Financing the Low-Carbon Future

A Private-Sector View on Mobilizing Climate Finance

September 2019

Table of Contents

CFLI

CLIMATE
FINANCE
LEADERSHIP
INITIATIVE

Mr. António Guterres
Secretary-General
United Nations
760 United Nations Plaza
New York, New York 10017

Dear Mr. Secretary-General,

We are pleased to present the Climate Finance Leadership Initiative report in support of building a sustainable low-carbon economy. In accordance with the objectives of the initiative, this report outlines solutions for further mobilizing private-sector capital in line with the goals of the Paris Agreement.

The need for climate action has never been more urgent, and finance can play a powerful role in the transition to a sustainable and inclusive global economy. To achieve this transition, the world requires a significant shift in investments that make financial flows consistent with pathways toward low greenhouse gas emissions and climate-resilient development. Meeting this goal will depend on the public and private sectors coming together to support an inclusive and orderly transition from high- to low-carbon assets on a global scale — and quickly.

Although each member of this initiative brings a different expert perspective from across the investment chain, we have all seen that progress is not only possible but also presents significant opportunities for our businesses and the clients and communities that we serve. This report highlights real-world examples of best practices and actionable solutions to the challenges that most often hinder sustainable low-carbon investment. Today, we have the knowledge, the capability, and the insight to further scale new investment in clean energy and other green opportunities and to support the transition of existing investments in reducing their emissions.

While we are committed to action, our organizations cannot drive the necessary change alone. We call on our peers, as well as industry, public finance, and policymakers, to join together in harnessing the power of financial markets and driving investment solutions to urgently address climate change. We must further catalyze efforts and work together to ensure sustainable and inclusive growth for our global economy.

Sincerely,

Michael R. Bloomberg
Founder
Bloomberg

Andreas Utermann
Chief Executive Officer
Allianz Global Investors

Thomas Buberl
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and General Manager
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Executive Summary

Unmitigated, climate change will have significant long-term impacts on people, ecosystems, and the global economy.

The Intergovernmental Panel on Climate Change (IPCC) recently provided a vivid picture of how 1.5˚C and 2˚C of warming are likely to affect human populations and natural systems — with a notable escalation of economic and ecosystem impacts between these two temperatures. The IPCC report found that achieving the 1.5˚C target would require emissions to decrease to net zero by 2050, necessitating far-reaching transitions across the global economy in energy, land, urban, infrastructure, and industrial systems.[1] Private-sector institutions, in partnership with the public sector, can help facilitate these transitions by mobilizing capital at the required scale and pace.

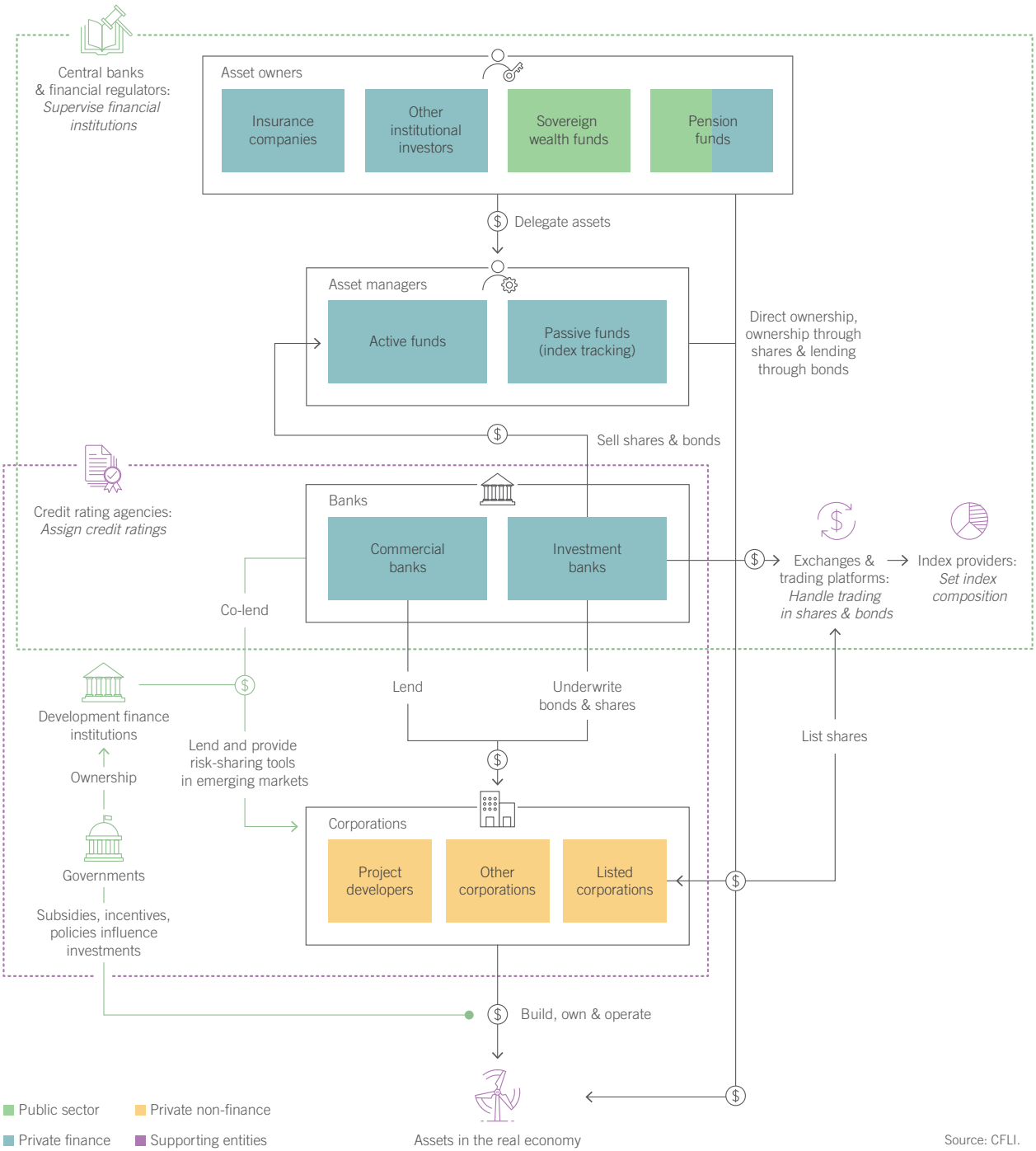
Recognizing the important role private-sector capital can play in expediting this transition, United Nations Secretary-General António Guterres asked Michael R. Bloomberg, UN Special Envoy for Climate Action, to lead a private-sector initiative to "support a global mobilization of private finance in response to the challenge of climate change." Senior executives of seven major private-sector institutions — Allianz Global Investors, AXA, Enel, Goldman Sachs, HSBC, Japan's Government Pension Investment Fund (GPIF), and Macquarie — joined Bloomberg as chair in creating the Climate Finance Leadership Initiative (CFLI). These leading institutions represent a diverse span of roles across the investment value chain, including an international power utility, commercial and investment banks, insurers, asset managers, and asset owners.

Informed by the deep expertise of CFLI institutions, this report offers insights into how to mobilize private climate finance at the scale and speed needed to support an orderly and inclusive transition to a low-carbon global economy. The report considers challenges to — and solutions for — financing the low-carbon future across both developed and emerging economies. In recognition of the opportunity to act in the near to medium term, emphasis is given to readily available and scalable solutions and technologies, examples of successful low-carbon investments and transitions, and policy actions with proven track records of attracting private-sector capital across sectors with the largest emissions reduction potential.

Chapter 1, The Financial Sector's Role in the Global Response to Climate Change, frames two key pillars for financing an effective low-carbon transition: (1) increasing low-carbon investment and (2) supporting the transition of carbon-intensive sectors. To provide a deeper understanding of how private finance influences change in the real economy, this chapter describes how the investment chain of private institutions works in practice. FIGURE ES-1 illustrates the flow of capital within the financial system and the various roles of private- and public-sector institutions.

[1] IPCC, "Special Report: Global Warming of 1.5°C: Summary for Policymakers," Geneva, 2018.

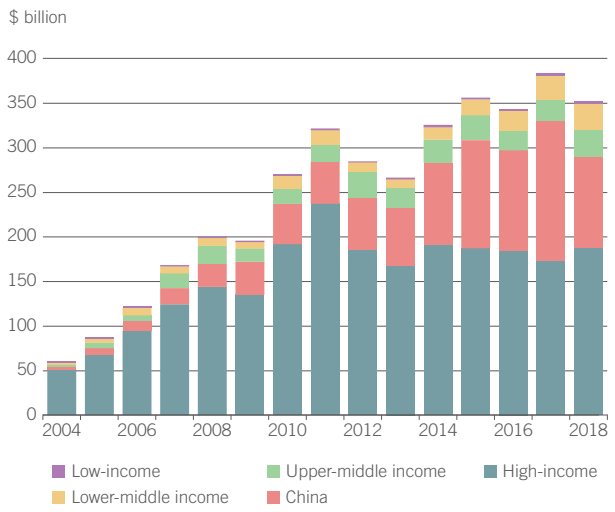
FIGURE ES-1:
The investment chain: The interaction of the private sector, public sector, and real economy



Source: CFLI.

Chapter 2, Trends in Climate Finance, takes stock of the state of low-carbon investment today. While global investment in clean power generation, electrified transportation, and building efficiency has increased significantly, low-carbon investment in other sectors is lagging. Cumulative solar and wind capacity installed worldwide exceeded 1TW in 2018 — roughly the size of the entire power system in the United States.[2] Provided sufficient revenue certainty and policy stability are present, developers in most markets can now deliver electricity generated by mainstream renewables at a lower cost than coal-fired power, on a levelized cost basis.[3] Private finance has responded to the attractive risk-adjusted returns offered by renewable energy by deploying hundreds of billions of dollars in equity and debt investments (FIGURE ES-2).

