

FSR

**Financial
Stability Review**

June 2019

**GREENING THE FINANCIAL SYSTEM
THE NEW FRONTIER**

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**Greening the financial system:
the new frontier**

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Benchmarks for the financial sector in the face of climate-related risk: facts and recommendations

11 The climate emergency: four facts



111 The Paris Climate Agreement¹ aims at:

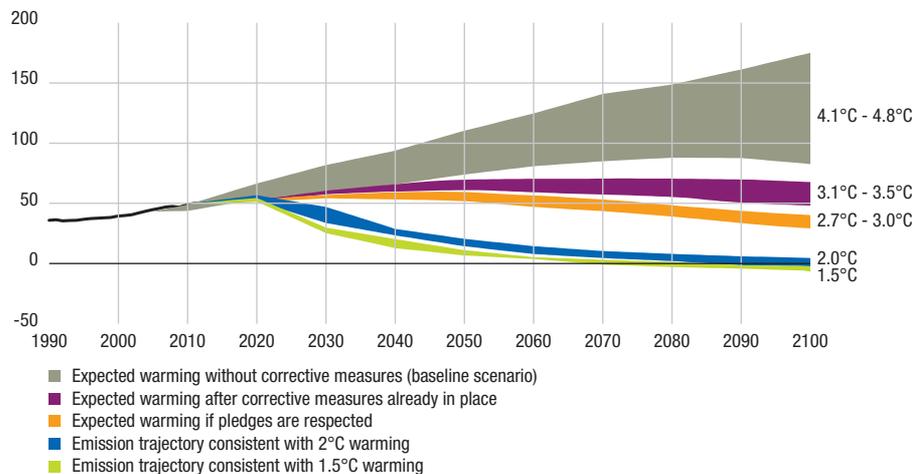
- limiting the increase in global temperature in 2100 to well below 2°C above pre-industrial levels and pursuing efforts to limit the temperature increase even further to 1.5°C;
- increasing the ability of countries to deal with the impacts of climate change by promoting low-carbon, climate-resilient growth;
- making finance flows consistent with this pathway.



112 The current carbon emissions trajectory must be radically changed to comply with the Paris Agreement

2100 projections for global greenhouse gas emissions and warming based on a range of scenarios

(emissions in gigatonnes of CO₂ (GtCO₂) per year with corresponding warming)



Source: Climate Action Tracker, *Warming Projections Global Update*, December 2018; and Banque de France presentation.

¹ The Paris Agreement entered into force on 4 November 2016, less than one year after its adoption. To date, it has been signed by 195 countries.



113 The risks of inaction are significant

-10%

losses to global GDP in 2100 if no action is taken to reduce carbon emissions²

USD 12,000 billion

the amount of stranded assets by 2050 – 3% of current capital stock³ – if policies remain unchanged



114 The financing needed for a successful transition is substantial

USD 830 billion per year

the additional annual average energy-related investment needed to limit warming to 1.5°C for the period from 2016 to 2050⁴

2 OECD (2016), *The economic consequences of climate change*, OECD Publishing, Paris: <https://doi.org/10.1787/9789264261082-fr>

3 IRENA (2019): *Global energy transformation: a roadmap to 2050*.

4 IPCC (2018): “Summary for policymakers”, in: *Global Warming of 1.5°C*.

5 NGFS (2019): “A call for action – Climate change as a source of financial risk”, *First Comprehensive Report*, April: <https://www.banque-france.fr>

2I Action: six recommendations⁵

| Recommendations | Actions of the Banque de France and the ACPR |
|--|---|
| 1 Integrating climate-related risks into financial stability monitoring and micro-supervision | The ACPR is working toward the integration of climate-related risks into day-to-day prudential supervision. ^{1,2} |
| 2 Integrating sustainability factors into own-portfolio management | The Banque de France has adopted a Responsible Investment Charter. ³ |
| 3 Bridging data gaps | |
| 4 Building awareness and intellectual capacity and encouraging technical assistance and knowledge sharing | The Banque de France provides the Secretariat for the Central Banks and Supervisors Network for Greening the Financial System (NGFS). |
| 5 Achieving robust and internationally consistent climate and environment-related disclosure | The Banque de France published its first Responsible Investment Report in March 2019. ⁴ |
| 6 Supporting the development of a taxonomy of economic activities | The Secretariat to the NGFS contributes to the activities of the European Commission Technical Expert Group that is notably working towards developing an appropriate taxonomy. |

1 ACPR (2019), *French banking groups facing climate change-related risks, Analyses et Synthèse, No. 101*.

2 ACPR (2019), *French insurers facing climate change risk, Analyses et Synthèse, No. 102*.

3 Banque de France (2018), *Responsible Investment Charter of the Banque de France*, March.

4 Banque de France (2019), *Banque de France – Responsible Investment Report 2018*, March.

Climate change: central banks are taking action

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The first central bank in History, the Riksbank, was founded in the 17th century to finance the Swedish government's war costs. Today, central banks must wage another type of "war" alongside the signatory states of the 2015 Paris Agreement – the fight against climate change and its consequences.

The mandates given to central banks generally assign a price stability objective and now a financial stability objective. As climate-related risk is a source of financial risks, its management falls squarely within the financial stability objective. Recognition of this fact is central to the ambition of the Central Banks and Supervisors Network for Greening the Financial System (NGFS), which was launched by the Banque de France at the end of 2017.¹ The NGFS is chaired by Frank Elderson, from De Nederlandsche Bank, and now has over forty members and observers from five continents. It works to improve the identification and measurement of the financial sector's exposures to climate-related risks, to devise climate change stress tests for financial institutions, and to develop opportunities associated with financing the transition towards a low-carbon economy. The excellent articles presented in this 23rd edition of the *Financial Stability Review* throw light on many of these issues, and their authors have my heartfelt thanks.

The consequences of climate change for goods and services price dynamics and, more broadly, for economic growth have received less attention however, even though the changes underway, such as increasing temperatures and rising sea levels, raise fears and questions in this respect. It is therefore essential for central banks to also explore the implications of climate change for their price stability mandate and monetary

policy. Consequently, the ideas developed in this article are rooted in two convictions. The first is strategic: central banks' mandates compel them to take account of climate change. The second is operational: to do so, they have several tools at their disposal that can be activated.

11 A mission in keeping with their double mandate

Climate-related risk is unique in character. It is irreversible, in that no technology currently exists that can remedy it. It is also potentially systemic, in that its materialisation could transform the functioning of the whole economy. This is accentuated by the fact that a catastrophic climatic event can provoke another and that climate shocks can be non-linear, making the evolution of risk difficult to predict.²

11.1 Climate risk and financial stability

The financial impact of climate-related risk takes two forms: the **physical risks** (which are the most immediate and visible) caused by the proliferation of extreme weather events such as floods, storms, wildfires and rising water levels, and the subsequent damages that insurance firms, for instance, will have to cover (the number of extreme temperature events has more than tripled since the 1980s, for example);³ and also the **transition risks** associated with public authority measures or private initiatives to support the move towards a low-carbon production model. France, for example, has announced that internal combustion engine vehicles will be phased out in the country by 2040, while cities such as Paris, Hamburg and Essen envisage banning diesel cars and vans entirely. These transition risks,

1 With seven other founding members: Banco de México, Bank of England, De Nederlandsche Bank, Deutsche Bundesbank, Monetary Authority of Singapore, the People's Bank of China, and Finansinspektionen (the Swedish financial supervisory authority). The Banque de France provides the Secretariat to the Network.

2 The difficulty of correctly predicting phenomena that are infrequent but whose consequences can be extreme is a recurring problem in economics, sometimes referred to as the "Peso problem" – an expression attributed to Milton Friedman in reference to the foreign exchange rate of the Mexican peso, which was significantly devalued in 1976 after a long period of stability.

3 See Munich Re (2018).

which are more long term and less visible, result, for example, from financial market volatility and adverse macroeconomic outcomes caused by the transition and uncertainties with regard to its winners and losers.

The management of climate-related risk is therefore required under the financial stability mandate of central banks and financial sector supervisory authorities.⁴ The NGFS report entitled *A call for action – Climate change as a source of financial risk* that was published in April 2019 represents a first major contribution on this point at the international level. It puts forward a series of recommendations⁵ aimed at: (i) central banks and supervisors themselves, so that they improve their methods and practices in terms of the identification and measurement of the financial system's exposures to climate-related risks and submit financial institutions to prospective stress tests; but also (ii) policymakers, as developing the opportunities associated with financing the transition to a low-carbon economy is equally important.

Since 2017, the Banque de France and the French Prudential Supervision and Resolution Authority (*Autorité de contrôle prudentiel et de résolution – ACPR*) have carried out regular assessments of climate change related risks in the financial sector, notably based on the new reporting requirements that came into effect for businesses and financial institutions in France.⁶ As part of this exercise, in April 2019 the ACPR published two analyses of how banks⁷ and insurers,⁸ respectively, incorporate climate-related risks into their risk management procedures. These studies were based on interviews and data provided by a sample of respondents representing, respectively, 86% of credit institutions' total balance sheets and 80% of French insurers' investments. They show that significant progress has been made in terms of governance of risks associated with climate change and in terms of transition-risk awareness among banks in particular. The twenty most

carbon-intensive sectors represented 12.2% of net bank exposures to credit risk in 2017. The progress made in terms of understanding and integrating physical risk has been more modest, even though French banks and insurers seem relatively little-exposed.

112 Climate risk and price stability

Climate change has first of all a direct impact on two pricing items: (i) agricultural and food products, because more regular adverse weather conditions accentuate price volatility; and (ii) energy, because extraction and supply difficulties related to climatic events could lead to sharp price adjustments, as could measures to reduce reliance on fossil fuels. It can therefore intensify medium-term inflationary pressures through repercussions of food and energy prices on production costs.

Second, extreme weather conditions have a broader impact on infrastructure, buildings, the health of employees and productivity, and consequently production and price structures (through resource shortages, loss of activity, growing uncertainty, etc.). According to the Organisation for Economic Co-operation and Development (OECD), losses to global gross domestic product (GDP) could reach 10% in 2100 if no action is taken to reduce carbon emissions.⁹

In this context, monetary policy confronted with climate shocks, i.e. sustained shocks whose impact extends across the economy as a whole, must play its role of supporting the gradual rebalancing of price structures, in line with its ultimate objective of price stability. Without prejudice to this, which is its primary objective, the Eurosystem should also support the general economic policies in the Union with a view to contributing to the achievements of its objectives, including “the sustainable development of Europe” and “a high level of protection and improvement of the quality

4 See Network for Greening the Financial System – NGFS (2018).

5 See NGFS (2019).

6 See Article 173 of Law No. 2015-992 of 17 August 2015 on energy transition for green growth.

7 See ACPR (2019a).

8 See ACPR (2019b).

9 See OECD (2016). Other studies assume that temperature increases have a permanent effect on production growth and thus estimate that the impact could be more severe: losses of up to 23%, for example, according to Burke et al. (2015).

of the environment” (see Article 3 of the Treaty on European Union).

However, monetary policy may find it difficult to manage climate shocks, insofar as they can be stagflationary supply shocks, which provoke both upward price pressures and a slowdown in activity. Furthermore, climate shocks are difficult to analyse and predict due to their magnitude, frequency and intensity, and can therefore blur the expectations of economic agents and complicate the central bank’s interpretation of economic conditions.¹⁰

In reality, the first effects of climate change on economic growth dynamics are already apparent in a number of countries, with forest fires in California, for example, or, in Europe, the drought in the summer of 2018, which reduced the level of the Rhine river to a historical low and slowed growth in Germany due to the disruption caused to raw material and food transportation. Moreover, the costs of the transition towards a low-carbon economy are also already being felt. In the automotive industry, the ambitious carbon dioxide (CO₂) vehicle emission reduction targets set by the European Union for 2021 are already affecting automobile production and are expected to accelerate the decline in diesel vehicle sales.¹¹ And in France itself, the so-called *gilets jaunes* protests largely began as a reaction to ecotaxes.

The times we live in require action; and the sooner the better, given that the majority of the benefits of corrective action may only be felt in the longer term.

21 Two priorities to be activated

The debate of the day, particularly in the United States, is “Green QE” (“green quantitative easing”). It has, however, serious limitations, as we shall see: it is vital to aim far

higher and be far more inclusive to mobilise monetary policy around two priorities.

211 Preparing for all the effects of climate-related risks

The award of the Nobel Prize in Economic Sciences in 2018 to William Nordhaus, a pioneer in the development of models to integrate climate change and macroeconomics, shows how research into the interactions between climate change and economics has come on in leaps and bounds over the past two decades. But we are still somewhat in the dark on some issues, particularly those of direct interest to central banks. It is therefore essential that central banks contribute to the collective research effort, while prioritising two fields in particular.

The first concerns the assessment of the economic impact of physical risk. A substantial body of empirical literature, which for the most part focuses on the situation in the United States, already draws on a wealth of microeconomic databases to try to assess the effect of catastrophic climate events or heat waves on labour productivity, economic activity or business survival. This work should be continued, refined and updated for other countries. The findings of these *ex post* assessments can then be used to develop scenarios of physical risk by extrapolating trends provided, for example, in Intergovernmental Panel on Climate Change (IPCC) scenarios. They can also be used to help calibrate the damage functions embedded in macroeconomic models, which notably serve as a basis for discussions and reflections on monetary policy options.

The second consists in better understanding how monetary policy should best be conducted against a backdrop of economic policy measures (subsidies or taxes) aimed at reducing carbon emissions, and how and to what extent monetary policy may be constrained by insufficient control over climate change, which is a source of more

¹⁰ See Cœuré (2018).

¹¹ See AlixPartners (2018).

regular and more severe negative shocks. To this end, the usual macroeconomic models of central banks,¹² which have been developed to analyse short to medium-term trends, will have to be enhanced.

The NGFS already has plans for 2019 to publish a series of simplified long-term scenarios integrating climate-related risks and intended to facilitate understanding of the destabilising effects of climate change.

Another “new frontier” for the central bank stems from the fact that climate-change related risks materialise over a far longer time period than the traditional decision-making horizon of a central bank. This has been referred to as the “tragedy of the horizon”.¹³ An interesting analogy is the well-known debate on the interrelationship between monetary policy and financial stability. According to the separation principle, monetary policy should be centred on inflation risks while macroprudential policy should adhere to its role of monitoring and mitigating financial risks. Compliance with this principle relies on the existence of operational macro-prudential instruments. Should they appear inadequate, monetary policy will have to be brought to bear on the changes in the financial cycle, in accordance with the so-called “leaning against the wind” approach. By analogy, taking account of climate-related risk within the financial system first involves supervisory microprudential instruments, but it could push central banks to consider whether they should take preventive action to join efforts aimed at limiting global warming and thus adopt an approach of “leaning against climate change”.

2|2 Better assessing collateral

Do we need to amend the rules defining the scope of assets eligible as collateral for monetary policy lending to take account of climate-related risk, so as to grant favourable treatment to eligible

green assets? We could consider eligibility criteria that reflect the specific risk associated with these assets, for example, or modifications to the haircut calculations applied to them. And if it is found that physical and transition risks have an impact on the profile of certain assets, central banks would have to draw the appropriate conclusions and integrate these financial risks into their collateral framework. This type of question could also be asked with regard to corporate bond purchase programmes (cf. the European Central Bank corporate sector purchase programme – CSPP), where these exist.

However, gaining a deeper understanding of these potential pathways requires the development of a robust methodology to accurately assess the impact of climate change on the credit risk of eligible assets. Above all, until now this credit risk reflects the profile of the corresponding issuing or debtor institutions (firms or governments), some of whose activities may be highly carbon intensive while others may be more carbon friendly. It will also be necessary to be able to carry out ex ante assessments of the impact of adapting eligibility rules in such a way on market structures and dynamics.

Furthermore, the widespread operational application of these pathways requires that several issues be resolved, particularly the identification of activities that contribute to the transition to a low-carbon, green economy (green assets) as opposed to activities that are most exposed to climate and environment-related risk (brown assets), and the determination of their respective risk profiles.

In this respect, developing a European taxonomy of sustainable economic activities, under the leadership of the European Commission, is an essential first step. The Banque de France, as Secretariat to the NGFS, is actively participating in the process. The taxonomy is intended to ensure the integrity of green financial instruments

¹² DGSE-type macroeconomic models.

¹³ See Carney (2015).

– be they green bonds, loans or securitisation vehicles – and to reassure private investors, lenders and borrowers that they can invest in complete confidence, protected against practices of green washing. Economic players will then have to integrate this taxonomy in order to further the development of deep and liquid markets for green assets.

Meanwhile, these markets still lack depth and liquidity, which illustrates the fact that climate-related issues have still not been properly taken on board, particularly by non-financial corporations. It is therefore vital for the green bond market and the various markets for green financial instruments in general (lending to the economy, securitisations, covered bonds, etc.) to scale up in order to square with the massive investments required for the transition. According to the Intergovernmental Panel on Climate Change (IPCC),¹⁴ the additional annual average energy-related investments needed to limit warming to 1.5°C is estimated at USD 830 billion for the period from 2016 to 2050.

A variety of proposals have been made to allow monetary policy to play a more direct and sector-focused role in financing the transition to a low-carbon economy. For example, we could bring in “green” quantitative easing, by introducing a bias towards green assets in the purchase programme framework. Or we could launch long-term facilities designed to steer the credit supply towards activities that contribute to the transition (green TLTROs – targeted longer-term refinancing operations). But despite the apparent simplicity of these proposals, they are less appropriate and less effective than the two inclusive priorities mentioned previously.

The assumption underlying these targeted measures is that a central bank is better equipped to decide an efficient allocation of resources than democratic institutions – parliaments and

governments –, and private agents. If this were the case, the same theory could also be applied to other objectives essential for the common good, such as combating unemployment or inequality, or inspiration could be taken from the subsidised loans (*prêts bonifiés*) of the past. But the idea that central banks have this type of information advantage is neither proven nor valid. Monetary policy targets a macroeconomic objective (inflation) and at the operational level it strives to be market neutral in order to ensure the smooth functioning of its transmission channels, meaning that it does not single out specific social or sectoral objectives. Moreover, the pool of green bonds that comply with Eurosystem criteria is relatively shallow: today, it accounts for less than 1% of the scope of assets eligible for the public sector purchase programme (PSPP) and around 4% of the scope eligible for the corporate sector purchase programme (CSPP). The Eurosystem already holds nearly EUR 19 billion; but more massive purchases by the Eurosystem in this narrow and emerging segment would push up the prices of these assets and thus lead to undesirable and damaging distortions.

31 Conclusion

Our conviction is clear: the financial stability and monetary policy mandates of central banks impose the obligation and also give them the tools to respond to the climate imperative. And in fact, they are actively contributing to this fight through the work of the NGFS. Their primary lever is their microprudential supervision of financial intermediaries, banks and insurance undertakings, while they also lead by example through their investment policies. The Banque de France, in March 2018, was the first to adopt a responsible investment charter for the management of its own funds and pension portfolios to ensure their allocation to socially and environmentally responsible investment funds, and De Nederlandsche Bank is a signatory of the

14 See IPCC (2018).

Principles for Responsible Investment supported by the United Nations.

But monetary policy is also involved in this collective mobilisation; not so much by directly targeting specific sectors – "Green QE" may be seductive but is too limited – but by thoroughly integrating climate change into the monetary policy framework. In terms of research, this requires a deeper understanding of all the economic effects; in operational terms, it involves integrating all the consequences into the assessment of collateral.

According to Albert Einstein, "*The world as we have created it is a process of our thinking. It cannot be changed without changing our thinking.*" This is indeed the challenge that central banks must overcome, as must we all. In the fight for the climate, not everything depends on central banks: appropriate public policies – including a carbon tax – and innovative business strategies are essential. But in the situation we now face, as in others, central banks are here to serve society and future generations. And this is reflected in our unprecedented collective action within the NGFS.

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Climate change as a financial risk

Climate risks: why each half-degree matters

Human activities are estimated to have caused approximately 1°C of global warming above pre-industrial levels and the effects on natural and human systems are already visible. At the current pace of increase of 0.2°C per decade, global warming is expected to reach 1.5°C between 2030 and 2050.

The only way to stabilise global warming over multi-decade timescales is to reach and sustain net zero global anthropogenic carbon dioxide emissions and to rapidly reduce emissions of other greenhouse gases such as methane.

The Intergovernmental Panel on Climate Change Special Report on global warming of 1.5°C, published in October 2018, assesses current knowledge of the climate-induced impacts and risks for natural and human systems, especially those caused by global warming of 1.5°C and 2°C above pre-industrial levels.

The report concludes that the risks are higher than at present for global warming of 1.5°C, but lower than for warming of 2°C. They also depend on the magnitude and rate of warming, the geographical region, levels of development and vulnerability, and on the choices and implementation of adaptation and mitigation options.

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The core target set by the Paris Agreement is to keep the rise in global temperatures to well below 2°C and to pursue efforts to limit the rise even further to 1.5°C above pre-industrial levels. The agreement also aims to increase the ability of countries to deal with the impacts of climate change.

Against this backdrop, the 21st Conference of the Parties (COP21) of the UNFCCC¹ invited the IPCC² to provide a special report in 2018 on the impacts of global warming of 1.5°C above pre-industrial levels and the related global greenhouse gas emission pathways.³ The invitation was prompted by the realisation on the part of numerous countries that limiting warming to 2°C would be insufficient to avert major climate threats to their development. There was also a lack of knowledge in 2015 as to the impact of half a degree less of warming in terms of climate-related risks and greenhouse gas emission pathways.

The IPCC⁴ accepted this invitation in April 2016 and decided to draft this special report (hereafter “SR15”) in the context of strengthening the global response to the threat of climate change, sustainable development and efforts to eradicate poverty. The Summary for Policymakers was approved by all governments and the special report was adopted in October 2018. It is the first time that the IPCC has prepared a special report at the invitation of the UNFCCC, and under the joint supervision of its three working groups (which focused respectively on the physical science basis of climate change; the vulnerabilities, impacts and adaptation options; and the options for mitigation). The COP21’s invitation and the IPCC’s decision to prepare the SR15 spurred the production of new knowledge between 2016 and 2018 which formed the basis for the assessment.

The SR15 was prepared by 91 lead authors from 40 countries and 133 contributing authors, who together reviewed close to 6,000 scientific and socio-economic publications. The successive

versions of the report benefited from the critical comments of 1,113 reviewers, scientific experts and governments. A total of 42,001 comments were submitted which proved key in ensuring the assessment was exhaustive, objective and rigorous.

The SR15 was approved in an atmosphere of tension,⁵ due to unresolved issues in the UNFCCC’s political negotiations, and to the different implications of stabilising warming at 1.5°C, both for those countries most vulnerable to climate risks – notably small island developing states – and for those whose economies depend on the production and export of fossil fuels. These tensions were also apparent at the COP24.⁶

The SR15 indicates that climate-related risks differ markedly for each half a degree of global warming. This is the main focus of the following article, which is based on the Summary for Policymakers (IPCC – Masson-Delmotte et al., 2018a) and on Chapter 3 of the SR15 (IPCC – Høegh-Guldberg et al., 2018b).

11 How close are we to 1.5°C of warming?

11.1 1°C of warming caused by human activities

Human activities have already caused approximately 1°C of global warming above pre-industrial levels. Estimated anthropogenic global warming matches the level of observed warming to within ± 20%. Global warming is currently increasing at a rate of 0.2°C (± 0.1%) per decade. If it continues to rise at this rate, it is likely to reach 1.5°C between around 2030 and 2050.

11.2 Observed characteristics and impacts

Warming is generally higher over land than over the ocean, and is particularly high in the Arctic. Global warming has already resulted in more frequent heatwaves in most land regions, and an

1 United Nations Framework Convention on Climate Change.

2 Intergovernmental Panel on Climate Change. The IPCC’s mandate, activities and reports can be found at www.ipcc.ch. All reports are available in English only. However, technical summaries and summaries for policymakers have been translated into the other official languages of the United Nations (Russian, Spanish, Chinese, Arabic and French).

3 COP Decision 1/CP.21, paragraph 21.

4 For a detailed description of the plenary session of the IPCC, compiled by IISD Reporting Services, go to: <http://enb.iisd.org/>

5 For a detailed description of the plenary IPCC session approving the report, compiled by IISD Reporting Services, go to: <http://enb.iisd.org/>

6 See Katowice Climate Change Conference: <http://enb.iisd.org/>

increase in the frequency and duration of marine heatwaves. It has also led to a rise in the frequency, intensity and/or amount of heavy precipitation events at the global scale and an increased risk of drought in the Mediterranean region.

The impacts of global warming on biological organisms, ecosystems, human systems and well-being are already visible, and have increased both in frequency and intensity as temperature levels have risen.

113 The inevitable consequence of past emissions

Warming from anthropogenic emissions from the pre-industrial period to the present will persist for centuries to millennia and will continue to cause further long-term changes in the climate system, such as rising sea level and the associated impacts. However, past anthropogenic emissions alone (including greenhouse gases, aerosols and their precursors) are unlikely⁷ to cause further warming of more than 0.5°C over the next three decades or on a century timescale.

114 Conditions for stabilising global warming

The future level of warming will depend on the cumulative total of past, present and future CO₂ emissions, and on the radiative forcing⁸ of other non-CO₂ anthropogenic factors.⁹ The only way to stabilise global warming over multi-decade timescales is to reach and sustain net zero global anthropogenic CO₂ emissions and reduce the radiative forcing of non-CO₂ anthropogenic factors. The maximum temperature reached would then be determined by the cumulative net global anthropogenic CO₂ emissions up to the time of net zero, and by the level of non-CO₂ factors in the decades prior to the time the maximum temperature was reached. In the longer term, sustained net negative global anthropogenic CO₂ emissions and further reductions in non-CO₂ anthropogenic factors would be required to prevent further warming.

21 1.5°C and 2°C warmer worlds: what is the difference in terms of climate?

