Chapter 1

A decisive transition for growth and climate

Governments around the world are facing the triple imperatives of re-invigorating growth while improving livelihoods and urgently tackling climate change. This chapter contains an extended synthesis of the report, showing how acting on climate change can also be good for growth, provided the right policies and structural reforms are put in place. After setting the scene for combined action on climate and growth, the synthesis presents results on the macro-economic implications of a "decisive transition" to a low-emission, high-growth and resilient future. The synthesis then lays out development pathways compatible with the Paris Agreement and how they vary across country types, as well as the need to scale and shift infrastructure investment. Turning to policy, the synthesis also presents the mix of structural and targeted climate policies required, the implications of the transition for exposed businesses and workers and how governments can address them, and changes needed to the financial system. It concludes with the main policy messages arising from the report.

Creating the conditions for sustainable growth

The global economy is not generating the level or quality of growth to which the citizens of G20 countries aspire. Productivity growth, the key factor that increases income per capita, has been declining for years in many countries. Widening inequalities, often related to the slowdown in productivity growth, are forcing a rethink about how the benefits of growth are shared. Many advanced countries face concerns about persistent unemployment and how to meet expectations about pensions, health and education. For some economies, this is exacerbated by ageing societies. Developing and some emerging economies have the benefit of a more dynamic demography, though many have concerns about the quality of investment and regulation. In their 2016 communiqué, G20 leaders recognised that "the use of all policy tools – monetary, fiscal and structural – individually and collectively" is needed both to support aggregate demand in the short term and to build the foundations for resilient, longer-term growth prospects.

The top priority for many G20 countries is to reinvigorate their economies, but the quality of that growth is vital. To improve lives and well-being in the short-term, growth needs to be inclusive, with benefits felt by the whole population. Economic growth over the last two centuries has led to staggering increases in wealth and well-being for much – but not all – of the world's population. To continue to improve well-being over a longer time horizon, the sources of growth need to be sustainable economically, socially and environmentally. To date, growth has exploited natural capital to meet the demands of rising populations, using technology largely based on abundant fossil fuels. Those fuels have been cheap because little account has been taken of their social and environmental costs.

Climate change: a systemic risk for growth

The impact of the current growth model on the natural environment now threatens the foundations of continued growth. While local pollution is increasingly driving momentum for reform, environmental pressures, including climate change, are no longer just local or regional; they pose profound challenges to global development. The scale of potential damage from climate change poses a major systemic risk to our future well-being and the ecosystems on which we depend, in particular for societies in less-developed, less-resilient countries. The pace and scale of the required economic transformation is unprecedented, if the worst of these risks are to be avoided; planning and investment in adaptation and resilience are also essential to reduce vulnerability to climate change.

Governments acknowledged the intrinsic importance of climate change for sustainable development and poverty alleviation in both the Paris Agreement and the 2030 Agenda for Sustainable Development. In Paris, countries collectively agreed to strengthen the global response to climate change including by limiting the global average surface temperature increase to well below 2°C and to pursue efforts to limit it to 1.5°C above pre-industrial levels, while increasing the ability to adapt to adverse impacts of climate change.

Most countries have proposed national action plans under the Paris Agreement, but collectively these are insufficient to achieve the long-term objective of the agreement. The Nationally Determined Contributions to 2030 are a positive step, but even if they were fully implemented, warming would reach around 3°C, leading to severe disruption and economic damage. Reasons for insufficient ambition vary, but commonly include perceived high economic and social costs of climate policies, and concerns about competitive disadvantage if stringent climate policies are not mirrored elsewhere. These concerns persist despite the "enhanced transparency framework" of the Paris Agreement. In addition, political and investment horizons have pitted the long-term benefits of low-emission development against the short-term (but ultimately unsustainable) benefits of cheaper high-carbon options. The

threat of future damage from climate change has been too distant to drive sufficient early action, and short-term gain has tended to come first. But the threat of climatic disruption is not a conventional risk management issue, either temporally or spatially. While short-term costs are often local, a failure to address them will put future local and global benefits beyond reach.

Inclusive and climate-compatible growth

This report shows how action on climate change can generate inclusive economic growth in the short term, in addition to securing longer-term growth and well-being for all citizens. Governments can not only build strong growth but also avoid future economic damage from climate change if they collectively act for a "decisive transition" towards low-carbon economies. This requires combining climate-consistent, growth-enhancing policies with well-aligned policy packages for mobilising investment in low-emission infrastructure and technologies.

Investment in modern infrastructure is an important basis for economic growth, but underinvestment has been prevalent since the financial crisis. Energy, water supply, sanitation and waste management, mobility services and communications are foundations for economic activity and also essential for achieving the Sustainable Development Goals. Many advanced economies have suffered from a deficit of public infrastructure investment, hurting growth. Most emerging economies need massive investment to provide a growing population with universal access to modern services.

Countries are now facing a fundamental choice: the type of infrastructure investments they make will either support or seriously undermine future global well-being. As well as being a source of growth, infrastructure investment is a key determinant of future GHG emissions and resource efficiency, both directly (for example, through the type of power plants installed) and indirectly, by influencing behaviours (for example, through transport systems and urban planning). The window for making the right choices is uncomfortably narrow. The lifespans of much infrastructure and related physical investment means that future GHG emissions are going to be locked in by investment choices in the next decade, as infrastructure needs expand with the world economy. While investing in new and improved infrastructure is an important part of getting growth going now, investing in the right kind of infrastructure will deliver growth that can last. To manage climate risks and deliver long-term sustainable growth, infrastructure investment needs to be low-emission, energy-efficient and climate-resilient.

A unique opportunity

Current economic conditions – including low real interest rates in most countries – afford many governments the opportunity to invest in the right infrastructure now, to reignite growth while also paving the way to achieving the Paris Agreement goals. Governments need to bring together structural policy reforms, effective climate policies and the progressive alignment of regulatory frameworks to ensure effective action. A combined agenda for climate and growth offers numerous economic opportunities, including enhanced markets for low-emission infrastructure, technologies and services; increased market confidence spurred by greater climate policy clarity; and enhanced incentives for innovation and efficiency. These and other opportunities are relevant as the G20 prepares to revisit its Brisbane "2% upside growth" commitment and strengthen performance on growth; up to now, G20 countries have reached less than half of the 2% goal. The timing and mix of the policy interventions required will very much depend on countries' different developmental imperatives and exposure to climate risks.

The transition will not succeed unless the low-carbon economy is inclusive. To make pro-climate growth policies politically feasible, their implications for both households and businesses need to be taken into account. Beyond a well-functioning tax and welfare system, targeted measures can compensate for any potentially regressive impacts of climate policy on poor households. Past experience of industrial transitions shows that workers and communities relying on GHG-intensive activities should be actively engaged early in planning the transition. Where restructuring or plant closures are likely, authorities should aim for transparency and work with relevant companies, sectors and communities to develop economically sustainable alternatives and gain political and social support for policy measures. Clear policy signals are also essential to guide the transformation of technologies and business models for a low-GHG economy.

Acting together for better growth

The benefits of combined action on growth and climate increase as more countries act in a concerted way. Simultaneous action by countries generates economies of scale in climate solutions, magnifies the gains from learning and hastens a decline in technology costs, increasing the penetration of new technologies. Simultaneous action can also reduce the concerns of firms that competitors in countries not facing carbon pricing or regulation would be at an advantage.

Recognising their different economic structures and level of development, members of the G20 are well positioned to take the lead in uniting climate and growth efforts. The G20 countries not only account for 85% of global GDP and 80% of CO_2 emissions, they have far-reaching influence on the rest of the world through innovation, trade and development finance. They are also, collectively, leading the transition: G20 countries are home to 98% of global installed capacity of wind power, 97% of solar photovoltaic (PV) power and 93% of electric vehicles (IEA, 2017). While efforts to reduce emissions and sequence policies will vary from country to country, the G20 could spearhead the transition to low-carbon growth, generating technology cost reductions and best practices that will further accelerate the transition globally. Solar PV costs have declined about 80% in leading markets since 2010, for example. If G20 countries do not take the lead, it is hard to see how the transition can be effected.

