



# Scaling up climate finance in the context of Covid-19

A science-based call for financial decision-makers



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# FOREWORD

To avoid catastrophic climate change, 197 countries adopted the Paris Climate Agreement in 2015. It aims to limit the increase of global average temperatures since pre-industrial levels to well below 2°C, while pursuing efforts to stay within 1.5°C. Bringing all countries together to achieve this Agreement in 2015 is one of my proudest personal achievements as UN Secretary-General. Since the historic agreement, 123 countries responsible for 63% of emissions have adopted or are considering net-zero targets. These net-zero targets have put the Paris Climate Agreement's goals within striking distance.

Financing a rapid transition to a net-zero, climate-resilient economy in line with the goals of the Paris Climate Agreement will require significantly greater investments, investments in a different set of assets, and investments that address the humanitarian imperative of social inclusion and poverty alleviation. Rapid decarbonisation will have an overall net benefit but also significant distributional trade-offs.

Climate change places a triple responsibility on financial decision-makers, regulators of the financial systems and governments. First, they must maintain the capacity of the financial system to support economic activity, encourage entrepreneurship, and safeguard the assets of millions of people. Second, they must channel a much larger share of world private savings towards sustainable investments and low-carbon options.

Third, they must maximize the development co-benefits of climate policies. This is a precondition to scale up climate action in the context of the Covid-19 pandemic. Decisions taken by leaders today to revive economies will either entrench our dependence on fossil fuels or put us on track to achieve the Paris Climate Agreement targets and the Sustainable Development Goals.

A clear conclusion from the IPCC Special Report on the impacts of global warming of 1.5°C above pre-industrial levels is that the sooner we act, the lower the physical and transition risks of climate change and the higher the synergies between climate action and other societal benefits.

However, financial actors might not fully anticipate the consequences of climate change as it initially affects geographies that represent a limited share of the market economy and capital flows. In one scenario, the financial system could ultimately disengage from threatened assets but would transfer to communities and taxpayers the costs of climate damage. In another scenario, the financial system would not readjust on time in function of new information, endangering the stability of the entire financial system. In both cases, the financial system would fail to deliver on its triple responsibility to address climate change.

This publication is a science-based call to financial decision-makers to incorporate climate change in the valuation of financial assets and to lead the transition to net-zero, climate-resilient economies. Every policy and every investment have an impact on the future. Policy-makers and financiers continuously forecast future conditions. The report outlines how they can use models to understand the financial implications of climate change and capitalise on the new opportunities of a climate economy. Together, we must ensure that our response to the double tragedy of climate change and Covid-19 finances a safer, fairer and sustainable future for us all.

A handwritten signature in black ink, reading "Ki Moon Ban". The signature is fluid and cursive, with a long horizontal stroke extending from the end of the name.

**Ban Ki-moon**

President and Chair of the Global Green Growth Institute  
8<sup>th</sup> Secretary-General of the United Nations

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# EXECUTIVE SUMMARY

This publication aims to help financial decision-makers incorporate climate change in the valuation of financial assets and accelerate the transition to a net-zero, climate-resilient economy, based on the latest scientific findings and policy developments.

## 1. WHAT CLIMATE SCIENCE SAYS ABOUT RISKS ASSOCIATED WITH CLIMATE CHANGE

The earth's surface global mean temperature is currently 1.0°C higher (0.8°C - 1.2°C range) than in the pre-industrial period (1850-1900). It has increased faster in these 170 years than at any other time in the past 800,000 years. This trend is unequivocally linked to human activities responsible for the release of greenhouse gases (GHGs) (IPCC, 2018). The atmospheric concentration of carbon dioxide (CO<sub>2</sub>) has increased from 280 ppm (parts per million) in 1850-1900 to 417 ppm in 2020, predominantly due to fossil fuel combustion, cement manufacturing and land use change (deforestation, removal of land cover and land tilling).

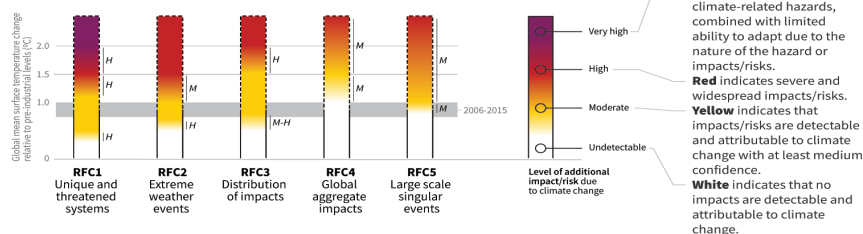
Multiple lines of evidence show warming is already affecting all earth systems and many human systems, and that its impacts are more severe than initially anticipated. As shown in Figure 1 below, we fear today that a 2°C increase in mean global temperatures could wipe out 90% of coral reefs and endanger the security and economic livelihoods of hundreds of millions of people.

**FIGURE 1: CLIMATE RISKS DEPENDING ON GLOBAL MEAN TEMPERATURE INCREASES.**

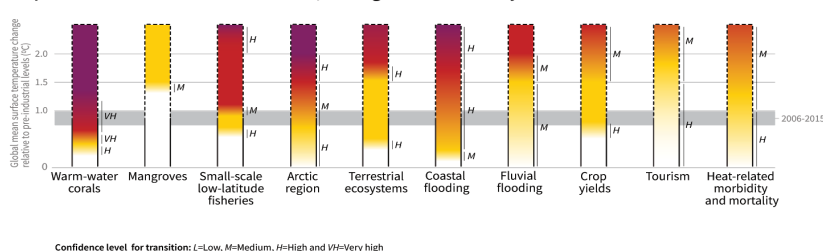
### How the level of global warming affects impacts and/or risks associated with the Reasons for Concern (RFCs) and selected natural, managed and human systems

Five Reasons For Concern (RFCs) illustrate the impacts and risks of different levels of global warming for people, economies and ecosystems across sectors and regions.

#### Impacts and risks associated with the Reasons for Concern (RFCs)



#### Impacts and risks for selected natural, managed and human systems



Source: IPCC (2018).

The net impact of warmer climates on people, ecosystems and the economy is the result not only of temperature increases, but also of the capacity to prevent damage and adapt to the changing circumstances. The impacts of a warmer world experienced so far are distributed unevenly. For most countries in the Global North, the evidence of net economic impacts is inconclusive, while in poorest countries global warming is already having a negative effect on Gross Domestic Product (GDP) and well-being.

To avoid catastrophic climate change, 197 countries in 2015 adopted the Paris Agreement. Its aim is to limit the increase of global average temperatures since pre-industrial levels to well below 2°C, while pursuing efforts to stay within 1.5°C. Cumulative CO<sub>2</sub> emissions and global mean temperature increase are directly related. To stabilise the global mean temperature, global net CO<sub>2</sub> emissions must decline to zero. Table 1 compares global net CO<sub>2</sub> emission declines depending on the targeted global warming limit.

**TABLE 1. GLOBAL CO<sub>2</sub> EMISSIONS DECLINE AND YEAR OF REACHING NET-ZERO CO<sub>2</sub> EMISSIONS ASSOCIATED WITH LIMITING WARMING TO 1.5°C AND 2°C. INTERQUARTILE RANGES ARE SHOWN IN SQUARE BRACKETS (BASED ON TABLE 2.4 IN ROGELJ ET AL., 2018).**

LONG TERM (2100) TEMPERATURE LIMIT	GLOBAL CO <sub>2</sub> EMISSIONS REDUCTION IN 2030 COMPARED TO 2010	YEAR OF REACHING NET-ZERO CO <sub>2</sub> EMISSIONS	YEAR OF REACHING NET-ZERO GHG EMISSIONS
1.5°C	45% [40-60%]	2065 [2060-2085]	2065 [2060-2085]
2°C	25% [10-30%]	2070 [2065-2080]	2090 or thereafter

The Nationally Determined Contributions (NDCs), which have been set by each country do not yet chart a path towards net-zero CO<sub>2</sub> emissions. Their full implementation is projected to result in warming within about 2.9°C - 3.4°C by the end of the century. The difference in projected impacts between 1.5°C and 2°C is already significant, but the difference between 2°C and 2.5°C is even greater. This further increases at higher temperatures. The estimated impacts at 3°C or 4°C of warming are expected to trigger very large, abrupt, or irreversible changes in the climate system with cascading impacts on nature and humans.

For example, chances of a major heat wave occurring somewhere in the world in a given year increases five- to six-fold in a 1.5°C warmer world compared to the past three decades and almost twenty-fold in a 4°C warmer world. For global staple foods, the chance of a damaging hot spell increases around two-fold for rice and four-fold for maize in a 4°C warmer world compared to 1.5°C.

We still have choices in how we limit warming to 1.5°C. To illustrate this, the Intergovernmental Panel on Climate Change (IPCC) in its Special Report on global warming of 1.5°C (SR1.5 2018) highlighted four illustrative emission pathways that give us a 50% to 66% chance of remaining within 1.5°C warming with limited or no temporary temperature overshoot (see table 2). All of them accelerate the deployment of fossil-free energies but they differ in the emphasis placed on reducing CO<sub>2</sub>

emissions more quickly in the next decades by lowering energy demand through behavioural change or relying on great quantities of carbon dioxide removal (CDR) (P1 and P2 pathways versus P3 and particularly P4 in table 2).

Pathways relying on CDR have greater uncertainties on technological maturity and economic, socio-cultural, and institutional feasibility. They are also likely to present greater trade-offs with food and water security, and biodiversity protection and restoration. Of the four illustrative pathways, P1 minimises these uncertainties and trade-offs while P4 exacerbates tensions between mitigation, adaptation and the Sustainable Development Goals (SDGs). Such tensions would represent economic and financial risks, for instance if they lead to a sudden shift in development strategies.

The longer the delays, the higher will be the adaptation needs. Fundamentally, adaptation cannot be disconnected from overall sustainable development trajectories (IPCC, 2018) because the magnitude of risk climate change poses is also a result of existing vulnerabilities and capacities to anticipate and adapt. Thus, development interventions such as reducing the infrastructure investment gaps or improving health systems intrinsically build adaptive capacities and reduce risk.

TABLE 2: CLIMATE RISKS CHARACTERISTICS OF FOUR ILLUSTRATIVE PATHWAYS.

	P1	P2	P3	P4
Storyline	<p>● Fossil fuel and industry ● AFOLU ● BECCS</p> <p>Social, business and technological innovations; lower energy demand by 2050; higher living standards (also in the global South); downsized energy system; rapid decarbonisation of energy supply; afforestation the only CDR option considered; no CCS.</p>	<p>Focus on sustainability incl. energy intensity; human development; economic convergence; international cooperation; shifts towards sustainable and healthy consumption patterns; low-carbon technology innovation; well-managed land systems; limited BECCS.</p>	<p>Societal and technological development follow historical patterns; emissions reductions through changing production of energy and commodities rather than through reductions in demand.</p>	<p>Economic growth and globalisation; greenhouse-gas-intensive lifestyles, including high demand for transportation fuels and livestock products; emissions reductions mainly through technological means; CCS and BECCS.</p>
Temperature outcome (within 0.1°C accuracy, median estimate)	Warming limited to 1.5°C	Warming limited to 1.5°C	Warming limited to 1.6°C	Warming exceeds 1.5°C limit by 20% (0.3°C) with assumption it can be reversed by 2100
Risk of overshoot of 1.5°C	Small	Small	Large	Very large (designed to first miss the target)
Alignment with sustainable development	Very strong	Strong	Medium, with potential trade-offs	Weak, with marked trade-offs
Physical climate risks to 2050	Lowest	Low	Medium	Highest

Physical climate risks after 2050*	Low	Lowest	Low	High
Transition risks and Opportunities				
Energy demand reduction/ management	Very high	High	Medium	Low
Energy supply Infrastructure investments	Lowest	Medium	High	Highest
Asset stranding	Near-term retirement of fossil-fuel assets	Near-term retirement of fossil-fuel assets	Moderate stranding of fossil-fuel assets	Stranding delayed by a decade but then with higher magnitude**
Reliance on CDR	Small	Medium	Large	Extreme
Deployment of land-based mitigation and bioenergy	Medium	Medium	High	Extreme
Discontinuation risks	Failure to achieve demand and behavioural changes may leave little time to ramp up supply-side measures like CCS.	Full portfolio of supply and demand options hedges against failures and discontinuation risks	Failure to address potential trade- offs policies being reversed due to societal concerns.	High risk of necessary post-2030 climate policies strongly competing with other societal concerns and hence not being implemented or discontinued.

Source: IPCC (2018).

Adaptation actions might also be maladaptive or insufficient. Maladaptation denotes adaptation actions that disproportionately burden the most vulnerable, have high opportunity costs, reduce the incentive to adapt or instil path dependency. In some places and for some human and ecological systems, there are limits to adaptation when the pace of climate change impacts makes the prevention of intolerable risks impossible (Klein *et al.*, 2014). Such limits emerge either from situations where the technological or institutional capacity to adapt is ‘bypassed’ by the pace of damage or from hard constraints such as thermal limits of survival for species, or sea level rise that makes permanent relocation the only viable adaptation strategy in certain low-lying areas.

Scaling up both climate mitigation and adaptation is critical to reduce the physical and transition risks from climate change. Physical risks stem from the impact of climate change. Transition risks are related to uncertainties about technological innovations, changes in legislation and regulation, implementation of a carbon tax and changes in consumer behaviour (e.g., a shift in attitudes towards the purchase of diesel cars, air travel or deforestation-based products).

Reducing the physical and transition risks of climate change on society will require an acceleration of the shift of our socio-economic systems towards zero-emission development pathways to avoid environmental and social tipping points. For adaptation and mitigation, four system transitions are key: the energy system transition, the land and ecosystem transition, urban and infrastructure system transitions, and the industrial system transition.

The combination of aggregated but integral modelled pathways, and a detailed assessment of the feasibility of mitigation and adaptation options across the four systems transitions, reveals that it is still technically feasible to limit warming to 1.5°C. However, the technical maturity and cost efficiency of many options need to be improved, especially in hard-to-decarbonize sectors. Furthermore, some options that are already financially attractive, are hampered by systemic barriers, including those in the financial system. The systems transitions will require a dramatic scale-up of climate-related innovation and investment.

## 2. CLIMATE INVESTMENTS: PROACTIVE APPROACHES FOR ADDRESSING GAPS AND REALISING OPPORTUNITIES

Financing a rapid transition to a net-zero emission, climate-resilient economy will require significantly more investment in low carbon and climate-resilient options. These will be scaled up at the required level only if they alleviate and do not exacerbate the short-term tensions that fragilize the world economy. They must also address the imperative of social inclusion and poverty alleviation (UNFCCC, 1992).

This places a triple responsibility on financial decision-makers, financial system regulators and governments:

- Maintain the capacity of the financial system to support economic activity, encourage entrepreneurship and safeguard the assets of millions of savers, pensioners, local public institutions and businesses;
- Channel a much larger share of private savings towards sustainable and low carbon options; and
- Create a business environment in which climate policies alleviate today’s tensions in the world economy (unemployment, poverty, inequality, trade disputes).

The Network for Greening the Financial System (NGFS, 2019) estimates that between 2% and 5% of total financial assets are directly at risk. The Sustainability Accounting Standards Board (2016) indicates that climate-related risks could impact 72 out of the 79 industries assessed, representing 93% of equities (or \$27.5 trillion) by market capitalization in the US alone. Financial players will progressively integrate physical risks under a 'value at risk' framework and revise them according to new information, but it is not certain whether this integration will happen fast enough to maximise the chances of a P1 or P2 scenario.

Financial actors might not immediately anticipate the consequences of climate change as it is initially affecting zones that represent a limited share of the market economy and capital flows. In a first scenario, the financial system would disengage on time from threatened assets but would transfer the costs to communities and taxpayers. In a second scenario, the financial system would not readjust on time to new information, endangering its own entire stability. In both cases, the financial system would fail to deliver on its triple responsibility to address climate change.

Understanding the challenge of climate finance requires differentiating between global low-carbon investment needs and the amounts needed to bridge the infrastructure investment gap (Kennedy & Corfee-Morlot, 2013; IMF, 2014). Global low-carbon investment needs are estimated between 3.9% and 8.7% of the world's GDP over the next two decades. However, the additional investment compared with a business-as-usual scenario could be funded by redirecting between 1.4% and 3.9% of global savings (2.4% on average, see box 4.8 of IPCC, 2018) that currently flow towards real estate, land and liquid financial vehicles. This task is not insurmountable macroeconomically. More challenging is that it has to be achieved together with the reduction of the infrastructure investment gap. This gap could be as high as 15.9% (Global Infrastructure Hub, 2017) or even 32% (Arezki *et al.*, 2016) between 2035 and 2040 for a cumulative value between \$14.9 and \$30 trillion worldwide.

The global infrastructure investment gap reflects risk-averse behaviours that cause a wedge between the propensity to save and the propensity to invest. It also represents a misalignment in the geographical distribution of savings, capital flows and infrastructure investment needs. Developed countries have ageing populations, high saving capacities, established social safety nets, and the bulk of their infrastructures in place. Developing countries have a significant opportunity to leapfrog, as they must still build two-thirds of their infrastructure capital. They have young populations, a wide range of savings rates (from 15% to over 40%) and underdeveloped social safety nets.

This misalignment is compounded by the limited capital flows from high-saving to low-saving regions. From a microeconomic point of view, the infrastructure investment gap looks like an economic paradox since, with current low interest rates, infrastructure investments deliver a real return between 4% and 8% (Bhattacharya *et al.*, 2016). With an estimated \$14 trillion of negative-yielding debt in OECD countries and \$26 trillion of low carbon, climate-resilient investment opportunities in developing countries by 2030, capital seeking higher results should flow from developed to developing countries to address this gap. This is not happening. Three quarters of global climate finance is deployed in the country in which it is sourced, revealing a strong preference for home-country investments where risks are well understood. This explains why sub-Saharan Africa accounts for only 5% of climate-related financial flows in non-OECD countries, at \$19 billion (CPI, 2019).

Neither financial investors nor project developers try and take advantage of what the IMF's World Economic Outlook (Abiad *et al.*, 2014) describes as 'free lunch' opportunities because these opportunities face several political, regulatory, macroeconomic, and technical barriers. These barriers and associated business costs



are magnified in developing countries because of the considerable differences in their creditworthiness. The spread between the interest rate of a bond issued by the US government and the interest rate of loans to a given country comes on top of the projects' risk premium. In 2018, it was 1.30% for a five-year project and 2.5% for a ten-year project in BBB-rated countries. At the beginning of 2020 it jumped to 6% and 9%, respectively, in B-rated countries. Before the Covid-19 crisis, more than 60 countries were rated below BBB and had access to capital only at interest rates higher than 18% for two-year projects. The impact of this inequality is exacerbated by the fact that countries in this class are often those whose creditworthiness might be most affected by climate change damages (Buhr *et al.*, 2018).

Two approaches are advocated to incentivise the changes needed in investment, production and consumption patterns, and to induce technological progress that brings down carbon abatement costs in time to avoid catastrophic climate change: market fixing and market shaping.

The market-fixing approach aims to send the right pricing and risk signals to enable financiers to better value assets and reallocate capital accordingly. To achieve these objectives, it relies on scaling up carbon pricing and promoting climate risk disclosure and taxonomies. There is a widely shared consensus in economics that, in a frictionless world with perfect capital markets and without uncertainty, carbon prices would be sufficient to secure the attractiveness of low carbon options in capital markets. In the real world, however, the carbon price signal is swamped by the noise of other signals, such as oil prices, interest rates and currency exchange rates, in addition to business uncertainty.

The high-level commission led by Joseph Stiglitz and Nicholas Stern (Stiglitz *et al.*, 2017) estimated that carbon prices should be higher than \$40–80/tCO<sub>2</sub> by 2020 and \$50–100/tCO<sub>2</sub> by 2030 to be capable of covering these noises. The scaling-up and geographical expansion of carbon prices to such levels is highly uncertain. The adverse economic and distributive effects of higher energy prices and the removal of fossil fuel subsidies are more severe for low-income countries, countries with a large share of energy-intensive activities, and countries exporting fossil fuels.

The full deployment of climate risk disclosure and taxonomies faces a different set of challenges. Historically, the concerns about climate change implications for the financial community have arisen from potential fiduciary obligations of reinsurers and pension funds. The focus on liability risks responded to the advocacy strategies used by university endowments and mission-based investors such as philanthropic and religious organisations to remove the 'social license' from the fossil fuel industry and to raise the cost of its access to capital. Marc Carney's speech (2015) on the 'tragedy of the horizons' broadened this perspective, adding the 'physical risks' and the 'transition risks' to the 'liability risks'. The alarm raised by the former Governor of the Bank of England had an influence amongst financial actors who generally do not consider the future beyond a quarterly horizon. This discussion led to the creation of a Taskforce on Climate-related Financial Disclosures (TCFD) under the auspices of the Financial Stability Board (FSB) that brings together financial authorities from G20 countries to prevent new financial crises. Climate disclosure is meant to help asset managers to correct their short-term bias and send financial signals to investors by setting the cost of loans in an inverse proportion to the projects' carbon content, thereby hedging against abrupt corrections in financial markets caused by cumulated mispricing of assets.

In late 2017, the Network for Greening the Financial System (NGFS) was launched. It now has 90 members, amongst which central banks from many developed and developing countries. Observers include the IMF, the World Bank, the Bank for

International Settlements, the Basel Committee for Banking Supervision, and the Green Climate Fund (GCF). Its first report established a taxonomy of green, non-green, brown and non-brown products (NGFS, 2019) to help direct investments to sustainable options. In parallel, stress test methodologies have tried to assess the risk exposure of various asset portfolios. The concrete outcome of these processes is still unclear, but they show an increasing demand for knowledge tools from high-level decision-makers in an uncertain environment.

While market-fixing approaches address information barriers for financiers, the market-shaping approach has gradually emerged over the past 30 years to address both demand and supply barriers to climate finance. It aims to tackle several risks that deter entrepreneurs and financiers from exposing their resources:

1. Political and regulatory risks arising from governmental actions, including changes in policies or regulations that adversely impact infrastructure investments;
2. Macroeconomic and business risks arising from the possibility that the industry and/or the economic environment are subject to change; and
3. Technical risks determined by the skills of operators and managers, and related to the features of the project (e.g. its complexity, construction and technology).

A direct consequence of these risks is the limited supply of high-quality, transparent, low-carbon and climate-resilient investment projects despite the unmet demand for new infrastructures.

The need to address market and investment barriers to low carbon options has inspired a wide array of public measures. According to the International Energy Agency's Policies and Measures Database, over 5,500 climate policies and instruments are currently in use globally. Table 3 shows the main types of instruments.

**TABLE 3: ENVIRONMENTAL POLICIES INSTRUMENTS**

	Information and empowerment instruments	Control and regulatory instruments	Economic and market instruments	Institutional instruments	Financial instruments
Market Creation Instruments	Rely on knowledge, communication, and persuasion to influence behaviour and supply skilled labour.	Rely on the establishment of obligations, encouraging or prohibiting or restricting certain types of behaviour	Financial incentives and disincentives to influence private sector behaviour and investment decision-making	Create an institutional and organizational environment to facilitate policy and technology development and deployment	Direct public sector (co) investment to establish a proof of concept or commercial track record of new solutions
Demand-side instruments	<ul style="list-style-type: none"> <li>Information disclosure and green taxonomies (climate risks, carbon liabilities, etc.)</li> <li>Long-term policy commitment and targets</li> <li>Valuation methodologies</li> <li>Public awareness and persuasion</li> </ul>	<ul style="list-style-type: none"> <li>Macro-prudential regulations (climate stress tests for banks and insurers, etc.)</li> <li>Mandates</li> <li>Ban</li> <li>Zoning</li> <li>Building codes</li> <li>Norms and minimum performance standards</li> <li>Standards and labels</li> </ul>	<ul style="list-style-type: none"> <li>Carbon taxes, phase out of fossil fuel subsidies</li> <li>Development of new asset classes</li> <li>Fossil fuel divestment by public financial institutions</li> <li>Taxes/tax breaks (e.g., carbon taxes)</li> <li>Charges and penalties</li> <li>Favourable tariffs</li> <li>Green procurement</li> <li>Advanced market commitment</li> <li>Tradable permits and quotas</li> </ul>	<ul style="list-style-type: none"> <li>Green finance regulatory networks, asset managers coalition and central bank coordination mechanisms</li> <li>Establishment / restructuring of environmental institutions</li> <li>Development of R&amp;D networks and ecosystems</li> </ul>	
Supply-side instruments	<ul style="list-style-type: none"> <li>Investment in education and research</li> <li>Technical and vocational training and retooling</li> </ul>	<ul style="list-style-type: none"> <li>Streamlining licensing processes</li> </ul>	<ul style="list-style-type: none"> <li>Power purchase agreements</li> <li>R&amp;D commissioning</li> <li>Property rights agreements</li> </ul>	<ul style="list-style-type: none"> <li>Dedicated financial institutions (green banks, green guarantee companies, green bond platforms, etc.)</li> </ul>	<ul style="list-style-type: none"> <li>Public sector-led R&amp;D</li> <li>Project concessional finance (grant and loans)</li> <li>Incubation grants/venture capital</li> <li>Guarantees</li> <li>Equity investment</li> </ul>

The first four columns list environmental policy instruments that create a business context conducive to the demand for low carbon investments and the supply of low carbon projects, including by reducing their transaction costs. In contrast, financial de-risking instruments do not seek to change the overall business context to reduce risks, but tackle projects' risks by transferring part of them to public actors. They blend public and private resources, often to encourage market-creating projects that will establish a proof of concept (innovation to market) or commercial track record (market deployment) for new climate solutions. The structuring approach of financial de-risking instruments is usually referred to as 'blended finance'.

A common limit of these instruments is that the tighter the public funding constraints, the lower the political credibility of their maintenance over time. Combined with the difficulty of controlling opportunistic behaviours in subsidies, this can lead to public budget officers working under tight constraints and competing demands to lower support to these measures or make their administration particularly complex.

Furthermore, blended finance has proven effective for mature technologies in mature markets, but not for early-stage technologies in early-stage markets. Between 2012 and 2018, \$205.1 billion were mobilised from the private sector by official development finance interventions. But only 5.3% of these went to Least Developed Countries (LDCs) and other Low-Income Countries (IRENA, 2020), and very little to adaptation and nature-based solutions (CPI, 2019). The role of guarantees was particularly important in these countries, as they mobilised 62% and 46% of the resources in 2015-16 and 2017-18 respectively. Direct equity investment followed, mobilising 14% and 24% of the resources in 2015-16 and 2017-18 respectively (Attridge and Engen, 2019). However, blended finance has usually taken the form of relatively safe senior debt rather than guarantees and equity.

While blended finance aims to use public resources in a catalytic manner to align private sector flows with sustainable development, its leverage ratio for climate change is very low. On average, every \$1 of resources invested from multilateral development

banks (MDBs) and development finance institutions (DFIs) leveraged just \$0.37 of private finance in LICs because of a poor business context (Attridge & Engen, 2019). The geographic and thematic concentration of blended finance and its low leverage ratio are significant obstacles to the opportunity of tapping into the vast private savings pool to reduce the infrastructure investment gap in emerging economies.

In theory, market-fixing approaches can be embedded in broader market-shaping efforts (see Table 3 placing key market-fixing policies within measures directed at the demand side - top line). In practice, market fixing and market shaping tend to emphasise different sub-sets of public instruments.

Market fixing relies on price signals to create a demand for low-carbon low-climate-risk goods and services and shift financial flows towards climate-friendly investments. Market shaping intervenes at the level of sector policies and endeavours to create a demand and directly de-risk the supply of climate-friendly investments to crowd-in private finance.

Experience to date, however, shows that these two approaches are mutually supportive and should be deployed in tandem. The combination of the two sets of instruments helps overcome the constraints inherent to each approach and increases the overall efficiency and effectiveness of public policies and finance to accelerate the transition to net-zero climate-resilient economies.

### 3. SCALING CLIMATE FINANCE IN THE CONTEXT OF COVID-19

The Covid-19 pandemic has pushed the global economy into the deepest recession since the Second World War. The World Economic Outlook (IMF, 2021a) estimated a 3.5% contraction in global growth in 2020, which is far higher than the 0.1% recorded after the 2008 financial crisis. The situation has been particularly devastating for developing countries. During the subprime crisis they continued growing, at a rate of 2.8% in 2008 (World Bank, 2021), whereas their GDP in 2020 contracted by 2.6% and 5% respectively, China excluded (World Bank, 2021). In addition to the health consequences of the pandemic, these countries experienced sharp drops in commodity export prices, including oil prices, a collapse in tourism revenues, reduced exports to developed economies, and the blocking of specific nodes in the supply chain. This caused an increase in the number of people facing food insecurity from 135 million in 2010 to 272 million in 2020 and a significant transfer of the employed population into 'inactivity' (ILO, 2020). An additional 500 million people have fallen below the poverty line. This increase, the first in thirty years, was particularly acute in LDCs and Small Island Developing States (SIDS) (Sumner *et al.*, 2020).

To rescue their economies and support a strong recovery, governments are adopting large-scale expansionary fiscal measures. The fifty largest economies in the world have announced \$14.6 trillion in fiscal spending in 2020, of which \$1.9 trillion for long-term economic recovery (UNEP, 2021). There is a disparity between announced spending by advanced economies (22.5% of their combined GDP), and that of emerging markets and developing countries (10.6%) – a 17 times greater amount on a per capita basis (UNEP, 2021). One of the key reasons for this disparity is the difference in the cost of additional debt. For most high-income countries, the cost of additional debt is close to 0% per year. For developing countries, with low credit ratings, interest rates are significantly higher, increasing the cost of any new debt thus burdening fiscal budgets. The proportion of poorest countries in or at high risk of debt distress has climbed to 55% in January 2021, from 50% in 2019 and 26% in 2013 (IMF, 2021a).

The Covid-19 crisis has brought the world at a crossroad in the fight against climate change. Shan *et al.* (2020) have shown that carbon-intensive packages would increase global emissions (2020 to 2024) by 16.4% (23.2 Gt) while the 'greenest' ones could reduce them by 4.7% (6.6 Gt). Forster *et al.* (2020) show that a 'colourless' recovery would put the world on an emissions pathway that would pass the 1.5°C threshold within a decade and the 2°C limit soon after 2050, whereas the world has a 50% chance to stay below the 2°C warming target with a moderate green stimulus, and below 1.5°C with a solid green stimulus. The UN Environment Programme (UNEP, 2021) finds that, in the 50 largest economies, only 18% of recovery spending and only 2.5% of total spending will enhance sustainability. In 2020, G20 countries spent \$208.73 billion supporting fossil fuel energy, compared with \$143.02 billion supporting clean energy.

Advanced economies are undertaking expansionary fiscal measures, but the low green content of the present recovery packages could entrench their dependence on fossil fuels and undermine the capacity to meet their net-zero emission targets by 2050. Developing countries, on their part, are suffering from increasingly restricted monetary and fiscal space, which seriously undermines their ability to finance mitigation and adaption measures. A weak come-back in regions that represent (China excluded) 55% of the world markets may in turn make the global economic recovery more fragile.

The main argument not to postpone climate action in a context of competing pressures on public budgets is that bridging the infrastructure investment gap would be a blueprint for a fast and robust global recovery thanks to the strong knock-on effect on infrastructure investments. This would notably unlock two thirds of world infrastructure markets currently 'frozen' in developing economies. The public policy devices mobilised to redirect savings towards low-carbon options have the advantage, compared with untargeted recovery measures, to secure the efficiency of every unit of public money spent.

The economic and financial impacts of Covid-19 have exacerbated the four challenges developing countries were already facing to scale up climate action. These countries will need to ensure that climate action and economic recovery are mutually supportive, scale up investment without increasing the debt burden, attract large scale private financial flows in a context of perceived higher investment risk, and secure access to long-term affordable finance at a time of rising capital costs.

These challenges can be addressed through four sets of complementary actions.

**1. Integrating policies on climate action, sustainable development, and Covid-19 stimulus to minimise incremental investment requirements and optimise development co-benefits**

NDCs are at the heart of the Paris Agreement and of countries' commitment to transform their development trajectories. Countries are currently in the process of submitting updated and more ambitious NDCs. Integrating policies on climate action, sustainable development and Covid-19 stimulus measures could reduce investment needs by 40% and leverage the stronger economic multiplier of climate action to build back better.

The imperative to green the Covid-19 recovery amplifies the need to translate integrated NDCs into investment plans that: (i) align, combine and sequence multiple sources of international and domestic finance from the public and private sectors; (ii) enable countries to take a more integrated value-chain investment approach, notably by acquiring the technical capacity to address policy and regulatory gaps to improve the bankability of the NDC project pipeline; and (iii) identify financial mechanisms and investment patterns that will not increase sovereign debt, but catalyse private funds and increase access to long-term affordable finance.

## **2. Alleviating the debt burden of developing countries to create fiscal space to finance their green, climate-resilient recovery plans**

Several multilateral actions are being taken to help developing countries cope with the economic crisis and create more fiscal space. The G20 has suspended – not cancelled – official bilateral debt payments for 42 low-income countries, corresponding to approximately \$5 billion. The discussion about the issuance of new special drawing rights (SDRs) has been re-opened by the IMF (IMFb, 2021). An even bolder action is to consider at scale ‘debt-for-climate swaps’, a partial cancellation of debt by the creditor government transforming the remaining part into local currency and directing it to investment in climate action. The use of debt reduction could be a function of a country’s overall climate vulnerability.

The scaling up of new payment facilities (debt-for-climate swaps, SDRs) is complex to design and requires a pipeline of high-quality bankable climate investments, which can be capitalised in the form of credible assets, together with transparent and credible domestic spending. A direct linkage with integrated and costed NDCs and dedicated facilities for technical assistance would remove some of these barriers. These unconventional debt management instruments respond to the specifics of the post-Covid-19 context and are additional, not alternative, to the commitment of developed countries to mobilise \$100 billion in climate finance per year by 2020 for developing states. Fulfilling such commitment is critical to finance essential non-market services, as is deploying environmental policy instruments to create a conducive business context to catalyse low carbon, climate-resilient private investment.

## **3. Leveraging sovereign and multi-country guarantee funds to reduce investment risk and catalyse private finance**

The experience of blended finance highlights the importance of sovereign and sub-sovereign (local governments) guarantees to overcome the barriers hindering climate-friendly investments in nascent technologies in nascent markets. They reduce upfront risks and ensure broad risk coverage, lower costs for public budgets of donor countries, and a high leverage ratio of public to private capital (Blended Finance Taskforce, 2018a).