FIGURE ES-2:
Clean energy investment by country income group[4]



Source: BNEF. Note: Includes renewable energy generation projects, smart metering, and energy storage projects.

Aggregate global energy demand, however, has grown at a faster rate than renewable energy supply. In 2018, increased use of renewables avoided 214Mt of emissions — a significant, yet insufficient, amount in light of the 1.25Gt of new energy-sector emissions attributed to economic growth.[5] Coal retains the largest share of global power generation, with 37% compared with 7% for wind and solar.[6] The IPCC estimates that annual investments in clean energy and energy efficiency would need to increase by a factor of six by 2050 compared with 2015 levels to limit warming to 1.5°C.[7]

Progress on clean energy investment has also been uneven across geographies, with advanced economies, China, and a select few fast-growing emerging economies remaining dominant. The 31 markets classified as low-income countries by the World Bank have seen only 0.1% of total clean energy investment from 2009 to 2018 (FIGURE ES-2).

Low-carbon investment in some sectors beyond power is expanding but from a small base. Clean transportation has seen robust growth in response to financial incentives, declining battery costs, and policy mandates. Sales of passenger electric vehicles increased from just 38,000 vehicles in 2011 to almost 2 million in 2018 but remained a small share of the 87 million new vehicles sold globally.[8] New business models and financing mechanisms have facilitated energy efficiency investments in the buildings sector, which accounts for a large portion of global energy demand. Other sectors, including heavy industry, heavy-duty transport, and agriculture, have yet to attract low-carbon investment at scale.

Meanwhile, the development of green financial products has expanded rapidly. In particular, issuance of green bonds has grown from less

2 BloombergNEF (BNEF), Capacity & Generation database.
3 BNEF, "1H 2019 LCOE Update," 29 March 2019.
4 China is separated from country income groups because it is the largest market for clean energy investment; inclusion would distort the amount of clean energy investment in upper-middle-income countries.
5 International Energy Agency (IEA), "Global Energy & CO_2 Status Report 2018," 2019.
6 BNEF, "New Energy Outlook 2019: Data Viewer," June 2019.
7 IPCC, "Special Report: Global Warming of 1.5°C: Summary for Policymakers," Geneva, 2018.
8 BNEF, "Electric Vehicle Outlook 2019," 2019.

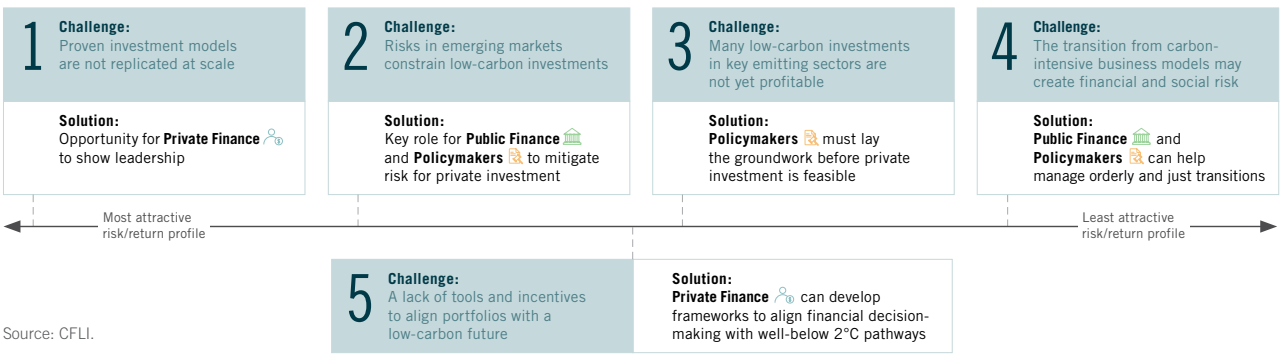
than $1 billion in 2009 to $177 billion in 2018.[9] Green bonds issued to date have predominantly taken the form of "use of proceeds" bonds, in which money raised is earmarked for the development of projects that meet specific green standards. However, a broader set of capital market instruments, such as transition bonds or sustainability-linked corporate bonds, will be required to support the transition of carbon-intensive business models.

Beyond investment trends and tools, climate change is increasingly factored into financial supervision as regulators acknowledge the risks climate change poses to individual institutions and financial stability. In April 2019, the Network for Greening the Financial System (NGFS) — comprising 42 central banks and financial regulators overseeing two-thirds of systemically important banks and insurers — recommended that climate risks be integrated into both financial stability monitoring and supervision of individual institutions.[10] In addition, more than 830 organizations have expressed their support for the recommendations of the Task Force on Climate-related Financial Disclosures (TCFD), and many companies plan to enhance their climate-related disclosures in line with these recommendations in the next five years.[11]

Chapter 3, Key Challenges and Solutions for Mobilizing Private Finance for the Low-Carbon Transition, outlines five barriers that need to be overcome through partnerships across the public and private sectors (FIGURE ES-3). The opportunity for leadership by private finance across these challenges depends, in part, on the availability of risk-adjusted returns matched to investor requirements. Instances where attractive risk-return profiles already exist offer greater opportunities for private-sector leadership to scale and replicate proven investment models. In cases where commercial investments offer revenue but uncertain or higher-risk returns, the private sector may work with public finance institutions and their blended finance, risk-sharing, and pipeline development tools. In other cases, policymakers can develop regulatory frameworks and incentives that unlock private-sector investment in low-carbon solutions.

Challenges 1 to 4 focus on links between the financial sector and the real economy, including assets, projects, and non-financial companies. **Challenge 5** focuses on practices within the financial sector. Proposed solutions to each challenge are organized by actions that can be taken by private finance, public finance, and public policy, and are supported by case studies showcasing the progress already under way.

FIGURE ES-3:
Challenges and solutions to mobilize private finance in support of the low-carbon transition



Source: CFLI.

9 BNEF, Sustainable Debt database.
10 NGFS, "A call for action: Climate change as a source of financial risk," April 2019.
11 TCFD, "2019 Status Report," June 2019.

1 Challenge: Proven investment models are not replicated at scale

Despite progress in clean energy investment, investor appetite for clean energy projects often exceeds the volume of investment opportunities. Renewable energy capacity additions have stagnated in some mature markets with a track record of solar and wind deployment. In part, this stagnation is due to policy reversals or uncertainty, which undermine the stable revenue models that support clean energy investment. Development of new coal-fired power plants continues even in markets where low-carbon alternatives are already cost-competitive, particularly in emerging markets with rapidly growing power demand.[12]

Key solutions to Challenge 1

Private Finance

Where the enabling regulatory frameworks exist, large electricity consumers can enter into power purchase agreements (PPAs) with project developers and utilities, especially where clean energy can deliver electricity at a lower cost than power procured from the grid. Depending on regulation, the electricity can be generated on site, delivered via the grid, or procured through a virtual PPA.

The securitization of clean energy project debt in bonds can also allow developers to access capital markets for long-tenor, fixed-rate financing and expand funding opportunities beyond the use of non-recourse loans. Given investors' strong appetite for low-carbon investment opportunities, these financial products can continue to be scaled.

Public Finance

Public budgets can continue to play a central role in clean energy deployment by guaranteeing revenues, especially in new markets and for newer technologies. Revenue security plays a decisive role in making clean technologies more attractive than carbon-intensive alternatives and providing investors with the confidence to deploy capital over longer periods.

Public Policy

Governments can set ambitious long-term targets for decarbonizing the energy sector, supported by short- to medium-term procurement goals for clean energy and stable enabling investment frameworks. Governments can also review permitting and litigation rules to help minimize project delivery times and avoid cancellations.

Note: Full explanation of challenge and solution can be found on page 38.

[12] BNEF, Capacity & Generation database and Coalswarm, Summary Statistics, accessed 30 July 2019.

2 Challenge: Risks in emerging markets constrain low-carbon investments

The recent rise of clean energy investment — both public and private — is highly concentrated in high-income countries, China, and a select group of fast-growing economies. Despite rapidly increasing energy demand, other emerging markets have struggled to attract capital for clean energy projects — even in cases where wind and solar may be more competitive than fossil fuels. This lack of investment is due to several factors, including country- and project-specific risks, a lack of policies and regulations to support clean energy markets, underdeveloped local capital markets, and the absence of experienced project developers and value chains. Such factors can deter investment or significantly raise risks for investors compared with advanced markets. The resulting increase in the cost of capital disproportionately affects capital-intensive investments such as renewable energy projects.

Key solutions to Challenge 2

Private Finance

In addition to providing asset financing where enabling conditions permit, international equity and debt providers can invest in or partner with local developers or other companies along the value chain. Investing in developers, rather than projects, can also offer higher returns and earlier stage access to growth markets. Private-sector organizations can also communicate clear guidelines for factors that make projects more appealing to investors, such as the CFLI Investment Readiness Guidelines (Appendix 1).

Public Finance

Development finance institutions (DFIs) can be critical for opening new markets and sectors to private investment by establishing a track record for investment, facilitating the regulatory change needed for commercial investment, and supporting project pipeline development through project preparation facilities. In more mature markets and sectors, DFIs can unlock more capital by partnering with banks and asset managers to co-finance projects and developing fixed income and structured finance products for other institutional investors. In instances where commercial opportunities do not exist, DFIs can leverage private investment through risk-sharing tools, such as guarantees and political risk insurance, and their ability to source and coordinate catalytic finance from donors and third parties.

