



Financing Climate Futures

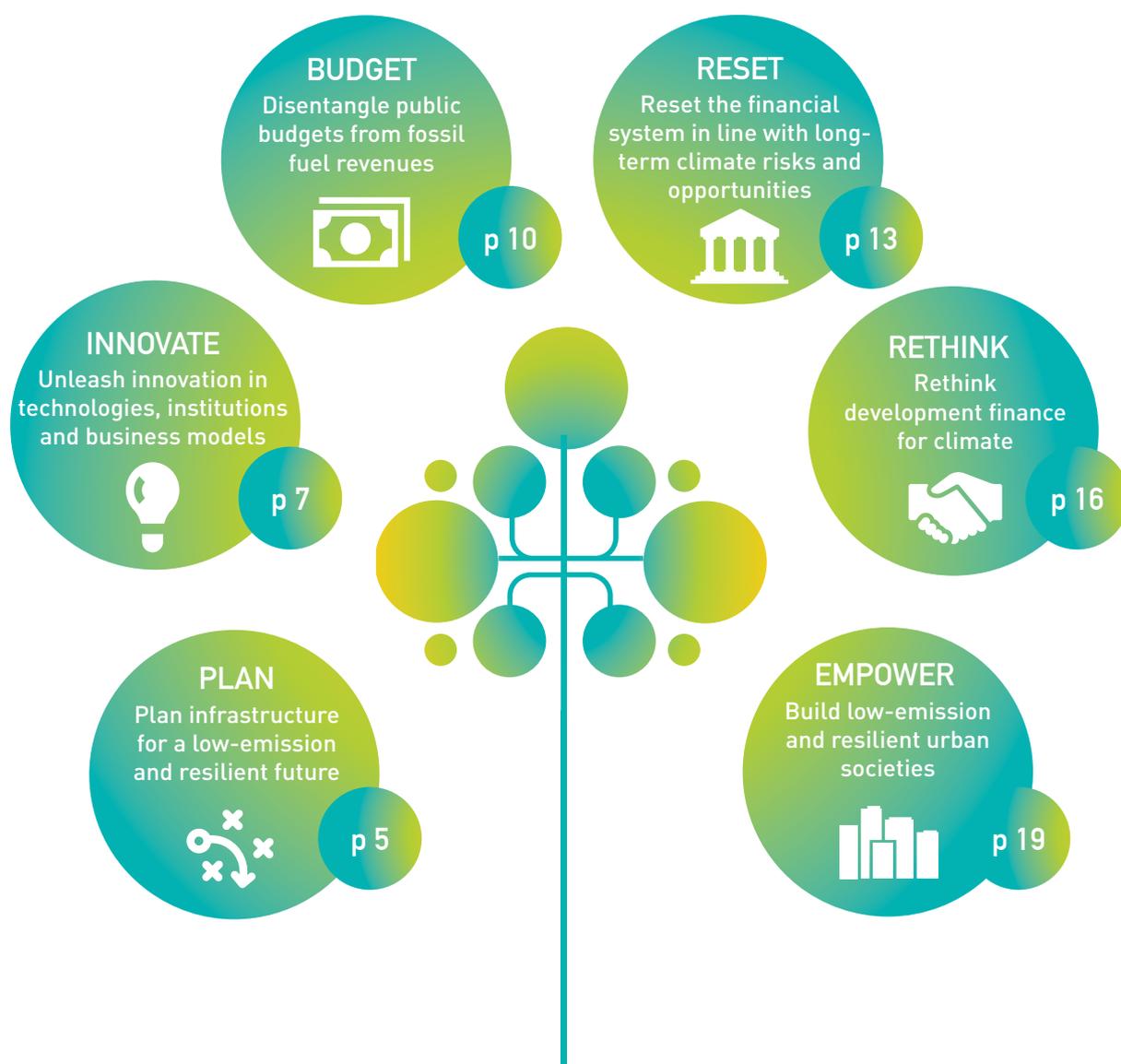
RETHINKING INFRASTRUCTURE

Policy Highlights

Financing Climate Futures: Rethinking Infrastructure

Policy Highlights

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



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Executive Summary

Infrastructure sits at the very centre of development pathways and underpins economic growth, productivity and well-being. Yet infrastructure has suffered from chronic underinvestment for decades, in both developed and developing economies. The OECD estimates that USD 6.9 trillion a year is required up to 2030 to meet climate and development objectives. Furthermore, current energy, transport, building and water infrastructure make up more than 60% of global greenhouse gas emissions. An unprecedented transformation of existing infrastructure systems is needed to achieve the world's climate and development objectives.

Aligning financial flows with low-emission, resilient development pathways is now more critical than ever to meet the goals of the Paris Agreement and deliver on the 2030 Agenda for Sustainable Development. Today there is a unique opportunity to develop infrastructure systems that deliver better services while protecting the environment. Harnessing the benefits of rapidly emerging technologies, new business models and financial innovations will be key in opening new pathways to low-emission, resilient futures.

Mobilising public and private resources across the financial spectrum is an essential part of generating the trillions of dollars needed for sustainable infrastructure. Public finance institutions, banks, institutional investors, corporations and capital markets all have a crucial role to play, both in their own right and as part of the broader financial ecosystem.

Governments need to set the right incentives to mobilise finance away from emissions-intensive projects, and provide investment and climate policy frameworks that support the rapid and radical transformations required. While there has been some progress, current policies continue to foster an incremental approach to climate. Existing policy frameworks, government revenues and economic interests continue to be entangled in fossil fuels and emissions-intensive activities. Deeper efforts are needed to drive systemic change, overcome institutional inertia and break away from the vested interests that are often barriers to low-emission, resilient development.

Enhanced international co-operation, through the Paris Agreement or fora such as the G7 and the G20, is an essential part of the transformation. The international community has increasingly recognised the need for such transformation: almost all G20 countries confirmed their willingness to embark on a global energy transition in line with climate and development goals in the 2017 G20 Hamburg Climate and Energy Action Plan for Growth. There is also growing awareness that the push for greater climate action must be accompanied by a just and inclusive transition to address inequalities and provide equal opportunities for all parts of society. Governments need to ensure that the transition benefits everyone and does not disproportionately affect the poor and most vulnerable.

This report lays out an agenda to enable societies around the world to undertake the kind of systemic actions that the transformation towards a low-emission, resilient future will require. It highlights 6 transformative areas and 20 actions that are key to aligning financial flows with climate and development goals in the areas of planning, innovation, public budgeting, financial systems, development finance and cities.

- **Plan infrastructure for a low-emission and resilient future**, by rethinking planning at all levels of governments to align current infrastructure project plans with long-term climate and development objectives, avoid carbon lock-in and make resilience the norm in infrastructure decisions.
- **Unleash innovation to accelerate the transition**, by deploying targeted innovation policies and accelerating the deployment of existing technologies, business models and services, swiftly moving the next generation of solutions from the lab to the market, and promoting international technology diffusion to make sure innovation benefits all.
- **Ensure fiscal sustainability for a low-emission, resilient future**, by diversifying sources of government revenue to reduce carbon entanglement, aligning fiscal and budgetary incentives with climate objectives and harnessing the power of public procurement and public institutions' spending while ensuring an inclusive transition along the way.
- **Reset the financial system in line with long-term climate risks and opportunities**, by fixing biased incentives, capability gaps and inadequate climate risk disclosure and pricing that are hindering the allocation of finance to low-emission, resilient infrastructure.
- **Rethink development finance for climate, by ensuring that development finance institutions have the resources**, mandates and incentives to deliver transformative climate action, attract new investors and sources of finance by using concessional finance strategically, and help countries advance their climate agendas and build enabling environments and "climate markets".
- **Empower city governments to build low-emission and resilient urban societies**, by developing capacity to more effectively plan and finance the right infrastructure, aligning national and local fiscal regulations with investment needs, and building climate-related and project finance capacity at the city level.

Delivering on the transformation will be challenging. While there is encouraging momentum, governments must continue to drive systemic changes to ensure that financial flows are well aligned with the infrastructure needed for low-emission, resilient pathways to the future. Moving towards a more transformative agenda will help governments deliver sustainable, balanced and inclusive growth and improve well-being within and across societies.

1. Climate, infrastructure and finance: An agenda for transformation

A fundamental transformation of existing infrastructure systems is needed

A pathway compatible with the objective of the Paris Agreement to limit global temperature increase to well-below 2°C and towards 1.5°C above pre-industrial levels requires a radical change to infrastructure, technologies and behaviours. Significant greenhouse gas emissions are embedded in the vast majority of human activities and preferences. The world's energy, transport, buildings and water infrastructure emit more than 60% of current greenhouse gases. Increased transport, agricultural, and housing pressures from a growing global middle class are all serving to drive increased emissions (NCE, 2016_[64]).