In a context of heightened risk perception in developing countries, multi-sovereign guarantees, where developed countries rated AAA-AA join forces to provide an AAA-AA backing to developing countries, could:

- Expand developing countries’ access to capital markets at a lower cost and with longer maturities thanks to the reduction of creditworthiness risks, especially for small states;
- Accelerate the recognition of climate assets suitable for institutional investors seeking ‘safe investments havens’, thanks to the reputational effect of a selection of projects with multilateral backing and transparent assessment methods;

- Strengthen climate disclosure through high grades in the environmental notation of these climate assets;
- Increase the effectiveness of carbon pricing with more mitigation activities unlocked by a given price level, a stronger employment impact and higher funding facilities to help industries adapt;
- Free up grant capacities for SDGs and adaptation by crowding in private investments for mitigation. For non-marketable activities, grants are the key instrument to develop policy and capacity and establish a conducive investment environment that deals with risks.

#### **4. Increasing developing countries' access to the green bond market**

The potential of green bonds is estimated at €29.4 trillion over 2030 (Bolton *et al.*, 2020). Green bonds can drive new public-private partnerships and increase access of developing countries to long-term affordable debt. The development of green bonds is far below this potential (only \$1 trillion in the ten years since their launch and \$258 billion in 2019, Climate Bonds Initiative, 2020). They represent about 5% of total bonds issued globally and fell by 11% in 2020 in the aftermath of the pandemic.

Options to significantly broaden developing countries' access to the green bond market include creating credible and standardised assessments and valuation methods to select, design, value, monitor and report on high-quality bankable climate projects, and enhancing capacity to design, float and implement green bonds.

Some countries are already exploring the four sets of instruments discussed above. For example, Saint Lucia, one of the SIDS hardest hit by climate change, is translating its NDC into a detailed investment plan exploring financial innovations like resilience bonds and climate debt swaps to supplement public resources and finance these efforts without raising its debt.



## 4. CONCLUSION

Accelerating the transition to reduce emissions along a P1 or P2 pathway is required to maximise development co-benefits and achieve both the Paris Agreement and the SDGs. The P1 and P2 pathways, which entail reducing energy demand and improving energy efficiency, are technically feasible for both adaptation and mitigation. Financing a P1 or P2 pathway will require significantly more investment and investment in a different set of low-emission, climate-resilient assets.

However, inertia on the part of the financial system means that in the absence of policy interventions, the financial system will not be able to redirect private capital on the needed scale. This will lead economies towards a P3 or P4 scenario causing greater tension with sustainable development outcomes and possibly more severe overshoots. The Covid-19 pandemic exacerbates this inertia, and with the large fiscal stimulus measures, 'colourless' investments could tip the world beyond the 1.5°C threshold within a decade and the 2°C limit soon after 2050.

To avoid this irreversible outcome, financial flows must first shift towards a P1 and P2 pathway. This can be achieved through a combination of market-fixing and shaping efforts. Deploying both approaches in tandem helps overcome the constraints inherent to each approach and increase the overall efficiency and effectiveness of public policies and finance to scale up climate action.

Second, four strategic interventions could enable developing countries to address the additional economic and financial challenges created by the pandemic and realise their climate ambitions. Together, these four interventions – support to integrated and costed climate policy and plans, alleviation of debt burden, leverage of sovereign and multi-country guarantee funds and increased access to the green bond market – would enable developing countries to foster a green, climate-resilient recovery from the Covid-19 crisis.

These four immediate actions could also have a structural positive impact on the future climate policy architecture. They could a) facilitate the deployment of carbon pricing since de-risking mechanisms will increase the volume of low-carbon investments at a given carbon price; b) magnify the impact of financial transparency and disclosure through the emergence of investments and asset classes of higher credibility; c) reduce the fragmentation of climate and development finance; and d) enhance the capacity of official climate and development assistance to support non-marketable services.

# INTRODUCTION

Earth's surface warming since the pre-industrial baseline period (1850-1900) has been faster than at any other time in the past 800,000 years. Currently, the global mean surface temperature is 1.0°C higher (0.8°C - 1.2°C range) than the baseline. Temperatures are rising at an average of 0.2°C (0.1 - 0.3°C) per decade (IPCC, 2018). Warming is unequivocally linked to human activities responsible for the release of greenhouse gases (GHGs) (IPCC, 2018). The atmospheric concentration of carbon dioxide (CO<sub>2</sub>) has increased from 280 ppm in the pre-industrial period (1850-1900) to 417 ppm in 2020, predominantly due to fossil fuel combustion, cement manufacturing, and land use change (deforestation, removal of land cover and land tilling) (NOAA, 2019).

Multiple lines of evidence show warming is already affecting all earth systems and many human systems. The net impact of warmer climates on people, ecosystems and the economy is the result not only of temperature increases, but also of the capacity to prevent damage and adapt to the changing circumstances. Poorer countries, where access to information, mobility, infrastructure, and state support is limited, are typically most exposed.

To avoid the catastrophic impacts of climate change, 197 parties adopted the Paris Agreement in 2015, aiming to limit the increase of global average temperatures since pre-industrial levels (1850-1900) to well below 2°C, while pursuing efforts to stay within 1.5°C. The Paris Agreement also aims to increase countries' ability to adapt to the adverse impacts of climate change (United Nations, 2015). This need to be done while eradicating poverty and meeting the UN Sustainable Development Goals (SDGs).

Further rises in temperature and sea level are inevitable until GHG emissions are cut to net zero. A report from the Intergovernmental Panel on Climate Change (IPCC) - the UN body providing scientific information on human-induced climatic changes - established that limiting warming to 1.5°C over the course of the century requires steep reductions by 2030 and net-zero CO<sub>2</sub> emissions by 2050.

Since the release of the report, 123 countries responsible for 63% of emissions have adopted or are considering net-zero targets. These net-zero targets have put the Paris Agreement's goals within striking distance (Climate Action Tracker, 2020). Rapid and deep decarbonisation will have overall net benefits but also significant distributional trade-offs. The entire business model of countless profitable corporations will be upended, and some countries and communities may be disproportionately affected.

Climate change creates two inter-related challenges for the financial system. First, climate change impacts pose growing risk to its stability and its capacity to support economic activity while safeguarding the assets of millions of savers, retirees, institutions and businesses. The Network for Greening the Financial System (NGFS, 2019) estimates that between 2% and 5% of total financial assets are directly at risk. The Sustainability Accounting Standard Board (2016) indicates that climate-related risks could impact 72 out of the 79 industries assessed representing 93% of equities (or \$27.5 trillion) by market capitalisation in the US alone. Because climate risk cannot be mitigated by current financial practices, investors need to understand and adequately price their exposure to it.

Second, supporting the transition to a low-carbon, climate-resilient economy in line with the goals of the Paris Agreement will require significantly more investment,

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investment in a different set of assets, and investment that addresses the humanitarian imperative of social inclusion and poverty alleviation (de Coninck *et al.*, 2018).

The financial system has a pivotal role to play in accelerating the transition to a net-zero economy, mitigating the physical and transition risks of climate change, seizing the opportunities that emerge from the transformation and ensuring a just transition. The latter is a precondition to a fast transition. The total value of the net-zero economy is estimated at \$2.3 trillion (UN and UAE, 2020).

Based on an extensive review of the scientific and economic literature, this Report highlights the key physical and transition risks associated with different low-carbon climate-resilient pathways and the imperative for financial decision-makers to integrate climate risks and net-zero opportunities into every single investment decision. While knowledge of the net-zero concept is growing, the understanding of its implications for individual businesses is poor. In a survey of 1,000 senior decision-makers across a range of industries in all parts of the UK, 64% were not confident they fully understood the implications for their firm (BSI, 2021).

The Report is divided into three chapters. Chapter I discusses the climate physical and transition risks associated with different climate mitigation and adaptation pathways and their financial implications. Chapter II discusses whether the financial system will be able to redirect private capital at the needed scale in the absence of policy interventions and presents past and ongoing efforts to align finance with the Sustainable Development Goals and the Paris Agreement. Chapter III proposes four interventions to achieve this objective in the context of Covid-19.

# CHAPTER 1: WHAT CLIMATE SCIENCE SAYS ABOUT RISKS RELATED TO CLIMATE CHANGE

Every policy and every investment are a bet on the future. Policy-makers and financiers continuously forecast future conditions. Since its 2nd assessment report (1996) the IPCC evaluates scenarios of the consequences of business-as-usual behaviours in contrast to mitigation pathways, with the aim of informing decision-makers. This chapter outlines the state of the art of such scenarios and pathways for limiting warming to 1.5°C, identifies how they can be used to understand the financial implications of climate change and climate policies, and outlines the feasibility conditions of the systems transitions needed to avoid the worst consequences of climate change.

## 1.1 CARBON BUDGETS AND MITIGATION PATHWAYS

### 1.1.1. CARBON BUDGETS AND LIMITS TO WARMING

The remaining carbon budget is the amount of CO<sub>2</sub> that can still be emitted while limiting warming to around 1.5°C or 2°C (see **Box 1.1**). Pathways that stay within this budget can be described by emission milestones in specific years and can be characterised by two core variables (see **Table 1.1**):

1. The decline in global annual net anthropogenic CO<sub>2</sub> emissions in 2030 compared to 2010
2. The year in which the goal of net-zero CO<sub>2</sub> emissions is reached.

Non-CO<sub>2</sub> emissions in pathways that limit global warming to 1.5°C also require deep reductions, but with little variation between 1.5°C and 2°C (IPCC, 2018; Rogelj *et al.*, 2018).

**TABLE 1.1. GLOBAL CO<sub>2</sub> EMISSIONS DECLINE AND YEAR OF REACHING NET-ZERO CO<sub>2</sub> EMISSIONS ASSOCIATED WITH LIMITING WARMING TO 1.5°C AND 2°C. INTERQUARTILE RANGES ARE SHOWN IN SQUARE BRACKETS, BASED ON TABLE 2.4 IN (ROGELJ ET AL., 2018).**

LONG TERM (2100) TEMPERATURE LIMIT	GLOBAL CO <sub>2</sub> EMISSIONS REDUCTION IN 2030 COMPARED TO 2010	YEAR OF REACHING NET-ZERO CO <sub>2</sub> EMISSIONS	YEAR OF REACHING NET-ZERO GHG EMISSIONS
1.5°C	45% [40-60%]	2050 [2045-2055]	2065 [2060-2085]
2°C	25% [10-30%]	2070 [2065-2080]	2090 or thereafter

#### BOX 1.1. HOW THE CARBON BUDGET DETERMINES CO<sub>2</sub> EMISSIONS LIMITS

Cumulative CO<sub>2</sub> emissions and global mean temperature increase are directly related. To stabilise the global mean temperature, global CO<sub>2</sub> emissions must decline to zero. The amount of CO<sub>2</sub> that can still be emitted while keeping warming below a specific temperature is known as the remaining carbon budget. To limit global warming to 1.5°C (i.e. exceeding it by no more than 0.1°C at any point during this century with some likelihood) this budget has been estimated at 420 and 580 billion tonnes of CO<sub>2</sub> (GtCO<sub>2</sub>) from 2018 onwards in order to have a two-in-three and one-in-two chance, respectively. These estimates can increase or decrease by up to 250 GtCO<sub>2</sub> depending on how successfully non-CO<sub>2</sub> GHGs, e.g. methane, are limited. Earth system feedbacks, like the release of CO<sub>2</sub> and methane from thawing permafrost, could further decrease the carbon budget by 100 GtCO<sub>2</sub> over the course of this century (Rogelj et al., 2018). These numbers are subject to considerable uncertainty and in the past, new insights have led to both upward and downward revisions. In addition, the temperature response to GHG concentrations shows a probability distribution.

In 2017, global CO<sub>2</sub> emissions were 42 billion tonnes (Le Quéré et al., 2018; Rogelj et al., 2018). If this rate continues, the remaining carbon budget for 1.5°C will be depleted within 10 or 14 years starting from 2018. Emissions in recent years, including the dip in 2020 because of the Covid 19-measures, have not modified this number by much (Friedlingstein et al., 2020; Forster et al., 2020).

The Nationally Determined Contributions (NDCs) as of 2018 do not yet chart a path towards net-zero CO<sub>2</sub> emissions. Their full implementation is projected to result in warming between about 2.9°C and 3.4°C until the end of the century. The annual emissions in 2030 for 1.5°C pathways would have to be 19-33 GtCO<sub>2</sub>e (or roughly 30-50%) lower than what the NDCs are projected to deliver (de Coninck et al., 2018; Rogelj et al., 2018).

### 1.1.2 MITIGATION PATHWAYS: NATURE OF THE TRADE-OFFS

The emissions pathway until 2100 varies depending on the speed and scale of mitigation action over time. Integrated Assessment Models (IAMs) explore the technological, economic and geophysical aspects of emissions pathways (see **Box 1.2** for more details).

#### BOX 1.2: HOW ARE EMISSION PATHWAYS CONSTRUCTED?

The emission pathways that the IPCC assesses are generally created with tools known as Integrated Assessment Models (IAMs). These models link the climate system with the economy, including all known sources and sinks of GHG emissions. All IAMs include emissions associated with the energy sector, and many include emissions from land use. They include energy efficiency but rarely model the specific and societal dynamics of transportation, industry and agriculture. The models are used to explore the dynamics of human-Earth systems under different scenarios for reaching certain climate targets. IAMs are internally consistent under a multitude of constraints and assumptions, and the model outcomes are often, but not exclusively, the result of a social cost optimisation over the course of the century.

IAMs utilise various model structures to represent society's behaviours. Some models start from an energy system optimisation core with a detailed representation of how various options for energy supply can meet a given level of energy demand and only to a limited degree represent the macro-economic feedbacks of climate policies. Other models start from an economic core and incorporate energy system transitions. IAMs do not represent individual companies and only a few represent the public and private finance sectors, always in a highly aggregated way. Although they do not model capital markets and monetary policies explicitly (Espagne, 2018), the IAM have been given inputs to highlight financial aspects (Bowen et al., 2014; UNEP Inquiry, 2018).

IAMs make assumptions about societal dynamics and drivers (population growth, economic growth, evolution of energy intensity), economic parameters (growth rate, discount rates), as well as international cooperation or the level of RandD. IAMs often link their assumptions to overarching socio-economic narratives. The standard in IPCC emission pathways are the five 'Shared Socio-economic Pathways' (SSPs): narratives with different premises for factors such as economic growth, population, international cooperation and energy demand.

A pathway is then generated by a) retaining assumptions on the costs and efficiencies of different technologies and on the potentials of wind, solar or fossil fuel energy or geological CO<sub>2</sub> storage, and b) imposing constraints, typically on the carbon budget and certain technologies (e.g., amount of energy storage required to support a given share of intermittent renewables).

The IPCC Special Report on the impacts of 1.5°C global warming (SR1.5) highlighted four illustrative pathways drawn from a range of IAMs (see **Table 1.2**). The difference between the pathways is the emphasis placed on eliminating gross CO<sub>2</sub> emissions quickly in the next decades by limiting and reducing energy demand and energy efficiency improvements through behavioural change and digitalisation (P1 and P2 pathways in **Table 1.2**) (Grübler et al., 2018; WBGU, 2019),

compared with reliance on great quantities of carbon dioxide removal (CDR) (P3 and particularly P4 in [Table 1.2](#)).

The active removal of CO<sub>2</sub> from the atmosphere plays two important yet distinct roles in shaping emissions trajectories. It first helps bringing global CO<sub>2</sub> emissions down to net zero. Mitigation strategies determine how high gross emissions will be, and therefore how much CDR is needed to reach net zero (compare the respective CO<sub>2</sub> emission contributions at the time global CO<sub>2</sub> emissions reach net zero in the illustrative pathways P1-P4 in [Table 1.1](#)). Second, CDR draws down CO<sub>2</sub> beyond the point of net zero to slowly revert global warming (see box 1.3).

### BOX 1.3: THE IMPLICATIONS OF 'OVERSHOOTING'

'Overshoot' refers to a situation in which a) a temperature limit is first exceeded with the intention of halting warming at a later point in time, and then relying on the possibility of reducing global mean temperature through active CDR, and b) there is a high likelihood that a return below the temperature limit by the end of the century will not be achieved.<sup>2</sup> In this strategy, the temperature limit that is considered safe can be exceeded before being sure that either halting or reversing global warming by CDR is possible and that the CDR will not be in conflict with food and water security or biodiversity protection. Pathway P4 further illustrates the characteristics of overshoot (see [Table 1.2](#)).

A way forward in conceptualising the scenarios that increase the likelihood of meeting the Paris Agreement's temperature goal (Rogelj et al., 2019) is to determine the cumulative amount of CO<sub>2</sub> emitted until emissions are net zero at a given point in time for a given target and calculate the amount of net negative CO<sub>2</sub> emissions needed to balance residual non-CO<sub>2</sub> emissions for which at present no mitigation options have been identified. This logic demonstrates that the transition challenge is situated in the next couple of decades, until net-zero CO<sub>2</sub> emissions are achieved globally.

**Strategies lowering energy demand show more synergies with other societal goals than strategies focused on the supply side** (Roy et al., 2018), which more often imply trade-offs with food and water security or biodiversity protection. Of the four illustrative pathways, P1 is most aligned with the sustainable development agenda, while P4 is projected to result in more tensions between mitigation and sustainable development objectives in the medium to long term (see [Table 1.2a](#)). Such tensions would represent economic and financial risks in case of a sudden shift in strategy when the trade-offs materialise.

<sup>2</sup> These risks could be exacerbated by societal responses to sector-scale impacts, e.g. in the form of mass migration, food riots, etc., which are not captured in the currently assessed pathways.



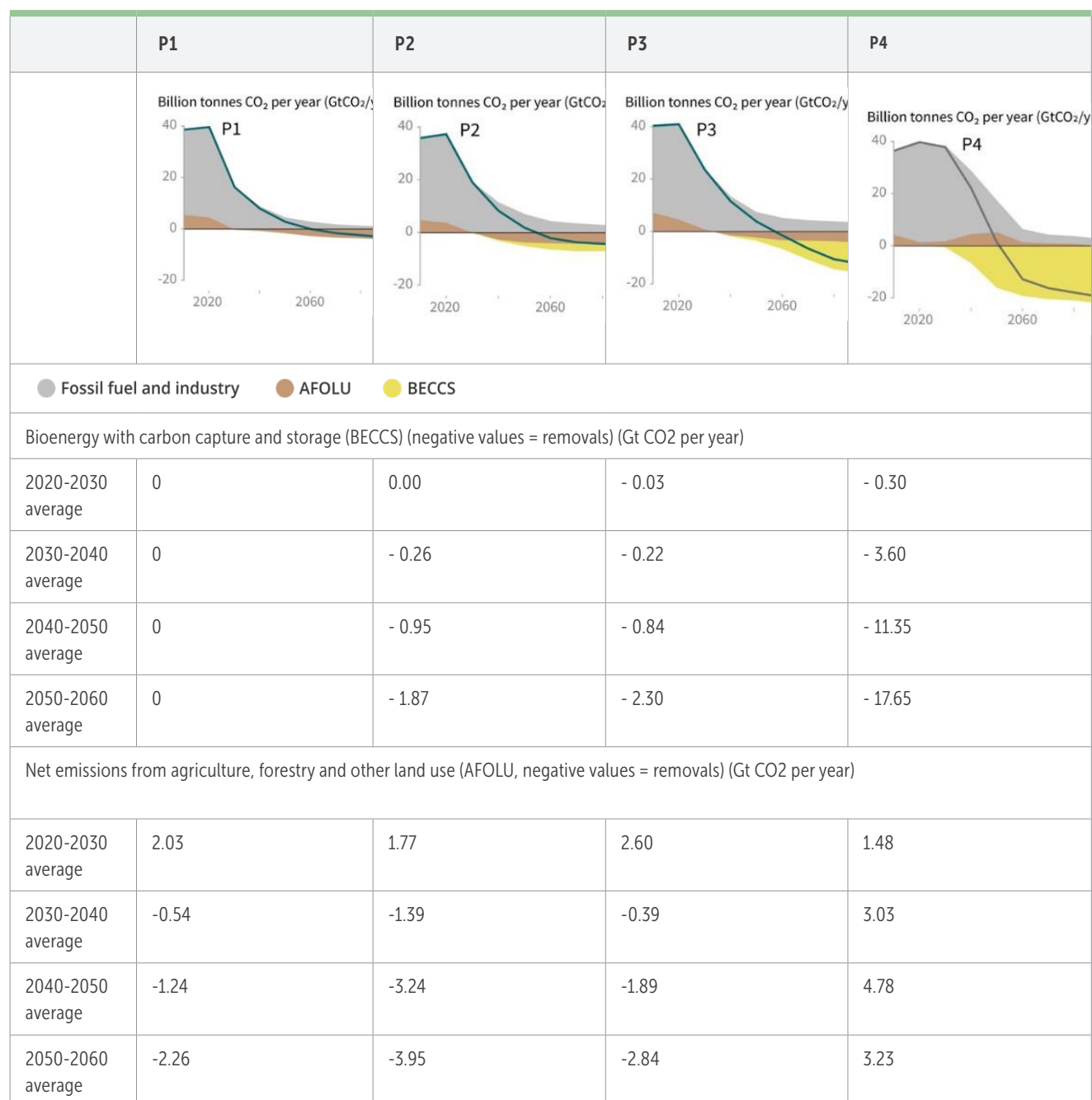
TABLE 1.2A | RISK CHARACTERISTICS OF FOUR ILLUSTRATIVE PATHWAYS PURSUING DIFFERENT STRATEGIES TO LIMIT WARMING TO 1.5°C AS SHOWN IN FIGURE SPM.3B OF THE IPCC SPECIAL REPORT ON GLOBAL WARMING OF 1.5°C (IPCC, 2018). DARKER CELL COLOURS INDICATE HIGHER RISK. AFOLU = AGRICULTURE, FORESTS AND OTHER LAND USE; BECCS = BIOENERGY AND CARBON DIOXIDE CAPTURE AND STORAGE.

	P1	P2	P3	P4
	<p>● Fossil fuel and industry    ● AFOLU    ● BECCS</p>			
Storyline	<p>Social, business and technological innovations; lower energy demand by 2050; higher living standards (also in the global South); downsized energy system; rapid decarbonisation of energy supply; afforestation the only CDR option considered; no CCS.</p>	<p>Focus on sustainability incl. energy intensity; human development; economic convergence; shifts towards sustainable and healthy consumption patterns; low-carbon technology innovation; well-managed land systems; limited BECCS.</p>	<p>Societal and technological development follow historical patterns; emissions reductions through changing production of energy and commodities rather than through reductions in demand.</p>	<p>Economic growth and globalisation; greenhouse-gas-intensive lifestyles, including high demand for transportation fuels and livestock products; emissions reductions mainly through technological means; CCS and BECCS.</p>
Temperature outcome (within 0.1°C accuracy, median estimate)	Warming limited to 1.5°C	Warming limited to 1.5°C	Warming limited to 1.6°C	Warming exceeds 1.5°C limit by 20% (0.3°C) with assumption it can be reversed by 2100
Risk of overshoot of 1.5°C	Small	Small	Large	Very large (designed to first miss the target)
Alignment with sustainable development	Very strong	Strong	Medium, with potential trade-offs	Weak, with marked trade-offs

Physical climate risks to 2050	Lowest	Low	Medium	Highest
Physical climate risks after 2050*	Low	Lowest	Low	High
Transition risks and Opportunities				
Energy demand reduction/ management	Very high	High	Medium	Low
Energy supply Infrastructure investments	Lowest	Medium	High	Highest
Asset stranding	Near-term retirement of fossil-fuel assets	Near-term retirement of fossil-fuel assets	Moderate stranding of fossil-fuel assets	Stranding delayed by a decade but then with higher magnitude**
Reliance on CDR	Small	Medium	Large	Extreme
Deployment of land-based mitigation and bioenergy	Medium	Medium	High	Extreme
Discontinuation risks	Failure to achieve demand and behavioural changes may leave little time to ramp up supply-side measures like CCS.	Full portfolio of supply and demand options hedges against failures and discontinuation risks	Failure to address potential trade- offs: policies being reversed due to societal concerns.	High risk of necessary post-2030 climate policies strongly competing with other societal concerns and hence not being implemented or discontinued.

\* P2 has the lowest post-2050 physical climate risk as it combines low peak warming with a strategy to achieve net CDR after 2050 and gradually reverse warming. \*\* Highest capital turnover due to short-term fossil-fuel expansion and medium-term retirement of carbon intensive infrastructure

**TABLE 1.2B | CONTRIBUTIONS OF BIOENERGY WITH CARBON CAPTURE AND STORAGE (BECCS), TOTAL CARBON CAPTURE AND STORAGE (CCS) AND AGRICULTURE, FORESTRY AND OTHER LAND USE (AFOLU) IN FOUR ILLUSTRATIVE PATHWAYS PURSUING DIFFERENT STRATEGIES TO LIMIT WARMING TO 1.5°C AS SHOWN IN FIGURE SPM.3B OF THE IPCC SPECIAL REPORT ON GLOBAL WARMING OF 1.5°C (IPCC, 2018).**

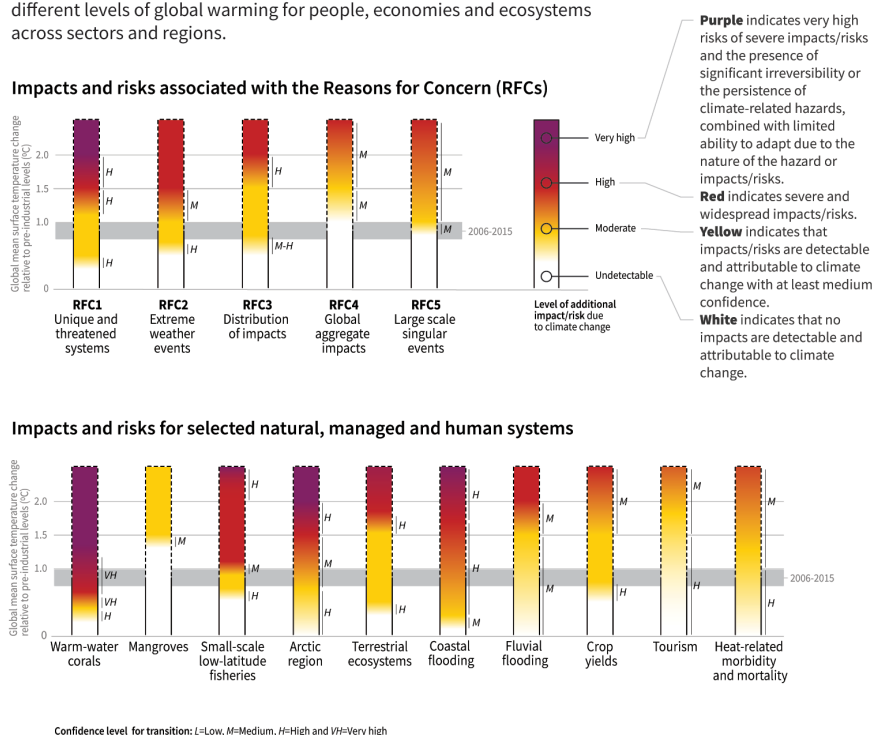


## 1.2. RISKS, DAMAGES AND ADAPTATION NEEDS UNDER DIFFERENT MITIGATION PATHWAYS

Global warming has already had significant impacts on human and natural systems (IPCC, 2014; IPCC, 2018; IPCC, 2019; IPCC, 2020) and all earth systems will continue to be impacted, due to their inertia (IPCC, 2001; IPCC, 2019). For example, even after stabilisation or reduction of GHG concentrations, sea level is projected to continue rising for centuries. Inertia related to human systems is more dependent on regional policies and actions, which in turn shape adaptation pathways and outcomes. It is important to understand the impacts associated with different levels of warming for various human, natural and managed systems. We examine first these links based on the difference between 1.5°C and 2°C temperature increases before emphasising the risks in terms of overshoot of these levels. We do so using the five reasons of concerns due to global warming pictured in **Figure 1.1**.

### How the level of global warming affects impacts and/or risks associated with the Reasons for Concern (RFCs) and selected natural, managed and human systems

Five Reasons For Concern (RFCs) illustrate the impacts and risks of different levels of global warming for people, economies and ecosystems across sectors and regions.



**Figure 1.1.** The identified reasons for concern are: threats to endangered species and unique systems, damages from extreme weather events, effects that fall most heavily on developing countries and the poor within countries, global aggregate impacts, and large-scale high-impact events. The colouring in the bars, nicknamed ‘burning embers’, is based on multiple lines of evidence showing that risks increase with global warming. They show that warm-water corals are heavily at risk even at 1.5°C, as well as fisheries, the Arctic and coastal regions. Terrestrial ecosystems, fluvial flooding, crop yields and the health and mortality impacts of heat waves show a contrast between 1.5°C and 2°C. Source: Figure SPM.2 in (IPCC, 2018).

### 1.2.1. RISKS AND IMPACTS TO NATURAL ECOSYSTEMS AT 1.5°C AND 2°C

On land, impacts on biodiversity and ecosystems, including species loss and extinction, are projected to be lower at 1.5°C of global warming compared to 2°C. Limiting global warming to 1.5°C is also projected to lower the impacts on freshwater and coastal ecosystems and to retain more of their services to humans (See [Table 1.3](#)). Warmer temperatures increase the risks to marine biodiversity, fisheries and ecosystems, as well as to their functions and services to humans, as illustrated by recent changes to the Arctic sea ice and warm-water coral reef ecosystems.

**TABLE 1.3 | PROJECTED IMPACTS OF CLIMATE CHANGE AT 1.5°C VS. 2°C VS. 3°C IN SPECIFIC REGIONS, INCLUDING IMPACTS FOR HUMAN SYSTEMS. REGIONS THAT WERE NOT HOTSPOTS AT LOWER WARMING LEVELS BECOME HOTSPOTS AT HIGHER LEVELS OF WARMING.**

REGION	WARMING OF 1.5°C OR LESS	WARMING OF 1.5° TO 2°C	WARMING OF UP TO 3°C
Arctic Sea Ice	Arctic summer sea ice likely to be maintained  Habitat losses for polar bears, whales, seals, and sea birds  Benefits for Arctic fisheries	50% or higher risk of ice-free Arctic in summer  Habitat losses for polar bears, whales, seals, and sea birds possibly critical if summers are ice-free  Benefits for Arctic fisheries	Arctic very likely to be ice-free in summer  Critical habitat losses for polar bears, whales, seals, and sea birds  Global atmospheric temperature rises from 1.5° to 3.5°C increase maximum catch potential from 29.1 ± 1.6% to 55.0 ± 3.9%
Arctic Land Regions	Cold extremes warm by a factor of 2 to 3, reaching up to 4.5°C (high confidence)  Biome shifts in the tundra and permafrost deterioration likely	Cold extremes warm by as much as 8°C (high confidence)  Larger intrusions of trees and shrubs in the tundra than under 1.5°C of warming likely; larger but constrained losses in permafrost likely	Drastic regional warming very likely  Collapse in permafrost possible (low confidence);  Drastic biome shift from tundra to boreal forest possible (low confidence)

REGION	WARMING OF 1.5°C OR LESS	WARMING OF 1.5° TO 2°C	WARMING OF UP TO 3°C
Alpine Regions	<p>Severe shifts in biomes likely</p> <p>Robust increases in runoff in Fenno-Scandinavia and the Alpine regions</p>	<p>Even more severe shifts likely</p> <p>Distinct increase in the changes to mean, low and high runoff at 2°C compared to 1.5°C</p>	<p>Critical losses in alpine habitats likely</p> <p>Increased runoff in most of Norway, Sweden and northern Poland</p> <p>Decreased runoff around the entire Iberian coast, the Balkan Coast and parts of French coast.</p>
Southeast Asia	<p>Risks for increased flooding related to sea level rise</p> <p>Increase in heavy precipitation events</p> <p>Significant risks of crop yield reductions avoided</p>	<p>Higher risks of flooding related to sea level rise (medium confidence)</p> <p>Stronger increase in heavy precipitation events (medium confidence)</p> <p>One-third decline in per capita crop production (medium confidence)</p>	<p>Substantial increases in risks related to flooding from sea level rise</p> <p>Substantial increase in heavy precipitation and high-flow events</p> <p>Substantial reductions in crop yield</p>
Mediterranean	<p>Increase in probability of extreme drought (medium confidence)</p> <p>Reduction in runoff of about 9%, with likely range 4.5 to 15.5% (medium confidence)</p> <p>Risk of water deficit (medium confidence)</p>	<p>Robust increase in probability of extreme drought (medium confidence)</p> <p>Robust change of average maximum temperature and temperature extremes over more than 50% of land; &gt;60% increase in the number of tropical nights in parts of the region</p> <p>Further reductions (about 17%) in runoff with likely range of 8 to 28% (medium confidence)</p> <p>Higher risks of water deficit (medium confidence)</p>	<p>Robust and large increases in extreme drought</p> <p>Substantial reductions in precipitation and in runoff (medium confidence)</p> <p>Very high risks of water deficit (medium confidence)</p>

REGION	WARMING OF 1.5°C OR LESS	WARMING OF 1.5° TO 2°C	WARMING OF UP TO 3°C
West Africa and Sahel	<p>Increases in the number of hot nights and longer and more frequent heatwaves likely</p> <p>Reduced maize and sorghum production likely, with area suitable for maize production reduced by as much as 40%</p>	<p>Further increases in number of hot nights and longer and more frequent heatwaves likely</p> <p>Negative impacts on maize and sorghum production likely larger than at 1.5°C; medium confidence that vulnerabilities to food security in the African Sahel will be higher at 2.0°C compared to 1.5°C</p>	<p>Substantial increases in the number of hot nights and heatwave duration and frequency (very likely)</p> <p>Negative impacts on crop yield may result in major regional food insecurities (medium confidence)</p>
Southern Africa	<p>Reductions in water availability with robust reduction in precipitation of up to 0.4mmday<sup>-1</sup> over parts of Zambia and South Africa under 1.5°C warming (medium confidence)</p> <p>Increases in number of hot nights and longer and more frequent heatwaves (high confidence)</p> <p>High risks of increased mortality from heatwaves</p> <p>High risk of undernutrition in communities dependent on dryland agriculture and livestock</p>	<p>Larger areas facing reductions in rainfall and water availability under 2°C warming (medium confidence)</p> <p>Further increases in number of hot nights and longer and more frequent heatwaves (high confidence), associated higher risks of increased mortality from heatwaves compared to 1.5°C warming (high confidence)</p> <p>Higher risk of undernutrition in communities dependent on dryland agriculture and livestock</p>	<p>Large reductions in rainfall and water availability (medium confidence)</p> <p>Drastic increases in the number of hot nights, hot days, and heatwave duration and frequency, with substantial impact on agriculture, livestock, and human health and mortality (high confidence)</p> <p>Very high risk of undernutrition in communities dependent on dryland agriculture and livestock</p>



REGION	WARMING OF 1.5°C OR LESS	WARMING OF 1.5° TO 2°C	WARMING OF UP TO 3°C
Tropics	<p>Increases in the number of hot days and hot nights as well as longer and more frequent heatwaves (high confidence)</p> <p>Risks to tropical crop yields in West Africa, Southeast Asia, Central and South America significantly lower than under 2°C of warming</p>	<p>Larger increase in hot days under 2°C compared to 1.5°C is projected</p> <p>Significant changes in rainfall; e.g. spatially-averaged annual mean precipitation across India increases by 2-14% under 2°C compared to 1.5°C</p> <p>Risks to tropical crop yields in West Africa, Southeast Asia, and Central and South America possibly extensive</p>	<p>Oppressive temperatures and accumulated heatwave duration very likely to have a direct impact on human health, mortality, and productivity</p> <p>Further changes in precipitation patterns; e.g. significant decrease in rainfall across NW Indian sub-continent; increase in the frequency of extreme precipitation in east India, Bangladesh.</p> <p>Substantial reductions in crop yield very likely</p>
Small Islands	<p>Land of 60,000 fewer people exposed by 2150 on Small Island Developing States (SIDS) compared to 2°C</p> <p>Risks for coastal flooding reduced by 20 to 80% for SIDS compared to 2°C</p> <p>Freshwater stress reduced by 25% as compared to 2°C</p> <p>Increase in the number of warm days for SIDS in the tropics</p> <p>Persistent heat stress in cattle avoided</p> <p>Loss of 70 to 90% of coral reefs</p>	<p>Tens of thousands of people displaced owing to inundation of SIDS</p> <p>High risks for coastal flooding and increased frequency of extreme water-level events</p> <p>Freshwater stress from projected aridity</p> <p>Further increase of ~70 warm days/year</p> <p>Persistent heat stress in cattle in SIDS</p> <p>Loss of most coral reefs and weaker remaining structures owing to ocean acidification (i.e., less coastal protection)</p>	<p>Substantial and widespread impacts through inundation of SIDS, coastal flooding, freshwater stress, persistent heat stress, and loss of most coral reefs (very likely)</p> <p>Risk of multi-meter sea level rise due to ice sheet instability</p>
Fynbos biome	About 30% of suitable climate area lost (medium confidence)	Increased losses (about 45%) of suitable climate area (medium confidence)	Up to 80% of suitable climate area lost (medium confidence)

Source: Amended from (Cheung *et al.*, 2016; Donnelly *et al.*, 2017; Dosio & Fischer, 2018; Hoegh-Guldberg *et al.*, 2018; Hoegh-Guldberg *et al.*, 2019; Maúre *et al.*, 2018; Mishra *et al.*, 2017; Nikulin *et al.*, 2018).