Public Policy

Domestic policymakers can stimulate private finance flows by enhancing the general enabling environment for low-carbon investment. Clear clean energy targets, regulatory frameworks that allow privately developed clean energy projects access to the electricity grid, and at least one major policy that directly incentivizes investment, such as clean energy auctions or feed-in tariffs, are typically needed to mobilize private investment. Domestic policymakers can also take steps to improve the general investment climate, including establishing predictable and fair dispute resolution frameworks.

Policy stability is also critical. Reversals or renegotiations of PPAs, tax incentives, or other agreements — particularly in the early stages of market development — can have a long-lasting negative impact on future investor interest.

Note: Full explanation of challenge and solution can be found on page 46.

3 Challenge: Many low-carbon investments in key emitting sectors are not yet profitable

In contrast to the growing cost-competitiveness of renewable energy generation and electric vehicles, fewer viable alternatives exist in many sectors with a significant share of global emissions. These sectors include heavy industry (18% of emissions), heavy-duty transport (13% of emissions), and agriculture, forestry, and land use (24% of emissions).[13,14] In some cases, solutions for decarbonizing these sectors are technically viable but not yet economical due to high capital costs and lack of incentives or revenue models. In other cases, the necessary technologies require further development to reach commercialization.

Key solutions to Challenge 3

Private Finance

Corporations that produce steel, cement, aluminum, and other commodities can develop labeling standards for low-carbon products, helping to lay the foundation for greater demand for these goods. Through their purchasing power, corporations and end-consumers can drive demand for low-carbon materials or products, creating an incentive for suppliers to invest in emissions reduction measures.

Public Finance

Public funding can provide revenues for low-carbon investments, for example, through market-based subsidy mechanisms or other results-based finance schemes. Incentives leveraging public finance are especially attractive in markets and sectors where the introduction of fully fledged carbon markets is not yet viable or when carbon market prices are too volatile to support long-term investment.

Public budgets, in collaboration with the private sector, can also support the commercial viability of earlier-stage, low-carbon technologies through funding for research, development, and demonstration. Public funding can also support the commercialization phase of these technologies through subsidy mechanisms and risk-sharing models such as loan guarantees.

Public Policy

The broad application of stable, long-range carbon pricing across major economies could level the playing field for trade-exposed, high-carbon industries such as steel and cement and spur more long-term investment in alternative industrial production processes. Phasing out policies like fossil fuel subsidies would also improve the economics of clean energy and efficiency. In addition, public procurement, incentive schemes, and product standards can support the development of markets for low-carbon products.

Note: Full explanation of challenge and solution can be found on page 58.

13 Energy Transitions Commission, "Mission Possible: Reaching Net-Zero Carbon Emissions from Harder-to-Abate Sectors by Mid-Century," 2018.
14 IPCC, "Climate Change 2014: Synthesis Report," Geneva, 2014.

4 Challenge: The transition away from carbon-intensive business models may create financial and social risk

Many assets in the real economy are long-lived, ranging from around 15 years for cars and buses, up to 50 years for fossil fuel power plants, and 100 years or more for buildings. As a result, the financing decisions of the past can lock in carbon emissions well into the future. "Committed" emissions from existing fossil fuel–based assets in the power, industrial, and transport sectors are already incompatible with a 1.5°C trajectory.[15] Consequently, some carbon-intensive assets will likely need to be retired early, requiring a transformation of the corporations, utilities, and communities that have historically relied on their operation.

Key solutions to Challenge 4

Private Finance

Investors and lenders can develop a wider range of financial products to support corporations that have adopted ambitious transition goals, such as transition bonds or corporate bonds linked to longer-term transition strategies. Supporting corporations in their transition can create a virtuous cycle: more money invested in clean companies can create a greater appetite for the transition — lowering financing costs and ultimately leading to more investment.

Corporations and investors can also support the just transition of communities and workers by incorporating social criteria into their investment decisions, investing in retraining programs, and recognizing the long-term value of inclusive growth.

Public Finance

Public budgets can provide direct support to communities, households, and workers affected by the transition. This support can include measures to mitigate short-term impacts, such as providing compensation, workforce development programs, and community grants to diversify local economies, while also investing in longer-term industrial transition strategies that may not generate the level of financial returns needed to attract private investment.

Public Policy

Government policy can encourage owners and operators of carbon-intensive assets to make the transition to low-carbon alternatives. For example, regulation can determine the schedule of closure of carbon-intensive assets or introduce emissions standards that increase in stringency over time. Such measures offer a path for investors to anticipate change and plan the decommissioning of carbon-intensive assets so as to avoid uncertainty for owners and operators as facilities are retired.

Note: Full explanation of challenge and solution can be found on page 69.

[15] D. Tong et al., "Committed emissions from existing energy infrastructure jeopardize 1.5°C climate target," *Nature*, 2019. This study assumes that assets would operate according to historical average lifetimes.

5 Challenge: A lack of tools and incentives to align financial portfolios with a low-carbon future

Achieving net-zero emissions by mid-century will also require the financial sector to more systematically account for material climate-related information in financial decision-making. However, there is currently a lack of decision-useful information and methodologies that facilitate the integration of climate-related risks and opportunities into investment decisions. In addition, there are practical challenges, including the quantity of suitable low-carbon investments across asset classes.

Key solutions to Challenge 5

Private Finance

Organizations across the investment chain can work to incorporate climate-related risks and opportunities into governance and financial decision-making. As part of this effort, financial-sector leaders can emphasize the importance of climate-related disclosure to inform their decision-making, such as reporting in line with the recommendations of the TCFD. In addition, investors and lenders can work to more systematically align financial flows with a well-below 2°C pathway, including by partnering with corporations through investing and financing to achieve climate-related targets, transition strategies, and industry-specific transition pathways.

Credit rating agencies can routinely, consistently, and transparently integrate climate-related risks and opportunities into credit assessments. Including climate risk and transition analysis in mainstream ratings could steer private-sector capital to corporations that are best positioned in the transition to a low-carbon economy.

Public Finance

The sovereign shareholders of public and multilateral financial institutions — notably development banks, sovereign wealth funds (SWFs), and government pension funds — can lead by example by encouraging these institutions to align portfolios with well-below 2°C pathways. Multilateral development banks and DFIs are already aligning their decision-making with the Paris Agreement, while a growing number of SWFs and government pension funds plan to integrate climate-related factors into their portfolio management activities.

Public Policy

Central banks and financial regulators can continue to promote an understanding of the climate-related risks and their potential financial implications. For example, they can assess the exposure of their domestic financial systems to climate-related risks, conduct stress tests, and encourage climate-related financial disclosure.

Policymakers can also develop standards and taxonomies to increase the transparency regarding which activities are aligned with the low-carbon transition. For example, the EU Technical Expert Group on Sustainable Finance has proposed a taxonomy to define which activities are considered environmentally sustainable and plans to update this taxonomy regularly to reflect the evolution of the market and technologies.

Note: Full explanation of challenge and solution can be found on page 78.

Introduction

Introduction

Context

Unmitigated, climate change will have significant long-term impacts on people, ecosystems, and the global economy. As greenhouse gas (GHG) emissions continue to rise, increasingly severe natural disasters and chronic changes in weather patterns have the potential to weaken global economic growth, including through impacts on human health and well-being, physical assets, and returns on affected investments. Already, the physical risks of climate change have begun to materialize: extreme weather, intensified by climate change, is estimated to have driven the majority of the $470 billion in natural catastrophe losses over the past two years.[16] These impacts have occurred with just 1°C of warming above pre-industrial levels.[17]

Avoiding the most dangerous impacts requires rapid and substantial low-carbon transitions across all sectors and regions. The Intergovernmental Panel on Climate Change (IPCC) recently provided a vivid picture of how 1.5°C and 2°C of warming are likely to affect human populations and natural systems — with a notable escalation of economic and ecosystem impacts between these two temperature levels. The IPCC report found that achieving the 1.5°C target would require GHG emissions to decrease to net zero by 2050, necessitating far-reaching transitions across the global economy in energy, land, urban infrastructure, and industrial systems.[18]

Recognizing the risk of delayed action, governments and regulators are increasingly committed to delivering a global response to climate change. Under the Paris Agreement, 185 countries set the objective of limiting global temperature rise to well-below 2°C.[19] Recently, jurisdictions such as the United Kingdom and France have adopted targets to achieve net-zero emissions by 2050 and Sweden by 2045.[20,21,22] In its first report, the Network for Greening the Financial System (NGFS) found that it is within the mandate of central banks and supervisors to ensure that the financial system is resilient to climate risks.[23] Meanwhile, the Bank of England has incorporated climate change impacts into its supervision of banks and insurers.[24]

> *"The Special Report by the IPCC unequivocally states that the world is not on track to limiting global temperature rise to 1.5°C as outlined in the Paris Agreement — and the window to achieve this is closing rapidly. We're almost out of time. Crucially, the report tells us that time remains to limit climate change. But only if we work with unprecedented speed, fulfill the Paris Agreement, and recommit ourselves to the multilateral process."*
>
> Patricia Espinosa, Executive Secretary of the UNFCCC, October 2018

16 Munich Re, "The natural disasters of 2018 in figures," 8 January 2019, and "Hurricanes cause record losses in 2017 — The year in figures," 4 January 2018.
17 Intergovernmental Panel on Climate Change, "Special Report: Global Warming of 1.5°C: Summary for Policymakers," Geneva, 2018.
18 Ibid.
19 United Nations Framework Convention on Climate Change (UNFCCC), "The Paris Agreement," 2015.
20 UK Government, "UK becomes major economy to pass net zero emissions law," 27 June 2019.
21 UNFCCC, "Sweden Plans to Be Carbon Neutral by 2045," 19 June 2017.
22 Reuters, "France sets 2050 carbon-neutral target with new law," 27 June 2019.
23 NGFS, "A call for action: Climate change as a source of financial risk," 2019.
24 Bank of England, "Enhancing banks' and insurers' approaches to managing the financial risks from climate change," Supervisory Statement 3/19, 15 April 2019.