The urgency and scale of the infrastructure challenge was starkly laid out in the Intergovernmental Panel on Climate Change (IPCC)'s special report on the impacts of global warming of 1.5°C above pre-industrial levels (IPCC, 2018_[11]). To limit warming to 1.5°C, CO₂ emissions would need to fall by about 45% by 2030 compared to 2010 levels, and would need to reach net-zero around 2050. The report concludes that "rapid and far-reaching transitions in energy, land, urban and infrastructure (including transport and buildings) and industrial systems" are required in order to limit global warming to 1.5°C. It highlights the need for an unprecedented transition across these systems, and a significant increase in investments. Annual investment in low-carbon energy and energy efficiency would need to increase by a factor of five by 2050.

Recent OECD estimates indicate that around USD 6.3 trillion of infrastructure investment is needed each year to 2030 to meet development goals, increasing to USD 6.9 trillion a year to make this investment compatible with the goals of the Paris Agreement (OECD, 2017_[2]). The urgent need to address this gap presents a unique opportunity in the coming years to move the climate and development agendas forward and develop infrastructure systems that deliver better services while also achieving climate and development goals.

The push for greater climate action is accompanied by a need for policies that address inequalities and provide the same opportunities for all. Across the OECD, the top 10% of the income distribution earn around 10 times more than the bottom 10%, up from just 7 times more 30 years ago. Climate change threatens to increase the effects of structural inequalities worldwide. Even though wealthier populations may have more assets at risk of climate change impacts, disadvantaged populations tend to be more vulnerable and suffer disproportionately from a changing climate.

Moving beyond an incremental policy approach to climate, infrastructure and finance

While there is clearly some progress in developing and implementing policies in support of sustainable infrastructure, it has proven to be challenging to move beyond relatively marginal



GREEN BOND MARKET



Source: G20 Green Finance Study Group (2016_[3])

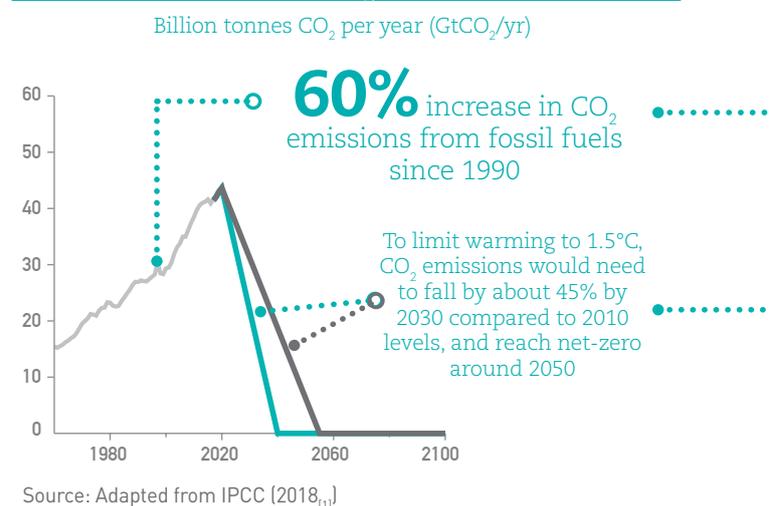


INFRASTRUCTURE INVESTMENT NEEDS

\$6.3tn is needed/year to 2030 to meet development goals
\$6.9tn to meet the Paris Agreement goals

Source: OECD (2017_[2])

STYLISTED NET GLOBAL CO₂ EMISSION PATHWAYS



GLOBAL GREENHOUSE GAS EMISSIONS



Over **60%** emitted by current energy, transport, buildings and water infrastructure

Source: NCE (2016^[64])

REQUIRED INVESTMENT IN LOW-CARBON ENERGY



5X increase required in low-carbon energy and energy efficiency investment annually

Source: IPCC (2018^[11])

GLOBAL GDP

In the same timeframe, world GDP has more than doubled.



Source: OECD (2017^[12])

According to the IPCC, “rapid and far-reaching transitions in energy, land, urban and infrastructure (including transport and buildings) and industrial systems” are required in order to limit global warming to 1.5°C

or incremental changes to policies and behaviours. Since 1990, world GDP has more than doubled while CO₂ emissions from fossil fuels increased by 60% (OECD, 2017^[2]). Climate action planned or currently underway, while heading in the right direction, has proven insufficient to deliver the transition required.

The scale of the transformation needed is such that government budgets are insufficient to generate the trillions of dollars required. Mobilising private investment towards the transition is therefore essential. Low-emission infrastructure investment remains less than 1% of the overall portfolios of institutional investors (G20 Green Finance Study Group, 2016^[3]). In the energy sector, infrastructure investment patterns fail to demonstrate the shift of capital required for the low-emission transition. Investment in the extraction and transport of fossil fuels, oil refining and construction of fossil fuel power plants still represented 57.1% of global investment in energy supply in 2017 (IEA, 2018^[4]).

Overcoming barriers to mobilise private sector investment at scale requires action across climate and investment policies in a co-ordinated way. First, governments should make greater efforts to improve the overall business environment and 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 (Fay et al., 2015^[5]). Second, developing a strong and stable climate policy framework to orient the economy away from emissions-intensive activities is essential to level the playing field with low-emission alternatives. Third, aligning the overall policy framework with climate goals is essential (OECD, 2015^[6]).

But it is not enough. Current institutional settings and processes are not fit to achieve the transformation needed. Current infrastructure planning practices, decision-making processes and institutional settings inherited from the last century reflect a status quo based on conventional practices and a continued “silo mentality” (Box 1). Governments need to move away from a sectoral

approach to infrastructure planning and financing, and move towards a more systemic, forward-looking and whole-of-government approach to infrastructure decisions.

Overcoming institutional inertia means addressing a series of barriers inherent to our processes, practices and institutions that are preventing more ambitious climate action. Governments can seek to address behavioural and data biases that encourage choices based on conventional practices rather than forward-looking potential. They can examine misaligned incentives and capacity gaps along the investment value chain, from procurement to investment decisions. Finally, 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 must be overcome (Röttgers and Anderson, 2018^[7]; Maimbo et al., 2017^[8])

An agenda for transformation

Financing Climate Futures: Rethinking Infrastructure lays out the agenda for a low-emission, resilient transformation that requires action across six areas:

- Plan infrastructure for a low-emission and resilient future
- Unleash innovation to unlock the transition
- Ensure fiscal sustainability for a low-emission, resilient future
- Reset the financial system in line with long-term climate risks and opportunities
- Rethink development finance for climate
- Empower city governments to build low-emission and resilient urban societies

Different country contexts, resource endowments and capabilities will determine the priority areas for individual countries. In all countries, however, it is critical that a whole-of-government and whole-of-society approach is employed, with a central role to be played by ministries of finance and economy. 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.

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.

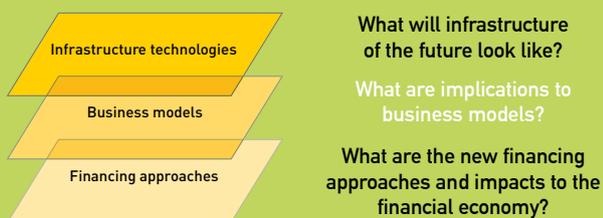
Shifting the Lens has used a simple analytic framework to identify a number of critical uncertainties that affect future infrastructure demand and supply.

Four Tier Analytic Framework

Factors affecting infrastructure demand:



Factors affecting infrastructure supply:



The report points to critical uncertainties that influence the selection, design, procurement, deployment and related financing decisions regarding low-emission, resilient infrastructure.

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 citizen 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 co-operation*: international co-operation 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.

Source: *Shifting the Lens* (2018_[9]), UN Environment.

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



Governments face the dual challenge of planning infrastructure that satisfies their citizens' immediate demands while simultaneously meeting long-term climate goals. On both counts, business-as-usual planning practices have underperformed, leading to underinvestment in infrastructure systems and sluggish action to mainstream climate resilience and curb emissions. Governments can undertake a series of important actions now to help prepare for a low-emission future.

Plan infrastructure in the present with long-term climate goals in mind

To deliver the transformation needed and help unlock financial flows towards low-emission, resilient infrastructure, countries should develop clear infrastructure investment plans that take mitigation and adaptation objectives into account (Box 2). Ensuring that infrastructure investments are flexible and robust against a different set of socio-economic uncertainties is essential to building systemic climate resilience. Countries' emission reduction pledges in the mid-term must be consistent with net-zero emission longer-term goals. While Nationally Determined Contributions (NDCs) adopt a 5- or 10-year view, infrastructure assets are often in operation for several decades so their potential impact on emissions and climate go far beyond what NDCs can capture.

Long-term planning exercises, such as the long-term low-emission development plans recommended by Article 4.19 of the Paris Agreement, need to become the norm across all countries to prepare adequately for the global transition towards a low-emission, resilient future. Some countries are beginning to advance these development strategies and systematically integrate climate considerations in infrastructure planning, but they remain the exception. To date, only 10 of the UNFCCC's 197 parties have submitted long-term low-emission development strategies.

A strategic vision of infrastructure's role in national development that runs across ministerial portfolios allows for connections between energy, transport, water and other infrastructure, as well as the co-benefits (such as improved health outcomes) to be exploited. This helps to create synergies, reduce inefficiencies and foster support for the transition. According to an OECD survey, only about half of OECD countries reported having a strategy for infrastructure that covers all sectors (OECD, 2018_[10]).