A "decisive transition" for climate and growth

The current global macroeconomic environment – including low interest rates – provides an opportunity to take swift action to address climate change while boosting economic growth. Spurring investment in smart, modern, clean and resilient infrastructure, if combined with stronger fiscal and structural policies in a synergistic way, can boost growth in the short term and underwrite robust long-term growth, in both advanced and emerging economies. Low interest rates have increased fiscal space, giving governments more flexibility over spending choices without compromising their future financial position. Even in countries where there is less fiscal space, there are opportunities to optimise the tax and spending mix to align stronger economic growth with inclusive and low-carbon development.

Many policies aimed at strengthening growth can also support the transition to low-emission pathways; by the same token, measures aimed at stimulating investment in low-emission infrastructure can be good for growth. Economic growth and the low-carbon transition both depend on the development and diffusion of new technologies and efficient reallocation of resources towards both low-carbon and high-productivity economic activity. Policies that stimulate technological diffusion and facilitate resource reallocation thus work

for both objectives and can ensure a cost-effective low-carbon transition. Such measures can be disruptive, but effects can be offset by spreading the benefits of growth widely, and through policies that improve access to new economic opportunities (education, vocational training) and provide an adequate social safety net to workers.

A decisive transition to spur growth while limiting climate change

New OECD modelling work presented in this report builds on IEA (2017) to show how combining economic reforms with ambitious climate policies in an integrated, synergistic manner can spur economic growth while also mobilising the investment needed to achieve longer-term climate objectives. Results suggest that such a collective "decisive transition" can boost long-run output by 2.8% on average across the G20, when comparing a current policies trajectory to a pathway set to hold warming below 2°C with a probability of 50% (Figure 1.1, right-hand panel). Importantly, the net effect on growth is also positive in the short term (left-hand panel).

The modelled growth effect is driven by a combination of investment in low-emission, climate-resilient infrastructure; an additional fiscal initiative to fund climate-consistent non-energy infrastructure; pro-growth reform policies to improve resource allocation; technology deployment; and green innovation. The benefits of combined growth and climate policies more than offset the impact of higher energy prices, tighter regulatory settings, and high-carbon assets that may become economically stranded before the end of their economic life. Carbon-tax revenues are assumed to be used to lower public debt in most countries. The overall macroeconomic benefits of the modelled policy package therefore also include substantial reductions in most countries' public debt-to-GDP ratios.

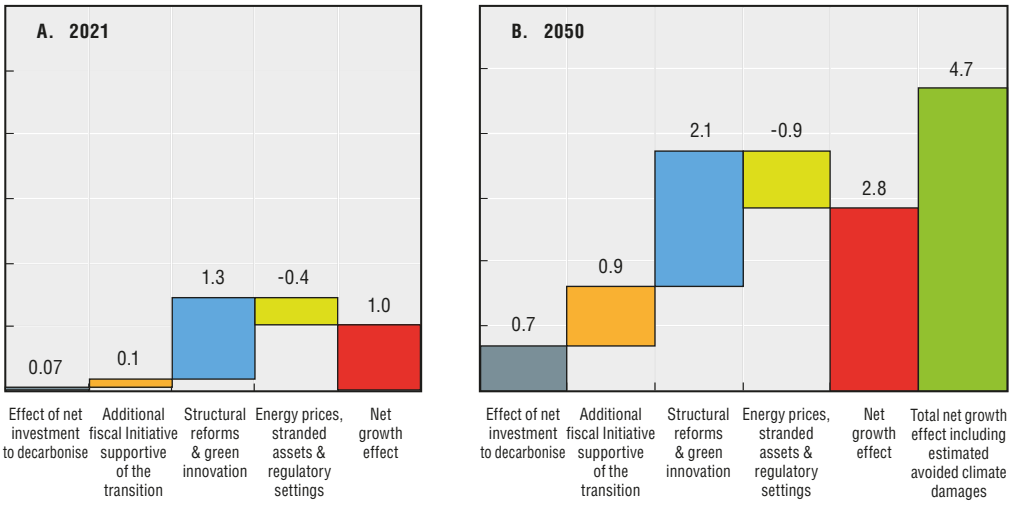
Avoided climate damages bring additional economic gains

If estimates for the positive impacts of avoiding damage from climate change are also accounted for, the net effect for 2050 rises to 4.7% higher than it would be if governments take no further action. While some economic damages are already captured in the modelling baseline, damages from climate change could pose a much greater threat to economic growth and well-being through mechanisms difficult to capture in economic modelling. The impact of these severe non-linear and unpredictable economic damages, such as flooding of coastal regions and increased frequency and strength of extreme weather events, could be very significant. Complementing model results with fuller damage estimates is important to give a more realistic picture of the long-term benefits of climate-friendly growth now. In addition, in the absence of action to reduce emissions, significant further damage can be expected between 2050 and 2100, outside of the timeframe of this exercise. Upper estimates of GDP costs without climate action range between 10 and 12% annually on a global scale by 2100.

The implications of a decisive transition will vary depending on a country's economic structure, but even fossil fuel exporters can offset losses and boost economic growth if policies are well chosen. This is a significant finding as climate action is usually expected to impose costs on fossil fuel exporters, including lower output and less employment in fossil fuel export activities. However, in a decisive transition these costs can be mitigated if carbon-tax revenues are judiciously recycled, in parallel with well-managed pro-growth reforms and proactive fiscal policies. The resulting positive effect on growth can more than outweigh the impact of stranded assets and higher energy prices. Results suggest the GDP boost would vary from 2% to 3% by 2050 in different G20 economies, not including avoided damages.

Figure 1.1. **Positive growth effects for the G20 by combining climate action with economic reforms in a decisive transition (50% probability of achieving 2°C)**

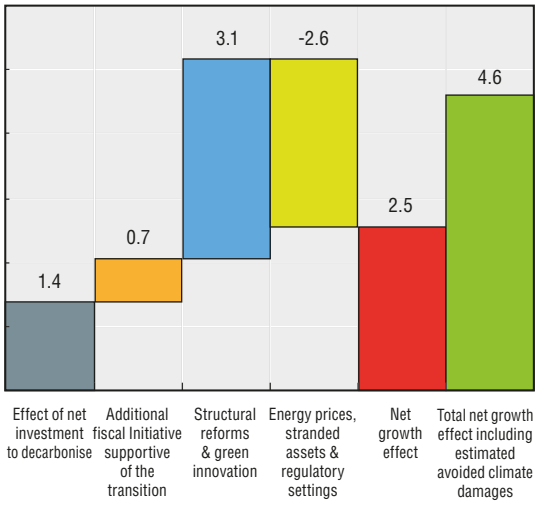
Average across G20, GDP difference to baseline, %



Note: See note under Figure 1.2.

Figure 1.2. **Positive growth effects in 2050 for the G20 by combining climate action with economic reforms in a more ambitious scenario (66% probability of achieving 2°C)**

Average across G20, GDP difference to baseline, %



Note: The average G20 is a weighted average of selected G20 economies, which represents 88% of the G20 countries (excluding the European Union). "Net investment to decarbonise" comprises the effects of specific investment needed to achieve a 2°C climate objective. "Fiscal initiative" includes additional investment in climate-friendly non-energy infrastructure and soft infrastructure (e.g. education and research). Total investment corresponds to an increase in public investment in all countries of 0.5% of GDP. Countries that experienced disinvestment as a result of mitigation policies are assumed to compensate for this disinvestment. The structural reform modelled here includes a package of measures to improve economic flexibility and resource allocation, calculated using the OECD Product Market Regulation index. Innovation captures the increase in R&D spending necessary to reach a 2°C scenario (50% scenario) and equivalent to 0.1% GDP (66% scenario). Stranded assets are consistent with IEA estimates. Regulatory setting captures the reduced costs of the transition in a more flexible regulatory environment. For damages, simulations presented here include only a subset of potential damages, excluding for instance damages from extreme climate events, due to difficulties in projecting their frequency, severity and location. The exercise models global damages associated with temperature increases, using the Nordhaus (2016) damage function.