In line with the call for action made by governments and regulators, the financial sector can facilitate the acceleration of an orderly low-carbon transition. This report describes how private financial institutions, in support of their clients and in partnership with the public sector, can help mobilize capital at the scale needed to deliver an orderly transition to a low-carbon economy.

The Climate Finance Leadership Initiative (CFLI)

In late 2018, United Nations Secretary-General António Guterres asked Michael R. Bloomberg, UN Special Envoy for Climate Action, to lead a private-sector initiative to "support a global mobilization of private finance in response to the challenge of climate change."[25] Senior executives of seven major private-sector institutions — Allianz Global Investors, AXA, Enel, Goldman Sachs, HSBC, Japan's Government Pension Investment Fund (GPIF), and Macquarie — joined Bloomberg as chair in creating the Climate Finance Leadership Initiative (CFLI). These leading institutions represent a diverse span of roles in the investment value chain, including an international utility, commercial and investment banks, insurers, asset managers, and asset owners. Together, they represent trillions of dollars in financial flows, including $4.5 trillion in assets under management alone, a market capitalization of more than $500 billion, and more than $25 billion in clean energy asset finance over the last decade. Collectively, this group offers a broad perspective on the central role of private climate finance.

Scope and purpose of this report

As the international response to climate change has intensified, including through global diplomacy in the context of the UN, the importance of harnessing private-sector capital is often invoked. **Informed by the deep expertise of CFLI institutions, this report offers insights into how to further mobilize private climate finance at the scale and speed needed to support an orderly and inclusive transition to a low-carbon global economy.**

This report considers challenges to — and solutions for — financing the low-carbon future across both developed and emerging economies. In recognition of the opportunity to act in the near to medium term, emphasis is given to readily available and scalable solutions and technologies (see box on page 16), examples of successful low-carbon investments and transitions, and policy actions with a proven track record of attracting private-sector capital across geographies, as well as the sectors with the largest potential for global GHG emissions reductions. While the analysis focuses on climate change mitigation, the CFLI recognizes the role private finance can play in adaptation and resilience as emphasized in the concurrent work of the Global Commission on Adaptation.

The report's three primary chapters are organized as follows:

Chapter 1, The Financial Sector's Role in the Global Response to Climate Change, describes two key pathways for finance to support the low-carbon transition: (1) increasing low-carbon investment and (2) supporting the transition of carbon-intensive sectors. This chapter also provides a brief overview of the investment chain and the interaction of public and private institutions along it.

[25] Bloomberg Philanthropies, "UN Secretary-General Taps UN Special Envoy Michael R. Bloomberg to Lead Climate Finance Leadership Initiative," [Press release], 26 September 2018.

Chapter 2, Trends in Climate Finance, uses the latest available data to provide a snapshot of low-carbon investment to date, its drivers, and its constraints.

Chapter 3, Key Challenges and Solutions for Mobilizing Private Finance for the Low-Carbon Transition, describes five key challenges to mobilizing private finance and proposes potential solutions to address these challenges. Solutions are categorized according to those that can be driven by private finance and those that will require stronger partnerships among private finance, public finance, and policymakers.

Finally, the report's **Conclusion** identifies three key areas for near-term and ambitious action from the private sector and calls for greater collaboration between the public and private sectors to address these critical challenges.

By sharing this perspective, the **CFLI hopes to drive the solutions and greater coordination between private finance, industry, public finance, and policymakers that will be necessary to realize the opportunities of a timely and orderly transition to a low-carbon economy.**

Financing a future that delivers climate goals

In its 2018 Special Report, the IPCC reviewed 90 scenarios that would limit average global temperature rise to 1.5°C. While these potential pathways present various assumptions and emissions reductions solutions, they typically share several key aspects.[26] First, global emissions decline to net zero by around 2050, with anthropogenic GHG emissions reduced significantly and the remainder balanced globally by GHG emissions removal, such as through carbon sinks. Second, all pathways require substantial changes in the energy system, including the following:

1. A significant increase in the use of renewable energy;
2. A decrease in energy demand through measures such as energy efficiency;
3. The electrification of energy end-use;
4. An increase in the use of nuclear energy and carbon capture and storage (CCS);
5. A decline in coal-fired power to nearly zero by 2050; and
6. The use of carbon dioxide (CO_2) removal.

Although many potential pathways to a 1.5°C goal exist, this report focuses primarily on measures that can accelerate the transition to a low-carbon economy in the near to medium term across the power, transport, industrial, buildings, and land-use sectors. These measures include dramatically increasing renewable energy deployment, increasing electrification, and reducing coal-fired power.[27] This report also highlights demand-side actions that can act as powerful drivers of emissions reductions, such as the more efficient use of energy or the demand from consumers to purchase more sustainable products. Together, if scaled, these approaches could substantially reduce global emissions over the next 10 to 15 years.

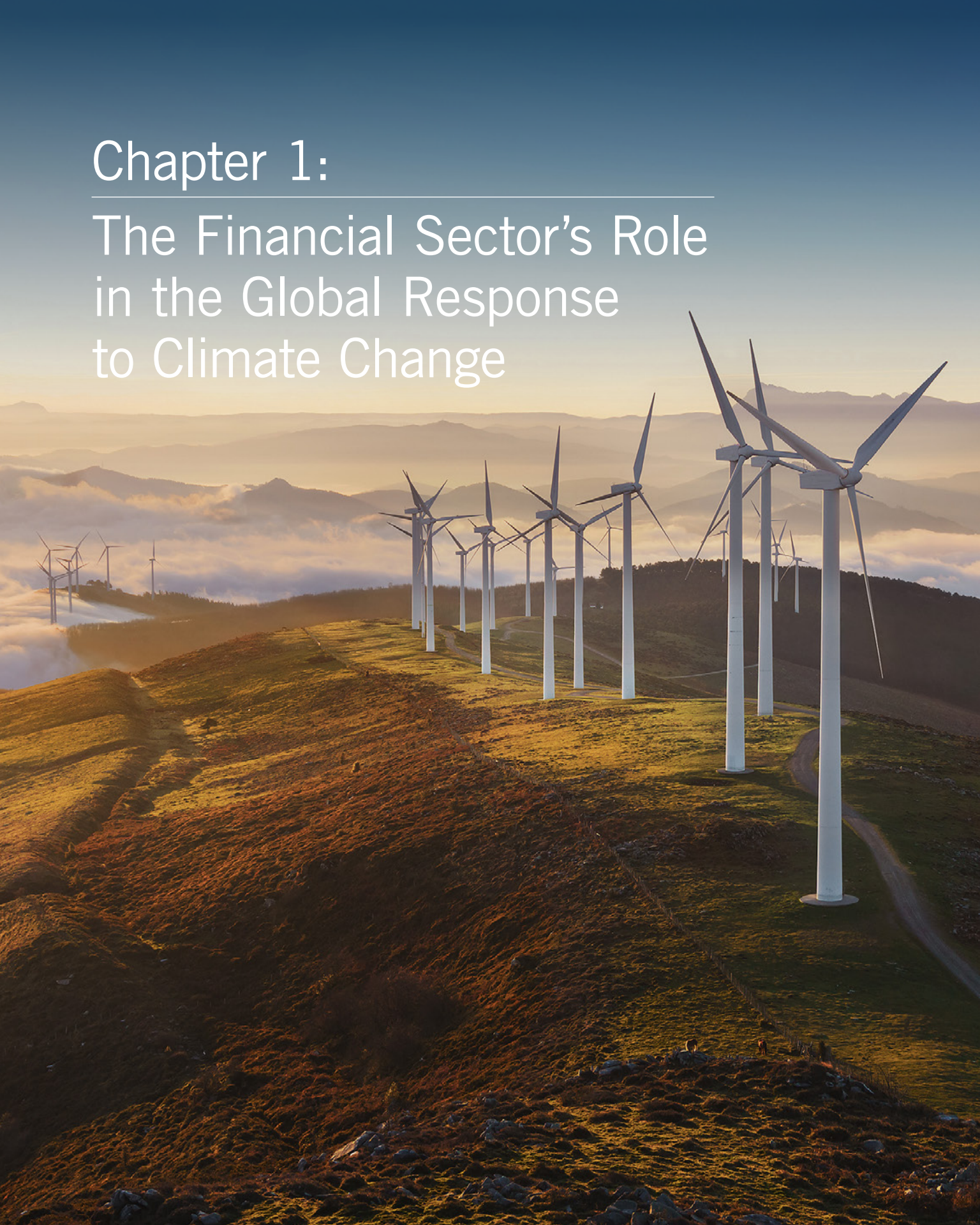
However, in the long term, this report recognizes that achieving net-zero emissions will require supporting innovative solutions through more research and development (R&D) and the creation of revenue models that can support technologies and processes that are currently not commercially viable. Such solutions will likely include a mix of hydrogen, retrofitting industrial processes with CCS, and commercializing CO_2 removal technologies.

[26] IPCC, "Special Report: Global Warming of 1.5°C," Geneva, 2018.

[27] Nuclear is not included within the scope of this report due to challenges related to its current cost, social acceptance, and environmental impact.

Chapter 1:

The Financial Sector's Role in the Global Response to Climate Change



Chapter 1: The Financial Sector's Role in the Global Response to Climate Change

This chapter outlines the role of the financial sector as a critical enabler of the low-carbon transition in the real economy and outlines the ways in which the financial system can support transitions across key sectors and regions.