A key component of success for meeting the Paris Agreement's objectives is building governments' climate-related capacities. This includes climate-modelling capacities to understand whether current infrastructure decisions are compatible with

carbon budgets and emission reduction trajectories of long-term plans. In addition to climate modelling, decision-makers can also employ 'backcasting' to determine which proposed policies or infrastructure projects are compatible with long-term science-based targets. In backcasting, rather than starting from present trends, modellers begin with the desired outcome (for example, national emissions reduction goals) and work backwards to construct a plausible pathway to achieve goals. This approach can be used to identify misalignments between present actions and long-term objectives in policy, infrastructure and investment.

It is essential that investments stop flowing towards projects incompatible with the Paris Agreement goals. As an alternative to emissions-intensive assets, 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' for investment to streamline the process between project conception and financing. To create such pipelines, governments and public institutions must develop detailed infrastructure investment plans and integrate them into the national priority context. This can help create clear signals to investors as to where investments should flow (OECD, 2018_[11]).

Make resilient infrastructure the norm, not the exception

Climate change poses threats to economic development, with rising sea levels, increased risk of drought, shifting rainfall patterns greater prevalence of temperature extremes, and increasing intensity and frequency of severe weather events. There is an urgent need to strengthen existing and build new

LOW-EMISSION STRATEGIES



as of November 2018

10/197 of the UNFCCC's parties have submitted low-emission, long-term strategies

Benin
Canada
Czech Republic
France
Germany
Marshall Islands
Mexico
Ukraine
United Kingdom
United States

Source: UNFCCC _[58]

infrastructure that can respond more adequately to the risks and impacts of a changing climate.

A key action for greater resilience is to fill the investment gap and mobilise additional resources for projects that enhance adaptive capacity, strengthen resilience and reduce vulnerability. This can be achieved, in part, through new technologies and better data, as well as by influencing the behaviour of infrastructure users and beneficiaries. These demand-side measures can help to reduce the likelihood of the failure of service provision or reduce the negative consequences when disruption occurs.

Nature-based solutions are increasingly being used as a complement to or replacement for traditional grey (i.e. manmade) infrastructure, particularly in the area of water and coastal management (Jones, Hole and Zavaleta, 2012^[12]). These measures have the potential to be significantly cheaper: The City of Copenhagen found that the use of nature-based solutions, such as more green spaces, to cope with heavy downpours would be DKK 7 billion (EUR 940 million) cheaper than reliance upon grey infrastructure alone. Nature-based solutions, predominantly in the land-use sector, also have important and cost-effective mitigation applications through avoided deforestation and restoration of degraded lands, for instance.

Use strategic foresight to improve decision making under uncertainty

It is impossible to predict precisely what the future will look like in 2050 or beyond, even with the most robust, finely-calibrated

models. Unexpected shocks – such as geopolitical upheaval or sudden technological breakthroughs – could have unforeseen impacts and disrupt those models' underlying assumptions. Strategic foresight can therefore be a useful tool for approaching decision making and can complement existing models by preparing for several plausible scenarios that could emerge from non-linear shocks.

Building 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 can adapt to emerging best available knowledge and possible future disruptions. Dedicated strategic foresight teams can analyse possible emerging trends (called 'weak signals') to predict how, at a larger scale, they could affect the future.

Some countries already have dedicated foresight units or teams that feed their insights into decision-making: Policy Horizons Canada, the National Institution for Transforming India NITI Aayog, the National Institute of Science and Technology Policy (Japan) and the Centre for Strategic Futures (Singapore). 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^[13]). 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.

Box 2.

Investments from the Belt and Road Initiative could present a unique opportunity for recipient countries to engage in low-emission, resilient development

China's Belt and Road Initiative (BRI), a large-scale infrastructure development strategy, will involve the world's single largest flow of infrastructure financing and build out ever. It covers more than 68 countries, including 65% of the world's population and 40% of the global GDP. The pace and scale of investments are unprecedented, with some estimates suggesting USD 1-1.15 trillion of infrastructure commitments by 2025.

Which infrastructure projects receive financing from the initiative will shape future emissions. Current infrastructure investment patterns in recipient countries are emissions-intensive. Over 50% of planned BRI investments in the power sector are coal-based. Without a major shift in the infrastructure profile, especially in power and transport, aggregate emissions across recipient countries could be several times those of China itself by 2040, effectively putting the Paris Agreement's temperature goals out of reach.

Source: UN Environment (2018^[14]), Greening the Belt and Road Initiative (forthcoming).

“BUILDING BACK BETTER”



\$173bn could be saved globally per year in well-being losses due to natural disasters, compared to business as usual

Source: Hallegatte et al. (2018^[15])

ADAPTATION FINANCING FROM MDBs



\$5.9bn
in 2016

\$6.8bn
in 2017⁵

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.

Opportunities for climate innovations are economy-wide, and include technologies for renewable energy, electric vehicles, drought-resistant crops, vaccines to inhibit methane production by ruminants, permeable materials for pavements and roads, or technologies for carbon capture, storage and use. But innovation is just as much about institutional and organisational changes (Box 4), and new services and business models (e.g. energy-as-a-service platforms, electric car sharing, circular supply models), all of which can help drive the systemic changes needed in production and consumption for the transition towards a low-emission, resilient future.

The development of technologies for climate change mitigation and adaptation has increased rapidly since the beginning of the century. Globally, the number of patented inventions related to climate change mitigation in buildings, transport and energy generation tripled between 2000 and 2010. However, the current level of innovation falls short of what is needed to reach the 2°C goal, let alone move towards 1.5°C. Of 38 clean-energy technologies included in the IEA's Sustainable Development Scenario in their World Energy Outlook (which is consistent with a well-below 2°C goal), only four are on track to penetrate markets sufficiently: solar photovoltaic, lighting, data centres and networks, and electric vehicles. Governments must accelerate the deployment of existing innovations in technology, business models and services, and swiftly move the next generation of climate solutions from the lab to the market.

CLIMATE CHANGE MITIGATION INVENTIONS

The number of patented inventions related to climate change mitigation in buildings, transport and energy generation

tripled between 2000 and 2010.



Source: OECD (2017_[60])

Deploy targeted innovation policies to create and shape markets for climate innovations

A sound enabling environment for innovation – e.g. well-aligned tax, competition, education, science, trade and investment policies – and a strong environmental policy framework are necessary, but not sufficient, conditions for the transformation. To deliver transformative change, governments must also adopt a suite of innovation policies and finance measures that are tailored to the climate challenge.

Governments can set the direction of innovation by adopting mission-oriented programmes. Mission-oriented programmes are government initiatives to align policies, public Research and Development (R&D) programmes and public-private collaboration towards a specific time-bound objective. This in turn helps to address a broader societal challenge or “wicked problem” – one that is complex, systemic, interconnected and urgent – such as climate change and environmental degradation (Mazzucato, 2017_[15]). Notable examples include Germany's *Energiewende* and China's policy to promote new electric vehicles.

Demand-side policies – such as performance standards or green public procurement – can help direct resources and capabilities by creating or strengthening the market pull for climate innovations. 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 yet competitive (OECD, 2011_[16]).

National and sub-national regulations or performance standards have demonstrated their effectiveness in encouraging more innovation. These include energy-efficient building codes or renewable portfolio standards that require electricity providers to include a minimum share of clean energy in their output mix. By introducing climate-related criteria in procurement decisions, governments can also use public procurement to bring low-emission solutions to the market, and trigger industrial and business model innovation through the creation of lead markets.

Consumers can also catalyse and influence the direction of innovation. Governments can empower consumers by deploying policies that counter inertia and scepticism about new goods and services. Monetary or price-based incentives such as demand subsidies or tax allowances can encourage risk-averse consumers to buy innovative new products.

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

Realising the full potential of innovation to drive the transition to a low-emission and resilient economy will require much greater levels of public investment in R&D. While estimates of the funding gap vary, there is a broad consensus that public investment in low-carbon R&D would have to at least double to reach the goals of the Paris Agreement (Dechezleprêtre, Martin and Bassi, 2016^[17]).

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.

Public research through government research institutes and laboratories plays an important role in linking basic and applied research. In addition to targeting technological progress, 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.

International co-operation and 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.

Overcome the financial barriers to demonstration 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 information asymmetry and the fragmented nature of investor networks, projects may face a discontinuity of investment and fall into a so-called funding “valley of death”. Clean energy technologies, that require large-scale capital investment, have long development timelines and face high technology risks, are particularly vulnerable to funding gaps.

There is a need to diversify and better align the investment vehicles and actors involved at the different stages of innovation, and to improve the allocation of investment risk. Governments can help by supporting the expansion of public and private incubators and accelerators. They could also use public money

to fund risky, long-term projects that could have large social benefits but are too early for private-sector investment. Low-interest loans, loan guarantees, tax incentives and quasi-equity financing can be deployed to reduce investment risk and attract private sector finance.

Governments can promote and facilitate new partnerships and coalitions to help align investment vehicles and actors, thereby ensuring a continued stream of investment all along the innovation chain from basic research through to deployment of new technologies. For example, the global Breakthrough Energy Coalition and its Breakthrough Energy Ventures funding mechanism, bring together patient and risk-tolerant private investors, global corporations and financial institutions with the capital necessary to finance large energy infrastructure projects that emerge from the Mission Innovation initiative¹.