Pursuing a more ambitious climate scenario

Limiting warming to 2°C is not enough to satisfy the objectives of the Paris Agreement. While it is difficult to precisely define what "well below 2°C" and "efforts to limit to 1.5°C" mean, a step towards a more ambitious scenario can be described in which more stringent action raises the probability of holding warming below 2°C from 50% to 66%. Such a scenario is set out in a parallel report to the German G20 Presidency which this analysis draws upon (IEA, 2017). New OECD simulations suggest that this more stringent mitigation scenario can also be a strong basis for economic growth, with a GDP increase of around 2.5% for the G20 on average in 2050, further increased to about 4.6% if avoided climate damages are accounted for. Ambitious pro-growth reforms coupled with innovation, and in some countries the recycling of carbon-tax revenues, can outweigh losses resulting from potential energy price increases and stranded assets (Figure 1.2). However, this result requires caution. The macroeconomic effects of this scenario are hard to model because the speed and depth of the necessary economic changes are profound and difficult to anticipate. These changes include the stranding of some fossil-fuel-intensive energy activities, massive investments in the global stock of buildings and radical changes to transport systems. The extent of important developments cannot yet be known, such as a more resource-efficient circular economy, new business models and technological breakthroughs that could change the economics of the transition.

Costs of delaying action

There are also significant costs involved in delaying action to reduce emissions. Countries may be tempted to delay decarbonisation for several reasons, including the long-term nature of the climate threat and political resistance based on perceived short-term risk of economic, distributional or competitiveness impacts of climate policies. Such a delay would simply increase the transition costs and require a more abrupt adjustment when action does finally start. If more stringent policies were introduced later they would affect a larger stock of high-carbon infrastructure built in the intervening years, leading to higher levels of stranded assets across the economy. In a delayed action scenario where action on climate change accelerates only after 2025, GDP losses are estimated to be 2% on average across the G20 after 10 years, relative to the decisive transition, and would be higher for net fossil fuel exporting countries. The losses could materialise as soon as the delayed transition starts and could be aggravated by financial market instability. The main uncertainty concerns how many assets might be stranded. Further research is warranted on how those assets should be measured.

Decisive action by leading countries

Even if action is not fully co-ordinated internationally, pro-active countries could still see benefits of combining climate and growth policies through a leadership alliance, demonstrating the benefits to other countries over time. The competitive advantage for such leadership economies is not likely to suffer in aggregate, due to the growth benefits of action described above and because their policies would drive demand for low-GHG products and spur innovation. They would also gain from short-term co-benefits of action, such as improved human health due to lower pollution. However, the pro-active countries may need to plan for significant structural changes in the economy, especially if some firms in carbon-intensive sectors relocate to countries with less stringent policies. This reinforces the case for accompanying structural reforms, as well as measures to ensure a proper transition of the work force. Cost-efficient decarbonisation policies, including carbon pricing with astute use of revenues, are even more important in this scenario. While

countries outside of the leading group could gain some short-term competitive advantage in carbon-intensive industries, they would likely face higher stranded assets later. And the burden these countries impose on other countries, including higher climate risks, will become increasingly clear and may have broader implications for a range of international geopolitical issues.

Regardless of the international picture, the appropriate combination of pro-growth policies and action on climate change will vary from country to country, depending on governance, economic and social structures. The following sections show how country characteristics will shape emissions pathways and infrastructure choices, before exploring how different combinations of structural reform and climate policies can trigger growth in various country contexts.

Pathways and priorities for a decisive transition

The long-term temperature goals of the Paris Agreement can be translated into a fixed quantity of long-lived GHGs to be released to the global atmosphere over time. This global "carbon budget" is best presented as a range, reflecting uncertainties on how the temperature target is interpreted, how the climate responds to GHG concentrations (climate sensitivity), and the role of non-CO_2 GHG emissions. The level of gross GHG emissions consistent with a given (net) carbon budget will also depend on assumptions about technologies for "negative emissions", which would allow for a temporary overshoot before emissions are removed from the atmosphere to maintain net emissions within the overall budget. The global carbon budget compatible with a 66% likelihood of remaining below 2°C is estimated to be 590-1 240 $GtCO_2$ from 2015 to the time of peak warming – roughly 15 to 30 years of fossil fuel-related CO_2 emissions at current rates.[1]

To remain within the carbon budget compatible with the Paris goals, the global emissions pathway created by a decisive transition requires three main features:

- an early peak in global emissions, as soon as possible;
- a subsequent rapid fall in GHG emissions;
- net GHG emissions near zero or net negative in the second half of the century.

The later the peak in global emissions, the greater the rate of emissions reduction required subsequently to stay within the carbon budget. Options for achieving ambitious mitigation goals may be lost if emissions peak too high or too late, and delayed action would lead to higher costs as described above. Further, failure to reach a global emissions peak before 2030 may make it impossible to limit global average surface temperature increase to well below 2°C, let alone 1.5°C. This is particularly important because although total global CO_2 emissions from energy have been flat for the past three years, the CO_2 intensity of primary energy across the G20 remains high. As growth picks up, global CO_2 emissions could therefore start to increase again unless governments take further action.

Low-emission pathways

The mitigation objective in the Paris Agreement is extremely stringent. A deep transformation of the energy sector is needed to decarbonise electricity supply, improve energy efficiency, deploy smart grids and storage to better manage electricity demand and supply, and electrify other energy end-uses such as transport and buildings. However, the energy sector is only part of the low-carbon transition story. Agriculture, forestry and other

land use contribute around a quarter of total GHG emissions, around half of which is from agriculture. The land sectors act as both sources of GHGs (including methane from cattle and rice, nitrous oxide from fertiliser use) and sinks of CO_2 (from forestry and carbon stocks in soils), so they have an important influence over the carbon budget remaining for energy-related emissions.

Most scenario modelling of global pathways that keep warming "well below 2°C" require not only reducing emissions of all GHGs but also "net negative" emissions later this century.[2] Land-use and forestry will have to go from being a net emitter to a net sink of GHG emissions, including through reforestation, avoided deforestation, and conservation and recovery of soils as carbon stocks. Agriculture also has the potential to become more GHG-efficient while meeting increased food demand from rising populations, though this is dependent on demographics and dietary preferences, as well as technological progress in crop yields. Energy-related CO_2 emissions can also be reduced by using bioenergy, either for advanced biofuels or in power plants fitted with carbon capture and storage (CCS). Potentially a means to create "negative emissions", the required technologies are still not yet proven at commercial scale across relevant applications. Concerns remain over competition for land and whether enough biomass can be produced sustainably, while meeting food demand, maintaining carbon stocks and protecting biodiversity.

Adaptation pathways are important planning tools

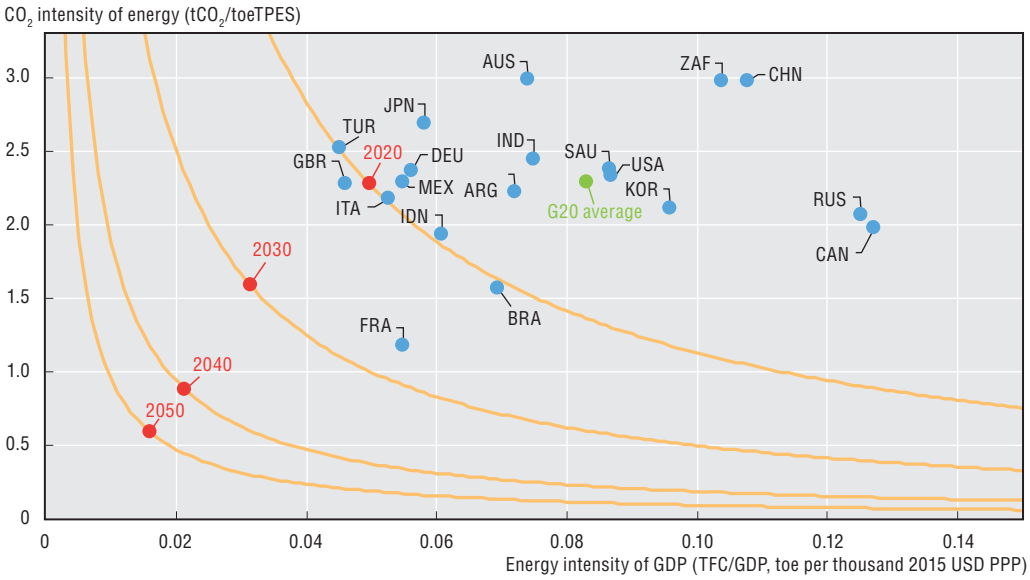
Adaptation is also at the heart of the Paris Agreement. Strong action to reduce emissions will lower the need for adaptation by reducing the intensity of climate-change impacts. Nevertheless, significant climate impacts are already locked in, so planning for and investing in adaptation and resilience is critical. Vulnerability to climate change varies greatly across sectors and within countries, shaped by geography, income, governance and development choices. Socio-economic trends and trans-boundary impacts are also relevant.

