

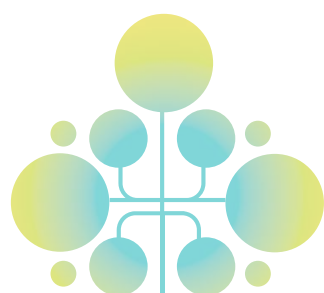


Financing Climate Futures

RETHINKING INFRASTRUCTURE

Synthesis and Key Messages for
High-level Discussion
New York, 25 September 2018





Financing Climate Futures

RETHINKING INFRASTRUCTURE

Project Background

The OECD, UN Environment and the World Bank Group have joined forces under a new initiative – *Financing Climate Futures: Rethinking Infrastructure*. The initiative explores what public and private actors should do to trigger the radical transformation needed to align financial flows in infrastructure for a low-emission, resilient development.

The initiative, supported by the German Federal Ministry of the Environment, Nature Conservation and Nuclear Safety (BMU), stems from the 2017 G20 Hamburg Climate and Energy Action Plan, which called on the three organisations to “compile ongoing public and private activities within the G20 for making financial flows consistent with the Paris goals and, building on this, to analyse potential opportunities for strengthening these efforts”.

This synthesis report identifies six transformative areas that have the potential to help the different financial actors move beyond an incremental approach to the low-carbon transition towards the transformational agenda needed for decisive action.

In addition to this synthesis, the *Financing Climate Futures* initiative consists of the following components:

- *Shifting the Lens*, a UN Environment analysis that explores the benefit of scenarios and foresight approaches in supporting the low-emission, resilient transition
- A series of case studies that dive deeper in specific aspects of these recommendations:
 - Specific jurisdictions: Financing climate objectives in cities and regions to deliver sustainable and inclusive growth (OECD); Financing Resilient Urban Infrastructure: Lessons from World Bank and Global Experience (World Bank Group); Greening the Belt and Road Initiative (UN Environment)
 - Technologies: Blockchain, infrastructure and the low-emission transition (OECD); Decarbonising energy intensive industries: options and strategies (Imperial College); How digital finance favours infrastructure investments, decarbonisation and energy access to all (UN Environment)
 - Development finance: Mobilising commercial capital for sustainable infrastructure: Insights from national development banks in Brazil and South Africa (OECD); Achieving Clean Energy Access in Sub-Saharan Africa (Jan-Corfee Morlot & Carbon Limits Nigeria)
- The final report, which will be launched at COP24 in Poland in December 2018

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"We need to urgently deliver on our climate and development goals, and to do so we need a systemic shift of trillions of dollars towards low-emission and resilient investment. OECD countries should lead by example. Continuing along our current path is simply not an option. We must embrace the challenge of tackling climate change and we must deliver on our climate commitments. This report identifies six transformative areas to help us align financial flows with a low-emission, resilient future."

Angel Gurría, Secretary-General of the OECD

"We cannot ignore the new reality of powerful weather events that threaten jobs, homes, food security and other critical areas of our lives. The infrastructure that is built today must be ready to cope with tomorrow's changing climate. We need the right incentives and regulations to urgently accelerate funding to these projects."

Kristalina Georgieva, Chief Executive Officer of the World Bank

"Building climate-compatible infrastructure is a cornerstone for the success of the Paris Agreement and broader sustainability goals, and we have seen encouraging momentum in this direction. But we need to start making real change happen. Only sustainable infrastructure can deliver huge benefits to people and the planet. To encourage the capital allocation that will unlock this promise, however, we need new thinking. This report presents some of the steps we can take to make this change."

Erik Solheim, Executive Director of UN Environment

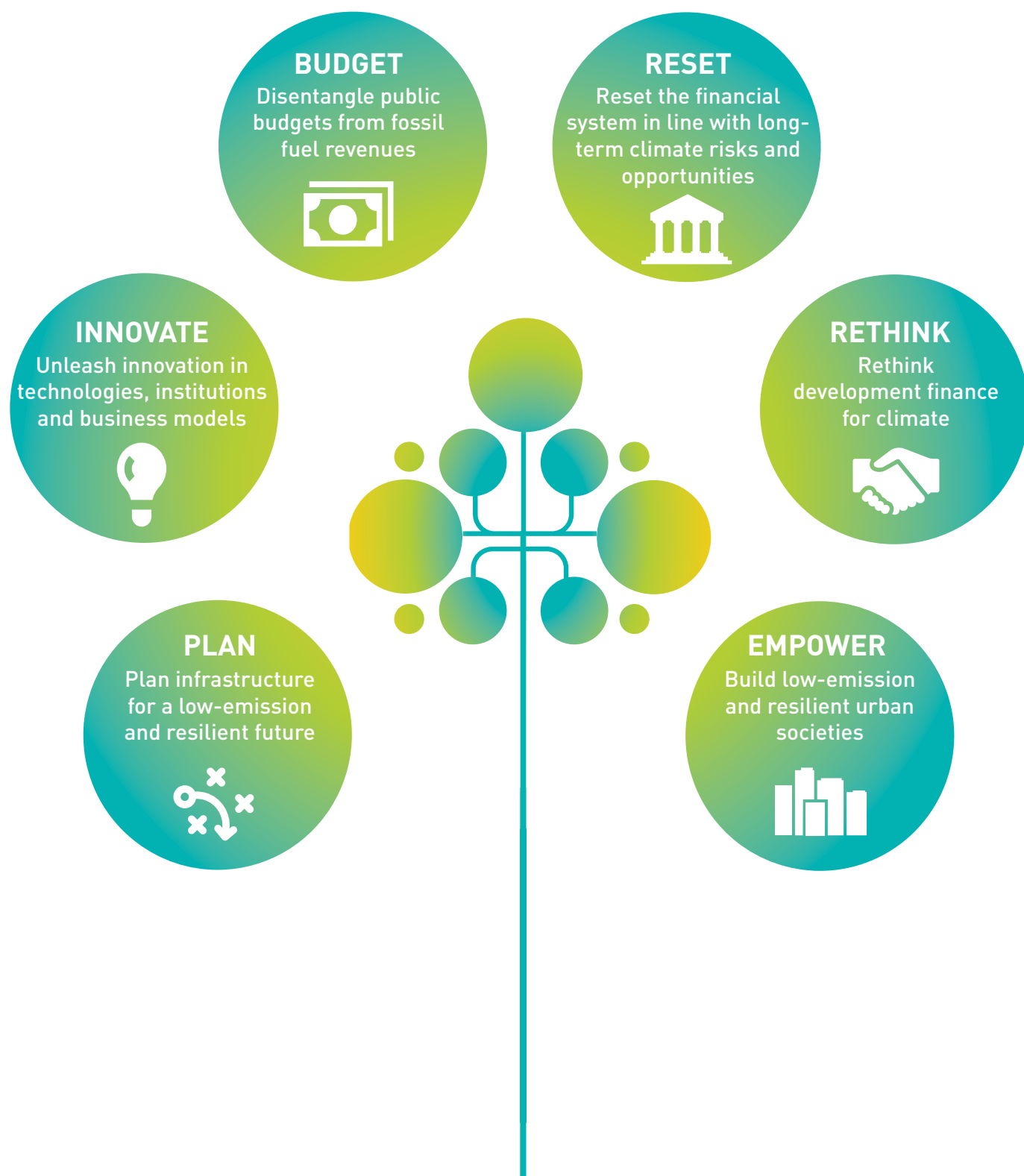


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Six transformative areas to align financial flows with low-emission, resilient infrastructure



Executive Summary

Aligning financial flows with low-emission, resilient infrastructure has become an urgent need to attain climate objectives and avoid further emissions lock-in. But infrastructure has suffered from chronic under-investment for decades. This investment gap and the urgency of the climate challenge present a unique opportunity to enable sustainable growth and increase resilience worldwide. Mobilising private resources across the financial spectrum will be necessary for sustainable investment in infrastructure, from public finance institutions to banks, institutional investors, corporations and capital markets. This mobilisation away from emission intensive projects will require getting the basic investment and climate policies right, such as putting a price on carbon and reforming fossil fuel subsidies.

Incentives that encourage rapid and radical transformation are also needed to drive systemic change, overcome institutional inertia, and break away from the vested interests that are often barriers to low-emission, resilient development. Harnessing rapid socio-economic and technological developments, such as digitalisation, will help to open new pathways to low-emission, resilient futures. This means embracing systemic conceptual and behavioural changes in how we manage and govern our societies and economies.

The international community has increasingly recognised the need for such transformative action, not only through international agreements such as the Paris Agreement but also through forums such as the G7 and G20 (for example the G20 Hamburg Action Plan on Climate and Energy for Growth). But going beyond an incremental approach to climate policy development and thinking “outside the climate box” remains a challenge.

This report lays out the agenda for a low-emission, resilient transformation that requires action across six key transformative areas, which should be articulated with respect to country contexts, and resource endowments and capacities: planning, budgeting, innovation, finance, development and cities.

Plan sustainable and resilient infrastructure for a low-emission and resilient future

There is a urgent need to rethink planning at all levels of governments to align current pipelines of infrastructure projects with long-term climate objectives and avoid carbon lock-in.

- Develop new institutional configurations to align infrastructure plans with a long-term low-emission, resilient development vision.
- Make resilience the norm in planning, and mainstream nature-based solutions and demand management tools in planning.
- Future-proof infrastructure investment decisions through approaches such as strategic foresight to monitor emerging socio-economic and technological changes and continuously adjust long-term strategies

Unleash innovation to accelerate the transition to low-emissions technologies, business models and services

Accelerating the deployment of existing technologies, business models and services, and swiftly moving the next generation of solutions from the lab to the market would open new opportunities for low-emission, resilient pathways.

- Deploy targeted innovation policies to create and shape markets for climate innovations.
- Scale-up public investment in Research and Development (R&D) of climate solutions, and promote collaborative approaches to pool resources, lower R&D costs and technology risks.
- Overcome the financial barriers to demonstration, deployment and early-stage commercialisation through co-funding mechanisms, loan guarantees and new coalitions of financial actors.
- Promote international technology diffusion and R&D at scale.

Ensure fiscal sustainability for a low-emission, resilient future

“Carbon entanglement” – the dependence of governments on revenues from the production of fossil fuels - is a major political economy and macroeconomic constraint to a low-emission, resilient future transformation. Carbon entanglement can be overcome if long-term climate policy planning also translates in budgetary policy.

- Diversify government revenues to reduce dependence on fossil fuels.
- Harness tax systems, including the use of carbon taxes and reform of fossil fuel subsidies, to incentivise investments and behaviours towards low-emission future.
- Anticipate and address the social consequences of the low-emission transition.
- Align incentives and mandates of state-owned enterprises and public finance institutions with climate objectives.

Reset the financial system in line with long-term climate risks and opportunities

An array of rules governing the financial system today are hindering the allocation of finance to low-emission, resilient infrastructure. For instance, incentive structures in the investment value chain system tend to encourage short-termism, and the lack of transparency on climate-related risks assessment and reporting leads to mispricing of climate-related risks and opportunities.

- Encourage investment practices with a climate impact, through the development of common taxonomies, definitions and metrics, and by removing perverse incentives that favour short termism.
- Incentivise the disclosure of climate-related financial risks and opportunities for investors and enhance scenario- based climate-risk management strategies.
- Support financial supervisory authorities to better assess and manage climate-related risks that could threaten the financial stability of the system in the short and long term.

Rethink development finance for climate

Development banks – multilateral, bilateral and national – have a critical role to play in infrastructure finance, particularly in developing countries. But for these banks to be transformational, they need to play a much greater role in unlocking private capital and supporting policy reform.

- Strengthen development banks’ mandates and incentives to deliver transformative climate action, including through capacity building at all levels of management.
- Enable and create “climate markets” to bring new investors and sources of finance.
- Use concessional finance strategically to focus on projects and programs with the greatest climate impact, and help bridge viability gaps for investment in sustainable technologies and in less mature markets.

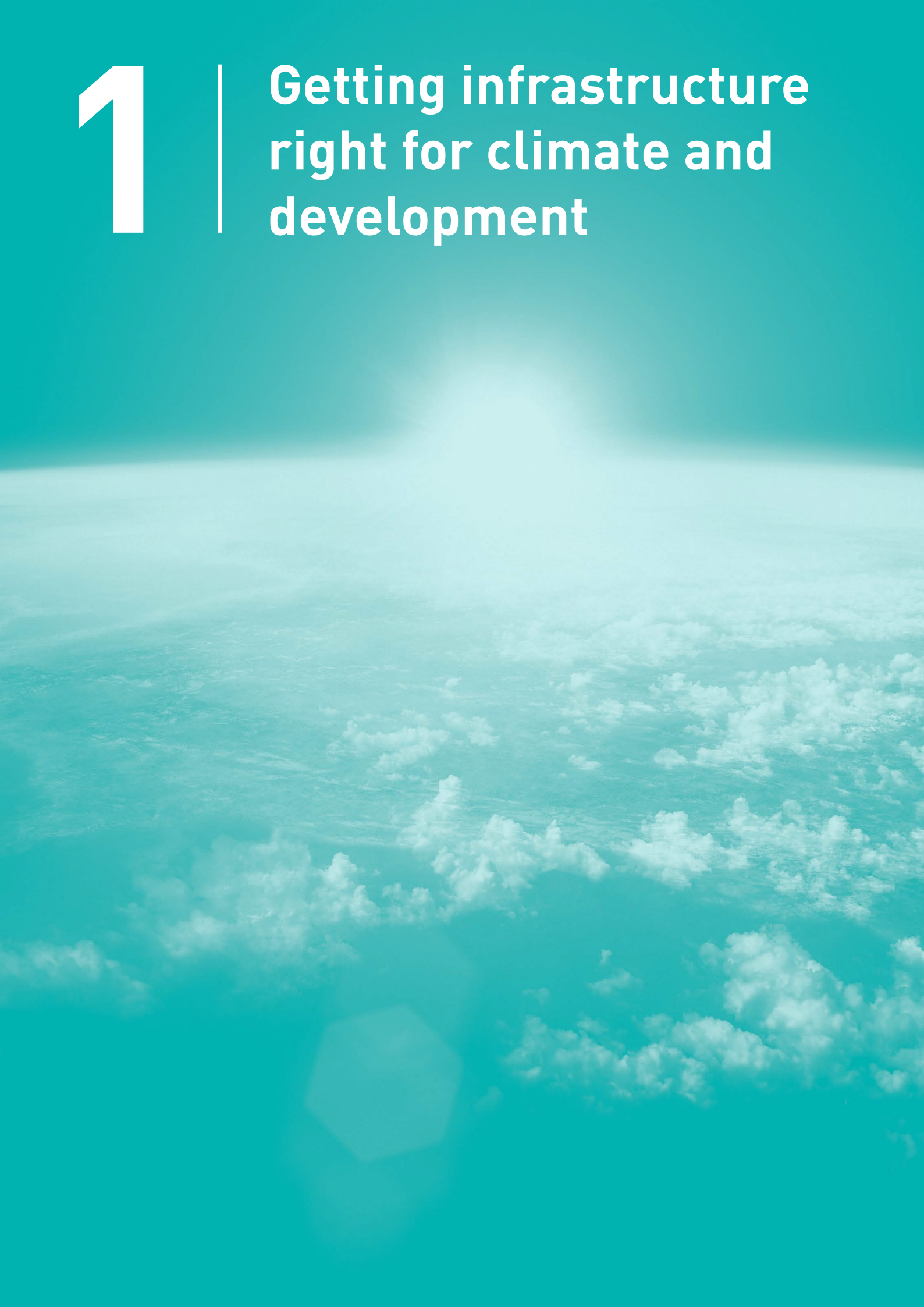
Empower city governments to build low-emission and resilient urban societies

Empowering local and city governments to plan and finance the right infrastructure is an essential part of achieving climate goals. Cities are also particularly vulnerable to climate risks and must weigh strategies that ensure urban resilience. The failure to invest in the right urban forms will put residents, the local economy and social cohesion at risk, potentially exacerbating today’s inequalities.