Promote international technology diffusion at scale

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. Removing tariff and non-tariff barriers to trade in mitigation and adaptation technologies, manufacturing equipment and services is also critical.

The extent and effectiveness of technology diffusion is also determined by the absorptive capacity of recipient countries. The higher the level of domestic human capital, the higher the level of technology transfer as well as the local spillovers from trade and foreign direct investment. Investing in education, technical extension services, public technology diffusion programmes and demonstrators is therefore important to enhance the ability of the public and private sectors to adopt, adapt, and employ the most appropriate technologies. It can also help to facilitate the transition of economies and workers dependent on energy-intensive industries (Box 4).

International transfers of low-emission technologies have been primarily between advanced countries. The diffusion of climate change mitigation technologies to and from developing countries – particularly emerging economies – has increased significantly since 1992. In 2016, emerging economies accounted for 29% of the global imports of low-emission equipment goods and 24% of global exports (Glachant and Dechezleprêtre, 2017^[18]). While emerging economies are better integrated into international technology markets, less developed countries remain largely excluded due to their general isolation and lack of absorptive capacity. International technology transfer mechanisms and development co-operation have an important role to play in ensuring that innovation benefits a larger number of countries.



THE FUNDING GAP

At least **2X** public investment in low-carbon R&D is required to reach the goals of the Paris Agreement

Source: Dechezleprêtre, Martin and Bass (2016^[17])

CLEAN-ENERGY TECHNOLOGIES

4/38 clean-energy technologies included in the IEA's Sustainable Development Scenario are on track to penetrate markets sufficiently.

Source: IEA (2018^[61])

Box 3.

Harnessing digital finance to engage citizens in sustainable development

Digital finance offers new opportunities for raising capital, enhancing transparency, and making market mechanisms more inclusive. New online financing platforms can aggregate global data on isolated investment opportunities, cutting the number of intermediaries between investors and project holders.

For instance, M-Pesa is a mobile phone-based service used to deposit, withdraw and transfer money easily. Customers can use M-Pesa to hire then acquire individual solar kits offered by the company M-Kopa. Both M-Pesa and M-Kopa are large successes, with the former raising USD 45 million in total equity funding and debt financing, and has connected 600 000 customers to affordable solar power to date.

Crowdfunding and financial match-making online platforms can also catalyse broader public participation in sustainable development projects. For example, LittleBigMoney is an online registry and financing tool for Colombians willing to support social and environmental projects. To date, it has facilitated over 4 000 projects, bringing together more than 1 600 stakeholders, and mobilised almost 500 million Colombian pesos (USD 170 000). Motif Investing is another online service, which uses robo-advisors to detect and offer to young investors investment opportunities in sustainability and infrastructure projects (e.g. solar, wind, electrical vehicles and biofuels) that are aligned with their environmental values.

While the unintended consequences of digital technologies (e.g. large electricity consumption, cyber-attacks, data privacy) are still poorly understood, exploring their potential to advance sustainable finance is important, and this has been recognised by the G20 under Argentina's Presidency through the launch of a Task Force on Digital Financing for the Sustainable Development Goals by the UN Secretary-General in 2018.

Source: UN Environment (2018_[20]), Digital Finance and Citizen Action in Financing the Future of Climate-Smart Infrastructure (forthcoming), *Financing Climate Futures Case Studies*.

Box 4.

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

The industry sector relies heavily on fossil fuels (e.g. for the iron, steel, cement and chemicals manufacture) and between 1990 and 2014, global industrial greenhouse gas emissions rose by 69%, all sectors included. Deep decarbonisation will require simultaneous technology, policy and financing innovations, as well as sector-specific actions to maintain competitiveness.

Existing solutions can help the sector's decarbonisation (e.g. through material and energy efficiency, fuel switching), but there is an urgent need for deploying new technologies to achieve the 2050 Paris Agreement goals, such as electrification of heat, high-temperature processes, or advanced waste heat recovery. However, further policy and financing efforts are required to overcome existing barriers hindering greater deployment of such technologies. For instance, collaborative networks bringing together trade associations and academia can be particularly effective platforms for sharing and fostering decarbonisation best practices. Subsidy programmes are other initiatives that can help create a market for sustainable alternatives. An example of this is the UK government's Renewable Heat Incentive which encourages the use high-grade heat generated from biomass and biogas in the iron, steel, cement, and chemicals sectors.

The successful decarbonisation of energy-intensive industries would generate numerous benefits, provided the low-skilled workers employed in these sectors are redeployed, re-trained or compensated, and not left stranded. Lessons from past transitions (e.g. UK coal mine closures of the 1980s) can help inform the development of such public transition policies.

Source: Oluleye, G., N. Shah and A. Hawkes (2018_[19]), *Emerging Strategies for Decarbonising Energy-Intensive Industries* (forthcoming), *Financing Climate Futures Case Studies*, Imperial College London Consultants, London.



lighting

electric
vehiclessolar
photovoltaicdata centres
and networks



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

What governments put a price on, and what they choose to support financially, can provide the signals needed to leverage and shift investments towards low-emission and resilient investments. Through their budgeting processes, policies and fiscal incentives, governments play a central role in directing financial flows and influencing climate-related behaviours of citizens, financiers and businesses. Specifically, governments must diversify their economies away from fossil fuels, align budgetary incentives and mandates of public institutions with climate objectives, and anticipate and address the social consequences of a low-emission transition.

Diversify government revenue streams away from fossil fuels

The carbon entanglement of government budgets is a major barrier to more ambitious climate action. Globally on average, nearly 8% of government revenues come from the extraction of oil, natural gas and coal resources. Carbon entanglement presents a 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 decarbonisation pathways, the prospect of declining tax revenues from fossil fuels raises serious concerns about the future tax base and tax mix.

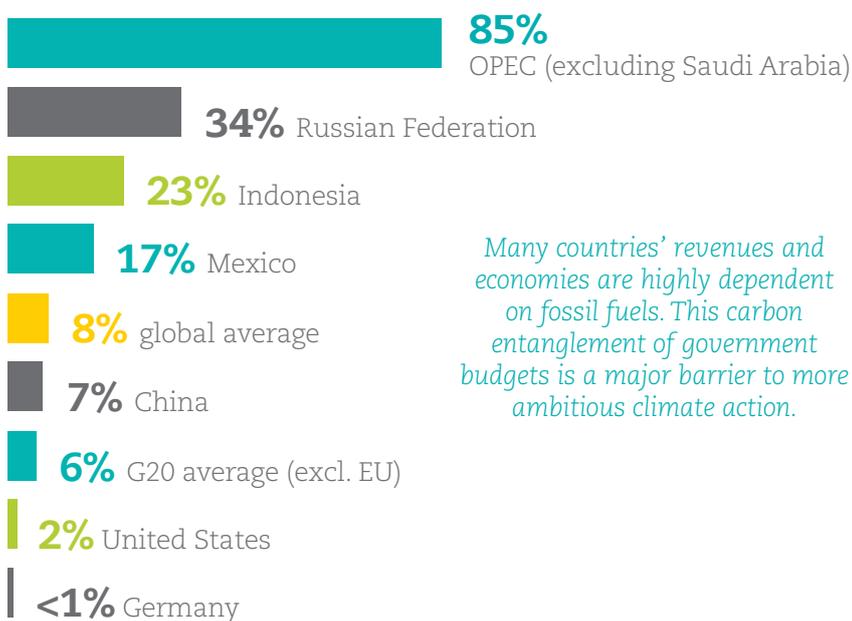
Governments will therefore need to diversify away from fossil fuels by committing to alternate energy sources, and rethink economic features such as future revenue streams, workforce skills, education and training institutions, and infrastructure. The twin issues of carbon entanglement and long-term fiscal sustainability are only just beginning to be discussed in government finance ministries. 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

The climate challenge demands a holistic, consistent and integrated approach by governments to align all channels of public finance with climate and growth objectives, while also taking into account medium-term budgetary cycles and longer-term fiscal sustainability.

CARBON ENTANGLEMENT OF GOVERNMENT BUDGETS

Total % of government revenues



Source: OECD, UN Environment and World Bank Group (2018)^[157]

CARBON PRICING IS ABSENT OR NOT AMBITIOUS ENOUGH



Source: OECD (2018)^[122]

Despite some progress, carbon pricing remains insufficient to meet the goals of the Paris Agreement. To date, 45 national and 25 subnational jurisdictions have implemented, or have scheduled for implementation, carbon pricing initiatives (World Bank and Ecofys, 2018^[21]). This represents 20% of global greenhouse gas (GHG) emissions, up from 15% in 2017. Currently, 88% of carbon emissions from energy use are priced below EUR 30 per tonne of CO₂, which is a low-end estimate of the damage that emissions cause (OECD, 2018^[22]). Carbon pricing is a growing source of government revenues, and can be used to overcome political economy barriers to climate action. The World Bank Group estimates that governments raised approximately USD 33 billion in direct carbon-pricing revenues in 2017, an increase of USD 11 billion from 2016 (World Bank and Ecofys, 2018^[21]).