Decisions being made today will affect future vulnerability to climate change, intentionally or not. However, climate vulnerabilities are diverse and projections of local and regional change are uncertain, so it is neither possible nor desirable to address the need for adaptation comprehensively at one point in time. "Adaptation pathways" can be developed to shape near-term planning and policy decisions that reduce short-term and long-term risks. These pathways provide a means to identify path dependencies and critical decision points, creating a flexible, forward-looking approach to decision-making. National adaptation plans can strengthen the capacity of national and local decision makers to account for climate change and direct investments in resilience. Relevant tools for adaptation strategies include national risk assessment, indicator sets and in-depth evaluations of large infrastructure projects.

Pathways for different countries

Both low-emission and adaptation pathways are specific to individual countries. This is highlighted by the diversity of current CO_2 intensity of energy and energy intensity of GDP, both key determinants of CO_2 emissions. The lines in Figure 1.3 show different combinations of these two determinants resulting in the level of CO_2 emissions per unit of GDP required to be on course for the IEA 66% 2°C scenario, which this report builds on, in 2030, 2040 and 2050. The 2014 positions of G20 countries are also plotted, highlighting the different starting points and challenges facing different countries as they choose the most appropriate pathways towards the Paris objectives.

Figure 1.3. **The carbon and energy intensity of G20 economies in 2014 and the path to 2050**



Notes: The average levels for G20 countries (excluding the European Union) refer to 2014 statistical data and the IEA 66% 2°C scenario projections for 2020, 2030, 2040 and 2050. The iso lines show other feasible combinations of CO_2 intensity and energy intensity levels. Calculations assume a constant ratio for total primary energy supply (TPES) to total final consumption (TFC). Toe = tonnes of oil equivalent.

Source: Calculations based on the IEA World Indicators and IEA 66% 2°C scenario projections.

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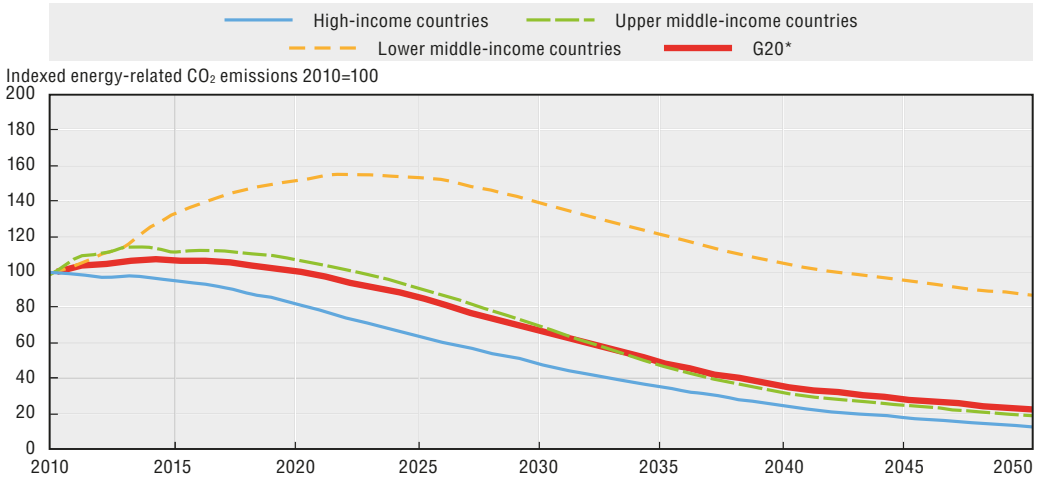
Pathways will vary according to different country circumstances. Figure 1.4 presents a new characterisation of CO_2 emissions pathways out to 2050 under the IEA 66% 2°C scenario, showing the G20 average and also groups of advanced and emerging economies. Measured against a starting point of 2010 emissions, global CO_2 emissions fall by about 80% by 2050. Advanced economies begin rapid emissions reductions from the outset and are projected to converge at very low levels by 2050. However, pathways for emerging economies are very different. Upper middle-income countries, taken together, show a gradual decline starting from the current period, also accelerating to reach low levels by 2050. Lower middle-income countries, given their stages of economic and demographic development, show continued increases in emissions to about 2025, followed by a gradual decline back to around 2010 levels.

As well as the diversity of potential country pathways, these scenarios illustrate the importance of policies (including climate support) that can combine growth with emissions reductions, to bring forward the required peak in emissions while not harming prosperity, in particular for emerging (middle-income) market economies. Understanding the appropriateness of different policies requires understanding how low-emission pathways apply to different countries, for both energy and non-energy sectors, taking into account the relative importance of energy, industry, land-use and other sources of GHG emissions. Groups of countries that share common characteristics could gain a significant advantage from joint analysis of policy developments as they develop their plans for combined growth and climate action.

Figure 1.4. **Emissions pathways by income group**



Note: Due to data limitations, G20 countries not included are Argentina, Saudi Arabia, South Africa and Turkey.
Source: IEA (2017) and OECD calculations.
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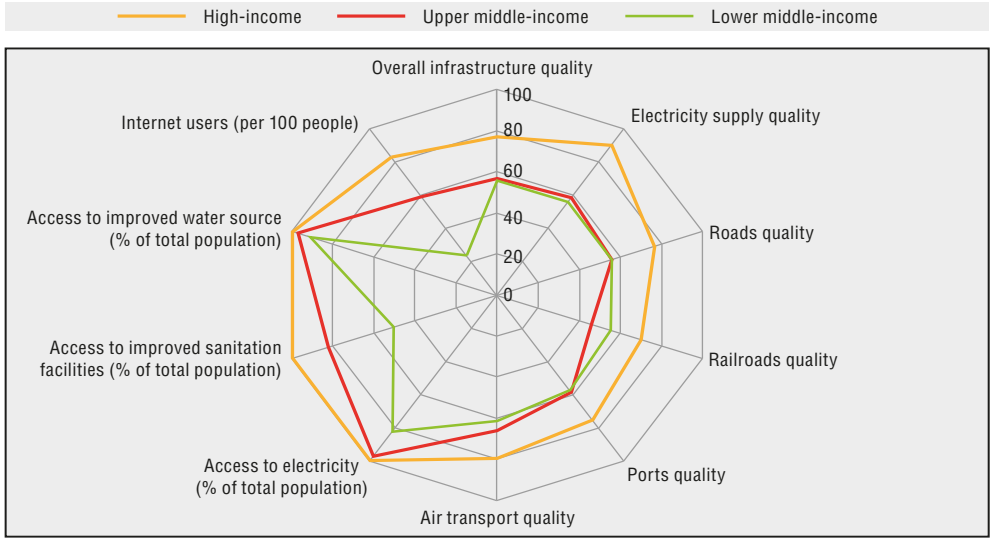
Scaled-up investment in clean, resilient infrastructure

Infrastructure investment is vital to underpin economic growth as part of a decisive transition towards low-emission, climate-resilient pathways, but current levels and types of investment are inadequate. The quality of infrastructure is declining in many advanced economies, public capital stock is shrinking in some countries, and more infrastructure investment is needed in developing countries to achieve universal access to energy and basic public services. The quality of different infrastructure types, and resulting access to basic services, varies greatly across different country income groups, with implications for the quality of growth and development (Figure 1.5). For example, having nearly universal access to electricity (bottom left) does not mean that the electricity supply is of good quality (top right).