- Rethink institutional configurations to integrate land-use planning and transport strategies and seize the immediate development benefits of low-emission, resilient planning.
- Align national and local fiscal regulations with investment needs, through adjustment of borrowing frameworks or improving the creditworthiness of cities.
- Build climate-related and project finance capacity at the city level, from developing long term, low-emission strategies to mainstreaming climate risk in infrastructure planning to efficiently finance and deliver complex infrastructure projects.

1

Getting infrastructure right for climate and development



1. Getting infrastructure right for climate and development

Infrastructure sits at the very centre of climate and development pathways. It underpins the development of societies, economic growth, productivity and well-being. Yet current energy, transport, buildings and water infrastructure make up more than 60% of greenhouse gas emissions, and infrastructure worldwide has suffered from chronic underinvestment for decades. Scaling-up public and private investments in low-emission and resilient infrastructure has now become critical to increase resilience, avoid further emissions lock-in, and deliver on climate and sustainable development goals. Getting investment and climate policy right is a necessary condition of success, but it is not enough. Existing policy frameworks, institutions and economic incentives encourage incremental changes when a rapid transformation is needed. Only systemic change will disrupt the roots of institutional inertia and vested interest.

A deep transformation of existing infrastructure systems is needed for both climate and development

A pathway compatible with the Paris Agreement objective of limiting temperature increase to well-below 2°C and towards 1.5°C above pre-industrial levels is dependent on the timely development of low-emission, climate-resilient infrastructure. Even if the Paris Agreement mitigation goals are attained, a significant amount of adaptation will still be needed. This will require much greater levels of planning and investment in order to reduce vulnerability to even this level of climate change.

Current transport systems rely largely on fossil fuels and impose a very high environmental cost (air pollution, noise and congestion). Energy relies on centralised power systems fuelled by fossil fuel energy, and vulnerable to weather events. Cement, aluminium and steel remain the basic raw materials of our built environment, yet their production is extremely energy and emissions intensive. New infrastructure is needed, to support a decarbonised electricity system, energy efficient processes and a low-emission and clean mobility.

Infrastructure worldwide has suffered from chronic underinvestment for decades. In developing economies, significant levels of investment are needed to upgrade current

infrastructure systems and to develop new infrastructure projects to deliver on the Sustainable Development Goals and provide populations with access to basic services. For example, 940 million people still do not have electricity access, 1 billion people live more than 2 kilometres away from an all-season road, and 2.4 billion lack sanitation facilities (Rozenberg, Fay and Nicolas, 2018^[1]).

Box 1.1.

Climate, growth and development go hand in hand

Climate change is part of a broader set of structural challenges faced today by policy makers such as restoring growth, addressing systemic risk and instability of finance, growing inequality and persistent poverty, and unemployment (OECD, 2017^[2]). While these issues fall under different portfolios in governments and are often dealt with in silos, they are deeply interconnected as climate is at the core of the growth and development agenda:

- The OECD estimates that investing in infrastructure compatible with the goals of the Paris Agreement could increase GDP by up to 2.8% on average by 2050 while keeping the temperature increase to below 2°C, provided that the right structural policy reforms are in place. If the positive impacts of avoiding climate damage – such as flooding of coastal regions and more frequent severe weather events – are also taken into account, the net effect on GDP could rise to 4.7% (OECD, 2017^[2]).
- In its Sustainable Development Scenario, the IEA finds that an integrated approach to achieving the objectives of the Paris Agreement while also delivering universal energy access and reducing energy-related air pollution would bring substantial development benefits: 700 million more people would get electricity access by 2030 than under current plans, and nearly 3 billion more would gain access to clean cooking; at the same time, the number of premature deaths linked to outdoor pollution would halve relative to current plans, a reduction of 1.6 million per year (IEA, 2017^[122]).

In many developed economies, the quality of infrastructure has been declining for decades, and significant investments are needed to maintain and upgrade the quality of the services provided by existing infrastructure systems (OECD, 2017^[2]).

The infrastructure gap and the climate challenge present a unique opportunity in the coming years to work together on the climate and development agendas and develop infrastructure systems that deliver better services while also achieving climate goals (see Box 1.1). Which infrastructure projects receive financing will shape not only development patterns but will also determine future emissions pathways. However, current institutions are not fit for purpose.

Policies and initiatives to promote investment in sustainable infrastructure are progressing, albeit incrementally

More countries are implementing carbon pricing policies and instruments, removing fossil fuel subsidies, carrying out regulatory interventions for energy efficiency and providing targeted support to low-emission innovation. The number of carbon-pricing initiatives has more than tripled in the last 10 years at the national and subnational level (World Bank Group, 2018^[3]). To date, 45 national and 25 subnational jurisdictions have implemented or have scheduled for implementation carbon-pricing initiatives. Countries' efforts in supporting low-emission technologies resulted in a significant decrease of the cost of low-emission technologies, increasingly competitive with emissions-intensive alternatives, even in the absence of policy support. Global investments in renewable electricity technologies have grown from USD 226 billion in 2000 to USD 298 billion in 2017, and are now more than double annual investments in fossil fuel generation (IEA, 2018^[4]).

There is also momentum for change in the financial system. Public and private financial actors are increasingly aware of the role finance could play as a force for good, to deliver on sustainable development and climate goals. Since 2013, the number of sub-national and national policy and regulatory measures to promote sustainable finance doubled, with notably China's 2016 'Guidelines for Establishing a Green Financial System' or the 2018 European Commission Action Plan on Financing Sustainable Growth (European Commission, 2018^[5]).

At the international level, the number of initiatives focusing on the incorporation of sustainability into the international rules of the game for finance quadrupled since 2013 (UNEP Inquiry, 2018^[6]), with encouraging developments in the G20

on sustainable infrastructure, with work on new metrics, definitions, standards and financial products as part of the Sustainable Finance Study Group and the Sustainable Insurance Forum; improved awareness, risk analysis and reporting through the contribution of the Financial Stability Board's Task Force on Climate-related Financial Risk Disclosure (TCFD, 2017^[7]); and enhanced public financing to support private financing, with the work of the G20 Eminent Persons Group on Global Financial Governance (2018^[8]).

Yet, progress to date remains incremental on emissions reductions, policy ambitions and capital re-allocation. While the rate of emissions growth slowed considerably and energy emissions were flat for three years up until 2016, global emissions rose again in 2017, driven in particular by strong economic growth and a slow-down in energy efficiency improvement (IEA, 2018^[9]). Far greater efforts are needed to both reverse that trend and bring about an early global peaking of CO₂ emissions and avoid lock-in to emissions-intensive development pathways. The aggregate level of pledged emissions reductions in Nationally Determined Contributions (NDCs) is insufficient, and are putting us on a trajectory of warming closer to 3°C (UNEP, 2017^[10]).

Progress in developing the necessary policy frameworks is also insufficient. Carbon pricing policies are not ambitious enough: only 12% of carbon emissions are priced at EUR 30 per tonne of CO₂ or higher, a low-end estimate of the damage that carbon emissions cause (OECD, 2018^[11]). Close to half of emissions are not priced at all: in 42 countries representing over 80% of global carbon emissions from energy use, 46% of carbon emissions from energy use remain unpriced (OECD, 2018^[11]). This figure is even higher in sectors such as agriculture and industry (OECD, 2018^[11]). More efforts are needed to remove fossil fuel subsidies, as estimates of support to fossil fuels range between USD 373 billion and USD 617 billion over the period 2010-2015¹ (OECD, 2018^[12]).

Progress in greening the financial system remains also marginal. Low-emission infrastructure investment remains less than 1% of the overall portfolios of institutional investors (G20 Green Finance Study Group, 2016^[13]); current green bonds have been estimated to exceed USD 1 trillion, yet this new asset class makes up less than 1% of the global USD 100 trillion bond market. Investment in upstream and downstream fossil fuel exploitation reached USD 825 billion in 2016 – far more than the global investment in renewables at USD 287.5 billion (Climate Policy Initiative, 2017^[14]).

¹ The combined dataset covers 76 economies that collectively contribute 94% of global CO₂ emissions

Investing in low-emission, resilient infrastructure has now become critical

Addressing the sustainable infrastructure challenge requires mobilising actors across the financial spectrum, from public finance institutions to banks, institutional investors, corporations and capital markets. The importance of finance in climate action is recognised in Article 2.1c of the Paris Agreement, which calls for “making finance flows consistent with a pathway towards low greenhouse gas emissions and climate-resilient development” (UNFCCC, 2015_[15]).

The scale of this transformation is such that government budgets are insufficient to generate the trillions of dollars required and must be supplemented by private resources. Mobilising private investment towards the transition is therefore essential. Governments can focus their efforts on financing infrastructure projects that do not have a clear revenue stream, leveraging their resources to mobilise large-scale private sector investment and creating the appropriate incentives to make low-emission, resilient projects more attractive than emissions-intensive alternatives, including in developing countries (OECD, 2015_[115]). Mobilising private sector investment requires action across three core areas in a co-ordinated way:

First, governments need to improve the overall business environment and the investment climate. This means, amongst other things, implementing clear and predictable regulations, enforcing property rights and the rule of law, growing local financial markets, and developing options to mitigate regulatory, corruption and currency risks.

Second, developing a strong and stable climate policy framework to orient the economy away from greenhouse gas-intensive activities is essential to level the playing field between low-emission and emissions-intensive alternatives. Core climate policies are an essential component of such a framework, including measures such as a robust and credible price on emissions, regulatory measures when pricing is not efficient or too low, fossil fuel subsidy reform, and specific measures to bring low-emission technologies to commercialisation.

Third, a number of obstacles embedded in current financial systems and regulations that are hindering the allocation of finance to long-term low-emission infrastructure investments need to be addressed. Such barriers range from the lack of definitions, information, data and capacities on low-emission, resilient infrastructure investment, to the governance of financial institutions and the financial system as a whole, including financial incentives across the system that favour short-termism (UNEP Inquiry, 2015_[16]; UN Environment and World Bank Group, 2017_[17]).

Only systemic change will disrupt the roots of institutional inertia and vested interests

Levelling the playing field between low-emission, resilient projects and emissions-intensive alternatives is not enough, as infrastructure investment decisions are taking place in an increasingly complex environment. Rapid technological, economic and societal changes are generating uncertainty around a number of variables that could affect the nature of demand for future infrastructure, as well as altering the climate change mitigation and adaptation challenges in coming decades (UN Environment, 2018_[18]).

Our current institutional settings, processes and institutions are simply not fit for purpose to achieve the transformation needed. Governments need to move away from a sectoral approach to infrastructure planning and financing, and move towards a more systemic, forward-looking and network approach to infrastructure decisions. Current infrastructure planning practices, decision-making processes and institutional settings are inherited from the last century and reflect a status-quo based on conventional practices and silos. Innovation and transformation depend on the engagement of parts of governments that so far have not been sufficiently mobilised in the development of climate response strategies, notably ministries of finance, planning and economy, to ensure a good connection between the real economy and the financial system.

Overcoming this institutional inertia means addressing a series of barriers in our processes, practices and institutions that are preventing more ambitious climate action:

- behavioural and data biases that encourage choices based on conventional practices rather than forward-looking potential
- misaligned incentives and capacity gaps along the investment value chain, from procurement to investment decisions
- political economy factors such as employment in the fossil fuel industry, government rents from fossil fuel-based activities that influence policy and investment priorities, time horizons, as well as citizens and incumbent market interests (Röttgers and Anderson, 2018_[19]; UN Environment and World Bank, 2017_[17]).

At the same time new approaches to planning need to complement traditional approaches. Foresight methodology provides a complementary perspective by constructing multiple plausible futures to inform decision-making under uncertainty (see Box 1.3).

Innovation in technologies, business models and financing tools create new opportunities for climate and development. Shared business models, such as Uber or Airbnb, could

reduce the demand for mobility and housing infrastructure. Disruptive technologies (e.g. 3D printing, autonomous vehicles) and business models (e.g. sharing economy) could also reduce oil demand by a third compared to a business-as-usual scenario (Thomä, Dupré and Fulton, 2018^[20]).

Advances in digitalisation present transformative opportunities to decarbonise and decentralise energy systems: smart charging technologies for electric vehicles could help address intermittency in renewable energy supply, which could reduce infrastructure investment needs by between USD 100 billion and USD 280 billion in the next two decades. Smart demand response could contribute a further USD 270 billion to infrastructure investment savings (IEA, 2017^[21]). Digital finance is also transforming the infrastructure investment value chain, enabling citizens to participate more directly in the investment value chain and unlocking new sources of finance for infrastructure.

Towards a transformative agenda

This report reviews government practices related to infrastructure planning and financing and identifies six

action areas that could help governments move away from a business-as-usual approach to infrastructure, remove some behavioural biases and political economy barriers, and unlock the radical reallocation of capital needed for low-emission, resilient infrastructure investment:

1. Plan infrastructure for a low-emission and resilient future
2. Unleash innovation to accelerate the transition
3. Ensure fiscal sustainability for a low-emission, resilient future
4. Reset the financial system in line with long-term climate risks and opportunities
5. Rethink development finance for climate
6. Build low-emission and resilient urban societies

The agenda for transformation requires action across all areas. While different country contexts, resource endowments and capabilities will determine the priority action areas for individual countries, it is critical that a whole-of-government and whole-of-society approach is employed. This will help to ensure that the planning, investment and finance systems in place are “fit for the future” in smoothing the path towards low-emission, resilient economies.

Box 1.3.

Shifting the lens

The *Shifting the Lens* report is a contribution to the *Financing Climate Futures* initiative and explores how foresight methodologies and scenario development can better inform infrastructure investment decisions today to align financial flows with a low-emission, resilient future.

Infrastructure decisions today do not take adequate account of critical socio-economic and technological uncertainties that will shape future infrastructure supply and demand. Scenarios could improve current infrastructure decisions by examining them against an ‘organised’ set of uncertain, plausible futures. Through such a lens, distortions in decision-making can be revealed, and adjustments made. Such distortions may arise from a combination of biases embedded in habits and norms, prevalent incentives, incumbent interests, or a lack of competencies.

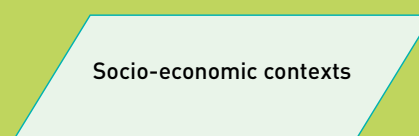
Shifting the Lens has used a simple analytic framework to identify a number of critical uncertainties that affect future infrastructure demand and supply.

The report points to critical uncertainties that influence the selection, design, procurement, deployment and

related financing decisions regarding low-emission, resilient infrastructure.

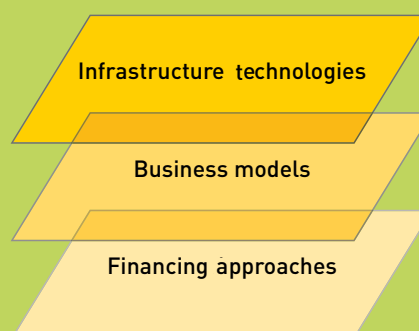
Four Tier Analytic Framework

Factors affecting infrastructure demand:



What are potential socio-economic circumstances of the future?

Factors affecting infrastructure supply:



What will infrastructure of the future look like?

What are implications to business models?

What are the new financing approaches and impacts to the financial economy?

Seven areas of critical uncertainties have been identified that are likely to impact financing decisions in low-emission, resilient infrastructure: (1) climate change itself; (2) shifts in the economic and geopolitical features of globalisation; (3) the technological intensification of infrastructure; (4) new economic, business and financing models such as the shared and circular economy and rentalisation; (5) new forms of citizen engagement; (6) changes to the financial system; and (7) economic downturns and external shocks.