### 1.2.2. RISKS AND IMPACTS TO HUMAN SYSTEMS AT 1.5°C AND 2°C

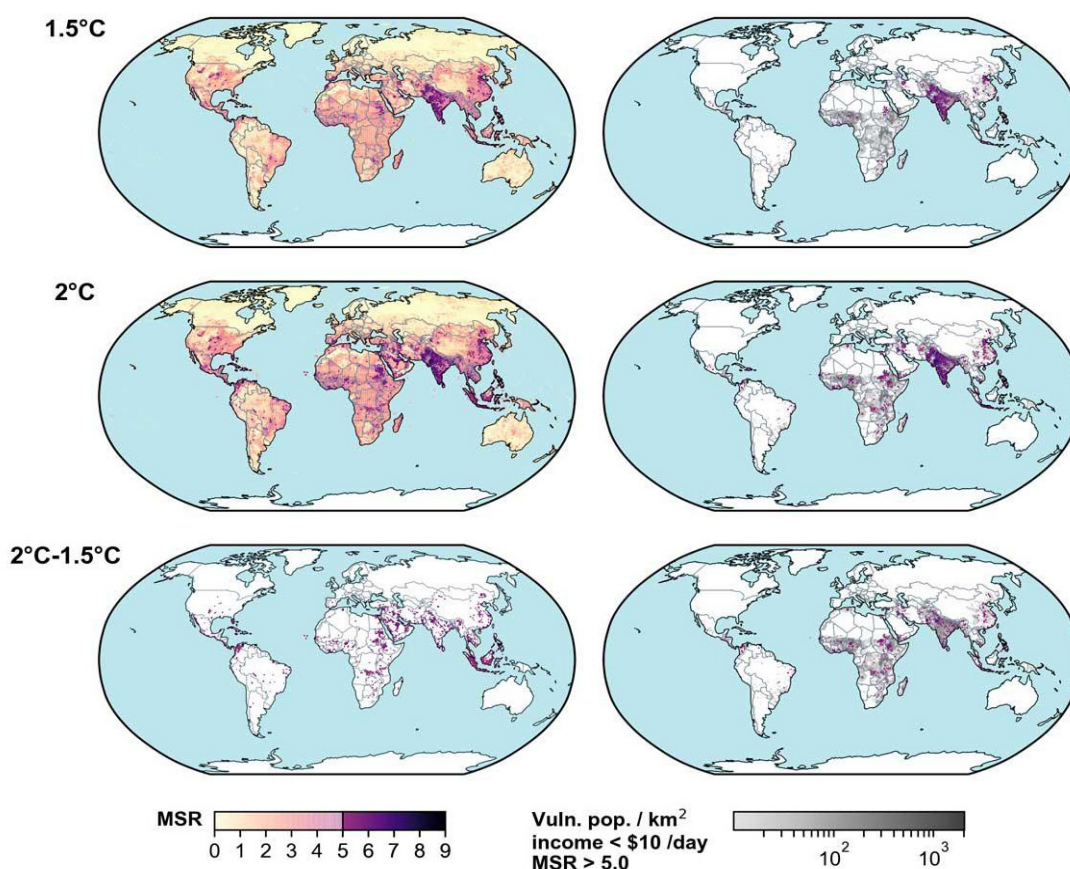
The impacts of a warmer world so far have been experienced unevenly. For countries in the Global North, the evidence of economic impacts is inconclusive, but “for most poor countries there is >90% likelihood that per capita GDP is lower today than if global warming had not occurred” (Diffenbaugh & Burke, 2019). The same imbalance exists for health impacts (Watts *et al.*, 2019). For example, risks from malaria and dengue fever are projected to increase with warming from 1.5°C to 2°C, including shifts in their geographic range (Hoegh-Guldberg *et al.*, 2019) and Western Pacific, South-East Asia and Africa seeing an increase of more than 10% since 1990 of the vulnerability to heat extremes (Watts *et al.*, 2019).

Limiting global warming to 1.5°C compared to 2°C is expected to reduce the proportion of the world population exposed to climate-induced water stress by up to 50%, with considerable variability between regions. For instance, many small islands could experience lower water stress (Hoegh-Guldberg *et al.*, 2019) while under SSP2 (‘middle of the road’ scenario), dryland populations vulnerable to water stress, drought intensity and habitat degradation could reach 178 million people by 2050 at 1.5°C warming, increasing to 220 million at 2°C warming and 277 million at 3°C (IPCC, 2019).

Warming of 2°C would see a loss of 7-10% of global rangeland stock. Pastoral systems are particularly vulnerable. In the land sector, several climate drivers exacerbate risk exposure for agriculture and food security: shifts in climate envelopes causing shifts in crop varieties planted, seasonal changes, extreme events affecting critical growth periods (flooding/droughts), diseases and pests. Such physical impact will lead to 1) reduced crop yields, mainly in lower latitude regions; 2) reduced nutritional content of crops (carbohydrate dilution, less protein, zinc, and iron); 3) food price instability; 4) supply chain disruption (due to extreme weather events); and 5) changes in crop suitability (Hurlbert *et al.*, 2019). The forestry sector will also face risks due to higher frequency and intensity of wildfires. Recent examples in California, Australia and Portugal are obvious testimonies.

With warming, impacts across energy, food and water sectors overlap spatially and temporally, creating new – and exacerbating current – hazards, exposures and vulnerabilities. These could affect an increasing number of people and regions. Exposure to multiple and compound climate impacts is projected to increase between 1.5°C and 2°C of global warming with greater proportions of people both exposed and susceptible to poverty in Africa and Asia. Such ‘risk hotspots’ are illustrated in **Figure 1.2**.

**FIGURE 1.2 COMPARING POPULATION CENTRES OF LOW-INCOME PEOPLE (RIGHT) TO HOTSPOTS OF MULTI-SECTOR RISK (MSR) (LEFT).**



The maps in the left column show the full range of the multi-sector risk (MSR) score (0–9). Scores  $\leq 5.0$  are shown with a transparency gradient and scores  $> 5.0$  with a colour gradient. Score must be  $> 4.0$  to be considered ‘multi-sector’. The maps in the right column overlay the 2050 vulnerable populations (low income) under Shared Socio-Economic Pathway (SSP)2 (greyscale) with the multi-sector risk score  $> 5.0$  (colour gradient), thus indicating the concentrations of exposed and vulnerable populations to risks in multiple sectors. Source: [Figure 3.19 in Hoegh-Guldberg et al. 2018 \(IPCC, 2018\)](#).

Beyond such ‘hotspots’ overshooting 1.5°C will already lock in impacts on infrastructure, livelihoods, income and biodiversity for SIDS and certain coastal cities such as Mumbai, Dhaka, Miami and New York, as well as increase disaster incidence.

### 1.2.3. THE IMPLICATIONS OF TEMPERATURE OVERSHOOTS

Temperature overshoots will be associated with increased physical risks (Hoegh-Guldberg et al., 2019). What is less understood is how higher temperatures might result in specific impacts for particularly vulnerable locations, populations or species, as well as the compounding risks at higher warming levels (Lawrence et al., 2020). Estimated impacts at 3°C or 4°C of warming are expected to trigger very large, abrupt or irreversible changes in the climate system with cascading impacts on nature and humans. Estimates of the probability in examples of global average climatic events may change as follows (Arnell et al., 2019):

1. The chance of a major heat wave increases from 5% in 1981–2010 to 28% at 1.5°C and 92% at 4°C
2. The chance of an agricultural drought increases from 9% to 24% at 1.5°C and 61% at 4°C
3. The chance of a river flood occurring every 50 years increases from 2% to 2.4% at 1.5°C and 5.4% at 4°C (so it becomes a 20-year-flood)
4. The chance of a damaging hot spell for maize increases from 12.3 at 1.5°C to 50% at 4°C and for rice from 27 to 46%.

Impact assessments at higher temperatures are associated with considerable uncertainty and regional variation (Arnell *et al.*, 2019). Estimates of changes in water availability find that the number of people exposed to freshwater vulnerability varies substantially from almost 1 billion people at 4°C in an SSP5 world to almost 3 billion people at the same temperature increase in an SSP3 world (Koutroulis *et al.*, 2019). These estimates show how higher temperatures can trigger significant and unprecedented impacts. In addition, in certain ecosystems, overshoot might result in irreversible losses and damages (e.g. in SIDS) (Hoegh-Guldberg *et al.*, 2018).

### 1.2.4. ADAPTATION PATHWAYS, LIMITS TO ADAPTATION AND RESIDUAL RISKS

Adaptation pathways are sequences of adaptation decisions/interventions (Werners *et al.*, 2021). They are characterised almost systematically by dynamic decision making under deep uncertainty and trade-offs across spatial and temporal scales (Wise *et al.*, 2014; Fazey *et al.*, 2016; Butler *et al.*, 2014; Gajjar *et al.*, 2019; Haasnoot *et al.*, 2013). Although local adaptive capacities depend on the context they operate in (e.g. local development, risk, existing vulnerability), the study of local adaptation pathways is needed to prioritise decision making and prepare for potential unintended outcomes (i.e. maladaptive outcomes) and trade-offs (Haasnoot *et al.*, 2013; Werners *et al.*, 2021).

Fundamentally, adaptation cannot be disconnected from overall sustainable development trajectories (Roy *et al.*, 2018; Gajjar *et al.*, 2019) because the magnitude of risk climate change poses is as much a result of existing vulnerabilities and capacities to anticipate and adapt as it is the level of exposure to the physical hazard (Hallegatte *et al.*, 2007; Simpson *et al.*, 2021). Thus, development interventions, such as reducing the infrastructure investment gaps or improving health systems, intrinsically build adaptive capacities and reduce risk.

The need to include prevention and adaptation as a major dimension of development choices emerges from studies on the repetition of tropical storms and typhoons. Based on the evidence of 6,700 tropical storms since 1950, Hsiang and Jina (2014) show that the strongest 10% of them reduces per capita incomes by 7.4% two decades later, effectively undoing 3.7 years of average development. Strobl (2019) shows that the repetition of typhoons can cause 3.2% GDP loss in some regions.

Adaptation actions might be insufficient, adaptive, or maladaptive (Magnan *et al.*, 2016; Gajjar *et al.*, 2019) (see **Figure 1.3**). The ex-ante assessment of multiple pathways can highlight synergies and trade-offs between options (e.g. as Haasnoot *et al.* (2019) for coastal systems), with signposts that can be tracked and used to mark the need for a better coordination of actors' decision (Lawrence & Haasnoot, 2017; Stephens *et al.*, 2018). *Maladaptation* denotes adaptation actions that disproportionately burden the most vulnerable, have high opportunity costs, reduce the incentive to adapt or instil path dependency (Barnett & O'Neill, 2010). Certain adaptation actions can lead to

unintended consequences and lock-ins, and sequencing of actions are critical to keep the envelope of feasible adaptation strategies open.

In some places, and for some human and ecological systems, there are limits to adaptation when the pace of climate change impacts accelerates, making the prevention of intolerable risks impossible even through accelerated action (Klein *et al.*, 2014). This comes from hard limits to adaptation (McNamara & Buggy, 2017; Djalante *et al.*, 2018). Soft ones are thresholds that represent an actual limit at the time of assessment (e.g. current availability or accessibility of technology) but can change over time (e.g. due to new technologies or institutional changes). For example, sea walls can be effective strategies under certain projects but might become insufficient over time in the face of surging higher storm. Hard limits to adaptation are those that will not change, such as thermal limits of survival for species or sea level rise that makes permanent relocation the only viable adaptation strategy in certain low-lying areas. (See [Table 1.4](#) for an overview.)

**TABLE 1.4 SOFT AND HARD LIMITS TO ADAPTATION.**

SYSTEM/REGION	EXAMPLES	SOFT LIMIT	HARD LIMIT
Coral Reefs	70-90% loss of tropical coral reefs by mid-century under 1.5°C		X
Biodiversity	6% of insects, 8% of plants, 4% of vertebrates lose over 50% of the climatically determined geographic range at 1.5°C (18% insects, 16% plants, 8% invertebrates at 2°C)		X
Poverty	24-357 million people exposed to multi-sector climate risks and vulnerable to poverty at 1.5°C (86-1220 million at 2°C)	X	
Human Health	Twice as many megacities exposed to heat stress at 1.5°C compared to present, potentially exposing ~350 million additional people to deadly heat waves by 2050	X	X
Coastal Livelihoods	Large-scale changes in oceanic systems inflict damage and losses to livelihoods, income, cultural identity, and human health for coastal communities at 1.5°C with higher potential losses at 2°C.	X	X
Culture, Lifestyle, Traditions and Heritage	Climate-induced relocation or loss of livelihoods can erode shared practices, narratives and customs that provide meaning and structure to people's everyday life	X	
Small Island Developing States	Sea level rise and increased wave run up combined with increased aridity and decreased freshwater availability at 1.5°C potentially leaving several atoll islands uninhabitable.		X

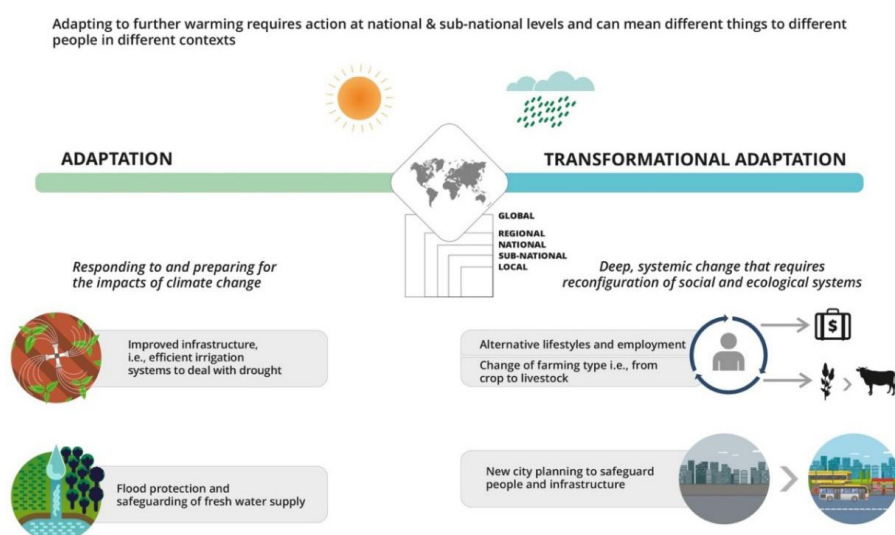
Adapted from Djalante *et al.* (2018); McNamara and Jackson (2019); Boyd *et al.* (2017); Tschakert *et al.* (2019).

The issue is whether, as highlighted by the SR1.5, an *incremental* approach to adaptation leading to marginal redirections of development choices will suffice or whether *transformational* adaptive changes will be needed. Transformational adaptation implies 'significant changes in structure or function that go beyond adjusting existing practices' (de Coninck *et al.*, 2018) and might be critical to deal

with hard limits to adaptation and tipping points, which have “the potential for abrupt, non-linear and climate change-triggered shifts in the elements of the Earth system” (Garschagen & Solecki, 2017). These adaptation tipping points are situations when the consequences of physical climate change impacts breach functioning thresholds of socio-ecological systems (Kwadijk *et al.*, 2010).

The absence of anticipatory, transformational adaptation in the present will make future adaptation within hard limits more economically and socially costly (Werners *et al.*, 2013). The social, political, institutional conditions for mainstreaming adaptation in current development choices remains a significant challenge (Garschagen & Solecki, 2017). What is clear, however, is that adaptation is tightly dependent on development trajectories and choices, and not undertaking anticipatory adaptation today will foreclose future options, leading to more costly interventions. (e.g., Haasnoot *et al.*, 2020; de Ruig *et al.*, 2019).

**FIGURE 1.3 DIFFERENCES BETWEEN ‘NORMAL’ (INCREMENTAL) AND TRANSFORMATIONAL ADAPTATION.**



Residual loss and damage occur when hard limits to adaptation are reached. For example, being unable to protect certain coastal regions from flooding or being unable to prevent health impacts of heat waves, despite adaptation, constitute residual risks. It is acknowledged that such losses and damages are differentiated across regions and populations (Boyd *et al.*, 2017; Djalante *et al.*, 2018; McNamara & Jackson, 2019; Tschakert *et al.*, 2019) and include tangible deprivations, such as the loss of assets and crops, as well as non-economic ones, such as the loss of biodiversity, culture or health.



## 1.3. FEASIBILITY OF ADAPTATION AND MITIGATION OPTIONS

Scaling up GHG emission reduction efforts is critical to avoid tipping points while anticipatory adaptation is critical to stay within hard limits in the least costly manner socially and economically. Reducing the physical and transition risks of climate change on society will require to accelerate the transition of our socio-economic systems towards zero-emission climate-resilient development pathways.

Physical risks stem from the impact of climate change and transition risks are related to uncertainties about technological innovations, changes in legislation and regulation, implementation of a carbon tax and changes in consumer behaviour (e.g. a shift in attitudes towards the purchase of diesel cars, air travel or deforestation-based products). The magnitude of implications of climate related risks on many activity domains will be determined by:

- How and when the physical impacts of climate change on natural systems result in human damages;
- How and when the human damages from physical impacts or mitigation measures translate into net economic losses; what share affect non-marketable services and fall on population poorly included in the monetised economy; what percentage of the GDP will be dedicated to repairing the damages;
- How the net economic losses translate into financial risks, which depend on their sectoral and geographical distribution, and the degree of surprises they involve.

Below we summarise these implications in terms of feasibility of mitigation and adaptation options grouped in four categories: energy system transition, land and (terrestrial) ecosystem transition, urban and infrastructure system transition and industrial system transition. The objective is to delineate the enabling conditions that will increase their feasibility space, conditions understood as consisting of six dimensions: environmental, economic, technological, institutional, socio-cultural and geophysical.

### 1.3.1. FEASIBILITY OF ADAPTATION OPTIONS

Twenty-three adaptation options are mapped in [Table 1.5](#) onto the four system transitions. Their multi-dimensional feasibility was assessed, resulting in the conclusions that several adaptation options are feasible ([Table 1.5](#); Singh et al., 2020).

**TABLE 1.5 HOW FEASIBLE ARE ADAPTATION OPTIONS?**

*Feasibility assessments of 1.5°C-relevant adaptation options, with dark shading signifying the absence of barriers in the feasibility dimension, moderate shading indicating that, on average, the dimension does not have a positive or negative effect on the feasibility of the option, or the evidence is mixed, and faint shading indicating the presence of potentially blocking barriers. No shading means that there was not sufficient literature to make an assessment. NA signifies that the dimension is not applicable to that adaptation option. A confidence assessment is undertaken at the option level but not shown here (see [Table 4.12](#) in the SR1.5 (de Coninck et al., 2018)). The context column indicates which contextual factors would change the assessment. For the methodology and literature, see the SR1.5 supplementary material 4.SM.4. Abbreviations used: Ec: Economic – Tec: Technological – Inst: Institutional – Soc: Socio-cultural – Env: Environmental/Ecological – Geo: Geophysical*

SYSTEM	ADAPTATION OPTION	EC	TEC	INST	SOC	ENV	GEO	CONTEXT
Energy System Transitions	Power infrastructure, including water							Depends on existing power infrastructure, all generation sources and those with intensive water requirements
Land and Ecosystem Transitions	Conservation agriculture							Depends on irrigated/rainfed system, ecosystem characteristics, crop type, other farming practices
	Efficient irrigation							Depends on agricultural system, technology used, regional institutional and biophysical context
	Efficient livestock systems							Dependent on livestock breeds, feed practices, and biophysical context (e.g., carrying capacity)
	Agroforestry							Depends on knowledge, financial support, and market conditions
	Community-based adaptation							Focus on rural areas and combined with ecosystems-based adaptation, does not include urban settings
	Ecosystem restoration and avoided deforestation							Mostly focused on existing and evaluated REDD+ projects
	Biodiversity management							Focus on hotspots of biodiversity vulnerability and high connectivity
	Coastal defence and hardening							Depends on locations that require it as a first adaptation option
	Sustainable aquaculture							Depends on locations at risk and socio-cultural context
Urban and Infrastructure System Transitions	Sustainable land-use and urban planning							Depends on nature of planning systems and enforcement mechanisms
	Sustainable water management							Balancing sustainable water supply and rising demand, especially in low-income countries
	Green infrastructure and ecosystem services							Depends on reconciliation of urban development with green infrastructure
	Building codes and standards							Adoption requires legal, educational, and enforcement mechanisms to regulate buildings



Industrial System Transitions	Intensive industry infrastructure resilience and water management							Depends on intensive industry, existing infrastructure and using or requiring high demand of water
Overarching Adaptation Options	Disaster risk management							Requires institutional, technical, and financial capacity in frontline agencies and government
	Risk spreading and sharing: insurance							Requires well-developed financial structures and public understanding
	Social safety nets							Type and mechanism of safety net, political priorities, institutional transparency
	Climate services							Depends on climate information availability and usability, local infrastructure and institutions, national priorities
	Indigenous knowledge							Dependent on recognition of indigenous rights, laws, and governance systems
	Education and learning							Existing education system, funding
	Population health and health system						NA	Requires basic health services and infrastructure
	Human migration							Hazard exposure, political and socio-cultural acceptability (in destination), migrant skills and social networks

These options are cost effective. In a frictionless world, they should mobilise investments to avoid larger costs or generate returns. In low and middle-income countries globally, based on willingness to pay for prevention, disruption in power supply (due to increased storm surges, typhoons, and cyclones) is estimated to impact firms directly (by up to \$120 billion/year), with coping costs of up to \$65 billion/year. For households, the direct impact and cost of coping could be between \$2.3–190 billion/year (Hallegatte *et al.*, 2019). The International Finance Corporation (IFC) reviewed climate-related sectors in 21 emerging market economies and identified almost \$23 trillion of climate-resilient and climate-friendly investment opportunities, with the largest ones related to buildings and transportation. In several regions, including South Asia, climate-resilient infrastructure is a major opportunity with the potential to unlock over \$2 trillion of investment (IFC, 2016). Chapter 2 will discuss how such investment could be triggered, connecting this discussion to the necessity of bridging the infrastructure investment gap (IMF, 2014) that block the fulfilment of SDGs.

## 1.3.2. FEASIBILITY OF MITIGATION OPTIONS

### 1.3.2.1. ENERGY SYSTEM TRANSITION

The required investment for the energy supply side to limit warming to 1.5°C constitutes a small share of overall investments (McCollum *et al.*, 2018) (see also chapter 2). However, compared with current trends, it will involve a radical shift that has no precedent at the scale and spread required, as it comprises all countries and economic sectors (de Coninck *et al.*, 2018). Investments will need to move rapidly towards efficient and low-emission options. The feasibility of some of them is evaluated in **Table 1.6**

**TABLE 1.6 HOW FEASIBLE ARE MITIGATION OPTIONS?**

*Feasibility assessment of 1.5°C-relevant mitigation options in energy system transitions. Dark shading signifies the absence of barriers in the feasibility dimension, moderate shading indicates that, on average, the dimension does not have a positive or negative effect on the feasibility of the option or the evidence is mixed, and faint shading indicates potentially blocking barriers. No shading means that the literature found was not sufficient to make an assessment. A confidence assessment is undertaken at the option level but is not shown here (see **Table 4.11** in the SR1.5 (de Coninck *et al.*, 2018)). The context column on the right indicates which contextual factors would change the assessment. For the methodology and literature basis, see the SR1.5 supplementary material 4.SM.4. Abbreviations used: Ec: Economic – Tec: Technological – Inst: Institutional – Soc: Socio-cultural – Env: Environmental/Ecological – Geo: Geophysical*

MITIGATION OPTION	EC	TEC	INST	SOC	ENV	GEO	CONTEXT
Wind energy (on-shore and off-shore)							Wind regime, economic status, space for wind farms, and the existence of a legal framework for independent power producers affect uptake; cost-effectiveness affected by incentive regime
Solar PV							Cost-effectiveness affected by solar irradiation and incentive regime. Also enhanced by legal framework for independent power producers, which affects uptake
Bioenergy							Depends on availability of biomass and land and the capability to manage sustainable land use. Distributional effects depend on the agrarian (or other) system used to produce feedstock
Electricity storage							Batteries universal, but grid-flexible resources vary with area's level of development
Power sector carbon dioxide capture and storage							Varies with local CO <sub>2</sub> storage capacity, presence of legal framework, level of development and quality of public engagement
Nuclear energy							Electricity market organization, legal framework, standardization and know-how, country's 'democratic fabric', institutional and technical capacity, and safety culture of public and private institutions

Current investment trends contrast with the requirement to limit warming to 1.5°C as they are still directed to fossil fuel-intensive options and tend to increase resistance on the part of those actors ‘invested in’ such an energy system. Given the dramatic reduction in the use of coal, oil and gas in the next couple of decades, the transition risk for the assets based on these options is obvious. Divestment from fossil fuel-based energy for lower temperature emission pathways could grow from just over \$275 billion over 2016-2023 to about \$400 billion over 2016-2030 and nearly \$550 billion over 2016-2050 (see box 1.4; McCollum *et al.*, 2018). Chapter 2 will discuss a specific mix of regulation, taxation, pricing and other policies necessary to mitigate the financial, macroeconomic and political adversities and risks of such a quick and drastic redirection of investments.

Such shifts also open investment opportunities in low-emission options. Many of them (wind and photovoltaic electricity) are technologically mature and increasingly competitive with fossil fuels from a purely economic perspective. Innovation in electricity storage is moving rapidly, while slower progress is reported for nuclear energy and CCS (REN21, 2017; de Coninck *et al.*, 2018; IEA, 2017). But the pace of wide-scale implementation of fast-growing low-emission options is still hindered by regulation and planning, upfront costs due to a mix of transaction costs and cost uncertainty, and other obstacles to financial access discussed in chapter 2. In many places, these factors result in a carbon lock-in (Unruh, 2002).

Investment opportunities are also important on the energy demand side, in particular in buildings. Demand-side action would require investments estimated at between \$0.38 trillion per year in a 2°C scenario and \$0.45 trillion per year in a 1.5°C scenario between

2016 and 2035 (Box 4.8 IPCC 2018). Such investment will have to be particularly significant in the short-term in P1- and P2-type of scenarios in table 1.2.

#### BOX 1.4 | A LOOK AT ENERGY SYSTEM INVESTMENT ESTIMATES

Estimates of energy system investments for climate change mitigation pathways consistent with the 1.5°C limit are only sparsely covered in academic literature. They are available from one multi-model study (McCollum *et al.*, 2018), which primarily covers P3-type pathways (see Table 1.2). Because P1 and P2 pathways put greater emphasis on reducing energy demand, such future would see reduced investment needs for energy supply compared with those reported below, but demand-side investment levels roughly with those in P3 pathways.

##### Sector-wide energy supply investments

Results from IAMs for a ‘middle-of-the-road’ reference scenario (i.e. SSP2 comparable to the P3 scenario in Table 1.2) indicate that mean annual energy supply investments would have to grow from \$1.8 trillion per year in 2015 to \$2.2 trillion per year (with a \$1.4 to \$3.4 trillion range surrounding the latter across six models) between 2016 and 2050 (McCollum *et al.*, 2018). While this is a substantial increase from the BAU scenario, it will represent a declining share of global GDP, due to stable long-term economic growth in the IAMs.

Reference scenario investments: Energy supply investments in developing countries would make up most of the world’s energy investments, thus forming a sizeable investment opportunity. Even in a reference no climate policy scenario, those investments would amount to \$1.35 trillion per year (range from \$0.81 to \$2.3 trillion) on average over 2016-50, 35% higher than the \$1 trillion investment in energy systems in developing countries in 2015.

Developed countries are projected to see investments in the order of \$0.8 trillion per year (range from \$0.36 to \$1.3 trillion). This is on average 10% higher than the \$0.7 trillion in 2015 (McCollum et al., 2018).

The large ranges of these estimates confirm the important uncertainties, which constitute an obstacle for risk-averse investors. Chapter 2 will discuss how climate finance can help overcome this obstacle.

**NDC scenario investments:** According to the models, pathways that extrapolate from countries' NDCs until 2050 require very little change in investments compared with the reference scenario mentioned above. Total annual investments over 2016-2050 would increase for both developed and developing countries in the order of tens of billions dollars per year. The NDCs do cause a notable reduction of investments in fossil fuel extraction and fossil power generation globally: from a share of 59% to 50% of total mean sector-wide energy supply investment between 2016 and 2050. There is an increase in the renewable investment share (by 3%, to 19%) under the NDCs, while the investment share of power transmission, distribution and storage stays roughly constant at around 21% over this period.

**Well below 2°C scenario investments:** this scenario requires a much more pronounced redirection of global investment flows than in the NDC pathway. The total investments would increase to about \$2.5 trillion per year (range from \$1.1 to \$4.4 trillion) on average over the 2016-2050 period. The modelled transition more than halves the share of global investment in fossil fuel extraction and power generation over the 2016-2050 period, from 50% of energy supply investment under the NDCs to 22% (with a range of 21 to 28% across models). The investment share of renewables, and of power transmission, distribution and storage over the 2016-2050 period increases to about 28% each. The share of investment in developing countries for such transition increases from 57% in 2015 to 62% over 2016-2050, not keeping pace with their share of global population, which rises to 75% over this period.

Similarly, mean investments for unabated fossil electricity generation (i.e., without carbon capture and storage) over 2016-2050 are found to be considerably lower in 2°C and 1.5°C futures than in the reference case: decreases of \$0.13 trillion per year (range from \$0.08 trillion to \$0.17 trillion) and \$0.14 trillion per year (range from \$0.09 trillion to \$0.17 trillion) respectively. Particularly noteworthy is the small difference in unabated fossil fuel-powered electricity investments when going from 2°C to 1.5 °C. This highlights how limited the space is for this specific class of 'brown' investments going forward.

**Near-term investments:** In the near term (up to 2023 and 2030), models suggest that amounts divested from fossil-based energy systems would need to be reinvested in solar photovoltaic (PV), wind and nuclear power. Investments in bioelectricity and biofuels, as well as CCS, scale up less quickly initially, but increase significantly after 2030 in P3-type pathways. Meanwhile, investments in hydrogen fuel technologies would be limited in the near term in both 1.5°C and 2°C pathways (McCollum et al., 2018). In 1.5°C pathways, dependence on investment in hydrogen fuel technologies is higher, due to the more urgent need to decarbonise end-use activities such as trucking, shipping and manufacturing.

#### **Investments in bioenergy with carbon capture and storage (BECCS)**

Besides afforestation and reforestation, BECCS is the only CDR option covered in IAM

pathways (See also box 1.5 on CDR). Only few pathways manage to achieve the 1.5°C limit without BECCS (e.g. the P1 pathway in Table 1.2). Pathways not relying on BECCS typically require strong demand-side emissions reductions and carbon-neutral alternatives to liquids and gases that do not rely on biomass (Grübler et al., 2018; van Vuuren et al., 2018). Potentials of CDR options other than BECCS and afforestation come with a wide range of uncertainty that depends on the local context of deployment.