Figure 1.5. **Quality of infrastructure status and access to basic services in G20 countries, by income groups**



Sources: Authors, based on WEF (2015) and World Bank (n.d.) (accessed February 2017).
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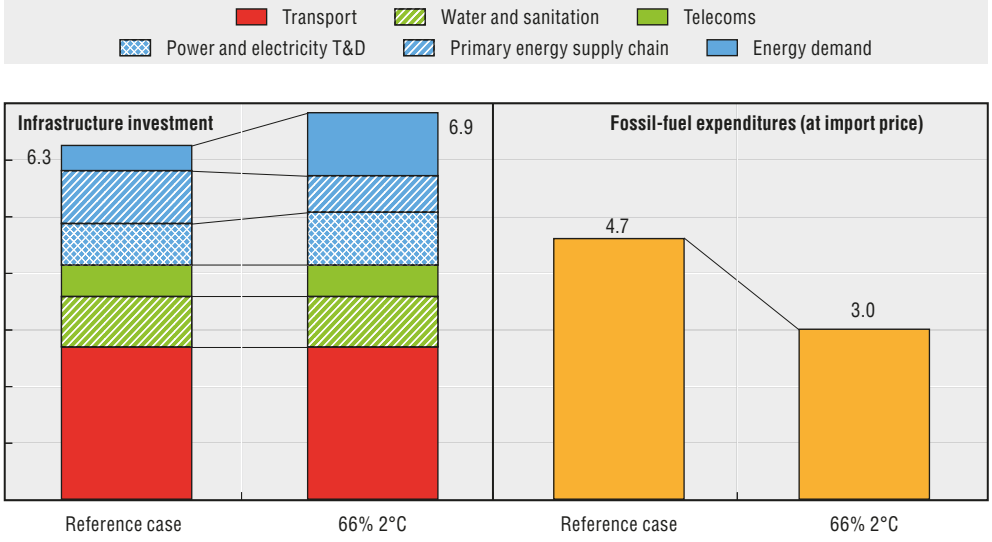
Unprecedented levels of infrastructure investment will be required to sustain growth and meet the basic needs generated by rapid population growth and urbanisation in developing countries, even before considering climate and pollution challenges. The OECD estimates that around USD 95 trillion of investments are needed from 2016 to 2030 in infrastructure (energy, transport, water and telecoms), equalling around USD 6.3 trillion per year without taking into account climate concerns. Transport represents 43% and energy 34% of those investment needs, 60% to 70% of which will be required by emerging economies.

The new estimates also suggest that for infrastructure to be consistent with the 2°C 66% scenario, investment needs reach USD 6.9 trillion per year in the next 15 years, an increase of about 10% in total infrastructure investment from the reference estimate above (Figure 1.6, left-hand panel). This covers transport, water and sanitation as well as energy supply and use. The additional capital cost is low overall and could be offset over time by fuel savings reaching USD 1.7 trillion per year up to 2030 (Figure 1.6, right-hand panel) – further reinforcing the case for robust low-emission economic growth.

Focusing on energy infrastructure, low-emission pathways require a deep transformation in the way energy is used and produced, requiring 29% more investment in the energy sector (Figure 1.6, top three segments). In the IEA 2°C 66% scenario, 95% of the electricity would need to be low-carbon by 2050, 70% of new cars would be electric, the entire existing building stock would have been retrofitted, and the CO_2 intensity of the industrial sector would be 80% lower than today (IEA, 2017). Achieving this would entail a major shift of energy supply investment towards low-carbon alternatives, and a significant increase in demand-side investments to make the economy more energy-efficient in the next few years.

Figure 1.6. **Annual infrastructure investment needs and fuel savings in a low-carbon future**

Global estimates (annual average for 2016-30, USD 2015 trillion)



Notes: Reference case assumes no further action by governments to mitigate climate change.

Sources: IEA (2017) for energy supply and demand; IEA (2016a) for road and rail infrastructure; OECD (2012) for airports and ports; McKinsey (Woetzel et al., 2016) for telecoms. The water and sanitation estimate is an average of estimates from: Booz Allen Hamilton (2007), McKinsey (Woetzel et al., 2016) and OECD (2006).

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While it is clear that a boost in investment is needed in the short term to engage on a low-emission pathway, the exact amount remains uncertain. Other modelling exercises (IEA 2016) show that in the long term (to 2050), overall investment needs could actually be lower in a low-carbon scenario than in a business-as-usual scenario. This would include savings from modal shifts to low-carbon transport, particularly at the urban level, where fewer vehicles and less parking space would be needed. In the long term, a world less reliant on fossil fuels is also likely to require less port capacity, fewer oil and gas tankers, and fewer hinterland railways to transport coal. On the other hand, digitalisation and smarter energy systems may require additional investment needs in telecommunication systems. G20 countries need to better understand the actual infrastructure investment needs associated with their low-emission development strategies.

Most existing energy and transport infrastructure was designed and built for a world in which fossil fuels were cheap and abundant. Given the long lifespan of infrastructure, failure to invest in the right type of infrastructure in the next 10 to 15 years would either lock the world into a GHG-intensive development pathway or risk stranding many assets. It would also imply serious and probably irreversible risks, not only of environmental damage, but also of financial instability that harms economic growth prospects. As explained above, the later a decisive transition begins in earnest, the more difficult and disruptive it promises to be for the energy sector and other GHG-intensive activities. Taking a low-carbon path offers an opportunity to accelerate investment in infrastructure, create a short-term boost to economic growth and development, and provide relief from persistent problems like congestion, air pollution and access to energy.

Improving the transparency of infrastructure project pipelines

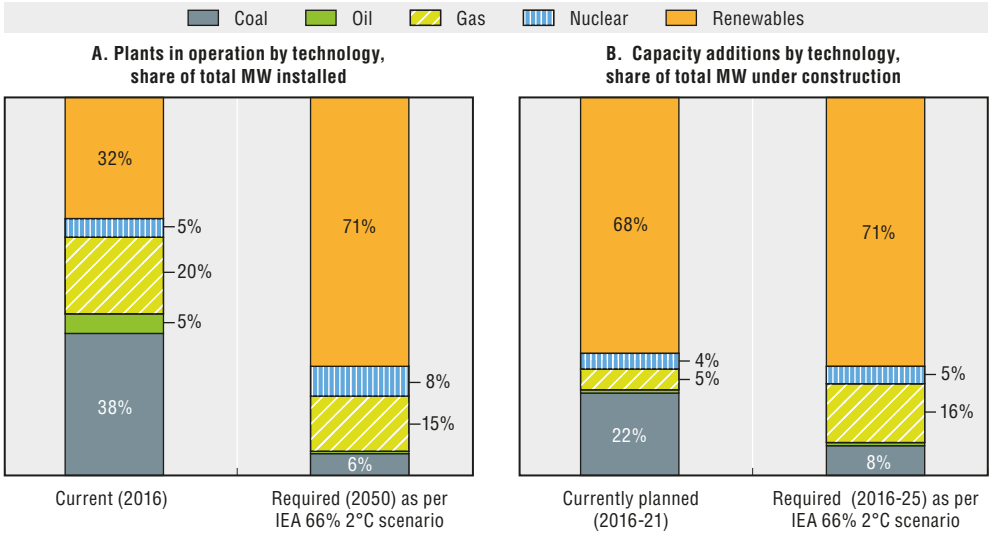
While long-term planning is a vital first step for the low-carbon transition, G20 countries must also be able to transform such plans into bankable, low-emission infrastructure projects. Most countries still lack clear and transparent information on their infrastructure investment pipelines, even though G20 leaders recognised in 2014 the importance of such pipelines for tackling the global investment and infrastructure shortfall. Improving the visibility of infrastructure plans and needs is a key priority and critical to gain the confidence of private sector investors. Where current investment plans are known, they are often limited to the energy sector and generally not consistent with the commitment in the Paris Agreement to mitigate GHG emissions and support adaptation. In addition, G20 countries have a significant influence on infrastructure developments in other countries through export credits and official finance, where better alignment with the Paris Agreement should be sought.

New analysis of the current existing capacity and current pipeline of power plants in G20 countries[3] indicates that a shift towards investment in renewable energy has started and is likely to continue in the next 15 years, as two-thirds of the global capacity under construction is based on renewable energy technologies – close to what is required by the IEA 2°C 66% scenario (Figure 1.7, right-hand panel). Despite this encouraging trend, more than 20% of the projects under construction are still based on coal. This number could increase as 416 GW of coal plants are in pre-construction development, and 543 GW are on hold. Continuing this trend will put the temperature targets set out in the Paris Agreement out of reach.