These critical uncertainties can offer broader insights about policy, market practice, and citizens action, which include:

- *Long-term time horizon*: long-term planning is key, and it is governments and their agents, and less so market actors, that are likely to be at the core of such long-termism.
- *Policy-guided finance*: significant policy guidance and support to ensure that private financial markets can fulfil their key role in investing in low-emission, resilient infrastructure.
- *Citizen action*: citizens can impact the financing of low-emission, resilient infrastructure, but are as likely going forward to constrain as enable progress given varied priorities and time horizons.
- *Resilient investment*: strong government and policy-directed finance will be required in the face of economic downturns and external shocks, inevitable over the period in question.
- *Shifting globalisation*: the combined effects of automation, climate, business model innovation and reinforcing policy may drive us towards higher fragmentation of the global economy, reshaping the demand for infrastructure, and increasing the

importance of local financing solutions.

- *International cooperation*: international cooperation is key, but may require significant shocks to system to strengthen it against countervailing interests and institutional inertia.

Scenarios reinforce the importance of examining institutional and behavioural norms that inform investment decisions in low-emission, resilient infrastructure, by governments, market actors and civil society. Overcoming distortions in decision-making is likely to make a significant difference to the pace and form of investment in low-emission, resilient infrastructure:

- *Risk pricing*: needs to be more sensitised to complex and critical uncertainties, including through the use of scenario planning rather than exclusively singular, probability analysis.
- *Capabilities*: there is a need to enhance capabilities to better handle decision-making under uncertainty all along the investment value chain, including investors through to procurement.
- *Incentives*: there is a need to shift incentives and institutional norms to increase the rate of adoption of a new generation of technologically intensive infrastructure and associated business and financing approaches.

Shifting the Lens points to the potential to unlock investment opportunities in low-emission, resilient infrastructure by taking critical uncertainties more fully into account.

For more information, please see:

UN Environment (forthcoming^[18]), *Shifting the Lens*.

A wide, modern concrete staircase with a curved wall and a metal handrail, set against a light blue background. The staircase is made of light-colored concrete steps and a matching wall. A sleek, curved metal handrail runs along the wall. The overall aesthetic is clean and architectural.

2

Plan infrastructure for a low-emission and resilient future

2. Plan infrastructure for a low-emission and resilient future

Governments face the dual challenge of planning infrastructure that satisfies the immediate demand of their citizens for services like energy and mobility while simultaneously meeting the goals of the Paris Agreement. On both counts, the gap between objectives and action continues to widen.

Global investment in infrastructure is on a trajectory to fall significantly short of projected needs, and the emissions abatement currently pledged by governments is off track by an amount equal to between a fifth and a quarter of total annual emissions globally² (UNEP, 2017_[10]).

Political pressure to meet development needs in the short and medium terms tends to push governments to build infrastructure that is well known and understood, often in the style of existing infrastructure, therefore delaying action on climate change. The challenges of climate change action, as captured in the Paris Agreement, and broader economic development objectives are not, however, at odds, but rather two essential components of infrastructure planning as part of long-term low-emission development planning.

Improved planning practices will certainly help governments address fundamental concerns about the way in which infrastructure projects are currently developed and implemented, and can enhance the linkages between infrastructure planning and broader economic objectives. Moving towards a more transformative approach can significantly boost the ability of governments to more effectively and systematically reconcile development and climate goals in a rapidly changing global environment.

Priority actions include:

- Develop long-term strategies with development and climate at their core
- Harness climate modelling capacities and institutional processes to align near-term action with long-term targets
- Make resilient infrastructure the norm, not the exception
- Use strategic foresight methodologies to adjust long-term pathways to critical socio-economic and technological uncertainties

Develop long-term strategies with development and climate at their core

In accordance with Article 4 of the Paris Agreement, countries aim to peak greenhouse gas emissions as soon as possible and, in the second half of the century, reach a “balance between anthropogenic emissions by sources and removals by sinks” (i.e. net-zero emissions). To this end, Article 4.19 calls for countries to develop long-term low-emission development strategies. Although the development of such strategies and submission of them to the UNFCCC are voluntary, they are an essential tool to ensure that short-term choices are consistent with longer-term decarbonisation goals. Despite this, very few countries have developed such strategies. Only nine countries have submitted strategies to the UNFCCC, and all but three are high-income economies (UNFCCC_[22]).

Such long-term planning exercises need to become the norm across all countries to prepare adequately for the global transition towards a low-emission, resilient future. To help countries elaborate and implement long-term strategies, multi-stakeholder initiatives like the 2050 Pathways Platform have emerged and developed key principles for the development of long-term strategies (see Box 2.1 for a summary of these principles). These principles stress the importance of reconciling climate action with socio-economic development objectives and crafting the strategies with input from all stakeholders across sectors, industries and ministerial portfolios (2050 Pathways Platform, 2017_[23]). Crucially, the platform encourages national governments but also cities, subnational governments and companies³ to undertake this exercise.

When there is a strategic vision for infrastructure's role in national development that runs across ministerial portfolios, the connections between infrastructure for energy, transport, water and other sectors can be exploited to create synergies and reduce inefficiencies. Such planning, however, is not yet standard practice. According to a recent OECD survey (OECD,

² The gap between emission levels required to keep average global temperatures below 2°C above pre-industrial levels and the emissions resulting from full implementation of both conditional and unconditional NDCs for 2030 is between 11 and 13.5 GtCO₂e (UNEP, 2017_[10]). Total global greenhouse gas emissions were 52.8 and 53.5 GtCO₂e in 2011 and 2012 (the most recent years with available data) respectively (World Bank Group_[116]).

³ Its membership currently includes 27 countries (both advanced and developing economies), 15 cities, 17 subnational governments and 192 companies (2050 Pathways Platform_[114]).

2018^[24]), only about half of OECD countries reported to have a strategy for infrastructure that covers all sectors.

In addition to cross-sector synergies, mainstreaming climate change considerations in infrastructure plans is essential to achieve long-term goals. However, the extent to which climate change is considered within countries' infrastructure objectives and long-term plans varies considerably (ITF, 2017^[25]). A 2015 survey revealed uneven application of infrastructure planning across sectors, and strategies in only nine G20 countries include both mitigation and adaptation considerations (OECD, 2017^[2]).

Box 2.1.

Principles and building blocks of 2050 pathways

Principles: A general approach to 2050 pathways analysis, based on the principles below, is recommended for producing pathways that meet the criteria of clarity, relevance, practicality, and credibility.

- Socio-economic and emissions objectives are incorporated side by side as integral parts of the analysis.
- Backcasting: starting with the desired long-term goal and working backward to the present to shed light on key decision points and tradeoffs.
- Analysis focuses on the physical transformations required to meet long-term emissions and socio-economic goals.
- Pathways development is a process that engages stakeholders in the analysis and promotes communications about the findings.
- Policy questions, objectives and boundary conditions of the analysis are defined at the outset and the analytical toolkit is selected accordingly.

Building blocks. The principles of 2050 pathways are embodied in three building blocks of the pathways design process.

- Creation of narratives describing possible futures.
- Analysis and modelling of scenarios based on those narratives.
- Use of dashboards for communicating modelling assumptions and results.

Source: 2050 Pathways Platform (2017^[23]), *2050 Pathways: A Handbook*.

Develop and harness climate modelling capacity to align near-term action with long-term targets

Long-term planning needs to inform new courses of action in the present and planning in the near and medium terms. This requires aligning different time horizons: shorter-term plans should align with long-term objectives to ensure that actions taken today help rather than hinder efforts to achieve the transition. A key component of success relates to building climate-related capacities in governments, including climate models, to understand whether current infrastructure decisions are compatible with the carbon budget and emissions reduction trajectory of long-term plans. For instance the United Kingdom set a 2050 target of reducing emissions by 80% compared to 1990 levels and charged the Committee on Climate Change with translating this target into a carbon budget over five-year segments, which are then assigned to individual sectors (OECD, 2018^[26]). This creates the necessary link between national long-term targets and the decision-making process in the shorter term.

Models that project current trends into the future are helpful, but decision-makers can also employ models to determine which proposed policies or infrastructure projects are compatible with long-term science-based targets through 'backcasting'. In backcasting, rather than starting from present trends, modellers begin with the desired outcome (e.g. national emissions reduction goals) and work backwards to construct a plausible pathway to the present. It can be used to identify misalignments in policy, infrastructure and investment between present actions and long-term objectives. It can also shed light on practices that contribute to incremental emission abatement but that are incompatible with long-term targets (2050 Pathways Platform, 2017^[27]).

Nationally Determined Contributions (NDCs) are an essential mechanism of the Paris agreement, and it is critical that countries' emission reduction pledges in the mid-term are consistent with net-zero emission longer term goals. While NDCs adopt a 5- or 10-year view with the most recent iterations covering up to 2030, infrastructure assets are often in operation for several decades so their potential impact on emissions can climate go far beyond what can be captured in NDCs. New coal-fired power plants could, for example, be compatible with energy access objectives and even with 2030 NDCs in certain countries, but over the course of such plants' lifetimes the total emissions would be incompatible with the global goal of achieving net-zero emissions by the second half of the century (ClimateWorks Australia, 2017^[28]).

Current infrastructure planning practices have already led to considerable investment in assets that will face stranding

if global climate goals are to be met. Looking at coal power plants alone, total emissions from all plants currently operating or under development over the course of their economic life cycles would emit enough to put both the 2.0°C and 1.5°C temperature goals out of reach⁴ (Shearer et al., 2018_[30]). Infrastructure investments on a very large scale, like China's Belt and Road Initiative, offer a unique opportunity to ensure that projects align with a low-emission pathway (see Box 2.2).

In addition to phasing out investment in projects incompatible with the Paris Agreement's goals, countries should identify and promote projects that meet development needs and align with their long-term objectives and NDCs. Together, these infrastructure projects should form a 'pipeline' of projects for investment to streamline the process between project conception and financing. One practical step would be to create dedicated facilities to support pipeline development. For example, the EU High-Level Expert Group on Sustainable Finance (HLEG) is proposing to establish Sustainable Infrastructure Europe, which would provide advice, improve capacity and reduce regulatory uncertainty for EU member states (EU High Level Expert Group on Sustainable Finance, 2018_[108]). These dedicated entities would convene and link up key actions and host information that could help countries estimate their infrastructure needs and translate them into clear project pipelines.

Existing public financial institutions and entities could be used to support better pipeline development. In developing countries that may not be able to develop in-house capacities, initiatives such as the NDC Partnership⁵ are instrumental to enhance co-operation and provide technical and financial support to set climate targets as soon as possible. Initiatives led by development finance institutions such as the Agence française de développement (AFD) and the Inter-American Development Bank (IDB) now help countries screen projects for climate risks. Governments can use their export credit facilities and official development assistance providers to encourage better infrastructure pipelines that are aligned with the objectives of the Paris Agreement (OECD, 2017_[2]). Domestically, green investment banks, which are public financial institutions dedicated to green investment, could be developed or expanded to support the development of pipelines as part of their mandate (OECD, 2016_[31]).

Box 2.2.

Infrastructure built as part of the Belt and Road Initiative could present a unique opportunity for recipient countries

The Belt and Road Initiative will involve the world's single largest flow of infrastructure financing and build out ever. The pace and scale of investments are unprecedented, with some estimates suggesting USD 1-1.15 trillion of infrastructure commitments by 2025. Given the scale of investment, how much of these flows go towards low-emission and resilient infrastructure projects could determine the success (or failure) of global climate objectives like the Paris Agreement.

Which infrastructure projects receive financing from the initiative will shape future emissions. Mainstreaming

climate and resilience objectives in those investments is a unique opportunity to ensure that these investment flows will deliver the following benefits:

- Avoid the lock-in of emissions-intensive assets for decades
- Strengthen the resilience of infrastructure systems and the regional economy as a whole to climate change and its potential impacts. These impacts could stem directly from catastrophes or indirectly from reactions to them in policy, technology, markets and liabilities
- Reduce risk to the financial system, as getting infrastructure investment right will decrease the risk of stranded assets in a Paris-compatible future

Source: UN Environment (forthcoming_[32]), *Greening the Belt and Road Initiative*.

Note: This material derives from a forthcoming Financing Climate Futures case study.

⁴ Global coal power plants currently operating or under development would emit 233 Gt CO₂ over their life cycles (Shearer et al., 2018_[30]).

⁵ Launched at COP22 in Marrakesh, the NDC partnership is a coalition of countries and institutions working to mobilise support and achieve ambitious climate goals while enhancing sustainable development <https://ndcpartnership.org/>

Make resilient infrastructure the norm, not the exception

There is a need to strengthen and build new infrastructure to respond more adequately to the risks and impacts of a changing climate. Climate change poses a number of threats to economic development, with rising sea levels, increased risk of drought in some areas, shifting rainfall patterns and greater prevalence of temperature extremes, including a change in the intensity and frequency of extreme events. The 2011 flooding in eastern China illustrated the major damage that can be caused by extreme weather events, affecting 28 rail links, 21 961 roads, and 49 airports, as well as cutting power to millions of households (Xi, 2016^[94]). Choosing inclusive, climate-resilient approaches to infrastructure provision at the outset will help to moderate the extent of those negative impacts. The World Bank estimates that “building back better” after disasters could save up to USD 173 billion per year globally, compared to business as usual (Hallegatte, Rentschler and Walsh, 2018^[33]).

Countries are making progress towards integrating resilience in infrastructure investment. This is evident through an increased number of measures to strengthen the enabling environment for infrastructure resilience: providing climate information, integrating climate risks into technical standards, and encouraging physical climate risk disclosure (see Chapter 5 and Vallejo and Mullan, 2017^[34]). In addition, the volume of development finance targeting adaptation, although small, has been increasing. For example, adaptation financing from the MDBs increased from USD 5.9 billion 2016 to USD 6.8 billion in 2017⁶. This remains a key source of financing for cities in developing countries that face additional challenges in accessing finance (see Box 2.3).

Despite these promising developments, several barriers continue to prevent the alignment of financial flows with resilience. The impacts from climate change often lie beyond the time horizons considered by investors and other decision-makers; further complications include a lack of information, capacity and tools; policy misalignments and market failures; and insufficient weighting given to climate risks. There remains an urgent need to scale up action in a manner commensurate with the threat posed by climate change.

Governments can include the management of climate risks into the specifications and procurement policy for publicly funded infrastructure. An important innovation in this area is using decision-making strategies for infrastructure that incorporate uncertainty. While most of the global climate change trends are clear, at the local level some uncertainties represent a cost in themselves, as there is the risk of

preparing for a future that fails to materialise. Flexible, adaptive and proportionate approaches to infrastructure resilience can reduce the costs of building climate resilience given uncertainty about the future. Decisions about infrastructure should consider relevant uncertainties to ensure resilience across a range of potential future scenarios.

Another key action is filling the investment gap and mobilising additional resources projects that enhance

Box 2.3.

Improving cities’ access to financial resources is essential to build urban resilience

Infrastructure funding and finance needs are high in urban areas, and likely to grow over the coming years as urban populations continue to increase. However, funding and financing options in many cities in developing countries are limited. This makes creating an enabling environment for financing so critically important.

Local authorities have some key levers currently under their control, such as land-use powers and asset management controls, which can potentially reduce the size of the future funding challenge. However, basic credit-worthiness is a challenge.

Official development assistance (ODA) will remain a key source of funding for many countries, but a focus on urban infrastructure climate resilience requires a conscious policy choice by governments. The level of urban infrastructure focus varies across global climate funds, and currently is not a major source of funding for making urban infrastructure climate resilient. Many innovative funding and financing mechanisms and operating models exist, but building the appropriate enabling environment and local capacity are key. Building technical assistance is also essential to help cities improve the quality of their proposals to enhance funding prospects.