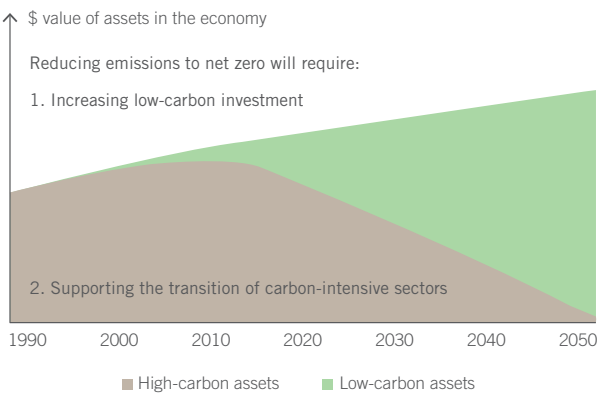
Finance as an enabler of the low-carbon transition

"Climate finance" refers to the deployment of financial solutions to support activities to reduce GHG emissions and adapt to the impacts of climate change. To date, the policy discourse and resulting analytic work around climate finance have focused largely on increasing the volume and efficiency of financial flows to low-carbon solutions. This focus is embodied in numerous multilateral climate agreements and decisions, notably the commitment of developed countries to mobilize $100 billion per year from the public and private sectors by 2020 to support climate change mitigation and adaptation in developing economies.[28]

While scaling financial flows to low-carbon alternatives is an important element of the transition, it represents only part of the answer. Reducing emissions to net zero will require a holistic approach that also supports the transition of existing carbon-intensive sectors (FIGURE 1).[29]

The private sector and the broader financial system play a key role in supporting both pathways through their engagement with the real economy through financing, investment, and management of investment portfolios and loan books.

FIGURE 1:
Two key pathways for finance to support the low-carbon transition



Source: CFLI. Note: Stylized asset value and transition trajectory.

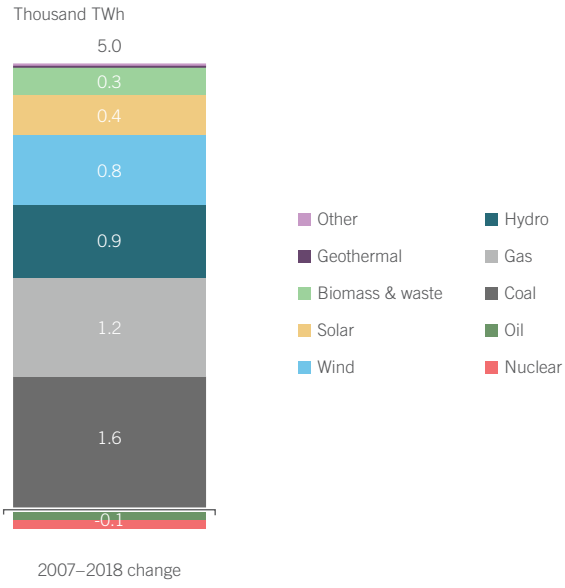
[28] Original commitment: see UNFCCC, "The Cancun Agreements," 2010. Extended commitment: see UNFCCC, "The Paris Agreement," 2015.
[29] IPCC, "Special Report: Global Warming of 1.5°C," Geneva, 2018.

Accelerating new low-carbon investment

Investment in low-carbon solutions is growing worldwide — but not at the pace required. In response to a rapid decline in the cost and technology risk of clean energy, cumulative clean energy investment reached $3.7 trillion between 2004 and 2018.[30] However, energy demand has grown at a faster rate than renewable energy supply: in 2018, increased use of renewables avoided 214Mt of CO_2 emissions — a significant, yet insufficient, amount in light of the 1.25Gt of new energy-sector emissions attributed to faster economic growth.[31] This growing demand has led to the build-out of fossil fuel–based power. Growth in coal generation delivered the largest share of additional demand for electricity over the last decade (FIGURE 2), and oil products continue to meet the vast majority of the increase in demand in the transport sector. The key indicator for climate change mitigation — global emissions — remains on an upward trajectory.[32]

Low-carbon investment has flowed unevenly across regions and sectors. The risks of investing in certain locations and technologies are often considered too high or the returns insufficient. Excluding China, emerging markets generated about one-quarter of global gross domestic product (GDP) but attracted only 13% of low-carbon investment over the last decade.[33,34] The lowest-income countries, where investment risks are particularly high, saw only 0.1% of total clean energy investment between 2009 and 2018.[35] In addition, in certain high-emitting sectors, such as heavy industry, heavy-duty transport, or agriculture, commercial investment in low-carbon alternatives has yet to scale.

FIGURE 2:
Net change in world electricity generation by source (2007–2018)



Source: BloombergNEF (BNEF).

Supporting the transition of carbon-intensive sectors

Supporting the attainment of climate targets means transitioning sectors that are currently carbon-intensive, not abandoning them. Reducing emissions in the real economy will involve both the transition of assets (i.e., how they are retired or retrofitted) and supporting the transition of the corporations, utilities, and communities that have relied on their operation. The financial sector, taking a balanced perspective of physical risk, transition risk, and opportunity, can play a key role in managing this process in an orderly fashion.

The most significant opportunity to assist the transition of carbon-intensive sectors is likely to be in industrialized economies and China.

30 BNEF, Global Clean Energy Investment database.
31 International Energy Agency (IEA), "Global Energy & CO_2 Status Report 2018," March 2019.
32 Global Carbon Project, "Carbon Budget 2018," December 2018.
33 World Bank, "World Bank Open Data, GDP (Constant 2010 US$)," 2019.
34 BNEF, Global Clean Energy Investment database.
35 Ibid.

These countries accounted for about 70% of global emissions in 2017 and house the majority of legacy carbon-intensive assets.[36] Many of these long-lived assets, including power plants, industrial facilities, and vehicles, may depreciate and cycle off balance sheets at a rate that is incompatible with global temperature goals. Consequently, in markets saturated with existing carbon-intensive infrastructure, assets would need to be retired to create opportunities for new low-carbon investment. In other cases, such as with inefficient housing stock, the opportunity may be to upgrade rather than replace existing infrastructure with the help of innovative financing solutions.

Corporations — not just the physical assets they build, own, or manage — face the challenge of adapting business models in the transition from a high- to low-carbon economy. While this shift will create opportunities for new products, markets, and corporate renewal, it will also likely require significant capital. Financial institutions, through their lending, investments, and facilitation, can help support businesses in implementing transition strategies.

Roles in the investment chain

The financial services sector — a diverse array of private institutions performing functions across the investment chain — serves as a vital partner for private industry and government in the transition to a low-carbon global economy. This section highlights the varied roles, risk-return profiles, and constraints of different types of private institutions. It also illustrates the interactions between institutions and the factors that influence their decision-making (FIGURE 3). As a prelude to the full discussion of challenges and solutions that follows, this section aims to provide insight into the mechanics of how private-sector capital influences changes in the real economy.

Private-sector institutions in the investment chain

Corporations and project developers

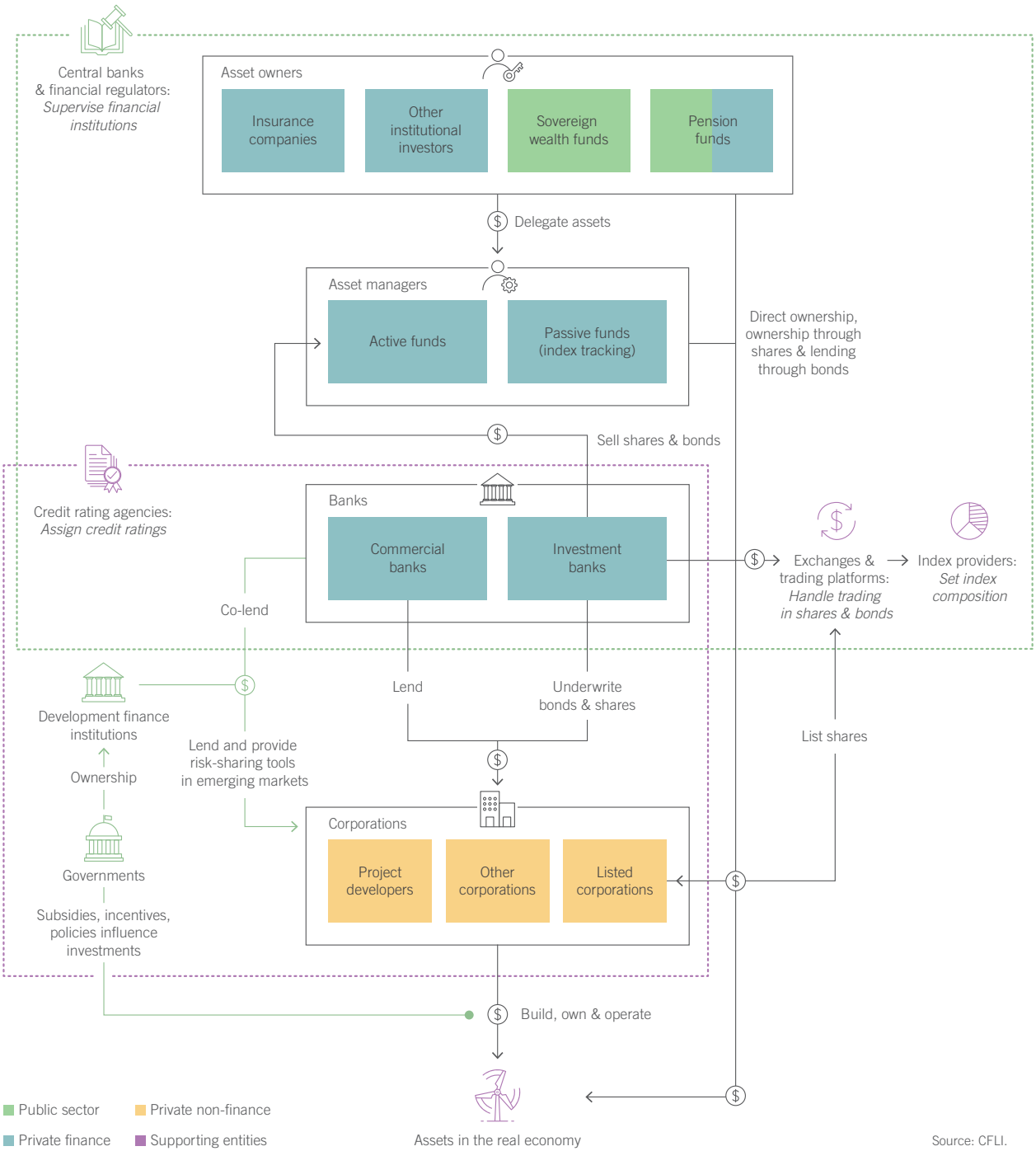
invest in assets in the real economy. Project developers, whose businesses typically focus on the development of new assets, often take on development risks and then source additional finance to build assets. While project developers sometimes continue to own and operate projects, more often they look to sell these assets to other investors, thus helping free up capital for other projects. Corporations build, own, and/or operate assets, often continuing to make decisions about an asset's operations throughout its lifetime.