Innovation will play an important role in achieving low-emission growth. While much progress can and needs to be made immediately using currently available technologies, a full low-carbon transformation will require widespread innovation and deployment of new infrastructure, technologies and business models. Beyond the need for new combinations of technologies to achieve net-negative emissions while meeting food demand sustainably,

heavy industry will require technology breakthroughs to mitigate process emissions and to reduce reliance on fossil fuels. Energy sector innovation is also important, including rapid advances in energy storage to accommodate larger shares of variable renewable sources. As mentioned above, structural reforms can play an important role in facilitating this green innovation and ensuring that it is good for growth.

Figure 1.7. **Current capacity and current pipeline of power plants relative to those required in a 66% 2°C scenario**



Source: Authors' analysis from i) Platts WEPP (2017) for oil and gas under construction in G20 countries; ii) the Global Coal Plant Tracker (2017) for coal under construction in G20 countries; iii) IAEA (2016) for nuclear under construction in G20 countries; iv) IEA (2016b) for renewable energy under construction in G20 countries; and v) IEA (2017) for capacity additions in the IEA 2°C 66% scenario, globally.

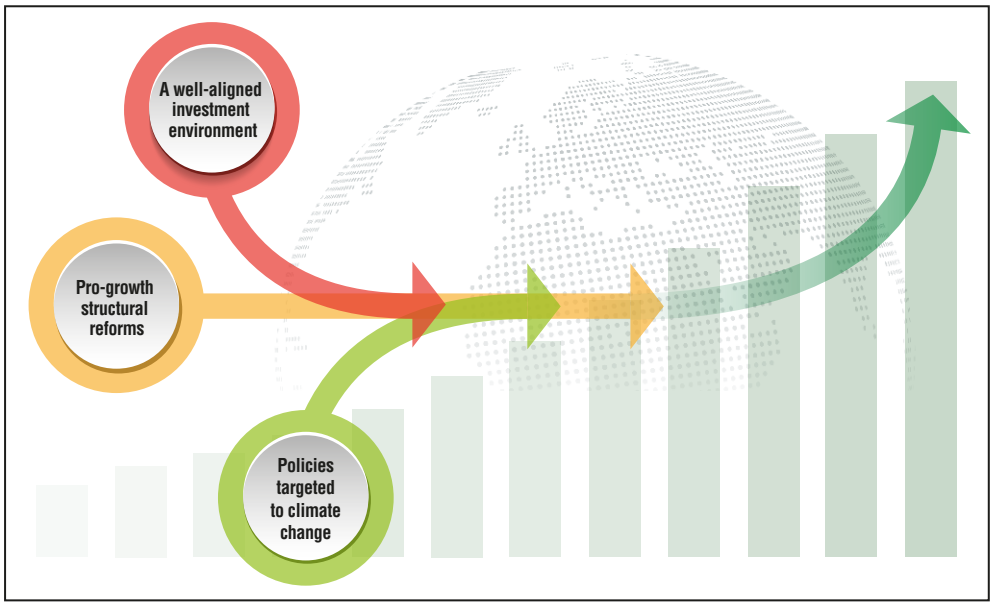
StatLink http://dx.doi.org/10.1787/888933484002

Combining pro-growth reforms with climate policy and well-aligned investment conditions

To mobilise the investment required for a decisive transition, governments need to support pro-growth structural reform policies with coherent climate policies and a well-aligned investment policy environment (Figure 1.8). The most effective policy combinations to mobilise investment in low-emission infrastructure vary from country to country, including the respective contributions of public and private investment.

Structural reforms that promote higher and more inclusive growth – such as measures to enhance product-market competition, facilitate access to jobs and improve skills – can be supportive of the low-carbon transition and are a key part of a decisive transition for climate and growth. The swift infrastructural, technological and industrial shifts implied by low-emission pathways to 2050 demand more rapid resource reallocation and faster technology diffusion. They can be further accompanied by improving dynamism in labour markets, provided that workers in the most affected carbon-intensive industries are supported through the transition. Pro-growth reforms that help meet these demands also generate more productive economic activity and enable new entrants to capitalise on emerging opportunities. Easier reallocation also boosts investment in R&D and other forms of knowledge-based capital, which boost adoption of new low-carbon technologies and long-term productivity growth. This requires reforms in product markets, financial markets, labour markets and housing markets. In short, policies that attempt to preserve the status quo – or at most favour an incremental transition – risk falling short from both a climate and an economic point of view.

Figure 1.8. **The three components of a well-aligned policy framework for climate and growth**



Strong and coherent climate policy as the basis for the transition

Carbon pricing can be a powerful, cost-effective tool for steering producers and households towards low-carbon and growth-oriented behaviour and investments. However, carbon prices have so far been low, especially when measured by "effective carbon rates" that incorporate the carbon price equivalent of energy taxes as well as explicit carbon prices. Currently, most CO_2 emissions within the G20 are not priced at all, and 91% are priced at less than EUR 30 per tonne of CO_2 (a conservative estimate of the lowest social costs that would result from a tonne of CO_2 emissions).

Where carbon prices exist, their impact on infrastructure investments has tended to be limited and indirect, partly because price signals have been weakened by transitional support measures or exemptions given to firms or households. Poorly targeted use of the public revenues from carbon pricing can also hinder their effectiveness and reduce the political acceptability of carbon pricing. On the other hand, intelligent use of carbon pricing revenues is an opportunity to improve fiscal space and make climate policy more inclusive and progressive, for example by reducing other taxes and lightening the burden on the poorest households.

Fossil-fuel subsidies are still widely prevalent and act as negative carbon price signals, leading to increased emissions of CO_2 and local pollutants. In 2014, G20 countries collectively provided subsidies amounting to USD 354 billion for fossil-fuel consumption, and USD 18 billion for fossil-fuel production. These subsidies translate into large fiscal costs for governments. For example, the fiscal burden of fossil-fuel subsidies reached as high as 1.4% of GDP in Mexico and 4.1% of GDP in Indonesia before both countries started reforming such subsidies; those subsidies were also regressive, benefiting mostly those on upper and middle incomes. In general, governments can make fossil fuel subsidy reform more acceptable if they precede such reform by improving energy services and introducing measures aimed at supporting the poor.

Even where carbon pricing is at the heart of countries' climate policy, local conditions and political compromises often make the design of schemes less than perfect and more susceptible to factors like information asymmetries, non-price barriers such as behavioural

change, and public opposition to new taxes or tax increases. This means that carbon pricing may need to be complemented by other targeted measures such as specific investment incentives; regulations and standards; information policies; and measures aimed at low-carbon innovation. The interactions between policies need to be carefully evaluated, however.

Tuning broader investment conditions for low-emission, resilient investment

For climate policies to be more effective – and more supportive of low-emission economic growth in a decisive transition – the broader policy environment in which they operate needs to be well aligned with climate objectives. Existing policy frameworks, developed over decades to support fossil fuel-based economic growth, can inadvertently weaken the low-emission investment signal provided by carbon pricing. Potential misalignments can be identified in many policy areas, including investment, competition, trade and tax. A first priority is to ensure that pro-growth reforms are well aligned with low-carbon growth, such as ensuring a competitive level playing field for electricity generation. In addition, specific policies and regulations that weaken the business case for investment and innovation in low-emission and climate-resilient infrastructure need to be identified and fixed. For instance, poorly designed support schemes and outdated maps of domestic natural resources may hinder the attractiveness of investment in renewables. Inconsistent land-use and transport planning can lead to a locking in of carbon-intensive infrastructure and behaviour, particularly in urban areas.

Some land-use policies can also be misaligned with climate objectives. Resolving these conflicts is vital to maximise the contribution of the land-use sector to low-emission pathways while balancing land-use priorities. For example, agricultural input subsidies, price support, tariffs and subsidies on agricultural products, and in some cases subsidised crop insurance premiums, often foster more emissions-intensive practices and impede investments in adaptive technologies (though in some countries specific policy designs are aligned with sustainability objectives). Land degradation is another example, resulting from uncontrolled open access to common land. Reforming land tenure arrangements – to increase private ownership or long-term leases – or strengthening the sustainability of traditional institutions and land use rights, can foster private investment in restoring degraded landscapes or preventing land degradation, which in turn help sequester more CO_2.

Public infrastructure choices and procurement

Public procurement at central and local government levels plays a key role in the economy as a whole (averaging 13% of GDP in advanced countries, and sometimes more in emerging economies). It is particularly important for pro-growth infrastructure investment, including low-emission and resilient infrastructure. Public procurement can also create lead markets for innovative, low-GHG industrial materials and infrastructure choices. This can be done by pricing life-cycle CO_2 emissions in procurement criteria, thereby encouraging a competition to lower emissions. To unlock this potential and align procurement with Paris Agreement objectives, public procurement organisations need to be strengthened.