Source: World Bank Group (forthcoming^[35]), *Financing Resilient Urban Infrastructure: Lessons from World Bank and Global Experience*.

Note: This material derives from a forthcoming Financing Climate Futures case study.

⁶ According to the 2016 (pg. 12) and 2017 (pg. 13) Joint Reports on MDB Climate Finance

adaptive capacity, strengthen resilience and reduce vulnerability. This can be achieved through new technologies and better data to improve resilience by influencing behaviour and investments of infrastructure users and beneficiaries. For example, smart water metering can facilitate conservation efforts by allowing users to better understand and manage their consumption, and providing rapid alerts of potential leaks.

Nature-based solutions can be more cost-effective than relying solely on grey infrastructure, but can also require new financing models. They are increasingly being used as a complement or replacement for traditional grey infrastructure, particularly in the area of water and coastal management. These measures have the potential to be cheaper than traditional options and can yield co-benefits such as amenity value, carbon sequestration and habitat provision. Governments would benefit from encouraging a scale-up in the use of nature-based solutions, and in setting policy objectives that do not preclude such innovative solutions.

Use strategic foresight to adjust long-term pathways to emerging weak signals

Achieving net-zero emissions and climate resilience involves taking risks, making decisions under uncertainty and handling high levels of complexity. Long-term planning is not a static exercise, and involves continuous learning and the ability to deal with non-linear changes.

Faced with the inconsistencies between long-term goals and planned actions in the mid-term, countries collectively have to scale up ambition or face greater climate risks individually. The long-term low-emission development strategies called for in the Paris Agreement are meant not only to set the long-term vision but also to evolve and

adjust to the best available information, just as NDCs provide a link between short-term action are meant to increase ambition along the national long-term pathway towards global net-zero emissions.

Strategic foresight can be a useful tool in this regard, as it considers points of uncertainty in the present and develops several plausible future scenarios stemming from them. Dedicated strategic foresight teams can analyse possible emerging trends (called ‘weak signals’) to predict how, at a larger scale, they could affect the future. Such capacity is a key complement to traditional modelling exercises, as it captures the impacts of unexpected disruptions. Models in the 1970s did not – and, indeed, could not have been expected to – predict the technological changes over the past fifty years; the current models can hardly be expected to capture the changes to come. As such, additional capacity dedicated to strategic foresight and the integration of its insights into long-term planning exercises could ensure that the pathways against which current actions are compared adapt to emerging best available knowledge and possible future disruptions.

In some countries, dedicated foresight units or teams within governments already feed their insights into decision-making: Canada’s Policy Horizons Canada, India’s National Institution for Transforming India NITI Aayog and Japan’s National Institute of Science and Technology Policy being good examples. In Finland, a more diffuse model has emerged with several actors across ministries and the private sector contributing to foresight outputs such as the Government Report on the Future, which is published once during each electoral period (Prime Minister’s Office of Finland^[95]). Governments have not yet employed these units to inform future iterations of long-term low-emission development strategies as the first ones were communicated to the UNFCCC only in 2016, but such capacity presents an opportunity to enhance the planning process.

3

Unleash innovation
to accelerate the
transition



3. Unleash innovation to accelerate the transition

Innovation – the creation and diffusion of new products, processes and methods – is fundamental to the economic transformation required to address climate change. The rate and direction of innovation will determine to a large extent the economic cost and therefore the likelihood of achieving the Paris Agreement's mitigation and adaptation goals.

The opportunities for low-emission and resilient innovations are economy-wide, and include, for example, technologies for renewable energy, energy storage, and smart grids; energy-efficient lighting, heating and cooling in buildings; electric, hybrid and fuel-efficient vehicles; more efficient crop varieties, vaccines to inhibit methane production by ruminants and laboratory-grown meat; and carbon-capture and storage. Innovative technologies such as permeable materials for

pavements and roads, drought-resilient crops and improved irrigation schemes can enhance resilience to climate impacts.

Innovation is just as much about finding new ways of doing things as it is about technological breakthroughs. It involves institutional and organisational changes, as well as new services and business models (e.g. energy-as-a-service platforms; electric car sharing; circular supply models) that could deliver systemic changes in production and consumption practices, habits and behaviours (see Box 3.1).

Technological and non-technological innovations can be interdependent and often transverse multiple sectors, highlighting the need for a holistic and integrated approach to innovation. Many of the emerging innovations have their roots

Box 3.1.

Decarbonising energy-intensive industries will be a key challenge to meeting climate objectives

Many low-emission pathways scenarios indicate that the industrial manufacturing sector will remain relatively emissions-intensive compared to other energy end-use sectors (particularly road transport and buildings) by mid-century, owing to its reliance on fossil fuel combustion to provide high-temperature heat for processes such as iron and steel, cement and chemicals manufacture. Identifying the different mitigation measures that would help to stretch ambition in this sector over the period to 2050 is likely to be critical to achieving a net-zero emissions economy this century, as envisaged by the Paris Agreement. To date, there has been incremental progress towards decarbonising the industrial manufacturing sector. Entrenched long-term assets, job security and the possibility of competitiveness loss and leakage act as barriers to the uptake of low-emission technologies and measures.

There are two mutually non-exclusive pathways to low emission energy intensive industries:

- Improving the overall carbon footprint of production processes, through the diffusion and deployment of promising emerging innovations, such as increased energy efficiency, carbon capture and storage, and substituting coal with lower-emitting fuels such as gas, biomass, and hydrogen. The use of other less commercialised technologies is also possible, including high temperature heat from electricity generation (e.g. CSP, high temperature nuclear), as well as the electrification of high temperature process heat.
- A more radical approach to reduce industrial manufacturing emissions through circular economy approaches that have significant levels of product and material re-use, including lowering yield losses in product manufacturing processes, light-weighting of products so as to use less material input, and increased recycling of products to reduce the demand for new products.

Source: Imperial College (forthcoming^[36]), *Decarbonising energy intensive industries: options and strategies*.

Note: This material derives from a forthcoming Financing Climate Futures case study.

in the digital revolution, and could potentially be leveraged to enable more decentralised and flexible energy systems, and increase energy efficiency (see Box 3.2). For example, on the supply side, digitalised smart grids are facilitating the integration of variable renewable energy (e.g. solar and wind) in the system. On the demand side, smart charging technologies for electric vehicles (EV) are helping address intermittency in renewable energy supply, while smart meters are changing energy consumption patterns in homes and businesses.

Despite pockets of progress, climate innovation falls short of what is required to meet the goals of the Paris Agreement. Of 38 clean-energy technologies included in the IEA's Sustainable Development Scenario consistent with the 2°C goal, only four are on track to penetrate markets sufficiently: solar photovoltaic, lighting, data centres and networks as well as electric vehicles (IEA, 2018_[4]). Some technologies, such as carbon capture and storage, are only at a pilot stage.

There is an urgent need to accelerate the deployment of existing technologies, business models and services, and to swiftly move the next generation of solutions from the lab to the market. This will require government intervention to overcome three key barriers: First, markets undersupply innovation because of the positive externalities associated with the generation and diffusion of knowledge (i.e. firms do not capture all the benefits of their innovations). Second, when firms and households do not have to pay for environmental services or the costs of pollution (i.e. environmental externalities), the demand for green innovation is constrained and there are fewer incentives for companies to invest. Third, financing of innovation is constrained by information asymmetry, moral hazard, and other market failures.

Given the scale and urgency of the climate challenge, there is a strong case for governments to go beyond fixing market failures and actively drive innovation through a mission-oriented approach. Four priority actions are:

- Deploy targeted innovation policies to create a market for climate innovation
- Deliver and scale-up support for research and development of climate solutions
- Overcome the financial barriers to demonstration, deployment and early-stage commercialisation
- Promote international technology diffusion at scale.

Deploy targeted innovation policies to create a market for climate innovations

A sound enabling environment for innovation – e.g. well-aligned tax, competition, education, science, trade and investment policies (OECD, 2015_[40]) – and a strong environmental policy framework must underpin efforts to scale up climate mitigation and adaptation innovation. Setting a clear and stable policy

Box 3.2.

Digitalisation engages citizens directly in transforming infrastructure

Digital finance enables citizens to participate more directly in infrastructure investment value chains, unlocking new sources of finance for low-emission, resilient infrastructure. M-Akiba, for example, is a retail bond issued by the Government of Kenya that offers Kenyan citizens the opportunity to invest directly in new and ongoing infrastructure development projects through their mobile phones. It builds on M-Pesa, which revolutionised financial inclusion through 'mobile money', and M-Kopa, which leverages the M-Pesa mobile money platform to take off-grid and digitally enabled solar energy to poor and excluded communities. A low minimum level of investment (approximately USD 30 or 3000 Kenya shillings) offers Kenyan citizens an affordable savings product, with 10% per annum fixed returns over 3 years comparable to peer financial saving products, as well as an opportunity to contribute to building Kenya. The government is seeking to borrow approximately USD 50 000 000 (5 billion Kenyan shillings) through the M-Akiba Bond. It has raised approximately USD 2.4 million (247.75 million Kenyan shillings), but has fallen short of its target (Sanyal et al., 2017_[37]).

While examples like M-Akiba may be small scale today, experience with incentivising citizens' behaviour towards low-emission, resilient choices has already demonstrated its scalability. The Ant Forest mobile application in China, for example, was developed by Ant Financial Services in association with UN Environment to green citizens' consumption patterns by using mobile payment platforms, big data and social media. Over the first 16 months, 280 million people across China voluntarily joined this application, resulting in over 2 million tonnes of avoided emissions and over 13 million trees planted (Geng, 2018_[38]).

Source: UN Environment (forthcoming_[39]), *How digital finance favours infrastructure investments, decarbonisation and energy access to all*.

Note: This material derives from a forthcoming Financing Climate Futures case study.

signal through, for example, carbon pricing and long-term low-emission strategies (see Chapter 2) is critical for enhancing investor confidence and ensuring that innovation activity supports rather than undermines the low-emission transition. However, these framework conditions are necessary but

insufficient. To deliver transformative change, governments must deploy innovation policies that are tailored to the climate challenge. One way governments can set the direction of innovation is through mission-oriented programmes, which align policies, public R&D programmes and public-private collaboration with a clear objective or mission, such as curbing climate change (Foray, Mowery and Nelson, 2012^[41]). Relevant examples include mission programmes for renewable energy in Germany, electric vehicles in China and Norway, and the circular economy in Belgium.

Governments also have at their disposal demand-side policies that can strengthen the market-pull for climate innovations. In general, governments should emphasise competition and technology neutrality, rather than support specific technologies and solutions. However, judicious use of more technology-specific measures may be required to overcome the barriers facing low-emission technologies and drive transformative rather than incremental innovation. Feed-in-tariffs (FITs), for example, were instrumental in bringing wind power in Denmark and Germany to full commercialisation at a time when the technology was not commercially competitive (OECD, 2011^[42]).

National and sub-national regulations or performance standards, such as energy-efficient building codes or renewable portfolio standards that require electricity providers to include a minimum share of clean energy in their output mix (e.g. California Renewables Portfolio Standard), have also demonstrated their effectiveness in encouraging more innovation (Rozenberg, Vogt-Schilb and Hallegatte, 2014^[43]), but tend to benefit technologies that are closer-to-market. This points to the need for a broad policy mix that includes both technology-specific and technology-neutral measures, regulatory and economic instruments, and direct research and development (R&D) funding for technologies that are further from market.

Another way national and sub-national governments can create market pull for innovations in climate change mitigation and adaptation is through public procurement. By introducing climate-related criteria to procurement decisions, public procurement can trigger industrial and business model innovation through the creation of lead markets (Baron, 2017^[44]). A number of governments have adopted sustainable public procurement criteria and practices, such as tenders that include life-cycle costing that incorporates the costs of CO₂ emissions in value-for-money assessments, and market dialogues to help procurers and potential suppliers to formulate innovative tenders (OECD, 2017^[45]). Public support for enabling infrastructure (e.g. charging stations for vehicles) may also help pull the demand for low-emission technologies (e.g. electric vehicles).

Deliver and scale-up support for research and development of climate solutions

Research is the foundation of future innovation, but tends to be under-supplied by the private sector due to its long time horizon and the uncertainties surrounding the future commercial viability of a technology. Governments can help scale up R&D from private firms and universities through direct funding in the form of loans and grants, or through fiscal incentives, such as tax credits. Aligning R&D subsidies for fossil fuel research with low- and net-zero emissions goals is equally important.

Realising the full potential of innovation to drive the transition to a low-emission economy will require much greater levels of public investment in R&D. There are however positive signs that governments are starting to respond to this need. The IEA (2018) indicates that public innovation investment in clean energy technologies increased by 13% in 2017 to USD 22 billion, breaking a streak of declines and stagnation over several years (IEA, 2018^[117]). Furthermore, through the international initiative “Mission Innovation”, 23 countries and the European Union have pledged to double their clean energy R&D spending by 2021 to address climate change, make clean energy affordable, and create new jobs and commercial opportunities. If the pledge is achieved, the combined annual R&D investment from these countries will rise to approximately USD 30 billion per year (Mission Innovation, 2018^[46]).

Public research through government research institutes and laboratories has an important role to play in linking basic and applied research. In addition to targeting technological breakthroughs, public research should explore socio-economic and political aspects that could help deliver systemic changes in production and consumption practices, habits and behaviour or that could influence the acceptance and adoption of new technologies. The French Environment and Energy Management Agency’s Strategic Roadmap for Smart Electricity Systems, for instance, identifies research priorities concerning economic and regulatory conditions (e.g. developing innovative business models to support the integration of storage systems), and human and social sciences (e.g. improving and developing user interfaces; identifying and analysing the governance processes needed for innovations to spread), in addition to technological research priorities.

Well-designed collaborations between the public and private sectors, across firms, and among academia and national laboratories can help match problem-owners with solution-providers, pool resources, bring together complementary skills and expertise, and lower technology risks and R&D costs. Examples include the US DOE Sunshot, the German Kopernikus programme, UK Catapult programme and the European Institute of Innovation and Technology’s Climate-KIC. International co-operation on R&D could also accelerate

innovation by enabling projects of greater scale, avoiding duplication and bringing together different skills and expertise. However, few examples of successful in-depth collaborations exist. Examples include the long-term 12 billion ITER fusion reactor project in which 35 countries collaborate and the US-China Clean Energy Research Center (Chan et al., 2017^[47]).

Bottom-up open innovation strategies can also facilitate the emergence of innovations not prioritised by strategic road-mapping or technology and innovation assessments, and hence help prevent potentially promising innovations from being overlooked. Open innovation strategies can be pursued through challenge-led calls, which utilise prize competitions, crowd sourcing, ideation, or open dialogues.

Overcome the financial barriers to demonstration, deployment and early-stage commercialisation

Innovative technologies and solutions emerging from R&D must pass through several stages of validation and refinement before reaching full commercialisation, and depend on different types of investors and investment instruments along the way. Due to the fragmented nature of investor networks and information asymmetry, projects may face a discontinuity of investment and fall into a so-called funding “valley of death” (Soh Young In, Monk and Levitt, 2017^[48]). This tends to occur at the demonstration phase (the “technology valley of death”) or at early-stage commercialisation (the “commercialisation valley of death”).

Clean energy technologies that require large-scale capital investment, have long development timelines and face high technology risks may confront additional challenges (Gaddy, Sivaram and O’Sullivan, 2016^[49]). Indeed, recent analyses have highlighted the limitations of traditional venture capital (VC) models for funding such innovations. Although VC has played an important role in accelerating the commercialisation of some clean energy technologies, recent investment in clean technology tends to focus on a narrow range of more mature technologies, with energy efficiency and transportation receiving the lion’s share. This is due in part to the time and capital constraints of VC investors and the relatively poor risk-return profile of clean energy investments (Gaddy, Sivaram and O’Sullivan, 2016^[49]).