A number of budgetary support measures, such as fossil fuel subsidies, still favour emissions-intensive behaviours and practices. Of 76 economies that collectively emit 94% of global CO₂ emissions, aggregate estimates of the annual production and consumption support to fossil fuels ranged from USD 373 billion and USD 617 billion over the period 2010-15 (OECD, 2018^[23]). While some countries have begun to phase out fossil fuel support measures, 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.

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. For example, many countries' fiscal policies provide favourable tax treatment for the use of company cars and commuting expenses, which indirectly results in more cars and more intensive car use. Certain property taxes favour urban expansion and therefore increase commuting and car use. Corporate tax provisions may also 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^[24]).

Governments can calculate the full costs of emissions using cost-benefit analysis (CBA). CBA can capture individual projects' climate impact using the social cost of carbon, which measures the present value of the damage resulting from an additional tonne of emissions. This can help shift finance towards low-emission, resilient projects.

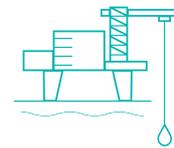


PUBLIC PURCHASE OF GOODS AND SERVICES

12% of GDP

is spent on average by governments of OECD countries on the public purchase of goods and services

Source: OECD (2017^[25])



FOSSIL FUEL SUPPORT

\$373-617bn

annually over the period 2010-15 of 76 economies that collectively emit 94% of global CO₂ emissions

Source: OECD (2018^[23])

DIRECT CARBON-PRICING REVENUES

raised by governments

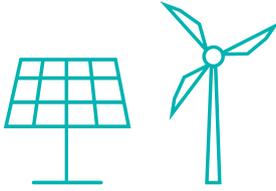
... 88% of carbon emissions are priced below €30 per tonne of CO₂ which is a low-end estimate of the damage that emissions cause

... 12% of carbon emissions are priced at €30 per tonne of CO₂



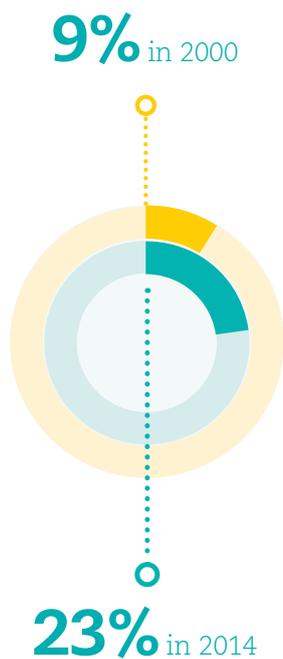
Part of those revenues could be used to facilitate a just and inclusive transition

Source: World Bank and Ecofys (2018^[21])



RENEWABLES IN ELECTRICITY CAPACITY PORTFOLIOS

State-owned enterprises in
OECD and G20 countries



Source: Prag, Röttgers and Scherrer
(2018_[62])



SOVEREIGN WEALTH FUNDS

Projected to reach over
\$15tn by 2020

Source: One Planet Summit (2018_[27])

Align incentives and mandates of all public institutions with climate objectives

In addition to budgetary processes, governments have significant influence over broader sectors of the economy through public procurement decisions, state-owned enterprises (SOEs), development co-operation, export credits² and public investment funds. By aligning the core mandates and decision-making processes of public institutions with climate objectives, governments can further align their financial flows with a low-emission, resilient future.

Governments of OECD countries spend on average 12% of GDP on the public purchase of goods and services (OECD, 2017_[25]). Considering life-cycle costing (including life-cycle carbon emissions) and building resilience criteria into infrastructure investments could help shift procurement decisions towards low-emission options.

In many countries, SOEs occupy a central role in the electricity generation sector and as a result can be more exposed to climate change and transition risks. 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_[61]). Governments can further assist by mainstreaming climate concerns in SOEs' strategies to influence investment decisions towards low-carbon infrastructure.

For development co-operation to support a transformative shift in countries' development pathways, bilateral 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 (OECD, 2017_[26]). However, this suggests that the bulk of bilateral portfolios – over 80% – did not explicitly consider climate change, highlighting an urgent need to better mainstream climate and other environmental objectives across development co-operation.

Through export credits, countries can influence the type of infrastructure financed outside their borders. Historically, the majority of export credits provided by countries that report to the OECD went towards more carbon-intensive sources of power, but recent years have witnessed an increase in volume of official export credit for renewables.

Governments can be powerful institutional investors, wielding influence over financial flows through their public investments – Sovereign Wealth Funds (SWFs) and public pension funds in particular. SWFs, for example, are projected to reach over USD 15 trillion by 2020 (One Planet Summit, 2018_[27]). Governments can continue to shift public investments away from fossil fuels by building ESG factors and climate objectives into their investment strategies.

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

Governments should plan for future generations by leaving a sustainable fiscal and economic legacy. They would benefit from developing strategies on how to include those worst affected by the transition to a low-emission economy.

Governments can introduce structural reforms that help firms and workers adjust to market conditions. For example, housing policies could help people move more easily from a low-employment region to a higher-employment region (for example, by improving access to low-cost housing, or decreasing transaction costs).

Fiscal policies that favour low-emission innovation and small businesses could result in greater employment opportunities while also benefitting the climate. Revenues from carbon pricing can be used to invest in education, health, and clean technology as well as reducing taxes for poorer households. Labour market policies could maintain high levels of employment and a fair distribution of the transitional cost. Policies to build active labour markets could help the unemployed find work, while skill development systems could smooth workers' reintegration into employment. For example, the Government of the Canadian province of Alberta has mandated the phase-out of coal generation by 2029. It released 35 recommendations to promote a just transition from coal mining, and announced a CAD 40 million transition fund for workers and communities (Botta, 2018_[28]).

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



INCREASES IN SUSTAINABLE FINANCE BETWEEN 2013-2017

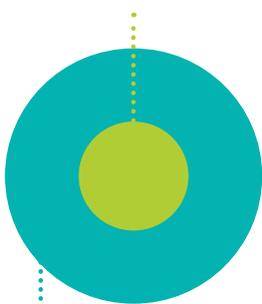
2X sustainable finance measures and
4X international initiatives to promote sustainable finance

Source: UNEP Inquiry (2018_[31])

GREEN BOND MARKET

\$3bn
in 2011

\$163bn
in 2018



\$895bn in 2018 including climate-aligned bonds

Source: Climate Bonds Initiative (2018_[29])

Given the considerable need for long-term infrastructure investment, countries need to improve the efficiency of public investment while mobilising private investment. Innovative financial instruments, supported by digitalisation (Box 5), can create new opportunities for diversification of financing sources. They can also help align public and private sector interests in infrastructure provision and management, while optimising the capital structure and reducing the cost of capital for the public sector.

There is some progress in incentivising private investment in sustainable, low-emission and resilient infrastructure. Many innovative financing mechanisms have been implemented to blend public finance, limit the risk for private actors, and subsidise and incentivise private lending, investments and insurance. For instance, the green bond market increased from just USD 3 billion in 2011 to USD 163 billion in 2018, or to USD 895 billion when including climate-aligned bonds (Climate Bonds Initiative, 2018_[29]).

There is also increasing momentum for change in the financial system, with a growing number of initiatives to harness the financial system to drive the low-emission transition (Maimbo et al., 2017_[8]; UNEP Inquiry, 2018_[30]). Globally, the number of sustainable finance measures doubled between the end of 2013 and the end of 2017, and international initiatives to promote sustainable finance have quadrupled (UNEP Inquiry, 2018_[31]). Notable examples include the Financial Stability Board's Task Force on Climate-related Financial Disclosures (TCFD) and the G20's Sustainable Finance Study Group and Sustainable Insurance Forum (SIF). Governments can take action to further build on this momentum.

Encourage the integration of climate impacts into investment decisions and strategies

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' activities and investors' portfolios. Mainstreaming climate considerations in investment decisions and strategies across the entire financial system requires action on different fronts.

Enhancing greater market transparency and improving data on performance, risks and costs and opportunities of low-emission and resilient investments across available channels is essential for promoting sustainable infrastructure as an asset class and leveraging long-term investment. Developing benchmarks and metrics of success could facilitate due diligence of low-emission infrastructure and asset allocation modelling (OECD, 2015_[32]) and measure performance to feed into the asset allocation process. Establishing a harmonised definition of sustainable infrastructure could be essential to ensure consistency of data collection and help harmonise project preparation.

Appropriately valuing risk in the financial system can help investors take climate-related risks and opportunities into account in capital allocation. This requires a range of interventions to value risks, including broadening concepts of risk and the time horizons over which they are assessed, embedding climate considerations into incentive structures and the key performance indicators of financial decision-makers, and mainstreaming related concepts into professional education programmes. Regulators have a key role to play here.

Mapping investor channels would help improve the understanding of how financial policies and regulations affect low-emission, resilient infrastructure investment patterns. This 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^[31]). Finally, harnessing the new opportunities created by digital finance could also transform the infrastructure investment value chain, enable citizens to participate more directly in investment and unlock new sources of finance for infrastructure.

