as land use planning, waste management, infrastructure, and community development. Despite constraints on legal authority and dependence on national policy priorities in many countries, subnational climate change policies exist in more than 120 countries.

Economic instruments for GHG mitigation are widespread with 32 carbon pricing initiatives (emission trading systems, carbon tax or both) in subnational jurisdictions as of 2020. Regulatory instruments at the sub-national level include land use and transportation planning, performance standards for buildings, utilities, transport electrification, and energy use by public utilities, buildings and fleets. Other policies include information and capacity building, such as carbon labelling aimed at providing information to consumers; mandatory building performance standards; disclosure and benchmarking policies to increase awareness and track progress; as well as government provision of public goods, services, and infrastructure.

The main drivers of climate actions at sub-national levels include high levels of citizen concern, jurisdictional authority and funding, institutional capacity, national level support and effective linkage to development objectives. Subnational governments often initiate and implement policy experiments that could be scaled to other levels of governance.

Chapter 14

FAQ 14.1: Now that the Paris Agreement has entered into force, and it requires countries to develop their own nationally determined emissions reduction contributions, does this mean that international cooperation no longer plays a useful role in achieving long-term climate goals?

Continued international cooperation remains critically important. The Paris Agreement has changed the framework for international cooperation, from one built on multilaterally negotiated emissions reduction targets, backed by a compliance mechanism with an enforcement branch and penalties for non-compliance, to one relying on nationally determined contributions (NDCs)that are subject to an international oversight system, and bolstered through international support. The international oversight system is designed to generate transparency and accountability for individual emission reduction contributions, and regular moments for stock-taking of these efforts towards global goals. Such enhanced transparency may instill confidence and trust, and foster solidarity among nations. It can also influence domestic politics in these countries, with theory-based arguments that this will lead to greater levels of ambition. Further, for most developing countries, international cooperation and support is important for their mitigation efforts. Such support includes bilateral and multilateral cooperation on low-carbon finance, technology support, capacity building, and enhanced South-South cooperation. It can take place through the implementation of the Paris Agreement, and through a large number of sub-global and sectoral agreements, as well as the actions of transnational organizations (high confidence).

FAQ 14.2: Is international cooperation working?

Countries' emissions were in line with their internationally agreed targets – the collective Greenhouse Gas (GHG) mitigation stabilization target for Annex I countries in the UNFCCC for 2000, and their individual target in the Kyoto Protocol for 2008-12. Neither of these required transformational policy changes, whereas meeting the long-term goals of the Paris Agreement will. International support of the kinds that the Paris Agreement advances are yet to be fully implemented, as well as those embodied in other cooperative agreements at the sub-global and sectoral levels, play an important role in making political, economic, and social conditions more favorable to ambitious mitigation efforts in the context of sustainable development and efforts to eradicate poverty. The degree to which countries are willing to increase the ambition of their NDCs over time, which has yet to be observed, will be an important indicator of the success of the Paris Agreement.

FAQ 14.3: Are there any important gaps in international cooperation, which will need to be filled in order for countries to achieve the objectives of the Paris Agreement, such as holding temperature increase to 'well below 2°C' and pursuing efforts towards '1.5°C' above pre-industrial levels?

While international cooperation is contributing to global mitigation efforts, its effects are far from uniform. Cooperation has made a contribution to falling CO2 emissions in the Agriculture, Forestry, and Other Land Use (AFOLU) sector, although these gains are not immune to backsliding in some countries. Likewise, international cooperation is leading to rapid reduction in emissions of many non-CO2 greenhouse gases, such as those covered under the Kigali Amendment to the Montreal Protocol, and it may influence institutional factors that are vital for achieving the objectives of the Paris Agreement, such as with respect to administrative capacity (including on accounting, and reporting of emissions). In most other respects, further strengthening of international cooperation is necessary to improve the likelihood of achieving the Paris Agreement's long-term global goals. Finalizing the rules to pursue voluntary cooperation in the implementation of NDCs, without compromising environmental integrity, may play an important role in accelerating mitigation efforts in developing countries. Finally, there appears to be a large potential role for international cooperation addressing sectoral-specific technical and infrastructure challenges to eliminating emissions quickly, as well as those associated with managing Carbon Dioxide Removal (CDR) and Solar Radiation Management (SRM).

Chapter 15

FAQ 15.1 What's the current status of global climate finance and the alignment of global financial flows with the Paris Agreement?