While a strong enabling environment and demand-side innovation policies are fundamental for pulling innovations through the valley of death, there is also a need to diversify the investment vehicles and actors involved at the different stages of innovation to better allocate and align investment risk. Responses to overcome finance barriers to demonstration include: supporting the expansion of public and private incubators (e.g. Israel’s Incubators Centre for Technological Initiative) and accelerators (e.g. Start-Up Chile); providing

public finance as an alternative or complement to VC funding, with a particular focus on risky, long-term projects that could have large social benefits but are too early for private-sector investment (e.g. the US Department of Energy’s Advanced Research Project Agency); reducing the risk to lenders through loan guarantees; and promoting novel assemblages of actors that can help ensure a continued stream of investment across the innovation lifecycle. The Breakthrough Energy Coalition, for example, brings together patient and risk-tolerant private investors, global corporations and financial institutions with the capital necessary to finance large energy infrastructure projects. The innovation funding gap can also be filled by investments from corporates and corporate venture capital funds, crowd-sourcing and philanthropic funding.

Promote international technology diffusion at scale

The wide diffusion of low-emission and climate adaptation innovations is critical for achieving the goals of the Paris Agreement and broader environment and sustainable development objectives. This calls for international co-operation in the transfer and adoption of technologies. While international transfers of low-emission technologies have been primarily between advanced countries, there is an increasing amount of North-South and South-South exchange. International mechanisms such as the UNFCCC’s Technology Mechanism, IEA’s Collaborative Technology Agreements and the new Technology Facilitation Mechanism established under the 2030 Agenda for Sustainable Development have been developed to help enhance technology development and transfer to developing countries.

The adoption of strong environmental policy can drive international technology diffusion, as it helps create markets for low-emission innovations and provides firms with incentives to acquire new technologies. However, because technology diffusion takes place primarily through trade, foreign direct investment (FDI) and other market channels, removing tariff and non-tariff barriers to trade in low-emission technologies and manufacturing equipment is fundamental (OECD, 2011^[50]). Indeed, Chinese producers became world leaders in photovoltaic panel production through the purchase of manufacturing equipment on the global market (De La Tour, Glachant and Ménière, 2011^[51]).

Lowering barriers to trade in services is also important as the deployment of climate mitigation and adaptation technologies often depends on the availability of specialised services, including those imported from other countries. Ensuring appropriate protection and enforcement of Intellectual Property Rights can incentivise investment in innovation as it allows firms to recover their investment costs. The absorptive capacity of the country is a key determinant of technology adoption.

The higher the level of domestic human capital, the higher the level of technology transfer as well as the local spillovers from trade and FDI (OECD, 2011^[50]). Investing in education and capacity building is therefore important to enhance the ability of the public and private sectors to adopt adapt, and employ the most appropriate technologies. Ensuring mobility of

scientific and technical personnel can help encourage cross-fertilisation of ideas and build capacity. The Indian wind turbine manufacturer Sulzon established R&D offices in Germany and the Netherlands, making it easier for its staff to learn from local expertise, while the Start-Up Chile accelerator aims to bring in foreign entrepreneurs to galvanise Chile's transition.

4

**Ensure fiscal
sustainability for
a low-emission,
resilient future**



4. Ensure fiscal sustainability for a low-emission, resilient future

The climate challenge demands a holistic, consistent and integrated approach by governments to align all channels of public finance while also taking into account medium-term budgetary cycles and longer-term fiscal sustainability. However, decades of fossil fuel development have led to the carbon “entanglement” of government budgets. This refers to the fact that fiscal revenues from fossil fuels (for example, from collecting royalties on the extraction of oil, natural gas and coal) form a key part of most governments’ taxation revenue base. This share in government revenues varies from country to country and is typically below 5%, although it can be more than two-thirds in countries with a resource base dominated by fossil fuels (OECD, 2017^[2]). Such carbon entanglement can be an important political obstacle for governments to engage in the radical transformation needed to transition to a low-emission, resilient future.

Governments also play a central role in influencing financial flows that will influence climate-related behaviours of citizens and companies through their budgeting processes, policies and fiscal incentives. What governments put a price on, and what they choose to support financially, will provide strong signals for investment that can either help or hinder climate objectives.

Beyond the issue of taxation and subsidisation, reforming the public spending policies of agencies or entities under their control can have major impacts on the way in which public expenditures influence climate outcomes. For example, ensuring that the mandates of state-owned enterprises (SOEs), development co-operation agencies, export credit agencies, and national development banks are compatible with climate goals can be a powerful and transformative action. Similarly, the experience of “greening” public procurement processes in a number of countries has been very effective in driving innovation and uptake of new technologies.

As governments transition to a low-emission economy, they must also address the social consequences of the transition. Certain industries will thrive, while others that are dependent on fossil fuels and do not adapt to the new low-emission economy may not fare as well. This also means that specific regions, workers, and investors may be particularly affected. The use of public resources to address these issues is tightly linked to the fiscal sustainability question through the need to ensure that adequate resources are available, well-targeted and focus on the broad suite of transition

measures required (for example, through education and re-skilling of affected workers).

The power and influence of public budgets, if channelled towards climate objectives, can be a shift towards building a low-emission, resilient economic future. In order to make meaningful progress on climate, four policy priority action areas are:

- Diversify government revenue streams to prepare for carbon neutrality in the long run, and reduce government’s exposure to incumbents and vested-interests in fossil fuel technologies;
- Align fiscal incentives with climate objectives to discourage carbon-intensive behaviours or investments by economic actors;
- Leverage public procurement practices and indirect spending through SOEs or development finance institutions to align spending with climate objectives; and
- Ensure an inclusive transition along the way, to facilitate the social acceptance of the transition to come.

Diversify government revenue streams away from fossil fuels

Long-term fiscal sustainability is already a central consideration for governments, particularly those with revenues and economies highly dependent on fossil fuels. However, carbon entanglement is a major barrier to more ambitious climate action.

Carbon entanglement presents a significant risk for countries’ medium- to long- term fiscal sustainability as they transition to low-emission economies. Given that declining production and consumption of fossil fuels is a key element of projected carbon emission pathways to meet the Paris Agreement goals, the prospect of declining tax revenues from fossil fuels raises serious and growing concerns about the future tax base and tax mix.

Countries must be aware of the shifting revenue base that will accompany the low-emission economy. Government revenues will need to adapt to decarbonisation, implying a structural shift away from reliance on revenues from fossil fuel extraction, production, and consumption over the long term. The economic transition will also result in stranded assets and

workers, who will require government intervention. A successful and decisive transition away from carbon entanglement hinges on planning and is best if done from a position of relative economic strength when international energy prices are high. It will require diversification away from fossil fuels by rethinking economic aspects such as revenue streams, workforce skills, education and training institutions, and infrastructure. There are some examples of this in practice from fossil fuel endowed countries. The Saudi Vision 2030 identifies risks and opportunities in the transition to a less oil-dependent Saudi Arabia (OECD, 2017^[2]). Norway manages its oil wealth through a sovereign wealth fund, which has helped the country achieve high living standards and reduce its exposure to fluctuations in the oil price while also diversifying its economy away from fossil fuel dependence. Emerging business models and diversifying economic activity are therefore crucial in expanding the government revenue base to ensure fiscal and economic sustainability.

A shift away from fossil fuel use also has implications for tax revenues collected by governments. Broadening the tax base, for example by diversifying economic activity, will be essential to the move away from a carbon-intensive economy. As the tax base erodes, governments will need to identify new streams of revenue in order to compensate. In the area of carbon tax, there is significant space for broadening the tax base and increasing rates and therefore in the short term may help to bridge the gap in revenues. However, this will not be sufficient in the long term as carbon use decreases.

The twin issues of carbon entanglement and long term fiscal sustainability are only just beginning to be discussed in government finance ministries. Yet, as noted above, they are central to the success of the transition to low-emission, resilient economies. There is considerable scope for deepening the debate on the issue and boosting the evidence base to inform future government actions.

Align fiscal policies with climate objectives

Aligning fiscal policies with climate objectives has long been seen as a core element of the transition to a low-emission, resilient future. Revenue-raising mechanisms, such as carbon pricing, have direct links to climate objectives by shifting behaviours and investments away from emissions-intensive behaviour. While the number of carbon-pricing initiatives has more than tripled in the last 10 years at the national and subnational level (World Bank Group, 2018^[3]), the current rate of change is too slow to meet the goals of the Paris Agreement. Looking beyond carbon pricing to energy taxation as a whole, recent estimates of the effective carbon price from energy reveal that close to half of CO₂ emissions from energy are not priced at all. Moreover, 88% of carbon emissions are priced

below EUR 30 per tonne of CO₂e – a low-end estimate of the damage that emissions cause (OECD, 2018^[11]). Governments should price carbon at a level reflecting its climate damage as well as increase the scope of emissions that are priced.

Beyond direct actions focused on carbon emissions, governments should also focus on ensuring that the entirety of their budgetary processes are aligned with climate objectives (Box 4.1). For example, many countries' fiscal policies provide favourable tax treatment to the use of company cars and commuting expenses, which indirectly results in more cars and more intensive car use (Roy, 2014^[52]; Harding, 2014^[53]). Certain property taxes favour urban expansion and therefore increase commuting and car use (OECD, 2014^[54]; OECD, 2018^[55]). Corporate tax provisions may encourage or discourage decarbonisation, for example due to the way corporate taxation allows deductions for different types of capital costs (Dressler, Hanappi and van Dender, 2018^[56]).

A number of budgetary support measures, such as fossil fuel subsidies, still favour emissions-intensive behaviours and practices. Removing inefficient fossil fuel subsidies offers the dual benefit of addressing environmental objectives through the reduction of carbon emissions, while also reducing tax expenditures and simplifying the tax code. Aggregate estimates of the annual production and consumption support to fossil fuels ranged from USD 373 billion and USD 617 billion over the period 2010-15⁷ (OECD, 2018^[12]). Some countries have begun to phase out fossil fuel support measures, but such reforms must be scaled up, mainstreamed, and be part of a more holistic approach to aligning fiscal policies with low-emission outcomes. Finance ministries should carefully review their tax systems, and ensure that taxes and budgetary expenditures are in line with sectoral decarbonisation objectives. A central component of this is to craft fiscal policies that encourage behaviours, investments or practices that will not counteract, and where possible, encourage the radical transformation needed to move towards a low-emission economy.

Calculating the full costs of emissions using cost-benefit analysis (CBA) could shift finance towards low-emission, resilient projects. CBA strives to capture individual projects' climate impact using the social cost of carbon (SCC), which measures the present value of the damage resulting from an additional tonne of carbon emissions – or emissions of any other greenhouse gas. For example, particulate matter, sulphur dioxide, nitrous oxides and carbon monoxide can be included in CBAs of transport-related and energy-related projects. Environmental CBA can also capture positive and negative well-being impacts, and can help provide a more holistic picture to decision makers by capturing the co-benefits of low-emission, resilient infrastructure, such as improved air quality, improved access to transport, less traffic congestion, and better health (OECD, 2018^[57]).

⁷ Of 76 economies that collectively emit 94% of global CO₂ emissions.

More effectively aligning public budgets with climate objectives can have powerful transformative impacts on the behaviours of consumers and producers. It can send political signals on the direction of change, influence individual and company consumption and production patterns, and leverage private sector resources for the transition. The power of this area is yet to be fully realised by governments and there is considerable scope for scaling up activities on public budget alignment.

Align incentives and mandates of public institutions with climate objectives

The significant level of public purchase of goods and services – amounting to 12% of GDP on average among OECD countries (OECD, 2017^[45]) – can play a major role in driving low-emission, resilient infrastructure investments. Traditionally, procurement decisions are based on the lowest-cost bidder. Methodologies that take into account externalities could allow for objective evaluation criteria alongside cost (such as carbon emissions). Considering life-cycle costing, including life-cycle carbon emissions and other externalities, could help shift procurement decisions towards low-carbon options, for example. Building resilience criteria into infrastructure investments is another important way that governments can avoid climate risks (Vallejo and Mullan, 2017^[34]).

In many countries SOEs occupy a central role in the electricity generation sector, accounting for 61% of total global electricity capacity installed in 2016 and approximately 52% of capacity planned or under construction (Prag, Röttgers and Scherrer, 2018^[58]). They serve different purposes, such as controlling strategically sensitive energy supply chains, generating state revenues and securing jobs. As a result of their important presence in these sectors, SOEs are also more exposed to climate change and transition risks. Governments in countries with a high share of SOEs and coal will therefore bear the largest cost associated with the transition if they do not take concrete steps to pivot away from fossil fuels. Encouragingly, between 2000 and 2014, SOEs in OECD and G20 countries increased the share of renewables in their electricity capacity portfolios from 9% to 23%, leading investments in newly installed renewables capacity (Prag, Röttgers and Scherrer, 2018^[58]). This demonstrates that jurisdictions with power market SOEs can directly influence the energy mix by investing more in renewable power and less in fossil fuel technologies.

For development co-operation to support a transformative shift in countries' development pathways, bilateral co-operation portfolios overall need to be aligned with climate goals. The volume of climate-related development finance as a share of overall development finance has been increasing year on year, making up 17.5%, on average, in 2014-15. However, over 80% did not consider climate change as an objective, highlighting

Box 4.1.

The Paris Collaborative on Green Budgeting

The Paris Collaborative on Green Budgeting was launched by the OECD and presented by French President Emmanuel Macron as part of the 12 announcements at the 2017 One Planet Summit in Paris. It aims to design new, innovative tools to assess and drive improvements in the alignment of national expenditure and revenue processes with climate and other environmental goals.

In practice, this involves the development of a range of tools and methodologies for a systematic approach to evaluating and improving the environmental impact of public expenditures and revenue raising and to mainstreaming an environmentally aware approach across all policy domains.

Building on the international work-streams on budgetary, fiscal, environmental and climate policy, the collaborative is working towards new and pragmatic deliverables. These include a Green Budget Statement to provide an overview of how the annual budget supports achieving environmental goals; guidelines for environmental cost-benefit assessments in support of green budgeting; and country scans to investigate the tax revenue effects of environmentally oriented tax policy.

Further information: <http://www.oecd.org/environment/green-budgeting/>

an urgent need to better mainstream climate change and other environmental objectives across development co-operation (discussed further in Chapter 6).

Anticipate and address the social consequences of the low-emission transition

Considering poor and vulnerable populations in climate policies will also be key for governments to meet their social objectives and reduce undesirable unintended distributional impacts of climate policy. Further, governments must carefully consider the issue of intergenerational equity; the current cost of addressing the climate challenge may seem significant, but pales in comparison to the financial and societal costs for future generations if not addressed. Governments should plan for future generations by leaving a sustainable

fiscal and economic legacy. Governments would benefit from developing strategies on how to include those worst affected by the transition.

Governments can introduce structural reforms that facilitate the adjustment of firms and workers to market conditions. For example, housing policies could better facilitate mobility from a low-employment region to a higher-employment region (for example, by improving access to low-cost housing, decreasing transaction costs). Fiscal policies that favour low-emission innovation and small businesses could result in greater employment opportunities while also furthering climate objectives. Revenues from carbon pricing can be used to invest in education, health, clean technology as well as reducing

taxes for poorer households. Revenues can also be dedicated to improving low-income households' energy affordability (OECD, 2018^[60]).