211 Trends and extremes

Climate models project robust differences in regional climate between present-day and global warming of 1.5°C, and between 1.5°C and 2°C. These differences include increases: in mean temperatures in most land and ocean regions; in the intensity of hot extremes in most inhabited areas; in the frequency, intensity and/or amount of heavy precipitation events in several regions; and in the intensity or frequency of precipitation deficits or droughts in other regions (see charts in the box and table below).

Temperature extremes on land are projected to warm more than the global mean surface temperature (GMST). Extreme hot days in mid-latitudes could warm by up to about 3°C at global warming of 1.5°C, and by about 4°C at 2°C, while extreme cold nights in Arctic regions could warm by around 4.5°C for global warming of 1.5°C, and by 6°C at 2°C. The strongest warming of hot extremes is projected to occur in central and eastern North America, central and southern Europe, the Mediterranean region, western and central Asia, and southern Africa. The number of exceptionally hot days is projected to increase in most land regions, even at warming of 1.5°C, with the highest rises occurring in the tropics.¹⁰

The risk of drought and precipitation deficits is expected to be higher at 2°C of global warming than at 1.5°C in some regions. In particular, risks associated with increases in drought frequency and magnitude are projected to be substantially larger at 2°C than at 1.5°C in the Mediterranean region and southern Africa.

The risk of heavy precipitation events should also be higher at 2°C than at 1.5°C in several high-latitude and/or mountainous regions in the northern hemisphere, eastern Asia and eastern

7 Probability of 0-10%.

8 Radiative forcing is a measure of the influence a factor has in altering the balance of incoming and outgoing energy in the Earth-atmosphere system and is an index of the importance of the factor as a potential climate change mechanism. Positive radiative forcing leads to an accumulation of energy in the climate system.

9 Such as methane, nitrous oxide, aerosols (particles emitted into the atmosphere), changes in land use.

10 Assuming vulnerability remains constant, limiting global warming to 1.5°C instead of 2°C could result in around 420 million fewer people being frequently exposed to extreme heatwaves, and about 65 million fewer people being exposed to exceptional heatwaves.

North America. Moreover, heavy precipitation associated with tropical cyclones is projected to be higher at 2°C than at 1.5°C of global warming.

2|2 Sea level

The risks associated with a rise in sea level are expected to be higher at 2°C than at 1.5°C of global warming. The slower rate of sea level rise at 1.5°C of warming¹¹ leads to a reduction in these risks and enables greater opportunities for adaptation. Conversely, stronger global warming amplifies the exposure of small islands, low-lying coastal areas and deltas to the risks associated with sea level rise for many human and ecological systems, including increased saltwater intrusion, flooding and damage to infrastructure.

Sea level will continue to rise well beyond 2100. Moreover, marine ice sheet instability in Antarctica and/or the irreversible loss of the Greenland ice sheet could result in a multi-metre rise in sea level over hundreds to thousands of years. These instabilities could be triggered at around 1.5°C-2°C of global warming.

11 Projections for the global mean sea level rise suggest an indicative range of 26 cm to 77 cm by 2100 (relative to 1986-2005) for global warming of 1.5°C, which is 10 cm less than for warming of 2°C.

12 Of the 105,000 species studied, 6% of insects, 8% of plants and 4% of vertebrates are projected to lose over half of their climatically determined geographic range for global warming of 1.5°C, compared with 18% of insects, 16% of plants and 8% of vertebrates for global warming of 2°C.

13 With 2°C of global warming, the likelihood of a sea ice-free Arctic summer increases to at least one per decade, compared with one per century at 1.5°C of warming.

14 The global annual catch for marine fisheries could be reduced by as much as 1.5 million tonnes at 1.5°C of global warming, and by more than 3 million tonnes at 2°C of global warming.

3| What are the impacts for ecosystems of 1.5°C and 2°C of warming?

3|1 Land ecosystems and biodiversity

On land, the impacts on biodiversity and ecosystems, including species loss and extinction, are projected to be lower at 1.5°C of global warming than at 2°C.¹² The effects on terrestrial, freshwater and coastal ecosystems would all be more limited, allowing them to retain more of their services to humans (see charts in the box). The impacts linked to forest fires and the spread of invasive species would also be lower at 1.5°C than at 2°C of warming.

The global terrestrial land area projected to be affected by ecosystem transformations is approximately halved at 1.5°C of global warming

compared with 2°C. Above 1.5°C, the changes to the Mediterranean biome would be unparalleled in the last 10,000 years.

In the Arctic region, the tundra and boreal forests are particularly at risk of climate change-induced degradation and loss, with woody shrubs already encroaching into the tundra. Limiting global warming to 1.5°C compared with 2°C is projected to prevent the thawing over centuries of a permafrost area in the range of 1.5-2.5 million km².

3|2 Oceans and marine ecosystems

Limiting global warming to 1.5°C compared with 2°C is expected to reduce increases in ocean temperature as well as associated increases in ocean acidity and decreases in ocean oxygen levels. Consequently, it should reduce the risks to marine biodiversity, fisheries and ecosystems, and to their ecological functions and services to humans. The probability of a sea ice-free Arctic Ocean during summer is substantially lower at global warming of 1.5°C when compared with 2°C.¹³

Global warming of 1.5°C is projected to shift the ranges of many marine species to higher latitudes and increase the amount of damage to many ecosystems. It is also expected to drive the loss of coastal resources and reduce the productivity of fisheries and aquaculture, especially in tropical regions. The risks of climate-induced impacts are projected to be higher at 2°C.¹⁴

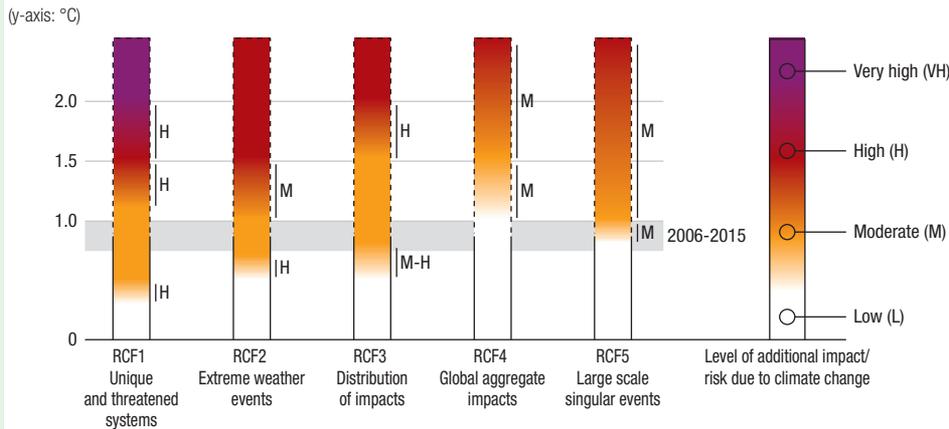
The level of ocean acidification due to the increasing CO₂ concentrations associated with global warming of 1.5°C should amplify the adverse effects of warming – and even further at 2°C.

The impacts of climate change in the ocean are increasing risks to fisheries and aquaculture via impacts on physiology, survivorship, habitat, reproduction, disease incidence and the risk of invasive species, but are projected to be less at 1.5°C of global warming than at 2°C.

Box

Impacts and risks according to the level of global warming

Ca How the level of global warming affects impacts and risks associated with five reasons for concern



Source: IPCC Special Report on global warming of 1.5°C.

Notes: The y-axis shows the change in the global mean surface temperature relative to pre-industrial levels. The letters L, M, H and VH indicate the confidence level for the transition: L = low, M = moderate, H = high and VH = very high.

Purple indicates very high risks of severe impacts/risks and the presence of significant irreversibility or the persistence of climate-related hazards, combined with limited ability to adapt due to the nature of the hazard or impacts/risks.

Red indicates severe and widespread impacts/risks.

Orange indicates that impacts/risks are detectable and attributable to climate change with at least medium confidence.

White indicates that no impacts are detectable and attributable to climate change.

These five integrative reasons for concern (RCFs) provide a framework for summarising key impacts and risks across sectors and regions. They illustrate the implications of global warming for people, economies and ecosystems.

Unique and threatened systems: ecological and human systems that have restricted geographic ranges constrained by climate-related conditions and have high endemism or other distinctive properties. Examples include coral reefs, the Arctic and its indigenous people, mountain glaciers and biodiversity hotspots.

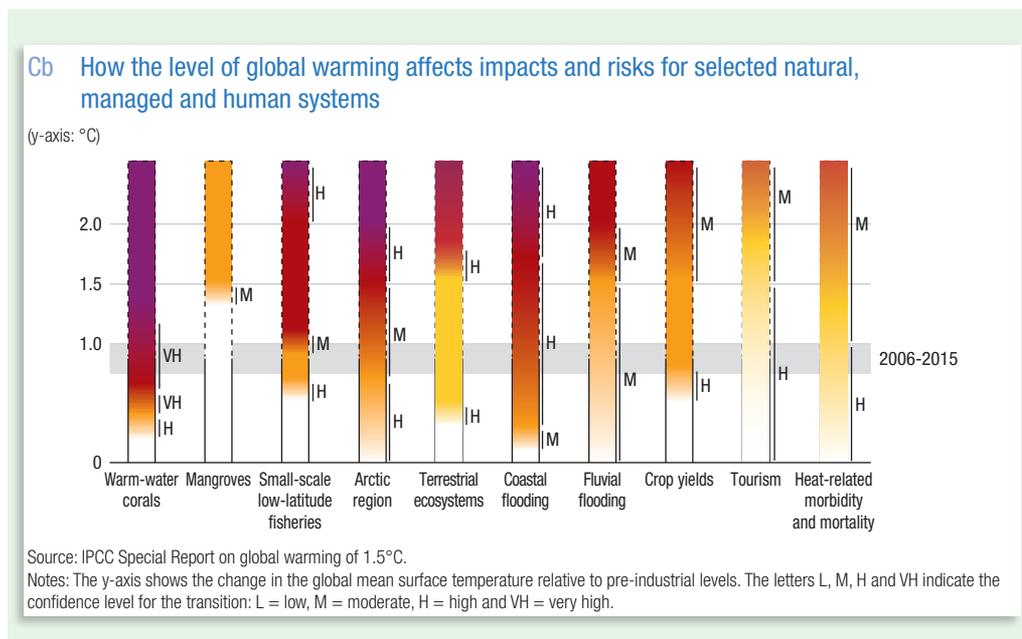
Extreme weather events: risks/impacts to human health, livelihoods, assets and ecosystems from extreme weather events such as heatwaves, heavy rain, drought and associated wildfires, and coastal flooding.

Distribution of impacts: risks/impacts that disproportionately affect particular groups due to uneven distribution of physical climate change hazards, exposure or vulnerability.

Global aggregate impacts: global monetary damage, global-scale degradation and loss of ecosystems and biodiversity.

Large-scale singular events: relatively large, abrupt and sometimes irreversible changes in systems that are caused by global warming. Examples include the disintegration of the Greenland and Antarctic ice sheets.

.../...



4I What are the climate risks to human systems of 1.5°C and 2°C of global warming?

The characteristics of 1.5°C or 2°C warmer worlds will depend on the actions taken to contain global warming (with regard to greenhouse gas emissions, aerosols, land use). Political choices can also influence the resilience of human and natural systems, as well as the nature of regional and local risks. Climate-related risks will depend on the degree of warming, and on the size and duration of potential overshoots in temperature.

4I1 Implications of overshoot scenarios

The SR15 examines the consequences of scenarios where the average peak temperature exceeds 1.5°C of warming before coming back down to the 1.5°C level. These scenarios pose significant risks to human and natural systems, such as the irreversible loss of certain ecosystems, especially if the temperature at peak warming is high. The risks

are potentially larger in the case of a rapid rise to overshooting temperatures, and even if actions are subsequently taken to achieve 1.5°C by the end of the 21st century or later through net negative emissions. If overshoot is to be minimised, large, immediate and unprecedented efforts need to be made to mitigate greenhouse gas emissions.

Pathways that overshoot 1.5°C of global warming assume that CO₂ removal (CDR) will exceed residual CO₂ emissions later in the century, allowing warming to return to below 1.5°C by 2100. As a result, any factors influencing the speed, scale and societal acceptability of CDR deployment will determine the ability to return global warming to below 1.5°C following an overshoot. Carbon cycle and climate system understanding about the effectiveness of net negative emissions in reducing temperatures after they peak is still limited.

Most current and potential CDR measures could have significant impacts on land, water

or nutrients if deployed on a large scale. Afforestation and bioenergy may compete with other land uses and may have significant impacts on agricultural and food systems, biodiversity, and other ecosystem functions and services. Some AFOLU-related¹⁵ CDR measures could provide benefits such as improved biodiversity and soil quality. If deployed on a large scale, they would require governance systems enabling sustainable land management.

4|2 Risks to human security

Climate-related risks to health, livelihoods, food security, water supply, human security, and economic growth are projected to increase with global warming of 1.5°C and increase further with 2°C (see charts in the box and table below).

Limiting global warming to 1.5°C compared with 2°C could reduce the number of people both exposed to climate-related risks and susceptible to poverty by up to several hundred million by 2050. Certain indigenous peoples and local communities dependent on agricultural or coastal livelihoods are at a disproportionately higher risk of adverse consequences with global warming of 1.5°C and beyond. Regions at disproportionately higher risk include Arctic ecosystems, dryland regions, small island developing states, and least developed countries. Poverty and disadvantage are expected to rise in some populations as global warming increases.

Lower risks are projected at 1.5°C than at 2°C for heat-related morbidity and mortality, and for ozone-related mortality.¹⁶ Urban heat islands often amplify the impacts of heatwaves in cities. Risks from some vector-borne diseases, such as malaria and dengue fever, are projected to increase with warming from 1.5°C to 2°C, including potential shifts in their geographic range.

Limiting warming to 1.5°C compared with 2°C is projected to result in smaller net reductions in yields of maize, rice, wheat, and potentially other

cereal crops, particularly in sub-Saharan Africa, South East Asia, and Central and South America, and in the nutritional quality of rice and wheat. Reductions in projected food availability are larger at 2°C than at 1.5°C of global warming in the Sahel, southern Africa, the Mediterranean, central Europe, and the Amazon. Livestock are also projected to be adversely affected with rising temperatures.

Limiting global warming to 1.5°C compared with 2°C may reduce the proportion of the world population exposed to a climate change-induced increase in water stress by up to 50%, although there is considerable variability between regions. Many small island developing states could experience lower water stress when global warming is limited to 1.5°C, as compared with 2°C.

Exposure to multiple and compound climate-related risks increases between 1.5°C and 2°C of global warming, with greater proportions of people both so exposed and susceptible to poverty in Africa and Asia. For global warming between 1.5°C and 2°C, risks across energy, food and water sectors could overlap spatially and temporally, creating new and exacerbating current hazards, exposures, and vulnerabilities that could affect increasing numbers of people and regions.

Risks to global aggregated economic growth due to climate change impacts are projected to be lower at 1.5°C than at 2°C by the end of this century. This excludes the costs of mitigation and adaptation investments and the benefits of adaptation. Countries in the tropics and southern hemisphere subtropics are projected to experience the largest impacts on economic growth due to climate change should global warming increase from 1.5°C to 2°C.

Since the publication of the IPCC's Fifth Assessment Report (IPCC, 2014), the assessed levels of risk have increased for four of the five reasons for concern (RFCs) for global warming of 2°C.

¹⁵ Agriculture, forestry and other land use.

¹⁶ If emissions leading to ozone formation remain high.

Climate risks: why each half-degree matters

Valérie Masson-Delmotte and Wilfran Moufouma-Okia

T1 Emergence and intensity of climate change hotspots under different degrees of global warming

| Region and/or phenomenon | Warming | | |
|----------------------------------|--|--|---|
| | of 1.5°C or less | of 1.5°C–2°C | of 2°C–3°C |
| Arctic sea ice | Arctic summer sea ice is likely to be maintained. Habitat losses for organisms such as polar bears, whales, seals and sea birds. Benefits for Arctic fisheries. | The risk of an ice-free Arctic in summer is about 50% or higher. Habitat losses for organisms such as polar bears, whales, seals and sea birds may be critical if summers are ice free. Benefits for Arctic fisheries. | The Arctic is very likely to be ice free in summer. Critical habitat losses for organisms such as polar bears, whales, seals and sea birds. Benefits for Arctic fisheries. |
| Arctic land regions | Cold extremes warm by a factor of 2–3, reaching up to 4.5°C. Biome shifts in the tundra are likely. Permafrost deterioration. | Cold extremes warm by as much as 8°C. Larger intrusions of trees and shrubs in the tundra are likely. Larger but constrained losses in permafrost are likely. | Drastic regional warming is very likely. A drastic biome shift from tundra to boreal forest is possible. A collapse in permafrost may occur. |
| Alpine regions | Severe shifts in biomes are likely. | Even more severe shifts are likely. | Critical losses in alpine habitats are likely. |
| South East Asia | Risks of increased flooding related to sea level rise. Increases in heavy precipitation events. Significant risks of crop yield reductions are avoided. | Higher risks of increased flooding related to sea level rise. Stronger increases in heavy precipitation events. One-third decline in per capita crop production. | Substantial increases in risks related to flooding from sea level rise. Substantial increase in heavy precipitation and high-flow events. Substantial reductions in crop yield. |
| Mediterranean | Increase in probability of extreme drought. Reduction in runoff of about 9% (likely range 4.5-15.5%). Risk of water deficit. | Robust increase in probability of extreme drought. Stronger reduction of about 17% in runoff (likely range 8-28%). Higher risks of water deficit. | Robust and large increases in extreme drought. Substantial reductions in precipitation and in runoff. Very high risks of water deficit. |
| West Africa and the Sahel | Increases in the number of hot nights and longer and more frequent heatwaves are likely. Reduced maize and sorghum production is likely, with area suitable for maize production reduced by as much as 40%. Increased risks of undernutrition. | Further increases in number of hot nights and longer and more frequent heatwaves are likely. Negative impacts on maize and sorghum production likely larger than at 1.5°C. Vulnerabilities to food security in the African Sahel will be higher at 2°C compared with 1.5°C. Higher risks of undernutrition. | Substantial increases in the number of hot nights and heatwave duration and frequency are very likely. Negative impacts on crop yield may result in major reductions in yield. Regional food insecurity. High risks of undernutrition. |

.../...

T1 Emergence and intensity of climate change hotspots under different degrees of global warming (cont.)

| Region and/or phenomenon | Warming | | |
|--------------------------|--|--|---|
| | of 1.5°C or less | of 1.5°C–2°C | of 2°C–3°C |
| Southern Africa | <p>Reductions in water availability.</p> <p>Increases in number of hot nights and longer and more frequent heatwaves.</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>About 30% of suitable climate area lost for fynbos-type shrubs.</p> | <p>Larger reductions in rainfall and water availability.</p> <p>Further increases in number of hot nights and longer and more frequent heatwaves.</p> <p>Associated increases in risks of increased mortality from heatwaves compared with 1.5°C warming.</p> <p>Higher risks of undernutrition in communities dependent on dryland agriculture and livestock.</p> <p>Loss of about 45% of suitable climate area for fynbos-type shrubs.</p> | <p>Large reductions in rainfall and water availability.</p> <p>Drastic increases in the number of hot nights, hot days and heatwave duration and frequency, affecting agriculture, livestock and human health and mortality.</p> <p>Very high risks of undernutrition in communities dependent on dryland agriculture and livestock.</p> <p>Up to 80% of suitable climate area lost for fynbos-type shrubs.</p> |
| Tropics | <p>Increases in the number of hot days and hot nights as well as longer and more frequent heatwaves.</p> <p>Risks to tropical crop yields in West Africa, South East Asia and Central and South America are significantly less than for 2°C of warming.</p> | <p>The largest increase in hot days at 2°C compared with 1.5°C is projected for the tropics.</p> <p>Risks to tropical crop yields in West Africa, South East Asia and Central and South America could be extensive.</p> | <p>Oppressive temperatures and accumulated heatwave duration very likely to directly impact human health, mortality and productivity.</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 with impacts at 2°C of global warming.</p> <p>Risks of coastal flooding reduced by 20–80% for SIDS compared with 2°C of global warming.</p> <p>Freshwater stress reduced by 25%.</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 70-90% of coral reefs.</p> | <p>Tens of thousands of people displaced owing to inundation of SIDS.</p> <p>High risks of coastal flooding.</p> <p>Freshwater stress from projected aridity.</p> <p>Further increase of about 70 warm days per 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.</p> | <p>Substantial and widespread impacts through inundation of SIDS.</p> <p>Coastal flooding.</p> <p>Freshwater stress.</p> <p>Persistent heat stress.</p> <p>Loss of most coral reefs.</p> |

413 Adaptation

Most adaptation needs will be lower for global warming of 1.5°C compared with 2°C. There are a wide range of adaptation options that can reduce the risks of climate change for different sectors. However, there are also limits to adaptation and adaptive capacity for some human and natural systems at global warming of 1.5°C, with associated losses.

A wide range of adaptation options are available to reduce the risks to natural and managed ecosystems (e.g. ecosystem-based adaptation, ecosystem restoration and avoided degradation and deforestation, biodiversity management, sustainable aquaculture, and local knowledge and indigenous knowledge), the risks of sea level rise (e.g. coastal defence and hardening), and the risks to health, livelihoods, food, water and economic growth, especially in rural landscapes (e.g. efficient irrigation, social safety nets, disaster risk management, risk spreading and sharing, and community-based adaptation) and urban areas (e.g. green infrastructure, sustainable land use and planning, and sustainable water management).

Adaptation is expected to be more challenging for ecosystems, food and health systems at 2°C of global warming than for 1.5°C. Some vulnerable regions, including small islands and least developed countries, are projected to experience high multiple interrelated climate risks even at global warming of 1.5°C.

Limits to adaptive capacity exist at 1.5°C of global warming, become more pronounced at higher levels of warming and vary by sector, with site-specific implications for vulnerable regions, ecosystems and human health.

matters. It underlines the need for economic scenarios to take better account of the damage linked to climate risks, including the cumulative effects of different risks and the costs of adaptation.

The SR15 contains an in-depth analysis of the residual carbon budgets, pathways for greenhouse gas emissions and aerosols, and changes in land use that are consistent with the stabilisation of warming at 1.5°C, with or without overshoot. It stresses that we have a small window of opportunity to constrain warming to 1.5°C, but only if we take unprecedented action to halve global CO₂ emissions by 2030 and achieve net zero by 2050. Each year counts.

The SR15 explores the latest knowledge on the major transitions in energy, land management, food production, urban, infrastructure and industrial systems (supply), and the changes in demand (for energy, materials, food) that would be necessary to achieve this climate stabilisation. For each system, the report analyses the available mitigation and adaptation options and the associated enabling conditions, and assesses their feasibility from six different perspectives. It also assesses the links between sustainable development, climate change and the potential responses, and examines the synergies and trade-offs between mitigation and adaptation options through the framework of the United Nations Sustainable Development Goals, which aim to improve social well-being. Each choice counts if we are to implement ethical and equitable transitions combining both development and climate-related policies.

As part of the IPCC's 6th assessment cycle, two other special reports are being prepared for 2019, one on climate change and land use (SRCCL), and the other on the ocean and cryosphere in a changing climate (SROCC). These will complete the SR15's assessment for warming pathways of more than 2°C. If implemented, and without any further strengthening of climate ambitions, the mitigation measures announced by governments up to 2030¹⁸ will imply global warming of around 3°C by 2100, and continuing temperature rises thereafter.

51 Conclusions and outlook

The SR15's assessment of current knowledge of climate-related risks¹⁷ clearly demonstrates the extent to which each half a degree of warming

¹⁷ At the end of each chapter there is a detailed analysis of the main sources of uncertainty and the gaps in current knowledge.

¹⁸ Nationally Determined Contributions (NDCs) set within the framework of the Paris Agreement.

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Unlocking the strategic economic opportunity of clean and inclusive growth

Climate change is already harming global development. Further warming will have immense impacts on the functioning of economies, societies and ecosystems.

Flawed economic models of climate choices continue to underestimate and distort the full costs of disruption – as well as the strategic benefits of low-carbon innovation. These flaws are contributing to delays in robust climate action.

Unprecedented efforts are now needed to decarbonise the global economy at scale and speed. Importantly, this clean and inclusive growth path will yield strong economic and social benefits.

Delivering these benefits requires system-wide efforts from financial policymakers and financial institutions, as a key element of overall policy, at a time of growing geopolitical and economic uncertainty.

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11 Climate change: the severe dangers of further delay

Climate change is already affecting human well-being and economic development. Evidence suggests that climate change is increasing the intensity of extreme weather events across the world,¹ exacerbating droughts,² and leading to large-scale losses of coral reefs.³ These impacts are being felt at around 1°C of warming above the pre-industrial levels.⁴

Understanding of the magnitude of risks and the urgency of action has been deepened still further by the Intergovernmental Panel on Climate Change (IPCC) *Special Report on Global Warming of 1.5°C* released in 2018. The report highlights the various impacts of reaching and stabilising global temperature increases at 1.5°C, the lower end of the temperature targets included in the 2015 Paris Agreement. The impacts include more extreme, and more frequent, hot days in mid-latitude countries and more frequent extreme cold days in high latitudes. Alongside temperature increases, there could be a 0.4 metre sea level rise, up to a 90% decline in coral reefs, a 6% loss in insect species, more intense extreme events (hurricanes, floods, etc.) and an increase in the average length of droughts. Different places will experience different impacts.

At 2°C of warming all of these impacts would be magnified, often by more than double those experienced at 1.5°C.⁵ This would also make the chances of reaching potentially irreversible biophysical thresholds (or “tipping points”), such as melting of the permafrost or the loss of Greenland ice sheets, more likely, which would set in motion a cycle of ever-increasing temperatures and consequent impacts for society.⁶ Each extra increment in temperature generates greater and greater impacts and risks.