In the P3-type pathways, investment requirements for BECCS add up to a rough mean of ca. \$50 to 150 billion over the 2016-2050 period. In the pathways using BECCS, developed countries start out with larger investments than developing countries, but their distribution is broadly similar in absolute terms (see Table 1.7).

**TABLE 1.7: ESTIMATED ANNUAL INVESTMENTS IN BECCS (2016-2050) IN BILLION \$ 2015/YR.**

	DEVELOPING COUNTRIES			DEVELOPED COUNTRIES		
2015 investment	2016-23	2016-2030	2016- 2050	2016-2023	2016-2030	2016-2050
0	1.1 (0-4.4)	7.4 (0- 32.4)	26.5 (0- 75.3)	2.4 (0-11.4)	8.6 (0-25.7)	27.1 (0-73)

#### ENERGY DEMAND-SIDE INVESTMENTS

For demand-side investments, specifically the portion increasing energy efficiency, it is more difficult to make estimations due to a lack of reliable statistics and issues around definitions (Grübler & Wilson, 2013). A first-order approximation of energy efficiency investments across all end-use sectors (transport, buildings, industry) indicates that the needs under 2°C and 1.5°C pathways (relative to a reference without additional climate policies) would be in the tens of billion dollars per year prior to 2030 and in the low hundreds of billions per year afterward – or around 10% of the energy supply investment estimates provided above.

Demand for primary energy has been growing at 2.5% per year since 1965 and 1.7% per year since 2009, suggesting a trend towards energy efficiency (BP, 2019). Much more rapid energy efficiency improvements or changes in consumption patterns would, however, be needed to reduce demand growth posited in the P1 and P2 pathways. rapid energy efficiency improvements or changes in consumption patterns would, however, be needed to reduce demand growth posited in the P1 and P2 pathways.

The success of the energy transition depends on specific aspects of energy issues in developing countries.

The first specificity is the need to scale up investment to achieve universal access to modern energy by 2030, as stated in SDG7 on clean and affordable energy. An ESMAP report shows that \$45 billion are needed annually from 2019 to 2030, mostly for electricity, to fulfil the IEA Sustainable Development Scenario (SDS). At the moment, the total global investment for energy access is falling short of this number, with some countries even reducing it (ESMAP, 2020).

The second comes from the P3 pathways divestment estimates for limiting warming to 1.5°C, which show a growing pattern. Based on the model assessed in McCollum

*et al.* 2018, the projected net divestment from fossil fuel-based energy in developing countries could grow from close to \$130 billion a year over 2016–23, to just over \$200 billion over 2016–2030 and close to \$300 billion over 2016–2050. This raises particularly important challenges in countries that are dependent on fossil fuel export and import, including risks of economic and political instability.

The third specificity is related to the financial implications of the transition for both households and firms in developing countries. This must take place in a context of limited financial inclusion in large parts of Asia and the Pacific, Africa and some parts of Latin America. Chapters 2 and 3 will examine how to help developing countries in redirecting their economies and domestic finance towards climate friendly energy investments, including through transborder financial flows.

Given different trends in demography and urban/spatial dynamics over the next few decades, the absolute size of investments in low-emission options in developed countries will be half of those in developing countries (CPI, 2019). Even for present NDC pathways (which are projected to lead to 3°C of warming by 2100) the investment opportunity in developing countries ranges from close to \$350 billion over 2016–23 to some \$500 billion over 2016–50 (McCollum *et al.*, 2018). For the more ambitious 2°C pathways, the amount rises to over \$750 billion over 2016–50, and to enable a 1.5°C transition it reaches close to \$900 billion. This is about the same order of magnitude of current investment in oil and gas exploration.

### 1.3.2.2. LAND AND ECOSYSTEMS TRANSITION

Any attempt to bring Agriculture, Forestry and Other Land Use (AFOLU) emissions to net zero will be closely intertwined with the pursuit of SDGs, notably ending hunger and protecting biodiversity (Roy *et al.*, 2018), as well as with the employment and livelihoods of almost 30% of the world workforce (ILOSTAT, 2019). There is a range of small-scale land-based and terrestrial ecosystem transition options to deliver 1.5°C pathways (Rogelj *et al.*, 2018; de Coninck *et al.*, 2018; IPCC, 2019), largely related to improved management of agriculture, forests and soils. However, implemented in existing lands, they induce competition with other land uses geared to support food security (SDG2), livelihoods and sustainable water resource management. Risks of trade-offs can be exacerbated by growing demand for agricultural and forestry products and rising land needs for bioenergy and CDR. The feasibility of some of these options for the land and ecosystem transition are evaluated in table 1.8.

**TABLE 1.8 FEASIBILITY ASSESSMENT OF MITIGATION OPTIONS IN LAND- AND ECOSYSTEM TRANSITIONS. FOR MORE DETAILS AND THE LEGEND, SEE THE CAPTION OF TABLE 1.2, BASED ON DE CONINCK ET AL. (2018).**

MITIGATION OPTION	EC	TEC	INST	SOC	ENV	GEO	CONTEXT
Reduced food wastage and efficient food production							Will depend on the combination of individual and institutional behaviour
Dietary shifts							Depends on individual behaviour, education, cultural factors and institutional support

Sustainable intensification of agriculture							Depends on development and deployment of new technologies
Ecosystems restoration							Depends on location and institutional factors

Radical shifts in the demand side, including waste management and decline of meat and milk products overconsumption as today in OECD countries (Paillard *et al.*, 2014), can alleviate the transition risks, both by reducing the pressure on agricultural land and the need for land-based negative emissions (van Vuuren *et al.*, 2018; IPCC, 2020; Mbow *et al.*, 2019; IPCC, 2019). However, implementation is challenging and requires a shift in public policies and consumer behaviour. Transitions in AFOLU systems are also associated with transition risks for the related industries.

Improved management in agricultural systems includes increasing the productivity of land used for food production and avoiding the emissions that would occur if increased food demands were met through expanding agricultural land area. But the conventional intensification of land productivity through industrial technologies could both lead to a rebound effect, encouraging such expansion of agricultural land (Desquilbet *et al.*, 2017), and to an increase in GHG emissions related to the manufacture, distribution and application of industrial inputs. Alternative approaches, based on agroecology, are increasingly proposed (Wezel *et al.*, 2009; Perfecto & Vandermeer, 2010). But it is still hard to represent them in global integrated models due to the multiplicity and complexity of the synergies between plant and animal species under and above the ground surface (Dorin & Joly, 2020).

Reducing conversion of grassland to cropland could also provide significant climate mitigation benefits by retaining soil carbon stocks that might otherwise be lost. Integrated water management provides moderate benefits for climate mitigation due to interactions with other land management strategies. Improving forest management and increasing organic matter stocks in mineral soils could also potentially yield mitigation benefits globally. One of the most effective and robust options for climate change mitigation is reducing deforestation and forest degradation, especially in the tropical regions. For instance, in Brazil, Rochedo *et al.* (2018) estimate that investments for controlling illegal deforestation in the Amazon and improving forest restoration between 2010 and 2050 would require 2-3 times fewer investments than those required to decarbonise the energy sector. For managed forests, the most effective mitigation strategy is through increasing biomass productivity that optimises carbon stocks (in forests and in long-lived products), as well as wood substitution. Soil-based mitigation options include increasing soil organic carbon ([www.4p1000.org](http://www.4p1000.org)), control of erosion to prevent losses of organic carbon and the use of biochar.

### 1.3.2.3 INDUSTRIAL SYSTEMS TRANSITION

The heavy industry sectors of steel, cement, chemicals, aluminium, wood products, non-ferrous metals, glass and ceramics have relatively high GHG emissions per unit of value-added, long facility lifespan and low profit margins. This makes them particularly sensitive to carbon pricing and climate policies in general (Dechezleprêtre & Sato, 2018; Sato *et al.*, 2015). The basic materials produced by these sectors are essential to the physical functioning of the economy while representing only a small part of GDP. Moreover, demand in these sectors is expected to grow in the coming decades (OECD, 2019).



Currently, these sectors represent 21.5% of non-land-use anthropogenic CO<sub>2</sub> emissions. Their total emissions are projected to grow, even if significant efforts towards material efficiency are pursued (IEA, 2019). Given their 20-50 year lifespan, without drastic innovation by the early 2030s, these high-carbon facilities will be locked-in past mid-century and their emissions by 2050-2070 will have to be offset with CDR or air-captured carbon with CCS (Bataille *et al.*, 2018), estimated at \$100-300/t CO<sub>2</sub> (de Coninck *et al.*, 2018; Keith *et al.*, 2018). As a result, facilities that cannot be retrofitted for lower or near zero emissions and are too expensive to offset, should be prematurely retired. This would cause potential damages to workforce communities and local supply chains, which might block their retirement.

The technical options to transition these sectors to very low or zero emissions are electrification, hydrogen, CO<sub>2</sub> capture, utilisation and storage (CCUS) or other technologies (Axelson *et al.*, 2018; Material Economics, 2019; Energy Transitions Commission, 2018; Bataille *et al.*, 2018). Based on expected prices for low-emission electricity, hydrogen and CCUS, these technologies will cost more than current production technologies, e.g. 20–40% more for steel, 70–115% more for cement and 15–60% for chemicals (Material Economics, 2019). Material efficiency and circularity strategies can help reduce the need for more expensive low-emission primary materials through better design for longer life, reusability and easier recycling (Allwood & Cullen, 2015). Most of the cost of decarbonising these sectors is required at the primary and intermediate producer level, and consumers are unlikely to see more than a 0.5-2% increase in the cost of buildings, infrastructure or vehicles as a consequence.

A generalised feasibility assessment can be found in table 1.9, indicating significant gaps in knowledge for institutional, socio-cultural and environmental impacts of the mitigation options. This suggests that the challenges for financing this transition are potentially greater and depend on policy interventions.

**TABLE 1.9 FEASIBILITY ASSESSMENT OF MITIGATION OPTIONS IN INDUSTRIAL SYSTEM TRANSITIONS. FOR MORE DETAILS AND THE LEGEND, SEE THE CAPTION OF TABLE 1.6, BASED ON DE CONINCK ET AL. (2018).**

MITIGATION OPTION	EC	TEC	INST	SOC	ENV	GEO	CONTEXT
Energy efficiency							Potential and adoption depend on existing efficiency, energy prices and interest rates, as well as government incentives
Bio-based and circularity							Faces barriers in terms of pressure on natural resources and biodiversity. Product substitution depends on market organization and government incentivization



Electrification and hydrogen							Depends on availability of large-scale, cheap, emission-free electricity (electrification, hydrogen) or CO2 storage nearby (hydrogen). Manufacturers' appetite to embrace disruptive innovations
Industrial carbon dioxide capture, utilization and storage							High concentration of CO2 in exhaust gas improve economic and technical feasibility of CCUS in industry. CO2 storage or reuse possibilities

The key policy challenge in industrial transformation towards climate neutrality is connecting the low economic impact on consumers with the high impact on producers. If well planned, and if local economics support it, there can be significant synergies between industrial decarbonisation and net-zero energy systems (Vogl *et al.*, 2018; Bataille, 2020). For instance, industries using hydrogen could produce hydrogen when variable electricity generation is high and prices are low, and remove their demand when generation is low. If so equipped, they can also send electricity back to the grid when variable electricity generation is low using reversible fuel cells or sending surplus hydrogen to electricity generation turbines.

Transitioning heavy industry to very low or zero emissions will require carefully designed and negotiated policy packages that include: 1) clear direction, 2) transition plans prepared with the active input and acceptance of all stakeholders, 3) accelerated research and development, 4) dedicated support for demonstration and lead markets (for example, through minimum content regulations or green procurement or feed-in-tariffs realised through contracts for difference (Sartor & Bataille, 2019), 5) carbon pricing with competitiveness protections, 6) infrastructure planning and support for electrification, hydrogen and CCUS (United Kingdom Committee on Climate Change (UKCCC), 2019), 7) support to institutions and education for, amongst other things, material design, and 8) clear regulatory frameworks and accounting for lifecycle emissions (Wyns *et al.*, 2019; Wesseling *et al.*, 2017; Bataille *et al.*, 2018). Along with these, it would require the financial system – both public and private – to de-risk the needed investments along the value chain and guarantee their transformation in credible assets.

#### 1.3.2.4. URBAN AND INFRASTRUCTURE

Today, 55% of the global population lives in urban areas, a number projected to reach 68% by 2050 (UNDESA, 2018). Over the next three decades, nearly 70 million people will move to urban areas every year, a majority of whom will live in small- to medium-sized cities in the developing world (Revi *et al.*, 2014). This trend will imply large investments in urban and infrastructure sectors that are central to economic growth and have critical implications for GHG emissions (Bazaz *et al.*, 2018).

Urban and infrastructure sectors are highly capital intensive (New Climate Economy, 2014) with investment needs consistently falling, despite discrepancies amongst assessments, by a few trillion dollars per year in the next decades (Acclimatise, 2018; Global Infrastructure Hub, 2017; New Climate Economy, 2016). Cities around the world are actively formulating building codes to improve energy efficiency and reduce cooling needs; planning transportation systems to reduce energy consumption; investing in green and blue infrastructure such as tree planting, green roofs, rainwater harvesting to reduce urban heat islands; and regulating construction in coastal

zones and other areas subject to flooding (de Coninck *et al.*, 2018; Revi *et al.*, 2014; Bazaz *et al.*, 2018). The feasibility of some of the mitigation options for the urban and infrastructure system transition is assessed in **Table 1.10**, revealing that although the investment need is high, many options are highly feasible and there are only few gaps in literature.

**TABLE 1.10 FEASIBILITY ASSESSMENT OF MITIGATION OPTIONS IN URBAN AND INFRASTRUCTURE SYSTEM TRANSITIONS. FOR MORE DETAILS AND THE LEGEND, SEE THE CAPTION OF TABLE 1.6, BASED ON DE CONINCK ET AL. (2018).**

MITIGATION OPTION	EC	TEC	INST	SOC	ENV	GEO	CONTEXT
Land-use and urban planning							Varies with urban fabric, not geography or economy; requires capacitated local government and legitimate tenure system
Electric cars and buses							Varies with degree of government intervention; requires capacity to retrofit "fuelling" stations
Sharing schemes							Historic schemes universal, but new ones depend on ICT status; undermined by high crime and low levels of law enforcement
Public transport							Depends on presence of existing 'informal' taxi systems, which may be more cost-effective and affordable than capital-intensive new build schemes, as well as (local) government capabilities
Non-motorized transport							Viability rests on linkages with public transport, cultural factors, climate and geography
Aviation and shipping							Varies with technology, governance and accountability
Smart grids							Varies with economic status and presence or quality of existing grid
Efficient appliances							Adoption varies with economic status and policy framework
Low/zero-energy buildings							Depends on size of existing building stock and growth of building stock

The economic and financial conditions to mobilise investments for the mitigation options in **Table 1.10** differ significantly between building and transportation.

In the building sector, the financing of low-energy, resilient, cool architecture is constrained by the need for several small investments with long payback times (Ürge-Vorsatz *et al.*, 2018). More critically, short-term financial ‘low hanging fruits’ can disincentivise longer-term systemic change – e.g. easy investments with fast returns (such as replacing a boiler) can prevent holistic and deeper mitigation opportunities (retrofitting a whole-building becomes less financially viable after a new boiler is installed). Avoiding the lock-in of 40–80% thermal energy use in buildings would require a fundamentally different approach to traditional energy efficiency incentives through innovative financing (Ürge-Vorsatz *et al.*, 2018).

The dynamics in the transport sector are governed by the complex interplay of diverse factors, including energy prices, transportation costs, housing costs, real estate markets, spatial organisation of human activities, mobility needs, congestion, modal choices and GHG emissions (Lampin *et al.*, 2013; Waisman *et al.*, 2013; Allio, 2016; Behrens *et al.*, 2007; Anas & Xu, 1999; Choi and Sjoquist, 2015). This highlights the risks of self-reinforcing loops and lock-in within the structure of transportation systems, the localisation of activities and the demand for mobility, possibly generating a bifurcation towards more carbon intensive pathways if consistent policies are not adopted (carbon prices, housing prices, infrastructure choices) (Guivarch & Hallegatte, 2011). These risks are far higher in developing countries, where pre-Covid-19 estimates anticipated the growth of mobility needs by a factor of four by 2050, against a factor of two for developed economies (ITF, 2017). Other key factors influencing investment needs are the evolution of road construction costs (Rodríguez-Alloza *et al.*, 2019) and the future occupancy rate of rail networks (the modal shift towards rail is a lever for reducing investment only if combined with a higher rate of occupancy).

The integration of these factors in a global IAM analysis (Fisch-Romito & Guivarch, 2019) shows that the cumulative investment needs in the transportation sector (roads, rail and airports) up to 2050 are similar in climate policy scenarios compared with a reference scenario for developed economies, but are significantly lower for developing countries (median value of decrease is -10% for Asia, -17% for Latin America and -47% for the Middle East and Africa).

A large increase of investments in transportation by 2050 is needed in developing countries (Gaya & Campos, 2009; OECD, 2017; Jakob *et al.*, 2016). The share of transport investment in countries’ GDP would increase from 1% on average to between 2% and 3% in Asia and Latin America, while remaining almost stable in OECD countries. This is a case of infrastructure investment gap that chapter 2 tackles in depth. The issue is that the investment generated by mobility are more sensitive to policy integration than those in the electricity sector. For example, Rozenberg and Fay (2019) show that, under current urbanisation trends, transportation investments in developing countries may increase by up to 3.3% of GDP by 2030. But assuming other modes of urban transport, the reduction of forced mobility, as well as higher electric and rail mobility, would limit them to around 1.3% of GDP. We come back to this in chapter 2.

### 1.3.2.5. CARBON DIOXIDE REMOVAL (CDR)

Carbon Dioxide Removal is needed in all 1.5°C pathways, but with differences in terms of options and scale of deployment, as indicated in the bottom-up SR1.5 assessment for 2050<sup>3</sup>. The BECCS deployment in P1 to P3 pathways reaches up to 5 GtCO<sub>2</sub> per year by 2050, while in P4 it exceeds the bottom-up potential by a factor of more than two.

<sup>3</sup> “Bottom-up” refers here to an assessment of deployment of a technology or practice that adds environmental and social side-effects of rapid ramp-up to technical, geophysical and economic constraints. Bottom-up assessments therefore arrive at lower estimates of potentials than what is seen in most pathways.

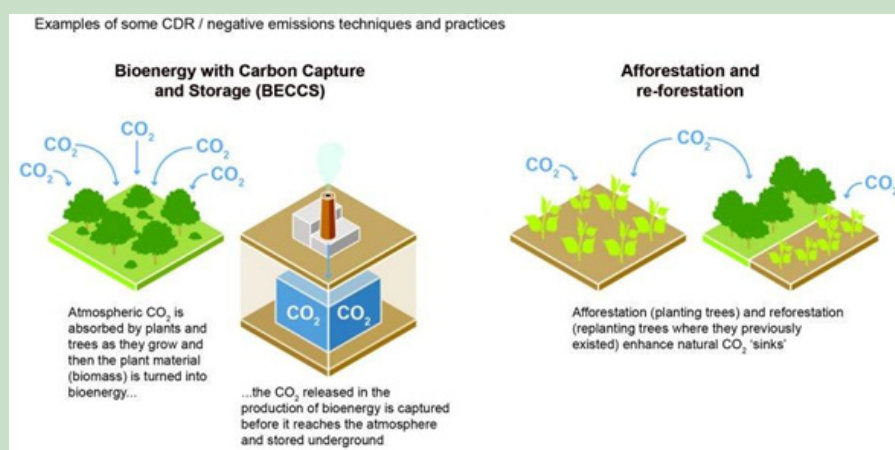
The CDR potential depends on technological and yield developments, land availability and sustainability criteria. Under the assumption that the bulk of removals in the AFOLU category stem from afforestation measures, pathways P1 to P3 lie below the best estimate of bottom-up potential of 3.6 GtCO<sub>2</sub> per year up to 2050. In P3, however, the use of BECCS exceeds the bottom-up potential around 2070.

### BOX 1.5 | CARBON DIOXIDE REMOVAL

All mitigation pathways in **Table 1.2** use CDR to offset residual or hard-to-abate CO<sub>2</sub> emissions on the way to the net-zero CO<sub>2</sub> goal, but the degree to which they can be used varies.

A distinction can be made between natural CDR options, including planting trees and the restoration of ecosystems, and technological CDR options. The pathways in the SR1.5 only consider two CDR options: planting biomass to generate bioenergy in combination with CO<sub>2</sub> capture and storage (BECCS), and afforestation and reforestation (both illustrated in **Figure 1.4**). However, other CDR options could play a role in the order of a few billions tonnes of CO<sub>2</sub> removal per year by 2050 (de Coninck et al., 2018).

Some nature-based options, such as applying biochar to soils or enhancing soil carbon sequestration, can have positive side-effects on soil health or sustainable energy access. The other CDR options are still very costly and energy intensive. These include Direct Air CO<sub>2</sub> Capture and Storage (DACCS), where CO<sub>2</sub> is extracted from the air through chemical processes using energy (currently at demonstration phase), and enhanced weathering, a collection of methods to fixate CO<sub>2</sub> in carbonates in mineral rocks.



**FIGURE 1.4 TWO OF SEVERAL CARBON DIOXIDE REMOVAL OPTIONS**

Source: de Coninck et al., 2018

Uncertainty dominates the investment needs estimates for CDR options. The tentative estimates rarely consider land or water resource competition, and when they do, potentials are considerably limited (Hanssen *et al.*, 2020). Researchers have hardly assessed their feasibility so far, given their low technological maturity. Especially for soil carbon sequestration and biochar, enhanced weathering, and Direct Air Capture with Carbon Storage (DACCS), information is sparse on socio-cultural, institutional and environmental consequences (see table 1.11).

As for the potential of geological CO<sub>2</sub> storage, recent literature reviews (Bui *et al.*, 2018; Fuss *et al.*, 2018) show that even more conservative estimates do not exceed the requirements for CCS considered in 1.5°C pathways. Even in P4, adding up storage in **Table 1.2** until 2060 would require storing less than 350 Gt CO<sub>2</sub> based on a conservative 1% of all sedimentary basins (Koide *et al.*, 1993). Higher estimates would require storing 750 Gt CO<sub>2</sub> but storage potentials range from 3,900 (Dooley, 2013) to 55,000 Gt CO<sub>2</sub> (Kearns *et al.*, 2017). However, even if the global storage potential is ample, it is not evenly distributed. There could be bottlenecks in individual regions which would limit the CCS potential or require considerable CO<sub>2</sub> transport and storage infrastructure investments.

**TABLE 1.11 FEASIBILITY ASSESSMENT OF CARBON DIOXIDE REMOVAL (CDR) OPTIONS. FOR MORE DETAILS AND THE LEGEND, SEE THE CAPTION OF TABLE 1.6, BASED ON DE CONINCK ET AL. (2018).**

MITIGATION OPTION	EC	TEC	INST	SOC	ENV	GEO	CONTEXT
Bioenergy and carbon dioxide capture and storage							Depends on biomass availability, CO <sub>2</sub> storage capacity, legal framework, economic status and social acceptance
Direct air carbon dioxide capture and storage							Depends on CO <sub>2</sub> -free energy, CO <sub>2</sub> storage capacity, legal framework, economic status and social acceptance
Afforestation and reforestation							Depends on location, mode of implementation, and economic and institutional factors
Soil carbon sequestration and biochar							Depends on location, soil properties, time span
Enhanced weathering							Depends on CO <sub>2</sub> -free energy, economic status and social acceptance

These assessments show, however, that many CDR options are still at a fairly early stage and that counting on multi-gigatonne scale CDR as early as 2040 risks putting the Paris Agreement temperature limits out of reach (see **Table 1.2a**). The vast majority of existing CDR literature is focused on early stages of the innovation chain and very little is known about how these technologies will eventually mature from R&D to deployment or how institutional governance can secure both their public acceptance and the development of niche markets (Nemet *et al.*, 2018).

Afforestation or soil carbon sequestration would require far lower investment than BECCS at present and could benefit from learnings in REDD+ (Reducing Emissions from Deforestation and Forest Degradation). However, as land availability decreases, and as permanence becomes an issue because of ongoing climate change or

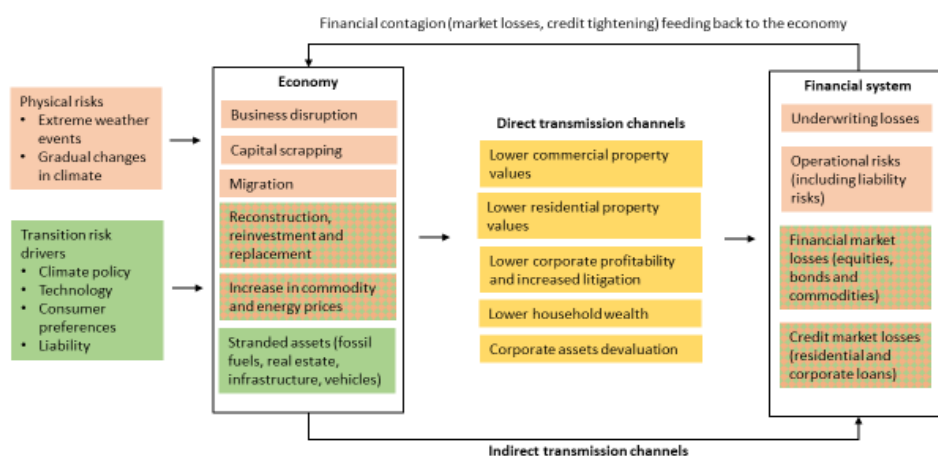
anthropogenic disturbances, other – currently still more expensive – options could be envisaged, e.g. DACCS (Fuss *et al.*, 2018). But a large-scale roll out of DACCS would only make climate sense in a different energy system (Creutzig *et al.*, 2019). This is because DACCS captures CO<sub>2</sub> from ambient air, which requires a lot of energy. BECCS, instead, produces energy. As models improve to incorporate these technologies (Strefler *et al.*, 2018; Realmonte *et al.*, 2019), we shall better understand this scaling dynamic and resulting financing needs.

## THE1.4. FINANCIAL SYSTEM FACED WITH CLIMATE CHANGE RISKS

There is not one unambiguous link between the physical risks induced by climate change and the resulting social and economic damages, or between claimed climate stabilisation targets and the content of mitigation strategies. Similarly, there is no unambiguous link between overall climate risks for societies and for the financial system. However, risk transmission channels can be identified, though not yet quantified.

**Figure 1.5** pictures the direct and indirect channels through which transition and physical risks are transmitted, as well as the feedback loop that could threaten financial stability. Direct transmission happens from the real economy (fragilisation of some business sectors, costs of accelerated capital scrapping and reconstruction, increase of commodity prices and forced migration) to the financial system. Indirect transmission comprises the impact on the financial system of overall economic deterioration. As the financial system can affect the real economy via market losses and credit tightening, a financial contagion could emerge.

**FIGURE 1.5 OVERVIEW OF THE POTENTIAL SYSTEM DYNAMICS BETWEEN THE ECONOMY AND THE FINANCIAL SYSTEM (BLUE BOXES) BECAUSE OF PHYSICAL AND TRANSITION CLIMATE RISK DRIVERS.**



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*The dynamics are negotiated through direct transmission channels in the real economy and indirect economic deterioration because of economic consequences of the physical impacts. Economic deterioration and financial contagion with direct and indirect transmission channels can jointly form a feedback loop that could threaten financial stability. Adapted from: NGFS, 2019.*

The indirect transmission channel is important, but it is fully dependent of the pre-existing stability of the affected economies and the efficacy of their policy responses. These are parameters that the actors in the financial system cannot control. The financial actors are directly hurt by, and have a capacity to adapt to, the signals transmitted directly. For the physical risk, these signals pass through the impairment of:

- Agriculture assets: increased uncertainty and variability in crop and fisheries yields, degradation of water and soil quality and quantity, increased virulence of pests (Taylor *et al.*, 2018), more frequent disruptions of distribution and processing due to extreme weather, logistical constraints that prevent or delay the shipment of crops, seeds and materials (Bakker *et al.*, 2018).
- Infrastructure assets (transportation, water, energy, telecommunication, health care delivery): cascading failures resulting from accelerated material degradation of concrete, steel, timber and earthen structures in case of extreme precipitation, extreme temperatures and changes in relative humidity and salinization (Stewart & Deng, 2015; Bastidas-Arteaga, 2018). Coastal flooding, inundation from rising sea levels, extreme heat, icing, subsidence and forest fires also challenge nearly every component of transportation systems, from bridges and airports to railways and ports (Jacobs *et al.*, 2018) and of energy systems (dams, transmission lines, cooling systems in thermoelectricity, pipelines). These risks do not just impact particular sites and locations, but also shorten the infrastructure's life cycle and degrade its operational reliability (Maxwell *et al.*, 2018). Progressive degradation in life cycle performance and quality of the logistics can compromise investment yields and creditworthiness.
- Real estate and land: perception of increased physical risk in a local housing market leading to decreasing prices of homes exposed to sea level rise, flooding and wildfires. Any drop in the values of real estates and land, in turn, threatens the value of mortgages that play a critical role in the balance sheets of many financial market participants, including banks holding them, investors in mortgage-backed securities and government-backed enterprises which guarantee their default risk (Ouazad & Kahn, 2019).
- Financial institutions: especially insurance companies and smaller regional and local banks, which are also vulnerable to claims and loan default losses from chronic and acute physical risks.

Transition risks are different in nature. They emerge from the interplay between the market and technological uncertainty, and the policy uncertainty due to the accelerators and inhibitors in climate policies shaped by social perceptions of climate damages and in reaction to their unmitigated economic consequences. One important category of these transition risks are stranded assets, losses incurred by investing in carbon-intensive options whose profitability could be wiped out by accelerated climate policies and reputational effects amplified by pressure from the pro-divestment movement. Stranded capital from fossil fuel assets alone could lead to a potential loss of wealth between \$1 trillion and \$4 trillion globally (Mercure *et al.*, 2018). The risk extends to demand-side sectors. For instance, sales of diesel cars are expected to shrink within the European market.



Another category includes the risks taken by investing in alternative low-emission and climate-resilient options. The economic viability of these options, usually capital intensive, is very sensitive to uncertainties about

1. The overall business context;
2. How specific markets evolve as a result of policy changes (e.g., ban of high emission products, carbon tax, regulation of electricity markets, real estate policies);
3. Shifts in consumer behaviour (e.g., attitudes towards diesel and electric cars, air travel, plastic versus natural fibre products, animal protein);
4. The cost/efficiency and social acceptance of energy supply options, e.g., wind energy, nuclear, CCS (L'Orange Seigo *et al.*, 2014), adaptation measures and resilience technologies (micro-irrigation, drought and dryness tolerant biotechnology);
5. Capacity of technological breakthroughs (battery or hydrogen) to survive the innovation 'valley of death' (Grubb *et al.*, 2014); and
6. Feedbacks from land-use policies and ecosystems management.

These uncertainties are all the more critical as the pace and chances of success of every individual low-emission option depend on systemic changes in our energy, urban, land-use and industrial systems. In turn, these systemic changes require a re-optimisation of the upstream industry and logistic chain, which adds another layer of uncertainty that might be exacerbated by adaptation measures themselves.

The overall risks depend upon the capacity of financial institutions to absorb the changes in the value of assets. These changes affect differently:

- **Credit-providing institutions** (banks and other financial actors) that lend to entities weakened by climate risks. Credit-providing institutions are exposed to losses from impaired loans and might become less able to provide credit to affected entities. For example, they would stick strictly to loans with a maturity of one to three years and refuse to roll over loans if they believe a company becomes high risk.
- **Institutions holding climate-impacted assets** that operate along a broad spectrum of investment horizons, but under prudent management, and hold assets that may be affected by climate risk. Examples of such assets are commercial mortgage-backed securities pooled together and secured by commercial property, such as hotels, office and retail buildings, warehouses, as well as municipalities' bonds. Typically, insurance companies and small regional and local banks are vulnerable to claims and loan default losses from chronic and acute physical risks.

Whether and how climate-related risks could harm these two categories of financial institutions depends on three parameters: i) the deployment pace of these risks resulting not only from the direct impacts on the assets of individual financial institutions, but also from the feedback loops pictured in **Figure 1.5**; ii) the capacity of financial institutions to internalize the risks; and iii) the efficacy of shock absorbers (Litterman, 2020) (private insurance and reinsurance, government-sponsored entities) for assistance to people and businesses during extreme events<sup>4</sup>.

A related question is whether, in these conditions, the financial system will evolve in such a way that it will help households, small and medium enterprises, farmers,

<sup>4</sup> These shock absorbers have intrinsic limits. On the one hand, experience demonstrates that private insurers often raise premiums in the aftermath of major events to ensure that they have sufficient reserves



corporations, cities and the public sector to launch the four systems transitions needed to avoid the worst of climate change. The problem is that physical climatic changes are significant but 'baked in' for the next few decades and expected to accelerate later. Financial players will progressively integrate physical risks under a 'value at risk' framework and revise them according to new information, but it is not certain whether this integration will happen fast enough to motivate them to support the four systems transition and maximise the chances of realizing a P1 or P2 scenario. Chapter 2 will address this question.

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*to cover future losses or exclude coverage for too large risks to cover even at an acceptable price in the case of flood protection. On the other hand, the existence of public shock absorbers may exacerbate risk by creating a moral hazard. For example, subsidizing some properties' insurance premiums can be an incentive to excessive risk-taking in areas most exposed to flooding, inundation from sea level rise, and extreme precipitation.*

# CHAPTER 2: HOW TO BE PROACTIVE IN ADDRESSING GAPS AND CAPTURING OPPORTUNITIES?

Accelerating climate action requires over the next two decades a massive increase in low-carbon and climate-resilient investments. This places a triple responsibility on financial decision-makers, including governments and regulators:

- To maintain the capacity of the financial system to support economic activity, encourage entrepreneurship, and safeguard the assets of millions of savers, pensioners, local public institutions, and businesses
- To channel a much larger share of private savings towards sustainable and low-carbon options
- To create a business environment in which climate policies contribute to alleviate today's tensions in the world economy (unemployment, poverty, inequality, trade disputes). This is, according to the IPCC 1.5° C report, an overarching pre-condition of scaled-up climate action.