Encourage the disclosure of climate-related risks and opportunities in financial markets

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, investors with

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. Three types of climate-related risks could inflict potential losses on investors, and eventually challenge the stability of the financial system:

1. Physical risks related to the increased frequency and severity of climate- and weather-related events could damage property and disrupt trade (see Chapter 1). 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^[33]).
2. Liability risks arising if those suffering from climate change losses seek compensation from those they hold responsible. For instance in 2015 a court in The Hague upheld a historic legal order urging the Dutch government to accelerate carbon emissions cuts (Nelsen, 2015^[34]).
3. Transition risks caused by the revaluation of assets in a lower-emission economy (Garney, 2018^[35]). Building more fossil fuel dependent

infrastructure will result in stranded assets, defined as assets that are "unable to recover their investment cost as intended, with a loss of value for investors" (Baron and Fischer, 2015^[36]). This risk is particularly acute for investors that are closely linked to coal mining or energy production from coal.

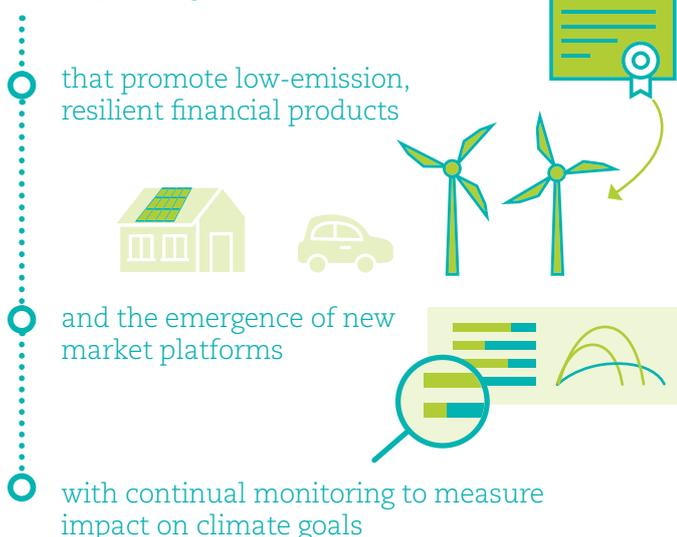
Building climate-related capacity among investors and private firms is an essential factor of success. Low-emission, resilient strategies and science-based targets need to be developed, data on climate-related risks and opportunities of businesses and portfolios need to be collected and reporting on climate-related risks will need to broaden and improve. Regulators and standard-setters could provide guidance to ensure the credibility and comparability of commitments.

Rethink financial supervision in light of climate imperatives

Financial stability is a prerequisite to any type of investment, including investment in low-emission, resilient infrastructure, and the primary role of financial regulators is to ensure the stability of the financial system. 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.

ENSURING THAT THE FINANCIAL SYSTEM IS ALIGNED WITH CLIMATE OBJECTIVES REQUIRES GOVERNMENTS, FINANCIERS AND FINANCIAL REGULATORS TO ACT ON DIFFERENT LEVELS

Development of standards and policy frameworks



Promoting transparency in the financial system



While recognising that national circumstances matter and that there is no one-size-fits-all approach, governments, financial regulators and climate policy makers can act on a variety of levels. For example, they can support the growth of low-emission, resilient investment market 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. They can continuously monitor the potential unintended consequences of financial regulations and regulatory reforms on the supply of long-term investment financing for climate. This could include preserving the integrity of standards for “low-emission” labels and markets or initiatives such as the emerging global dialogue on capital risk weightings (Ang, Röttgers and Burli, 2017^[37]).

Promoting transparency in the financial system is also important, through policies and regulations that support the disclosure of risks and opportunities associated with climate change, disclosure of financial flows, and developing climate-scenario analysis for insurance companies and banks. Finally, clarifying legal frameworks and mandates, for instance on the interpretation of long-term investor obligations and responsibilities in the context of climate change or how climate considerations can be interpreted within the existing mandates of supervisory bodies.

Clarifying legal frameworks and mandates

- on investor obligations and responsibilities
- and interpreting climate considerations



Box 5.

Moving towards a low-carbon future: blockchain technology as the digital infrastructure enabler

A number of digital innovations are emerging in the infrastructure space, which offer the potential to transform how physical systems operate by making infrastructure more connected, intelligent, and efficient, including blockchain.

While there are concerns around blockchains' CO₂ impacts (as vast amounts of energy are required to sustain the network), the technology can also help fight climate change. First, it allows to standardise and better manage contracts. This in turn reduces costs and complexity, and facilitates the assessment and tracking of projects. Second, it supports advanced analytics of projects, which strengthens the availability, transparency and reliability of data and the management of investment risks. Third, as a decentralised financing infrastructure, blockchain-based platforms allow a wide spectrum of investors to invest directly in low-carbon projects, as well as automation of transactions and price discovery.

However, greater public attention is needed to limit some of the anticipated negative environmental impacts of blockchain technologies. Many legal questions are still open and issues related to liability, intellectual property, or data privacy are yet to be resolved by governments. Collaboration between public and private stakeholders will also be essential to ensure the technical standards, protocols and network designs developed are as energy efficient as possible, and that blockchain technologies are playing their full role in the low-carbon transition.

Source: OECD (2018^[38]), Blockchain, infrastructure, and the low-emission transition (forthcoming), *Financing Climate Futures Case Studies*.





6. Rethink development finance for climate



POVERTY LEVELS

> 100m into poverty by 2030

Source: Hallegatte et al. (2016_[39])



CLIMATE-RELATED MIGRATION

143m people from across sub-Saharan Africa, South Asia and Latin America could be caused to emigrate

Source: Rigaud et al. (2018_[40])



DEVELOPMENT BANKS

\$35bn committed in 2017 in climate finance by development banks

a **28%** increase from 2016

Source: IDB et al. (2017_[42])

Poorer populations and communities are often the most vulnerable to the impacts of a changing climate, and without decisive action, increasing climate impacts could drive more than 100 million people into poverty by 2030 (Hallegatte et al., 2016_[39]). Further, new work shows that climate change could induce over 143 million people from three regions – sub-Saharan Africa, South Asia, and Latin America – to migrate out of their own countries (Rigaud et al., 2018_[40]).

While many different actors will need to be mobilised to help address the challenge, development banks – publicly-owned financial institutions with a specific development or policy mandate – are critical. These institutions leverage finance from capital markets due to their strong credit ratings and the backing of their shareholder governments, and in turn provide financing to support development outcomes. Development banks particularly support the low-emission, resilient transition in three areas:

- providing concessional and non-concessional finance for greenfield low-emission, resilient infrastructure projects in developing countries,
- mobilising private and commercial investment by providing risk mitigation tools and instruments (OECD, 2018_[41]) and
- supporting governments in reforming climate and broader investment policies, removing specific barriers to investment, and planning infrastructure

Major multilateral development banks (MDBs) committed USD 35 billion in climate finance in 2017, representing a 28% increase from 2016 (IDB et al., 2017_[42]). Members of the International Development Finance Club (IDFC) – a global network of bilateral and national

development banks and finance institutions based in OECD and non-OECD 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 for other environmental objective (IDFC, 2017_[43]).

Strengthen development banks' mandates and incentives to deliver transformative climate action, especially in national development banks (NDBs)

Climate targets, strategies and tools are driving increases in funds to support climate action, but there are still gaps in support for climate-compatible infrastructure, as illustrated by MDBs' support for infrastructure sectors. In 2015-16, 31% of MDB commitments to infrastructure sectors was climate-related, with the energy sector recording the highest share (48%), and transport and water sectors recording lower shares (25% and 17%, respectively).³ Several banks already recognise the need to align their portfolios with the goals of the Paris Agreement. At the 2017 One Planet Summit, the major MDBs and IDFC committed as a group to “redirect financial flows” in support of a transition towards climate-compatible development. In addition to aligning portfolios, development banks must continue to integrate climate objectives into their development goals and provide financing for infrastructure that delivers simultaneously on the Sustainable Development Goals (SDGs).

Shareholder governments need to give development banks stronger, more coherent mandates to deliver transformative climate action by integrating climate with underlying development objectives (Box 6), reflecting this in corporate scorecards, and putting in place supportive internal incentive systems to encourage staff to scale up climate action. Incentive structures in development banks need to reflect sustainability outcomes alongside financial targets. Corporate and

staff performance in some institutions, and unless otherwise managed, can be driven more by financial indicators (e.g. commitments or disbursements) than by efforts to mobilise commercial finance, or the potential contribution to development outcomes such as climate change.

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 (Box 7). 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, and also provide financing in local currencies. But 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 develop and scale up approaches to mobilise domestic commercial investment.

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

The investment gap for infrastructure, especially in developing countries, highlights the need for scarce public resources to be used strategically to attract commercial investment, where suitable. As a result, the links between private finance and development finance are getting closer, 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.

A much stronger focus on mobilising commercial investment is needed and will require banks to re-envision the way in which they finance development. In order to implement this vision, there will need to be a much stronger focus on bringing new investors and sources of finance with the explicit aim of creating new climate markets.