Experiencing any one of these risks could have immense impacts on the functioning of

economies, societies and ecosystems, but they are all predicted to occur alongside, and amplify, each other. The consequences could mean the inundation of previously habitable areas (flooding or sea level rise), increasing desertification, battering of people and infrastructure from more intense and frequent extreme weather events (hurricanes, floods, fires, etc.), or expose more people to slower onset impacts (droughts or heat) leading to crop failures or intense water shortages. The impacts could lead to the collapse of ecosystems on which people’s lives and livelihoods rely. Taken together, all this could redefine where people can live and be productive. Unmanaged climate change could lead to mass movement of people, whether internally or between countries, resulting in local and regional destabilisation and conflict.⁷

We must recognise that current paths would likely take us beyond 3°C over the next century or so,⁸ temperatures that have not been seen for around three million years and way outside the experience of Homo sapiens. The consequences would likely be devastating for the livelihoods of many of the world’s peoples.

21 The limits to current economic models in understanding economic costs

There have been some attempts to estimate the scale of the economic impacts of climate change. In 2014, the IPCC estimated that 2°C of warming would result in economic losses of between 0.2% and 2% of global GDP.⁹ Other studies have made more regional or country projections of the losses; for example, the United States’ Fourth National Climate Assessment¹⁰ estimates that climate change could cost up to 10% of US gross domestic product (GDP) by the end of the century.

However, it is important to note that these projections are most often based on

1 See, for example, van Oldenborgh et al. (2018).

2 See Otto et al. (2018).

3 See Hughes et al. (2018).

4 This refers to increases in average global surface temperature since the end of the 19th century (the conventional benchmark).

5 See IPCC (2018).

6 See Steffen et al. (2018).

7 See Abel et al. (2019).

8 See UNEP (2018).

9 See IPCC (2014).

10 See USGCRP (2018).

integrated-assessment models (IAMs) that aim to combine the biophysical impacts of climate change and their consequential impacts on economic systems. While IAMs are noteworthy in their attempt to combine the two systems and have contributed to increased understanding of some of the economic impacts, those using IAMs have to recognise their limits; and the effect of these on the assessments of economic costs and opportunities should be considered accordingly. As argued in Stern (2016), the current IAMs fall far short in three main areas when considering the economics of climate change. They are profoundly flawed and grossly underestimate the potential damages from climate change.

First, they struggle to incorporate many of the largest risks. In particular, these relate to incorporating the latest evidence from the physical sciences, such as the knock on effects from crossing climate thresholds or “tipping points”. These risks make up some of the largest and potentially irreversible risks arising from climate change (for example, melting permafrost, Amazon dieback or melting of the Greenland and Arctic ice sheets). These risks are inherently uncertain and the current approach in IAMs is to either exclude or minimise them as the lack of detailed understanding cannot be easily incorporated into the current model designs, notwithstanding the emphasis placed by scientists on these very serious dangers.¹¹

Second, current IAMs struggle to account for the dynamic benefits of innovation, learning and feedback loops that promote institutional and behavioural change, discovery and economies of scale. The benefits of these processes are already being seen through the rapid falls in the costs of renewable energy and energy storage technologies and the roll out of such technologies. However, these decreases were grossly underestimated by the current suite of IAMs.¹² This underestimation of the pace of technology advancement and costs falls leads to

an overestimation of the costs of strong action, making it less attractive to policymakers to take decisive action. The error is compounded by the models utilising increasing marginal costs of carbon reduction when we see strong returns to scale in both product innovation and discovery.¹³ The assumptions on the costs of action in these models have been dramatically misleading.

Third, the utilisers of IAMs often apply high discount rates to future scenarios. This can have the effect of assuming that the lives of people in the future are less valuable, or less important, than those today even in the context where their consumption is identical. That is discrimination by date of birth which most would regard as ethically unacceptable. The models also make assumptions on an underlying rate of future economic growth, and conclude that people in the future will be much wealthier than people are today and thus more resilient to shocks. These assumptions combine a weakness of understanding of the principles of discounting and implausible assumptions around the magnitude of climate risks.

In spite of these shortcomings the IAMs, and their outputs, have entered the mainstream and are widely used to inform policymaking and design around climate change. Indeed, William Nordhaus was jointly awarded the 2018 Nobel Prize in Economic Sciences for his pioneering work in this area. But when taken together these assumptions result in the downplaying of the immense shocks climate change would have on welfare and livelihoods, as well as underplaying the enormous benefits of action. The models generally identify an “optimum” temperature stabilisation range of around 3°C,¹⁴ a level not seen for millions of years and discordant with what the science is telling us. Scientists are understandably astonished at such statements but it is clear that they follow directly from bad models and assumptions.

11 See Ackerman et al. (2010).

12 See Dietz and Stern (2015).

13 See Dechezleprêtre et al. (2017), for examples.

14 See, for example, Nordhaus (2018).

At temperature levels of this magnitude the shocks to lives and livelihoods, as illustrated earlier, could be so large that they fundamentally undermine economic systems or lead to large losses of life. This would result not in mere deviations from constantly increasing GDP, but in permanently reduced stocks of capital (physical, human, natural, social and financial) leading to reduced wealth and opportunities for future generations.

3I Unprecedented action now required to decarbonise the global economy

Avoiding these outcomes requires unprecedented economy-wide action to reduce greenhouse gas (GHG) emissions. Current rates of global GHG emissions are on the wrong trajectory. In 2018, annual carbon dioxide emissions from fossil fuels were around 37 gigatonnes of carbon dioxide (GtCO₂); annual total GHG emissions¹⁵ were around 50 gigatonnes of CO₂ equivalent (GtCO₂e). For the past three years (2016 to 2018), annual CO₂ emissions from the combustion of fossil fuels¹⁶ have risen at a rate of 0.6%, 1.3% and 2.7% respectively.

The United Nations Environment Programme¹⁷ provides a stark illustration of how maintaining current levels of GHG emissions translates into future temperatures. If no further action is taken and GHG emissions continue at current rates, then the world would be on track for an increase of more than 4°C by the end of this century. If increased mitigation action is taken in line with current country commitments under the Paris Agreement,¹⁸ then this could result in an increase of around 3°C above pre-industrial levels.

In comparison, the Paris Agreement has set a temperature target of “well-below 2°C, with best efforts for 1.5°C”. At the current rates of GHG emissions, there are 10 to 12 years of

atmospheric space left to limit warming to 1.5°C, for 2°C about 20 years. If we follow a managed annual decline in emissions, we need to reach net-zero GHG emissions around mid-century for 1.5°C, or around 2075 for 2°C. Note that stable temperatures require stable concentrations and thus net-zero emissions. The earlier net-zero is reached, the lower the stabilised temperature. It is clear that meeting the Paris targets requires reduced emissions and rapid change and failing to meet them is profoundly dangerous. The next two decades are decisive.

4I The shift to zero-carbon is the inclusive growth story of the 21st century

In the next twenty years or so, if global growth continues at around 3% a year then global output will roughly double. At the same time, cumulative investment in infrastructure will likely more than double to enable and support this growth. The majority of this investment will need to be made in the urban areas of developing countries. How this investment happens will determine our ability to manage or avoid the immense potential impacts of climate change. If we follow the growth model of the past and lock in high-carbon and polluting investments we will be in great danger. We can, however, set off on a new and very attractive direction for growth and development.

Evidence from many countries, including the European Union, United Kingdom and United States, has demonstrated that it is possible to decouple economic growth and development from GHG emissions. But the opportunities we now have are much stronger than embodied in the word “decoupling”. The discoveries, innovations and investments being made now are the drivers of growth and are only the beginning.

This argument has been developed in the report of the New Climate Economy.¹⁹ Through focusing

15 Including GHG emissions from agriculture, forestry and land use and a range of GHGs beyond CO₂.

16 CO₂ emissions from combustion of fossil fuels account for around 75% of anthropogenic GHG emissions (Global Carbon Project, 2018).

17 See UNEP (2018).

18 Known as “nationally determined contributions”.

19 See NCE (2018).

immediate action and investment in the five areas and systems of energy, cities, food and land use, water, and industry, the analysis indicates that it is possible to generate over 65 million new jobs, and to avoid 700,000 premature deaths as a result of reduced air pollution, by 2030, with USD 2.6 trillion of extra output by 2030. In our view, the projections are conservative in that it has been quite cautious on assumptions on technical progress; for example, the iPhone is just over ten years old and has revolutionised whole sectors of the economy. This change was not captured in models from ten to twelve years ago.

The broader underlying logic of the new growth story could be illustrated as follows. The economic and social benefits of investment in the short term would come via increased demand and sharpened supply from investment in smart and suitable infrastructure. In the medium term, the new approach would unleash waves of innovation and discovery. In the long term, investment would protect lives and livelihoods by avoiding the worst impacts of climate change. Growth, poverty reduction and strong action on climate change are complementary and highly attractive.

Unleashing this new growth path requires widespread structural changes to many systems. This change will come with disruptions to some existing industries and people's livelihoods. This will occur at the same time as other fundamental changes occur in economies and societies, such as increasing shifts to services and automation.

These changes should and can be considered and managed together. We must learn from past mismanagement of structural change. It is for this reason that designing and delivering a "just transition" has rapidly risen up the climate change agenda, highlighted by the Silesia Declaration launched at the COP24 climate conference in December 2018.²⁰ There is much we can

do in terms of helping to create new skills and opportunities and improving social safety nets, with priority for the poorest.

51 Harnessing the financial system in a time of turbulence

Supporting and managing the transition will require significant investment of the right kind; modern, smart, efficient and sustainable. Infrastructure alone will require, globally, around USD 90 trillion over the next 15 years or so.²¹ Much of this investment will have to happen one way or another, but to meet climate change objectives and the Sustainable Development Goals all of it has to be sustainable from now on.

The challenge of effective climate change policy is to translate the great array of attractive investment opportunities into real projects and programmes. This requires sound policy to draw the investment through and requires the right kind of finance, at the right scale and at the right time. In this short paper with its emphasis on finance we focus on the financial issues.

Responding to the challenge of mobilising finance around these investments requires a recognition of the problem that, in recent decades, the finance sector has become divorced from the real economy. Finance has become a dominant sector in and of itself, rather than playing its "notional" role of intermediation between savers and investors, or its role in risk management for insurance, pensions and so on. The separation of finance from "real investment" fosters asset bubbles and accentuates a focus on short-termism. Short-termism in turn forms part of the pressure on investors or corporations to act without due consideration for the impacts of their operations on the environment or wider society, particularly over the longer term. It also results in an unwillingness to take risks through innovation or investment, which may have longer-term pay-offs.

²⁰ See Polish Government (2018).

²¹ See NCE (2016).

Spurring climate action requires change in the financial system. Many of the key ingredients are starting to come together. But a further bout of financial turmoil could raise significant barriers to action.

In 2018, ten years after the global financial crisis, a powerful set of structural, cyclical and circumstantial fault lines were revealed. Debt per unit of output is continuing to rise. According to the International Monetary Fund, total non-financial sector debt in major economies stands at USD 167 trillion, up from USD 113 trillion in 2008, a rise from more than 200% of gross domestic product to close to 250%.²² This increased debt dependency creates new fragilities. If we are not careful, this could divert attention away from the urgent need to scale up investment in climate action and sustainable development.

Already there are signs that this new phase in the markets is having an impact on raising finance for climate action, with the global green bond market hitting a plateau. Between 2016 and 2017, issuance almost doubled from USD 87 billion to USD 162 billion. In 2018, however, issuance rose marginally to USD 167 billion, far below market expectations. Deleveraging in China has been a contributing factor.

Economic growth is also slowing and forecasts are being cut further. No one knows, of course, whether today's turbulence will translate into a full-blown crisis. But if it does, the consequences for financing climate action could be serious if policymakers and market participants are not prepared. The task ahead for all is to anticipate possible shocks and plan ahead.

We are, however, in a stronger position to take decisive action in the near term. There are increasing signals from across the financial system highlighting the desire for long-term climate action. Nearly 400 investors representing

USD 32 trillion in assets under management are taking action on one or more areas of the globally coordinated Investor Agenda²³ on climate change – and are calling on governments to introduce more ambitious policy frameworks.

We also now have an internationally consistent framework through the recommendations of the Task Force on Climate-related Financial Disclosures (TCFD) for companies and financial institutions to report publicly on their activities.²⁴ A growing number of countries and regions – such as Canada, China, the European Union, Morocco and the United Kingdom – are putting in place roadmaps to drive sustainable finance. And 30 of the world's top central banks and regulators have come together in the Network for Greening the Financial System (NGFS) to respond to the financial stability implications of climate shocks.²⁵

In development finance, there are many positive developments too. The multilateral development banks (MDBs) have united under a common framework to increase their flows of finance to support low-carbon and resilient development.²⁶ 2018 also saw increases in commitments for resources to combat climate change, led by the World Bank.

The challenge is to maintain momentum through any potential turbulence, and to scale up rapidly too. One starting point to manage any shock is to fast-forward essential reforms. Crises tend to shorten time-horizons, putting off vital long-term actions. Weak and uncertain policy remains one of the major obstacles facing financiers wishing to back the transition. 2019 should therefore be the year when governments put in place long-term strategies for decarbonisation, with clear, credible policies, to give confidence to markets on the strategic road ahead. Europe's climate neutral 2050 strategy is one example of the economy-wide response that is needed. This will be central to the United Nations Secretary-General's Climate

²² See IMF (2018).

²³ See <https://theinvestoragenda.org>

²⁴ See <https://www.fsb-tcfd.org>

²⁵ See <https://www.banque-france.fr/en/communique-de-presse/ngfs-1st-anniversary-and-announcement-five-new-members>

²⁶ See <https://www.adb.org>

Summit in September, which is a key step along the road to United Nations Framework Convention on Climate Change COP26 in 2020 when national commitments on climate action are due to be strengthened under the Paris Agreement.

Importantly, a systemic approach also requires the linkages between climate action and wider efforts to implement the SDGs to be clearly underlined. For financial institutions, the transition to a resilient, net-zero economy has profound environmental, social and governance (ESG) dimensions. In particular, these efforts to shift large flows of capital have to be placed in a broader social context of building an inclusive economy. For banks and investors, this means working with other stakeholders to support a just transition.

Governments should also consider a second and more sustainable “green stimulus” programme. Back in 2008, many governments responded to the global financial crisis with a fiscal stimulus. Some of these were tailored to promote the sustainable or green economy, helping to spur renewables, energy efficiency and mass transit investments, notably in China and the United States. Calls for an ambitious Green New Deal are back on the table, not least in the United States. At times of uncertainty, markets yearn for direction. Those governments that seize the opportunity in strategic climate action could use 2019 as the moment to launch a coordinated issuance of sovereign bonds.

Importantly, governments have the experience of the last stimulus before them to guide what to do in the face of intersecting monetary, trade and macroeconomic challenges. Here, governments could usefully focus public investment on projects that can get off the ground quickly, reach scale and unleash waves of costs falls, innovation and investment. This would lay the foundation for an efficient, sustainable and productive economy

for decades to come. Such projects would afford good value for money for taxpayers, promote fiscal sustainability and have positive global spillovers that could accelerate decarbonisation. With public debt still funded at close to zero real interest rates, investment in new assets would improve public sector net worth and bolster fiscal sustainability through securing a more resilient future tax base.

One of the weaknesses of the previous green stimulus was its stop-start nature, with positive fiscal support removed in subsequent rounds of austerity. This time any stimulus should be designed so that it generates steady and durable incentives for growth sectors. The annual budget cycle gives governments the opportunity to load the dice in favour of the transition, removing perverse incentives and giving preferential treatment for measures that increase the shift of the capital stock towards sustainable assets. Policy will have to be flexible as circumstances change and technologies advance, but it must be “predictably flexible” against criteria that are transparent. Here, the role of national and multilateral development banks will also be crucial, providing precious patient capital at a time of mounting uncertainty. It will be vital for these institutions to better use their ample balance sheets to build the pipelines of assets where private actors fear to tread. Creating the power of the example is key, particularly in developing and emerging markets.

Another response to the last financial crisis was the introduction of quantitative easing (QE), which was vital to sustaining demand and liquidity. But there were a variety of knock-on impacts for markets and inequality. One of these was a blindness to the environmental and social quality of bond purchases.²⁷ This time around, central banks are winding down QE. But they can still play a vital role by sending clear signals that they will integrate environment and social factors into the management of their balance

²⁷ See Matikainen et al. (2017).

sheets and monetary operations. The European Central Bank (ECB), for example, has announced that it will no longer make new bond purchases, but will buy new bonds as its existing stock come to maturity. As Paul De Grauwe has argued recently, this creates a “window of opportunities” for the ECB to replace the old bonds with new “environmental bonds”.²⁸

The nature of climate change means we cannot disregard or downplay the long-term impacts and focus on short-term responses. Tools, institutions, resources and ideas should be set on a course for many decades to take up the new opportunities, rise to the climate challenge and

manage the transition. If policymakers recognise the scale of the challenge and work decisively to bring the finance sector back towards the real economy through providing clear, credible and long-term direction for all to follow, that would be a vital contribution.

Time is of the essence. If done well, strategic action to get ahead of possible market disruption and embrace the opportunities presented by climate action could make 2019 the year when there was an irreversible shift to a more sustainable system. We know how to do it, the finance is available and the challenge for all is to act decisively, seize the opportunities and scale up action.

²⁸ See <https://escoriallaan.blogspot.com>

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The importance of being forward-looking: managing financial stability in the face of climate risk

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The relation between climate change and financial risk has gained unprecedented attention and there is now growing consensus on the fact that climate risk is material. Yet, the vast majority of private and public financial capital is not aligned with the climate targets of the 2015 Paris Agreement. This misalignment can be a source of risk for financial institutions. A fundamental difficulty with assessing and managing climate-related financial risk comes from the fact that it is largely endogenous and involves multiple scenarios. The author discusses the benefits of a framework of climate-related financial risk management under uncertainty that combines the climate stress test approach with decision theory under uncertainty. This approach makes it possible to reconcile financial stability objectives with the multiplicity of future climate policy scenarios. In debates about financial stability in the face of climate risk, central banks have an important role to play in terms of leadership by example. However, the data necessary to manage climate financial risk are complex and currently fragmented. Since these data are critical for markets to factor climate-related information into prices, regulators could support the case for a public entity with the mandate to collect, validate and make available climate-relevant data at the European Union level.

11 Introduction: climate risk has taken centre stage in financial policy

The relationship between climate change and financial risk has gained unprecedented attention in policy discussions on financial regulation.¹ The impressive list of recent prominent initiatives includes: the Task Force on Climate-related Financial Disclosures,² the Central Banks and Supervisors Network for Greening the Financial System,³ the French Article 173 and the European Commission (EC) action plan on sustainable finance.⁴ The main takeaway from these developments is the growing consensus on the fact that climate risk is material. This means that gains and losses on financial assets related to climate change, either resulting from physical shocks or from policy and technology shocks, cannot be ignored. Yet, the vast majority of private and public financial capital is still allocated today to economic activities that are not aligned, or even at odds, with the climate targets to which most countries have committed in the 2015 Paris Agreement. Therefore, several crucial questions arise: to what extent is this misalignment a source of risk for financial institutions and in particular for financial stability? What methodological frameworks can we use to understand and assess climate risk? What can financial institutions and regulators do to mitigate and manage it? In this contribution, I try to clarify these questions based on the recent stream of policy-relevant academic work.

21 From climate change to financial risk: climate physical risks and climate transition risks for financial institutions

Climate change physical risk refers to risk of damage to physical assets, natural capital and/or human lives as a result of climate-induced extreme events. Climate change transition risk refers instead to the risk arising from sudden asset price adjustments as a result of the coordination of market participants' expectations about the implementation or the impact of climate policies (e.g. a carbon tax, renewable energy target share). These adjustments are expected to negatively impact the value of fossil fuel-related assets (the so-called carbon stranded assets). They are also expected to impact indirectly the value of assets in other sectors. However, the sign of the impact can be positive or negative, depending on whether firms are able to anticipate the policy and adapt their business to alternative sources of energy. The argument that markets are good at processing information efficiently could suggest that they are also good at anticipating price changes associated with future climate policies, and that therefore there cannot be significant sudden price adjustments related to climate policies. However, the events of the last three years (e.g. US elections, US withdrawal from the Paris Agreement, Brexit, Italian elections, social tensions in France, as well as uncertainty on the upcoming European Union elections in 2019) provide evidence

1 See Carney (2015); Villeroy de Galhau (2018); Cœuré (2018).

2 See TCFD (2017).

3 See NGFS (2018).

4 In more detail: in 2017, the G20's Financial Stability Board has issued guidelines for financial institutions regarding the voluntary disclosure of climate related information (see <https://www.fsb-tcfd.org/>); the Central Banks and Supervisors Network for Greening the Financial System (NGFS) since it was set up in 2017 has set up a global and visible platform for the policy discourse on this topic; the 2015 French Energy Transition Law has been enacted and requires investors to disclose climate risks (Article 173); the European Union is currently working on a sustainable finance action plan that in 2019 will deliver a taxonomy of sustainable assets and criteria for green bonds (see <https://ec.europa.eu>).

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that: (i) market players sometimes make incorrect predictions, even collectively, on events with long lasting economic impact and thus misprice risks, and (ii) policies that entail new risks are sometimes adopted, even unexpectedly so. Thus, today, there is awareness that transition risk can be more material than many would tend to think.

3I What do we know and how can we use the available information for financial risk management?

3I1 Climate-related financial risk is endogenous

A fundamental difficulty with climate-related financial risk comes from the fact that it is largely endogenous. The risk depends on whether governments and firms continue on a business-as-usual pathway (i.e. misalignment with the Paris Agreement) or undertake a climate mitigation policy pathway and how they do this. Risks are very different across the possible scenarios. But the occurrence of the scenarios depends itself on how the decision makers, including financial investors and financial regulators, perceive the risks involved.⁵

3I2 Inadequacy of standard financial risk approaches

Because of this endogeneity and its associated deep uncertainty, the standard approach to financial risk consisting of computing expected values and risk based on historical values of market prices, is not adequate for climate risk.⁶ There are also two more interconnected reasons:

- forecasts of climate change and its impact on humans and ecosystems imply tail events⁷ and tipping points,⁸ which cannot be overcome by model consensus;⁹

- even in a single scenario, costs and benefits vary substantially with assumptions on agents' utility, productivity, and intertemporal discount rate, which ultimately depend on philosophical and ethical considerations.¹⁰

3I3 Climate (policy) event tree

Based on the 2018 Intergovernmental Panel on Climate Change report,¹¹ reaching the climate targets requires undertaking, approximately by 2030, a low-carbon energy transition, i.e. a substantial transformation of the value chain of the primary and secondary energy sectors. Consistent with the idea of identifying “high level qualitative scenarios of transition”,¹² it is useful to regard the problem of assessing climate risk as an event tree.

- If the energy transition occurs by 2030, then it could be orderly or disorderly.
 - ⇒ An orderly transition means a relatively predictable pathway in which market players anticipate price changes for assets associated with energy transition because policies are announced beforehand and are credible. While *idiosyncratic* risk related to individual firms' performances remains, there are no aggregate shocks in this scenario.
 - ⇒ In contrast, a disorderly transition implies aggregate shocks on assets prices and thus potentially *systemic* risk and undermined financial stability. The reasons why the transition could be disorderly lie in the complexity of the political economy involved, including the social dynamics. Some actors in the economy may have a narrow and short-term interest in a delayed and even in a disorderly transition, including incumbent actors who anticipate that they fail to catch up, or political parties who try to ride popular discontent. Other actors

⁵ See Battiston et al. (2017).

⁶ See Kunreuther et al. (2013).

⁷ See Weitzman (2014).

⁸ See Solomon et al. (2009).

⁹ See Knutti (2010).

¹⁰ See Nordhaus (2007); Stern (2008); Pyndick (2013).

¹¹ See IPCC – Allen et al. (2018).

¹² See TCFD (2017); NGFS (2018 progress report).

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see an early and orderly transition as an opportunity for long-term benefits in terms of business environment, competitiveness, and reputation. Hence, the very tension between these two opposing incentives may lead to disorderly transition once the latter side prevails and all actors suddenly head towards the new benchmark.

- ➔ If the energy transition is undertaken later than in 2030, then irreversible changes to the Earth system become more likely¹³ and, in addition, the transition could be disorderly.
- ➔ If the energy transition is never achieved, the increase in temperature will surely result in changes to the Earth system that are irreversible (on a scale of 1,000 years at least).¹⁴ The magnitude of socio-economic effects is unknown, but the lower bounds seem sufficient to affect economic growth, food security and migrations flows in many countries, and hence financial stability of the institutions directly and indirectly exposed.

13 See Bahn et al. (2011).

14 See Solomon et al. (2009).

15 See Drouet et al. (2015); Berger et al. (2017).

16 See Battiston et al. (2017); Monasterolo et al. (2018).

17 See Roncoroni et al. (2019); Battiston and Monasterolo (2019).

18 Note that IAMs consider only in very stylised way, if at all, the impact of climate change on the socio-economic system. In particular, it can be argued that the convex damage function used in this literature cannot account for the essential characteristics of climate risk such as tail risk and climate tipping points. The approach presented here can be adapted to use trajectories from economic models that would take also these effects into account.

19 See Henry et al. (2013).

20 See EBA (2018).

314 An approach to financial risk management under uncertainty for institutions and regulators

Decision theory under uncertainty offers a useful framework to deal with the lack of reliable probabilities for the occurrence of the events in the above event tree. Recent works have applied this approach to climate risk in the presence of model uncertainty, showing that decision-making criteria that account for aversion towards model uncertainty (e.g. MaxMin expected utility as opposed to maximum expected utility) lead to significantly different choices of the optimal climate policy.¹⁵ Decision theory under uncertainty can be fruitfully combined with the climate stress test approach¹⁶ in order to provide a portfolio risk management approach to climate-related financial risk under uncertainty. While more formal work in this direction is still in progress,¹⁷ the general idea can be summarised

as follows. We consider a risk averse investor with an information set representative of the best available knowledge:

- sets of future climate scenarios, as summarised by the IPCC reports, i.e. forecasts of greenhouse gaz (GHG) emissions and temperature, and socio-economic impacts of climate change;
- economic trajectories under climate policy scenarios, as provided by well-established economic models of climate change, e.g. integrated assessment models (IAMs);¹⁸
- historic values of market data on financial performance of firms and sectors.