Climate finance covers both mitigation and adaptation finance. Annual global climate finance flows have been on an upward trend since the fifth Assessment Report, reaching a yearly average all time high estimate of almost 600 billion USD in 2017/2018, with almost 95% allocated to mitigation activities and more than 50% in renewable energy generation, followed by low carbon transport (approx. 25%). However, current climate finance flows come in significantly below average needs across all regions and sectors to reach the long-term goals of the Paris Agreement. Global yearly needs are estimated at around 6 trillion USD yr^{-1} and [more to come]

Significant progress has been made in the commercial finance sector with regard to the awareness of climate risks resulting from inadequate financial flows and climate action. However, a more consequent investment and policy decision making that enables a rapid redirection of financial flows is needed. Regulatory support as a catalyser is an essential convey of such redirections.

Dynamics across sectors and regions vary with some being better positioned to close financing gaps and to benefit from an enabling role of finance in the short-term. The investment flows in the global power and fuel sector - accounting for approximately USD 1.62 trillion USD in 2019 – only slightly exceed the investment needs for attaining the sustainable development scenario [IPCC xx] - accounting for approx. 1.91tr USD yr^{-1} between 2023 and 2032.

FAQ 15.2 What's the role of climate finance and the finance sector for a transformation towards a sustainable future?

The Paris Agreement has widened the scope of relevant financial flows from climate finance only to the full alignment of finance flows with the long-term goals of the Paris Agreement. While climate finance relates historically to the financial support of developed countries to developing countries, the Paris Agreement and its Article 2.1(c) has developed on a new narrative that goes beyond traditional flows and relates to all sectors and actors. Climate-related financial risk is still massively underestimated by financial institutions, financial decision-makers more generally, and also among public sector stakeholders, limiting the sector's potential of being an enabler of the transition.

The private sector has started to recognise climate-related risks and consequently redirect investment flows. Dynamics vary across sectors and regions with the financial sector being an enabler of transitions in only some selected (sub-)sectors and regions. Consistent, credible, timely and forward-looking political leadership remains central to strengthening the financial sector as enabler.

FAQ 15.3 What defines a financing gap, and where are the critically identified gaps?

Difference between current flows and average needs until [2030] by sector/region and/or type of financing to meet the long-term goals of the Paris Agreement driven by various barriers (Market and non-market failures) inside (short-termism, information gaps, home bias, limited visibility of future pipelines) and outside (e.g. missing pricing of externalities) of the financial sector. Major reason for financing gaps are […] [Numbers to come…]. Unmet financing needs are mostly discussed as a demand-side challenge. However, understanding challenges for deploying funds is critical as well - with a significant role remaining for public finance to close viability gaps and close funding gaps for preparatory action to increase absorptive capacity for commercial investments.

Chapter 16

FAQ 16.1 Will innovation and technological changes be enough to meet the Paris Agreement objectives?

The Paris Agreement stressed the importance of development and transfer of technologies to improve resilience to climate change and to reduce greenhouse gas emissions. However, business-as-usual innovation and even fast technological change will not be enough to achieve Paris agreement objectives.

Besides technological changes, policy and behavioural changes, changes in the financial system and in development of human capacity and resources will be needed for the systems transitions that are needed to achieve the Paris Agreement objectives.

Trends in some sectors, such as energy, show that technological innovation and the spread of new technologies can reduce greenhouse gas emissions and enable low-emission development. However, such technological changes never happen in a vacuum. They are always accompanied by, for instance, people changing habits, companies changing value chains, or banks changing risk profiles.

The implication is that if the speed, spread and direction of technological change is to be accelerated, holistic approaches are needed. In innovation studies, such systemic approaches are said to strengthen the functions of technological or national innovation systems, so that climate-friendly technologies can flourish. Innovation policies can help respond to local priorities and technology needs of all actors, including private and societal ones. Such policies could also help prevent unintended and undesirable consequences of technological change. Such consequences could include unequal access to new technologies across countries and between income groups, environmental degradation and negative effects on employment.

In summary, innovation and technological change are necessary but insufficient conditions for achieving the Paris Agreement objectives. Only with the help of policy interventions and other factors can the appropriate implementation of new technology can be enabled.

FAQ 16.2 What can be done to promote innovation for climate change and the widespread diffusion of low-emission and climate-resilient technology?

The innovation process includes basic research, applied research, demonstration, deployment, diffusion and eventually obsolescence. Whether a technology successfully passes each stage is based on different factors including financing needs, policy support and actors involved.

Recent years have shown the widespread diffusion of several new technologies needed to address climate change, such as solar energy, batteries for electric vehicles and energy-efficient lighting. For their adoption, policies by some governments have played an important role and have led to almost global adoption, although this took multiple decades.

The increasing complexity of technologies and global competition means that technology development is a truly international process, and the necessary knowledge flow transcends borders. Research and development could generate new knowledge, skills, ideas and practices.