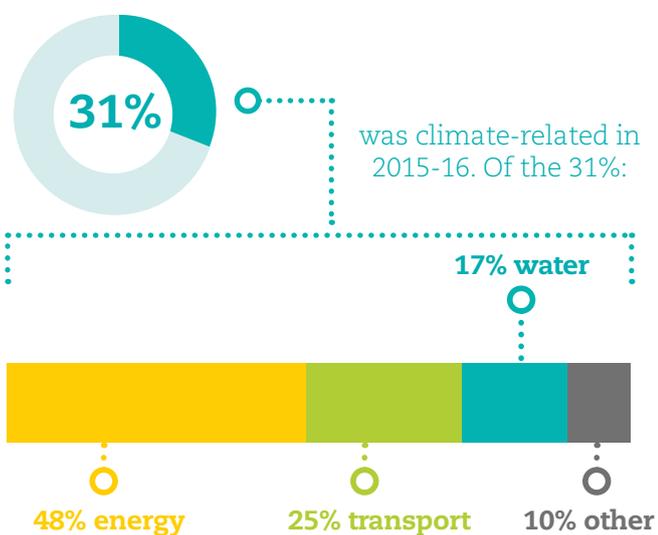
Development banks and other stakeholders, working together, can help resolve major bottlenecks and build the much-needed project pipelines in developing countries. Specifically, they can aggregate smaller investments through, for example, structured blended finance vehicles to help bridge the mismatch between the nature of the demand side of financing for projects and the nature of supply of financing from financial markets, and to bring in institutional investors. They can standardise the terms and conditions related to low-carbon infrastructure projects to help unlock private investment, including those underpinning different instruments, approaches and contractual agreements. Finally, they can deploy risk mitigation measures, including efforts to effectively manage currency risks, which are critical for channeling investment towards developing countries.

Use concessional finance strategically to enable development banks to drive the transformation

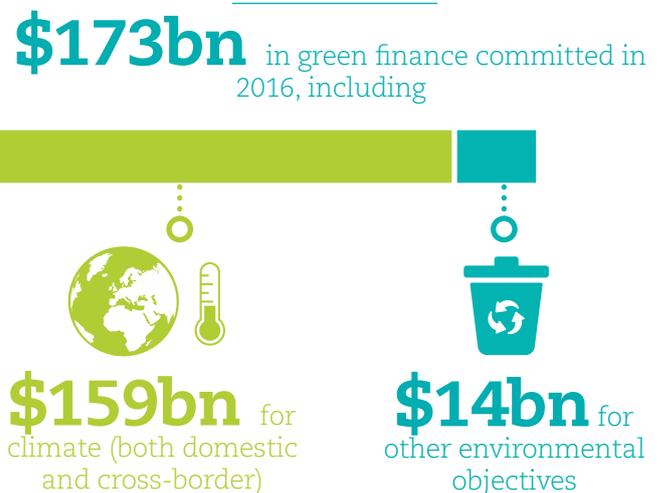
Governments – and the capital as well as the concessional finance that they provide – are important direct and indirect drivers of change among development banks. Targeted, concessional finance for climate action – provided bilaterally from governments as well as through multilateral climate funds – can help development banks make the case for climate-related investments to client countries and institutions that are not yet actively seeking such investments. Importantly, the changing climate finance architecture, including the scale down of the Climate Investment Funds and the operationalisation of the Green Climate Fund, has implications for how national, bilateral and MDBs access concessional finance.

To continue to encourage development banks to help developing countries’ transform their development pathways, governments should ensure there is adequate concessional financing available, and that it is allocated 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.

MDB COMMITMENTS TO INFRASTRUCTURE SECTORS³



INTERNATIONAL DEVELOPMENT FINANCE CLUB



Source: IDFC (2017_[43])

Box 6.

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

In sub-Saharan Africa, electricity access extends to only about half of the population, and access to clean cooking to only one-third of the population. This situation is slowing the region's economic and social development. Each year, chronic electricity shortages cost an estimated 2% of GDP, and reliance on highly polluting cooking fuels (e.g. wood, dung, and charcoal) an estimated half a million premature deaths.

Greater policy and financing efforts are required to overcome the barriers to expanding existing clean energy access technologies. For example, solar household systems (SHS) are fast growing, but could expand even more quickly if import tariffs and foreign currency restrictions in certain countries were removed. Mini-grid businesses with the right skill sets are also emerging, but the risk-return proposition for investors is still weak and the enabling policy environments are often missing.

Official development finance (ODF) flows, for example, can play a role here. They can be applied to de-risk investments, attract private funding at scale, and leapfrog fossil-fuel centralised power systems. Domestic leadership, policy reforms and greater capacity are also required to better align fiscal incentives, allow system-wide integration of decentralised renewable electricity, and help public and private investments flow.

Deployment of new off-grid and mini-grid options offer various benefits, including clean and affordable energy, which is essential for rural populations and women to be economically productive and, there is a strong case for supporting these solutions to unlock them as “golden thread” for sustainable development for all.

Source: Corfee-Morlot, J., P. Parks, J. Ogunleye and F. Ayeni (2018^[44]), *Achieving Clean Energy Access in Sub-Saharan Africa* (forthcoming), *Financing Climate Futures Case Studies*, OECD Publishing, Paris.



Box 7.

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^[45]) 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^[43]). 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 (2018^[46]), *Mobilising commercial capital for sustainable infrastructure: Insights from national development banks in Brazil and South Africa* (forthcoming), *Financing Climate Futures Case Studies*; IDFC (IDFC, 2017^[43]), *IDFC Green Finance Mapping Report 2016*, International Development Finance Club (IDFC).



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



Cities are home to over half of the global population (UNDESA, 2018_[47]) and account for over 80% of global GDP (UN-Habitat, 2016_[48]). They also account for between 60 and 80% of global energy consumption and 70% of global greenhouse gas emissions (UN-Habitat, 2016_[48]). Cities are particularly vulnerable to climate risks and must therefore carefully craft 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 that are highly vulnerable to economic losses from natural disasters (UNDESA, 2015_[49]). As urban populations are expected to account for over 70% of the world population by 2050, trillions of dollars will be needed to expand and renew urban infrastructure.

Local governments have a central role to play in getting the low-emission, resilient transformation right. They often have authority over many of the 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_[39]). However, they can lack the finance and capacity to carry out their responsibilities. The choices made today about the types, features and location of long-lived infrastructure can play a major role in limiting the extent of climate change, contributing to the resilience of urban societies and creating the backbone for strong, inclusive urban development.

Integrate land-use and transport policies

The way in which cities are designed and built is a key aspect of sustainability. Infrastructure investment must therefore be integrated with land-use and transport planning. In fast-growing cities, where most infrastructure is being built, urban layouts – and therefore emissions pathways – are being determined now. Over 60% of the land that will be urbanised by 2030 has yet to be developed (New Climate Economy, 2018_[50]).

In most OECD countries, urban sprawl has increased since 1990. 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_[51]). Urban sprawl is driving many challenges facing cities today, including traffic congestion, air pollution, longer commuting time, reduced access to affordable housing, and increasing per-user costs of public services such as water, energy and public transport.

Targeted policy action can help drive more sustainable city growth, particularly in land-use and transport policies. Governments can appropriately price car travel to better reflect the cost of parking and by introducing road pricing mechanisms. This should be accompanied by a shift towards greener urban transport, by investing in public and non-motorised transport infrastructure like bicycle lanes (OECD, 2018_[51]). Land-use policies can be reformed to encourage more sustainable urban development patterns, for example by 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_[51]).

To better facilitate integrated planning, governments need to strengthen collaboration between cities and different levels of governments. For example, through the creation of single entities with authority for transport and land use, and favouring more collaborative and co-ordinated forms of decision making.



GLOBAL URBANISATION Cities account for:



50% of the global population

Source: UNDESA (2018_[47])



Over **80%** of GDP

Source: UN-Habitat (2016_[48])



60-80% of energy consumption

Source: UN-Habitat (2016_[48])



70% of greenhouse gas emissions

Source: UN-Habitat (2016_[48])

Align national and local fiscal regulations with investment needs in cities

On average, subnational governments are responsible for 64% of climate-related spending and investment (Box 8).⁴ But cities often struggle with insufficient access to financing. One of the primary barriers is their limited ability to tax and borrow, which is typically constrained by legislation at higher levels of government. Municipalities in developing countries face the even greater challenge of having typically limited capacity or authority to raise revenues, but also the largest infrastructure deficits.

National finance ministries can help by reviewing the fiscal framework of cities and identifying misalignments with climate objectives, and by developing national legislation that clearly articulates whether cities can borrow and under what circumstances. 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.

Build climate-related and project finance capacity in cities

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^[52]). Developing capacity in local governments and administrations is fundamental to making climate action work, particularly in developing countries that suffer from capacity constraints and severe vulnerabilities to the adverse effects of climate change (Box 9).

Seize the development benefits of low-emission, resilient planning

Income inequality is already higher in cities than their national averages – this situation is likely to be worsened by climate change (Hallegatte et al., 2016^[39]; OECD, 2018^[53]). The health implications of poverty in cities are already startling: while the richest 40% of urban dwellers are likely to reach the age of 70 or more, the poorest 20% struggle to reach 55 years (UN-Habitat, 2015^[54]).