While the probabilities of occurrence of the climate scenarios are not available, for each scenario, future output trajectories are available for several models, and each model can provide estimates of probabilities of certain variables. There are several established ways to make use of this mixed type of information set by combining prudential policies that do not require probabilities (e.g. a MinMax rule) with financial risk measures (e.g. Value at Risk) based on probabilities distributions.

315 From stress tests to climate stress test for financial institutions

Using the approach described above, financial regulators can conduct a climate stress test for individual financial institutions that is in line with current established approaches to stress tests as conducted by the European Central Bank¹⁹ and the European Banking Authority.²⁰ In simple terms, classic stress tests consider one or more scenarios where a shock consists in changes in macro-economic or sectorial variables that are compatible with an equilibrium state of the economy (e.g. a decrease in output in an economic sector is compatible with corresponding changes in output in other sectors, with unemployment etc.). Such shocks can be obtained from equilibrium

macro-economic models and computed as differences between two equilibrium states.

Using the information set described earlier, it is possible to obtain a similar type of shocks that represent climate policy shocks. Indeed, IAMs are (partial or general) equilibrium models of the economy that consider GHG emission targets and (to some extent) physical damages from climate change. For instance, the LIMITS (Low climate IMPact scenarios and the Implications of required Tight emission control Strategies)²¹ database provides scenarios of the evolution of the output of different sectors of the real economy in different policy scenarios (e.g. RefPol500, StrPol450, etc.) as computed by the IAMs developed by leading academic institutions in the field such as the International Institute for Applied Systems Analysis, the Potsdam Institute for Climate Impact Research (PIK – *Potsdam Institut für Klimafolgenforschung*), and the *Fondazione Eni Enrico Mattei*. Since the shock scenario that we want to analyse is a disorderly energy transition, we consider the transition of the economy from a business-as-usual (BAU) trajectory to a given trajectory (P) compatible with the 2°C target. Shocks are obtained from different sectors' output between the two trajectories (BAU and P) for the same IAM. The disorderly transition is thus intended as temporary out-of-equilibrium evolution of the economy between two separate equilibrium trajectories. This formulation has some caveats but it has the merit of being very clear and familiar from a methodological standpoint.

316 Financial shock transmission channel

The financial risk part of the climate stress test consists in translating the sectoral shocks into shocks on the value of the financial contracts (e.g. securities and loans) in which financial institutions have invested. The transmission channel works as follows: during a disorderly transition, the firms in the energy sector that have not adapted their business to the climate targets face unanticipated costs and reduced

revenues. In contrast, firms that have invested in low-carbon technologies face unanticipated profits via changes in production costs, prices and revenues. Accordingly, the positive/negative shocks on the energy firms reflect on shocks in the value of the financial contracts associated. The relationship between changes in economic output and changes in the values of financial investments depends on the type of asset class considered (e.g. equity, sovereign bond, corporate bond, loans, etc.) and the valuation approach used.

To conclude, for a given climate policy shock it is possible to compute familiar risk measures in order to obtain a climate Value at Risk (VaR, at a certain level of confidence p , for instance $p = 1\%$).²² Risk adverse financial institutions could follow the risk management strategy of comparing the climate VaR for several climate policy shocks that are judged to be severe but plausible, applying a MinMax rule across scenarios. In this way, such institutions would be able to withstand a one-in-one-hundred-year loss in the most adverse of the transition shock scenarios considered. This forward-looking approach to risk under uncertainty can also be supplemented with the use of historical market data on firm's performance.

317 Climate-relevant economic activities

The assessment of transition risk for financial portfolios requires identifying the economic activities affected by the energy transition under different scenarios of climate policy shocks. A general approach to this problem was described in Battiston et al. (2017). Starting from the standard EU classification of economic sectors (400+ NACE four-digit code, maintained by Eurostat),²³ we group economic activities by the following criteria: (i) position in the value chain of energy (e.g. suppliers of components for renewable energy technologies, or customers of fossil fuel producers), (ii) role in the business lines of a firm, (iii) direct and indirect contribution to GHG emissions or emission reductions, and (iv) relevance to policy. The process yields

21 The LIMITS Scenario database is operated by the International Institute for Applied Systems Analysis (IIASA): <https://tntcat.iiasa.ac.at>

22 See Dietz et al. (2016) for global estimates; Battiston et al. (2017) for individual portfolio estimates.

23 See <https://ec.europa.eu>

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six sectors (fossil-fuel, utility, energy intensive, transportation, housing, and finance)²⁴ and 20+ sub-sectors related to the technologies²⁵ most relevant for the energy transition (e.g. coal-fired plants versus wind turbines, internal combustion engines versus electric engines for vehicles).

These sectors are then mapped onto the variables of forward-looking economic models of climate policies (e.g. IAMs, see above) to obtain the shock as explained earlier.

318 The importance of metrics for climate transition risk for scaling up climate finance

Because financial investors respond to metrics that are relevant to regulation such as Value at Risk, computing a climate Value at Risk represents a key step to align investment to climate targets. With this view, in the last years, the Center for Financial Networks and Sustainability at the Department of Banking and Finance at the University of Zurich (UZH FINEXUS) has pursued a research program in collaboration with Paris School of Economics and Vienna University of Economics and Business (WU Vienna), with the financial support of the Swiss National Fund and the European Commission.²⁶ In a stream of work, we have introduced the climate Value at Risk for individual institutions²⁷ and covered the asset classes of equity holdings,²⁷ energy infrastructure loans,²⁸ corporate bonds²⁹ and sovereign bonds³⁰ in applications to commercial banks, central banks, development banks. These methods provide a basis for investors to mainstream climate risks in their portfolio's management.

41 What opportunities for financial supervisors and central banks to play a role?

Several studies analyse the possible role of monetary policies and macroprudential tools in

the climate action.³¹ Here I offer my view on some specific issues pertaining financial supervisors and climate risk.

411 Leadership by example: central banks can carry out climate stress tests on their own portfolios

By carrying out peer-reviewed climate risk assessment of their own portfolios, central banks can give a strong signal. Several NGFS members are already doing so. The Dutch National Bank has analysed both physical risks³² and transition risks³³ in the Netherlands. Banco de Mexico in collaboration with UZH has analysed transition risk in the network of banks and investment funds in the Mexican economy.³⁴ The Austrian National Bank supports a collaboration with WU Vienna and University of Zurich to assess transition risk on sovereign bond holdings.³⁵ Bank of England and Banque de France have announced that they will conduct climate stress tests in the near future. Central banks and regulators can encourage all financial institutions to follow their example by computing forward-looking Value at Risk in a set of agreed climate policy scenarios.

412 Leadership on thinking about climate risk in terms of risk management under uncertainty

While standard approaches are not suitable to deal with climate risks, moving to new approaches requires some innovation in the culture of corporates and organisations, which is often elicited by exercising leadership. The proposed approach to climate risk in terms of financial risk management under uncertainty has the advantage of bridging the gap between the required innovation and the established methodological frameworks. Financial supervisors can be leaders in the debate by leveraging on the NGFS platform and its “qualitative scenarios of transition”.³⁶

24 Note that while finance is not directly affected by climate policy, it is an important sector to look at because under some circumstances it can propagate and amplify shocks indirectly.

25 While the NACE classification does not have the sufficient granularity to distinguish some of these technologies it can be supplemented with industry-level or even firm-level sources of transition risk.

26 See projects SIMPOL (Simultaneous Policy, <https://cordis.europa.eu/>), DOLFINS (Distributed Global Financial Systems for Society, <https://cordis.europa.eu/>) and CLIMEX funded by the Future Emerging Technologies programme.

27 See Battiston et al. (2017).

28 See Monasterolo et al. (2018).

29 See Battiston and Monasterolo (2019).

30 See Battiston and Monasterolo (2018).

31 See Matikainen et al. (2017); Dunz et al. (2019); Campiglio et al. (2018); Monasterolo et al. (2018); Monnin (2018); Schoenmaker (2016, 2019); D'Orazio et al. (2018).

32 See Regelink et al. (2017).

33 See Vermeulen et al. (2018).

34 See Roncoroni et al. (2019).

35 See Battiston and Monasterolo (2019).

36 See NGFS (2018).

**4/3 Supporting the disclosure
of climate-related financial information**

Climate-related financial information requires firm-level data that, although not confidential, are fragmented, and would therefore need complex consolidation (e.g. shares of technologies across business lines) that is not currently provided by commercial financial data providers. Since these data are critical for the market to factor climate-related information into prices, regulators could support the case for a public entity with the mandate to collect, validate and make available climate-relevant data at the EU level.

**4/4 Signalling to policy makers
the critical role of the energy transition**

It is in the interest of financial stability that regulators signal to decision makers in the areas of economic and environmental policy that: (i) the energy transition is possible and that the financial sector is onboard (see e.g. initiatives as PRI – Principles for Responsible Investment and UNEP FI – United Nations Environment Programme Finance Initiative); (ii) markets await credible signals from politicians in terms of stable energy policies in order to factor future scenarios into prices and market values of risk.

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Financial exposure: climate data deficit

Climate change is now recognised as a key driver of risk and opportunity within the global economy.

Over the past two years, we have seen a critical paradigm shift in the way the financial sector considers and responds to climate risks. These considerations extend beyond ideology or environmental concerns, as economic and financially sound decision-making requires firms to respond to the risks posed by climate change.

The transition to a low-carbon economy is already underway. The world's leading supervisory authorities and central banks are encouraging this smooth transition, and working to close the climate data deficit around the likely impact of the physical, transition and liability risks of climate change.

There is a role for regulators, supervisors and central banks globally to ensure that the entities they regulate identify, assess, manage and publicly disclose their climate risks. However, a multi-stakeholder approach, involving industry, academia, think tanks and policymakers will be required for a smooth transition to a low-carbon economy.

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The following article is based on a speech that was delivered by Geoff Summerhayes, Australian Prudential Regulation Authority (APRA) Executive Board Member and Chair of the Sustainable Insurance Forum (SIF), at a University of Cambridge Institute for Sustainable Leadership event on 22 February 2019. The event launched two ClimateWise reports which aim to help the financial industry prepare for both the transition and physical risks associated with climate change.

The present article describes how supervisors – in particular insurance supervisors – can contribute to managing climate change risks on a global scale, and articulate the need for disclosure on climate change risk.

¹ See ABC News (2019).

11 The climate data deficit

The Australian summer is rarely mild, but the 2018/2019 one has been particularly intense, with January officially the hottest month ever recorded by the Australian Bureau of Meteorology.¹ In parts of the inland, temperatures over recent weeks have peaked at close to 50°C. At that temperature, the ability of people and animals to safely go about their daily lives is seriously impeded. Working or playing outside is dangerous. Compounding the situation, vast areas of the continent, mostly farming communities, are in severe drought. Rivers have dried up, fish are dying and livestock are starving. At the other extreme, the city of Townsville in Queensland's north is recovering from a one in 100-year flood. Parts of the city that were thought

Box 1

The Sustainable Insurance Forum (SIF)

The SIF is a network of insurance supervisors and regulators from around the world, including the *Autorité de contrôle prudentiel et de résolution* (the French Prudential Supervision and Resolution Authority), who are working together on sustainability challenges facing the insurance sector. The SIF provides a platform for international collaboration among supervisors, facilitating knowledge sharing, dialogue, and uptake of policy innovations. It convenes supervisors, makes consensus statements on sustainability developments, provides expert input on sustainability topics and produces research outputs.

The SIF works in cooperation with the Central Banks and Supervisors Network for Greening the Financial System (NGFS), of which the Banque de France is a founding member and for which it provides the Secretariat.

The SIF has also partnered with the International Association of Insurance Supervisors (IAIS) to explore the risks that climate change poses to the insurance sector. Together, the SIF and IAIS released an *Issues Paper on Climate Change Risks to the Insurance Sector* in mid-2018,¹ the first effort by an international financial standard setting body to assess how climate change risks may affect financial institutions. This issues paper was targeted at raising awareness for insurers and supervisors of the challenges presented by climate change. Case studies of leading supervisory agencies, including Australian Prudential Regulation Authority (APRA), were set out in the paper, to inform supervisory bodies around the world when designing and implementing their own responses to these risks.

The SIF will continue to work in partnership with the IAIS to develop a second issues paper, and with a focus on the implementation of the recommendations of the Financial Stability Board's Task Force on Climate-related Financial Disclosures and insurer investment in low-carbon sectors.

¹ See <https://www.iaisweb.org>

to be out of the reach of even the worst inundation were flooded, and the water was not the only danger.

Extreme weather and the hardship it brings are nothing new for Australia. Indeed, scientific evidence points to both the frequency and severity of extreme weather events intensifying further over coming years due to climate change. Despite this, Australia – like many other countries – still lacks the political consensus needed to respond to the threat with the urgency scientific evidence suggests it deserves. The debate has typically centred around the economic cost of acting, with sceptics alternatively arguing that climate change is a con, or overstated, or that reducing carbon emissions will harm Australia's economy to the benefit of rivals.

However, climate change is rapidly moving beyond a purely partisan or moral issue – indeed, the threat is distinctly financial in nature. The Sustainable Insurance Forum (SIF) believes that climate risk – and society's responses to it – are driving substantial changes to the global economy. The weight of money, through consumer demand, investor decisions and regulatory responses, is pushing the transition to a low carbon economy relentlessly forward. This shift has consequences for us all, but to make good decisions, governments, regulators, businesses and investors need access to timely, reliable and sufficiently granular information.

Although the scientific link between rising carbon emissions and warming temperatures is irrefutable, data around the likely impact of the physical, transitional and liability risks of climate change, and how to best manage them, remains under-developed. The key message of this article is that this climate data deficit must urgently change if boards, governments and regulators are to adapt smoothly and effectively to the changing environment.

Regulators are working to close the knowledge gap, as they shift from raising awareness towards

actively mandating that companies undertake climate risk analysis and market disclosure. But forward-thinking business leaders are not waiting to be pushed. By signing up to initiatives such as ClimateWise,² and by implementing the recommendations of the Task Force on Climate-related Financial Disclosures (TCFD),³ these companies are committing to identify, assess, manage and publicly disclose their climate risks. By moving ahead of the pack, these can gain crucial competitive advantages over their rivals. Rather than economic factors being a barrier to taking action on climate change, far-sighted business leaders recognise that economic factors make such actions imperative.

21 Decision-making in an uncertain environment

Insurers – by their very nature – are experts in measuring and managing risk. But doing this accurately requires access to reliable data, such as historical records, models and scientific analysis to underwrite their policies and calculate premiums that keep the business competitive and profitable. But what if past experience is no longer a reliable guide as to what will happen in future?

While global insured losses in 2018 were roughly half of those in 2017, 2018 was still the fourth most costly year on record.⁴ The primary contributing factor was natural disasters, around 80% of which were deemed to be climate-related.⁵ As average global temperatures trend upwards, scientists predict the frequency, severity and distribution of natural catastrophes and extreme weather events will be impacted. Evidence to date suggests these changes will not be economically favourable. According to Aon Benfield, total economic losses in the United States from hurricanes in 2017 were nearly five times the average of the preceding 16 years, losses from wildfires were four times higher and losses from other severe storms were 60% higher.⁶

2 See <https://www.cisl.cam.ac.uk>

3 See <https://www.fsb-tcfd.org>

4 See Swiss Re (2018).

5 See World Meteorological Organization (2014).

6 See Aon Benfield (2017).

Although insurers are the most obviously exposed to the physical impacts of climate change through the potential for higher claims, the flow-on effects have the potential to harm every financial industry and impair global economic growth. Potential secondary impacts include the creation of stranded assets, the inability for households or businesses in high risk areas to secure credit and a widening of the insurance gap. The ever more-interconnected nature of the global economy means an economic ailment in one part of the world can quickly cause an epidemic in another part, as occurred during the Asian and global financial crises. It is for these reasons that the NGFS, a counterpart coalition of the SIF, warned last October that the financial risks of climate change could be system-wide and irreversible if not addressed.⁷

3I Overcoming the data deficit

The challenge governments, regulators and financial institutions face in responding to the wide-ranging impacts of climate change is to make sound decisions in the face of uncertainty about how these risks will play out. As the NGFS notes, tools and methodologies for conducting climate and environmental analysis are under-developed, the quality and availability of the data are limited, and further work is needed to translate the science into useful decision-making risk assessment information.

Another barrier is the absence of an accepted global standard for identifying, assessing, comparing and disclosing climate risks and opportunities – the closest effort yet being the TCFD. Today, the TCFD is supported by more than 500 companies with a combined market capitalisation of around USD 8 trillion. But as impressive as that sounds, it is not enough. Those 500 companies are a fraction of the number of companies in the world, while that USD 8 trillion needs to be put in the context of a global gross domestic product (GDP) estimated at USD 88 trillion in 2018.⁸ On that basis, regulators are increasingly questioning whether market-led action alone will produce an uptake in TCFD

compliance at the scale and speed necessary to avert damaging financial consequences down the track.

From a regulator's perspective, the benefits of enhanced disclosure and transparency are clear. In order to confidently assess whether entities are financially viable, well-governed, regulatory compliant and resilient, regulators need information – especially relating to new and emerging risks. For investors too, climate risk disclosure delivers obvious benefits. The availability of detailed, accurate information on past performance and future prospects helps investors to make informed decisions when pricing risk and allocating capital. But the companies at the forefront of climate risk disclosure are also benefitting. By providing additional assurances to the market, these businesses put themselves at a competitive advantage in attracting investment, not to mention customers who are increasingly prone to vote with their wallets by boycotting those with poor environmental records.

What these companies no doubt understand is that the very act of committing to disclose inevitably prompts companies (not only the ones that disclose, but also their counterparts) to take practical steps to enhance their business preparedness for the climate-related risks on the horizon. In order for a company to effectively disclose its exposure to the risks of global warming and its potential opportunities, it needs to know what these are. Once these risks and opportunities have been identified, boards and executives are in a position to act to mitigate against risks and take advantage of opportunities, be they developing new products, expanding into untapped markets or investing in green finance opportunities. Early movers are also prescient enough to understand that regulators' current stance of merely encouraging climate-risk disclosure will inevitably harden towards making such disclosure mandatory. It is no coincidence that the companies leading the shift towards the low carbon economy tend to be most sophisticated businesses, with the greatest ability to model, predict and pre-empt market changes.

⁷ Network of Central Banks and Supervisors for Greening the Financial System (2018), p. 3.

⁸ International Monetary Fund (2018).

4I Governance under the microscope

Financial regulators in most jurisdictions are not yet at the point of mandating climate-risk disclosure, let alone requiring companies to take specific actions beyond considering the issue as part of their normal risk management processes. However, mindful of the systemic risks associated with transitioning to a low carbon economy, regulators are asking ever more pointed questions to deepen their understanding of regulated entities' levels of preparation and resilience. For example:

- Is your organisation assessing the potential for climate change to have impacts on capital adequacy and solvency?
- Has your organisation directly or indirectly incorporated physical or transition-related climate change factors into the pricing of insurance products?
- Does your organisation expect that transition risks will affect the valuation of financial assets in your investment portfolios?

These are actual questions from the Sustainable Insurance Forum's Question Bank, a tool developed by the SIF last year to aid insurance supervisors during their on-site meetings and off-site supervisory reviews. Once again, those companies that are more advanced in their response to emerging climate risks will be better positioned to satisfy regulatory scrutiny.

The Question Bank is just one of the practical tools that the SIF, in co-operation with the IAIS, is developing to support supervisors' efforts to mainstream climate change issues into everyday practices. Armed with new tools and a growing understanding of the prudential threat climate change poses to the industries and entities they supervise, regulators are poised to step up their engagement on these issues. Measures that companies might expect to see regulators undertake over coming years include:

- assessments of portfolio exposure to carbon asset risk,
- climate-related stress testing and scenario analysis, and
- examining whether insurers underwriting and investment activities align with climate goals.

Such initiatives will help to give regulators greater insight into what is happening across the industries and companies they supervise, but of greater importance is companies actively deepening and disclosing their understanding of what is happening in their own businesses. Without that action, the totality of relevant data will inevitably be limited, because no one can know what climate-related risks and opportunities a company faces better than its own board and management.

On that front, there have been several promising recent developments. The first is a partnership between UN Environment Finance Initiative and 16 of world's largest insurers⁹ to develop a new generation of climate risk assessment tools to support TCFD Implementation. This project is especially important for smaller or less sophisticated companies that may lack the expertise or resourcing to develop those capabilities independently. Another positive development concerns the two documents that have been issued by ClimateWise.¹⁰ These reports provide practical guidance to help investors and lenders anticipate and respond to the physical and transitional risks of adapting to a warming planet and the move to a low carbon economy.

5I Towards a sustainable future

The word "sustainable" has a distinctly environmental connotation these days, and there is no doubt that failure to meet the targets set down under the Paris Agreement would have serious consequences for the sustainability of life.

⁹ See <https://www.unenvironment.org>

¹⁰ See CISL (2019a and b).

Box 2

The Australian Prudential Regulation Authority and climate risk

In the Australian domestic context, the Australian Prudential Regulation Authority (APRA) has promoted awareness and understanding of the financial risks associated with climate change and the need for resilience among the authorised deposit-taking institutions, insurance companies and superannuation (pension) funds that it regulates.

APRA has engaged with industry, academics, scientists and other relevant stakeholders to encourage them to consider the risks posed by climate change. This engagement has included speeches, conversations with boards and senior executives, presentations to directors and through a range of international forums, and is ongoing.

APRA has advised that climate change risks are material, foreseeable and actionable. It continues to encourage the entities it regulates to consider climate risks within their risk management frameworks, consistent with the minimum requirements set out in APRA's risk management prudential standards: *Prudential Standard CPS 220 Risk Management (CPS 220)* and *Prudential Standard SPS 220 Risk Management (SPS 220)*.

APRA has also taken steps to improve the understanding of climate change risks internally, to ensure that APRA supervision and risk teams are equipped to supervise the risks. APRA developed an internal heat map of the key risk areas set out in APRA's risk management standards and assessed the respective criticality of climate change risk considerations of each of these by regulated industry. This heat map is supported by internal guidance tailored to each regulated industry, which includes a summary of the risks, relevant reference material from both international and domestic sources and guiding questions for supervisors to refer to when discussing climate change issues with supervised entities.

In order to coordinate the Australian domestic regulatory responses to climate change risks, APRA participates in the Council of Financial Regulators Working Group on Financial Implications of Climate Change, along with the Australian Securities and Investments Commission, the Reserve Bank of Australia and the Commonwealth Department of Treasury.

In mid-2018, APRA conducted a voluntary survey of 38 entities, across all of its supervised industries. The survey was designed to help APRA assess industry practices with regard to the management and disclosure of climate-related financial risks and to inform APRA's future supervisory approach. The survey aligned with the TCFD's recommended framework, collecting information related to climate change risk governance, assessment, management and disclosures.

Following the series of activities undertaken by APRA to increase the awareness and understanding of climate change risks, APRA will be taking steps to enhance its supervisory action. APRA will be increasing its scrutiny of the management of financial risks resulting from climate change among its regulated entities, in line with the continuous improvement of responses to climate change risks that APRA expects to observe. This enhanced supervisory action will involve a supervisory assessment of entities' governance, strategy, risk management, analysis and disclosure. The internal assessment – conducted within APRA's regular supervisory functions – will provide comprehensive insights into the adequacy of response to climate risks. The assessment will ensure that APRA's iterative approach to the supervision of the risks is proportionate to the continuous developments in sophistication of all of APRA's regulated entities.

At the same time, APRA will continue to engage with domestic and international stakeholders in order to coordinate its ongoing supervision of climate risks. This will include ongoing consultation with industry, where APRA will continue to highlight the need for disclosure and transparency on these risks, to allow both supervisors and investors the insights needed to make accurate assessments.

But regulators and supervisors' mandates are also strongly focused on financial sustainability: helping the institutions we oversee remain strong, stable and able to continue meeting their promises to their customers. With every passing year, as the world moves closer towards the low carbon economy, those two definitions become ever more entwined.

The idea that taking action to address climate change is a luxury or a financial burden is redundant. To the contrary, it is a financial necessity. Only weeks ago, US electricity giant PG&E Corporation filed for bankruptcy in the face of an estimated USD 30 billion liability caused by California's devastating wildfires. It will not be the last company to fold as the physical, transitional and liability risks of global warming bite ever more sharply in years to come. Companies – and countries – that fail to mitigate against climate-related risks and seize emerging opportunities are going to be left behind.

Making informed and appropriate decisions as the transition to the low carbon economy unfolds will require a determined and coordinated effort across the financial industry to expand and sharpen the pool of knowledge and expertise in this area. For that to happen, more companies need to sign up to implement the TCFD recommendations. Therefore we ought to urge the leaders of those companies that have yet to commit to the disclosure regime set out by the TCFD to think again. In simple terms, a comprehensive understanding that will help to identify and avert potential vulnerabilities is not possible unless entities and regulators are systematically monitoring, disclosing and talking about these risks. The fact that the world's largest, most sophisticated businesses are at the vanguard of this movement should be a clear indication that committing to the regime is not a cost or an inconvenience; it's an investment in the future prosperity and viability of both the company and our planet.

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Meeting the challenge of green finance

Green finance, at the heart of the ecological transition

Isabelle KOCHER
Chief Executive Officer
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The ecological transition is now of the utmost urgency as global warming threatens our immediate future. It is acknowledged as a crucial issue by all players in the economy – from companies and employees to investors and consumers – and necessitates a redefinition of our approach to growth in order to achieve a genuine revolution in our priorities and behaviour.