Levers of capital allocation: Project developers typically obtain financing on a project-by-project basis (also known as "asset finance"), often through bank loans but sometimes through project bonds. The availability of asset finance depends more on the risk-return characteristics of the project than on the state of the developer's balance sheet.

Corporations can finance projects in two ways: through cash in hand, usually from retained earnings, or with financing from the financial sector. Smaller corporations can usually only access bank loans, whereas larger corporations can also issue bonds or new equity. The cost of financing depends on many factors, including the corporation's creditworthiness and its relationship to its financing partners. Corporations aim to make a profit for their owners while complying with any relevant regulations. Because most corporate finance, like bond issuance, is general purpose, corporations have flexibility in deciding how to invest. For instance, some decisions may prioritize short-term profits, while others may entail larger investments that may create short-term losses with the expectation of greater returns in the future.

36 International Monetary Fund (IMF), World Economic Outlook database, 2019.

FIGURE 3:
The investment chain: The interaction of the private sector, public sector, and real economy[37]



Source: CFLI.

[37] Figure 3 is highly simplified and focuses on major roles across the investment chain. Individual financial institutions may serve in multiple roles. In line with the scope of the report, Figure 3 does not include financing that may be needed for early-stage solutions.

Commercial and investment banks play a central role within the financial system, acting both as providers of capital and as financial intermediaries. Commercial banks can lend directly to projects or to corporations. Their portfolios are essentially their loan books, or the outstanding loans owed to the bank. Investment banks, which can be part of larger financial institutions or stand-alone entities, also act as intermediaries between investors and corporations or project developers by underwriting bonds or equity offerings. Investment banks may also be trading houses in bonds, currencies, equities, derivatives, commodities, and other financial products.

Levers of capital allocation: Banks are for-profit enterprises seeking to make a return for their shareholders, subject to complying with regulations. Although their lending and underwriting decisions mainly depend on the creditworthiness or bankability of a firm or project, they can also be influenced by regulatory capital requirements. Regulators require banks to hold a certain proportion of equity in relation to their total risk-weighted assets. In particular, regulators require more capital to be held against asset classes and business lines that they consider risky.

Asset managers are intermediaries who manage other organizations' and individuals' investments. They can range from small specialized firms (such as ones focused solely on clean energy) to large institutions that manage trillions of dollars across all asset classes and geographies. A large share of asset manager activities involves buying and selling pre-existing financial assets, such as bonds and equities. However, some asset managers invest directly in assets in the real economy, such as infrastructure (e.g., toll roads, airports, power plants, or pipelines) or real estate.

Levers of capital allocation: Asset managers have a legal obligation to act in their clients' interests and in accordance with "fiduciary duty," which is, however, defined and interpreted differently across regions and financial institutions. Beyond the influence of client preferences and regulation, asset managers typically reach smaller institutions or retail clients through fund structures for which asset managers themselves choose the investment approach.

Asset owners include institutional investors such as endowments, family offices, foundations, pension funds, insurers, or sovereign wealth funds (SWFs). Many asset owners delegate large portions of their portfolios to asset managers or invest them in passive index-tracking funds. While their functional activities are often similar to those of asset managers, asset owners may have longer investment horizons (e.g., 40 to 50 years for pension funds, reflecting the need for long-term income for their beneficiaries).

Levers of capital allocation: Most asset owners seek to optimize returns over the long term without taking undue risk. However, decisions on how to allocate capital vary between types of asset owners, depending on their investment horizon, risk tolerance, and regulatory constraints. For example, governments may influence the investment priorities of SWFs and public pension funds.

Other private-sector entities influencing the investment chain

Credit rating agencies evaluate the likelihood of an organization or project being able to pay back debt and distill this analysis into a rating on a scale from least to most creditworthy. These ratings are widely used to inform investors' allocations, as ratings are a standard input into

assessing the credit quality of investments. Many types of institutional investors, including pension funds, have investment policies that stipulate that they cannot invest assets rated below "investment-grade."[38]

Growing interest from investors in factoring environmental (including climate), social, and governance (ESG) factors into their investment decisions has given rise to **ESG rating agencies**. These agencies can range from stand-alone entities to arms of larger index providers or credit rating agencies and rank companies according to specific ESG criteria. This information can help investors inform their decisions directly, or it can be integrated into financial products such as indices or bonds. As there is no standard method or set of criteria for determining ESG ratings, scores can be inconsistent across agencies.

Index providers influence the allocation of asset owners' capital by constructing investable indices that passive funds track and active funds use to benchmark performance. Although indices are constructed by committees that receive input from investors, index providers often retain significant autonomy in determining index composition.

Finally, **insurers** underwrite certain risks to assets and corporations, for example, liability risk, business interruption risk, and damage risk (e.g., from natural hazards or human-caused damage, such as vandalism or theft). They guarantee to pay out in case of losses in exchange for an annual premium. Accordingly, they play a vital role in reducing the risk of certain investments.

Public-sector actors influencing the investment chain

National governments set public policies that establish the frameworks, conditions, and priorities for investments. For example, policymakers can set sectoral standards to drive investments in a particular direction, or they can establish the necessary legal framework for low-carbon investments to generate revenues. Policies are also often supported by **public budgets**. Public subsidies can make projects investable where costs or uncertainty would otherwise be too high, and they can also be used to support early-stage R&D for new technologies.

Development finance institutions (DFIs) are government development agencies or the private-sector arms of multilateral development banks (MDBs). DFIs work to advance sustainable economic development in emerging economies by providing equity, long-term finance, risk mitigation, and other tools that stimulate investment in development. DFIs operate as public-sector, mission-driven investment banks and are mandated to be financially self-sufficient. Therefore, they apply market-driven commercial principles, along with impact measurement and monitoring. DFIs are often the principal source of asset finance in emerging markets and play an important role in opening up new markets for private investment and establishing investment-friendly market standards.[39]

Central banks and financial regulators oversee the financial system. The core job of a central bank is the use of monetary policy (including through interest rates and as a lender of last resort to private banks) to manage macroeconomic conditions — primarily inflation and employment. They typically are also responsible for limiting systemic financial risk, including through macroprudential regulation. In addition, central banks often supervise individual banks, although in some countries, this task is delegated to a separate financial regulatory agency. In some jurisdictions, different parts of the financial

[38] Ratings have letter designations, which represent the quality of an asset. The rating agencies S&P and Fitch assign ratings of AAA, AA, A, BBB, BB, B, CCC, CC, C, and D, whereas Moody's uses a slightly different scale of Aaa, Aa, A, Baa, Ba, B, Caa, Ca, and C. Assets rated below Baa3 or BBB- are considered to be below "investment-grade."