Efforts to improve climate resilience, in particular infrastructure resilience, need to take country and locally specific contexts into account. In general, the owners and operators of infrastructure are best placed to decide on the appropriate measures to implement. The public sector has a key role to play, however, to ensure that the current direction of infrastructure investment is aligned with the goal of increasing resilience to economic and climate-related shocks, and also catalysing private sector investment in adaptation by creating an enabling environment. A well-designed regulatory framework, information on climate risk and pricing externalities, and better aligned policies could help drive adequate investment in resilience by owners, operators and financiers.

A transition that is inclusive, progressive and good for business

Even though action on climate change can be positive for overall economic growth and welfare, most countries face political challenges in implementing ambitious policy reform. Vested interests and incumbent actors in today's high GHG-emissions societies can prevent governments from acting decisively and consistently. In a decisive transition, certain assets, especially in the fossil fuel and power sectors, will lose value and be economically stranded, with potential implications for employment opportunities. Even if the impact on overall employment is likely to be modest, jobs will shift as GHG-intensive activities change business profiles and technologies.

Most countries' economies are "entangled" with fossil fuels and other GHG-intensive sectors, reflecting the significant contribution of these activities to past economic development. Even in countries that are not fossil fuel producers, tax revenues, financial markets, pension funds and jobs depend to varying degrees on GHG-emitting activities, which can place governments in a position of significant conflict should they try to implement strong climate policies. This entanglement can render climate action ambivalent at best unless governments adopt an inter-ministry, cross-cutting approach to climate action.

Governments have previously had to learn about the modernisation and restructuring of some heavy industries, experience which may prove instructive in managing the transition to a less GHG-intensive economy, including engaging with affected firms and communities. Relevant measures used in the shipbuilding and iron and steel sectors include the creation of funds and targeted subsidies (e.g. restructuring investment aid, closure aid), special legislation and fiscal measures. Clearer decarbonisation and adaptation pathways will help governments anticipate, plan for and communicate the structural consequences of the transition away from GHG-intensive activities. This should minimise the destruction of asset values. Disruption linked to business cycles and other factors, such as the global excess capacity of iron and steel, can allow governments to prepare industry for the shift.

Creating opportunities for workers most affected by the low-carbon transition will be essential. The aggregate effect of the transition on jobs may be modest, but reallocation across sectors and activities will be necessary and in some sectors significant. Trade unions are aware of the challenges posed by the transition and advocate a role for workers in a "just transition" – a transition that includes proactive measures to plan and invest in environmentally and socially sustainable jobs, sectors and economies. Good planning to anticipate and facilitate retraining and mobility, and an active social dialogue between government, employers and workers, are vital for climate-friendly development.

The low-carbon transition will also directly affect households. Energy supply costs may increase, at least in the short term, so households could face transitional costs for new efficient equipment and infrastructure. Households could also face higher energy unit costs, for example where carbon pricing is the instrument of choice. These changes may be regressive, affecting the poorest households the most, but targeted recycling of carbon tax revenues can offset this effect. In many countries, the need to improve energy access and affordability will have a strong bearing on policy choices to facilitate the adoption of low-carbon energy practices. The reforms of fossil-fuel subsidies, initiated in some G20 countries and beyond, have shown how governments can compensate for rising energy prices and avoid regressive impacts.

The transition is unlikely to succeed, however, unless the low-carbon economy includes and provides opportunities to all actors. The transition will affect everyone, from central and local governments to the private sector, the labour force and citizens, whose divergent interests and influence will come into play. An improved understanding of aligned and divergent interests can help governments to make policy that addresses multiple needs and musters coalitions in favour of action – in business, institutions, civil society and different government portfolios. This would ensure that other pressing policy priorities, such as

poverty alleviation and inclusiveness, are not compromised, making the transition more sustainable. This broad-based engagement should be an essential element in the domestic processes guiding the elaboration of low-greenhouse gas development strategies.

Overall, to improve the chances of achieving the Paris Agreement goals, it is vital to incorporate political economy considerations early in the process of elaborating domestic strategies to implement Nationally Determined Contributions. In addition, pursuing "whole-of-government" approaches to low-emission, climate-resilient growth can help governments to avoid entanglement in high-carbon sectors and activities.

Mobilising capital for a decisive transition

Coherent climate policy and a well-aligned investment framework are essential to steer the investment flows needed to pursue low-emission, resilient pathways, but in themselves are not enough. Mobilising the necessary capital also requires diverse financial instruments tuned for infrastructure financing, efficient allocation of risks and use of risk mitigation techniques, public financial institutions geared towards low-carbon investment, and a financial system that correctly values climate risk.

Private financing of infrastructure, including low-emission energy infrastructure, has undergone a major shift in the last decade. Renewable energy projects have been able to access more diversified pools of financing through project finance structures, attracting equity investors such as pension funds and sometimes project bonds. At the same time, banks are facing challenges such as non-performing loans and stricter regulation, so there is a need to open complementary sources of finance such as institutional investment and capital markets. The low-carbon transition will require substantially stronger efforts to overcome the remaining barriers to mobilising the private investment capital required for low-emission, resilient infrastructure.

New models and partnerships are scaling up financing for low-emission infrastructure, by drawing on the changing role of traditional financial actors and their respective strengths. Increased co-operation, for instance between banks and utilities, or between development finance institutions and institutional investors, has significant potential to facilitate finance for key elements of low-emission pathways, including renewables and energy efficiency in buildings and industry.

Real and perceived risks related to infrastructure financing, for example due to weak governance and regulation, currency fluctuations, and lack of domestic capital markets, continue to hamper private investment, particularly in emerging economies. There is also a need to improve the understanding of the specific risks and returns associated with investment in low-emission infrastructure. These risks often relate to infrastructure as an asset class, characterised traditionally by its long-term nature and high upfront costs, together with political, regulatory, macroeconomic and business risks and, more recently, climate change risks.

Despite the crucial role of technology and innovation, as highlighted in the pathways analysis above, new venture capital finance in clean technologies has been declining. Current investment models are not always aligned with the capital intensity and long development timelines required by clean technologies. Governments need to remove bottlenecks in clean technology finance, particularly in early stages and commercialisation, by enhancing public and private co-operation and improving business models for the financing of research and development in energy efficiency and low-emission infrastructure.

Various risk mitigation and "blended" finance approaches have been developed and need to be scaled up. Tools such as guarantees, credit enhancements, currency hedging and more diversified insurance offerings help to mitigate and better allocate risk across different actors, while instruments such as green bonds and securitised loans help to secure

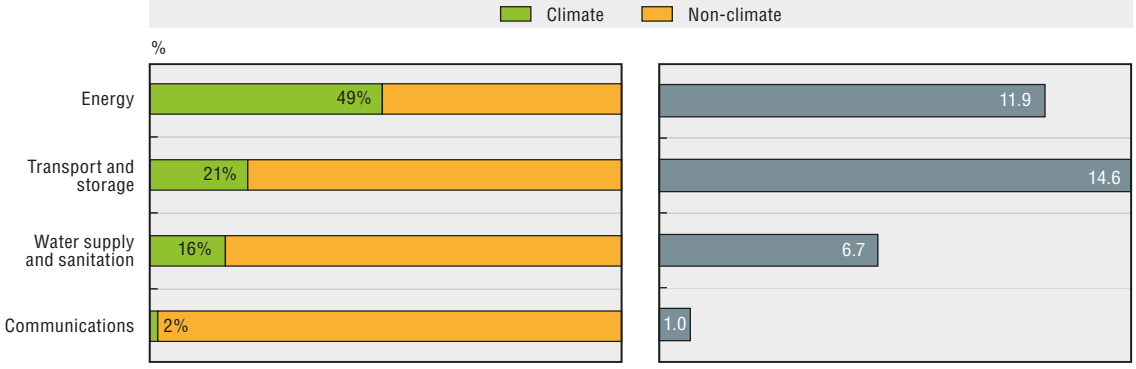
a reliable long-term funding basis for infrastructure projects. Blended finance models – with a focus on crowding in private finance – can de-risk and mobilise private investment in infrastructure, while optimising public investment.