In this context, green finance, and the green bonds market in particular, provides a way forward. ENGIE, the largest corporate issuer of green bonds worldwide, was quick to seize upon this tool, which was fully consistent with the radical transformation undertaken by the group in recent years. But the development of green finance is far too hesitant given the emergency we face, even though it is the crux of a war that we cannot afford to lose. We have to establish a long-term vision and to stop pitting profit against the environment.

That is why we have to go further and faster, and to do so, act collectively. Financial players must demonstrate drive and creativity to provide support to ecological projects and to companies that invest in the environment. Because, at a time when governments are not in a position to handle everything alone or sometimes simply opt out, companies like financial institutions must take on a political role and fully accept their responsibilities as an economic, social and ecological player.

Greta Thunberg, a 16-year old Swedish climate activist invited to the Davos World Economic Forum in January 2019, had these scathing words to say to decision-makers around the world: “...*I don't want your hope. I don't want you to be hopeful. I want you to panic. I want you to feel the fear I feel every day. And then I want you to act... I want you to act as if the house is on fire. Because it is.*”

Greta Thunberg is right: the house – *our* house – is on fire. And it will soon be impossible to put it out unless we act collectively and quickly.

Whether we are a services company, an industrial group, a bank or an investment fund, it is our duty to fight against climate disruption and to engage in behaviour that is far more environmentally friendly through a coherent and holistic approach. Let's stop being satisfied with half measures and let's put an end to the schizophrenia of righteous rhetoric but unchanged behaviour.

All sectors and all aspects of the economy, starting with its sources of financing, must mobilise in favour of the environment.

That is why the group ENGIE has chosen a coherent and compelling green financing programme and why financial institutions have a key role to play in helping us to reassess our ways of working, to rethink our processes and to take concrete action to promote the energy transition.

11 A groundswell behind ecological transition

Climate disruption is a reality and sadly the world is proving it to us on a daily basis. It is not a question of a hypothetical future that may be confronted by our great-great-grandchildren. It is very much our present.

Visualising the end of the world as we know it is no longer the reserve of sci-fi scriptwriters. It is

our future – our *near* future – if we do not take quick and drastic action.

Fortunately, there is a growing sense of urgency. The energy transition has become a central issue for all economic and social players.

Internationally, the United Nations has translated this urgency into 17 sustainable development goals for issues such as water, energy, decent working conditions, sustainable cities and communities, and responsible production.¹

Of course, commitment to the fight against global warming varies greatly from government to government and political discourse is not everything. But the fact that a giant like China sets itself the objective of building an ecological civilisation and taking the lead in the energy transition sends a powerful message. Incidentally, the energy transition has reshuffled the geopolitical balances.

The withdrawal of the United States from the Paris Agreement was a disappointment, but it is interesting to note that momentum at the regional level continues unabated nonetheless. For example, as part of the United States Climate Alliance, 21 US states have committed to introducing policies that will allow them to meet the Paris Agreement objectives.²

Cities are also becoming key players and groups and networks have flourished during the past several years. For example, 40 of the greatest cities from around the world joined together to create the global C40 Cities coalition to respond to the challenges of climate change.³

Everywhere, regions, institutions, universities, companies, associations and communities are committed to the energy transition and are putting in place increasingly concrete corporate social responsibility (CSR) policies.

At the end of the chain, the consumer too is becoming more and more knowledgeable and

¹ See United Nations (2018).

² See United States Climate Alliance (2019).

³ See C40 Cities Climate Leadership Group (2019).

attentive. Consumers now want more than to simply see their needs and desires satisfied. They also question the sources of supply, production processes and business models, and increasingly are modifying their choices accordingly. Traceability, ethical conduct, health and respect for the environment are all new levers that surpass reasoning based on value for money.

This evolution is also affecting the labour market: talented people are becoming more cautious, making sure that they only send their CV to companies that measure up to their ethical standards and values.

For example, several months ago, around 24,000 students from France's most prestigious schools and universities signed a petition asserting their commitment to only work for companies that prioritise the ecological transition.⁴

Companies are presented with a real challenge: if they are to avoid losing a war for talent that is now being waged on a planetary scale, they must integrate these new criteria of business attractiveness.

And savers too are beginning to join this groundswell. Like voters, citizens, consumers and employees, savers are increasingly looking for moral value and transparency.

This movement may still be in its infancy, but we can imagine that the day when savers hold banking institutions to account for the social and environmental impacts of their investments is perhaps not so far off. Confronted with the staggering implications of climate transition, returns on investments can no longer be measured against financial criteria alone. They must also bring positive impacts for society, and not just in terms of the environment: social responsibility is also being called into question.

In other words, our approach to growth is being redefined.

21 The green finance boom

211 Investor expectations are beginning to change

The financial sector is the sword arm in a fight that we cannot afford to lose: a special report by the Intergovernmental Panel on Climate Change (IPCC) estimates that USD 2,400 billion of investment, or 2.5% of world gross domestic product (GDP), is needed annually from 2016 to 2035 to transform energy systems.⁵

There will be no energy transition without massive targeted investment. And the financial sector must take on a crucial role, by actively steering financial resources towards low carbon offerings and projects with a positive environmental impact.

A number of key financial players have started to embed these new challenges and are now tending to focus their attention on companies whose actions are guided by a long-term vision.

This is the message that Larry Fink, Chief Executive Officer of BlackRock, the largest asset management firm in the world (and one of the most influential), conveyed in his 2018 letter to the heads of companies in which BlackRock invests on behalf of its clients:⁶ *“To prosper over time, every company must not only deliver financial performance, but also show how it makes a positive contribution to society. Companies must benefit all of their stakeholders, including shareholders, employees, customers, and the communities in which they operate. [...] public expectations of your company have never been greater. Society is demanding that companies, both public and private, serve a social purpose.”* Larry Fink concluded that companies that failed to take this on board would ultimately lose their *“licence to operate”*.

He sent the same message in January 2019 in his now customary annual letter, writing:⁷ *“... that every company needs a framework to navigate this*

⁴ See Wake up call on the environment – A student manifesto (2018).

⁵ See IPCC (2018).

⁶ See BlackRock (2018).

⁷ See BlackRock (2019).

difficult landscape, and that it must begin with a clear embodiment of your company's purpose in your business model and corporate strategy. Purpose is not a mere tagline or marketing campaign; it is ... what [a company] does every day to create value for its stakeholders. Purpose is not the sole pursuit of profits but the animating force for achieving them."

Many investors are now rallying to this vision, insisting that the environment, and more generally, the contribution to the common good be taken into consideration when assessing company performance.

For example, the Shell Group, under pressure from its investors, announced during COP24 that it planned to link part of the remuneration of its senior executives to the achievement of the company's climate-related targets.⁸

Let's also mention the group of more than 300 investors, with total assets under management of USD 32,000 billion, behind the Climate Action 100+ initiative to work with the world's 100 largest corporate greenhouse gas emitters to ensure they take action on climate change.⁹ This involves establishing an "engagement approach" – a dynamic of dialogue and information exchange – to position the two stakeholders in a virtuous circle of co-construction.

Climate change appears to be more and more central to investors' concerns. The challenge now is to ensure that these grand principles produce concrete results on the ground.

While investors have become increasingly aware of the importance of environmental issues, their requirements are still too often contradictory, caught between the demand for short-term returns and the need for long-term responsible investments.

We have experience of this at ENGIE: of course, it is increasingly common for our investors to quiz us on questions related to CSR – Where

do we stand on the objective to limit global warming to 2°C? How do we manage climate risk? Don't our goals lack ambition in comparison with our competitors? – but at the same time, far too often during our roadshows we see that people continue to focus on short-term financial indicators at the expense of other factors of performance assessment.

So let's be optimistic, but let's stay realistic: we have only just started down this path.

2|2 The attraction of green finance

The rapid development of new tools, such as green bonds, to finance climate-friendly projects sends a powerful message as to the attraction of green finance. Green bonds, which were only introduced in 2007, amounted to USD 167 billion in 2018.¹⁰

And it is only the beginning: the rating agency Moody's expects bond issues of this type to accelerate in the next few years as new issuers emerge following the boost to the market given by the arrival of sovereign issuers (governments) in particular. We should also mention that France is a world leader, just behind the United States and China.¹¹ And the main French issuers are the government, ENGIE and EDF.¹²

But here again, we have a long way to go: despite the buzz around green bonds, they are still only a sub-segment of the market. And let's not forget the big names that are missing, starting with the US multinationals,¹³ with the exception of banks and Apple.

2|3 Green finance, an essential lever in ENGIE's strategy

ENGIE was a pioneer in green finance. It believed that green bonds were a particularly well suited tool to support the strategy of the group – a group that has totally reinvented itself in only a few years.

⁸ See Shell (2018).

⁹ See Climate Action 100+ (2018).

¹⁰ See Climate Bonds Initiative (2019).

¹¹ See Climate Bonds Initiative (2019).

¹² See Climate Bonds Initiative (2018a).

¹³ See Environmental Finance Bond Database (2018).

In 2016, we launched a sweeping transformation plan based on a solid conviction that the energy transition is irreversible and will bring with it a profound reconfiguration of the energy sector.

The energy sector is the main contributor to climate change, and consequently we appeared to be part of the problem. In this situation, there is a choice to be made: we can try to buy time and play out the end of the life cycle; or we can decide to transform and become part of the solution.

ENGIE chose the second option. We did it because we wanted to, because we were convinced it was right, but also because we were already fully aware that we were holding the right cards: 100,000 employees working in energy efficiency solutions; an extremely strong position in the gas industry; and a small but established position in renewables – all of which accounted for 80% of our activities.

We also chose this option for very clear economic reasons. Our analysis was that in becoming a leader in this new world of energy we would be more competitive because we would be preferred.

It was not an easy choice to make. But we took up the challenge, which led to the launch at the beginning of 2016 of an extensive three-year transformation plan built around three main themes.

First, an ambitious disposals programme of almost EUR 15 billion in assets, corresponding to the 20% of our activities that were not aligned with our strategic orientations. This was a painful decision, but essential as it allowed us to embark on our change of direction.

Second, a plan to invest heavily in renewable energy technologies (EUR 14 billion) to widen the gap between ENGIE and its competitors, by investing in three pillars that are now our greatest strengths, with a particular emphasis on digital transformation.

Third, a project to completely overhaul the structure of our group, focusing on decentralisation and the shortest possible reporting and managerial lines, with the group's organisation shifting from five major business lines to over 20 business units.

And the work paid off. One year ahead of schedule, ENGIE returned to organic growth at end-2017 (+5% compared with -9% at end-2015) and this trend has continued throughout 2018 – clearly, our initial instincts were good.

This transformation, which firmly positions the group within the energy transition, is also reflected in the group's financing strategy.

ENGIE has become one of the largest corporate issuers of green bonds in the world. Since 2014, the group has carried out five bond issues for a total of EUR 7.25 billion, with EUR 1 billion issued in 2018 and another EUR 1 billion issued in January 2019 alone.

Green bonds now account for one-third of ENGIE's debt and help to fund renewable energy generation activities and energy efficiency solutions, as well as a number of R&D projects, around the world.

For example, we were able to fund a 50-year energy management contract with the Ohio State University for its 485-building campus. The goal is to reduce energy consumption by 25% in the first 10 years of the contract and to finance the creation of an Energy Advancement and Innovation Center.

To a more modest extent, these green bonds can also provide funding for programmes led by our social impact investment fund, ENGIE *Rassembleurs d'Énergies*, which invests in sustainable energy access projects for impoverished populations.

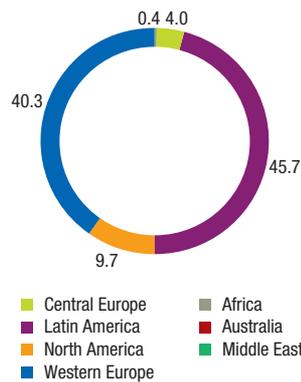
One such example is ENGIE *Rassembleurs d'Énergies*' investment in the development

C1 Sustainability: progress on green bond allocation

(%)

1) EUR 2.5 billion green bond issued in 2014 fully allocated

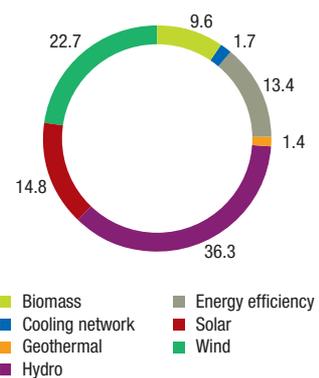
a) % funds allocated by geographical area



EUR 2.5 billion allocated at the end of 2016

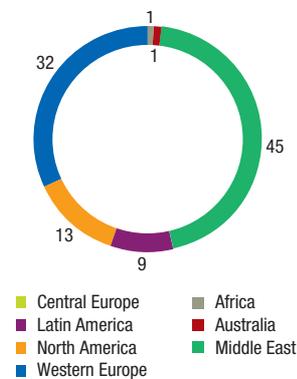
48 projects funded from 2014 to 2016

b) % funds allocated by technology



2) EUR 1.5 billion green bond issued in March 2017 fully allocated*

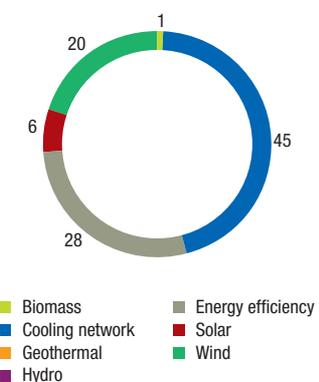
a) % funds allocated by geographical area



A 7-year tranche of EUR 700 million and a 11-year tranche of EUR 800 million

EUR 1.5 billion allocated in 2017 on 28 projects

b) % funds allocated by technology



Source: ENGIE.

* provisional allocation before validation by auditors.

of Sistema Biobolsa, a social enterprise that offers accessible and easily deployable modular biodigesters to Mexican, Kenyan and Indian farmers. In addition to providing clean, safe cooking solutions, these systems help to combat deforestation, reduce greenhouse gas emissions and increase agricultural yields thanks to the biofertilisers they produce.

Since the creation of the fund in 2011, these investments have helped almost 3 million people to have access to clean energy.

In short, ENGIE's commitment to green finance has presented the group with a three-fold opportunity: diversifying our investor base; increasing transparency in our corporate climate reporting;

and putting into practice our commitment to gradually introduce the recommendations of the Task Force on Climate-related Financial Disclosures (TCFD), which have our full support.

We have enhanced both our credibility and our appeal in the eyes of all our stakeholders – major investors, individual shareholders, nongovernmental organisations (NGOs), employees – who have become far more demanding in terms of environmental issues. And we have improved our procedures and multiplied our disclosures and communications on the value added of the group's projects.

In addition to this financial strategy, ENGIE plays an active role in the bodies promoting green finance.

In addition to its dialogue with Climate Action 100+ mentioned above, the group is a member of the Green Bond Principles,¹⁴ is an active participant in the decision-making bodies of Paris Europlace's Finance for Tomorrow initiative,¹⁵ and is a contributor to the Ducruet-Lemmet project to develop a green finance strategy for France.¹⁶

We are proud of the approach we have taken. It may be demanding but it allows us to commit our business activities and financing to a coherent energy transition framework.

3 | Going further and faster for successful ecological transition

Faced with the urgency of the situation, the challenge is to accelerate the development of a global virtuous circle. With this objective in mind, I would like to make five proposals:

1. Let's stop pitting performance against environmental protection! According to Novethic, the responsible investment research arm of the Caisse des Dépôts Group, socially responsible investment funds performed

extremely well during the second quarter of 2018. In particular, the amounts under management in environmental funds were up 12% to EUR 20.8 billion.¹⁷ In other words, there is absolutely no need to choose between responsibility and profitability. Quite the opposite – they are both inextricably linked. And the success of ENGIE's transformation plan shows it.

2. Let's give free rein to creativity. The success of green bonds has demonstrated how attractive these types of products are to financial players. It is now down to banks and financial institutions to be innovative and to propose other financial products, such as green or sustainable loans, that reconcile financial performance with corporate social responsibility. The European Union is considering the possibility of introducing a "green supporting factor", which would help to favour loans for projects that contribute to accelerating the energy transition.¹⁸

3. Let's reward environmental commitment. In order to be attractive, green bonds should generate financial advantages and lower costs for eco-investing economic players. It is also an obvious lever to encourage more reluctant investors to turn to green finance. Green bonds could then play their role as a vector of integration between financial objectives and CSR challenges to the full.

4. Let's be transparent. As adequate standards are not yet in place for green finance products, there are risks of green washing. Companies and investors alike must develop a culture of transparency because transparency nurtures a vital driver of change – trust. It is therefore absolutely essential that we develop classifications and ratings for green finance products in order to construct a common language and to help investors distinguish clearly between genuine ecological products and those that are not. Following the same

¹⁴ See Climate Bonds Initiative (2018b).

¹⁵ See Finance for Tomorrow (2018).

¹⁶ See Lemmet, Ducruet et al. (2017).

¹⁷ See Novethic (2018).

¹⁸ See the European Banking Federation (2018).

logic, TCFD recommendations could become the norm. We must prevent products that are cloaked in a veneer of ecological respectability and that would lead investors away from real green finance as a result of a lack of clarity.

- 5. Let's help small projects find funding.** If we want this transition to work, it is absolutely essential that we establish connections between large providers of capital and the countless small, often local, projects that are supported by numerous players but which go under the radar of funds and large financial institutions. To achieve this, let's work on regulatory frameworks, contract standardisations and financing models to bring down the cost of capital for these projects, group them together and ultimately give them access to funding. In this regard, the Lomé Initiative¹⁹ in particular comes to mind: in September 2018, six African countries – Benin, Burkina Faso, Gabon, Mali, Niger

and Togo – launched a platform aimed at mobilising investments in their countries' solar energy sector. Let's support them.

The ecological emergency gives companies the opportunity to take on a real political role by adopting a long-term vision and acting accordingly as a responsible economic, social and ecological player in order to accelerate the energy transition.

This means we have to be bold and be brave enough to take strong measures, both in terms of investment choices and their related financing schemes. Green finance can then become a key driver in the success of a competitive ecological transition.

So let's respond to this challenge with courage, commitment, tenacity and enthusiasm. Let's apply all our strength, our invention, our determination. Let's be ambitious. Let's aim for the common good.

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PGGM: a pension investor's perspective on accelerating sustainable finance

PGGM started its journey as a responsible investor in the mid-eighties, committed to contributing towards both retirement security and a sustainable world. As its responsibility is first and foremost a financial one, PGGM is often confronted with the tensions between required returns and calls to accelerate positive societal impact. In order to get out of this dilemma, it has set specific sustainability targets related to reducing the carbon dioxide footprint and achieving a positive societal impact. Additionally, PGGM has worked actively on industry initiatives that enhance data availability and comparability within the sector.

The challenge lies in enlarging the space for investments that create financial returns alongside positive impacts. To this end, the authors introduce a framework based on three zones: the grey zone, in which investors look at financial returns without considering externalities; the green zone, in which sustainability is integrated alongside market rate returns; and the red zone, in which sustainability considerations prevail above financial returns. The movement from grey to green is growing based on scientific evidence and societal pressure. The red zone however is often misunderstood, as pension money is often perceived as a societal good that can be allocated freely between financial and societal objectives.

The answer lies in enlarging both the green zone and the number of investors operating in the green zone, which implies setting the right preconditions. Some of them can be created by the investment community. However, preconditions set by governments are needed to enable a large movement of capital, as they can increase the ability of investors to assess the likelihood and timing of sustainable transition scenarios. As probabilities and their impact become clearer, committing capital to the sustainable economy becomes easier. The authors believe that the transition towards a sustainable economy is within reach, if we all play our part in accelerating this movement.

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Sustainable finance can pride itself on rising ever higher on the agenda of the institutional investor community in Europe. Having a specific ambition in this field, we are committed to being an innovative and ambitious responsible investor. In this article we will explore the current state of affairs as well as what we consider the way forward on accelerating the development of sustainable finance and our role. More specifically, we will share our thinking as well as the challenges we experience in contributing to a more sustainable world, while not straying away from our primary objective of providing retirement security through solid financial returns.

Ten years ago PGGM was spun-out from PFZW (*Pensioenfondsen Zorg en Welzijn*, Pension Fund for Care and Well-Being), the industry wide pension fund for health care and welfare workers in the Netherlands, to become a multi-client pension service organisation. Our focus on responsible investing and ESG (environmental, social and governance) issues dates back to the mid-1980s. Since then we have continued to develop our investment platform and ESG policies in close partnership with PFZW. PGGM manages the pension money for more than two million workers in the health care sector in the Netherlands. Our total assets under management are approximately EUR 200 billion, making it the second largest pool of pension money both in the Netherlands and the European Union (EU). We stand for a strong collective pension system that can invest for the long term, harvesting world class returns through best-in-class investment management. It has come naturally to also build the notion of sustainability into the collective design of our pension system and our way of investing money, integrating ESG factors throughout the investment process.

However, the landscape is full of difficult challenges. In the Netherlands, confidence in retirement security has been deteriorating since the advent of the global financial crisis. Pervasive market uncertainty continues to dominate news

of coverage ratios. In the current low-yield environment, the tensions between required returns and calls to accelerate positive societal impact is also becoming more apparent. In this light, we have spent significant time and resources on the question of how the two can complement or even strengthen one another. The risks and opportunities related to energy transition and climate change are a case in point.

Below we will discuss our wider journey and current limitations. We hope to shed some light on the preconditions and collaborative strategies to accelerate responsible investing and the transition to a sustainable world.

11 Our heritage in establishing a sustainable investment strategy

PGGM has had an active sustainable investment programme for a long time. Our focus on responsible investing (RI) issues – starting with human rights – dates back to the mid-1980s, triggered by the transition towards investing increasingly in global public equities. Issues such as controversial weapons and apartheid led to the first ESG-policies. The controversy around cluster munition gave a huge boost to RI in the Netherlands. An important moment was the responsible investment policy document drafted in 2006. This document stipulates that: “PGGM sees responsible investment as an important expression of its identity”. Since that moment, we have introduced sustainability as an integral element of our investment policies and fiduciary duties. We also recognised this to be an evolutionary issue that requires continuous development and maintenance as we learn along the way.

The global financial crisis inflicted huge damage to the coverage ratios in the Dutch pension system and led to an erosion of the societal trust that before 2008 was the normal state of affairs. These challenges led PFZW and PGGM to the

“White Sheet of Paper” project resulting in an Investment Framework in which our investment beliefs on both the financial and the societal side were laid down.¹ These beliefs serve as the “constitution” for the investments. Two of the investment beliefs show our commitment to being a responsible pension investor: first, “we assume our social responsibility by contributing tangibly to a sustainable, viable world”; and second, “a sustainable, viable world is necessary in order to generate sufficient returns over the long term”.

These beliefs came from an aspirational “Who do we want to be?” angle, even though at the time there was limited evidence of the impact of sustainability on financial returns and the term itself was considered to be vague in the eyes of the financial community. Notably, the notion of contributing to a sustainable financial system was also an explicit part of our reasoning.

It is important to note that these beliefs were not only built on a concept of benevolence or good citizenship, but also on an element of enlightened self-interest. As a long-term investor, we need to ensure that the return-generating capacity of capital markets and the real economy are kept intact. Only solid financial performance can provide for retirement security over the long term. The potential – and increasingly present – consequences of climate change are testament to the power of this investment belief.

The Investment Framework, adopted in 2013, laid the foundation for the actual movement in the years thereafter. The translation from “constitution” to actual strategy was completed with the “Investment Strategy 2020”, which was adopted in 2014. We explicitly formulated stretched goals to force ourselves to be creative. The challenge lies in finding a structure to achieve them, without compromising our duty to realise the financial objective.

Both the Investment Framework and the Investment Strategy 2020 were tough exercises,

as they forced us to re-examine our own behaviour as an investor and to readjust accordingly. This experience has led PFZW and our other clients to some remarkable changes in the (structure of their) investment portfolio. Ambitious goals were formulated to de-complexify the portfolio, bring down total investment management costs by over 20%, increase cost transparency, invest more in the Netherlands economy and lower agency issues through a more direct investment approach in private markets and by largely exiting hedge funds in public markets. Also trustees agreed on two specific targets: (i) to halve the carbon footprint in public equities; and (ii) to quadruple investments with a positive impact on the four interrelated themes of climate change, water security, access to health care and food security. The first target involves the divestment of companies with high carbon dioxide (CO₂) emissions. The second is focused on increasing our “Investments in Solutions” from EUR 5 billion to EUR 20 billion to 2020.

Our investment beliefs brought us to the question of the next phase of implementation of sustainability within a portfolio. Two important challenges needed to be solved. Firstly, we needed to solve how to direct the capital to the right assets. Secondly, we needed to monitor progress. As impact investment at that time lacked a common framework, we had to define our own terminology. Our impact themes were both close to our identity and related to the Millennium Development Goals, the predecessor of the 17 Sustainable Development Goals (the SDGs) that are increasingly important in the investment community. We added the specific ambition to measure the physical impact of these investments. We are now nearing the end of the programme and it has taught us that it is no simple feat to achieve the targets we set out to reach, particularly in the area of impact investing and investing in local communities. By the end of 2018 PGGM had invested roughly EUR 14.5 billion in positive impact investments for its clients. This accounts to roughly 7% of the portfolio. These impact investments still fall short of the EUR 20 billion target set for 2020.

¹ For a description of the White Sheet of Paper project and its outcomes, see van Dam (2014).

The same challenge we mentioned in finding investments also holds true for monitoring due to data availability. Ten years ago, either there were no ESG data available to build our strategies on, or the data were of poor quality. Believing that “what gets measured gets managed”, we continuously put effort into improving market standards, data and definitions. Around 2006 we co-authored the United Nations-supported Principles for Responsible Investing. More recently we contributed to the recommendations and progress reports of the Michael Bloomberg Task Force on Climate-related Financial Disclosures (TCFD). For some asset classes we had to proactively build the datasets ourselves. One of the ways in which we did this was by co-founding the Global Real Estate Sustainability Benchmark (GRESB) almost ten years ago. This benchmark was the first to collate information on the environmental sustainability of both public and private real estate companies. GRESB enables us to benchmark across our entire real estate portfolio and now also our infrastructure portfolio. This simultaneously provides us with the information we need and offers other investors the same benefits.