Labour market policies could maintain high levels of employment and a fair distribution of the transitional cost. For example, these policies can include active labour markets that help unemployed people to find a job, including skill development systems to smooth workers' reintegration into employment. Demand-side policies can foster a competitive green sector through strong product market competition and moderate employment protection. Income support such as unemployment insurance and work benefits can ensure a fairer transition for workers (Chateau, Bibas and Lanzi, 2018^[59]).



5

Reset the financial system in line with long-term climate risks and opportunities



5. Reset the financial system in line with long-term climate risks and opportunities

Bridging the infrastructure investment gap for climate and development requires a rapid scale-up of private sector investment, and a reallocation of those investments away from emissions-intensive assets to low-emission, resilient infrastructure and technologies. The failure to align investments with a pathway compatible with the Paris Agreement could have direct implications on the profitability of investors, and for the financial system as a whole. Three types of climate-related risks that could challenge the stability of the financial system can be identified: i) physical risks related to the increased frequency and severity of climate- and weather-related events could damage property and disrupt trade; ii) liability risks arising if those suffering from climate change losses seek compensation from those they hold responsible; and iii) transition risks caused by the revaluation of assets in a lower-emission economy (Carney, 2018^[62]). For instance, investing now in infrastructure compatible with long-term climate goals could decrease the transition risks of stranded assets in the oil and gas sector alone from USD 2.1 trillion to USD 0.8 trillion, avoiding the equivalent of USD 1.3 trillion in stranded assets (IEA, 2016^[61]).

There is growing number of initiatives among financial policy makers and regulators as well as some private actors to harness the financial system as a force for good by driving the low-emission transition (UN Environment and World Bank Group, 2017^[17]; UNEP Inquiry, 2018^[64]). In parallel, investors' interest in and allocations to infrastructure are gradually increasing, driven by low yields in traditional asset classes and attracted by the inflation protection provided by infrastructure assets (OECD, 2018^[65]).

However, progress to date is still patchy and incremental. Current allocation and volumes of investments still fall short of the estimated USD 6.3 trillion per year required to support economic development worldwide (OECD, 2017^[2]). Data available on infrastructure investment patterns in the energy sector fail to demonstrate the shift of capital required for the low-emission transition. Despite a growing interest and attention to sustainable infrastructure investment, investors still lack knowledge and conviction of the benefits to invest in projects compatible with low-emission, resilient pathways (Serebrisky et al., 2018^[66]).

Governments have a central role to play to mobilise and shift private sector investments towards low-emission, resilient infrastructure. Improving the overall business and investment environment and developing a strong and stable climate policy framework is essential to orient the economy away from emissions-intensive activities and level the playing field between low- and high-emission alternatives, but such changes are not enough (see Chapter 1). A number of obstacles embedded in current financial systems and regulations are preventing the re-allocation of finance to long-term low-emission infrastructure investments at the pace and scale needed.

The way climate risks and opportunities are managed, disclosed and mitigated in financial systems remains a key obstacle that could hinder the allocation of finance to low-emission, resilient infrastructure investments. Barriers to a better pricing of risk range from the lack of definitions, information, data and capacities on low-emission, resilient infrastructure investment, to the governance of financial institutions and the financial system as a whole, including financial incentives that favour short-termism (UNEP Inquiry, 2015^[16]; UN Environment and World Bank Group, 2017^[17]).

Priority action areas include:

- Encourage the integration of climate impact in investment decisions and strategies;
- Disclose climate-related risks and opportunities for investors and support scenario-based climate risk management strategies and disclosure;
- Rethink the supervision of the financial system in light of climate-related risks that could threaten the financial stability of the system in the short and long term.

At all levels of governance, climate and infrastructure finance communities have to date functioned quite separately and sometimes at cross-purposes, preventing or slowing investment in low-emission infrastructure. It is necessary to break the silos between these communities to embark on national and international initiatives that aim to mobilise long-term investment on the one hand, and green long-term investment on the other. Such collaboration is a necessary condition to

deliver the financial system needed for development in line with climate goals.

Encourage the integration of climate impact in investment decisions and strategies

Investors have started implementing a variety of measures to adapt their investments to climate risks and benefit from climate-related opportunities. The extent to which such actions have an impact on the real economy and are compatible with a low-emission, resilient pathway is still unclear and requires further analysis (Ang and Copeland, 2018_[97]). Given the growing threats from climate change, understanding, quantifying and actively managing business exposure to climate-related risks should be an important part of risk management practices in companies and investors' portfolios. Improving our understanding of how financial policies and regulations affect low-emission, resilient infrastructure investment patterns is an essential element of the transformation.

Investment strategies consisting of investment in best performing companies within each industry sector, blacklisting emissions-intensive investment or divestment

are generally focused on the chronic dimensions of climate change. These may not necessarily translate into low-emission development in liquid markets, as other financiers may still finance emissions-intensive assets. Other strategies – such as investing in and financing new, low-emission infrastructure – may contribute more directly to climate change mitigation objectives and have a clearer impact on the real economy. Another example is active ownership, the strategy by which equity investors use their ownership stake in a company to influence its decision-making. At the One Planet Summit in 2017, the Climate Action 100+ coalition, representing 225 investors with USD 26.3 trillion of assets under management, committed to engage with the 100 most polluting corporations, responsible for about two-thirds of worldwide industrial emissions, and to step up their ambition on climate action (Ang and Copeland, 2018_[97]).

Mainstreaming climate considerations in investment decisions and strategies across the entire financial system requires action on the following fronts:

- Enhancing greater market transparency and improving data on performance, risks and costs of sustainable energy investments across available channels while promoting public-private dialogue. The deployment of blockchain

Box 5.1.

Blockchain's secure and transparent ledger could catalyse the transition

Blockchain is a shared database of trusted transactions distributed across large peer-to-peer networks. The encrypted, distributed nature of data on the blockchain and system of consensus makes it an inherently secure, immutable, verifiable and transparent way of storing transactions and records. Specific examples of blockchain's potential applications to climate include:

- **Building trust in global carbon markets:** carbon credits could be represented as tokens and traded on a blockchain ledger, improving the efficiency and transparency of carbon markets (OECD, 2016_[99]).
- **Facilitating transparency in financial markets and value chains:** Blockchain technology could increase the transparency and traceability of products or financial flows, while reducing the transaction costs involved.
- **Promoting compliance with climate change standards:** Blockchain could facilitate regulatory requirements and compliance with standards (e.g. validating compliance with sustainability standards for green bonds), and could also be used to track green finance or development aid with greater confidence about its flow and ultimate use.

- **Helping new business models to emerge:** Blockchain applications could facilitate the emergence of decentralised business models in the energy sector through peer-to-peer connections; enabling demand-side response management through smart meters and help manage electricity grids (Basden and Cottrell, 2017_[100]).

However, there are challenges to consider related to the energy intensity of the transactions and data confidentiality. For example, the energy used to mine (the process of consensus-based validation) non-backed payment tokens (like bitcoin) on public blockchains is substantial. The estimated annual energy usage of bitcoin has climbed with the level of transactions: a single bitcoin transaction now uses the same amount of energy as the daily usage of 33 homes in the United States (Digiconomist, 2018_[118]). Governments need to implement the proper regulatory framework to seize the opportunities created by block chain and mitigate the risks.

Source: OECD (forthcoming_[119]), *Blockchain, infrastructure and the low-emission transition*.

Note: This material derives from a forthcoming Financing Climate Futures case study.

technologies could help enable this transparency provided that the right regulations are in place (see Box 5.1).

- Developing benchmarks to facilitate due diligence of low-emission infrastructure and asset allocation modelling (OECD, 2015^[98]) and to measure performance to feed into the asset allocation process.
- Ensuring that climate-related risks and opportunities become material for investors. This will require a range of interventions, including broadening concepts of risk and the time horizons over which they are assessed, embedding climate into incentive structures and the key performance indicators of financial decision-makers, and mainstreaming related concepts into professional education programmes.
- Improving the understanding of how financial policies and regulations affect low-emission, resilient infrastructure investment patterns. It includes developing better classification systems for financial measures,

effective frameworks to measure impact, and enhanced understanding of the transferability of measures across countries at different stages of development and with different financial systems (UNEP Inquiry, 2018^[6]).

- Harnessing the new opportunities created by digital finance could also transform the infrastructure investment value chain, enable citizens to participate more directly in the investment value chain and unlocking new sources of finance for infrastructure. For instance, innovative payment models could contribute to increasing low-emission and clean energy access in Sub-Saharan Africa (see Box 5.2).

Box 5.2.

Decentralised solar and innovative business models can dramatically increase clean energy access in sub-Saharan Africa

Sub-Saharan Africa currently has the lowest rate of electricity access in the world, and current policies and the region's rapid population growth will likely result in an increasing number of people without access through 2030 and beyond. Home to about 1 billion people today, this region is expected to see the world's highest rates of population growth – at about 2.5% per year – in the coming decades, suggesting the population could double by 2050 (UNDESA, 2017^[101]). Only one in two people in the region have access to basic electricity services. Only one in four people have access to clean cooking, and rely overwhelmingly on traditional biomass for cooking, which is harmful to human health and the environment. Current and planned policies are insufficient and if continued by 2030 the region will account for more than 90% of the global population living without electricity and 44% those without clean cooking (IEA, 2017^[102]).

Technological advances and new business models in renewable energy, especially solar, are dramatically expanding options for electricity access. While national grids will play a key role, off-grid solar solutions offer new avenues to provide access to individuals and households; development of solar energy mini-grids can expand the level of service and increase opportunities to add renewables energy into the grid. Such solar options are expanding rapidly in East Africa and now also in West Africa, reaching millions of people in rural unconnected

and urban underserved areas. The concept of electricity access being solely grid based is changing to one of a “lego” design, where varied electricity options are helping to achieve full access.

Financing is key to fill the large investment gaps. To reach universal access, electricity investment needs to be USD 30 - 50 billion per year between 2017 to 2030, a magnitude of 6 times today's levels; for clean cooking, about USD 2 billion is needed, yet recent expenditures are less than 2% of this (IEA, 2017^[102]; SE4ALL, 2017^[103]). Leveraging the high use of mobile phones in Africa, innovative business models such as “pay-as-you-go” (PAYG), use mobile payment platforms and sophisticated geographical information systems to identify customers bases and organise self-financing to boost sales of off-grid solar systems, clean cooking and now mini-grid electricity (Bardouille & Shepherd, 2016^[104]). PAYG is supported by commercial policies, for example to enable movement towards a cashless economy and use of mobile money. Domestic green bonds are starting to be issued, assuring government funding for clean energy mini-grids as shown by the case of Nigeria. Several donors, such as the World Bank, are increasing their efforts to develop mini-grids and solar option. Establishing supportive domestic policies and regulations, such as for mini-grid expansion and clean cooking, is essential to ensure viable markets and attract the investment needed.

Source: Jan Corfee-Morlot et al. (forthcoming^[105]), *Achieving Clean Energy Access in Sub-Saharan Africa*.

Note: This material derives from a forthcoming Financing Climate Futures case study.

Disclose climate-related risks and opportunities for investors, corporations and governments

There is a growing awareness that inadequate disclosure of climate-related risks and opportunities can lead to a mispricing of assets and capital. For instance, some fossil fuel assets might not be able to recover their investment fully due to more stringent climate regulations, but this is not properly accounted for in financial actors' allocation decisions. This is due to a range of factors including relatively short time horizons of many mainstream financial models used to price financial securities.

Measuring and disclosing adequate climate-related information is a first step in making markets more efficient and economies more resilient. Private investors and governments alike can make better decisions with improved transparency and access to information on the climate-related performance and exposure of assets and businesses, and financial systems as a whole. In fact, not disclosing climate-related financial information would amount to knowingly excluding key information on risk and opportunity factors that would lead to mispricing, biased investment decisions and sub-optimal investment outcomes.

Many investors and corporations are actively advancing the climate-related disclosure agenda. For instance, at the One Planet Summit in Paris in 2017, financial institutions responsible for managing USD 80 trillion of assets – equivalent to annual global GDP – publicly supported the Task Force on Climate-related Financial Disclosures (TCFD) (see Box 5.3).

An important element of the disclosure agenda is the necessity to change the paradigm around disclosure. Instead of disclosing and measuring emissions with static foot-printing techniques, the TCFD encourages use of scenario analysis to consider dynamically the potential impact of the risks and opportunities of the transition to a low-emission economy on strategy and financial planning. While some institutions are affected by risks associated with climate change today, many are likely to face the most significant effects of climate change over the medium to long term, with their timing and magnitude uncertain. They need to consider how their climate-related risks and opportunities may evolve to incorporate potential effects in their planning processes appropriately.

Reporting practices could move towards the measurement of the emissions embedded in coal, oil and gas reserves and resources; scenario analysis to stress-test investors and companies' portfolios against decarbonisation scenarios; and measuring progress of companies towards science-based targets. Such disclosure would help to better understand the risks for investments misaligned with climate goals,

differentiated by financial risks and impact risks. Such practice would trigger the behavioural change needed by investors and financiers, and help move away from incremental progress to the radical reallocation needed (TCFD, 2017^[7]).

Building climate-related capacity in investors and corporations is an essential factor of success: Low-emission, resilient strategies and science-based targets need to be developed, data on climate-related risks and opportunities of businesses and portfolios need to be collected and reporting on climate-related risks will need to take off on a broad base and improve. Regulators and standard-setters could provide guidance to ensure the credibility and comparability of commitments.

Box 5.3.

What do investors need to disclose about climate?

Recommendations from the Task Force on Climate-related Financial Disclosures (TCFD)

Established by the Financial Stability Board (FSB) in response to a call from G20 Leaders, the TCFD designed a set of recommendations to “*shift financial flows towards a low-carbon economy and to avoid stranded assets, reduce or better manage climate-related risks for individual investors, corporates and reduce climate-related risks for the financial system as a whole*”. It delivered recommendations for voluntary disclosures of material, decision-useful climate-related financial risks for the G20 Summit in Hamburg.

The recommendations promoted by the TCFD are articulated around the disclosure of four essential elements :

- **Governance:** the governance around climate-related risks and opportunities;
- **Strategy:** the actual and potential impacts of climate-related risks and opportunities on the organisation's businesses, strategy and financial planning where such information is material;
- **Risk management:** the risk management arrangements on how the organisation identifies, assesses and manages climate-related risks;
- **Metrics and targets:** the metrics and targets used to assess and manage relevant climate-related risks and opportunities, where such information is material.

Source: TCFD (2017^[7]), *Final Report: Recommendations of the Task Force on Climate-related Financial Disclosures*.

Improving climate-related risks assessment and disclosure may not necessarily lead to the desired behavioural change in cases where such risk is still considered acceptable. Such measures should be part of a set of policies that make climate-related risk material to investors, and a broader disclosure agenda that could target more transparency about the financial flows themselves. Improving transparency on financial flows that contribute to the desired transition, as well as on flows that potentially undermine it, could help governments measure progress towards aligning all flows with a low-emission future.

Improving risk disclosure could also have unintended consequences that need to be addressed: there is growing evidence suggesting that developing countries vulnerable to climate change are experiencing a higher sovereign cost of debt due to climate factors, and that this might increase in the future (Buhr et al., 2018^[68]). A worsening credit status for a sovereign borrower will affect the cost of capital in domestic markets, especially those that rely on foreign capital. The unintended consequences of increased transparency on

climate-related risks and opportunities should be addressed by proposing adequate tools and instruments to mitigate such risks, and might require the development of risk transfer mechanisms and tools. Development finance institutions need to propose instruments to take over part of this risk to avoid diverting investment away from countries more exposed to climate change, particularly in the developing world. This will require significant volumes of well-targeted concessional finance with low transaction costs (see Chapter 6).

Rethink financial supervision in light of climate imperatives

There is a growing awareness among regulators and financial supervisors that success in transitioning to a world with manageable levels of climate change is a determinant of financial stability in the long run. As a first step, climate considerations need to be integrated into the rules and regulations that support the stability of the financial system.