We will see in chapter 3 that this responsibility is even more critical in the post-Covid-19 context. This chapter will specify the differences and interplays between climate-related risks for societies and the financial system. It will also discuss the stakes for scaling-up climate-friendly investments in the context of a structural investment gap for infrastructure, and how climate finance can help bridge this gap contributing to more sustainable and equitable development and a safer financial system.

## 2.1. CLIMATE-RELATED RISKS FOR THE FINANCIAL SECTOR AND SOCIETIES: DIFFERENCES AND INTERPLAYS

Chapter 1 highlighted that the earth system is entering a situation of non-linear consequences and 'unknowable unknowns' related to global warming (Lenton *et al.*, 2019). For an effective framing of policy issues, a distinction must be made between these physical consequences and tipping points for the financial system, the world economy and the human community.

For example, the 'risks hotspots' for human systems might primarily affect areas with a marginal share of the market economy and capital flows. Thus, financial actors might not immediately predict the consequences of exacerbating vulnerabilities in these societies and their impact on the world's security (Stern, 2007; Mach *et al.*, 2019). According to the 'rational expectations and efficient markets' hypothesis (Fama, 1970, Lucas, 1972) that underpins the current functioning of the global financial system, this delay is acceptable because financial actors will readjust their choices and deploy

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an optimal hedging strategy for both the financial system and society when these consequences will fall upon them.

However, this hypothesis might not hold true in relation to climate change. It might lead to a trade-off between the protection of the financial system and of the collective interest.

Indeed, learning from experience, financial actors can disengage from assets exposed to physical risks as home insurers did for flood and wildfire insurance, for example in California (Ouazad & Kahn, 2019). As regards transition risks, the disengagement will take the form of high coefficients applied on infrastructures and investments with a long lifespan. In both cases, the probability of 'extreme but plausible' scenarios will be progressively revised upwards in the 'value at risk' (VAR) calculations reinforcing the disengagement behaviour.

The ensuing question is whether the VAR revision based on experience will lead financiers to readjust their choices quickly enough to avoid that climate change and climate policies destabilise the financial system in the coming decades. There is no need for a catastrophe on a planetary scale in the Weitzman sense (2014) for that. In the context of already-stressed balance sheets and high levels of corporate and municipal debt, a few destructive events affecting key economic hubs or revisions of technological expectations (e.g. negative surprises about low-carbon options or a drop in fossil fuel prices) could trigger a sudden spike in risk aversion, and it might be difficult to restructure the portfolios in a short time. Time is of the essence. When time runs out, risks can turn into catastrophes. Investors could rush out of certain bond funds causing liquidity shortages that could dry up futures markets already fragile because of higher volatility in certain commodity prices, including oil.

The financial system might delay the readjustment if it misses the signal of increasingly worrying statistics of climate damages during the financial cycles' upward-oriented phases with a momentum of cumulating debts and buying permanently revalued assets (Borio, 2014). At the cycle's turnaround, financiers might pay more attention to sources of risks not related to the climate, such as high corporate debt and suddenly devaluated assets based on other risk factors, and this would destabilise the system.

This leads to two opposite outcomes.

**In the first scenario,** a successful spontaneous adjustment due to new information would keep the financial system safe (Keenan & Bradt, 2020; Litterman, 2020), but transfer to taxpayers the onus of damage compensation and the funding of adaptation and mitigation investments. The growing fiscal pressure on public budgets already put under strain by unfunded pension obligations and rising health care costs (Gilmore and St. Clair, 2018) might increase the population's vulnerability and delay the scaling-up of climate mitigation activities.

**In the second scenario,** the financial system would not readjust on time to new information, endangering its own stability (DNB, 2017). In both cases, the 'rational expectations and efficient markets' hypothesis would be invalidated and the financial system would fail to deliver on its triple responsibility to address climate change.

Since the Nineties, the economic literature has highlighted that action must be taken before a fully-fledged assessment of damages associated to climate change becomes available because of the inertia of the earth and economic systems. 'Act then learn' is preferable to 'learn then act' (Manne & Richels, 1992; Ha-Duong *et al.*, 1997) and there is no need to wait for a scientific consensus about global climate catastrophes (Weitzman, 2011) to justify precautionary action (Pottier *et al.*, 2015). This is why the

international community adopted the below 2°C warming target. *But the financial system's spontaneous reaction is closer to the 'learn then act' approach and will likely lead to a P3 or P4 mitigation pathway in the absence of policy action and reforms of its internal dynamics.*

What set of public policies, self-adaptation measures, reforms of the financial regulatory framework, and international cooperation arrangements can enable the financial system to adopt a proactive attitude towards climate change and support the scaling-up of climate-friendly investments? All these tools cannot ignore the general operating principles of the financial system (Malesky, 2017) so climate finance will have to be an adaptive market (Hall *et al.*, 2017) embedded in, and contributing to, the evolution of these principles. The challenge is to reduce the internal vulnerability of the financial system and its consequences for societies, while better aligning with climate priorities and accelerating the transition to net-zero emission economies. This would reduce societies' intrinsic vulnerabilities and allow them to better resist to global warming dynamics already underway. The magnitude of damage caused by climate change depends indeed on the seriousness of physical impacts as much as on the resilience of impacted societies (Hallegatte *et al.*, 2007).

## 2.2. CLIMATE FINANCE, INVESTMENT GAP AND CAPITAL FLOWS' GEOGRAPHICAL MISALIGNMENT

Circulating figures on the investment required for a climate-friendly transition without uncertainty ranges misrepresent the challenges ahead. It would be simple to channel capital flows towards projects whose overall volumes, technical content, and returns are easily predictable. The financier's mission is precisely to help decision-makers take manageable risks in an uncertain context.

The reasons for this uncertainty lie in the interplays between a) the baseline economic growth rates, b) the link between economic growth and energy demand, c) the evolution of low-carbon options' cost efficiency, d) the level of integration between climate policies and other public policies, and their efficacy. Every scenario collected in the IPCC report incorporates various hypotheses about these parameters, except for policy uncertainty<sup>5</sup>. The full range of the modelling results help understand the orders of magnitude at play and the determinants of their uncertainty.

Understanding the challenge of climate finance requires differentiating between global low-carbon investment needs, the incremental costs of a less-than-2°C warming target and the amounts needed to bridge the infrastructure investment gap (IMF, 2014). Global low-carbon investment needs are estimated between 3.9% and 8.7% of the world's GDP over the next two decades<sup>6</sup>. The incremental costs of low carbon options are less than that and their funding could be achieved without reducing global consumption by reallocating 1.4% to 3.9% of global savings, 2.4% on average (see box 4.8 of IPCC,

<sup>5</sup> This caveat from the IPCC AR4 about cost assessments: "most models use a global least cost approach to mitigation portfolios and with universal emissions trading, assuming transparent markets, no transaction costs, and thus perfect implementation of mitigation measures throughout the 21st century." (AR4 WGIII SPM **Box 3**). Scenarios thus minimize transition costs and assume the best available options are adopted by all economic agents in all countries. They provide useful benchmarks but political uncertainty matters when designing efficient financial arrangements.

<sup>6</sup> These estimates aggregate energy sector information from box 4.8 of the IPCC 1.5°C report (IPCC, 2018) with results of Fisch-Romito & Guivarch (2019) on transportation infrastructure and of the OECD (2017) on other sectors.

2018), that currently flow towards real estate, land and liquid financial vehicles<sup>7</sup>. More challenging is the reduction of the infrastructure investment gap, as repeatedly pointed out in specialist literature. According to the Global Infrastructure Outlook, this gap could reach a cumulative value of \$14.9 trillion worldwide in 2035, meaning a global deficit of 15.9%. Arezki *et al.* (2016) retain the more pessimistic projections of a 32% deficit by the Boston Consulting Group. Rozenberg and Fay (2019) find that this investment gap is even higher in low and middle-income countries, especially when SDG-related investments are included. Meeting the 2°C target and SDGs 6.1 (drinking water) and 6.2 (sanitation and hygiene) would demand to multiply by 1.24 to 2.36 investments in water supply and sanitation, flood protection and irrigation in such countries.

Fundamentally, *the chronic infrastructure investment gap and the geographical misalignment of capital flows are symptoms of the 'fault lines' of the current world economy.*

First, the global infrastructure investment gap reflects a *misalignment between the geographic distribution of savings, capital flows and infrastructure investment needs*. This gap exists at the national level due to limited access to capital for key stakeholders of the low-carbon transition (local authorities, SMEs and households) (World Bank, 2019b) and to the diverse causes of the efficiency gap, for example energy efficiency (Ürge-Vorsatz *et al.*, 2018). It is critical at the international level given countries' heterogeneity. Developed countries have aging populations, high savings capacities, established social safety nets, and the bulk of their infrastructures in place. Developing countries have a significant opportunity to leapfrog to low-carbon infrastructure as they still have to build two-thirds of their infrastructure capital. But they have young populations, a wide range of savings rates (from 15% to over 40%) and underdeveloped social safety nets. Even regions with high savings can suffer from deficient energy access and inadequate infrastructure coverage (ADB, 2018). This misalignment is compounded by the limited capital flows from high-saving to low-saving regions. The main barriers to these capital flows are discussed later in the chapter.

A second fundamental reason behind the chronic infrastructure gap is the *short-term bias of economic and financial decisions* (Miles, 1993; Bushee, 2001; Black & Fraser, 2002). This bias results from a business environment in which returns weighted on short-term risk dominate the investment horizon of both financial actors and firms working under a 'shareholder value business regime' (Roe, 1994; Froud *et al.*, 2000) instead of the 'managerial business regime' that characterized the late 20<sup>th</sup> century (Galbraith, 1967). In such an environment, risk-averse financial players tend to direct more savings towards liquid financial products and real estate and avoid confronting the risks of early-stage technologies and markets in developing countries. We will examine more in detail why this bias works against infrastructure investments even though they deliver returns between 4% and 8% (OECD, 2017).

This behaviour results in a gap between the 'propensity to save' and the 'propensity to invest' (Summers, 2016) in which some analysts see a driver of an unstable and uncertain growth over the past and forthcoming decades, if not of a possible secular

<sup>7</sup> On the basis of global private capital stock estimates in 2017 (\$100 trillions in bonds, \$60 trillions on equity and \$226 trillions in banks loans, and assuming that half of investment are funded by public capital, Dasgupta *et al.* (2019) show that redirecting between 0,8% and 3% of the private capital's yearly revenues would be needed to fund the incremental costs. This wide range encompasses the range of investments needs and a pessimistic 3% to an optimistic 5% average returns of capital. This does not mean that it is an easy task since innovative financial channels and products have to be set up, but that there is no apparent global constraint for such a shift in financial portfolios. However, these assessments imply the emergence of new assets classes to compensate for the stranded assets due to early retirement of capital stock and divestment from the fossil-fuel industry, which could amount to 32% of the carbon-intensive assets (Mercure, 2018) in the case of a speedy transition.

stagnation (Krugman, 2014; Blanchard, 2019; Rachel & Summers, 2019). This has become a severe threat to the stability of the modern financial system (Christopher, 2017; Schwab, 2019).

### 2.2.1. THE UNINTENDED IMPACTS OF THE RESPONSE TO THE SUBPRIME CRISIS

*After the subprime crisis, tight regulations adopted to minimise the vulnerability of the financial and monetary systems and the liquidity injections by central banks did not help reduce the infrastructure investment gap.* They resulted in an increase of corporate debt worldwide, not in an increase of long-term investments. While syndicated bank loans have traditionally been an important source of funds for risky long-term projects, the tighter bank regulations under Basel III, combined with an economic context with more uncertainty and flatter yield curve, have pushed banks to retrench from risky and less profitable asset classes (Blended Finance Taskforce, 2018a). In this context, they tended to limit loan maturity to 5 or 8 years, while infrastructure projects typically require the amortisation of debt over 15-20 years (Arezki et al., 2016).

The private sector's recourse to debt has then largely bypassed the banking system via '*shadow banking*' actors, with bonds and equity traded through Non-Bank Financial Intermediaries (NBFI) (mutual funds, insurance, asset managers, hedge funds, exchange-traded funds) that are not subject to the same regulatory regime. The percentage of global financial assets held by the NBFI sector grew from 42% in 2008 to 49.5% in 2019 (FSB, 2020). Since this sector can provide, through green bonds, the easiest vehicle to mobilise savings for low-carbon investments, the question (discussed later) is how such vehicles should be built to improve and not undermine the stability of the non-bank banking system.

Between 2008 and 2019, the upward phase in the financial cycle allowed the accumulation of debt with accrued risks concealed in the loaners' asset column, preparing a slowdown in economic growth at the downturn of the cycle (Borio et al., 2018). The threats materialised in 2019 prospecting lower economic growth worldwide even before the Covid-19 crisis. This generated a loss of confidence in asset prices and revealed systemic vulnerabilities. A symptom was, in 2019, the negative 10-year to 3-month US spread (-7.6bps).<sup>8</sup>

These post-2008 dynamics have had indirect negative consequences for the willingness of the private sector to invest in the low-carbon transition. In particular:

- For long-term sovereign bonds negative yields reflect very risk-averse behaviours (preferring the certainty of small losses to the expectation of gains that are associated with the risk of large losses) that lead to credit rationing for projects (Stiglitz & Weiss, 1981) and penalise capital intensive and less mature low-carbon options;
- In the investment-grade universe 50% of private companies were rated BBB at the end of 2019 compared with 34% in 2000, which inhibits their capacity to invest (CEIC Data stream: <https://www.ceicdata.com/en/indicators>); and
- In emerging economies average sovereign spreads reached 524bps on March 18<sup>th</sup> 2020 undermining their refinancing capacity. Besides, an increasing number of developing countries have been or are at risk of being downgraded at CCC, and thus deprived of access to the capital market if not at usurious discount rates.

<sup>8</sup> <https://tradingeconomics.com/country-list/rbeasating>

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### 2.2.2. THE INVESTMENT GAP FOR ADAPTATION AND ESSENTIAL GOODS AND SERVICES

The warmer the planet, the higher the sea-level rise and the more frequent the floods, typhoons, hurricanes and heat waves. As a consequence, the investment needs in new and retrofitted resilient infrastructure, flood protections, water management, health systems, climate-resilient agriculture, nature-based solutions, community-based initiatives, and early warning systems will also increase (IPCC, 2018).

Studies indicate that adaptation investment needs are in the order of \$140 to \$300 billion per year for developing countries over 2016-2030 (UNEP, 2018; IFC, 2016). Only 18-25% of climate finance is currently directed to these measures in developing countries with fragmented support and small amounts flowing through UNFCCC channels (Shine & Campillo, 2016).

The funding of specific adaptation investments is only part of the challenge because, ultimately, improving societies' adaptive capacities depends on the fulfilment of the SDGs (Hallegatte *et al.*, 2015). Bridging the investment gap on irrigation, water supply, health care, energy access, and quality buildings is an essential enabling condition for adapting to climate change.

Investment at scale in these essential infrastructures and services is however hampered by two intrinsic features. First, it is more challenging to capture monetary revenues from beneficiaries of these projects as their benefits frequently have a local public good nature and concern activities that often do not deliver marketable goods and services. Second, adaptation projects are not easy to standardise, making financial, technological and organisational innovations more difficult than for mitigation activities.

This is why much of adaptation mobilises local, regional and national partnerships, including with the support of national and sub-national government budgets, supplemented by NGO and private climate funds (Nakhooa & Watson, 2016). Adaptation investments and the provision of basic infrastructure will likely continue to require public subsidies and development assistance. In 2018, the private sector brought only 5.7% of the adaptation projects to the portfolio funded by Multilateral Development Banks (MDBs), while the proportion for mitigation projects was 47%. The difficulty to monetise adaptation benefits explains why 70% of their funding by the MDBs is operated through loans, 9% through grants and only 0.04% through guarantees which cover instead 4.4% of mitigation projects (MDB, 2019).

## 2.3. BRIDGING THE INVESTMENT GAP FOR LOW-EMISSION, CLIMATE-RESILIENT INFRASTRUCTURE: MARKET FIXING AND MARKET SHAPING

For decades, discussion on how to incentivise the changes needed in investment, production and consumption patterns, and induce technological progress that brings down carbon abatement costs, centred on the relative merits of pricing and non-pricing instruments, and ways of articulating them. The prevailing assumption was that, with the proper carbon prices, well-defined standards and norms supported by public funding, private finance would follow automatically. This assumption no longer holds given the variety of market failures in the infrastructure investment gap and the geographical mismatch of capital flows.

As the traditional distinction between market-based and command-and-control instruments does not capture the diversity of policy packages experimented over the



past three decades to accelerate climate innovation and investments, we consider here, and interpret more broadly, the distinction between two approaches to correct market failures. This distinction has been made by several authors (Mazzucato, 2015; Ryan-Collins, 2019).

The *market-fixing* approach focuses on removing information barriers that hinder investments by adding financial disclosure to pricing signals with no specific demand for systemic reforms of the capital markets and no fiscal and regulatory policies to guide microeconomic choices. The *market-shaping* approach aims to remove investment barriers directly through a mix of self-regulatory measures and financial instruments, and direct public investment to improve risk-weighted returns of low-emission, climate-resilient infrastructure for a given carbon price.

### 2.3.1. MARKET FIXING: SENDING THE RIGHT SIGNALS

The market-fixing approach aims to send the right pricing and risk signals to enable financiers to better value assets and reallocate capital accordingly.

#### Carbon pricing, necessity, forms and limits

There is a widely shared consensus in economics that, in a frictionless world with perfect capital markets and without uncertainty, carbon prices would be sufficient to secure the attractiveness of low-carbon options for capital markets. In the real world, however, the carbon price signal is swamped by the noise of other signals, such as oil prices, interest rates, and currencies exchange rates, in addition to the business uncertainty (Gross *et al.* 2010, Roques *et al.* 2008)

Carbon prices capable of covering these noises should be set at a higher level than the \$40–80/tCO<sub>2</sub> by 2020 and \$50–100/tCO<sub>2</sub> by 2030 recommended by the high-level commission led by Joseph Stiglitz and Nicholas Stern (Stiglitz *et al.*, 2017). The main reason is that the payback period of low-carbon options with higher upfront capital expenditure and lower operations and maintenance costs is longer and therefore much more sensitive to uncertainty than alternatives with fuel costs dominated technologies (Hirth & Steckel, 2016; Hourcade *et al.*, 2017; Iyer *et al.*, 2015; Schmidt, 2014).<sup>9</sup>

The scaling-up and geographical expansion of carbon prices to such levels<sup>10</sup> are highly uncertain because they have to be embedded into country-specific fiscal and social policies to hedge against the regressive impact on welfare, competitiveness and employment caused by the propagation of higher energy costs throughout the economy (Michaelowa *et al.*, 2018). This impact needs to be offset using the proceeds of carbon taxes or auctioned emission allowances to reduce distortive taxation (Goulder, 1995; de Mooij, 2000; de Mooij & Bovenberg, 1994; Chiroleu-Assouline & Fodha, 2014) and fund compensating measures for the population sections that are

<sup>9</sup> These studies, although conducted with different methodologies and for different contexts, deliver convergent messages. Schmidt (2014) finds that a risk premium that doubles the financial costs increases the life-cycle costs of electricity from renewable energies by 31% to 46%, while the costs of electricity from coal and gas increase by 17% and 7% (they even decrease by 3% for diesel). As for switching carbon price, it triples for wind and biogas, more than doubles for small hydro and increases by 70% for photovoltaic. Hourcade *et al.* (2017), for a similar risk coefficient, find that the switching carbon price almost doubles for coal plus CSS in the EU and hydro projects in Brazil. Hirth and Steckel (2016) find that the switching carbon price securing a 25% share of renewable energy in the electricity sector in Germany increases by 80% when a higher risk perception leads a weighted average capital cost of low-carbon options to increase from 7.5% to 12%.

<sup>10</sup> The minimum and maximum marginal costs of carbon reported in the AR6 report range between \$70 and 160 for 2030 worldwide for a 2°C target and the summary for policy-makers of the IPCC 1.5°C report states that the carbon prices for a 1.5°C target should be set at a level three to four times higher than those needed for a 2°C target. These ranges might be optimistic in case of policies only focused on carbon prices because they assume transparent markets and perfect mitigation of least cost measures (AR4 WGIII SPM Box 3). Moreover, they do not represent the compensations needed to equate the marginal welfare costs across countries and assume implicitly that their implementation would be costless.



most adversely impacted (Combet *et al.*, 2010; Jaccard, 2012; Klenert *et al.*, 2018). The adverse economic and distributive effects of higher energy prices and the removal of fossil fuel subsidies are more severe for low-income countries, countries with a large share of energy-intensive activities and countries exporting fossil fuels. These also have a lower potential to mitigate impacts because of lower wages and lower pre-existing taxes (Lefevre *et al.*, 2018).

The challenge is almost identical in the case of emission trading systems. A frequent misconception is to see in this mechanism a way of financing the low-carbon transition through the revenues from the sale of emission permits. But this is possible only if at least part of the emission allowances are given for free to companies. In this case, finding the rules for the allocation of allowances for a given overall carbon constraint is an uncertain exercise. It has to allow all sectors to self-finance their low-carbon investments or cover the debt service of loans without generating 'carbon rents' that would impose a burden on the rest of the economy (Branger & Quirion 2015). The perspective of voluntary carbon markets growing more than 15-fold by 2030 to deliver the 1.5°C pathway envisaged by The Taskforce on Voluntary Carbon Markets (Task Force on Voluntary Carbon Markets, 2021) might face the same obstacles, including the political pressure for auctioned permits and the difficulty of controlling the effects of linking cap and trade systems that are very heterogeneous in scope and jurisdiction (Holtsmark & Weitzman, 2020).

Carbon price signals alone leave financing challenges unresolved because of the constraints on their scaling-up and the need to use a significant share of their revenues to mitigate their effects directly (recycling option) or indirectly through companion policies that tackle market failures other than greenhouse gas emissions and that involve public funding. These failures are related to knowledge spillovers, learning and R&D, information, capital markets, labour markets and unpriced co-benefits of climate action. This is why a consensus, expressed by the High-Level Commission on Carbon Prices (Stiglitz *et al.*, 2017), is now emerging on the need to embed carbon prices in more complex policy packages.

The Stiglitz-Stern commission also emphasises the interest to complement explicit carbon prices with implicit carbon pricing. The way to do so is to embed notional prices in financial instruments and public incentives that foster low-carbon programmes and projects, such as specific project-based credits and 'shadow pricing' internal to public enterprises. The link between carbon pricing and financial instruments is explored below.

## Climate risk disclosure and taxonomies

Historically, the concerns of the financial community about the implications of climate change arose from potential fiduciary obligations of reinsurers and pension funds (Freshfields *et al.*, 2005; Girgis & Barker, 2015; Mansley, 1994; Wilder & Curnow, 2012). The focus on liability risks responded to the advocacy strategies deployed by university endowments and mission-based investors such as philanthropic and religious organisations to remove the 'social license' from the fossil fuel industry and to raise the cost of its access to capital (Ansar *et al.*, 2013; Baron & Fischer, 2015). The Carbon Tracker Initiative (CTI), a UK think tank, first quantified in 2011 the climate-related risks of stranded assets in the fossil fuel industry (Carbon Tracker Initiative, 2018). Since then, other tools have emerged covering other sectors and asset classes, such as the 2° Investing Initiative's PACTA<sup>11</sup>. Such tools demonstrate a rising interest in business circles to engage in an 'investor revolution' (Eccles & Klimenko, 2019) with climate change incorporated in the Social Responsibility of Enterprises to induce changes in

<sup>11</sup> The scientific robustness of these tools deserves scrutiny. Comparing the amounts of fossil fuels in a baseline scenario with those in a 2°C or 1.5°C target to assess stranded assets twenty years ahead comes to assume a benevolent dictator imposing a low-emission path on one hand and investors ignoring its existence and never changing their decision pattern despite the costly experience of trajectory corrections on the other.

companies' routine decisions, and more attention paid to alternatives with a lesser climate impact.

A few asset owners started, for example, to sell their fossil fuel-based assets. Before the recent crash of oil prices, the question was whether a divesting movement could be large enough to weigh on share prices of oil companies (Denning, 2019). The question is even more difficult if we are to disentangle the impact of such movements from other causes of oil price volatility in the Covid-19 context<sup>12</sup>.

Marc Carney's speech (2015) on *the 'tragedy of the horizons'* broadened this perspective, adding the 'physical risks' and the 'transition risks' to the 'liability risks'. This alert from the former Governor of the Bank of England had an influence amongst financial actors who generally do not consider the future beyond a quarterly horizon. It opened a discussion about the unseen build-up of climate risks across multiple companies and actors that could threaten the system's stability by suddenly writing down significant classes of assets. This discussion led to the creation of a Task Force on Climate-related Financial Disclosures (TCFD) under the auspices of the Financial Stability Board (FSB) that brings together financial authorities from G20 countries to prevent new financial crises. The voluntary nature of the TCFD facilitated its endorsement by governments and regulators, in addition to numerous companies and investors. But it allowed for a patchy adoption of its principles.

The Sustainability Accounting Standard Board, a non-profit organisation, published in 2016 detailed technical guidelines (Sustainability Accounting Standards Board, 2016) to better understand the probability, magnitude and timing of climate risks for each industry across the economy in the near term and to compare corporate performance among peers. In 2017, the TCFD released a universal framework (Task Force on Climate-related Financial Disclosures, 2017) with a set of quantitative and qualitative criteria to disclose the climate risks embedded in portfolios (See box 2.1).

There are currently five leading voluntary disclosure frameworks, which have recently begun to work together towards a joint vision: the Carbon Disclosure Project (CDP), the Climate Disclosure Standards Board (CDSB), the Global Reporting Initiative (GRI), the International Integrated Reporting Council (IIRC) and the Sustainability Accounting Standards Board (SASB). They follow the recommendations of the Inter-Agency Task Force on Financing for Development (IATF), which includes over 60 UN and

<sup>12</sup> For example, BNP Paribas Asset Management is divesting from thermal coal across all its actively managed funds. Source: <https://institutional.bnpparibas-am.com/divesting-coal-new-policy/>. Danish pension fund MP Pension sold off shares in 10 major oil companies in part because returns were considered poor and were expected to continue to deteriorate. The Norwegian Government Pension Fund Global is divesting from some oil companies to manage its climate-related risks deriving from exposure to the sector: <https://www.regjeringen.no/en/dokumenter/the-report-on-energy-stocks-in-the-government-pension-fund-global/id2662171/>

As for oil companies, the difficulty to disentangle the causes of the share price changes is illustrated by the fact that the shares of Exxon Mobil plummeted from \$69.89 on 12/27/2019 to \$32.74 on 03/20/2020, rose to \$53.08 on 06/05/2020, fell again to \$32.78 on 06/11/2020 and was \$61.93 on 03/03/2021. The share price of Total followed a similar trend: \$50.38 on 01/03/2020, \$25 on 03/20/2020, \$38.34 on 06/05/2020, \$25.82 on 10/30/2020 and \$42.19 on 03/12/2021.

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international entities on global mandatory disclosure of climate-related financial risks (United Nations, 2020).

### BOX 2.1 EXAMPLES OF CLIMATE-RELATED FINANCE INITIATIVES, FRAMEWORKS, STANDARDS AND METHODOLOGIES

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**Disclosure-oriented platforms, scorecards, and tracking lists.** These seek to provide decision-makers or institutional customers with information about the way specific companies or institutions perform in relation to climate change. Examples are the Climate Disclosure Project (CDP), the Asset Owners' Disclosure Project and the Global Coal Exit List.

**Financial reporting standards.** These seek to include climate and other ESG or non-financial factors into accounting standards. Examples are the Sustainability Accounting Standards Board (SASB), the Global Reporting Initiative (GRI) and Integrated Reporting. Others, such as the Partnership for Carbon Accounting Financials, include features of both reporting standards and disclosure platforms.

**Analytical methodologies and certification schemes.** These go a step beyond disclosure-oriented platforms by analysing and seeking to incentivise possibilities for the reduction of embodied emissions and physical climate risks. Examples come from both NGO and proprietary/commercial providers, such as the 2 Degrees Investing Initiative, the Transition Pathways Initiative, the Platform for Carbon Accounting of Financials, and many commercial providers.

**Scenario-related tools.** A critical element of the TCFD recommendations, scenario analyses attempt to capture future risk. Examples are the Paris Agreement Capital Transition Assessment (PACTA), a tool to test entire portfolios against a scenario, and the Inevitable Policy Response, a modelled, policy-driven transition scenario with resources to apply it.

**Physical risk analysis tools.** These use information from climate models combined with data about the location and features of assets and business activities to estimate their vulnerability to climate impacts. Examples are the World Resources Institute (WRI)'s Aqueduct tool or 427MT's physical risk services.

The primary outcome expected from climate disclosure approaches is that banks and asset managers will correct their short-term bias and launch financial signals to investors by setting the cost of loans in an inverse proportion to the projects' carbon content.

An important macroeconomic side-benefit would be to hedge against abrupt corrections in financial markets caused by cumulated mispricing of assets (Plantinga & Scholtens, 2016). In late 2017, the Network for Greening the Financial System (NGFS) was launched. It now has 90 members, among which central banks from many developed and developing countries. Observers include the IMF, the World Bank, the Bank for International Settlements, the Basel Committee for Banking Supervision, and the Green Climate Fund (GCF). Its first report made several recommendations for central banks and other policymakers and established a taxonomy of green, non-green, brown and non-brown products (NGFS, 2019) to help direct investments to sustainable options. The European Union recently developed a first essay of such a taxonomy (EU

Technical Expert Group on Sustainable Finance, 2020) and some EU companies have just launched the first application trials.

In parallel, stress test methodologies have tried to assess the risk exposure of various asset portfolios (Battiston *et al.*, 2017). In 2019, the Bank of England and the Netherlands announced plans to conduct climate risk stress tests for banks and insurers. In March 2020, the European Central Bank (ECB) announced the preparation of a macro prudential stress test to reveal how climate risks could propagate across the financial system and the non-financial economy.

The concrete outcome of these processes is still uncertain, but they show an increasing demand for knowledge tools from high-level decision-makers in an uncertain environment.

### Lessons learned from market-fixing experiences

Experiences of carbon pricing started in the early Nineties in Sweden. Twenty-five years later, in 2016, explicit carbon prices covered only 15% of global emissions and three quarters of them were below \$10 per tCO<sub>2</sub> (World Bank *et al.*, 2016), far lower than \$40 to \$80 worldwide recommended by the Stiglitz-Stern report. This has to be compared with the \$5.2 trillion (6.5% of the world's GDP) dedicated in 2017 to subsidising fossil fuel consumption (Coady *et al.*, 2019).

The scaling-up of carbon prices and the removal of fossil fuel subsidies remain fundamental conditions for the low-carbon transition, but their pace depends ultimately on each government's capacity to incorporate them into a set of public policies (fiscal reforms, regulation of the electricity and transport systems, real estate policies, safety nets) that minimise their adverse effects on development priorities and, possibly, turn them into a double dividend. The design of these policies will always have to consider national and local circumstances. This explains why paragraph 136 of the Paris Agreement's decision recognises the usefulness of a carbon price but states that it *"applies to non-Party entities and is not binding upon countries that are Parties to the convention."* There is, therefore, little chance that carbon prices can reach in the coming years the levels required to overcome the noise of other market signals.

A still underexplored area is the use of notional carbon prices to drive public policies. Such prices have been adopted in the UK and France with a 'valeur tutélaire du carbone' (safeguard carbon value) of 250€/tonne (Quinet, 2019) but with, so far, no observable consequences.

Climate transparency approaches are too recent to assess their impact. In June 2019, a TCFD survey found that most companies do not disclose sufficient information on the potential financial impact of climate-related issues affecting them (Task Force on Climate Financial Disclosures, 2019). A recent report by the Climate Disclosures Standards Board also found that the adoption of the TCFD recommendations continues to be slow and that 78% of Europe's largest companies are falling short of reporting environmental and climate-related risks despite EU guidelines (Climate Disclosures Standards Board, 2020). As for the practical consequences of these efforts, an IMF study found that equity valuations across countries did not reflect any of the commonly discussed global warming scenarios nor associated projected changes in hazard occurrence or physical risk incidence.<sup>13</sup>

<sup>13</sup> <https://blogs.imf.org/2020/05/29/equity-investors-must-pay-more-attention-to-climate-risk>

## The TCFD and taxonomy tools face three main limits:

- The methodological difficulties associated with calculating aggregated indicators of portfolios' 'greenness'. The quantification of the so-called 'scope 1', 'scope 2' and 'scope 3' of emissions to be attributed to each activity as defined by the GHG Protocol launched in 2001 by the World Business Council for Sustainable Development (WBCSD) and the World Resources Institute (WRI) might not be easy to resolve<sup>14</sup>. Another question is about the grades given to emissions from energy-intensive industries like cement, steel and specific chemicals, which have high production-based emissions but are also absolutely needed to build low-carbon climate-resilient infrastructures.
- Decarbonising an asset portfolio by divesting coal or other carbon-intensive activities does not necessarily lead to investing in the technical options needed for deep decarbonisation<sup>15</sup>. One can decarbonise a portfolio by investing not in such options but in other non-carbon intensive activities, like health, education or information systems, or assets like real estate that indirectly induce mobility needs contributing to higher CO<sub>2</sub> emissions.
- A company that gives up a carbon-intensive project may make way for a competitor less sensitive to environmental virtue, which would find support by financial institutions with a looser interpretation of climate disclosure.

Hence, even if public pressure mounts to require financial institutions and industry to disclose their climate risks and the emissions embodied in their investment, disclosure and transparency alone might not effect the redirection of saving quickly enough for a 1.5°C or a 2°C warming transition (Christophers, 2017; Ameli, 2020). Transparency is needed to address behavioural routines, what Grubb et al. (2014) call the first domain of action, but it cannot address on its own the market failures that interact with the financial system and the structural issues of climate finance, the second and third domains of action.