Regulators and governments can play an important role in the standardisation of sustainability data and frameworks. The way in which policies and rules are set influences our playing field and can change the rules of the game. This is why we find that the EU's action plan on financing sustainable growth is a welcome development. It is also the reason why we want to be proactively involved: for example, by contributing to the development of the EU's taxonomy for sustainable activities through the Technical Expert Group.² We make similar investments in supporting and building frameworks like the materiality framework³ of the Sustainability Accounting Standards Board (SASB), as well as in national and supranational programmes to improve both transparency and implementation of sustainability.

We observe a shift in societal thinking that is starting to influence finance. The Paris Climate

Agreement, the increasing importance of the SDGs and similar agreements closer to home help to strengthen responsible investment ambitions by financial parties.

2I How does our purpose fit in with sustainable finance?

Our specific role in the financial system drives our ambition, but also limits our ability to direct our capital towards sustainable investments. In explaining this, two elements are worth mentioning. First, as a pension investor, our primary purpose is firmly in the financial domain. Solid financial returns are required to cover pension liabilities over the long horizon. In practice more than two-thirds of retirement income is derived from compounded investment returns. Realising this is quite challenging in the current low-yield environment. Second, as a pension investor, we are primarily an agent for our beneficiaries and not for society at large. Our investments are a tool to realise the primary goal of providing them with retirement security, and not necessarily also creating a sustainable economy. This is obviously a contentious statement, which appears harsh. However, it is reality. The complexity therefore is that whilst we are providers of a monetary good to our beneficiaries, society at large needs a collective and non-monetary good, i.e. a sustainable future. To find ways to speed up sustainable finance, we collectively need to bring these two seemingly opposing concepts closer together.

To define the possible contribution of investors to a sustainable world, we can set up a framework consisting of three zones: the grey, the green and the red zones. These zones reflect what we are required to do, what we could do and what we cannot do, given the assignment we have. The zones are defined here as follows.

- The grey zone is the zone of classic investment management. This can be dubbed the neo-classical zone and is how most of us

² The European Commission set up a Technical Expert Group on Sustainable Finance (TEG) to assist it in developing an EU classification system to determine whether an economic activity is environmentally sustainable; an EU Green Bond Standard; benchmarks for low-carbon investment strategies; and guidance to improve corporate disclosure of climate-related information. Its 35 members come from civil society, academia, business and the finance sector, as well as additional members and observers from EU and international public bodies.

³ SASB's guidance on issues that are financially material in various business sectors. The framework is used to identify and assess which information is most useful for making financially-related decisions.

were taught at university. The grey zone is the investment zone in which non-financial arguments are not part of the investor rationale. The key idea is that the negative externalities you or your investments impose on society as an investor are irrelevant, because they are free to you and outside of your responsibility. In this zone, you will only contribute to a sustainable world when there is proof or a strong conviction that this will contribute positively to your return per unit of risk. In the grey zone the individual financial returns are optimised, but the collective – and non-financial – returns are not.

- The green zone is the responsible zone. Investors in this zone will do what they can to contribute to a more sustainable world as long as it will not come at the expense of the expected outcomes to their beneficiaries. In this zone, the idea is to contribute to the societal return as long as it is not detrimental to the individual financial return. In this zone, investors see contributing to sustainability as an intrinsic motivation within their mandate.
- The red zone is the zone where there is a contribution to the collective good while sacrificing a part of the individual good. This would translate into reducing the financial pension of beneficiaries in order to contribute to the sustainability of the world. It is the zone of the tragedy of the commons and the tragedy of the horizon as Mark Carney called it. For pension investors, this option does not lie within the mandate.

Most investors in the world are firmly in the grey zone. As an investor we need to focus on the negative consequences that can be generated by this behaviour, such as short-termism, irresponsible corporate behaviour and incentives and – consequently – financial instability. PGGM has countered these potential negative effects by developing instruments like a leading sustainable tax policy and clear policies on remuneration (both internal as well as for investee

companies). Through these practices we both aim to contribute to financial stability and more sustainable finance practices.

With sustainable finance accelerating, an increasing number of institutions are moving from grey to green. It is our conviction that investors, if they have the right mindset or purpose, can do much more than they currently do. It is to a large extent the benchmark-orientation, short-term thinking and efficient market theory that keep investors from acting on a larger scale within this zone. Moreover, pension plans realise that the outcome of big changes to society like a global energy transition is by no means certain. This implies that they must prepare for multiple climate scenarios with the risk that this leads to insufficient collective action.

The red zone is the most debated zone. This zone is often ill-understood by market participants and stakeholders; the perception being that pension money is a societal good that can be allocated freely between financial and societal objectives. This is not desirable. Understanding the limits of pension investors is central to the debate on how to increase the contribution of pension money to the creation of a more sustainable society. We want to be very clear here: we would like to make the red zone as small as possible, but we cannot do that on our own.

3| Enlarging the green zone and reducing the red zone

From the above, it is clear that the answer to growing sustainable investment lies in enlarging the number of investors operating in the green zone. It also implies that setting the right preconditions is key to increasing the size of the green zone and decreasing the size of the red zone. When it comes to increasing the green zone, we believe that the growing body of evidence that sustainability pays off supports this development. This increases the confidence of investors. Also the fact that many

stakeholders exert their influence on pension funds and other long-term investment institutions will support a movement towards the green zone.

Further growing our share of direct private market investments will significantly contribute to our stated goal of EUR 20 billion of targeted impact investments by 2020. To reach this goal we are actively seeking new partnerships. A case in point for investments in the energy transition is the joint venture between PGGM and Royal Dutch Shell to bid for the Dutch energy company Eneco. The intention of the joint venture being to build on Eneco's sustainable strategy and competitively grow the renewable energy products and services offered to millions of customers in North West Europe. We expect such opportunities to further expand through private-public partnerships (PPP), at home and abroad. A recent example is the creation of Invest-NL, an investment vehicle launched by the Dutch government that aims to commit long-term capital to such ventures. This will help bridge the gap in the field of green technologies and infrastructure development risks, particularly in the area of energy transition. We see similar PPP initiatives gaining traction through multilateral development banks and at EU level. In emerging markets, long-term investors collaborate on sustainable infrastructure by knowledge transfer and training programmes through the so-called

G7 Investor Leadership Network, of which we are a part. Also, common standards for defining the contributions of investors and their portfolio companies to the SDGs will help scale up sustainable finance. We are working with peers to explore new collaborative ventures in this field.

At the same time, we call on policymakers to (re)direct their efforts to factors enabling this movement. The assumption that there would be insufficient capital available to foster change is in our view incorrect. Unlocking the capital is predominantly a question of setting the right preconditions, such as carbon pricing, to incentivise investors and the business community to allocate more capital to the green zone. Realistic long-term policy objectives in combination with government action will help. As mentioned before, the uncertainties that are now preventing investors from committing to the green zone are predicated on their ability to assess the likelihood and timing of sustainable transition scenarios. When probabilities and their impact become clearer, pension funds will commit more capital to the sustainable economy.

In many respects we appear to be on the cusp of the transition to a more sustainable economy. We look forward to playing our part in accelerating this movement.

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The European Commission's action plan on sustainable finance: promoting a sustainable future in the European Union and beyond

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The European Union (EU) is strongly committed to achieving the climate commitments of the Paris Agreement and the United Nations Sustainable Development Goals. Considerable investment is necessary to meet this challenge and public money will clearly not be sufficient. Adding to the challenge are potential threats to financial stability such as a risk of sudden asset repricing. Sustainable finance, which aims to mobilise private capital towards sustainable investment and provide tools and frameworks for managing the risks, has a major role to play in this situation. In March 2018, the European Commission adopted an ambitious action plan on financing sustainable growth. The action plan proposes a comprehensive EU strategy on how the financial sector should support the transition towards a climate-neutral and more inclusive economy, while safeguarding financial stability. Looking forward, there is great potential to scale up sustainable finance globally, by encouraging cooperation across different jurisdictions. This article outlines the Commission's approach to tackling the challenges of the transformation to a more sustainable economy.

The recent report of the Intergovernmental Panel on Climate Change (IPCC) calls for capping global warming at 1.5°C and proposes that carbon emissions be reduced to net zero by 2050 (IPCC, 2018). In contrast, our current economic trajectory would lead to a global temperature increase of between 3°C and 3.5°C. This would have drastic consequences for our way of life, for our economies, and for the ecosystems on which our societies are built. Financial stability could also be at risk, notably due to a sudden repricing of assets.

The European Union (EU) has therefore put in place a climate, energy and broader sustainability policy – including the 2030 climate and energy framework – and a long-term vision on a climate-neutral Europe by 2050. Around EUR 175 billion to EUR 290 billion of additional investments are needed each year to reach a climate-neutral Europe by 2050.¹

It is clear that public money will not be sufficient and that the bulk of these investments will have to be financed through private capital.

The EU financial sector, with more than EUR 100 trillion of assets, has a key role to play in reorienting capital flows towards sustainable investment to put Europe on a sustainable path.

Sustainable finance is essential for mobilising private investors to deliver tangible results on climate change and the environment. The strategy is a key enabler of cross cutting EU and national sustainability policies and has therefore become a key Commission priority.

This article explains how the EU action plan on financing sustainable growth addresses the challenge of managing the transition to a more sustainable economy.

11 The action plan on sustainable finance

The action plan on financing sustainable growth adopted in March 2018² is centred on three policy goals:

- managing financial risks stemming from climate change, resource depletion, environmental degradation and social issues;
- reorienting capital flows towards sustainable investments in order to achieve sustainable and inclusive growth;
- fostering transparency and long-termism in financial and economic activity.

It aims to equip investors with the right tools and the appropriate policy framework to integrate sustainability into their investment decisions, identify sustainable investment opportunities and address the risks related to climate change. The action plan develops these tools through a mix of legislative and non-legislative measures that act together to mainstream sustainability in the financial sector.

As regards legislative actions, the Commission tabled three legislative proposals in May 2018:

- a proposal to establish a unified EU classification system (or **taxonomy**) of sustainable economic activities;³
- a proposal on **disclosures** on sustainability by financial market participants and financial advisers toward end-investors;⁴ and
- a proposal creating two new categories of low-carbon **benchmarks**.⁵

Co-legislators have reached a political agreement on the proposals on disclosures and benchmarks. On the taxonomy proposal, the Commission is working actively with the co-legislators to reach an agreement in the upcoming months.

1 This estimate is based on PRIMES model projections used by the European Commission's Communication "A Clean Planet for all" (See European Commission, 2018a).

2 See European Commission (2018b).

3 See European Commission (2018c).

4 See European Commission (2018d).

5 See European Commission (2018e).

Further initiatives presented in the action plan include: developing standards and labels for sustainable financial products, which would foster trust and help to develop markets for these products; strengthening companies' disclosures of climate-related information; and incorporating sustainability in prudential requirements, where it is justified from a risk perspective.

The action plan on financing sustainable growth complements other EU initiatives to support climate-related, environmental or sustainable investments such as the 2016 Clean Energy package and the 2018 Circular Economy package.

21 Sustainability in risk management and financial stability

Climate change could have a considerable impact on the financial system and on financial stability. An appropriate policy response is therefore indispensable. The magnitude of the risk depends largely on the abruptness of the transition and the extent to which the changes are anticipated and priced in by the markets. If the transition towards a more sustainably economy is abrupt we could face a sudden repricing of assets with potentially far-reaching consequences. Meanwhile, some consequences of climate change have already materialised. For instance, between 1998 and 2017, the cost of climate-related disasters amounted to almost EUR 2 trillion. This represents a rise of 251% compared to the previous 20-year period (United Nations Office for Disaster Risk Reduction, 2018). The financial sector cannot afford to ignore the risks of climate change – the cost of inaction would simply be too high.

Financial supervisors, central banks and other public authorities increasingly recognise the importance of better understanding and acting on the challenges ahead. In 2016, the European Systemic Risk Board published a report that presented the systemic risks related to climate change and their macro prudential implications.

Last November, the European Central Bank (ECB) warned that climate change had become one of the key drivers of risks to the euro area banking system. Climate change will likely affect monetary policy and the ECB has an important role to play in supporting the transition to a carbon neutral economy by helping to define the rules of the game (Cœuré, 2018).

The Commission recognises the important role of central banks and supervisors in safeguarding financial stability in light of sustainability risks. It therefore welcomes the creation of and the great progress achieved by the Network for Greening the Financial System (NGFS). The Network's first progress report explicitly identified climate-related risks as falling within the supervisory and financial stability mandates of central banks and supervisors (NGFS, 2018). As part of the Network's work, the macro-financial workstream is developing an analytical framework for assessing climate-related risks. The Commission is following this work with great interest and welcomes another great milestone achieved this year – the publication of the Call for Action Report (NGFS, 2019). Measures by commercial banks are also an important part of the puzzle. The launch of the Principles for Responsible Banking by the European Banking Federation this February was another encouraging development.⁶

The Commission's action plan recognises that supervisory authorities have an important role to play in identifying and mitigating the impact of climate-related risks on the financial soundness of the banks they supervise. The Commission has therefore already proposed to include environmental, social and governance (ESG) factors in the mandates of the European supervisory authorities⁷ and has asked them to provide guidance on how sustainability can be effectively taken into account in relevant EU financial services legislation.

Climate-related risks should also be integrated in supervisory approaches such as stress tests.

⁶ See Dombrovskis (2019).

⁷ See European Commission, press release, "Creating a stronger and more integrated European financial supervision for the Capital Markets Union": <http://europa.eu>

This would permit supervisory authorities to make use of the entire panoply of supervisory powers provided for in EU law.

The Commission's action plan on financing sustainable goals aims to help investors integrate sustainability risks in their investment decisions and therefore to better manage the risks related to climate change and other sustainability issues. A first step was taken in May 2018 with the proposal on disclosures on sustainability by financial market participants and financial advisers toward end-investors. A political agreement was reached in March and the European Parliament has adopted the proposal. The regulation will require financial market participants and financial advisers to integrate sustainability risks and consider adverse sustainability impacts in their processes, and to provide sustainability-related information on financial products. The Commission also intends to clarify how financial market participants should integrate sustainability risks in their investment processes. To this end, the Commission has requested technical advice⁸ from the European Securities and Markets Authority and the European Insurance and Occupational Pensions Authority, and may adopt potential new rules in this area.

To reflect long-term risks such as climate change in their decision-making, companies need to consider a longer horizon. This could, however, be at odds with their focus on short-term performance. The Commission has therefore asked the European supervisory authorities to assess by December 2019 whether the financial sector places any undue short-term pressure on corporations.⁹ The Commission is also exploring possible steps to foster a more sustainable corporate governance.¹⁰

The Commission is also exploring whether climate and environment-related risks need to be reflected in the prudential framework. More specifically, it is assessing the possible merits of recalibrating capital requirements in order to reflect possibly lower risks of sustainable assets and investments, which would further incentivise banks and insurance companies

to invest sustainably. Any change would have to be justified from a risk perspective.

3I Scaling up investments in sustainable economic activities

The EU takes a comprehensive approach to addressing the considerable investment gaps outlined above. Public finance can mobilise private capital, for instance through co-financed investment funds or risk-sharing arrangements with investors. The EU already boosts sustainable finance through these instruments, for example under the European Fund for Strategic Investments (EFSI) for projects in the EU or via the External Investment Plan (EIP) for investments in countries outside of the EU. With EFSI support, the European Investment Bank has provided direct finance to renewable energy projects and partnered with private investors to finance sustainable infrastructure investment. Under the EIP, sustainable investments in urban development, energy and agriculture, both in neighbouring and developing countries, are supported. In addition, the proposed EU multiannual financial framework for 2021-27 sets a clear overall target of at least 25% to be spent on climate objectives. In February 2019, member states reached an agreement that 30% of the new InvestEU Programme funding should contribute to climate objectives.

Sustainable finance complements these efforts¹¹ by helping align private capital flows with climate and broader sustainability objectives. Before sustainable investments can be scaled up, there needs to be a common understanding of which economic activities are sustainable. Creating an EU-wide taxonomy (a classification system for sustainable economic activities) is therefore central to the EU's sustainable finance strategy. The taxonomy responds to the urgent need to act on climate change by focusing first on developing a list of economic activities that contribute significantly to climate change mitigation, together with economic activities that help our societies

⁸ See https://ec.europa.eu/info/sites/info/files/letter-eiopa-esma-24072018_en.pdf

⁹ See https://ec.europa.eu/info/publications/190201-call-for-advice-to-esas-short-term-pressure_en

¹⁰ See https://ec.europa.eu/info/business-economy-euro/doing-business-eu/company-law-and-corporate-governance_en

¹¹ For instance, the EU taxonomy, which is being developed by the Commission's Technical Expert Group on Sustainable Finance, will help track the InvestEU Fund's contribution to meeting the climate targets and foster investment in sustainable projects.

to adapt to the consequences of climate change. The work would then continue by assessing which economic activities significantly contribute to meeting the other EU environmental objectives and, depending on the outcome of a review, be extended to social activities.¹²

The EU taxonomy and its applications will have numerous benefits once complete. It will for example:

- help the EU to develop standards and labels for green financial products or funds;
- underpin financial institutions' and companies' disclosure and reporting obligations on climate and environmental activities;
- help companies raise private capital to finance their green activities or their transition to green policies;
- benefit investors who prefer to invest sustainably but do not have sufficient information about the environmental, social and governance aspects of potential investments, enabling them to find investable projects with a real impact.

To develop the EU taxonomy, the Commission is drawing on the wealth of expertise of the Technical Expert Group on Sustainable Finance (TEG). This group was set up in June 2018 and is tasked to deliver by June 2019 a first list of economic activities contributing substantially to climate change mitigation and adaptation objectives (while not significantly harming any of the other environmental objectives). The Commission will consider this advice when preparing its delegated acts on the EU taxonomy to be adopted once the European Commission gets the respective empowerment from the co-legislators.

The TEG is also helping the Commission to develop an EU Green Bond Standard and benchmarks for low-carbon investment strategies and climate-related reporting. The TEG published

an interim report this March in which it presented its recommendations for a possible EU Green Bond Standard for feedback. The TEG published its proposals on climate-related reporting in early January (TEG, 2019). Building on this report, the Commission has put forward draft guidelines on climate-related reporting for consultation with a view to publishing the final guidelines this June. The guidelines will integrate the work of the Task Force on Climate-related Financial Disclosures and take it to the next level by addressing the impact of climate change on the company as well as the impact of the company on the climate. This will help investors integrate sustainability risks and opportunities into their investment process, ultimately contributing to a smoother transition to a low-carbon and climate resilient economy.

Benchmarks aligned with the Paris Agreement and with climate transition pathways will also contribute to scaling up sustainable finance by serving as a reliable reference tool for investors pursuing low-carbon strategies. In line with the political agreement on the benchmarks proposal reached in February 2019, the TEG is assisting the Commission in (i) defining minimum standards for the methodologies of EU Climate Transition and Paris-aligned benchmarks and (ii) improving the transparency of benchmarks on ESG factors and Paris alignment.

4I The global dimension of sustainable finance

The challenge to achieve the Paris Agreement objectives and the United Nations Sustainable Development Goals (SDGs) knows no borders. Developing countries in particular face difficulties in accessing adequate financing for their sustainable infrastructure and energy efficiency needs. Thanks to their global nature, financial markets have the potential to support all countries in their transition to a sustainable economy by bridging local needs with global sources of funding.

¹² Sustainable use and protection of water and marine resources, transition to a circular economy, waste prevention and recycling, pollution prevention control, and protection of healthy ecosystems.

In its recently adopted *Reflection paper – Towards a sustainable Europe by 2030*, the Commission stressed that international coordination is essential to make markets for sustainable assets compatible, to set incentives for private investors and to scale up sustainable finance globally. Aligning sustainable finance initiatives and tools, such as taxonomy, standards, labels and benchmarks across jurisdictions would ensure compatible markets for sustainable financial assets across borders.

An international network of jurisdictions from developed, emerging and developing countries that are committed to advancing sustainable finance would best serve this purpose. A coherent international strategy and architecture, leveraging the efforts of member countries as well as the European and international institutions, organisations and networks, would contribute to scaling up sustainable finance and mobilising international investors towards sustainable investments across the globe.

To explore how we could coordinate these efforts across jurisdictions, the Commission held a high-level conference on sustainable finance¹³ on 21 March 2019. The conference brought together high-level representatives of countries such as China, India, France, Japan, Hong Kong and Morocco and international organisations including the World Bank, the Organisation for Economic Co-operation and Development, the European Investment Bank and the European Bank for Reconstruction and Development to discuss possible ways forward to scale up sustainable finance globally.

¹³ See https://ec.europa.eu/info/events/finance-190321-sustainable-finance_en

5I Looking forward: next steps and future challenges

To speed up efforts to reform the financial system and to ensure that sustainability remains a permanent feature of EU policies, the Commission will set up a new multi-stakeholder platform on sustainable finance that will begin its work in 2020. As a central forum for discussion among policymakers and relevant stakeholders, the platform will bring together private sector experts, market participants and public bodies such as the European supervisory authorities, the European Environmental Agency and the European Investment Bank. It will assist the Commission by:

- carrying out the necessary tasks to achieve the objectives of the sustainable finance action plan on financing sustainable growth;
- ensuring the development of the EU taxonomy of sustainable activities and its adaptability;
- monitoring capital flows towards sustainable investment and other important developments;
- providing advice on future sustainable finance measures and on how to reinforce international cooperation.

The Commission will continue its efforts to ensure that the EU's sustainable finance strategy becomes a game-changer in the fight against climate change, environmental degradation and in meeting all the relevant SDGs in Europe and beyond.

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Greater transparency and better policy for climate finance

Many developing countries face substantial challenges from climate change and need significant financial resources to fund essential mitigation and adaptation efforts. Mobilising more private sector resources requires balancing economic incentives and policy choices to encourage long-term investment in a financial system that prices the physical and transition risks from climate change adequately and allocates capital efficiently. Such a practice of finance would focus on strategic fundamentals and fully integrate sustainability considerations into its operations, including the full costing of positive and negative externalities under comprehensive disclosure. In this context, funding reliable, low-carbon infrastructure is an essential step toward addressing climate risks at scale and building resilient societies in developing countries to generate sustainable, long-term growth. This article explores how the World Bank Group supports the development of climate risk management and funding mechanisms through its own market operations (as financial institution) and client country engagements (via capacity building and infrastructure projects) to green the financial system against the background of an evolving climate finance paradigm.

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11 The climate finance challenge

At the World Bank Group (WBG), we recognise the adverse impact of climate change on our development agenda of ending extreme poverty and boosting shared prosperity, which are essential elements of achieving the United Nations Sustainable Development Goals (SDGs) by 2030. The SDGs remind us that ensuring equity from economic progress is not just a concern for this generation but for generations to come. Ambitious and credible climate action will not only help mitigate the physical risk from climate change but also encourage long-term investment in enhanced socioeconomic resilience and application of new technologies to support climate solutions.

Developing countries are disproportionately affected by environmental shocks and extreme weather events. It is estimated that more than 90% of people facing extreme poverty live in countries that are politically fragile or vulnerable to natural disasters and climate risk – or, in many cases, both. Poor people are more likely to depend on income sources, such as agriculture, which are often vulnerable to climate shocks, and lack the savings and access to borrowing that can help them cope with disasters.¹ For instance, without urgent global and national climate action, Sub-Saharan Africa, South Asia and Latin America could see more than 140 million people move within their countries' borders by 2050.² This underscores the importance of connecting growth-friendly policies with sustainable investment to strengthen these countries' resilience, prevent a reversal of current development gains, and arrest a downward spiral of economic degradation from climate change, particularly affecting those who are already the most vulnerable.

Many rapidly growing developing countries already face substantial structural gaps that weigh on their capacity to transition to a low-carbon path. We are working closely with developing countries to help them manage

risks through a combination of self-insurance policies, contingency funding, climate-resilient debt instruments, and insurance (including risk pooling mechanisms).³ We have also partnered with the private sector through the Insurance Development Forum (IDF).

The mitigation and adaptation efforts to address climate change require substantial funding, with a focus on climate-friendly infrastructure. Since 55% of global greenhouse gas (GHG) emissions are directly or indirectly attributable to infrastructure,⁴ making infrastructure projects climate-friendly helps reduce the carbon footprint of economic progress. While estimates of resources needed for climate action can vary considerably (and depend on methodology and assumptions), most projections suggest up-front investments of more than USD 1 trillion annually will be needed to meet the climate commitments by 2030, two-thirds of which in developing countries⁵ – and they remain substantial even after factoring in the long-term benefits (which reduce the net cost overall). Over the next 15 years, most investment will be in new infrastructure, which will cost developing countries up to 8% of gross domestic product (GDP) per year to 2030, depending on their ambition and spending efficiency.⁶ Cost must also be allocated to accelerate the retirement of legacy carbon-based infrastructure and ensure that the adaptation and the structural transition to more resilient economies is socially fair and inclusive.

Given the urgency and the enormous demand for climate finance, the World Bank Group is ramping up its efforts. We have already surpassed our target of 28% of all operations having climate co-benefits by June 2018, which had been announced at the Annual Meetings in Lima in 2015, we are aiming to double our investments to USD 200 billion over the five years from 2021 to 2025.⁷ And we are continuing to speed up our contribution to adaptation and mitigation efforts in developing countries by ramping up our support to around USD 50 billion over the same period, which will now give it equal emphasis to investments

1 See World Bank Group (2019a).

2 See Rigaud et al. (2018).

3 The World Bank Group has developed a series of customised financial products and advisory services to help countries increase their financial resilience. The Disaster Risk Financing and Insurance Program (DRFIP) builds donor-funded risk-absorption capacity together with the private sector.