Box 5.4.

European Commission's Action Plan on Financing Sustainable Growth

In September 2016, the European Commission launched the industry-led High-Level Expert Group (HLEG) on Sustainable Finance to examine how to integrate sustainability considerations into the European Union's financial policy framework.

The HLEG's interim report (June 2018) recommended integrating sustainability into the EU's regulatory and financial policy framework, including through climate disclosure, accounting, fiduciary duties, corporate governance and reporting, and stewardship codes. Its final report (January 2018) stressed that moving towards sustainable finance involves two imperatives: improving the contribution of finance to sustainable and inclusive growth as well as the mitigation of climate change; and strengthening financial stability by incorporating environmental, social and governance (ESG) factors into investment decision-making. The report included 30 proposals, including eight key recommendations.

Building on the recommendations provided in the HLEG's final report, the European Commission launched in March 2018 a broad Action Plan on Financing Sustainable Growth, laying down the roadmap to integrating sustainability in the financial system at

the EU level around 10 main proposed actions:

- Establishing an EU classification system for sustainable activities
- Creating standards and labels for green financial products
- Fostering investment in sustainable projects
- Incorporating sustainability when providing financial advice
- Developing sustainability benchmarks
- Better integrating sustainability in ratings and market research
- Clarifying institutional investors' and asset managers' duties
- Incorporating sustainability in prudential requirements
- Strengthening sustainability disclosure and accounting rule-making
- Fostering sustainable corporate governance and attenuating short-termism in capital markets.

The European Commission announced its first four proposals to support sustainable finance in the European Union in May 2018. It proposed legislation on benchmarks, green definitions, investor duties and retail investing.

Sources: EU High-Level Expert Group on Sustainable Finance (2017^[107]), *Financing a Sustainable European Economy: Interim Report*; EU High-Level Expert Group on Sustainable Finance (2018^[108]), *Financing a Sustainable European Economy: Final Report*; European Commission (2018^[71]), *Action Plan: Financing Sustainable Growth*.

Progress on this front has already been made. The European Commission's High-Level Expert Group recommended integrating sustainability into the European Union's regulatory and financial policy framework (see Box 5.4). At the One Planet Summit in December 2017, central banks and supervisors from three continents created the network for "greening the financial system", an initiative that intends to help accelerate climate mainstreaming in financial supervision and in the refinancing of secondary markets to promote an orderly development of green finance (One Planet Summit, 2017^[69]).

While recognising that national circumstances matter, and that there is no one-size-fits-all approach, governments, financial regulators and climate policy makers can usefully act on different levels (UN Environment and World Bank Group, 2017^[17]):

- Support low-emission, resilient investment market growth through the development of standards and policy frameworks that promote the issuance of low-emission, resilient financial products and the emergence of new market platforms. Policy banks and state controlled financial institutions including sovereign wealth funds could potentially be harnessed more comprehensively.
- Continuously monitor the potential unintended consequences of financial regulations and regulatory reforms on the supply of long-term investment financing for climate (Ang, Röttgers and Burli, 2017^[70]). This could include preserving the integrity of standards around low-emission labels and markets or by initiatives including the emerging global dialogue around capital risk weightings.
- Promote transparency in the financial system, through policies and regulations that support the disclosure of risks and opportunities associated with climate change, disclosure of financial flows and stock themselves, and developing climate-scenario analysis for insurance companies and banks. Such scenarios could be a strategic tool for policy-making. For instance, article 173 of the French energy transition law introduces mandatory climate change reporting for assets owners and managers and pension funds. In South Africa, under the South African Pension Act investors must consider how environmental factors can affect long-term performance. The Central Bank of Brazil published guidelines for the social and environmental responsibility of financial institutions (Resolution no. 4,327 of 2017). (UN Environment and World Bank Group, 2017^[17]; OECD, 2017^[106]).
- Clarify legal frameworks and mandates, related for instance to the interpretation of long-term investor obligations and responsibilities in the context of climate change or how climate can be interpreted within existing mandates of supervisory bodies.



6

Rethink development finance for climate



6. Rethink development finance for climate

While many different actors will need to be mobilised to help address the sustainable infrastructure challenge, development banks and development finance institutions – publicly owned financial institutions with a specific development or policy mandate – are critical, particularly in developing country contexts. Strong credit ratings and the backing of their shareholder governments allow development banks to leverage finance from capital markets that can be used to support development. Within the climate context, the value added of development banks is three-fold: i) they provide financing for new low-emission, resilient infrastructure, often in less mature markets; ii) they mobilise commercial finance for infrastructure investments in developing countries; and iii) they play an important role in supporting policy reform, and building institutional, technical and knowledge capacity, for both public and private actors.

Development banks have made ambitious commitments to scale up climate action and are increasing their green and climate finance activities. The latest joint report by the major multilateral development banks (MDBs) estimates that these institutions committed USD 35 billion in climate finance in 2017, a 28% increase from 2016 (African Development Bank et al., 2018^[72]).

Beyond MDBs, the development finance landscape includes a broad range of institutions which work in domestic and/or international contexts, and many national and subregional development banks are taking on a stronger role in climate action than before. Members of the International Development Finance Club (IDFC) – a global network of bilateral and national development banks and finance institutions based in developed and developing countries – committed USD 173 billion in ‘green’ finance in 2016, including USD 159 billion for climate (both domestic and cross-border) and USD 14 billion in finance supporting other environmental objectives (IDFC, 2017^[73]). Many development banks now have approaches in place to screen projects for climate and disaster risk, often including sector specific approaches, which helps to ensure that their portfolios contribute towards resilience.

As established financers of infrastructure, development banks are poised to play a much greater role in helping countries move from incremental to transformational action on climate change. But development finance is limited when compared with infrastructure investment needs in developing countries,

and development banks need to do more to better align overall portfolios with the Paris Agreement and scale up efforts to unlock commercial investment. Development banks cannot do this alone – their activities are dependent on and strongly influenced by shareholder and client governments.

Scaling up climate action requires shareholder governments and the banks themselves to make three key changes:

- Strengthen development banks’ mandates and incentives to deliver transformative climate action
- Bring new investors and sources of finance to investments to create new climate markets
- Use concessional finance to enable development banks to drive the transformation

Strengthen development banks’ mandates and incentives to deliver transformative climate action, especially in NDBs.

Shareholder governments need to give development banks stronger, coherent mandates to deliver transformative climate action by aligning portfolios with climate goals, reflecting this in corporate scorecards, and putting in place supportive internal incentive systems.

While development banks are scaling up support for climate action, the extent to which their activities overall are coherent with the goals of the Paris Agreement is less clear. MDBs’ climate-related support for infrastructure sectors illustrates some gaps. Based on data reported by MDBs to the OECD Development Assistance Committee (DAC), on average in 2015-16, across infrastructure sectors, the energy sector recorded the highest share of climate-related commitments (48%), with 24% of commitments to transport and 17% of commitments to water being climate-related (Figure 6.1). While the optimum level of mainstreaming of climate considerations will vary by sector, these figures point to a general need for more concerted action in transport and water sectors.

There is also a need for more work to define what alignment of portfolios with the goals of the Paris Agreement means in practice. Some banks are beginning work in this area. Agence française de développement (AFD), for example, has committed to ensuring that all their activities will be ‘100% Paris Agreement-compatible’ and to support countries in their

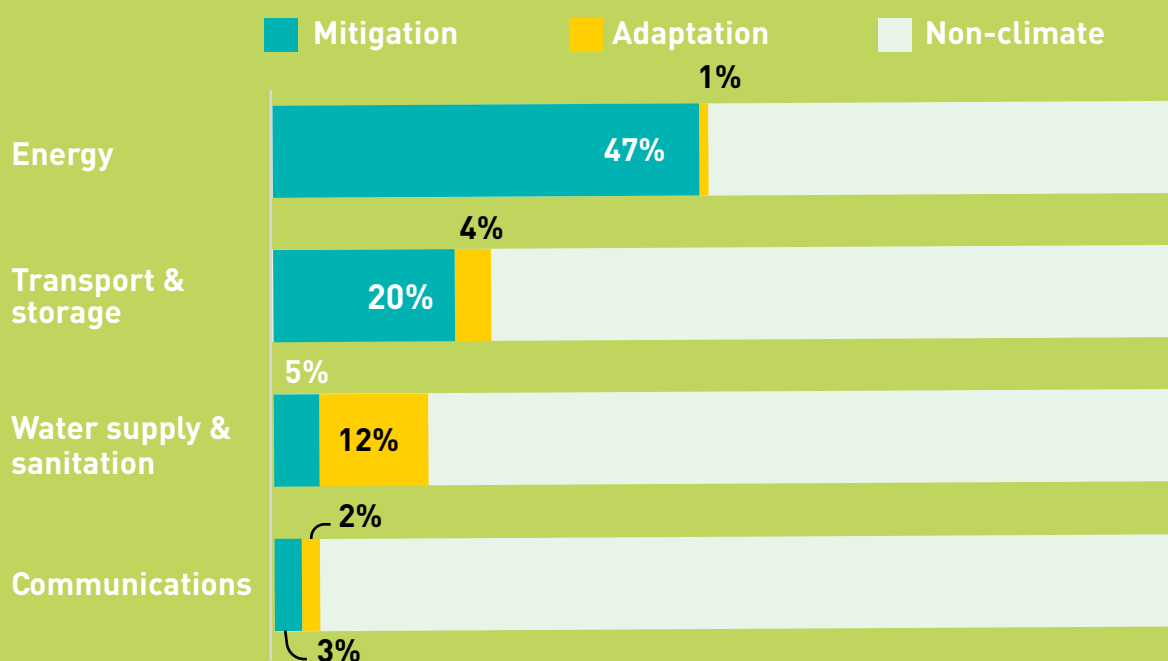
formulation of low-carbon and climate-resilient development trajectories (AFD, 2017^[109]).

Coherent mandates are important for bilateral and multilateral development banks that have to deliver on several development priorities. Incentive structures that drive corporate and staff performance in development banks need to reflect climate and other outcomes, including through the mobilisation of commercial finance. In addition, banks need to build capacity and skills among management, investment officers, analysts, and research teams to avoid a bias towards ‘business-as-usual’ infrastructure projects and instead promote investment in technologies and programmatic approaches centred on climate change such as distributed renewable energy, energy efficiency, low-carbon forestry, climate-proofing, etc.

National Development Banks (NDBs) from emerging economies, in particular, need to be empowered by their governments and the international community to take on a stronger role in climate action (see Box 6.1). NDBs are well placed to understand country-specific bottlenecks to climate investments due to their proximity to the market and relationships with local public and private actors. NDBs also provide financing in local currencies, and by adopting measures to integrate climate considerations into their lending activities, they can have a demonstration effect among other financial institutions in the country. Clear mandates and clear policy trajectories are critical for NDBs, many of which continue to support carbon-intensive technologies, such as coal. Many NDBs lack the capacity and resources to effectively mainstream climate change into their operations, and need support to better access international climate finance and to develop and scale up approaches to

Figure 6.1.

Share of multilateral development bank (MDB) financing for infrastructure that is climate-related, by sector, 2015-16 average



Note: This graph is based on commitment data (constant USD 2016 values) reported to the OECD Development Assistance Committee by the following MDBs: African Development Bank (AfDB), the Asian Development Bank (AsDB), the European Bank for Reconstruction and Development (EBRD), the European Investment Bank (EIB), the Inter-American Development Bank (IDB) and the World Bank. IFC is not included in this graph due to data unavailability. 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.

Box 6.1.

NDBs from emerging economies play a growing role in climate and green finance

The development and climate finance landscape is changing rapidly, and international public sources of finance play a relatively modest role, especially for infrastructure. Miyamoto and Chiofalo (2016^[110]) estimate that official development finance – from donors, MDBs and bilateral banks – makes up only 6-7% of infrastructure financing in developing countries, with most of the resources coming from national governments and a third from the private sector.

Against this backdrop, national development banks (NDBs) from major emerging economies such as Brazil (BNDES), China (the China Development Bank), South Africa (DBSA) and Turkey (TSKB) are increasingly featured in international discussions on infrastructure and climate change. Many of these banks are part of the International Development Finance Club (IDFC), a global network of 23 development banks and finance institutions based in OECD and non-OECD countries. In addition to emerging economy NDBs it includes bilateral development banks like KfW, AFD and JICA; and subregional development banks like the Development Bank of Latin America (CAF).

Together, IDFC members committed USD 173 billion in 'green' finance in 2016 (IDFC, 2017^[73]). The major share of this finance stemmed from institutions based in non-OECD countries. Only a relatively modest share of the USD 173 billion went towards cross-border financing projects in other countries, with the lion's share supporting domestic projects. While much of this cross-border financing originated in banks in OECD countries, USD 7 billion was committed by IDFC members based outside the OECD for other developing countries, highlighting the growing role emerging economy banks are beginning to play in international environment-related development finance.

Source: OECD (forthcoming^[74]), *Mobilising commercial capital for sustainable infrastructure: Insights from national development banks*.

Note: This material derives from a forthcoming Financing Climate Futures case study.

mobilise domestic commercial investment. Governments should promote collaboration between international and national development banks, and encourage forums that help develop standards for reporting green investments amongst NDBs.

Bring new investors and sources of finance to investments to create new climate markets

The overlap between private finance and development finance is getting larger, with many private finance actors embracing the Environmental, Social and Governance (ESG) agenda, and with more pressure on development banks and development finance institutions to work closely with commercial actors. This convergence is particularly prominent in impact investing where private investors and development finance institutions work side-by-side to support projects that have a measurable environmental or social impact as well as produce financial returns (OECD, 2016^[75]).

There needs to be a much stronger focus on mobilising private finance and commercial investors in the approaches used by development banks, especially bringing new investors and sources of finance to investments. This means working with governments to develop enabling policies and regulations to scale up commercial investment, optimising the risks development banks carry, and using concessional finance – through blended finance, for example – in cases where investments are critical to achieve climate goals, but cannot be viably financed through non-concessional windows. Working together, development banks and other stakeholders can help address major bottlenecks and build the much needed project pipeline in developing countries by:

- Providing intermediation solutions and aggregating smaller investments to help bridge the mismatch between the demand side of project financing and the supply of financing from financial markets for climate-related investments
- Standardising the terms and conditions related to low-carbon infrastructure projects to reduce transaction costs
- Rolling out risk-mitigation, including efforts to effectively manage currency risks, which are critical for channeling investment towards developing countries.

Use concessional finance to enable development finance institutions to drive the transformation

Governments – and the capital as well as concessional finance they provide – are important direct and indirect drivers of change among development banks. Governments directly influence the behaviour of multilateral and bilateral development banks, and guide their activities and operations, usually engaging at a strategic level (on policy) and at an

operational level (on projects) on environmental issues (Crishna Morgado and Taskin^[76]). They can encourage banks to scale up transformative climate actions while reviewing their policies and strategies, as well as during trust fund and capital replenishment discussions.

Amidst demands for support on a variety of development challenges, development banks' efforts to mobilise private capital for low-carbon infrastructure are dependent both on their own balance sheet and lending capacity, as well as on concessional finance from donors. In their role as shareholders, governments must make greater efforts to provide clear, coherent signals and guidance to development banks to take a stronger role in driving transformative climate investments.

Targeted, concessional finance for climate action – provided bilaterally from governments as well as through multilateral climate funds – is also important to help development banks make the case for climate-related investments to client countries in cases where there is less demand for these. To continue to encourage development banks to support

developing countries' transform their development pathways, governments should allocate concessional finance for climate to investments which have the potential to create markets and make way for more investments at less concessional terms e.g. by creating scale or serving as proof of concept for newer approaches.