Thus, price mobilisation and financial signals alone might fail to reduce the infrastructure investment gap in due time. Their common limit is that ***the deficit in low-carbon investments depends on many market failures that improved information alone cannot reduce***. Symptomatically, climate-related resolutions have proliferated in the past couple of years (Westcott, 2019), while investors use their power to appeal to governments directly. An example is the Global Investor Statement to Governments on Investor Expectations, a call to governments worldwide to meet the objectives of the Paris Agreement endorsed by 420 investors managing over \$32 trillion<sup>15</sup>. ***Market-shaping approaches aim to respond to this call by addressing directly the market and institutional failures that inhibit the efficacy of price and financial signals.***

<sup>14</sup> Scope 1 registers Direct Emissions under the control of the activity (fuel combustion on-site, fleet vehicles); scope 2 encompasses indirect emissions (e.g., from purchased electricity) and scope 3 all Indirect emissions from sources that the activity does not control but incorporate (through the purchase of non-energy inputs) or induce and that is usually the most significant share of the carbon footprint. Beyond data uncertainty, which will be hopefully reduced over time, the difficulties come from two interrelated problems. The first is the 'attribution' given the complexity of the global value chains (Antras et al., 2017; De Loecker et al., 2016; Goldberg & Knetter, 1997; World Bank, 2021). This complexity makes it difficult to track value-added chains in a consistent way with capital flows, the circulation of physical products and their energy content. Overcoming the risks of double-counting and controversial attribution with an acceptable level of approximation is possible for correcting the countries' emission considering the emissions content of their imports and exports. It grows rapidly at the higher level of granularity needed to track the carbon content of capital flows. The second difficulty is that any work on the alignment of portfolios towards climate targets, or any stress test, demands a set of baseline and climate constrained trajectories. One alternative option has been explored by the French Energy Agency (Ademe). This combines a top-down approach with an attribution per type of activity (ADEME, 2014) but has not been replicated so far.

<sup>15</sup> The Global Investor Statement to governments on climate change: <https://globalinvestorcoalition.org/wp-content/uploads/2019/09/190916-GISGCC-for-UNCAS.pdf>

### 2.3.2. MARKET SHAPING: REMOVING ECONOMIC AND NON-ECONOMIC BARRIERS TO CLIMATE-FRIENDLY INVESTMENTS

From a microeconomic point of view, the infrastructure investment gap looks like an economic paradox since, with current low-interest rates, infrastructure investments deliver a real return between 4% and 8% (Bhattacharya *et al.*, 2016). With an estimated \$14 trillion of negative-yielding debt in OECD countries and \$26 trillion of low-carbon, climate-resilient investment opportunities in developing countries by 2030, capital in search of higher yields should flow from developed to developing countries to address this infrastructure investment gap. This is not happening.

Finance for projects in non-OECD countries reached \$356 billion per year in 2017–2018, or 61% of global climate finance. However, 76% of these resources are deployed in the country in which they are sourced, revealing a strong preference among investors for home-country investments where risks are well understood (CPI, 2020). East Asia and Pacific was the largest regional provider of and destination for climate finance, at \$238 billion. Sub-Saharan Africa accounted for only 5% of climate finance flows in non-OECD countries, at \$19 billion (CPI, 2019). The bulk of climate finance in Sub-Saharan Africa originates from the public sector (MDBs, NDBs, multilateral climate funds).

Neither financial investors nor project developers try and take advantage of what the IMF's World Economic Outlook (Abiad *et al.*, 2014) describes as 'free lunch' opportunities because these opportunities face several political and regulatory, macroeconomic and business costs, as well as technical barriers. These costs are magnified in developing countries because of the considerable differences in their creditworthiness. The spread between the interest rate of a bond issued by the US government and the interest rate of loans to a given country comes on top of projects' risk-premium. In 2018, it was 1.30% for a five-year project and 2.5% for a ten-year project in BBB-rated countries. At the beginning of 2020 it jumped to 6% and 9%, respectively, in B-rated countries. Before the Covid-19 crisis, more than 60 countries were rated below BBB and had access to capital only at interest rates higher than 18% for two-year projects. The impact of this inequality is exacerbated by the fact that countries in this class are often those whose creditworthiness might be the most affected by climate change damages (Buhr *et al.*, 2018).

Aligning capital flows and investment needs is not just a matter of North-South aid and foreign assistance, of which flows are currently falling. It demands correcting the world economy's structural mechanisms behind the well-known Lucas' paradox, '*why doesn't capital flow from rich to poor countries*' (Lucas, 1990), and the non-negligible share of their savings flowing into the 'safe havens' of developed countries (World Bank, 2019b).

While market-fixing approaches address information barriers for financiers, a second approach gradually emerged over the past 30 years to direct private investments towards low-emission climate-resilient development pathways addressing a range of other barriers. This approach couples climate finance channels with tools designed to develop the demand for 'green' products, promote low-carbon technical innovation and remove the political and regulatory barriers that hinder demand and supply of climate-resilient investments. In essence, market-shaping approaches embed pricing signal into broader policy packages.

This section highlights barriers to climate-friendly investment and describes how the market-shaping approach removes them through policy and financial de-risking.

## Barriers and risks time profiles

At the microeconomic level, the persistent infrastructure investment gap is caused by several risks that deter entrepreneurs and financiers from exposing their resources. The OECD (2016b) suggests to cluster these risks into three main categories and to follow them along the four phases of the project development cycle (table 2.1).

**Political and regulatory risks** arise from governmental actions, including changes in policies or regulations that adversely impact infrastructure investments. For example, complex, inconsistent or opaque licensing procedures lead to transaction delays and costs. Similarly, changes in tariff regulations or off-taking contract renegotiation can affect the profitability of investments.

**Macroeconomic and business risks** arise from the possibility that the industry and/or the economic environment are subject to change. These include macroeconomic variables like inflation and exchange rate fluctuations, as well as shifts in consumers' demand, access to finance and liquidity constraints.

**Technical risks** are determined by the skills of operators and managers, and related to the features of the project (e.g. its complexity, construction, and technology). These risks can also arise from the lack of supporting physical infrastructure (e.g., cranes or roads to unload and transport heavy equipment).

**TABLE 2.1: MAIN RISKS BY PROJECT DEVELOPMENT PHASE (OECD, 2016)**

RISK CATEGORIES	DEVELOPMENT PHASE	CONSTRUCTION PHASE	OPERATION PHASE	TERMINATION PHASE
POLITICAL AND REGULATORY	Environmental review	Cancellation of permits	Change in tariff regulation	Contract duration
	Rise in Preconstruction costs (longer permitting process)	Contract renegotiation		Decommission
				Asset transfer
			Currency convertibility	
	Change in taxation			
	Social acceptance			
	Change in regulatory or legal environment			
	Enforceability of contracts, collateral and security			
MACROECONOMIC AND BUSINESS	Prefunding	Default of counterparty		
	Financing availability		Refinancing risk	
			Liquidity	
			Volatility of demand / market risk	
	Inflation			
	Real interest rates			
	Exchange rate fluctuation			



RISK CATEGORIES	DEVELOPMENT PHASE	CONSTRUCTION PHASE	OPERATION PHASE	TERMINATION PHASE
TECHNICAL	Governance and management of the project			Termination value different from expected
	Environmental			
	Project feasibility	Construction delays and cost overruns	Qualitative deficit of the physical structure / service	
	Archaeological			
	Technology and obsolescence			
	Force majeure			

All the four phases (development, construction, operation and termination), including their specific risks, will count in the investment calculus of both entrepreneurs and financiers. The development phase is critical because, at this stage, entrepreneurs are particularly exposed as they engage personal equity and take the risks of sunk costs. They will therefore expect higher returns before investing their time and personal resources in an infrastructure project. Similarly, finance providers will demand a higher margin and offer less attractive terms to protect themselves from these higher risks.

This translates into higher interest rates (debt) and required returns (equity), shorter loan tenors and a larger share of costlier equity in capital structure, affecting the attractiveness of the investment. The additional financing costs are even higher in less developed countries in which infrastructure projects would not reach investment grade (Blended Finance Taskforce, 2018b).

These barriers appear to restrict even further climate-friendly investments, as suggested by the limited private funds leveraged by public money for such projects, the low share of carbon saving potentials tapped by dedicated policies such as energy renovation programmes (Ürge-Vorsatz *et al.* 2018), and a demand for climate finance lower than the volume of economically viable projects (de Gouvello & Zelenko, 2010; Timilsina *et al.*, 2010).

Part of the risk is primarily transactional. Risks come from the uncertain results of environmental reviews, surprises in the costs and delays incurred in the pre-construction phase (permitting process longer than expected, difficulties raising the pre-funding and identifying credible financial partners, risks of permit cancellation, and renegotiation of the initial contract). These factors, ***combined with those of cost overruns for less mature technical options, generate upfront risks that deter many initiatives***. They are very high for sub-critical project sizes, fragmentation of financing windows, limited familiarity with particular geographies, uncertain governance landscape, and weak project preparation. These parameters can be found in almost all economies but are decisive in developing countries

A direct consequence is the limited supply of high-quality, transparent low-carbon climate-resilient investment projects despite the unmet demand for new infrastructures. Hence, although the issuance of green bonds reached a record high of \$225 billion in 2019, it was far below the potential of low-carbon investments. This ***chicken and egg problem*** explains the paradox of complaints from entrepreneurs about difficult access to capital on the one hand, and from financiers about a deficit of bankable project proposals on the other. Any green market will require addressing the barriers to both the demand and the supply of climate-friendly investments to be successful (Mazzucato, 2015).



## Public support instruments to create demand and supply for climate-friendly investments

The need to address market and investment barriers to low-carbon options has inspired the development of a wide array of public measures modelled around the energy efficiency policies conducted since the Seventies. According to the IEA's Policies and Measures Database, over 5,500 climate policies and instruments are currently used globally today.<sup>16</sup> Table 2.2 shows the main types of instruments.

The first four columns list environmental policy instruments that create a business context conducive to the demand of low-carbon investments and the supply of low-carbon projects. They include information, regulatory, economic and institutional measures that create a demand for green, climate-resilient goods and services by reducing market uncertainty. They also encourage climate-friendly investments by reducing their transaction costs.

In contrast, financial de-risking instruments do not seek to change the overall business context but tackle project risks by transferring part of them to public actors. They blend public and private resources, often to encourage market-creating projects that will establish a proof of concept (innovation to market) or commercial track record (market deployment) for new climate solutions.

TABLE 2.2: ENVIRONMENTAL PUBLIC SUPPORT INSTRUMENTS

	Information and empowerment instruments	Control and regulatory instruments	Economic and market instruments	Institutional instruments	Financial instruments
Market Creation Instruments	Rely on knowledge, communication, and persuasion to influence behaviour and supply skilled labour.	Rely on the establishment of obligations, encouraging or prohibiting or restricting certain types of behaviour	Financial incentives and disincentives to influence private sector behaviour and investment decision-making	Create an institutional and organizational environment to facilitate policy and technology development and deployment	Direct public sector (co) investment to establish a proof of concept or commercial track record of new solutions
Demand-side Instruments	<ul style="list-style-type: none"> <li>Information disclosure and green taxonomies (climate risks, carbon liabilities, etc.)</li> <li>Long-term policy commitment and targets</li> <li>Valuation methodologies</li> <li>Public awareness and persuasion</li> </ul>	<ul style="list-style-type: none"> <li>Macro-prudential regulations (climate stress tests for banks and insurers, etc.)</li> <li>Mandates</li> <li>Ban</li> <li>Zoning</li> <li>Building codes</li> <li>Norms and minimum performance standards</li> <li>Standards and labels</li> </ul>	<ul style="list-style-type: none"> <li>Carbon taxes, phase out of fossil fuel subsidies</li> <li>Development of new asset classes</li> <li>Fossil fuel divestment by public financial institutions</li> <li>Taxes/tax breaks (e.g., carbon taxes)</li> <li>Charges and penalties</li> <li>Favourable tariffs</li> <li>Green procurement</li> <li>Advanced market commitment</li> <li>Tradable permits and quotas</li> </ul>	<ul style="list-style-type: none"> <li>Green finance regulatory networks, asset managers coalition and central bank coordination mechanisms</li> <li>Establishment / restructuring of environmental institutions</li> <li>Development of R&amp;D networks and ecosystems</li> </ul>	
Supply-side instruments	<ul style="list-style-type: none"> <li>Investment in education and research</li> <li>Technical and vocational training and retooling</li> </ul>	<ul style="list-style-type: none"> <li>Streamlining licensing processes</li> </ul>	<ul style="list-style-type: none"> <li>Power purchase agreements</li> <li>R&amp;D commissioning</li> <li>Property rights agreements</li> </ul>	<ul style="list-style-type: none"> <li>Dedicated financial institutions (green banks, green guarantee companies, green bond platforms, etc.)</li> </ul>	<ul style="list-style-type: none"> <li>Public sector-led R&amp;D</li> <li>Project concessional finance (grant and loans)</li> <li>Incubation grants/venture capital</li> <li>Guarantees</li> <li>Equity investment</li> </ul>

The mobilisation of these two classes of instruments to address the infrastructure microeconomic paradox remains a complex exercise because it requires to find the right *balance between three parameters: a) the social acceptability of end-use services' delivery prices, b) the coverage of costs to develop the systems, and c) the risk-weighted profitability for private investors.*

<sup>16</sup> <https://www.iea.org/policies>

## Environmental policy de-risking: a matter of stability and policy integration

The core objective of environmental policy instruments is to create a business context conducive to markets for low-carbon goods, services, and technologies that will attract investors. Their de-risking dimension stems from their adequacy to the pursued objectives and their stability.

Historically, technical standards and norms have played a dominant role. Their first important field of application has been end-use equipment energy efficiency (e.g., miles/gallon or level of CO<sub>2</sub> emission per km)<sup>17</sup>. They also included building codes, retrofitting standards and, more recently, shares of renewable energies in the electricity supply, recycling rates and norms for construction materials.

These tools have been questioned repeatedly in economic literature since the early Nineties (Pearce, 1991; Barde, 1994) because they result from negotiation processes necessarily influenced by lobbying interests. Therefore, they cannot equate the marginal GHG emissions abatement costs throughout the economy and minimise the social costs of meeting a given environmental target. Another criticism is that they do not deliver the promised emission reductions because of the 'rebound effect', which means that in the absence of carbon prices, efficiency gains lead to cheaper end-use services and higher consumption of these services (Sorrell, 2009; Dimitropoulos et al., 2018). This typically occurs when more efficient heating systems allow for higher thermal comfort or when an annual CO<sub>2</sub> emission target for the entire fleet sold by vehicle manufacturers leads to increasingly efficient cars but does not limit the driven distance.

However, they continue to be extensively employed because they reduce uncertainty for the industry and accelerate learning by doing processes (Kahouli-Brahmi, 2009). They are also the only way to coordinate the emergence of competence networks fast enough to avoid technological lock-ins. For example, building codes are needed to avoid the lock-in of rapidly urbanising countries to poorly performing buildings that remain in use for the next 50-100 years (Ürge-Vorsatz et al., 2014).

Technical standards and norms are increasingly supplemented by a large set of financial incentives: RandD funding (battery and hydrogen technologies), public procurement of zero-emission vehicles, feed-in tariffs based on the quantity of renewable energy produced, energy savings (Bertoldi et al., 2013; García-Álvarez et al., 2017; Pablo-Romero et al., 2017; Ritzenhofen & Spinler, 2016), feebates and 'bonus-malus' schemes that foster the penetration of low-emission options (Butler & Neuhoﬀ, 2008), rebates on value-added tax (VAT) and trading schemes with Energy Savings Obligations (Haoqi et al., 2017) for energy retailers or Green Certificates for renewable energy portfolio standards (Upton & Snyder, 2017).

<sup>17</sup> In this domain, the existing diversity of command and control tools can be grouped in:

- End-use standards for domestic appliances, lighting, electric motors, water heaters and air-conditioners in OECD countries and, more recently, in developing countries (Brown et al., 2017; Scott et al., 2015). Mandatory efficiency labels often complement them to attract consumers' attention and stimulate the manufacture of more efficient products.
- Efficiency standards (e.g. miles/gallon or level of CO<sub>2</sub> emission per km) in the transport sector for light and heavy-duty vehicles. In the EU (Ajanovic & Haas, 2017) and the US (Sen et al., 2017), vehicle manufacturers must meet an annual CO<sub>2</sub> emission target for the entire fleet they sell.
- Regularly revised building codes (Evans et al., 2017) to increase their efficiency per unit of floor space. These codes are essential to avoid the lock-in of rapidly urbanising countries to poorly performing buildings that remain in use for the next 50–100 years (Ürge-Vorsatz et al., 2014) and in OECD countries to incentivise the retrofitting of existing buildings. In the context of a 1.5°C warming a new focus is placed on public and private coordination to better integrate building policies with the promotion of low-emission transportation modes (Bertoldi, 2017).

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On the supply-side, environmental policies are the first part of general legal and institutional reforms that ensure an appropriate supply of skilled labour, secure a social license to operate and reduce complex, inconsistent, or opaque permitting procedures.

Although some of these instruments have a neutral impact on public budgets by incentivising low-emission products and penalising high-emission ones (de Haan *et al.*, 2009), most of them come at a cost to industry, consumers or the taxpayer.

The limit of these instruments lies in the fact that the tighter the public funding constraints, the lower the political credibility of their maintenance over time. Combined with the difficulty of controlling opportunistic behaviours in subsidies, *this can lead public budget officers working under tight constraints and competing demands to lower the support to these measures or making their administration particularly complex.*

### Financial de-risking and blended finance

Financial instruments include direct public investment and public co-investment to de-risk private investment. De-risking instruments include concessional finance (grant, concessional debts), loan guarantees, deferred or income-contingent repayment, political risk insurance (PRI) and public equity co-investments. They are blended with private resources to reduce the high perceived and real risks faced by private investors in early-stage climate solutions and markets.

Blended finance is a structuring approach that allows organisations with different objectives to invest alongside each other while achieving their own targets. The main forms of blended finance include the provision of: (i) concessional capital (below-market terms finance) to lower the overall cost of capital to private investors; (ii) credit enhancement through guarantees or insurance to provide an additional layer of protection to private investors; and (iii) grant-funded technical assistance facilities that can be utilised for bidding and project development phases.

One lesson from the agency theory (Holmstrom 1979; Mirrlees, 2011) is that the optimal contract between a Principal pursuing a collective goal and an Agent involves a trade-off between risk sharing and incentives. If public budgets are the risk carriers in the last resort, one challenge is how they can play this role in a context where their position is fragile because of competing demands, and they must maximise the efficacy of every public money spent.

**Table 2.3** shows the main types of financial de-risking instruments as a function of the type of risks they tackle. The key information is that the *public guarantees are neutral vis-à-vis the type of risk*, including the ‘macro’ country risks (currency risks, political risks). This *broad coverage* is the reason why public guarantees have been increasingly proposed to cut the risk-premium of low-carbon investments (de Gouvello & Zelenko, 2010; Studart & Gallagher, 2015; Emin *et al.*, 2014) (Lee *et al.*, 2018; Schiff & Dithrich, 2017). The World Bank initiated a Partial Guarantee Scheme (Launay, 2016), and the Blended Finance Task Force (2018) called recently for the scaling up of these instruments.

TABLE 2.3 | FINANCIAL INSTRUMENTS AND RISKS (ADAPTED FROM BFTF (2018))

	MACRO		CREDIT / COMMERCIAL			TECHNICAL		FINANCE	INFRA
	Country risk	Currency risk	Credit worthiness risk	Liquidity risk	Demand risk	Construction risk	Operation risk	Access to capital	Lack of pipeline Off-take risks
1. PUBLIC GUARANTEES									
1B GUARANTEES									
2. INSURANCE									
3. HEDGING									
4. JUNIOR/ SUBORDINATED CAPITAL									
5. CONTRACTUAL MECHANISM									
6. GRANTS									

Insurances also de-risk these phases of the project life cycle. For example, were insurances for an infrastructure project in Africa, unlisted in the Solvency II framework, be backed on AAA guarantees, the corresponding reserve requirement would be reduced by 30% (Déau & Touati, 2017). However, the limit of insurances is that they entitle the issuer to review claims concerning events. They thus must be combined with guarantees that cover lenders or investors against payment defaults.

Contractual arrangements like power purchase agreements (PPA) are powerful instruments to reduce market risks through a guaranteed price and a guaranteed access to the grid. They can also provide favourable tariffs to increase return on investment. However, they do not tackle directly macro and credit-worthiness risks. Moreover, the credibility of a price premium on sales might be undermined by the policy uncertainty about the ability to maintain it under strongly pressured public budgets. Private actors and government officials may not have equally good information when prices for feed-in tariff programmes are initially set so they may turn out to be too high. This can erode support for the programme and lead to unnecessary public costs.

The same pressure on public budgets will be a constraint for sovereign concessional finance. The capacity of public institutions to provide concessional finance will depend on the fiscal situation of originating and receiving governments. Highly indebted governments might not be able to contract additional sovereign debt. Grant resources are by nature limited and cannot be deployed at scale to finance capital-intensive infrastructure work.

### Experiences and limits of financial de-risking and blended finance

Between 2012 and 2018, \$205.1 billion were mobilised from the private sector by official development finance interventions. The data show an upward trend over the period, with a significant acceleration between 2017 and 2018. Overall, guarantees catalysed the most of private finance (39% of the total), followed by direct

investment in companies (DICs) and syndicated loans, accounting for 18% of the total each (OECD, 2020).

While private finance was almost evenly distributed across the other regions, 96.3% of that mobilised through blended finance flows to countries with a credit rating that most low-income countries do not have. It primarily benefits high and middle-income countries, and catalyses investment mostly in mature technologies such as on-grid renewable energy (ODI, 2019).

Only 5.3% went to LDCs and other LICs. The role of guarantees was particularly important in these countries, as they mobilised 62% and 46% of the resources in 2015/16 and 2017/18 respectively. Direct equity investment followed, mobilising 14% and 24% of the resources in 2015/16 and 2017/18 respectively (ODI, 2019). However, blended finance has usually taken the form of relatively safe senior debt rather than guarantees and equity.

In terms of thematic distribution, 55.5% of the amounts targeted energy and financial sectors, and only 4% critical climate adaptation priorities such as agriculture and forestry (3.3%) and general environmental protection (0.7%). In terms of market creation, blended finance has leveraged so far limited private funds for low-carbon investments – less than 1:2 compared to a range between 1:3 and 1:15 for traditional public finance (BTF, 2018; Ward *et al.*, 2009).

*The geographic and thematic concentration of blended finance as well as the overall low leverage, are significant obstacles to tapping into the vast private savings pool to reduce the infrastructure investment gap in emerging economies.* On average, every \$1 of MDB and DFI resources leveraged just \$0.37 of private finance in LICs because of a poor investment climate (ODI, 2019). This observation calls for further efforts to tailor such instruments to low-income countries and the specifics of their climate management, as well as to better meet private investors' risk requirements. It will demand greater use of higher impact instruments, such as guarantees and equity, particularly for market creating investments in adaptation and nature-based solutions in nascent markets. It also shows the need to combine project-level financial de-risking instruments with market-level policy instruments to enhance the investment climate and improve the catalyst role of public resources.

One symptom of this limited use of high leverage instruments, such as guarantees and equity in blended finance, is the gap between the potential of green bonds, estimated at €29.4 trillion by 2030 (Bolton *et al.*, 2020), and the \$1 trillion only issued in the ten years since their launch (Climate Bonds Initiative, 2020). Only 50% of them are backed on sovereign and sub-sovereign guarantees.<sup>18</sup> As a result, the market for green bonds remains largely concentrated in developed and emerging markets, with the USA, China and France accounting for 44% of global issuance in 2019, and the increase in issuance in 2019 driven largely by Europe (CPI, 2020). Chapter 3 will examine how to unlock such markets in developing countries, so that they contribute to reduce the geographical mismatch of capital flows.

### 2.3.3. COMPLEMENTARITY BETWEEN MARKET FIXING AND MARKET SHAPING

In theory, market-fixing approaches can be embedded within broader market-shaping efforts (placing key market-fixing policies within measures directed at the demand side, see top line of table 2.2.) In practice, market-fixing and market-shaping approaches tend to emphasise different sub-sets of public instruments. Market fixing relies on price signals to create a demand for low-carbon low-climate-risk goods and services and shift financial flows towards climate-friendly investments. Market shaping intervenes

<sup>18</sup> <https://nordsip.com/2020/07/14/green-bond-issuance-to-recover-in-second-half-of-2020/>

at the level of sector policies and endeavours to create a demand and directly de-risk the supply of climate-friendly investments to crowd-in private finance. However, the above discussion shows that these two approaches are mutually supportive and should be deployed in tandem. The combination of the two sets of instruments helps overcome the constraints inherent to each approach and increase the overall efficiency and effectiveness of public policies and finance to accelerate the transition to net-zero climate-resilient economies.

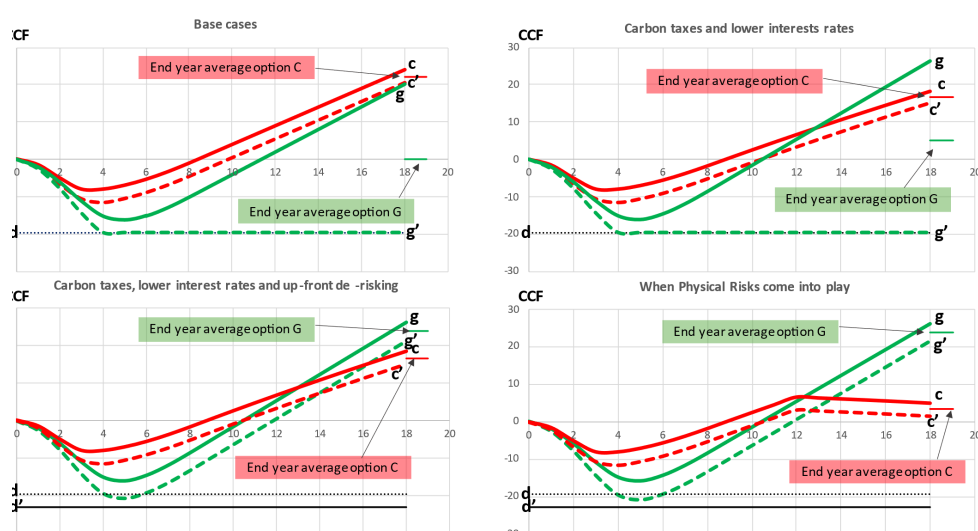
The four graphs below (figure 2.1) sketch the cumulated net cash flows over time of an archetypal conventional carbon-intensive project *C* and a 'green' low-carbon project *G*. The modelled policy impacts are magnified in many low-income countries, which face high financing costs, and for early-stage technologies.

In the North-West panel, the red and green curves show the net cash flow trajectories of projects *C* and *G* that make *G* economically non-attractive. Its higher net operating margins (lower purchase of fossil fuels) do not compensate for its higher capital intensity, particularly in developing countries with limited access to long-term and affordable finance. This is even more the case if, during the projects bidding, development and construction phases, a slippage in administrative and construction costs or a site delay causes the cumulative cash flows to pass the red and green dotted lines. The risk of slippage is comparatively higher for novel green technologies and practices. If the project initiator selects *C*, it will earn a lower net present value, but the extra costs will not threaten the project viability. If it selects *G*, it might be trapped in the dotted green line and touch the 'danger line' *D*, beyond which it will lose bankers' and shareholders' confidence when asking for additional support. It will then stop the project and lose its down payment with a potential higher penalty related to the drop of the enterprise value if not bankruptcy. A simple calculation of the expected yielded cash at the projects' end year (50/50 probability in the panel) will lead the investor to prefer *C* to *G*.

In the North-East panel, pricing and financial signals are used to tilt the balance in favour of *G*. A carbon tax penalises the conventional project *C* and shifts its cumulated cash flows down from the red curves while a lower interest rate for *G* reduces its debt service and moves its cumulated cash upward. This is the aim of Climate Disclosure, which prices the value of loans as an inverse function of their carbon footprint.

FIGURE 2.1

Impact of carbon taxes, lower interest rates, and up-front de-risking on the time profile of the cumulative cash flows (CCF) of Conventional and Green options



This is an illustration of the *green infrastructure microeconomic paradox*. Even though the net present value of *G* becomes higher than that of *C* thanks to the two market-fixing tools, project initiators might refrain from selecting *G* because of the upfront risks of extra costs. The relative advantage given by price and financial signals to project *G* comes too late and does not prevent the project initiator from touching the danger line *D*. The average value of the end year yielded cash of *G* increases but stays below that of *C*.

In the South-West panel, the market-shaping tools come into play. This panel shows their impact pushing down the danger line from *D* to *D'* through risk-sharing between project initiators, private finance and governments, such as public pre-funding to cover project development and bidding costs. It demonstrates the *complementarity of market-fixing and market-shaping approaches*. Indeed, unleashing project initiatives that would have been deterred upfront, the de-risking devices *reinforce the efficacy of the price and the financial signal*. Project *G* will benefit from the bonified interest rates and reach cumulated cash (*g'*) in the 'extra cost' case higher than the cumulated cash (*c'*) of project *C*. It will no longer be blocked at a shallow level in the North-East panel. As a result, its average end year cumulated cash will be higher than that of the conventional option.

The South-East panel sketches how the consideration of physical risks of climate change (extreme weather events affecting operations, supply chains, etc.) and transition risks (early retirement of carbon intensive infrastructures, products, services, etc.) reinforces the economic superiority of *G* if *C* is affected directly or indirectly through a reputational effect. The curves here are purely illustrative but show an interesting case, as the consideration of physical and transition risks is not enough to establish superiority in the absence of upfront de-risking. The average end year cumulated cash of the conventional option with and without over-costs does not differ much from the 'green' option in the North-East panel. In runaway climate scenarios, these risks will lead to *C* crossing the danger line.

#### 2.3.4. PAVING THE WAY FOR CLIMATE-FRIENDLY STRUCTURAL CHANGES OF THE FINANCIAL AND MONETARY SYSTEM

Arguably, the learning process triggered by a synergy between market-shaping and market-fixing tools to unlock climate-friendly projects might not go very far without fundamental financial and monetary reforms (Campiglio, 2016; Schoenmaker & Tilburg, 2016; Svartzman *et al.*, 2019, Bolton *et al* 2020)). The International Monetary Fund started to mainstream climate change into reflections about such reforms (Krogstrup & Oman, 2019).

*The cornerstone of such systemic reforms is that central banks recognise the climate remediation assets as collateral of debts.* This recognition cannot be disconnected from the basic rules for the issuance of money and international payment currencies, which explains the suggestions for a new Bretton-Woods agreement (Sirkis *et al.*, 2015; Stua, 2017). Many capital market-shaping proposals are made in this direction. They go beyond making compulsory the disclosure of climate-related information or taxonomies (EU TEC, 2020) and require changes of macroprudential regulatory rules. One of them is to change the Basel III guidelines on liquidity that encourage debt issuance to any activity, regardless of its emitting content, but discourage investing in long-term assets even with long-term negative interest rates of AAA countries (Campiglio *et al.*, 2018; Dikau & Volz, 2018). Others suggest imposing new prudential standards on banks and non-bank banks<sup>19</sup> (D'Orazio & Popoyan, 2019; Ryan-Collins, 2019). For example, the differentiation of minimum reserves and mandatory climate risk indicators included in the E&S assessment of the borrowers would push central banks

<sup>19</sup>These regulations can include leverage limits, liquidity requirements, contingent capital requirements, risk committees on non-bank banks, on the asset purchases of central banks injecting liquidity to maintain the cash position of firms in adverse conditions, on securities issuers, on commodities and derivatives markets and financial market utilities (regulation of market participants and swap dealers).



to re-purchase in a preferential manner debt based on climate-friendly asset classes (Honohan, 2019; Schoenmaker & Tilburg, 2016).

All these proposals give central banks and the IMF a more 'activist' role (Volz, 2017) to support the greening of the economy and play a developmental role through their regulatory oversight of money and credit. One difficulty is that this role can be perceived as violating the principle of neutrality of monetary policies concerning microeconomic decisions (Weidmann, 2020) and extend the central banks' mandates beyond their traditional core responsibility of safeguarding overall macroeconomic and financial stability (Dikau & Volz, 2018; McKibbin *et al.*, 2017; UNEP Inquiry, 2018). Such debates involve long-standing traditions about the independence of the banking system from political influences that differ between OECD and developing countries and even within the OECD<sup>20</sup>. The time needed to reach a robust consensus amongst these traditions and overcome the geopolitical obstacles makes significant monetary reforms incompatible with the urgency of climate action.

This does not mean that the reforms are not needed. It means that they are not a precondition for climate action, and one question to be explored further is to what extent *launching a circle of trust to scale up climate-friendly investments can pave the way for structural reforms of the financial systems for reasons other than climate risks*. This might occur because an immediate scaling up of low-carbon investment with high credibility could lead, without political interferences, to a recognition of the underlying assets by central banks in their interbank payments. The conditions for this evolution are discussed in 3.2. They include multilateral sovereign guarantees and projects assessed by standard rules, including a common notional value of avoided carbon emissions that Stiglitz *et al.* (2017) recommend in the absence of high enough explicit carbon prices. The emergence of assets recognised in such a setting might address the concerns of high-level policy-makers about the risks of political arbitrariness of central banks' management, which is crucial to reject the perspective of a move in theirs and IMF's mandates.

The rationale for exploring this perspective is that, contrary to the rational anticipation and efficient market hypothesis, this system is vulnerable due to the absence of a mechanism that automatically returns capital markets to equilibrium. The works on the link between financial intermediation, credit policies, financial cycles, and economic growth show that market finance amplifies economic fluctuations (Gertler & Kiyotaki, 2010). Unlike business cycles, where an excess or deficit of demand over production capacity triggers rebalancing mechanisms, the momentum of the financial cycles is driven by debt to buy assets that permanently re-appreciate until confidence vanishes and the cycle turnaround provokes their sudden devaluation (Jordà *et al.*, 2017; Jordà *et al.*, 2019).

Ultimately, scaling up climate-friendly investments and new asset classes recognised in the interbank payments would constitute a step towards a carbon-based reserve currency, which comes back to Keynes' position about common money for international trade based on an indicator of 'real wealth' (Jaeger *et al.*, 2013; Hourcade *et al.*, 2012).

<sup>20</sup>The first attempts to incorporate climate issues in macroprudential policies at a national level were conducted by the central banks of some developing countries: green credit allocation in Bank Bangladesh and India (RBI)<sup>220</sup>, differential reserve by Banque du Liban (2010) to allocate more credit into renewable energy and energy efficiency<sup>243</sup>; the process of capital adequacy assessment, which originates from Pillar 2 of the Basel II accords and requires commercial banks to take the exposure to environmental damages and risks into account (Banco Central do Brasil, 2017), the Green Finance Task Force initiated by the People's Republic of China in cooperation with UNEP Inquiry with the aim of promoting green bonds (PBOC and UNEP Inquiry 2015).