4 Intergovernmental Panel on Climate Change (2014).

5 Gaspar et al. (2019) estimate the additional capital expenditure in developing countries at USD 1.3 trillion per year (in 2030 terms).

6 See Rozenberg and Fay (2019).

7 See WBG (2018b).

that reduce emissions. The recently announced adaptation and resilience action plan⁸ widens our client countries' access to a more diverse set of financing instruments to reduce their exposure to climate risks. It improves the effectiveness of

adaptation and resilience finance through domestic and global resource mobilisation, crowding-in of private sector finance, and facilitating, where feasible, access to (and effective use of) additional concessional finance.

⁸ See WBG (2019a).

T1 Climate finance paradigm in emerging market and developing economies

| Current | Evolving |
|---|---|
| Financing | |
| <ul style="list-style-type: none"> Primarily concessionary public finance channeled through DFI-managed projects as well as bilateral ODA and government transfers | <ul style="list-style-type: none"> Primarily private capital, complemented by public finance focused on (i) de-risking (via unfunded financial arrangements), such as guarantees/credit enhancements, especially for investments where risks are outside private sector's control/capacity to measure and (ii) DFI-facilitated risk pooling |
| <ul style="list-style-type: none"> Private capital via equity-based FDI capital flows | <ul style="list-style-type: none"> Private capital via debt-based portfolio flows |
| <ul style="list-style-type: none"> Seeks to leverage non-concessional finance by 6-10 times^{a)} | <ul style="list-style-type: none"> High leverage levels realized by attracting private capital with innovation and/or enabling environments |
| Scope | |
| <ul style="list-style-type: none"> Project-specific | <ul style="list-style-type: none"> Macroeconomic or sector level(s) |
| <ul style="list-style-type: none"> Focus on mitigation and co-benefits of development actions for adaptive capacity | <ul style="list-style-type: none"> Focus on bidirectional nature of adaptation/mitigation and development co-benefits |
| <ul style="list-style-type: none"> Concentrated in traditional economic infrastructure sectors (e.g., energy, transportation, water, and communications) | <ul style="list-style-type: none"> Combines investment decision in all relevant sectors with comprehensive consideration of transformational change (capturing efficiency gains, retiring carbon-intensive activities, and accounting for social implications of climate transition) |
| Mechanism | |
| <ul style="list-style-type: none"> Focus on policy-directed incentive mechanisms (carbon markets): pricing externalities, with priority on short-term reduction of emission at lowest costs | <ul style="list-style-type: none"> Combination of policy interventions and market mechanisms: creating sustainable economic incentives through growth-friendly policies and comprehensive disclosure, together with policy interventions to address market failure |
| <ul style="list-style-type: none"> Focus on fiscal and structural policy | <ul style="list-style-type: none"> Comprehensive multi-policy approach, especially financial sector policy |
| <ul style="list-style-type: none"> Risk ownership concentrated and mainly associated with government | <ul style="list-style-type: none"> Risk-sharing across all sectors (especially corporate sector, including financials) |
| Impact and Dispersion | |
| <ul style="list-style-type: none"> Public finance: project-level additionality, based on static assumptions | <ul style="list-style-type: none"> Public finance: scalability to support systemic transition, based on dynamic assumptions and feedback effects |
| <ul style="list-style-type: none"> Private capital: reduction of carbon tax, avoidance of policy uncertainty, public relations | <ul style="list-style-type: none"> Private capital: productivity and growth opportunities, business certainty |
| <ul style="list-style-type: none"> Risk-driven: project-specific impact (e.g., net emission reduction) | <ul style="list-style-type: none"> Opportunity and risk-driven: Total balance sheet and climate impact integrated in ESG criteria |

Sources: World Bank Group (2019a) and authors.

Note: DFI – development finance institution; ODA – official development assistance; FDI – foreign direct investment; ESG – environmental, social and governance.

a) The overall co-financing ratio for the total Climate Investment Fund (CIF) program is 1:7 (de Nevers, 2017).

However, limited concessional finance and available fiscal resources require greater mobilisation of private capital for developing countries to meet their climate objectives.

In 2016, climate finance from bilateral sources, multilateral development banks (MDBs) and dedicated climate funds (e.g. the Green Climate Fund) totalled only USD 74 billion. In addition, higher borrowing costs and rising debt burdens are constraining local government funding for climate action, especially in low-income countries. Thus, most financing is expected to come from the private sector. However, there are often structural barriers to the mobilisation of private capital.⁹ Many countries still subsidise fossil fuels or have negative prices on carbon.¹⁰ In addition, the lack of sufficient information, high upfront capital costs, as well as regulatory and political risks often hinder infrastructure investment in developing countries.

Effective climate finance would need to balance market-based mechanisms and policy interventions (see Table 1 above). Providing economic incentives for the transformational choices of mitigation and adaptation efforts requires pricing carbon (through fuel and carbon taxes and emission trading systems).¹¹ However, the outcome of climate-related market mechanisms alone is uncertain if significant negative externalities cannot be addressed through market signals only. Thus, price incentives to reduce emissions, increase energy efficiency, and adopt low-carbon technologies would ideally be combined with growth-friendly policies and appropriate regulatory and tax reforms.¹² Closing data gaps through mandatory, comparable and consistent disclosure of climate risk and eliminating fossil fuel subsidies will be crucial for individuals, firms and markets to efficiently price externalities and reward long-term benefits from sustainability – and they are likely to do so more quickly and effectively (avoiding disruptive adjustments) if climate actions become credible and consistent across countries. Both mechanisms require the development of effective climate risk management underpinning a greener financial system that fully integrates sustainability considerations into its

operations, supported by appropriate macro- and microprudential frameworks.

2| **Market mechanisms: pricing externalities through enhanced disclosure**

Financial markets have started pricing in climate risk. The corporate sector's awareness of climate change has increased over the last few years due to greater transparency. More and more corporates are making ambitious climate commitments and putting their pledges into action by (i) identifying the risks and opportunities from climate change and (ii) providing metrics to track progress in achieving sustainability (see Diagram 1) by following the recommendations of the Financial Stability Board's Task Force on Climate-related Financial Disclosures¹³ and the findings of the G20 Sustainable Finance Study Group.^{14, 15} The abrupt and disorderly transition to a low-carbon economy has the potential to result in significant "stranded assets" in carbon-intensive industries, and weather-related shocks from climate change have negative growth effects as damage to physical assets result in lower output, investment, and productivity.¹⁶ As data on GHG emission reduction and environmental, social, and governance (ESG) performance becomes more accessible, comparable, and reliable, business activities are coming under increased public scrutiny. Investors are rewarding companies that capture the benefits of low-carbon solutions and integrate good sustainability practices into their activities. This also extends to financial intermediaries and asset owners disclosing their strategy regarding climate risk. Reconciling fiduciary responsibility with long-term goals through clear metrics can provide a vocabulary useful to asset managers, institutional investors, and service providers, such as credit rating agencies and pension funds' investment consultants ("gatekeepers"). This can be reinforced by longer-term mandates that shift the evaluation of investment performance toward sustainability and long-term goals (see "market practice" in Diagram 1).

9 International Finance Corporation (IFC) published a report about the most attractive climate investment opportunities, which also offered governments a set of best practice policies and measures that have been proven to attract private investment (Kerr et al., 2017). Stein et al. (2018) identified climate-friendly investment opportunities of about USD 23 trillion in developing countries between 2016 and 2030.

10 According to the Global Commission on the Economy and Climate (2018), subsidy reform and carbon pricing alone could generate an estimated USD 2.8 trillion in government revenues per year in 2030.

11 Failure to include the cost of externalities into the price of carbon will tilt incentives towards unsustainable infrastructure (Pigato, 2019).

12 See Rudebusch (2019).

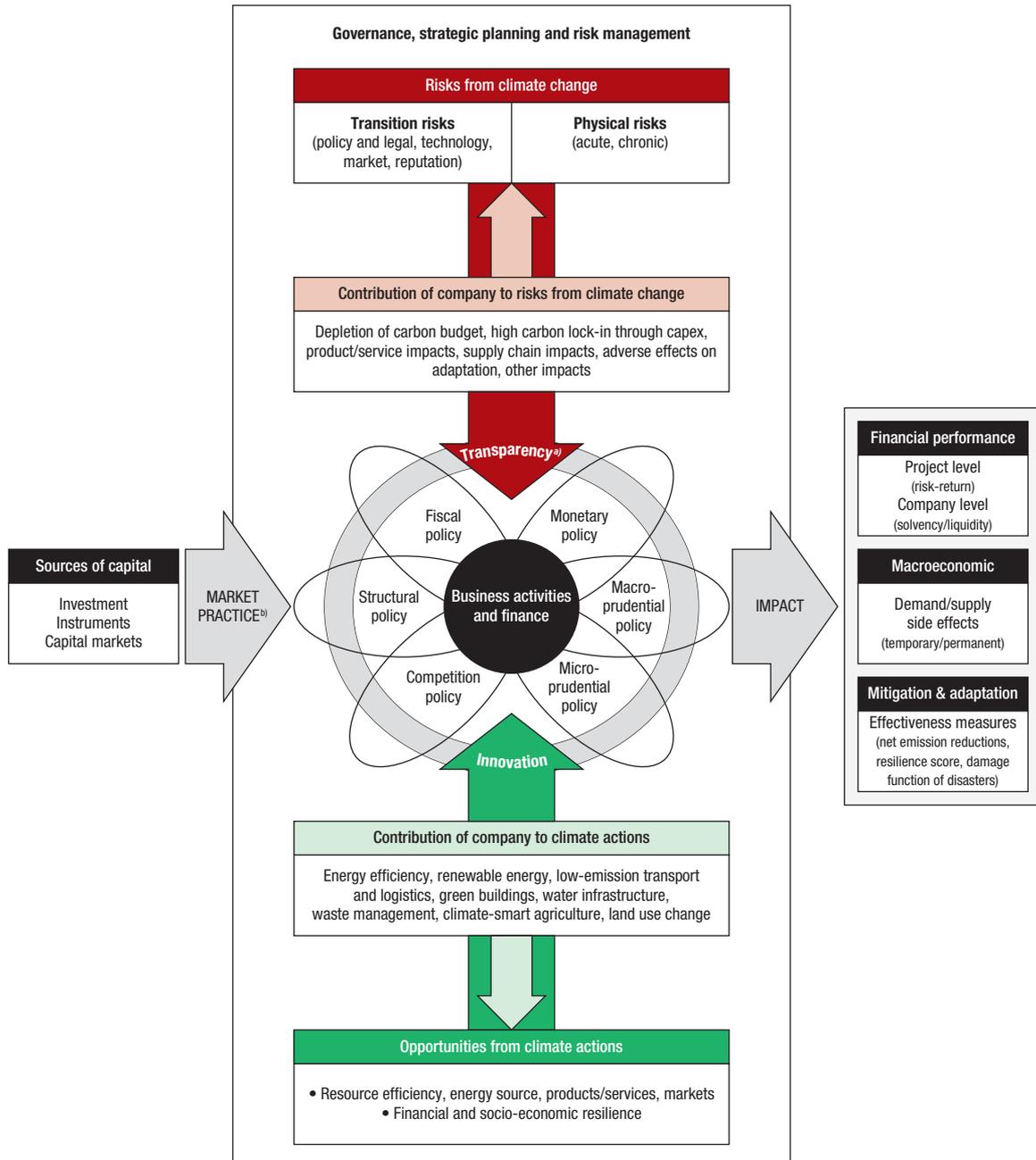
13 See TCFD (2017a and 2017b).

14 See SFSG (2018).

15 For instance, the European Commission's High-Level Expert Group on Financing a Sustainable Economy (European Commission, 2018) has developed a roadmap for sustainable finance and is developing a disclosure framework (European Commission, 2019).

16 See Cabezon et al. (2015); Acevedo et al. (2018).

Diagram 1 Concept of climate finance and business



Sources: Collin et al. (2014), European Commission (2019), Network for Greening the Financial System (2018 and 2019), Task Force on Climate-related Financial Disclosures (2017a), and authors.

a) Includes definitions, taxonomies, disclosure practices, and non-financial reporting standards.

b) Includes contractual obligations, fiduciary arrangements, and market conduct.

Greater transparency on sustainability, including climate risk, is essential to the way the World Bank Group helps mobilise funding for climate-friendly infrastructure projects.¹⁷

However, such mobilisation is inherently dependent on building trust. And such trust can only evolve through consistent and reliable financial reporting, as well as the information that can be extracted from it. In absence of such information, many developing countries remain unconnected to global markets and funding sources.¹⁸ Hence, we are working with the accounting profession to support the effective implementation of International Financial Reporting Standards in developing countries. This is especially important for infrastructure finance, which can be complex and carries a multitude of risks. On this front, we have joined forces with the Organisation for Economic Co-operation and Development (OECD) and the United Nations Environment Programme under a new initiative entitled *Financing climate futures – Rethinking infrastructure*, which published its first report in November 2018 on the importance of transparency in climate-friendly infrastructure projects. Greater transparency also means capturing the volume and distribution of the incremental costs for addressing climate change vulnerabilities. As part of our Adaptation and Resilience Action Plan,¹⁹ the World Bank is developing new resilience metrics to create incentives for countries, donors, and the private sector to engage in more and better adaptation by establishing a global standard for financial markets and public procurement.²⁰

The impact of our investment in projects with climate co-benefits is reflected in our own financial reporting. The World Bank has been disclosing the impact of climate-related investments and net GHG emission reductions through green bond impact reports for several years now.²¹ In October 2018, we introduced the Environmental and Social Framework (ESF), which applies to every new World Bank investment project.²² We are also moving toward broadening

the content of our financial statements by adopting integrated reporting as a mechanism to strengthen internal processes and communicate climate-related risks and opportunities to our member countries and investors.

We also promote greater transparency by helping restore price incentives through carbon markets.

After the collapse of the international carbon markets in 2012, the Paris Agreement has revitalized the global interest in market-based mechanisms to support countries in achieving their target reductions in GHG emissions. We support this effort through the Carbon Pricing Leadership Coalition, in line with our role as one of the first movers in creating carbon markets for climate change mitigation.²³ We also apply price incentives to our own operations and use internal carbon pricing for project finance. In 2018, International Finance Corporation²⁴ was the first among multilateral development institutions to disclose its climate-related risk under the TCFD guidelines.

However, the rising opportunity cost of inaction requires policy interventions for greening the financial system. Price incentives are powerful in changing long-term behaviour, but the outcomes of incentive-based measures on carbon emissions (and near-term effectiveness of market mechanisms) remain imperfectly predictable.²⁵ At the same time, *“the very fact that many energy efficiency improvements deliver positive returns even with a zero-carbon price suggests that non-price levers such as product standards and regulations will be more effective”*.²⁶

31 Policy interventions: growth-friendly policies and enabling regulation

The real challenge over the near term lies in the design and implementation of growth-friendly policies (which make remedial actions more urgent and help address market failures). The transition of GHG-emitting economic sectors

17 See Levy (2018a).

18 See Jobst (2018c).

19 See WBG (2019a).

20 The new metrics will build on past methodological work, complementing the current co-benefits methodology (World Bank, 2017a and 2017b).

21 See World Bank (2017c).

22 See WBG (2018).

23 See WBG (2019b).

24 See IFC (2018).

25 See Wolf (2019).

26 See Energy Transitions Commission (2017, p. 110).

and their infrastructure systems will require the greening of investment, consumption, and public spending flows as well as replacement of a large share of existing carbon-heavy private and public capital stock, with a focus on climate-friendly infrastructure and technology. We encourage

client countries to develop transition plans to (i) accelerate a scale-up of climate solutions and (ii) integrate climate risk and climate objectives into national policy frameworks. Several policy interventions are possible and/or have been being implemented (see Table 2), such as financial

T2 Climate finance channels: market mechanisms and policy interventions

| | |
|--|--|
| Business activities and financial sector practices | De-carbonization of investment portfolio Sustainable business practices Corporate disclosure and non-financial/integrated/ESG reporting, including from physical/transition risks of climate change Enhanced risk management with greater focus on climate change Innovative product/service development to seize opportunities |
| Microprudential policy | Prudential taxonomies of climate-smart investments/risk management/governance Disclosure requirements for climate-related risks, non-financial reporting Regulatory standards ^{a)} and capital requirements ^{b)} |
| Macroprudential policy | System-wide surveillance on the financial sector impact of climate risk Additional reporting and/or capital/liquidity requirements |
| Monetary policy | Climate-related considerations in: <ul style="list-style-type: none"> • Definition of central bank mandate (price stability/employment) and forward guidance • Design/implementation of conventional central bank operations (reserve management, refinancing operations)^{c)} • Design/implementation of unconventional central bank operations (asset purchases) |
| Fiscal policy | Sustainable development budgeting and climate-informed fiscal planning ^{d)} Government borrowing via green and/or social bonds Design and calibration of tax instruments: <ul style="list-style-type: none"> • Positive tax incentives: energy efficient housing, purchase of electric cars • Negative tax incentives: carbon tax, fossil fuel subsidy reform Debt sustainability: assessment of impact of natural disasters/climate change on debt sustainability (“modified DSA”) Disclosure: reporting of full public sector balance sheet with contingent liabilities from physical/transition risks of climate change |
| Structural policy | Energy efficiency standards, building codes, land use regulation, urban planning Disaster risk planning and management Structural policies and regulations for sustainable infrastructure investment Support for new technology and innovations (venture capital/start-up funding) |
| Competition policy | Dissemination of new technology and innovations Lower barriers to entry in key infrastructure markets (energy, transport, water, waste) |

Source: authors.

Note: ESG – environmental, social and governance; DSA – debt sustainability analysis.

a) Regulatory standards, such as Basel Core Principles for Effective Banking Supervision, Insurance Core Principles, and the International Organization of Securities Commissions’s Objectives and Principles of securities regulation, which are assessed in the International Monetary Fund Financial Sector Assessment Program, and/or the Report on the Observance of Standards and Codes.

b) Recent proposals for lower capital charges of climate-friendly investment include energy-efficient mortgages (Energy efficient Mortgages Action Plan) and green infrastructure projects (Jobst, 2018b).

c) For instance, the People’s Bank of China accepts green bonds as collateral in its liquidity operations, such as medium-term lending facility, to promote the development of the green bond market.

d) Sustainable development budgeting incorporates disaster costs into budget planning (e.g., impact on growth, higher infrastructure depreciation rates, and maintenance costs).

sector reforms (e.g. new asset classes as well as micro- and macroprudential requirements that include climate risk), fiscal policies and budgeting (e.g. environmental taxation), structural policies (e.g. early stage funding for new technologies), and sector-specific regulations (e.g. feed-in tariffs and an even playing field for non-incumbent technologies), which vary substantially according to their respective sectors.

The effective implementation of these policy interventions relies on a stable financial system that integrates climate risks. This will help safeguard long-term financial stability and the capacity of financial institutions to fund sustainable investments. In this context, the contribution of financial regulators is unique, as they define the perimeter of financial reporting and associated prudential requirements for regulated investors.²⁷ Greater disclosure and better understanding of climate risks, as well as the prudential response to them, are key elements of providing the right price signals to change business behaviour and consumer choice but might be constrained without uniform guidance and standards.^{28, 29} Regulators are recognising this, which is why the World Bank and IFC (representing the Sustainable Banking Network as Secretariat) have joined the Network for Greening the Financial System,³⁰ which was created by several central banks and financial supervisors in January 2018 to integrate, in a rigorous way, the implications of climate change into prudential frameworks.³¹ A consistent response from policymakers is welcome, because it will help the banks better manage climate-related risks in their balance sheet, as well as the growing number of institutional investors and asset managers that include ESG considerations in their strategies to shift their investment focus from short-term gains to long-term factors. While there are empirical limits to the scope and reliability of forward-looking assessment of climate risk impacts, regulators can use new models and data in scenario analysis and stress testing to better understand and address the

linkages of climate change, economic activity, and financial risks. The World Bank is exploring diagnostics to assess climate change-related financial sector vulnerabilities and a system-wide review of climate risk management practices in client countries.

4| Combining market mechanisms and policy interventions: integrating climate risk in investment demand

The World Bank Group has been active in fostering the cooperation across the investment value chain, private sector associations, and regulators to promote an effective integration of sustainability considerations into financial decisions. We strongly support green bonds as an instrument to unlock capital for sustainable investment. Green bonds can play an important role, as they raise resources from capital markets to fund climate-related activities by private and public actors. The World Bank and the IFC recently published guidelines for common reporting standards on green bond proceeds³² and creating green bond markets.³³ We have also involved the development of an adequate taxonomy and meaningful labelling. In this context, we encourage a greater focus on the overall balance sheet of issuer – in the future *all* finance ought to be green.³⁴ We have partnered with leading institutional investors in incorporating ESG principles into fixed-income strategies,³⁵ and we are building a global database capturing the way companies disclose how their business activities comply with ESG principles.

We also encourage portfolio rebalancing toward climate-friendly infrastructure investments in developing countries. The recent G20 Leaders' Summit in Buenos Aires delivered a strong commitment to closing the infrastructure investment gap, and the way this can help combat climate change, endorsing the "Roadmap to infrastructure as an asset class".³⁶ But this requires transforming the financial sector that

27 See Elderson (2018).

28 See Maimbo et al. (2017).

29 For instance, IFC provided in-depth technical assistance to China Banking Regulatory Commission (2012) for the design and implementation of the first policy framework for sustainable lending practices ("Green Credit Guidelines"). The *Global Progress Report of the Sustainable Banking Network* (SBN, 2018a) describes similar efforts by other developing countries, such as Brazil and Bangladesh.

30 See NGFS (2018 and 2019).

31 Analogous to financial sector policy, similar efforts are underway for fiscal policy. In April 2019, Finance Ministers from more than 20 countries formed the Coalition of Finance Ministers for Climate Action, which endorsed six common principles ("Helsinki Principle") for promoting national climate policies (World Bank, 2019). The World Bank serves as Secretariat for this initiative.

32 See Tlaiye (2018).

33 See SBN (2018b).

34 See Levy (2017).

35 See Inderst and Stewart (2018).

36 See OECD (2018).

better aligns the financing of the economy and the liabilities-driven investment of long-term investors. Life insurers and pension funds will be critical to mobilising private capital for development, but they need to be able to invest in productive capital that contributes directly to sustainable economic growth. Infrastructure investment can bring predictable yields and stable cash flows, providing a natural match to their long-term liabilities.

We promote climate-friendly infrastructure through a range of operations, from technical assistance and policy loans to investment operations. In particular, we support the inclusion of disaster risk and climate change in the planning, construction and operation of infrastructure:

- *Project preparation.* We help governments develop a favourable legal environment and prepare projects to attract investment in climate-friendly infrastructure, thus lowering the informational hurdles that often affect cross-border investment in developing countries. Here, the concept of “quality infrastructure” is becoming ever more important, notably for institutional investors, whose risk tolerance is limited and whose willingness to assume the management of assets is low.^{37,38} We are working with other multilateral development banks on global standards for comprehensive and quality project preparation (“G20 principles for the infrastructure project preparation phase”) as part of the MDB Infrastructure Cooperation Platform of the G20 Infrastructure Working Group.³⁹ This provides political impetus to the Global Infrastructure Facility (GIF), which we have created – with donors’ support and in partnership with other MDBs to collaborate on preparing, structuring, and implementing complex infrastructure projects that no single institution could handle on its own. Since 2015, the GIF has built up a portfolio of 41 projects, which are expected to mobilise over USD 36 billion in total investment.

More than half of GIF-approved funding has supported climate-smart projects.

- *De-risking.* We also help reduce the gap between the risk appetite of investors and the riskiness of infrastructure investment by making the range of guarantees offered by the World Bank Group institutions, both at project and portfolio levels, better understood. Here, the political risk insurance via our Multilateral Investment Guarantee Agency can be particularly appealing, as investment decisions in many developing countries are often dominated by the political and legal risks of expropriation, convertibility constraints, and contract enforceability. We are also working closely with the insurance industry to support infrastructure investment via de-risking of certain aspects of the infrastructure project life cycle.
- *Enabling regulatory environment.* We are reviewing the prudential treatment of infrastructure investment by insurance companies to ensure that capital charges are suitably calibrated to actual risk and do not discourage investment, with a focus on infrastructure projects in developing countries.⁴⁰ This effort follows the recommendations of the G20 Eminent Persons Group on global financial governance.⁴¹ Most insurance solvency regimes treat infrastructure debt as if its credit risk evolves like that of corporates, whereas infrastructure debt’s risk profile is very different. World Bank staff have calibrated a differentiated capital charge reflecting the actual credit risk profile of infrastructure projects under two important solvency regimes – Solvency II in Europe and the forthcoming Insurance Capital Standard for internationally active insurance groups, which is being developed by the International Association of Insurance Supervisors. Recent findings suggest that if current regulations were calibrated to reflect the low default risk and higher recovery rates in infrastructure debt over the last 30 years,

37 See Levy (2018a).

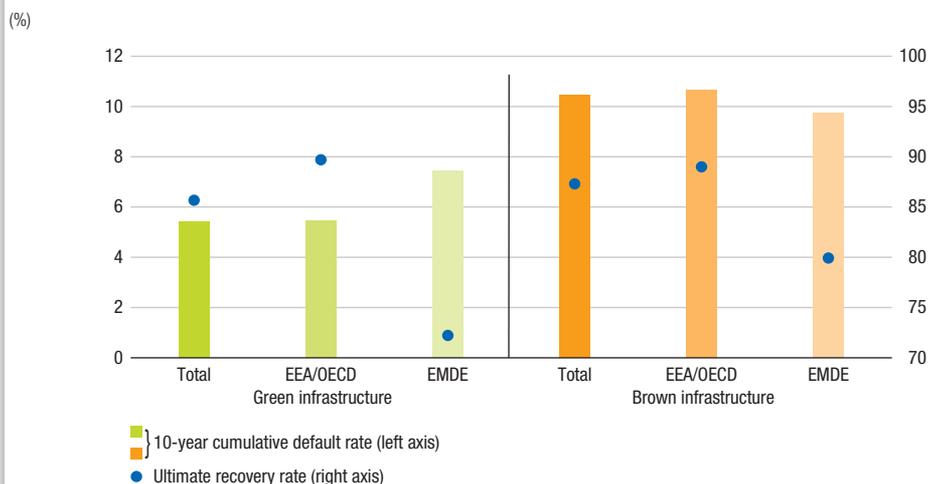
38 Quality means obtaining assets that are economically sound, are built and kept safe, and respond to sustainability requirements, providing additional layers of resilience to communities.