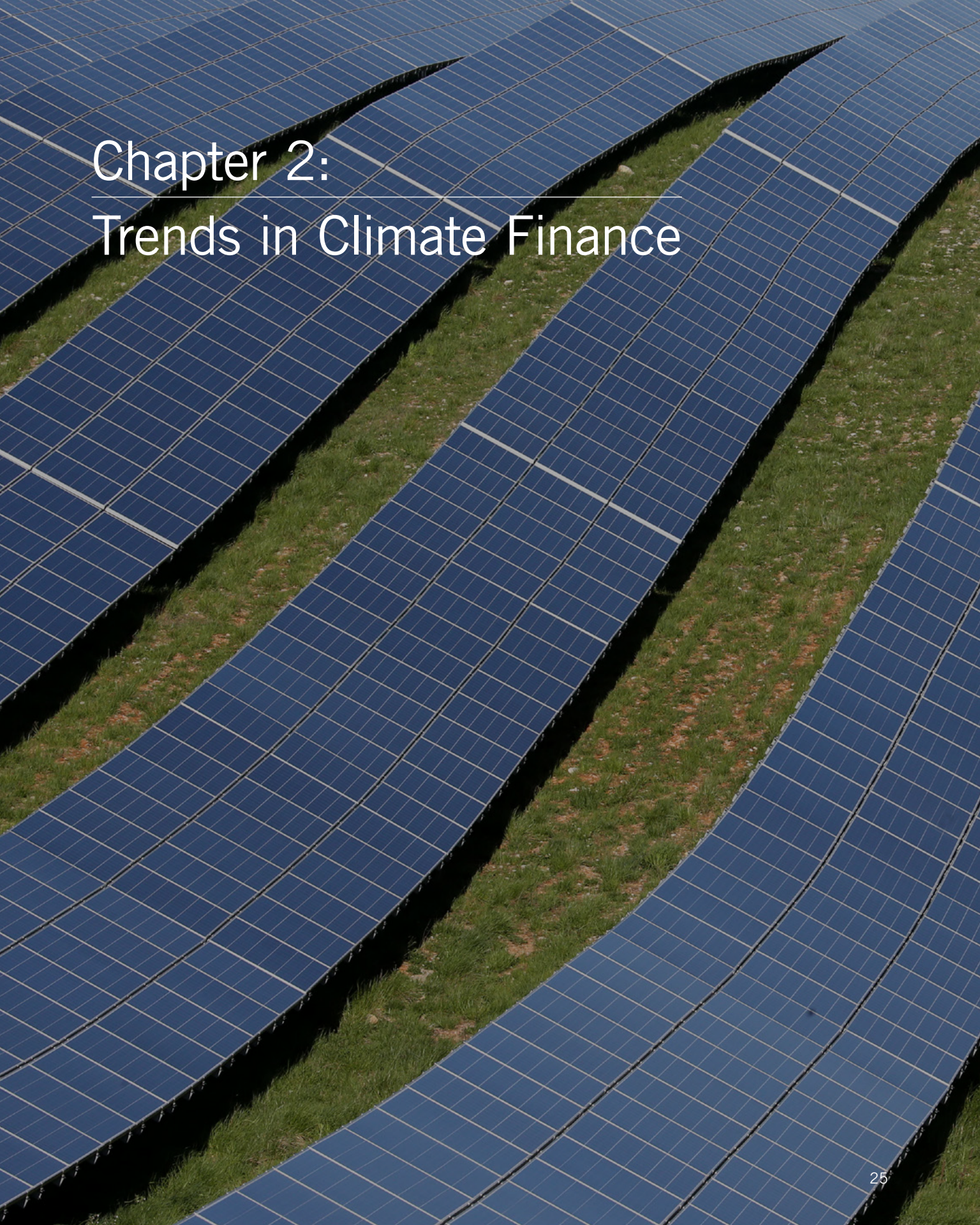
[39] European Development Finance Institutions, "Investing to Create Jobs, Boost Growth and Fight Poverty," 2016.

system, such as insurers and pension funds, may be subject to industry-specific regulation. Typically, the main goals of regulation are to ensure the stability of the financial system, the solvency of individual firms, and the protection of retail customers.

Engaging the investment chain

To those unfamiliar with its workings, the financial sector can seem like a complex system of differentiated firms in a state of constant change. Financial services companies each have tools at their disposal but also face important constraints driven by shareholder mandates and regulations. Yet, because of its essential role in facilitating the evolution of modern economies, engaging with the financial sector with an understanding of the investment chain can facilitate the partnerships needed to accelerate progress in the low-carbon transition.

> *"[Accomplishing the Paris Agreement] won't happen without private capital and underlines why aligning the world's financial system with the needs of climate action and sustainable development is every bit as important as emission-reduction pathways and removing fossil fuel subsidies."*
>
> Agustín Carstens, General Manager of the Bank of International Settlements and Patricia Espinosa, Executive Secretary of the UNFCCC, September 2016



Chapter 2:
Trends in Climate Finance

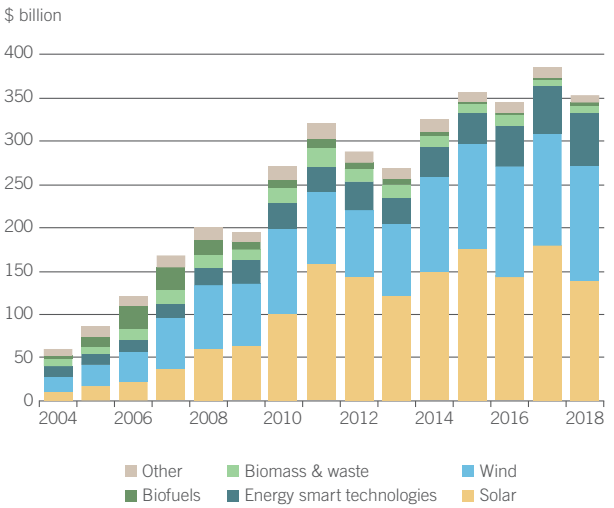
Chapter 2: Trends in Climate Finance

This chapter charts the dynamic evolution of climate finance both in the real economy and within the financial sector. While global investment in clean energy and electrified transportation has increased significantly, low-carbon investment in other sectors is still lagging.[40] The financial sector is responding to the climate challenge by expanding the range of available green financial products and services and by beginning to mainstream climate considerations into its financial decision-making.

Clean energy investment is growing rapidly, but a significant gap remains

Due to rapidly increasing investment levels, wind and solar energy collectively are the largest source of new power generation globally today.[41] Clean energy investment grew from around $60 billion in 2004 to an average of $311 billion per year over the last decade, with solar and wind accounting for the dominant share (FIGURE 4).[42] Technology innovation, paired with economies of scale in manufacturing, has driven a sharp decline in generation costs (FIGURE 5).[43] Consequently, although the absolute level of financial investment in solar and wind has recently stabilized, the corresponding amount of new capacity added to the grid continues to accelerate. Cumulative solar and wind capacity installed worldwide exceeded 1TW in 2018 — roughly the size of the entire power system of the United States.[44] As a result of this investment boom, renewable energy and energy efficiency together are currently the most significant drivers of GHG emissions abatement worldwide.[45]

FIGURE 4:
Global annual investment in clean energy



Source: BNEF. Note: Includes estimates for undisclosed deals. "Energy smart technologies" includes smart grids, demand response, and energy storage.

National policy incentives have been essential to unlocking most clean energy investment to date. The most successful of these incentives provide revenue security to clean energy projects, typically

40 Unless stated otherwise, "clean energy investment" refers to investment in solar, wind, biomass, geothermal, marine electricity generation, and biofuels production facilities, as well as in energy-smart technologies, which include smart grids, demand response, and energy storage.

41 BNEF, Capacity & Generation database.

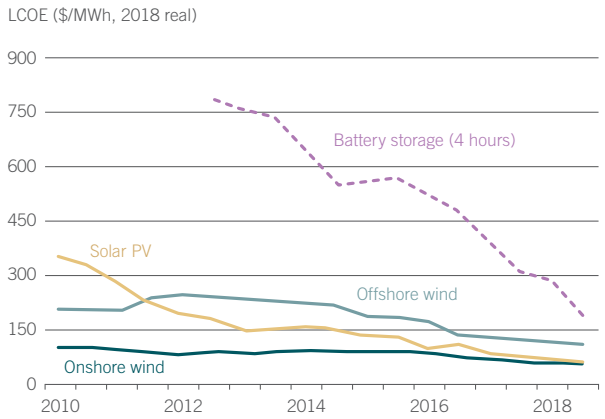
42 BNEF, Global Clean Energy Investment database.

43 BNEF, "1H 2019 LCOE Update," 29 Mar 2019.

44 BNEF, Capacity & Generation database.

45 IEA, "Global Energy & CO_2 Status Report 2018," March 2019.

FIGURE 5:
Global levelized cost of energy (LCOE) benchmarks for solar photovoltaic (PV), wind, and batteries



Source: BNEF. Note: The global benchmark is a country-weighted average using the latest annual capacity additions. The storage LCOE is reflective of a utility-scale, lithium-ion battery storage system running at a daily cycle and includes charging costs assumed to be 60% of wholesale base power price in each country.

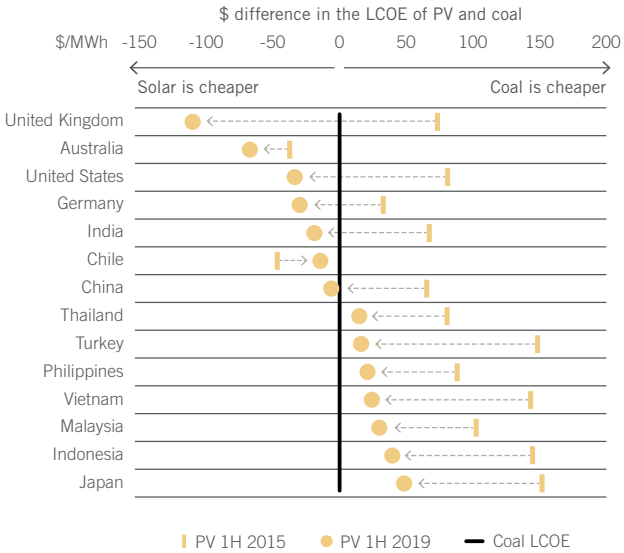
in the form of a guaranteed tariff or premium that can either be set competitively in auctions or by the government or regulator.

National policymakers have often combined these policies with renewable portfolio standards for utilities, tax incentives, grid regulation that favors clean power producers, and increasingly, carbon pricing and pollution regulations that disincentivize fossil fuel–based generation.

The tariffs needed to incentivize investment have fallen in tandem with renewable energy costs, resulting in a virtuous cycle of cost reductions and policy support. Whereas Germany set a €350/MWh tariff to incentivize solar projects in 2008, the level has decreased to an average of €50/MWh in 2019. In India, tariffs awarded to solar developers have decreased from $142/MWh in 2012 to an average of $35/MWh in 2018 and 2019.[46]

In a very short period, new wind and solar have become more cost-competitive than coal in most of the world. Provided there is sufficient revenue certainty and policy stability, developers can now deliver lower-cost electricity using mainstream renewables than can coal-fired technologies on a levelized cost basis.[47] FIGURE 6 illustrates how quickly the cost of solar electricity has decreased relative to the cost of coal and does not factor in the environmental externalities of coal.