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## CONCLUSION

Understanding the basic principles of complementarity between upfront de-risking instruments, carbon prices and lower interest rates for low-emission options helps identify how to implement them over time given the political economy constraints on each of them. The end objective is to allow the deployment of innovative business models (Déau & Touati, 2017) that bring together public agencies and firms, local authorities, private corporations, professional cooperatives and institutional financiers in order to both reduce legal, engineering and overhead costs of projects and commoditise markets of low-carbon options from an investor point of view.

*The strategic role of upfront de-risking of low-emission projects is to unlock many low-carbon projects under current economic conditions, lower the carbon prices needed to tilt the economic balance in their favour and give the necessary time to set up enabling conditions for the deployment of market-fixing tools over time.* This is true for fiscal reforms capable to offset the adverse effects of higher energy prices, agreements on common assessment principles to ease voluntary carbon trading internationally<sup>21</sup> and the upgrade of the scope, credibility and effectiveness of climate financial disclosure.

The scaling up of climate finance could ultimately contribute to the emergence of a more robust financial system by hedging against the systemic risks of climate change and partially offsetting one of its endogenous sources of destabilisation thanks to the reduction of *'the gulf between what markets value and what people value'* (Carney, 2020).

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<sup>21</sup>Initiated by the UN Special Envoy for Climate Action and Finance, Mark Carney, the Task Force on Scaling Voluntary Carbon Markets released 20 recommendations. They include a) "Core Carbon Principles" (CCPs) and a taxonomy of attributes to ensure high integrity and market liquidity, b) core carbon reference contracts that can be traded on exchanges to concentrate liquidity and unlock its associated benefits, c) market infrastructure to ensure resilient, flexible markets that handle large-scale trade volumes transparently, d) strong guidelines and frameworks that improve the integrity of carbon markets, and e) support for a clear demand signal to drive the development of liquid markets and scaled-up supply.

# CHAPTER 3: SCALING UP CLIMATE FINANCE IN THE CONTEXT OF COVID-19

The main message from chapter 2 is that climate finance can help bridge the infrastructure investment gap with low-emission climate-resilient options that fulfil the objectives of the Paris Agreement and the Sustainable Development Goals. This can be achieved by embedding carbon pricing and disclosure mechanisms within a market transformation approach that removes barriers on the demand and supply of low-emission climate-resilient investments. This also helps build a safer financial system.

The Covid-19 crisis has brought the world to a crossroads in the fight against climate change. On the one hand, advanced economies are undertaking expansionary fiscal measures. Depending on the content of their recovery packages, the large amounts of cash injected into economies in the forthcoming years will either entrench our dependence on fossil fuels and put the achievement of the Paris Agreement out of reach or create the momentum to shift towards net-zero, climate-resilient and inclusive development for all. On the other hand, developing countries – already the most vulnerable to climate change – are suffering from an increasingly restricted monetary and fiscal space, which seriously undermines their capacity to finance mitigation and adaptation measures (Bayat-Renoux *et al.*, 2020).

As a result of the Covid-19 crisis, policy and financial decision-makers face two responsibilities that are in line with those identified in chapter 2: narrowing the investment gap by greening economic stimulus measures worldwide and facilitating access to long-term and affordable finance for developing countries to implement recovery packages without increasing their debt burden.

This chapter discusses the impact of the Covid-19 pandemic on climate action and highlights why climate investments can promote a robust and fair recovery from the crisis. It also recommends four concrete actions that enable developing countries to scale up climate finance in order to promote a climate-resilient recovery and realise their climate ambitions.

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## 3.1. COVID-19: THE WORLD AT A CROSSROADS FOR ECONOMIC AND CLIMATE SECURITY

### 3.1.1. THE IMPACT OF COVID-19, A SHOCK QUANTITATIVELY AND STRUCTURALLY DIFFERENT FROM THE SUBPRIME CRISIS

Responses to the Covid-19 pandemic have pushed the global economy into the deepest recession since World War II. Lockdown measures worldwide have affected an estimated 81% of the global workforce leading to unprecedented job losses and furloughs (ILO, 2020). The World Economic Outlook (IMF, 2021b) estimated a 3.5% contraction in global growth in 2020, far higher than the 0.1% recorded after the 2008 financial crisis.<sup>22</sup> Non-conventional monetary policies allowed the world GDP to almost immediately return to its pre-crisis level in 2009, even though the average growth rate for over a decade remained 0.5% lower than before the crisis. However, in the context of the Covid-19 crisis, the IMF predicts that the GDP of advanced economies in 2021 will be 6.1% lower than it would have been otherwise (IMF, 2020). The latest World Bank assessment (2021) confirms this trend with a 5% reduction, even allowing for the success of vaccination campaigns.

The Covid-19 pandemic has been particularly devastating for developing countries. During the subprime crisis, emerging and developing economies continued growing at a rate of 2.8% in 2008 (World Bank, 2021), whereas their GDPs in 2020 contracted by 2.6% and 5% respectively, China excluded (World Bank, 2021). In addition to the humanitarian impacts of the pandemic, these countries experienced sharp drops in commodity export prices, including oil prices, a collapse in tourism revenues, reduced exports to developed economies and supply chain blockages. This led to an increase in the number of people facing food insecurity from 135 million in 2010 to 272 million (WFP, 2020), a significant transfer of the employed population into 'inactivity' (ILO, 2020)<sup>23</sup> and 500 million additional people falling below the poverty line. The poverty increase, the first in thirty years, was particularly acute in Least Developed Countries (LDCs) and Small Island Developing States (SIDS) (Sumner *et al.*, 2020).

The Covid-19 crisis and the consequent dramatic drop in economic activity led to an 8% reduction of greenhouse gas emissions (2.6 GtCO<sub>2</sub>) from the energy sector in 2020 (IEA, 2020), which is more in absolute terms than in any other year on record (Boden *et al.*, 2017; Le Quéré *et al.*, 2018).<sup>24</sup> A global adaptive multiregional input-output model at constant GDP with lockdown and fiscal counter-measures is shown to lower global emissions by 3.9% to 5.6% in five years (2020 to 2024) compared with a no-pandemic baseline (Shan *et al.*, 2020). However, these scenarios come with high economic and social costs and are not compatible with sustainable development and poverty alleviation. Once lockdowns end, without government action emissions will rebound to an extent that depends on the speed of economic recovery and the nature of recovery spending (Hepburn *et al.*, 2020).

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<sup>22</sup> This shock is even higher than the 3.6% GDP fall of the Great Recession in 1932.

<sup>23</sup> Inactivity is distinct from unemployment as it includes people who are no longer looking for a formal job. This group increased by 6.3% in Latin America, 3.3% in Africa and 3.1% in East Asia. [https://www.ilo.org/wcmsp5/groups/public/-/-dgreports/-/-dcomm/documents/briefingnote/wcms\\_767028.pdf](https://www.ilo.org/wcmsp5/groups/public/-/-dgreports/-/-dcomm/documents/briefingnote/wcms_767028.pdf)

<sup>24</sup> An interesting comparison is that annual CO<sub>2</sub> emissions fell by an average of 4% during World War II (1939–45), 3% during the 1991–92 recession, 1% during the 1980–81 energy crisis and 1% during the 2009 global financial crisis (Boden *et al.*, 2017). The decline in 2020 is significant relative to major historical wars and epidemics (Pongratz *et al.*, 2011).

### 3.1.2. COVID-19 FISCAL RECOVERY: A GREEN, CLIMATE-RESILIENT STIMULUS ALSO ACCELERATES GLOBAL GROWTH

In order to stimulate the economy and mitigate the impact of Covid-19, governments are undertaking large-scale expansionary fiscal measures. The fifty largest world economies announced \$14.6 trillion in fiscal spending in 2020, of which \$1.9 trillion for long-term economic recovery (UNEP, 2021). There spending announced by advanced economies (22.5% of their combined GDP) is 17 times greater on a per capital basis (UNEP, 2021) than that of emerging markets and developing countries (10.6%). One of the key reasons for this disparity is the difference in the cost of additional debt. For most high-income countries, the cost of additional debt is close to 0% per year. For developing countries, with low credit ratings, interest rates are significantly higher, increasing the cost of any new debt and thus burdening and stretching fiscal budgets. In the next two decades, developing countries will build infrastructures that will influence their development path over the century (Hourcade & Shukla, 2013). The question is therefore whether the Covid-19 crisis will deprive them of the capacity to bridge their infrastructure investment gap, taking away options compatible with a low-carbon path, which are generally more capital intensive.

Before the Biden administration's recent proposals, McKibbin & Vines (2020) estimated that on top of the \$9 trillion of recovery packages already spent or promised by advanced countries, the optimal response to the Covid-19 crisis would be nearly \$2 trillion in countries that have not been able to put such rescue packages in place. But the content of these packages is not discussed and the question is whether green recovery plans will have a knock-on effect at least as strong as 'colourless' ones.

Governments' reflex might otherwise be to resort to a mix of quantitative easing monetary policies and recovery packages that will stay 'colourless' until the return to a growth rate that is deemed satisfactory (Hepburn *et al.*, 2020). Chapter 2 has shown that the response to the subprime crisis, combined with stricter regulation of the banking system, penalised risk-taking and long-term investment, including low-carbon investments. The impact might be worse with oil prices at historically low levels, creating a temptation to slow down the behavioural and structural changes required by the low-carbon transition.

Conventional economic discussions focus on whether the crowding out effect of 'green stimuli' on consumption and other sectors will be compensated by their spill-over effects. This framing is relevant if the economy is on a balanced growth pathway where there is no idle capacity, production factors are fully employed and inter-temporal financial intermediation is frictionless. In this case, the economic (Keynesian) multipliers are near zero. In contrast, during deep crises, economic multipliers of stimulus packages can be high (Hepburn *et al.*, 2020) since capital is idle, consumers underspend and labour skills are underutilised. Fiscal injections can then generate multipliers as high as 1.5 to 2 (Auerbach & Gorodnichenko, 2012) or even as high as 2.5 (Blanchard & Leigh, 2013). They can consist of a mix of investment funding and cash transfers to the most fragile households (Gechert & Rannenberg, 2018).

Together with public budget constraints and difficult access of some countries to international currencies, there are six reasons why the post-Covid-19 recovery packages might have smaller multipliers than the post-2008 packages:

- The economic shock of the current crisis is bigger and the uncertainty surrounding its near future is deeper, leading to more precautionary behaviours;
- The global stock of non-financial corporate debt (\$13.5tn at the end of 2019) is higher than during the global financial crisis (OECD, 2020);

- The lower quality of public and private debt threatens the stability of the banking system and of non-bank banks;
- Household demand is held back by restrictions on the spending opportunities of the upper middle classes (for example air travel<sup>25</sup>), job losses, furloughs (OECD, 2020) and precautionary behaviours;
- The global health scare saves and investors giving priority to safe rents over risky investments in productive activities. How this sentiment evolves will depend on the speed at which vaccination campaigns will reduce the effects of the pandemic and prevent new outbreaks.

Can climate-oriented packages overcome some of these obstacles and have a stronger and more certain knock-on effect? The IMF (2020) suggests that a global 'green stimulus' of 0.8% of GDP in additional fiscal spending annually between 2020 and 2030 would accelerate the emissions reduction path and boost global recovery by about 0.6% of GDP per year in the forthcoming years.

The reason why 'green stimuli' have potentially a strong knock-on effect is that the infrastructure sector represents a dominant share of the world's gross capital formation (Leduc & Wilson, 2017) and involves principally domestic industrial demand<sup>26</sup>. The IMF has long advocated for an infrastructure push (Abiad et al. 2014), and recent studies confirm the positive impact of transportation infrastructure investments after the 2008-2009 recession (Donaldson et al., 2016; Donaldson, 2018).

However, the strength of the green spending multiplier, compared with that of colourless recovery packages, depends on its funding modalities (tax, foreign debt, domestic borrowing) (Batini et al., 2021), the overall policy environment (fiscal reforms, sectoral policies) and the synergies with other priorities, including health, poverty alleviation and security<sup>27</sup>. It will therefore differ across countries.

<sup>25</sup> Air travel is a good indicator of these restrictions. After a 60% drop in air travel in 2020 (<https://www.icao.int/Newsroom/Pages/FR/2020-passenger-totals-drop-60-percent-as-COVID19-assault-on-international-mobility-continues.aspx>), the European Organisation for the Safety of Air Navigation, Eurocontrol, forecasts flights will return to 2019 levels only between 2023 and 2024 if worldwide vaccination is achieved in 2021, and will stay 8% below that level if global vaccination is achieved in 2022: <https://www.eurocontrol.int/covid19>.

<sup>26</sup> Some studies conducted with models representing a world economy on a balanced growth pathway present the modest incremental investment cost of climate policies as an argument in favour of green packages (Andrijevic, et al. 2020). This argument, grounded on the moderate incremental investment costs of climate friendly options, ignores the macroeconomic knock-on potential of reducing infrastructure investment in the context of an economic slump which is of the utmost interest for policy-making. At the macroeconomic level, because of their incremental investment costs, low-carbon options will have a higher knock-on effect than conventional infrastructure if they are funded through higher taxes or higher debt, but will reduce the volume of infrastructures that can be built within a given investment budget. The assessment by Batini et al. (2021) of a green spending multiplier about twice as high as that of conventional spending is very recent and requires further examination, but highlights real potential. Whether the benefits of the additional short-term knock-on effect will outweigh the drawbacks of higher investment costs over the medium and long term will depend on the ability of innovative climate finance architectures to reduce the infrastructure investment gap faster than in the present context.

<sup>27</sup> The concerned sectors are critical for social inclusion. Building efficiency spending for renovations and retrofits, including improved insulation, heating and domestic energy storage systems, can rapidly generate extensive employment opportunities, reduce energy vulnerability among the poor, and increase resilience to extreme weather events. Similarly, investment in the resilience and regeneration of water management ecosystems, including restoration of carbon-rich habitats and climate-friendly agriculture, will preserve livelihoods, while investment in shovel-ready low-emission, resilient infrastructure will protect people, jobs and assets.

### 3.1.3. COVID-19 STIMULUS MEASURES ARE NOT GREEN ENOUGH YET

Examining the fiscal stimuli of 41 countries, Shan *et al.* (2020) have shown that carbon-intensive packages would increase global emissions from 2020 to 2024 by 16.4% (23.2 Gt), while the 'greenest' package could reduce them by 4.7% (6.6 Gt) (2020). Forster *et al.* (2020) show that a 'colourless' recovery would put the world on an emissions pathway that would pass the 1.5°C threshold within a decade and the 2°C limit soon after 2050. The world has a 50% chance to stay below the 2°C warming target with a moderate green stimulus and below 1.5°C with a solid green stimulus.<sup>28</sup> The distance between these trajectories would not be a problem if switching from one of them to another could be done at low economic cost. But because of the long lifespan of energy, transport and building infrastructures, an abrupt change of course would be very expensive, which justifies early climate action (Grubb *et al.*, 1995; Ha-Duong *et al.*, 1997).

The UN Environment Programme (UNEP, 2021) finds that, in the 50 largest economies, only 18% of recovery spending and only 2.5% of total spending will enhance sustainability. In 2020, G20 countries spent \$208.73 billion supporting fossil fuel energy, compared with \$143.02 billion supporting clean energy.<sup>29</sup> Considering the relative size and green characteristics of recovery spending, Denmark, Finland, Germany, France, Norway and Poland were global leaders. Spain and South Korea also introduced comprehensive green packages. The South Korean 'Green New Deal' announced in July 2020 demonstrated a commitment to sustainable recovery. But Hepburn *et al.* (2020) estimate that only 4% of the G20 rescue measures are 'green' and have the potential to reduce greenhouse gas emissions in the long run, 4% are 'brown' and are likely to increase net greenhouse gas emissions beyond the base case, and 92% are colourless, maintaining the status quo. In March 2021, the US President signed into law a \$1.9trillion Covid-19 relief package.

### 3.1.4. WIDENING THE GEOGRAPHICAL MISMATCH OF CAPITAL FLOWS AND INCREASING DEVELOPING COUNTRIES' DEBT BURDENS

Since early 2020, governments and Central Banks have adopted monetary and fiscal policies involving an unprecedented level of private and public debt outside war times (365% of GDP according to Tiftik *et al.* (2020) towards the end of 2020). More than two-thirds of the debt is in private hands, and a failure in economic recovery could lead to a dramatic decline in equity valuations and asset values that would severely hit corporate balance sheets.

Efforts to revive economies and mitigate the impact of Covid-19 have led to a sharp increase in debt, by 19.3% in developed countries, 23.6% in emerging economies and 14.6% in low-income countries.<sup>30</sup> A basic economic principle is that new public debt, subject to efficient use of the received funds, is not a problem for a country if a) it can be repaid by the tax revenues of the additional economic growth generated by the investments it finances; b) creditors recycle interest revenue in the economy, which is partly a function of the share of the debt held by nationals; c) the new liability is balanced by assets of credible value in public balance sheets; and d) there is no difficulty in accessing international currencies to pay imports and debt services to foreign entities.

<sup>28</sup> This study does not describe the impact of the general equilibrium effect of such pathways on growth and population welfare through, for example, very high carbon prices. It describes the main elements of the behavioural and technical changes to be induced and its key message is that the degree of 'greenness' of the recovery packages makes a difference of 0.3°C in the 2050 average world temperature.

<sup>29</sup> <https://www.energypolicytracker.org/region/g20/>

<sup>30</sup> [https://www.imf.org/external/datamapper/G\\_XWDG\\_G01\\_GDP\\_PT@FM/ADVEC/FM\\_EMG/FM\\_LIDC](https://www.imf.org/external/datamapper/G_XWDG_G01_GDP_PT@FM/ADVEC/FM_EMG/FM_LIDC)

Because they meet these four conditions and some have the privilege of a currency recognised as a reserve, developed countries have a debt/GDP ratio twice as high in percentage points as that of emerging and middle-income countries, and 2.5 times higher than that of low-income countries. Public debt management is easier for them than for developing countries that do not have the same latitude to adopt a counter-cyclical package stimulating demand. The Covid-19 context has reinforced this constraint in developing countries for three reasons:

- **Drop of domestic public revenue:** the plunge in economic activity has significantly reduced their tax revenues and already limited domestic public resources. Trade declined by 13-32% (WTO, 2020) and international tourist arrivals fell by 60-80% in 2020<sup>31</sup>. Plummeting commodity prices disproportionately affect countries that rely more strongly on natural resource revenues. Taken together, fiscal balances in developing countries are expected to turn sharply negative, to -9.1% and -5.7% of GDP in middle-income and low-income countries respectively (United Nations, 2020). For sub-Saharan Africa, estimates suggest that government revenue could deteriorate by 12% to 16% compared with a non-Covid-19 baseline scenario (World Bank, 2021). At the same time, the Covid-19 shock necessitates large public spending on health, social protection and economic relief, as well as longer-term investments to maintain the recovery. The simultaneous divergence in available funds and the increase in spending needs amplifies the 'scissor effect' of sustainable development finance identified by the OECD (2021), which means that public debt in developing countries is likely to increase further and sizeably.
- **Decline in foreign currencies inflows from exports and external private finance:** the deterioration of commodity and fossil fuel exports (Mulder & Tooze, 2020) together with the fall of international tourism (UNWTO, 2020) created a dangerous 'currency scarcity' in many countries. Simultaneously, private finance inflows were expected to decrease by \$700 billion in ODA-eligible countries and remittances dropped by 20% compared with 2019 levels. During the two first months of the crisis, an exodus of capital towards countries perceived as more secure (\$100 billion according to the IMF) represented the largest capital outflow in history. While debt flows to emerging markets recovered in April and May 2020, outflows of equity have continued. Overall portfolio and investment flows are not expected to recover quickly as the Covid-19 pandemic is still ongoing, which could result in a second wave of outflows, according to the Institute of International Finance (IIF, 2020). Foreign direct investment (FDI) to developing countries also slowed down in 2020, with an estimated 35% drop, particularly in terms of equity (World Bank, 2020). This will most likely be compounded by lower equity to debt leveraging ratios for infrastructure in the coming years. Infrastructure projects often have higher levels of leverage than non-infrastructure investments, given lower cash-flow volatility. Debt instruments have historically comprised 70-90% of the total capitalisation of infrastructure projects in developing countries (OECD, 2016) whereas in high-income nations there are examples of private debt financing 100% of infrastructure projects. The increased risk perception could lead financiers to require higher equity investment to mitigate lending risks in a deteriorating macro-economic environment.
- **Solvency and liquidity crisis for SMEs:** SMEs account for over 60% of GDP and over 70% of total employment in low-income countries, when considering the informal sector.<sup>32</sup> The economic lockdowns caused by containment measures have reduced demand for their products and disrupted supply chains. Given their limited resources, SMEs can survive shocks over very restricted periods<sup>33</sup> and are more exposed to corporate insolvency than larger firms. According to a survey by

<sup>31</sup> <https://www.unwto.org/international-tourism-and-covid-19>

<sup>32</sup> <https://bassounigroup.com/smes-driving-growth-in-developing-countries/>

<sup>33</sup> Most small businesses in the United States are operating with fewer than 15 days in buffer cash and even healthy SMEs have less than two-month cash reserve. Federal Reserve Bank of New York (2020).



the International Trade Center (ITC, 2020) in 132 countries, one-fifth of SMEs are at risk of shutting down permanently within three months.<sup>34</sup> The SMEs sector collapse would reverse years of efforts to strengthen developing countries' capacity to invest in climate action.

Even though the G20 has suspended official bilateral debt payments from the poorest countries, freeing up about \$5 billion for 42 low-income states in 2020, poor macroeconomic conditions, including currency devaluations and increased perceived country risk, led to downgrades in sovereign credit ratings, increasing the interest rate spread and cost of public borrowing. We have seen above that at the low end of the creditworthiness ranking, more than 60 countries, rated below BBB in 2019 had only access to almost usurious rates for projects longer than two years. The list of countries in debt distress has grown since then and outright defaults have already begun (Bulow *et al.*, 2021) with substantial downgrades in sovereign credit rating.<sup>35</sup> Among the poorest countries (assessed using the Low-Income Country Debt Sustainability Framework), the proportion of those in or at high risk of debt distress has climbed to 55% in January 2021, from 50% in 2019 and 26% in 2013.<sup>36</sup> These countries have neither deep domestic financial markets nor excess savings. The conditions are such that some financially strapped countries are now hesitant to accept debt standstills for fear of jeopardising their credit ratings, creating issues long into the future. Notably, FDI greenfield investment, which is more important in developing economies than mergers and acquisitions, declined significantly over the first two months of 2020, and the announced inflows for such investments for 2021 are 60%, 51% and 38% lower than in 2019 in Africa, Latin America and Asia respectively.<sup>37</sup> There will not be a sustainable debt if such trends continue.

Developing countries will thus not be able to mount counter-cyclical climate investment paths since past experiences show that rising domestic taxes to balance public budgets slows down recovery and increases capital outflows. After the subprime crisis, macroeconomic policies did not prevent the GDP growth rates of Latin America and Low-Income Countries from falling from 3% per year and 6% per year respectively between 1997 and 2007 to 2.05% and 3.92% between 2009 and 2019. The situation might be worse in the post-Covid context because developing countries might also receive less help from the MDBs than after the subprime crisis. The World Bank, the African Development Bank (AfDB), the Asian Development Bank (ADB) and the Inter-American Development Bank (IADB) increased their total lending by \$46.4 and \$42.9 billion in 2009 and 2010 (compared with 2008) against \$18.2 billion and \$20.1 billion only in 2020 and 2021 (compared with 2019) (United Nations, 2021). Actually within this total, LDCs received a higher support than after 2008. This is the case for the World Bank's IDA commitments (an increase of 40% in 2020 against 26% in 2009), for the AfDB's concessional window, which is expected to reach its \$3.0 billion target, and for the ADB due to significant lending room gained from the merger of its concessional and non-concessional windows in 2017. But financial capacity constraints are limiting MDB countercyclical support for middle-income countries.

<sup>34</sup> A 2020 study by the London School of Economics found even more pessimistic results for financially fragile countries (Gambia, Greece, Mongolia, Myanmar, Nicaragua and Zambia), with four out of five firms at risk of falling into insolvency (<https://blogs.lse.ac.uk/businessreview/2020/09/08/firms-in-emerging-markets-fall-to-covid-19/>).

<sup>35</sup> The observed trends suggest an increasing discrepancy amongst developing countries with a return to positive yield curves of market assets in East Asia, [https://www.bis.org/publ/qtrpdf/r\\_qt2103.htm](https://www.bis.org/publ/qtrpdf/r_qt2103.htm)

<sup>36</sup> World Bank LIC DSF database.

<sup>37</sup> Investment trends monitor : [https://unctad.org/system/files/official-document/diaeiainf2021d1\\_en.pdf](https://unctad.org/system/files/official-document/diaeiainf2021d1_en.pdf)



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The World Bank's International Bank for Reconstruction and Development (IBRD) loan commitments for middle-income countries are estimated to have increased by only 36% in 2020, compared with a 145% increase during its response in 2009. Similarly, AfDB lending through its non-concessional window is hampered by financial constraints and expected to fall compared with 2019. The situation is similar for IADB, whose 2020 response is also lower than its response to the global financial crisis (United Nations, 2021).

If these pessimistic prospects materialise for a significant number of developing and emerging economies, OECD countries will fail to recover full employment even using robust rescue and recovery packages. In the absence of a dynamic demand from developing countries (55% of the world markets, China excluded), these packages might deepen the gap between the propensity to save and the propensity to invest worldwide. The combination of yields falling because of expansionary monetary policies, an impressive increase of households saving rates<sup>38</sup>, and persistent risk-averse corporate saving trends (Demary *et al.*, 2021) are indeed the key ingredients of a 'saving glut' whereby high-income people refrain from financing productive investments (Mian *et al.*, 2020; Chen *et al.* 2017). Lowering the risk perception of such investments is a matter of domestic public policies but will not be achieved without a conducive international context.

Unconventional monetary policies such as debt cancellation, debt swaps and issuance of new special drawing rights (SDRs) (Gallagher *et al.* (2020) are currently envisaged to avoid economic collapse in many countries. They are being discussed, but a major difficulty is the cascading effect they will have on the world economy and the financial system. Large-scale economic stimulus packages from OECD countries pump trillions of dollars into the global financial system and lead to a series of asset price bubbles that could burst soon and undermine financial stability if the liquidity is not invested productively. The way out is to direct part of the additional debt where the greatest needs are, including low-carbon investments (Bulow *et al.* 2021).

Chapter 2 has shown that well-designed climate investments can create this redirection by lowering the investment risks coefficient in developing countries. Such risks currently prevent the flow of capital to solve the geographical mismatch and restrict access to the largest greenhouse gas emissions abatement opportunities and corresponding markets. The challenge is then to convince the climate-agnostic decision-maker that these basic principles can be enforced and will ensure that any new payment facility will use money efficiently to create jobs and economic wealth in the short term. The following section examines this challenge.

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<sup>38</sup> This increase of savings rates results from the fact that high and upper-middle income households could not access certain forms of leisure consumption (restaurants, travels, cultural events) and that the middle class adopted precautionary savings behaviors. Although data are not consolidated, they show a clear trend. The European Union statistical office Eurostat has shown (own calculations) that the average increase in savings was about 7% over the three first quarters of 2020 in the EU, representing a 56% increase by comparison with the previous year (<https://ec.europa.eu/eurostat/fr/web/products-eurostat-news/-/ddn-20210202-1>). In the US, after a peak of +24% in April 2021, the average savings increase was 10% between April and December (still 12% in January 2021) representing a 130% increase compared with 2019 (<https://tradingeconomics.com/united-states/personal-savings>).

## 3.2. IMMEDIATE ACTIONS FOR A CLIMATE-RESILIENT COVID-19 RECOVERY IN DEVELOPING COUNTRIES

The economic and financial impacts of Covid-19 have exacerbated the four pre-existing challenges facing developing countries to scale up climate action. In order to address these challenges, developing countries will need to ensure that climate action and economic recovery are mutually supportive, scale up investment without increasing their debt burden, attract large-scale private financial flows in a context of perceived higher investment risk, and secure access to long-term affordable finance at a time of rising capital costs.

This can be achieved through a set of four complementary actions: (i) integrating policies on climate action, sustainable development and Covid-19 stimulus measures to minimise incremental investment requirements and optimise development co-benefits; (ii) alleviating developing countries' debt burden to create fiscal space to finance their green, climate-resilient recovery plans; (iii) leveraging sovereign and multi-country guarantee funds to reduce investment risk and catalyse private finance; and (iv) increasing developing countries' access to the green bond market.

### 3.2.1. POLICY: INTEGRATING CLIMATE, SUSTAINABLE DEVELOPMENT AND COVID-19 STIMULUS MEASURES

Nationally Determined Contributions (NDCs) are at the heart of the Paris Agreement and countries' commitment to transform their development trajectories. Countries are currently in the process of submitting updated and more ambitious NDCs. This process will culminate at the 26<sup>th</sup> session of the Conference of the Parties (COP 26) to the UNFCCC in November 2021 in Glasgow. This section discusses how the next generation of NDCs can promote integrated policy planning and support the development of investment plans that identify the right sources of finance and the opportunities to combine and sequence different sources of finance.

#### Leveraging NDCs to promote integrated policy planning between climate action, sustainable development and Covid-19 recovery measures

One pervading message throughout this report is the importance of integrating sectoral policies, adaptation measures, mitigation action and Covid-19 recovery stimulus (Fankhauser & McDermott, 2014; Morita & Matsumoto, 2015; Adenle *et al.*, 2017; Sovacool *et al.*, 2015; Sovacool *et al.*, 2017; Peake & Ekins, 2017).

An illustration of the gains deriving from policy integration is given for a 2°C scenario that also meets the targets of SDGs 6.1 (drinking water) and 6.2 (sanitation and hygiene). They find that the total annual infrastructure investment of low- and middle-income countries in energy, transportation, water supply, sanitation, flood protection and irrigation should amount to \$2.7 trillion/year over the next 15 years, under current decision-making practices and fragmented policies, against \$1.5 trillion/year only in case of policy coordination. For the sole investments that are critical for adaptation (water supply, sanitation, flood protection and irrigation) the reduction would be from \$0.66 trillion/year to \$0.35 trillion/year.

Similarly, integrating macroeconomic policies, debt management and sectoral 'green' packages will maximise the knock-on effect of recovery strategies and their development side-benefits. For example, investment in energy efficient buildings can generate large employment opportunities, reduce energy poverty and increase resilience to extreme weather events. Investments in climate-resilient agriculture and water management will preserve livelihoods and foster ecosystem restoration while

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investment in shovel-ready low-emission, resilient infrastructure will protect people, jobs and assets.

However, at the domestic level, policy-making is typically split across different government ministries, e.g. ministries of environment are responsible for developing and updating NDCs, ministries of planning are responsible for national SDG plans, and ministries of finance for economic stimulus packages and creditworthiness concerns. Experience from the first NDCs has shown that they were often siloed in environment ministries with weak alignment with national, sectoral and sub-national development planning (Riva *et al.*, 2020).

### Translating NDCs into investment plans

NDCs and national SDG plans are often designed as policy signals for national priorities, rather than portfolios of bankable investment projects. Few countries have completed their NDC financing plan (Cooke *et al.*, 2018) due to the lack of clarity on what these plans should look like and a poor understanding about the financing mechanisms available for NDC implementation. As a result, priorities expressed in NDCs are too numerous and/or too abstract to guide investments grade project development at the national/sub-national levels. This is a major obstacle to attracting the right mix of finance and using scarce public resources to catalyse private funds for climate investments with high socio-economic co-benefits.

In addition, the domestic financing landscape is complex and fragmented. Institutional partners, including international development agencies and banks, tend to have their own country strategies and programming documents to identify investment priorities and different focal points in line ministries. Similar challenges also emerge at the sub-national level, where there is often no structured engagement or coordination mechanism dedicated to municipalities for climate investment decisions.

There is a need to translate integrated NDCs into investment plans that:

- Align, combine and sequence multiple sources of international and domestic finance from the public and private sectors;
- Enable countries to take a more integrated value-chain investment approach, notably by acquiring the technical capacity needed to address policy and regulatory gaps in order to improve the bankability of the NDC project pipeline; and
- Identify financial mechanisms and investment patterns that will not increase sovereign debt, but catalyse private funds and increase access to long-term affordable finance.

This need is amplified in order to green Covid-19 recovery efforts.

Developing NDC investment plans can take place as part of countries' efforts to update their NDCs or increase their access to climate finance. **Box 3.1** highlights the Government of St. Lucia's efforts to develop and implement an NDC Financing Strategy to realise its climate and sustainable development ambitions without increasing its debt burden.

Translating NDCs into investment plans can also take place as part of a country's broader effort to finance its national sustainable development strategies. In line with the Addis Ababa Action Agenda, countries are beginning to design integrated national financing frameworks (INFFs). INFFs set out the national financial landscape and coordinate efforts to mobilise and align a wide range of financing sources with the country's sustainable development priorities (United Nations, 2019).

Consistent with the INFF process, such policy integration and the development of NDC investment plans can be achieved through high level inter-ministerial coordination mechanisms that also bring together institutional partners and financiers. Such mechanisms would create opportunities to jointly identify climate friendly investment priorities, map different sources of finance and strengthen synergies between public domestic resources, public international finance, including through direct budgetary support (DBS), and private finance. Identifying priority investments should also reflect the impact of non-action and how climate change may affect countries' macroeconomic stability and development objectives. Priority investments could be duly costed and translated into a pipeline of bankable projects. Contributions from public resources (domestic and international through DBS) can then be integrated in annual budgets via Medium-Term Expenditure Frameworks (MTEFs) and Public Investment Programming (PIP), which create regular timeframes to embed climate investments as part of national domestic spending plans and processes. This in turn would enable institutional partners and private sources of finance to align their investments with national climate friendly investment priorities.

Within this context, a key responsibility of the international community is to reduce the fragmentation of the current climate finance (Watson & Schalatek, 2020) and enable synergies between different sources of finance.