Concessional finance – through blended finance – is also key to help bridge viability gaps for public and private investments in countries where markets are not yet optimal for mobilising commercial finance purely at market terms. This support needs to be well-targeted and efficiently allocated to help make projects viable, and its use in mobilising private finance should be underpinned by strong policy principles and standards to ensure that the focus is on crowding in investment without distorting markets (OECD, 2018^[77]).



7

Build low-emission and resilient urban societies



7. Build low-emission and resilient urban societies

Cities are home to over half of the global population (UNDESA, 2018^[78]) and account for over 80% of global GDP (Akhmouch and Matsumoto, 2018^[79]). However, they are also responsible for two-thirds of energy consumption and 70% of greenhouse gases globally (OECD, 2014^[54]). As urban populations are expected to grow to over 70% of the world population by 2050 (Figure 7.1) (UNDESA, 2018^[78]), trillions of dollars will be needed to expand and renew urban infrastructure. Choices made today about the types, features and location of long-lived infrastructure will determine the extent and impact of climate change, contribute to the vulnerability or resilience of urban societies, and create the backbone for a strong, inclusive urban development. The failure to invest in the right urban forms will put residents, the local economy and social cohesion at risk; and potentially entrench and exacerbate today's inequalities.

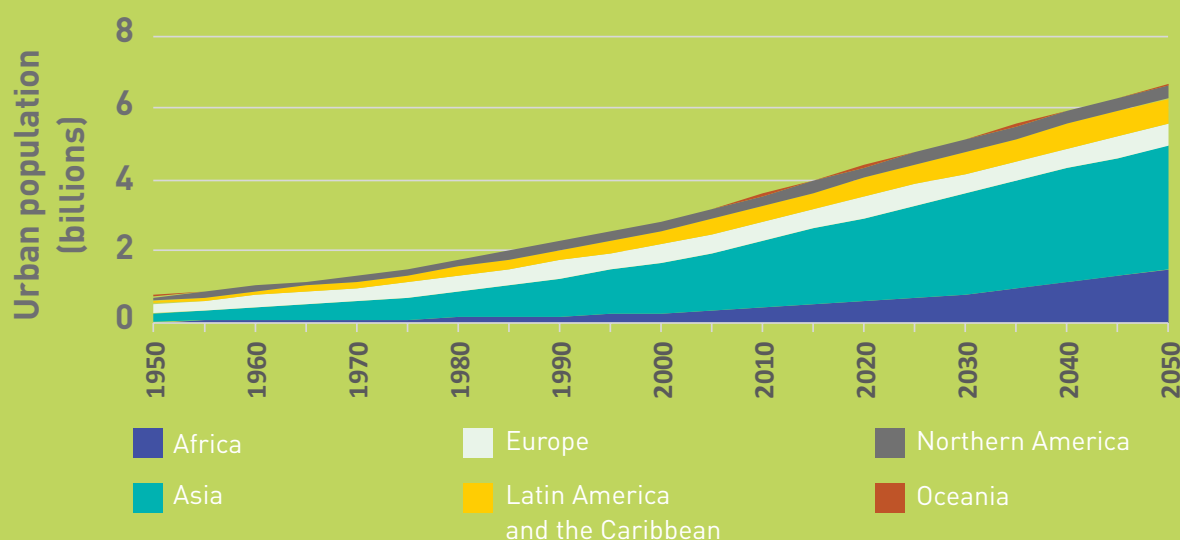
Cities are particularly vulnerable to climate risks and must therefore weigh strategies to ensure that investments made today do not become tomorrow's damaged or stranded assets. In 2014, 89% of cities – home to 2.1 billion people – were located in areas highly vulnerable to economic losses from natural disasters

(UNDESA, 2015^[80]). Extreme weather events can be particularly disruptive to complex urban systems and areas of high population density. Much of the world's urban population inhabits low-lying coastal areas, making them more vulnerable to storm surges and rising sea levels. Many of these low-lying urban areas are also rapidly expanding – 90% of urban population growth is forecast to occur in Asia and Africa – compounding risks. Cities in developing countries are particularly vulnerable to flood risks, as they are also less equipped to prepare for and address the fallout from disasters (Hallegatte et al., 2013^[81]).

The short-term benefits of climate action are greater at the level of cities, because citizens feel them more directly. Increasing public transport and infrastructure for pedestrians and cyclists in cities can lead to increased physical activity, lower traffic mortality rates, less air and noise pollution, less traffic congestion, and lower personal transport costs. It can also result in greater social inclusion, as more accessible forms of transportation can help vulnerable populations participate in the workforce by increasing access to jobs (OECD, 2018^[60]). Investing in climate-resilient infrastructure therefore presents

Figure 7.1.

Urban populations are expected to continue growing, particularly in Asia and Africa



United Nations, Department of Economic and Social Affairs, Population Division (2018^[78]), World Urbanization Prospects: The 2018 Revision, custom data acquired from website: <https://population.un.org/wup/>

a tremendous opportunity, and imperative, for cities to ensure their sustainability towards a changing climate, drastically reduce their emissions, and reduce inequalities within and between regions.

Local governments are instrumental in getting the low-emission, resilient transformation right. They often have authority over many local decisions that matter for limiting greenhouse gas emissions and strengthening the adaptive capacity of cities, such as spatial planning and zoning, regulation of transport, building construction, water, and emergency management systems (Hallegatte et al., 2016_[82]). Local governments are also major spenders and investors. Their budgets account for an increasing share of public expenditures, carrying out 40% of total public spending on average in the OECD and 57% of public investment in 2016 (OECD, 2018_[83]). On average, subnational governments are also responsible for 64% of climate-related spending and investment (OECD, 2018_[83]). Despite this responsibility, cities report constrained financing capacity to deliver on their infrastructure needs (OECD, 2018_[83]).

To empower local governments, four key steps are necessary:

- Integrate land-use and transport policies
- Align national and local fiscal regulations with investment needs in cities
- Build climate-related and project finance capacity in cities
- Seize the development benefits of low-emission, resilient planning

Integrate land-use and transport policies

Infrastructure investment needs cannot be disconnected from land-use planning. Urban forms influence the demand for infrastructure services, as denser developments reduce the demand for mobility, as well as the supply of infrastructure services. Making cities more compact and connected can also lower investment requirements by as much as 10% (New Climate Economy, 2014_[120]). In most OECD countries, urban sprawl has increased since 1990 (OECD, 2018_[55]). Specifically, cities have become more fragmented and the share of land allocated to very low-density areas has increased. Urban areas have become denser on average, but 60% of urban space is sparsely populated (OECD, 2018_[55]). In fast-growing cities, urban layouts – and therefore emissions pathways – are being determined now.

Land-use policies can be reformed to encourage more sustainable urban development patterns. This includes relaxing minimum density restrictions, shifting the cost of infrastructure provision to developers, streamlining land-use taxation to remove incentives for developing land on the outskirts of cities, and introducing market-based instruments that encourage densification in key urban areas (OECD, 2018_[55]). This should be accompanied by a shift towards greener urban transport, by investing in public and non-motorised transport infrastructure

while appropriately pricing car travel and parking (OECD, 2018_[55]). Urban planning can also encourage functionally and socially mixed neighbourhoods with access to green spaces (New Climate Economy, 2018_[85]).

Subnational and local governments can strengthen collaboration between cities and different levels of governments, for example by creating single entities with transport and land-use authority, and favouring looser forms of collaboration. National and local transport agencies can develop pipelines of low-emission, resilient infrastructure projects aligned with long-term climate goals. Finally, local planning agencies can mainstream climate and resilience in their cost-benefit analyses.

Align national and local fiscal regulations with investment needs in cities

There is a potential infrastructure financing gap of more than USD 1 trillion per year, much of this falling to cities (Floater et al., 2017_[86]). One of the primary challenges is cities' limited ability to tax, as they are typically constrained by legislation at higher levels of government. The Inter-American Development Bank (IDB) governance database shows less than half of countries have devolved fiscal or legislative powers to subnational governments (Floater et al., 2017_[86]). Cities are further constrained in their ability to borrow; they may be limited by whether and how much they can borrow from the private sector (OECD, 2014_[54]). According to the IADB database, 56% of countries do not allow borrowing of any kind by local governments (Floater et al., 2017_[86]). Sometimes national frameworks also prevent cities from issuing bonds. While this limits financial risks, it also can deprive cities of an important source of finance.

Cities with devolved revenue-raising capacity can align their existing municipal revenue streams to help achieve climate goals; for example, congestion charges and parking fees can help shift users towards using less emitting public transit alternatives, and property taxes and development charges can encourage density in urban areas (OECD, 2013_[88]; OECD, 2018_[55]). Some cities can also introduce emissions pricing initiatives, offering the dual benefit of raising revenues that fund low-emission, resilient infrastructure while also helping to internalise the costs of emissions. For example, Beijing, Shenzhen and Tokyo have all implemented or are planning to implement emissions-trading schemes (World Bank Group, 2018_[3]).

Multi-national development banks and development finance institutions can provide technical support to facilitate access to international markets and propose city-specific financial instruments such as bonds (Box 7.1) and grants to scale up investment, and help improve credit-worthiness of cities through guarantee mechanisms. Coalitions such as the Cities

Climate Finance Leadership Alliance (CCFLA), launched in 2014, work to mobilise and accelerate investment into low-emission, resilient infrastructure in cities and urban areas (Cities Climate Finance Leadership Alliance^[111]).

National ministries of finance can help by reviewing the fiscal framework of cities and identifying misalignments with climate and resilience objectives, and by developing national legislation that clearly articulates whether cities can borrow and under what circumstances. Finally, local governments can align local taxes and charges with low-emission, resilient development (such as introducing appropriately priced parking fees, congestion charges, and emissions pricing), and reform fees and taxes that encourage sprawl.

Box 7.1.

The role of bonds for cities

Subnational green bond growth issuance is rising, and accounted for 21% of green bond issuance in 2017 (Climate Bonds Initiative, 2018^[113]). The first green bonds for cities were issued in 2013; 180 bonds in 13 countries have since been issued (Climate Bonds Initiative, 2017^[89]). Major cities plan to use the resulting funds for various projects: New York City plans to improve wastewater adaptation and build a USD 1.7 billion subway expansion, while Wuhan in central China's total issuance of USD 8.7 billion will go towards planned projects including flood protection and a public bicycle service. Amsterdam, Lagos, Mumbai, and Tokyo are all potential green bond issuers (Climate Bonds Initiative, 2017^[89]). Further financing mechanisms for climate-resilient urban infrastructure include the use of catastrophe bonds, the establishment of dedicated finance facilities, dedicated global climate funds as well as ODA used by developing countries' cities.

Build climate-related and project finance capacity in cities

In addition to the challenges facing local governments with respect to their fiscal autonomy, there is a lack of capacity at different levels of the low-emission, resilient infrastructure value chain, from measuring emissions to mainstreaming climate risks in infrastructure planning to efficiently finance and deliver infrastructure projects. These capacity gaps can affect not only governments' success in delivering on their climate objectives, but also poses a barrier to being able to borrow (Box 7.2).

Only 20% of the world's 150 largest cities have the basic analytical tools at their disposal for low-carbon urban planning (World Bank, 2013^[90]). Developing capacity of local governments and administrations is fundamental to make climate action work, particularly in developing countries that suffer from capacity constraints and severe vulnerabilities to the adverse effects of climate change. This is recognised in Article 11.2 of the Paris Agreement, which states that "Capacity-building should be country-driven, based on and responsive to national needs including at the national, subnational and local levels" (UNFCCC, 2015^[15]).

National governments and development finance institutions can help by building capacity at the local government level in enhancing access to private capital markets or working with the private sector (OECD, 2014^[54]). They can develop capacities and skills to elaborate risk-informed urban plans, and to design and select urban infrastructure to take into account future climates and the associated uncertainties. Further, they can help build climate-related capacities to develop long-term low-emission strategies and measure greenhouse gas emissions and progress.

Box 7.2.

Creditworthiness initiatives can help cities access external financing

One of the key problems for cities in developing countries is their poor creditworthiness. Improving the creditworthiness of cities is key to unlocking private finance. Estimates suggest that less than 4% of the largest 500 cities in developing countries are considered creditworthy in international markets, and less than 20% are considered creditworthy in local markets (World Bank, 2013^[91]). Improving creditworthiness can have tremendous impacts: just USD 1 of investment in improving city creditworthiness in a developing country can leverage more than USD 100 in private investment in sustainable urban infrastructure (World Bank, 2013^[91]).

City creditworthiness initiatives and project preparation facilities, such as the World Bank's City Resilience Program (CRP) or the C40 Finance Facility, can support public entities' capacities in developing bankable projects and scale up their investment on infrastructure. This applies in particular to cities in developing countries, as the majority still lack access to external financing sources.

Seize the development benefits of low-emission, resilient planning

Income inequality is already higher in cities relative to their respective national averages, and could be worsened by climate change (Hallegatte et al., 2016^[82]; OECD, 2018^[60]). Cities therefore have a crucial role to play in implementing and delivering the low-emission energy transition in an inclusive way. In Baltimore (US) and London (UK), life expectancy, which has been linked to income, can vary by 20 years across neighbourhoods (OECD, 2016^[121]). Globally, a billion people live in slum-like conditions that are extremely vulnerable to climate impacts (UN Habitat, 2016^[92]).

Core climate policies – such as those relating to energy, transport and carbon taxation; subsidy and pricing reforms; support for renewable and low-carbon energy; energy efficiency programmes; and transport planning and management – have the potential to affect household spending and the affordability of energy, transport services, and housing, particularly for low-income households (OECD, 2018^[60]). Policies outside the

climate portfolio can also influence climate and inclusive growth. For instance, local tax policies, by affecting the costs and benefits of land use, can have a significant impact on emissions and on housing affordability (OECD, 2017^[2]). Considering the impacts of policies at the subnational level on development and inclusiveness is therefore central to strategic, cohesive planning.

Sub-national and local governments can help by mainstreaming inclusiveness in infrastructure planning (Box 7.3). Specifically, cities can integrate climate and inclusiveness outcomes through investing in revenues from environmental taxes and fees in measures that also boost inclusive growth and measure greater use of land value capture tools to support climate and inclusive growth objectives. Finally, cities can take advantage of skills development and job-creation opportunities in urban infrastructure financing and investment, particularly relating to energy efficiency investments, and explore the potential for green bonds to achieve both climate and inclusion goals.

Box 7.3.

Cities present an opportunity to tackle both the climate change and inclusive growth agendas

Climate change may exacerbate inequalities in cities, which are already relatively higher in cities than the country average. Investing in climate objectives in cities can also support inclusion objectives, for example by channeling revenues towards climate investments that benefit low-income populations.

National and subnational governments can mitigate the impacts of climate change on vulnerable populations by applying an inclusion lens to climate-related spending and financing. They can get the governance right for infrastructure planning by integrating land-use and transport policies, can invest revenues from environmental taxes and fees in measures that also boost inclusive growth, and make greater use of land value capture tools to support climate and inclusive growth objectives. They can also take advantage of skills

development and job-creation opportunities in urban infrastructure financing and investment, particularly relating to energy efficiency investments.

While investments in low-emission urban infrastructure can have positive impacts on low-income and vulnerable populations, policies and financing tools designed to address climate change can also have significant distributional impacts that may disproportionately affect low-income populations. One example is financing tools that effectively put a price on carbon, such as carbon taxes or congestion charges, which tend to be regressive. To address these concerns, authorities can channel revenue from such instruments towards climate investments that benefit low-income populations, such as improvements to sustainable public transport.

Source: OECD (2018^[83]), *Financing climate objectives in cities and regions to deliver sustainable and inclusive growth*.

Note: This material derives from a forthcoming Financing Climate Futures case study.

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