The speed of innovation processes could be greater if policies could be enhanced with involvement of a wider range of global industry, research and financial actors as well as consumers, in partnerships at the regional and international level. This would help strengthening another necessary enabling condition: of institutional and human capacities as well as domestic and international financing in developing countries.

FAQ 16.3 What is the role of international technology cooperation in addressing climate change?

To address climate change, new technologies are needed. Also, sustainable technologies that are currently known but not yet widely used, need to be spread around the world and adapted to local preferences and conditions. To do that, it is not only research and development that is needed, although that is part of the story. It is also about education systems that teach new students how to use, improve and innovate on those new technologies. It is also about governmental institutions that might make policies to promote those new technologies. Businesses need to be able to use and sell new technologies, and banks need to be able to estimate the financial risks.

Different countries can learn from each other's experiences and insights. If every country would figure out everything by itself, the climate response would get much more expensive and slower. This is one reason why international cooperation is needed.

The other reason for international cooperation on technology is that poor countries are able to be active players in this global process. More even than developed countries, that have better education systems, modern infrastructure, and the financial resources to invest, developing countries need to build the capacities to be able to participate fully in the development, implementation and spread of new climate-friendly technologies.

The United Nations, including the 2015 Paris Agreement, therefore requires all parties to cooperate in the development, application and spread of climate-friendly technologies. Although technology transfer is mainly done by the private sector, through foreign direct investment and international trade, the UN also requires developed countries to help transfer technologies and knowledge to developing countries.

Many initiatives exist both regionally and internationally to help countries in achieving technology development and transfer, such as through partnerships and research collaboration, with a key role for universities. Enhancing current activities would help an effective, long-term global response to climate change, while promoting sustainable development.

Chapter 17

FAQ 17.1 Will decarbonisation efforts slow or accelerate sustainable development transitions?

Sustainable development offers a comprehensive pathway to achieving ambitious climate change mitigation goals. Sustainable development requires the pursuit of synergies and the avoidance of trade-offs between the economic, social and environmental dimensions of development, and can thus provide pathways that accelerate progress towards ambitious climate change mitigation goals. Factoring in equity and distributional effects will be particularly important in the pursuit of sustainable policies and partnerships and accelerating the transition to sustainable development. Using climate change as a key conduit can only work if synergies across sectors are exploited, and if policy implementation is supported by national and international partnerships.

The speed, quality, depth and scale of the transition will depend on the developmental starting point, explicit goals as well as the enabling environment – individual behaviour, mindsets, beliefs and actions, social cohesion, governance, policies, institutions, social and technological innovations etc. The integration of both climate change mitigation and adaptation policies in sustainable development is also essential in the establishment of fair and robust transformation pathways.

FAQ 17.2 What role do considerations of justice and inclusivity play in the transition towards sustainable development?

Negative economic and social impacts in some regions as a consequence of ambitious climate change mitigation policies could emerge if these are not aligned with key sustainable development aspirations such as those represented by the SDG's no poverty, energy-, water-, and food access etc, which could in turn, slow down the transition process. Nonetheless, many climate change mitigation policies could generate incomes, new jobs, and other benefits. Capturing these benefits could require that specific policies and investments are targeted directly towards including all parts of society in the new activities and industries created by the climate change mitigation policies, and that activities, which are reduced as part of transitions to low carbon, including industries and geographical areas, are seeing new opportunities. Poor understanding of how governance at multiple levels can meet these transition challenges may fail to make significant progress in relation to national policies and a global climate agreement and may therefore support or weaken the climate architecture, thus constituting a limiting factor.

FAQ 17.3 How critical are the roles of institutions in accelerating the transition and what can governance enable?

Institutions are critical in accelerating the transition towards sustainable development. Institutions can help to shape climate change response strategies both in terms of adaptation and mitigation. Local institutions are custodians of critical adaptation services ranging from mobilisation of resources, skills development and capacity building as well as dissemination of critical strategies. Transitions towards sustainable development are mediated by actors within a given institution, the governance mechanisms they use as implementing tools and the political coalitions they form to enable action. Patterns of production and consumption have implications for a low carbon development and many of these patterns can act as barriers or opportunities towards sustainable development. Trade policies, international economic issues and international financial flows can positively support the speed and scale of the transition or they can negatively impact on policies that may inhibit the process. Nonetheless, contextual factors are a fundamental part of the change process, and institutions and their governance systems provide pathways that can influence contextual realities on the ground. For instance, politically vested interests may lead powerful lobby groups or coalition networks to influence the direction of the transition or could put pressure on a given political elite through the imposition of regulatory standards, taxation, incentives, and policies that may speed or delay the transition process. Civil society institutions, for example, NGOs or research centres, can constitute effective governance 'watch dogs' in the transition process, particularly when they exercise a challenge function and question government's action in the transition process related to sustainable development.