39 See IWG (2018).

40 See Jobst and Merville (forthcoming); Levy (2018b).

41 See G20 EPG (2018).

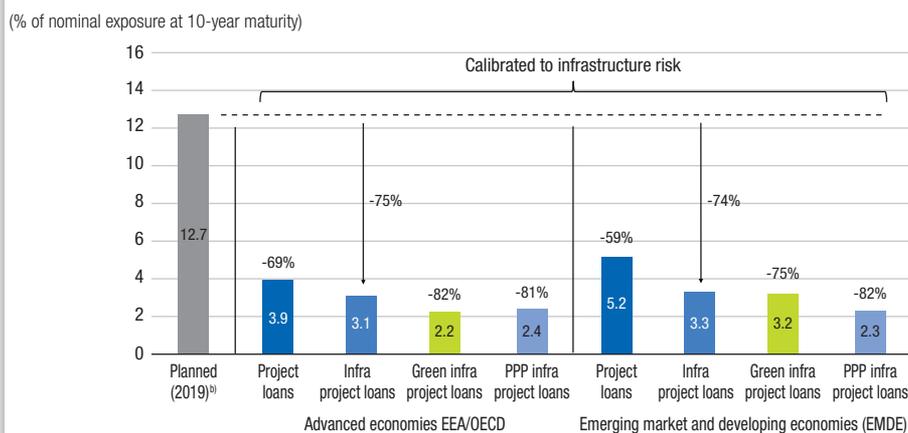
C1 Infrastructure project loans: historical credit performance (1995-2016)



Sources: Jobst, 2018a and 2018b.

Notes: EMDE means emerging market and developing economies. "Green" denotes project finance in industry sectors that meet the use-of-proceeds eligibility criteria of the International Capital Market Association (ICMA) Green Bond Principles. The sub-samples refer to (i) all European Economic Area and Organisation for Economic Co-operation and Development member countries ("EEA" or "OECD") and (ii) all non-high income countries ("EMDE-A") according to World Bank's World Development Indicators based on the sample selection in Moody's Investors Service (2018a and 2018b) over a study time period between 1995 and 2016.

C2 Insurance Capital Standard: capital charge for unrated bonds/loans^{a)}



Sources: Jobst, 2018a and 2018b.

Notes: PPP means public-private partnership. "Green" denotes project finance in industry sectors that meet the use-of-proceeds eligibility criteria of the International Capital Market Association Green Bond Principles. The sub-samples refer to (i) all European Economic Area and Organisation for Economic Co-operation and Development member countries ("EEA" or "OECD") and (ii) all non-high income countries ("EMDE-A") according to the World Bank's World Development indicators based on the sample selection in Moody's Investors Service (2018a and b) over a study time period between 1995 and 2016.

a) Single factor model consistent with Vasiček (2002) is applied to the credit risk parameters (annual default rates and constant recovery of unrated loans [1995-2016]) to determine the capital requirement for expected losses at 99.5% statistical confidence.

b) Currently in field-testing, to be adopted after the end of 2019.

a significant amount of regulatory capital could be freed, including in developing countries⁴² (see Charts 1 and 2).⁴³ This favourable profile is even more pronounced for “green projects,” i.e., those that would meet use-of-proceeds requirements of the International Capital Market Association *Green Bond Principles*.⁴⁴ Hence, we believe there is scope for a discussion about how solvency regimes can better reflect the special features of infrastructure to reduce the regulatory cost to long-term regulated investors.

51 Conclusion

The evolving paradigm of climate finance requires substantial funding of investments in adaptation, especially in developing countries,

which are disproportionately affected by environmental shocks and extreme weather events. More investment in climate-friendly infrastructure will require a greener financial system that (i) fully integrates sustainability considerations into its operations, including the full costing of externalities from climate change under comprehensive disclosure and (ii) helps allocate savings to productive capital that reduces the carbon footprint of economic progress in more resilient societies. As new technologies evolve, and relative prices adjust, this will also create new jobs increase productivity, and enhance innovation if capital flows are adequately steered. Developing a clear and rigorous framework that balances economic incentives and policy interventions will not only mitigate climate risks but also support effective and timely adaptation to the changes we may not be able to avoid.

⁴² See Jobst (2018a).

⁴³ Such an approach was referenced in the FSB's evaluation of the impact of regulatory reforms on infrastructure finance, which was submitted to the G20 Leaders' Summit in Buenos Aires as part of its broader framework for post-implementation evaluation of the G20 financial regulatory reforms (FSB, 2018).

⁴⁴ See Jobst (2018b).

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Green finance: an African perspective

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During its presidency of the 22nd session of the Conference of Parties (COP 22), the Kingdom of Morocco confirmed its ambitious commitments to reduce its carbon footprint while pushing for support for Africa's efforts to adapt to the impacts of climate change.

Morocco, like other countries in Africa, is particularly vulnerable to the effects of climate change, particularly soil degradation and diminishing natural resources, including water, despite being a minor contributor to the principal cause of climate disruption, namely greenhouse gas emissions. This vulnerability has necessitated a comprehensive review of Morocco's environmental strategy and a transition to a more ecologically responsible economy in order to strengthen its climate resilience.

This article provides an overview of the climate change challenges facing the economies of both Morocco and Africa, and looks at the dangers and opportunities for the continent's financial sector, which must rally to support the implementation of the Nationally Determined Contributions pledged by African countries at the Paris Agreement and to help in their transition towards a more sustainable economy.

It also explains the role that the Kingdom's financial authorities can play in order to contribute to the emergence of African green finance, thanks to their close cooperative ties with their counterparts in Africa and the Moroccan financial sector's strong presence across the continent.

11 Climate change threatens Africa with severe socio-economic repercussions

11.1 Climate and African development: a delicate equation

Experts agree that despite being responsible for a mere 4% of the world's greenhouse emissions, Africa will be the worst affected of all the continents by the impacts of climate change. According to the Intergovernmental Panel on Climate Change (IPCC), the gross domestic product (GDP) of Africa, which includes seven¹ of the ten countries considered to be most threatened by global warming, could fall by 2% to 4% by 2040 and between 10% and 25% by 2100, compared with the Organisation for Economic Co-operation and Development (OECD) projection of a global decline in GDP of between 1% and 3.3% by 2060. According to certain estimates cited by the African Development Bank (AfDB), the continent's economy has already contracted by 1.4 percentage points of GDP due to the impact of climate change.

Desertification, deforestation, drought, soil degradation and rising sea levels blight the continent and constitute an increasing threat to agricultural yields and food and water security, and to the sanitary and housing conditions of communities already made vulnerable by poverty,² restricted access to water and electricity, and financial exclusion. Should the situation continue unchanged, experts estimate that by 2050 Africa will only be able to meet 13% of its own food requirements and 65% of jobs could be at risk due to their dependence on agriculture. The scale of the threat is further magnified by the fact that the majority of inhabited areas, economic infrastructures and financial centres are located in coastal regions and are therefore more vulnerable to natural disasters.

Consequently, climate change can no longer be dealt with as an isolated issue. It must now form an integral part of a multi-sectoral, multi-regional and even continental approach to

socio-economic policy, as the relationship between these problems is, in the words of the World Bank, “well established, won't disappear, and will only grow stronger”.

Morocco, like the rest of the continent, is particularly vulnerable to the impacts of climate change due to its exposure to drought, its 3,500 kilometre-long coastline at risk from rising sea levels,³ its pronounced dependence on imported energy,⁴ and the economic importance of its agricultural sector, heavily reliant on rainfall, which accounts for almost 12% of the country's GDP⁵ and employs nearly 38% of the population.⁶

Moreover, as the country's macroeconomic balances are dependent on key trading partners that have already committed to greening their economy, particularly the European Union, there is a risk that if the Kingdom does not comply with environmental standards, competitiveness and foreign demand directed towards Morocco could decline, thereby impacting the country's economic growth, trade balance and exchange reserves.

Consequently, the issues associated with the struggle against climate change have been at the heart of the country's preoccupations for several decades. In terms of energy in particular, Morocco aims at transforming its currently hydrocarbon-dominated energy mix, with the goal of sourcing 52% of its energy requirements from renewables by 2030. This objective also represents one of the main pillars of the commitment made by Morocco as part of its Nationally Determined Contribution (NDC) pledged at the Paris Agreement to reduce its greenhouse gas emissions by 42% over the same horizon.

Furthermore, the country has launched a range of initiatives to conserve and protect the environment in strategic areas such as agriculture, tourism and transport. The Green Morocco Plan was launched in 2008 to make the agricultural sector a lever for socio-economic development, for example by promoting modernised agriculture while

1 Sierra Leone, South Sudan, Chad, Nigeria, Central African Republic, Eritrea and Ethiopia.

2 According to World Bank figures, 41% of the population of Sub-Saharan Africa live below the international poverty line of USD 1.90 per day – i.e. half of all the people in poverty in the world live in Sub-Saharan Africa.

3 As noted in Morocco's Nationally Determined Contribution, rising sea levels could submerge half of the surface area of Morocco's beaches by 2050 and 72% by 2100 and the flooding caused could affect 187,400 people.

4 According to the Minister of Energy, Mines and Sustainable Development, almost 95% of Morocco's energy consumption is imported. Imports of energy and lubricants corresponded to 6.5% of GDP at end-2017, compared with 13% in 2012.

5 10-year average.

6 Average for the past two years.

supporting smallholder farming or through a damming policy pursued within the framework of the national water strategy that aims to safeguard the country's water resources and mitigate the negative effects of drought cycles.

These initiatives were acknowledged in the Climate Change Performance Index 2019 results prepared by Germanwatch, the NewClimate Institute and the Climate Action Network, in which Morocco was moved up the classification to become the second best performing country in terms of combating climate change⁷ out of a field of 56 countries and the European Union.

112 Climate risk, a financial risk still poorly understood

Even if the severity of the impacts of climate change and their incidence trajectory may still be uncertain, the need for the financial sector to make preparations and to manage the related financial risks is no less urgent. These risks may be physical, generated by climatic events, or transitional, created by the economic transition to responsible, low-carbon models.

With regard to physical risks, financial losses due to natural events in Africa were estimated at USD 300 million in 2017, of which less than 13% were insured, compared with costs of USD 330 billion worldwide with a coverage rate of 41% (according to Munich Re figures). As for the banks, these physical risks ultimately translate into classic financial risks, i.e. credit, liquidity and market risks, whose eventual severity is intrinsically linked to the existence or absence of insurance coverage. In Morocco, drought cycles⁸ have affected agricultural production and increased the sector's cost of risk for both the most exposed banks and also for microcredit, whose customers are more vulnerable.

The risk associated with the transition to a green economy can also affect the balance sheets of banks, insurance undertakings and other long-term

investors due to losses sustained on their portfolios' carbon-intensive investments mainly in the fossil fuel sector and the chemical, para-chemical and extractive industries. The pressure on these stranded assets could have negative repercussions for the country's macroeconomic balances, particularly the export sectors, and as a result affect the financial system. Consequently, managing transition risk will require the development of an overall strategy based on a gradual and orderly exit from carbon assets to avoid brown-sector investment losses and the bursting of a carbon bubble.

Managing these risks is not a simple task. It is a general problem that nonetheless affects Africa more acutely as the greater lack of data and sophisticated risk-management tools (such as stress-tests or economic capital models) and the particularly high degree of concentration in bank portfolios may exacerbate difficulties in assessing climate risks and transmission channels towards the financial sector.

21 Several challenges need to be addressed before green finance in Africa can become an opportunity

211 Alarming gaps in financing despite the initiatives underway

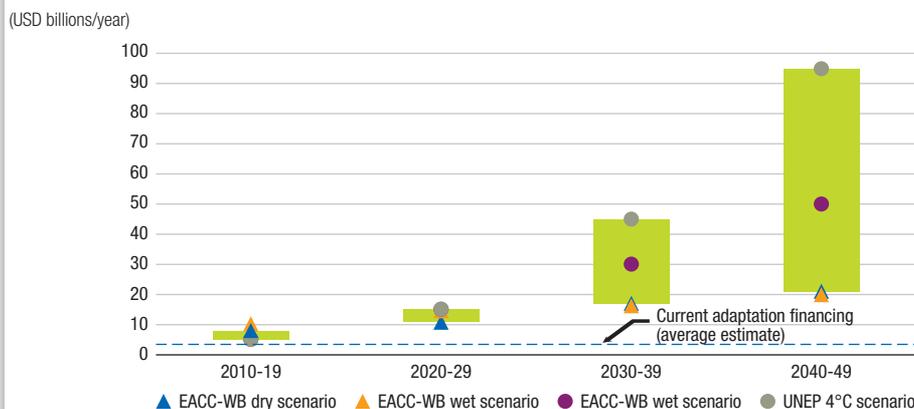
Given their extreme vulnerability to climate change, every African country signed the Paris Agreement and more than 90% ratified their NDCs, whose implementation largely depends on external financial support. Indeed, this Accord requires the developed economies, acknowledged as being primarily responsible for climate change, to provide financial support to developing countries to help them achieve their objectives, in terms of both climate change mitigation and adaptation. This climate finance support was fixed at at least USD 100 billion annually from 2020.

According to the World Bank, Africa currently requires between USD 5 billion and

⁷ This Index leaves the first three positions vacant as no countries perform well enough to merit a top three place. Sweden leads the classification, followed by Morocco and then Lithuania.

⁸ Over the past 70 years, Morocco has experienced 20 years of drought.

C1 Financing required to implement the climate change adaptation programme in Africa



USD 10 billion each year to adapt to climate change rather than the USD 3 billion actually allocated. It is estimated that this figure will rise to USD 50 billion by the middle of the century, and even USD 100 billion in the event that global warming raises temperatures to more than 4°C above pre-industrial levels.

At a global level, climate finance flows in 2017 largely came from private investors (54%) – mainly project sponsors and commercial financial institutions –, then national development financial institutions (28%) and bilateral and multinational development financial institutions (13%), and lastly to a far lesser extent, climate funds (4%). 66% of these flows are captured through the debt market and 30% through the capital market. However, Africa cannot receive these same types and proportions of climate finance due to the obstacles faced by private investors in the Global South. This therefore creates a gap between the continent’s requirements and the climate finance funds it is able to attract. Against this backdrop, several initiatives similar to those instigated by multilateral development banks have been launched.

Box

Examples of initiatives launched in Africa by multilateral development banks:

- the World Bank’s Africa Climate Business Plan (ACBP) incorporates funding of USD 19.3 billion for the 2016-20 period and aims to bring attention to and accelerate resource mobilisation for priority initiatives to strengthen the climate-resilience of countries in Sub-Saharan Africa and promote low-carbon development;
- the Climate Investment Funds (CIF) invested USD 700 million in financing that was mobilised until November 2018 by the African Development Bank (AfDB), which, in addition to committing its own funds, serves as an implementing agency of the CIF;
- the Africa Climate Change Fund (ACCF), created in 2014 by the AfDB, has received total contributions of EUR 11.5 million and aims to contribute to the continent’s sustainable economic development and social progress.

Meanwhile, according to the Climate Bonds Initiative, during the period up to first-half 2018, 21 climate bonds were issued by African-based issuers for a total of USD 1.65 billion, including eight that were labelled as “green” (USD 1.23 billion). These represent less than 0.15% and 0.35% respectively of all climate bonds and labelled green bonds issued worldwide.

Thus, it is clear that the financing flows destined for the African continent are still derisory, with an annual average (according to the African Development Bank) of USD 20 billion in 2016⁹ – i.e. less than 4.5% of global flows – including barely USD 3 billion for adaptation programmes. And these funds continue to fall far short of the investment needed for the transition to a green, sustainable economy across Africa as a whole.

Focusing on Morocco, for the country to implement its NDC it needs an estimated USD 50 billion for mitigation policies (almost half of which require international support) and a minimum of USD 35 billion for adaptation projects during the period up to 2030. According to the Climate Funds Update, in November 2017 the Kingdom received 15%, or nearly USD 780 million, of the international climate fund financing allocated for Africa. Over the previous decade, the World Bank pledged almost USD 1.14 billion for green projects.

The Moroccan financial sector has also been called upon to contribute to the Kingdom’s transition to a green economy. Moroccan banks support national sector plans for sustainable development and energy transition, such as the Green Morocco Plan, which has received around USD 3 billion over the past five years, and have also allocated USD 1.2 billion to the renewable energy sector during the same period.

Some banks have started to develop specific financing products, particularly dedicated lines of credit, in partnership with international donor agencies. These financing initiatives must be strengthened while savings initiatives still have to be developed.

For its part, over the last few years the Moroccan bond market has seen the first bond issues essentially intended to fund renewable energies, energy efficiency and environmental compliance for an amount corresponding to EUR 450 million, 60% of which came from the banking sector.

212 Green finance: specific challenges as well as shared global constraints

Around the world – and despite the progress made – the development of green finance is confronted with numerous challenges. In its 2016 report, the G20 Green Finance Study Group discussed the challenges facing countries in both the Global North and the Global South. The first of these challenges is to implement incentives targeted at reducing the costs of green projects, thereby increasing their return and attractiveness. This problem is then further exacerbated by asymmetries in terms of green project maturity mismatches and environmental information disclosures. The last of these challenges is to strengthen the capacity to assess and quantify the economic and financial implications of climate change. While these obstacles may act as stumbling blocks to the development of green finance everywhere, some of them are particularly obstructive in Africa.

In the countries of the Global South, certain structural constraints, such as the absence of adequate infrastructure, institutional and legal deficiencies, corruption or the lack of political visibility, increase country risk and restrict African countries’ access to climate finance.

Consequently, environmental concerns should be considered alongside the economic and social priorities of African countries in order to enhance the continent’s attractiveness for climate investment. African authorities must act quickly to incorporate their NDCs in their national development strategies and to strategically manage the limited resources available to them in order to

⁹ Including financing flows to Sub-Saharan Africa and the Middle East and North Africa (MENA).

create a more favourable context for private sector investment. Authorities could help to resolve the problems associated with high green project costs by implementing incentive programmes, including subsidies, tax credits and regulations. This situation is worsened by the operational and administrative difficulties involved in accessing international funds.

Moreover, financing for adaptation, which accounts for the majority of the funding needs, can in itself be an additional constraint for African countries in that it involves long-term projects whose future risks and profitability are often difficult to assess.

Lastly, financial institutions' grasp of the economic implications of environmental risks is generally in its infancy at a continental level. Strengthening the capacities of African partners is therefore a particularly important challenge, inciting the United Nations Environment Programme to insist on the need to implement sustained cooperation to share knowledge internationally.¹⁰

213 Green finance: an opportunity for the continent

The rise of the green economy also offers possibilities for growth and development, by capitalising on opportunities in terms of energy efficiency, the development of new products and services and the emergence of new markets and technological innovations.

Consequently, the prospects of development afforded to the financial sector by sustainable finance are promising and go well beyond contributing to the introduction of a more sustainable economy or complying with Paris Agreement commitments. The financial sector must therefore show creativity and a sense of innovation and seize these opportunities.

Direct foreign investment in green projects combined with international funding could act as a

catalyst for the development of local, climate-related financing across all African countries. In this way, green finance could help to boost growth in bank lending and limit the climate-related financial risks of financial institutions.

The development of new financial instruments can also generate fresh impetus in African capital markets. This can be seen in the case of climate bonds in particular, which have proven to be an effective tool in mobilising flows towards green projects.

The growing appeal of green finance for investors can also offer new avenues for the development of financial centres at a continental level. In this respect, financial centres are compared on the basis of criteria such as bond issue volumes or environmental, social and governance disclosures, which are used as performance indicators.

The creation of Morocco's financial centre – Casablanca Finance City – in 2010 through a public-private initiative is characteristic of this trend. It aims to establish itself as the Pan-African hub for climate finance and to help in mobilising resources to support the struggle against climate change in Africa. As such, it is a committed partner in the organisation of environmental finance events such as the 2016 Climate Finance Day or the Global Green Finance Leadership Program planned for June 2019.

31 What can the financial authorities do?

311 Expanded supervision and support for green finance

While the importance of the financial sector in African economies' transition towards a more inclusive and sustainable model is now acknowledged, financial regulators also have a fundamental role to play. They must work to ensure that this transition is supported by all elements of the financial sector according to a

¹⁰ For example, a regional climate finance workshop for francophone Africa was organised in Casablanca in 2016 by Moroccan stakeholder organisations, the Adaptation Fund and the *Institut de la francophonie pour le développement durable* (a sustainable development body for French-speaking regions).

shared, coordinated and progressive vision in order to maintain financial stability.

With this in mind, Bank Al-Maghrib (BAM) and other financial authorities and sector operators drew up a roadmap that aims to align the Moroccan financial sector with sustainable development issues. The roadmap's strategic vision centres around five key areas: extending the governance of financial establishments to include social and environmental risks; building capacity in the field of sustainable finance; promoting market transparency and discipline; working alongside stakeholders to develop green financial instruments and products; and promoting financial inclusion as a driver for sustainable development.

The implementation of these roadmap commitments involves regular dialogue between financial authorities on the one hand and with financial system participants on the other, and thus led to the creation of a dedicated Sustainable Development Committee that brings together BAM and Moroccan banks (through their federation) to report on sector initiatives and discuss the risks incurred and challenges to be addressed. Sustainable development is also included in the agenda for the twice-yearly meetings held between the BAM Governor and the presidents of Morocco's banks.

After an initial phase intended to raise awareness and to provide support for the voluntary individual commitments made by the banks, BAM began working on a regulatory text to provide a framework for the management of climate and environmental risks by credit institutions. This draft text will encourage banks to take environmental and climate concerns into account in their governance and strategy, to expand their risk mapping to include environmental issues, and to prepare and communicate climate-related risk disclosures, while progressively integrating the recommendations of the Task Force on Climate-related Financial Disclosures (TCFD) under the auspices of the Financial Stability Council.

The Moroccan financial market authority (AMMC) published its first guide to green bonds in 2016 to promote the mobilisation of green resources. The guide was revised in July 2018 to also include sustainable bonds. More recently, the AMMC released for consultation a text requiring, inter alia, companies that launch a public offering to prepare and disclose an ESG report. A specific benchmark index – the Casablanca ESG 10 – was also put in place in September 2018.¹¹

Meanwhile Morocco's Supervisory Authority of Insurance and Social Welfare (ACAPS) encourages the insurance sector to subscribe to sustainability standards through its membership in the Sustainable Insurance Forum, which also adheres to TCFD recommendations. ACAPS has also worked towards expanding the assets accepted as cover for technical provisions to include green assets in order to promote investment in sustainable development and the environment.¹²

Furthermore, the Minister of Finance and Bank Al-Maghrib have agreed a national strategy for financial inclusion that aims to promote the access, use and quality of adapted financial services for both individuals and companies, and thereby support financial sector sustainable finance policies.

While these initiatives meant that the Sustainable Banking Network ranked Morocco at the “emerging” stage in terms of advancing sustainable finance in its February 2018 Global Progress Report, there is still a long way to go and significant efforts are still required to ensure that the financial sector roadmap is implemented and that environmental and social risk monitoring is put in place by financial institutions.

312 The need for stronger international cooperation to face a common challenge

Strengthening the capacities of the various players and raising awareness of sustainable development issues, particularly through dialogue and constant sharing of information and experience, is vital

¹¹ This benchmark index assesses the SRI performance of companies listed on the Casablanca Stock Exchange on the basis of ESG criteria developed by Vigeo Eiris, and presents the top ten performers.

¹² A framework agreement was signed between the insurance sector and the Minister of Energy, Mines and Sustainable Development in this respect and a draft regulatory text is currently being drawn up to facilitate its entry into force.

to taking concrete and effective action. And this is all the more true for financial authorities in that understanding the related risks for the financial sector raises even more complex issues. For example, identifying green assets and brown assets, their associated risks and the means to measure them is an essential prerequisite to taking effective action but remains wanting.

In addition to these prudential issues, there are more general questions as to the best approach to take for the greening of the financial sector.

As part of this information-sharing dynamic, BAM became a member of the Central Banks and Supervisors Network for Greening the Financial System in April 2018 in order to better understand the challenges associated with sustainable finance policies but also to capitalise on the related experiences of more advanced countries in this field and as much as possible pass these insights on to its counterparts in Africa.

It was also with the firm conviction that the Moroccan financial sector can make an active contribution to the Network's efforts and in line with the Kingdom's reaffirmed commitment to promote South-South cooperation, that the roadmap drawn up for Morocco also includes a Pan-African dimension

to promote the expansion of green finance across the entire continent. The Kingdom is able to take on this bridging role thanks to the Moroccan financial sector's strong presence across Africa: Morocco's three largest national banking groups have operations in 26 Maghreb and Sub-Saharan countries through 46 subsidiaries that have significant standing in their host countries.

Existing partnerships and cooperation between Morocco's public and private players and their African counterparts must be further strengthened and expanded to incorporate sustainable development issues. With this in mind, BAM has included the issue of sustainable development in the cooperation agreements signed with several of the continent's central banks and/or supervisory authorities, which are intended to structure interactions with local supervisors of African subsidiaries in order to monitor the cross-border risks borne by national banks.

The intensity of this cooperation, which at the moment remains hesitant, will no doubt be a key factor in raising awareness of environmental risks at a continental level and, if carried through with commitment, will contribute to transforming the challenges of climate change into structural development opportunities for Africa.

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