### **BOX 3.1: SAINT LUCIA MOBILISES INTERNATIONAL CLIMATE FINANCE AND PRIVATE INVESTMENT FOR LOW-CARBON DEVELOPMENT<sup>39</sup>**

Saint Lucia, like all Small Island Developing States, is deeply affected by the impacts of climate change. The Government is committed to global efforts to reduce greenhouse gases and has pledged in its NDC to reduce the country's emissions by 23% by 2030. The achievement of Saint Lucia's NDC targets is conditional upon external financing. While international climate finance and ODA offer some relief to Saint Lucia's growing debt-to-GDP ratio, the decreasing level of international aid undermines the long-term sustainability of this approach. Saint Lucia faces a number of barriers, including limited fiscal space and limited access to long-term, affordable finance due to high interest rates – averaging 7.7% in 2019 – and collateral requirements. Enterprises also lack capacity and a track record in climate mitigation projects.

In order to address these barriers, the Government is striving to increase access to climate finance and develop new and innovative mechanisms to de-risk mitigation projects and attract private sector investments. The Government's strategy sets out a target of \$218 million in mitigation investments provided by the private sector by 2030, 90% of the total. In order to achieve this target, the Government has embarked on the development of an NDC Financing Strategy which proposes specific actions aimed at increasing and accelerating private sector participation, particularly for the development of commercial mitigation projects. The strategy includes:

- Accessing the green bond market by exploring their issuance and advancing go-to-market and pre-issuance activities, including the development of a Green Bond Roadmap and Green Bond Framework.
- Developing and implementing a 'debt for climate swap strategy and roadmap' by assessing Saint Lucia's public finance policy and external debt to assess readiness for

<sup>39</sup> Government of Saint Lucia; Global Green Growth Institute (2021). *Readiness and Preparatory support proposal – Mobilizing international climate finance and private investment for low-carbon development in Saint Lucia*.

a swap transaction, supporting engagement with priority creditors, identifying eligible projects, and developing an appropriate governance, monitoring, and reporting mechanism.

- Greening Saint Lucia's financial sector by strengthening the capacity of local financial institutions to understand environmental and social risks and benefits, integrate environmental and social standards into processes and procedures, and develop green credit instruments.
- Increasing the Government's capacity to implement public-private partnership projects by developing a web-based step-by-step public-private-partnership (PPP) toolkit to be used by

### 3.2.2. ALLEVIATING THE DEBT BURDEN OF DEVELOPING COUNTRIES TO CREATE FISCAL SPACE FOR A GREEN, CLIMATE-RESILIENT RECOVERY

The sharp increase in developing countries' debt level due to the Covid-19 crisis creates a vicious cycle, whereby these countries have almost no fiscal space to spend on economic recovery and climate action. The situation is especially critical for 55% of the poorest countries which were in or at high risk of debt distress in January 2021. For example, Fiji, a small island developing state that is highly vulnerable to climate change, has reduced government allocations to climate related projects by 32% in 2020<sup>40</sup>. Several multilateral actions are being taken to support developing countries coping with the economic crisis and create more fiscal space. The G20 has suspended – not cancelled – official bilateral debt payments for 42 low-income countries, corresponding to approximately \$5 billion. MDBs collectively announced over \$200 billion of support to developing countries (United Nations, 2021). The IMF will present by June 2021 a formal proposal to the Executive Board on a new Special Drawing Rights (SDR) allocation of \$650 billion to help meet the global long-term need to supplement reserves and boost liquidity (IMFb, 2021). However, a similar initiative taken by the G20 in 2009 for an amount of \$250 billion was blocked by the lack of easy country allocation rules and by the fear that greater payment facilities would lead to a lax selection of projects and generate windfall profits. These obstacles might still prevail today.

Even bolder action is 'debt-for-climate swaps', a partial cancellation of debt by the creditor government transforming the remaining part into local currency and directing it to investment in climate action. The level of debt reduction could be a function of a country's overall climate vulnerability. Many forms of debt swap for development and environment have emerged since the 1980s. They have proven to alleviate the fiscal pressure of debt repayment, improve macroeconomic stability, generate long-term, stable streams of revenue for environmental projects, and help build capacity in managing public environmental expenditure. However, such swaps have to date resulted in relatively small amounts of debt relief, limiting their impact on the overall debt burden. Their use has been limited for two reasons. First, they are complex to design and tend to require long legal negotiations and technical assistance to support reviews of countries' policies and legislative frameworks, and formulations of contractual agreements between debtor and creditor countries.

<sup>40</sup> <https://www.wri.org/profile/michael-westphal>

Early debt-for-environment swaps were negotiated by environmental NGOs, which did not always have the resources to implement large-scale programmes. Second, experience has also shown that such swaps require a pipeline of high-quality bankable climate investments which can be capitalised in the form of credible assets and supported with transparent and credible domestic spending.

Both 'debt-for-climate swaps' and the issuance of new SDRs, or any form of unconventional debt relief, will be scaled up and generate development and climate benefits if they credibly target the countries' infrastructure gap. Low-carbon climate-resilient options are interesting in terms of credibility as they can link the impact of mitigation and adaptation action to clear metrics (e.g. avoided emissions and number of people benefiting from increased resilience), designed using transparent assessment methods suggested below<sup>41</sup>.

These unconventional debt management instruments (debt-climate swap, debt suspension or cancellation, SDRs) respond to the specifics of the post-Covid-19 context and are additional, not alternative to the commitment of developed countries to mobilise \$100 billion in climate finance per year by 2020 for developing states. Reaching the \$100 billion commitment is critical to finance essential non-market services as well as the deployment of environmental policy instruments to create a conducive business context to catalyse low-carbon, climate-resilient private investment.

These commitments, formalised at the 16<sup>th</sup> Conference of the Parties of the UNFCCC in 2010, are central to the climate accords but have not been fulfilled so far even though they have been on an upward trajectory before 2020<sup>42</sup>. They are also pivotal to restoring a circle of trust and creating an enabling environment by de-risking market-creating investments in early-stage climate-friendly options (see Chapter 2). Connecting the \$100 billion target with access to new debt facilities and debt reliefs programmes would be an extremely powerful way to foster a green and inclusive economic recovery from the Covid-19 crisis both in developing and developed countries. However, according to a recent assessment by an independent group of experts, it is unlikely that the 2020 \$100 billion target will be reached, despite year-on-year progress between 2015 and 2018 (Bhattacharya *et al.*, 2020). A concerted increase of the effort is therefore needed to bolster climate finance in 2021. The question is how to shape this concerted action at a short notice.

### 3.2.3. SOVEREIGN, SUB-SOVEREIGN AND MULTI-SOVEREIGN GUARANTEE FUNDS TO REDUCE PERCEIVED INVESTMENT RISK

Chapter 2 has explained why sovereign and sub-sovereign (local governments) guarantees are increasingly recognised as one of the major blended finance mechanisms to overcome the barriers hindering climate-friendly investments. They reduce upfront risks while providing a broad risk coverage, a lower cost for the public budgets of donor countries and a high leverage ratio of public to private capital (BTFE, 2018). Chapter 2 also explained why there is a 'glass ceiling' limiting their scale-up by MDBs (Gropp *et al.*, 2013; Lee *et al.*, 2018; Schiff & Dithrich, 2017).

<sup>41</sup> In the context of Covid-19, Westphal and Liu (2020) have argued for a climate-health debt swap programme which would include measures to foster resilience in the climate and health systems and spending that achieves health benefits by reducing air pollution from the burning of fossil fuels. Currently about 4.2 million people die prematurely due to ambient air pollution. Simultaneously addressing climate and health needs is consistent with many countries' NDCs. Westphal and Liu also recommend using climate change trust funds to increase accountability. In the Time of COVID-19, China Could Be Pivotal in Swapping Debt for Climate and Health Action by Michael I. Westphal and Shuang Liu, November 04, 2020

<sup>42</sup> Climate finance counting towards the \$100 billion had been on an upward trajectory, but falls short of the \$100 billion per year by 2020 target. Based on the most recent OECD assessment, total climate finance counting towards the \$100 billion reached \$78.9 billion in 2018 compared with \$71.2 billion in 2017. Although the Biennial Assessment of the UNFCCC will only be released in 2021, it will likely reflect similar trends given the commonality of the underlying data



Sovereign guarantees might circumvent this obstacle but their use in finance related to overseas aid suffers from a mix of historic finance agencies' inertia, perceived loss of control over the use of funds (compared with direct project-based financing), and politics around fiscal accountability at home. To address these challenges, many proposals have emerged for multilateral guarantee funds: Green Infrastructure Funds (de Gouvello & Zelenko, 2010; Studart & Gallagher, 2015), Multilateral Investment Guarantee Agency (Enhanced Green MIGA) (Déau & Touati, 2017), guarantee funds to bridge the infrastructure investment gap (Arezki *et al.*, 2016), and multi-sovereign guarantee mechanisms (Dasgupta *et al.*, 2019). These proposals have in common the search for a credibility-enhancing effect provided by multilateral arrangements on capital markets for both donor and host countries. Such an effect would overcome the lack of familiarity by public administrations with guarantees outside major projects and programmes. On the one hand, unlike multi-year budgetary commitments, pre-commitments within multi-sovereign guarantee architectures do not depend on annual legislative approvals, which can be problematic given taxpayers' fiscal conservatism (Peltzmann, 1992). On the other hand, they would support a learning process about agreed-upon assessment and monitoring methods to strengthen, at low transaction costs, the environmental and economic credibility of green investments and financial products. They could also accelerate demand for science-based assessment tools.

In addition, a primary factor enhancing the credibility of multi-sovereign guarantees is the ability of the system to deliver immediately tangible reciprocal gains, thus securing their continuation over time despite competing demands for public support in all countries. The leverage effect of the Junker Plan in Europe, for example, has been estimated at 1 to 15. Even if such a ratio is not systematically reached, multi-sovereign guarantees are still efficient in mobilising domestic and international resources from financial institutions, asset managers and institutional investors at a low cost and with longer maturities.

Guarantor countries can compensate the public cost of their commitments with the fiscal revenues of induced exports. Only a percentage of the guarantees has to be set aside as a potential loss given the default risks, and it can be easily balanced by the positive impact of investments on tax revenues through exports. This depends on the country's foreign trade multiplier, i.e., the increase of a country's national income generated by a unit increase of its exports. USAID's extensive experience on a global guarantee fund for SMEs (known to be generally risky) over 1999-2017 shows a default rate as low as 2.4% (USAID, 2017). As to the host countries, they would benefit from new capital inflows and the grant equivalents of reduced debt service which might potentially go far beyond \$100 billion per year (Hourcade *et al.*, 2021).

The overall economic efficiency of the system would be higher with guarantees calibrated on an agreed notional value of the avoided tonne of emission (Stiglitz *et al.*, 2017). This value would express the "social, economic, and environmental value of mitigation actions [and] their co-benefits" (Article 108 of the Paris Agreement decision). It could be part of the assessment process discussed below, which is critical for the credibility of any climate-friendly financial architecture.

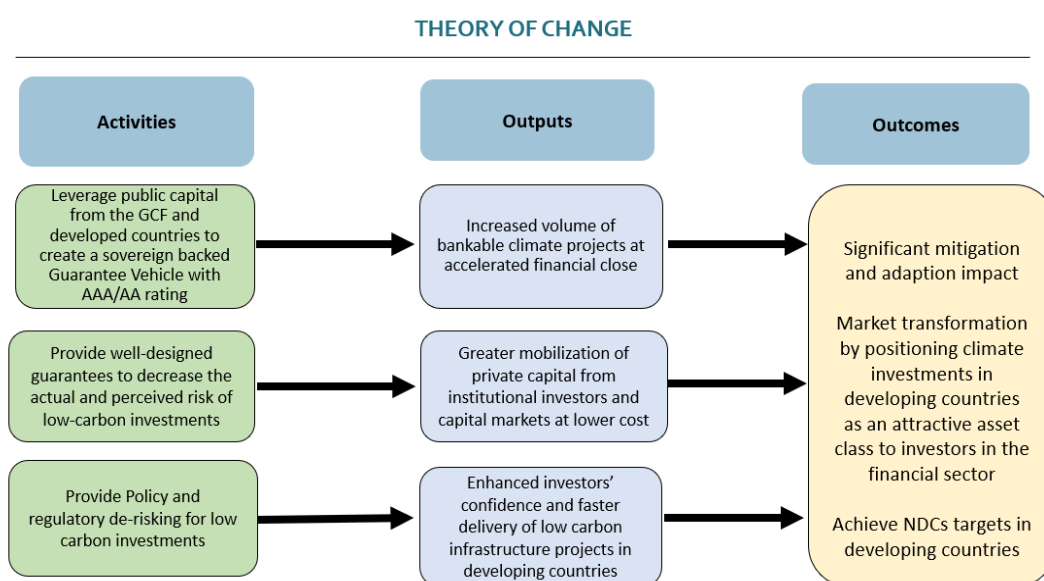
Multi-sovereign guarantees, where developed countries rated AAA-AA join forces to provide an AAA-AA backing to developing countries, thus provide a number of advantages. These include:

- *Expanding developing countries' access to capital markets at a lower cost and longer maturities* thanks to the reduction of creditworthiness risks, especially for

small states<sup>43</sup>. This also avoids the Basel III's liquidity impediment and the EU's Solvency II directive on liquidity (BFTF, 2018).

- **Accelerating the recognition of climate assets suitable for institutional investors seeking 'safe investments havens'**, thanks to the reputational effect of a selection of projects with multilateral backing and transparent assessment methods.
- **Strengthening climate disclosure** through high grades in the environmental notation of these climate assets. This would minimise the risks associated with the 'greening' of the portfolios by divesting from carbon-intensive activities for investing in 'carbon neutral' activities and not in riskier low-carbon infrastructures.
- **Increasing the effectiveness of carbon pricing** with more mitigation activities unlocked by a given price level, a stronger employment impact and higher funding facilities to help industries adapt. This would not remove the need for fiscal measures to accompany the increase of carbon prices, but it would make them lighter because they would have to offset the adverse effects of lower prices for the same emissions objective.
- **Freeing up grant capacities for SDGs and adaptation** by crowding in private investments for mitigation. For non-marketable activities, grants are the key instrument to develop policy and capacity and establish a conducive investment environment that deals with risks.

**FIGURE 3.1 BELOW PROVIDES AN OVERVIEW OF A THEORY OF CHANGE OF A POSSIBLE MULTI-SOVEREIGN GUARANTEE FUND.**



**Figure 3.1**

<sup>43</sup> Any loan or bond will be first recorded as an additional national debt. The question is whether credit rating agencies will consider this debt to be justified by expected fiscal revenues of induced growth and the built infrastructure's value as collateral, thanks to the recognition of new asset classes by capital markets. This is important for small and less developed economies with greater reliance on imported techniques and technical and organisational assistance. The creditworthiness risks come less from the absolute level of public deficit than from the share of debts held by foreigners, from the total public and private debt of the country and its capacity to get foreign currencies for its external payments.



### 3.2.4. INCREASING DEVELOPING COUNTRIES ACCESS TO THE GREEN BOND MARKET

De-risking low-carbon and climate-resilient investments is a necessary but not sufficient condition to reduce the mismatch between where the savings are and where they should be directed to for a 'green' recovery. Due to their cash profile and long lifespan, infrastructure investments tend to require financial backing for around 15-20 years, whereas (see chapter 2) the tighter regulations introduced after the subprime crisis have reduced the long-term risk appetite of banks and institutional investors. These regulations resulted in a preference for shorter loan maturities (5 to 8 years) and more secure assets. In 2015, only 5% of assets held by pension funds and public reserve funds were backed by infrastructure (OECD, 2017). Covid-19 has compounded this risk aversion.

It is also necessary to transform climate-friendly infrastructures into recognised asset classes to remove this barrier. Climate-resilient infrastructure as an asset class is needed to back the issuance of green bonds that can mobilise institutional finance at scale, respond to the needs of many actors in the low-carbon transition, and preserve the stability of the financial system (see box 3.2). The potential of green bonds, estimated at €29.4 trillion over 2030 (Bolton *et al.*, 2020), has the potential to create new public-private partnerships and increase developing countries' access to long-term affordable debt. However, as noted in chapter 2 in the assessment of blended finance to date, the development of green bonds is far below this potential (only \$1 trillion in the ten years since their launch and \$258 billion in 2019, Climate Bonds Initiative, 2020). They represent about 5% of total bonds issued globally and fell by 11% in 2020 in the aftermath of the pandemic. At the same time, governments and development banks globally have been actively issuing bonds to provide immediate relief amid the devastating impacts of Covid-19. In the first seven months of 2020, sustainable bonds issuance surpassed \$270 billion, up by 5% from 2019. This includes the issuance of 'pandemic bonds' largely driven by China (CPI, 2021) but no significant increase of 'green' bonds.

#### BOX 3.2: THE IMPORTANCE OF NEW CLIMATE RESILIENT ASSET CLASSES TO PRESERVE THE STABILITY OF THE FINANCIAL SYSTEM

In addition to its potential to unleash public-private partnerships and increase access to long-term affordable debt finance in developing countries, the creation of new asset classes for climate-resilient infrastructure is essential for:

- Project developers, as the recoverable assets enter the calculation of the project's net present value and can serve as loan collateral.
- Economic actors whose capital value could also collapse. These are not only the firms engaged in fossil fuel extraction, fossil fuel-based power and heat production, but households whose floor space is reduced by insulation works, the transport sector, energy-intensive manufacturing, food production, animal husbandry and forestry.
- Actors of the financial system (pension funds, insurance companies and asset managers) whose ability to meet their obligations might be impaired. They would consequently reduce their services (e.g. risk coverage by insurances) with detrimental effects for both mitigation and adaptation activities.
- Countries and regions highly dependent on fossil fuels, whose development capacity will be undermined by significant losses due to stranded assets. Their engagement in the

low-carbon transition depends on access to climate remediation assets to finance the industrial conversion.

- Host countries of any loan or bond as any new debt will be first registered as a liability on their public accounts, posing creditworthiness risks. These risks can be offset if new and credible asset classes emerge that can be registered on the asset column.
- Regulators, as financial products across asset classes backed by certified projects would increase liquidity and reinforce the efficacy of climate disclosure and taxonomy approaches.

Several initiatives are ongoing to broaden developing countries' access to the green bond market (see **Box 3.3** for the example of Jamaica). This requires (i) creating credible and standardised assessments and valuation methods to select, monitor and report on high-quality bankable climate projects; and (ii) developing the capacity to design, float and implement green bonds. Details across these two elements are discussed below.

### Project assessment and valuation methods

A pipeline of high-quality, bankable climate projects is a precondition for a strong bond market. On the part of institutional and impact investors, concerns around climate impact and possible 'greenwashing', as well as the risk of default, can prove major obstacles to scaling up green bonds. From the perspective of public budgets, additional challenges for using public resources to de-risk climate-friendly investments are aligned with country priorities and additionality, i.e. the risk of generating windfall profits to investors for projects that would have been undertaken anyway.

One way to address these concerns and to best reconcile the interests of investors, entrepreneurs, taxpayers and ratepayers is to link de-risking mechanisms with transparent and rigorous project selection methods. Such methods can assess country ownership, climate impact, additionality and sustainability and hedge against arbitrary project selection or 'hold-up' problems in PPPs structures (Dewatripont & Legros, 2005; Bolton *et al.*, 2020). The challenge is to set up these hedges without increasing the transaction costs of the project at the preparation stage, which would deter entrepreneurs' engagement. This strict selection will indeed be a *de facto* or implicit certification of bonds. While the challenges are not identical for adaptation and mitigation projects, progress is required for both.

There are several ongoing efforts in this regard. The Climate Bonds Initiative published a Climate Bond Standard and Certification Scheme to offer guarantees that funded projects fulfil environmental objectives. The International Market Association proposed sustainability bonds guidelines to incorporate non-climate related benefits of the projects' portfolio (ICMA, 2018). However, in 2019 the issuance of green bonds certified through these standards accounted for only 17% of the green bonds volume, which is insufficient in relation to needs. The UNDP recently released impact standards for bond issuers to optimise their contribution to sustainable development (UNDP, 2021).

Several proposals also aim to build on the experience of environmental funds such as GEF, CDM, GCF and others to develop specific additionality methodologies for green bonds and guarantees. For example, in a context of imperfect knowledge of projects' performance and costs of proving additionality (Shishlov & Bellassen, 2012; Bellassen, 2015), it is possible to create statistically significant additionality through standardized assessment methodologies.

Some contributions suggest that agreed-upon assessment methods can be standardised for mitigation projects thanks to the existence of a common metric - avoided tonne of emissions. Peer-reviewed modelled and non-modelled scientific information could help determine upper and lower bounds of avoided carbon emissions associated with a given type of project in a given country and/or region for various growth scenarios (Dasgupta *et al.*, 2019). It would then be possible in a multilateral setting to launch pilot programs to test methods to (i) evaluate the avoided tonnes of emissions (in quantity and value) by type of project, sector and geography balancing rigour and cost of the assessment, and including uncertainty coefficients (Hourcade *et al.*, 2012);<sup>44</sup> and (ii) value the avoided emissions based on an agreed value per tonne<sup>45</sup> and secure the economic efficiency of the world portfolio of low-carbon projects through the notional prices recommended by Stiglitz *et al.* (2017) in the absence of an explicit and high enough carbon price. Such methods could then be used by third party expertise (BFTF, 2018; Lee *et al.*, 2018; Schiff & Dithrich, 2017) to guarantee the credibility of the bundling of projects and of the bonds they back.

For adaptation, new valuation methodologies are required to better assess the benefits of climate resilient infrastructure projects and transform them into a new class of assets. Such mechanisms will enable investment decision-making to balance off risks associated with higher upfront costs of climate-resilient infrastructure with their lower O&M costs and lower climate physical and transition risks. This could lead to labelling investments as climate-resilient assets, highlighting their sustainable development benefits, including improved health, food security and job creation, all of which are critical to the Covid-19 response.

To develop valuations and labelling of climate-resilient infrastructure in developing countries, the Coalition for Climate Resilient Investments (CCRI) is piloting methodologies for their structuring and financing. With the Jamaican government (see box 3.3), CCRI is developing an assessment tool to enable investment prioritisation based on the exposure of selected infrastructure networks to physical climate risks, the economic and social value of risk due to such exposure, and the potential capacity of nature-based solutions (NBS) to partially replace hard infrastructures.

This tool, the first of its kind, will integrate climate risk analytics in programmatic infrastructure decision-making enhancing cost-benefit analyses at macro-economic and asset levels. Such analysis should in turn support and incentivise the development of project pipelines for resilient infrastructure and a more efficient allocation of public and private capital for their realisation. The CCRI will also analyse cash flows of selected projects to understand the quantitative changes climate risks bring to their budgets, and codify the results.

<sup>44</sup> A few initiatives are being launched to test innovative standardised assessment approaches within infrastructure platforms: the Global Innovation Lab for Climate Finance (<https://www.climatefinancelab.org/>), the Fast Infra framework of the World Bank (<https://www.climatepolicyinitiative.org/wp-content/uploads/2020/12/FAST-Infra-Conference-Presentation-Slides-Nov-2020.pdf>) and Terrawatt J.-P. Pham-Ba, A. Legrain (2020), "Well below 2cts", Terrawatt Initiative, <https://terrawatt.org/>.

<sup>45</sup> A Third Party Expertise could select a value within these bounds and assign to it an uncertainty coefficient in function of the projects' specifics (Hourcade *et al.*, 2012). Public guarantees could be calibrated on a notional value per ton of avoided emissions, retained within the corridors of marginal abatement costs trajectories considering the scenarios reviewed by the IPCC (Edenhofer *et al.* 2014) interpreted as the value that the international community attaches to a given climate target (Espagne, & Perrissin-Fabert, 2017a, Sirkis *et al.* 2015). One can even envisage to incorporate sustainable development co-benefits via an agreed 'social value of mitigation activities' (SVMA) per ton of avoided emissions (Hourcade *et al.*, 2015; Shukla *et al.* 2015), as recommended by Article 108 of the decision of the Paris Agreement (UNFCCC, 2015). Waisman *et al.* (2019) provides such a value for India for a climate mitigation strategy aligned with sustainable development outcomes like air pollution reduction, energy security, and mobility. A still underworked area is fixing such notional prices for elements other than avoided carbon, which are critical for sustainable development (water, forest, air quality, land, and climate resilience).

Generalising the use of this tool will speed up the emergence of an evidence-based benchmark for discussion on standardisation, even for projects whose assessment necessitates metrics more complex than the tonnes of avoided emissions. This would make it possible to structure financial instruments that realistically embrace resilience to climate change throughout the infrastructure project pipeline, which in turn will enable its development, financing and securitisation.

### Capacity development to design, float and implement green bonds in developing countries

Investment in domestic capacity to design, issue and report on bonds aligned with the unique requirements of developing countries will be required to fully leverage the potential of green bonds to finance the transition to net-zero climate-resilient development in developing countries. For example, strong technical capacity and standardised technical aggregation methods are needed to unlock small projects. A microgrid in a remote African village costs a few hundreds of thousands of dollars; equipping a large condominium with electricity distribution infrastructures costs ten thousand only. Such projects are barely significant for institutional investors and cannot respond to asset managers' calls for investments over \$100 million in diversified asset pools. Devices facilitating their bundling, securitisation and repackaging in standardised liquid financial products can overcome this obstacle (Andersson *et al.*, 2016; Arezki *et al.*, 2016; BFTC, 2018).

Issuing green bonds requires a regulated capital market to be in place and considerations related to liquidity to apply. The bond issuer also needs to meet certain criteria for listing financial products. While there is no specific legal requirement for issuing green bonds, existing international standards such as the Green Bond Principles or Climate Bond Standards can be recognised/adopted by national financial authorities, issuers and certifying bodies.

Financial and non-financial corporate issuers have been the biggest source of green bonds in every quarter since Q3 2018. However, government-backed entities experienced 35% growth in Q3 2020 compared with Q3 2019 (Climate Bonds Initiative, 2020). Publicly owned financial institutions with specific development or policy mandates – National Development Banks (NDBs) – have a critical demand-creating countercyclical role to play in reviving economies in ways that are consistent with the Paris Agreement and the SDGs. NDBs and regional development banks (which together are referred to as public development banks, PDBs) represent about 10% of global investment, disbursing more than \$2 trillion annually.

There are almost 260 PDBs in developing countries, representing \$5 trillion in assets. PDBs have the capacity of extending more than \$400 billion in climate finance per year. Doubling their investment capacity or leverage effect would be enough to bridge the infrastructure investment gap. However, only 58 NDBs in developing countries are accessing international capital markets to capitalise their operations. Issuing green bonds could be a game changer for NDBs and international efforts to scale up climate action.

To realise their full potential, NDBs need a clear 'green' mandate by policy-makers and strong governance to become first-tier financial institutions. They also require the skills, tools and track record to assess the specific risks associated with investments in new climate technologies, and identify the most appropriate financial structures. Finally, international public finance institutions will be key to support accessing international climate finance and capital markets so that they have adequate capitalisation to operate at the required scale and take on early investment risk.

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**BOX 3.3: FACILITATING AN ENABLING ENVIRONMENT FOR A CARIBBEAN GREEN BOND LISTING ON THE JAMAICA STOCK EXCHANGE<sup>46</sup>**

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Jamaica, a small island developing state, is highly vulnerable to the impacts of climate change, including droughts, increased intensity of extreme weather events, and higher temperatures. As an upper middle-income country, Jamaica also faces several economic challenges, including low growth, high public debt, and high energy costs. The Government is implementing an ambitious reform programme to stabilise the economy, reduce debt and fuel growth. The Government is also committed to accelerating climate investment from the private sector to implement its NDC ambitions.

Based on recommendations from a regional private sector study, the Government is taking action to increase its access to the green bond market in order to finance new and innovative business opportunities, and attract local and international institutional investors to support climate resilience and low-carbon development.

The Government aims to create an enabling environment for a Caribbean green bond listing on the Jamaica Stock Exchange, which will enable it to float through a dedicated green bond facility. Specifically, it is:

- Assessing the current structure of the debt capital market for bonds and the suitability for green bond growth;
- Developing appropriate policies and guidelines based on international standards and Green Bond Principles; and
- Strengthening the capacity of key market players from across the region.

Once the green bond facility has been established, the country envisions the aggregation of project assets (from public and/or private sources) and their refinancing through proceeds of green bonds to accelerate the implementation of its NDC.

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<sup>46</sup> Jamaica Ministry of Economic Growth and Job Creation (2019) Readiness proposal to the GCF Facilitating an enabling environment for a Caribbean Green Bond Listing on the Jamaica Stock Exchange.

# CONCLUSIONS

A key conclusion of this study is that meeting the goals of the Paris Agreement in a way that is consistent with the Cancun's mandate of equitable access to development (UNFCCC, 2011) depends on our capacity to use climate action to reduce today's economic and social tensions. We can do so by *bridging the structural investment gap worldwide* (energy, transport, building, water systems) *with low-carbon and climate-resilient options*.

The quantitative evidence is that funding an ambitious low-carbon transition is possible by *redirecting a significant part of private capital* towards climate-friendly infrastructures through reducing the mismatch between where the private savings are and where the bulk of infrastructure investment needs, and opportunities, lie, i.e. in developing countries. This is in line with the common but differentiated responsibilities principle of the UNFCCC (1992).

*In the absence of policy interventions, the financial system will not be able to redirect private capital on the needed scale.* It might also be too slow to integrate climate-related risks in the 'value at risks' calculations that guide the permanent restructuring of asset portfolios. Even if this integration is accelerated by the deployment of climate disclosure and transparency methods, the portfolios' decarbonisation could occur by investing in emission-intensive activities but not in low-carbon infrastructure. This would take the planet towards climate scenarios (P3 and P4) whereby limiting global warming to 1.5°C or 2°C would entirely depend on the mobilisation of large amounts of carbon capture and storage, although the technical feasibility of this technology and its consistency with the SGDs are still uncertain.

**The policy interventions** needed to increase the economic viability and bankability of climate-friendly options *must maximise the complementarity* of a) *market-fixing instruments* (carbon pricing, climate disclosure and transparency rules) that incite the financial sector to offer affordable financial terms to such investments, and b) *market-shaping approaches* (information, regulatory, economic and institutional measures) that reduce uncertainty on the demand for green, climate-resilient goods and services, and de-risk such investments. To scale up climate action, this complementarity should be backed by risk-sharing devices, amongst them *public guarantees that transfer to public actors part of the upfront risks currently deterring investment initiatives* on projects that could otherwise be economically viable.

A second key conclusion is that postponing such measures can be detrimental to climate action. In the post-Covid-19 context, those measures inevitably imply support from public budgets subject to competing priorities and unprecedented debt levels. The report brings together the latest economic expertise, emphasising the following aspects.

There is an important asymmetry between most OECD countries, which can roll out ambitious recovery packages contracting debt at almost zero interest rates, and developing countries facing the downgrading of their credit ratings and difficult access to international currencies. A weak recovery of countries representing 55% of the world's markets (China excluded) could undermine the efficacy of the unprecedented injection of liquidity in developed countries.

*Bridging the infrastructure investment gap would be a blueprint for a fast and robust global recovery thanks to the strong knock-on effect on infrastructure investments*, notably the unlocking of two-thirds of the world's infrastructures market currently 'frozen' in developing economies. The public policy devices mobilised to redirect

savings towards low-carbon options have the advantage, compared with non-targeted recovery measures, to ensure the efficiency of every unit of public money spent.

Four interrelated actions can be taken almost immediately.

**Integrating policies on climate action, sustainable development and Covid-19 stimulus,** which requires governments to transform their Nationally Determined Contributions (NDCs) into credible investment plans. Integrated national financing frameworks (INFFs) in line with the Addis Ababa Action Agenda Policy are necessary to meet the overall investment needs for a low-carbon transition. This includes a mapping of financial flows, which will enable countries to navigate complex financing landscapes and identify, combine and sequence the right sources of finance. The international community can help build an environment conducive to the translation of NDCs into investment plans as part of a country's effort to finance its sustainable development strategies, including by reducing the fragmentation of international climate finance.

**Alleviating the debt burden of developing countries to create the fiscal space for a green recovery.** Unconventional policies imposed in the context of the pandemic, such as emissions debts swaps, debt cancellation or the issuance of new SDRs, might not be scaled up at the required level in the absence of mechanisms to ensure that they are targeted to activities with a strong short-term recovery potential that will allow to easily repay the debt, and that deliver a strong contribution to the decarbonation of the world's economy and the fulfilment of the SDGs.

**Setting up multi-sovereign guarantee funds** to de-risk low-carbon investments in developing countries. This is possible thanks to AAA guarantees and enhanced credibility coming from the high leverage of public funds on private capital, and the delivery of immediately tangible reciprocal gains. For guarantor countries, the fiscal revenues of induced exports will quickly overcompensate the public cost of their commitments, while host countries will benefit from new capital inflows and the grants equivalent of reduced debt, which might potentially go far beyond \$100 billion per year. A second credibility-enhancing factor of the multi-sovereign guarantees is to facilitate the establishment of third-party assessment procedures backed on agreed-upon methods that include both the quantification of avoided emissions and the valuation of these emissions by a notional price of carbon to calibrate the amount of the guarantees. This is critical for the emergence of new asset classes and the development of credible bonds markets to hedge against arbitrary project selections and windfall profits for projects that would have been undertaken anyway.

**Developing credible green bond markets and facilitating developing countries accessing them** is critical to facilitate the bundling, securitisation, and repackaging of climate-friendly projects into standardised liquid financial products that could support the NDCs investment plans. On that basis, the key to success is enhancing domestic capacity to design bonds. Together with MDBs and the Green Climate Fund, NDBs could be the key players to realise this potential with some dedicated support to enable them to become first-tier financial institutions and obtain a clear 'green' mandate. The emergence of credible and standardised project assessment methods is also a precondition to dispel the suspicion of greenwashing, a key reason why over the past ten years the issuance of green bonds has been far below the theoretical potential in OECD countries.

These four immediate actions could have a structural positive impact on the future climate policy architecture. They could a) facilitate the deployment of carbon pricing since de-risking mechanisms will increase the volume of low-carbon investments at a given carbon price; b) magnify the impact of financial transparency and disclosure



though the emergence of investments and asset classes of higher credibility; c) reduce the fragmentation of climate and development finance and d) enhance the capacity of MDBs and overseas assistance to support non-marketable services. These are very important to boost the adaptive capacity of societies by crowding in private capital to fund mitigation activities.

To realise this potential, it is necessary and possible to *launch a self-reinforcing circle of trust worldwide* between project initiators, who take the risk of allocating private equity to climate-friendly investments; institutional investors, who co-invest and can redirect the pool of private savings; the banking system, which sends signals through interest rates and loan maturity; and governments, which can increase the bankability of climate-friendly investments through a wide range of public policies.

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