Important role of development banks and finance

Development banks (national and multilateral) and development finance institutions (DFIs) have a critical role as a bridge between private and public actors, helping countries to embark on a sustainable low-carbon development path. National development banks (NDBs) are widespread in the G20, and several are initiating efforts to finance low-emission, climate-resilient infrastructure. Multilateral development banks (MDBs) and bilateral DFIs have made ambitious climate commitments and are scaling up efforts to mobilise private climate investment, while dedicating significant financing to infrastructure (Figure 1.9). MDBs are able to leverage significant capital through their shareholder governments and mobilise knowledge, expertise and innovation developed in other parts of the world. Despite this, MDBs could better align their financing for infrastructure with low-emission pathways, particularly in the transport and water sectors, by increasing the share of climate-related commitments in their portfolios, improving disclosure of portfolio-wide carbon impacts and renewing efforts to mobilise private investment. To meet their targets, MDBs and bilateral finance institutions require strong mandates. They also need to work with countries to raise awareness and build demand for low-emission, climate-resilient infrastructure, facilitated by access to concessional climate finance. Increased collaboration and joint action between MDBs, bilateral actors and NDBs will be needed to scale up financing, particularly in emerging and developing countries.

Governments also need to co-operate to guide the global financial system to more accurately value climate risk and move towards investment in low-emission and climate-resilient infrastructure. Fuller disclosure and reporting of climate impacts and risks is required to enable a broader shift in the financial system towards alignment with the Paris Agreement and the Sustainable Development Goals. Policies need to focus on the mainstreaming of climate-change risk management practices across the financial system, and the efficient pricing of assets based on disclosure of climate change risks. In spite of progress through the Financial Stability Board, public-sector finance institutions still lag behind, and individual country responses are uneven across the G20.

Figure 1.9. **Share of MDB commitments for infrastructure that are climate-related and total MDB commitments for infrastructure (USD billion) by sector, 2013-15 average**



Notes: This graph is based on data reported to the OECD Development Assistance Committee by the following MDBs: the African Development Bank, the Asian Development Bank, the European Bank for Reconstruction and Development, the European Investment Bank, the Inter-American Development Bank, the Islamic Development Bank and the World Bank Group (WBG), which also includes the International Finance Corporation. Climate-related components of projects are those that target mitigation, adaptation, or both mitigation and adaptation, based on the joint MDB Climate Finance Tracking Methodology. MDB commitments include concessional and non-concessional support.

Source: OECD DAC statistical system.

StatLink http://dx.doi.org/10.1787/888933484375

Main policy messages

The analysis above points to a wide array of policy priorities that G20 countries can adopt to launch a decisive transition, creating strong, inclusive economic growth while reorienting economies towards low-emission, climate-resilient pathways:

Integrate the climate imperative into structural reform and broader national development strategies, reflecting the role of our physical environment as a fundamental pillar for strong, sustainable, balanced growth.

- Implement **structural reform policies** that boost both productivity and economic activity, as well as supporting the transition to low-emission, climate-resilient economies, through easier resource reallocation; faster technology development and diffusion; greater dynamism in labour markets; and measures to facilitate firm entry and exit.
- Reassess and optimise **national fiscal policies** to increase investment in low-emission, climate-resilient infrastructure and soft investment such as climate-focused R&D, recognising the potential of fiscal measures to revive economic growth and strengthen climate-friendly investment signals.
- Continue to develop **relevant metrics and analytical tools** to incorporate the impacts of climate change and the costs of inaction into economic policy design and implementation, to move towards a more sustainable long-term growth model.
- Pursue a **whole-of-government approach** to low-emission, climate-resilient growth and address barriers and policy misalignments with climate objectives across the investment environment, particularly in infrastructure sectors, using the OECD publication *Aligning Policies for a Low-carbon Economy* as a starting point.
- Improve understanding and management of the interdependencies between **climate change and biodiversity conservation**, in relation to **food security, poverty alleviation and human health and well-being**, which are vital to achieving the Sustainable Development Goals.

Speed up collective and national efforts towards full implementation of the Paris Agreement.

- **Jointly commit to advancing the international stocktaking and oversight mechanisms of the Paris Agreement**, including those on monitoring, reporting and review, and the robust assessment of collective progress, to encourage deeper international co-operation and more ambitious action and support.
- Develop and share experience of **long-term, low-emission development strategies**, and ensure Nationally Determined Contributions and near-term actions are consistent with such strategies. These strategies should address climate and economic development objectives in an integrated way, shaping expectations about the scale and nature of investment needs and helping minimise stranded assets.

Recognise that for growth to be sustainable it must also be inclusive, and ensure that policies to drive the transition towards a low-emission, climate-resilient economy are socially progressive.

- Integrate the **social and economic implications of the transition** more effectively into policies and planning. Support sectoral restructuring by identifying exposed labour forces, communities and regions, by assessing local capabilities, and by developing response measures, including retraining and reskilling of the exposed workforce.

Adopt flexible, forward-looking approaches to decision-making to increase climate resilience and ensure that these approaches are robust given the uncertainty surrounding climate changes effects at local and regional levels.

- Establish a **pipeline of infrastructure projects** that are consistent with long-term, low-emission development strategies, reconciling short-term action and long-term decarbonisation goals, as a means to **shift investment** to climate-resilient infrastructure
- **Bridge data gaps on infrastructure projects** and improve information on investment pipelines, for example with the support of the G20 Global Infrastructure Hub and the OECD.
- Introduce specific policies and regulations, such as spatial planning and technical standards, that promote **climate resilience of infrastructure**, including screening and factoring climate risks in public investments, including procurement procedures.

Realise GHG mitigation potential across the economy.

- Accelerate the **reform of inefficient fossil-fuel subsidies** that encourage wasteful consumption, including agreeing on a date for phasing out such subsidies. As the basis for reform, expand internationally comparable information on subsidies to more countries and types of support, for example through peer review. Share experience on successful and progressive subsidy reforms.
- Broaden the carbon pricing base, track impact and emissions reductions progress, and share policy experience of **effective carbon pricing** to inform flexible forward-looking policy decisions. Explore joint action in this area, such as minimum carbon prices, gradual increases in prices over time, and linking of emissions trading systems.
- Tap the **large mitigation potential in agriculture, forestry and other land-use sectors**. Preserve and expand existing carbon stocks in forests and other ecosystems; avoid net deforestation and forest degradation; and improve soil management, in particular of organic soils. Stimulate mitigation in the agriculture sector by increasing investment in the development and deployment of new technologies and sustainable practices. **Promote efficient and effective use of nitrogen fertilisers and limit their over-use**.
- Make greater use of **public procurement** to invest in low-emission infrastructure and to trigger industrial and business model innovation through the creation of lead markets, for example by introducing climate-related criteria to procurement decisions.
- **Implement and strengthen research, development and demonstration efforts** for breakthroughs in technologies essential for eliminating GHG emissions from industry and from road, maritime and air transport, as well as breakthroughs in energy storage and "negative emissions" technologies, including through international collaborative efforts such as Mission Innovation.

Mobilise financing for the transition.

- **Expand efforts to mobilise private investment** in low-emission, climate-resilient infrastructure by scaling up the use of diversified risk mitigation tools, improved environmental risk analysis, and diversified financial instruments and models.
- Take steps towards a **more climate-consistent global financial system** by assessing and addressing possible misalignments within financial regulations and practices, improving the ability of markets to price climate change risks, and assessing the risks climate change poses to financial stability.
- Call on all development banks and finance institutions – multilateral, bilateral and national – to put in place targets and action plans to boost support for low-emission infrastructure and climate-proofing efforts; improve disclosure of climate risks; scale up efforts to mobilise private investment; and continue to support policy and planning frameworks for climate-resilient infrastructure, especially in vulnerable countries.

Notes

1. The carbon budget from 2015 to 2100 is smaller than this for the same likelihood of remaining below 2°C, requiring negative emissions after the peak. See Chapter 2.
2. The IEA (2017) assumptions, which this report builds on, are therefore conservative in this regard.
3. The electricity sector is the only sector where enough information is available to analyse the pipeline, as surveys and commercial databases track information on capacity in operation, cancelled, announced or at pre-construction stage, as well as under construction.

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