While the transition to a low-emission economy will yield benefits in low-emission economic sectors, it will also reduce jobs for workers in carbon-intensive sectors. Low-skilled workers are likely to be most significantly affected. These negative impacts can be limited – and a high level of employment and a fair distribution of transition costs maintained – if governments can put effective policies in place to prepare the labour markets. Specifically, governments can focus on supply-side policies, with active labour market policies and skill development systems that can help facilitate a smooth reintegration of workers 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 in-work benefits, can ensure a fairer transition for workers (OECD, 2018^[53]).



VULNERABLE CITIES



Source: UNDESA (2015^[49])

DEVELOPMENT OF URBAN SPACE



Over **60%** of the land that will be urbanised by 2030 has yet to be developed

Source: New Climate Economy (2018^[50])

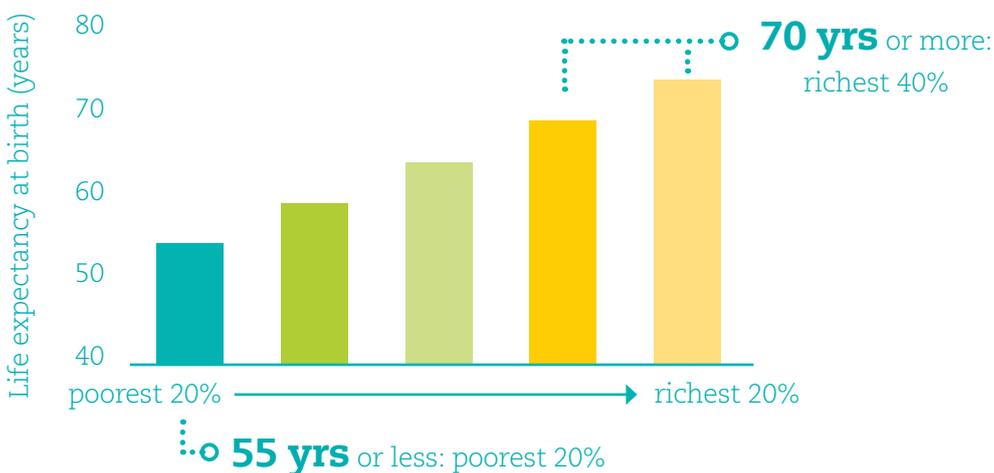


Urban areas have become denser on average, but

60% of urban space is sparsely populated

Source: OECD (2018^[51])

LIFE EXPECTANCY OF URBAN DWELLERS



Source: WHO (2010^[43])

Box 8.

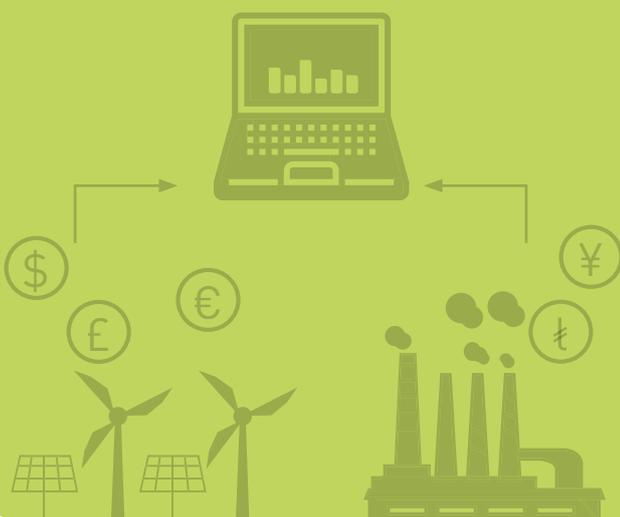
Strengthen capacity to track subnational data on climate spending and investment

Comparing the levels and trends of climate-related investments is currently not possible across subnational governments due to lack of consistent data. This in turn makes it difficult to evaluate progress towards the Paris Agreement in a standardised way, and to adjust climate action at the subnational level accordingly. Thus, there is a need to address the institutional, human and data capacity gaps that currently lower the quality and quantity of data for tracking local climate-related spending and investments.

Few countries have developed climate-specific statistics, and many use other categories of national accounts to capture climate-related spending and investments (e.g. counting energy efficiency investments in hospitals under health-related functions). Some countries have developed approaches to tracking climate expenditures at the national level (e.g. Belgium, France and Germany), but they all use different categories and classification systems. Only three European countries produce complete national data on mitigation spending, and none maintain comprehensive data on adaptation spending. These issues are even more obvious at the subnational level.

Governments should strengthen data collection, statistical systems and methodological approaches to track progress on climate objectives. This could be done in co-ordination with international fora such as the G20, and with the support of the OECD and other international organisations, building on preliminary efforts to track and compare existing subnational climate-related spending and investments.

Source: OECD (2018^[55]), *Financing climate objectives in cities and regions to deliver sustainable and inclusive growth* (forthcoming), *Financing Climate Futures Case Studies*.



Box 9.

Improving cities' access to finance is essential for building urban resilience

In the coming decades, cities will have to adapt to new conditions, triggered by climate change events, for the operation of essential infrastructure and services. Climate-related disasters bear high physical and economic costs, and recovering from these can be even more complex in many developing countries due to burgeoning populations, rapid urbanisation and limited financial and institutional means. In these countries, infrastructure stocks are insufficient, and capital investment needs are huge, possibly in excess of USD 1 trillion per year.

To deal with such existing infrastructure deficits, leading policy makers are exploring new ways to pay for climate-smart development, and some promising urban planning, regulatory and financial solutions are emerging. In the water sector for example, some municipalities are encouraging nature-based solutions (e.g. parks that can act as short-term storm water retention ponds) instead of grey (i.e. manmade) systems that can be more costly to build and maintain. In the construction sector, land-use laws and buildings codes for instance, are encouraging property owners to invest in climate-proofing as part of their design strategies. On other infrastructure projects, private sector partners are being required to ensure that whatever they build delivers against its intended function over an extended timeframe, under "fitness for purpose" warranties that are being included in Public Private Partnerships (PPPs) contracts.

Beyond these solutions, technical assistance initiatives can also facilitate access to public and private finance for resilience projects at the cities' level, and help address broader institutional capacity gaps. At the 2017 One Planet Summit, the Global Covenant of Mayors called for "improved vertical policy alignments between national and local governments" to ensure cities have enough room to manoeuvre on climate issues. This will likely remain an on-going concern, with financing implications, for cities and other local authorities engaged in climate resilience matters and planning.

Source: World Bank Group (2018^[56]), *Financing Resilient Urban Infrastructure: Lessons from World Bank and Global Experience* (forthcoming), *Financing Climate Futures Case Studies*.



Notes

- ¹ 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 USD30 billion per year (Mission Innovation, 2018_[26]).
- ² “Export credits” are government financial support, direct financing, guarantees, insurance or interest rate support provided to foreign buyers to assist in the financing of the purchase of goods from national exporters. Since export credits are commercially motivated and linked to a country’s trade strategy, data on export credits are usually not as readily available as data on development finance.
- ³ This is based on data reported by six MDBs (ADB, AfDB, EIB, EBRD, IDB and World Bank-excluding IFC) to the OECD Development Assistance Committee (DAC). For further information, please refer to the full report: OECD, UN Environment and World Bank Group (2018_[57]), *Financing Climate Futures: Rethinking Infrastructure*, OECD Publishing, Paris.
- ⁴ Climate investments can be defined as the acquisition (including purchases of new or second-hand assets) of assets for climate purposes (e.g. installing coastal defences against flooding and sea level rise). Climate spending can be defined as the amount of money spent on operating and maintain these (e.g. strengthening coastal defences).
- ⁵ According to the 2016 (pg. 12) and 2017 (pg. 13) Joint Reports on MDB Climate Finance. MDBs use a common method for tracking adaptation finance, which identifies adaptation activities within broader development operations carried out in response to perceived or expected climate impacts.

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Financing Climate Futures

RETHINKING INFRASTRUCTURE

The OECD, UN Environment and the World Bank Group have joined forces under an initiative entitled Financing Climate Futures: Rethinking Infrastructure. Supported by the German Federal Ministry of the Environment, Nature Conservation and Nuclear Safety (BMU), it explores what public and private actors should do to support the radical transformation needed to align financial flows in infrastructure for low-emission, resilient development. It 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”. The report outlines an agenda for transformation across six priority areas with 20 policy actions that have the potential to help governments move beyond incremental climate action. This document provides the key messages for policy makers, with a brief overview of each of the six priority areas.

In addition to the report, the Financing Climate Futures initiative has produced *Shifting the Lens*, a UN Environment analysis that explores the benefit of scenarios and foresight approaches in supporting the low-emission, resilient transition; and a series of seven case studies that further explore specific aspects of the report’s recommendations.

OECD/The World Bank/UN Environment (2018), *Financing Climate Futures: Rethinking Infrastructure*, OECD Publishing, Paris,
<https://doi.org/10.1787/9789264308114-en>.

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