FIGURE 6:
Evolution of the relative cost of new solar PV and coal projects



Source: BNEF. Note: H = semester. LCOE = levelized cost of electricity.

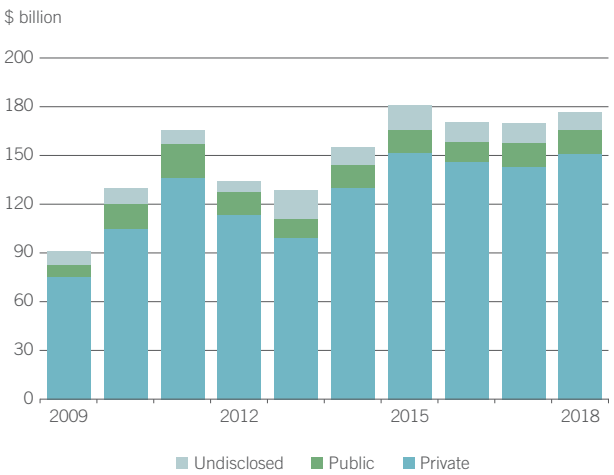
Private financial institutions have responded to the attractive risk-adjusted returns offered by renewable energy by deploying hundreds of billions of dollars in equity and debt. Most of this investment has been provided by private investors in the form of clean energy project finance (FIGURE 7).[48] The secondary market for clean energy projects under development or

46 BNEF, Prices, Tariffs & Auctions database.
47 BNEF, "1H 2019 LCOE Update," 29 March 2019.
48 Refers to the new-build financing of renewable energy generating projects as well as smart metering and energy storage projects. Projects may be financed off an owner's balance sheet or through financing mechanisms such as project finance, syndicated equity from institutional investors, or project bonds underwritten by banks.

already commissioned has also grown steadily — an important sign of maturity. For example, acquisition activity for commissioned solar PV projects increased from 337MW in 2009 to 12.6GW in 2018. [49]

The impressive rate of growth in renewables is offset by their still-modest share of global energy supply. Coal retains the largest share of global power generation, with 37% in 2018 compared with 7% for wind and solar (although note that when combined with all other carbon-free sources, including hydro and nuclear, zero-carbon electricity accounted for 36%).[51] The IPCC estimates that annual investments in clean energy and energy efficiency would need to increase by a factor of six by 2050 compared with 2015 levels to limit warming to 1.5°C.[52]

FIGURE 7:
Global clean energy asset finance (excluding China) by public and private investors[50]



Source: BNEF. Note: Excludes deals smaller than $1 million. Analysis done on $1.5 trillion in asset finance.

Clean energy investment is not flowing to emerging markets at scale

Emerging markets have become some of the leading markets for clean energy investment. Over the past five years, India, Mexico, Chile, Brazil, Pakistan, Thailand, and Jordan have ranked in the 20 largest solar and wind markets (TABLE 1). Common market success factors include a comprehensive and transparent set of clean energy policies, access to quality, low-cost technologies, and mobilization of public finance. National development banks have often played a key role in opening these markets to private clean energy investment by leading on financial structuring, offering co-investment, and partnering with national policymakers to promote favorable domestic policies and regulations.

TABLE 1:
Emerging markets in top 20 of 2014–2018 clean energy investment

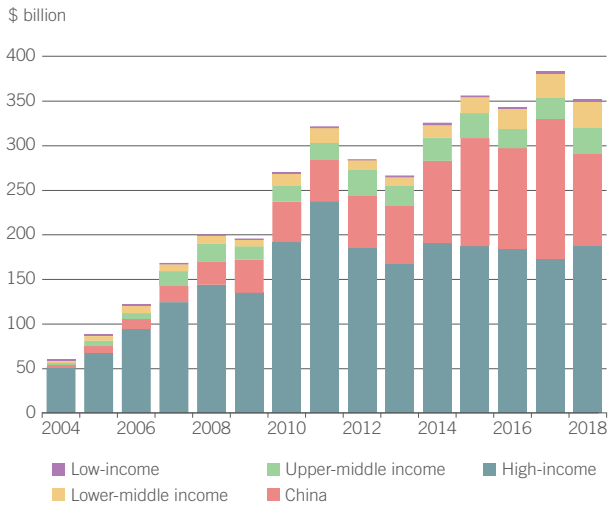
Country	Investment
1. China	$272.8bn
4. India	$30.0bn
9. Mexico	$5.9bn
11. Chile	$4.6bn
12. Brazil	$4.4bn
16. Pakistan	$3.5bn
17. Thailand	$3.4bn
19. Jordan	$3.1bn

Source: BNEF.

49 BNEF, "Portfolio Hunters 2018: Solar," 26 March 2019.
50 Chinese data is not included due to lack of information on investor origin.
51 BNEF, New Energy Outlook 2019: Data Viewer, June 2019.
52 IPCC, "Special Report: Global Warming of 1.5°C," Geneva, 2018.

However, advanced economies and China continue to dominate global clean energy investment (FIGURE 8**).** Many emerging markets that have successfully attracted investor interest in other sectors of their economies, such as Indonesia, Saudi Arabia, and Nigeria, have yet to attract similar interest for clean energy due to a lack of enabling policy.[53,54]

FIGURE 8:
Clean energy investment by country income group

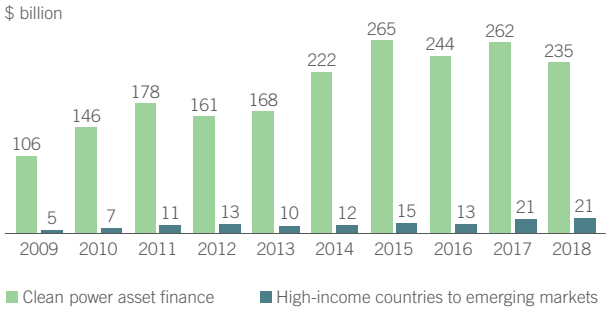


Source: BNEF. Note: Includes renewable energy generation projects, smart metering, and energy storage projects. World Bank 2020 fiscal year country classification.

In the context of all private investment in clean energy worldwide, FIGURE 9 shows the tiny share of such flows moving from advanced economies to emerging markets other than China.

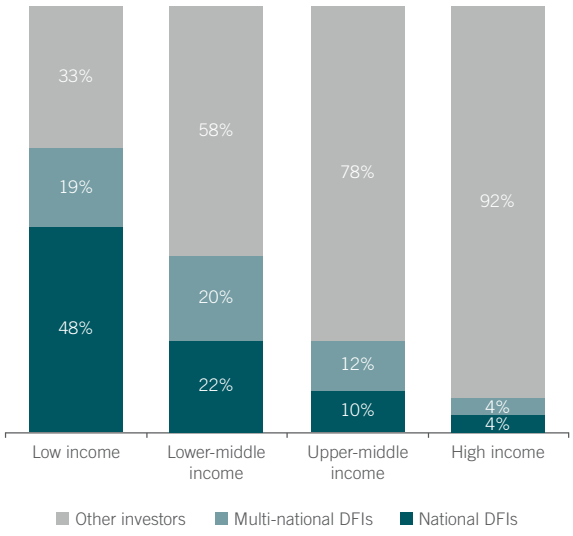
Many lower-income economies remain dependent on public-sector financing to drive clean energy growth. As a share of total clean energy asset finance, lower-income nations are more reliant on public finance institutions (FIGURE 10).

FIGURE 9:
Global clean power asset finance and clean power asset finance from high-income countries to emerging markets (excluding China)[55]



Source: BNEF. Note: "Clean power" includes solar, wind, geothermal, biomass, small hydro, and marine. "Emerging markets" includes all non-OECD ex-China, plus Chile, Mexico, and Turkey.

FIGURE 10:
Share of cross-border clean energy asset finance by DFIs across country income groups



Source: BNEF. Note: World Bank 2020 fiscal year country classification. "Other investors" is predominantly made up of private investors, including project developers, utilities, private equity, and commercial banks.

53 BNEF, Climatescope, "Emerging Markets Outlook 2018," 27 November 2018.
54 BNEF, Saudi Arabia country profile.
55 Chinese data is not included due to lack of information on investor origin.

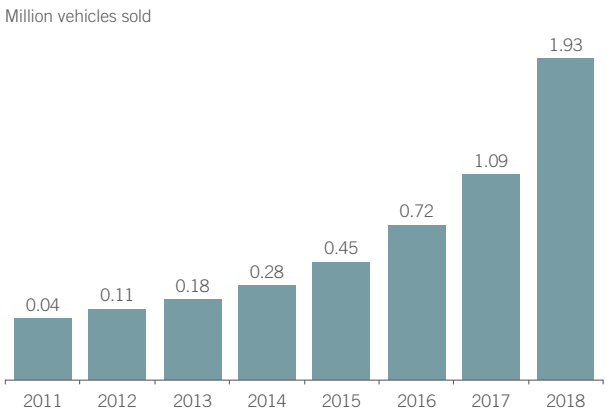
A combination of market risks, incomplete policy support for clean energy, and underdeveloped project pipelines often dampens interest from private investors. As emphasized throughout this report, strong partnerships between public and private institutions will be especially critical to supporting low-carbon growth in lower-income countries.

Low-carbon investment in sectors beyond power is growing but needs to scale

Transportation has seen robust growth in low-carbon investment due to financial incentives, declining battery costs, and policy mandates. A combination of policy drivers, including increasingly stringent air pollution and fuel economy standards, has ignited a global shift toward electric vehicles (EVs). Sales of passenger EVs, including plug-in hybrid vehicles and battery-EVs, increased from just 38,000 in 2011 to almost 2 million in 2018 (FIGURE 11).[56] A growing number of major markets such as the UK and France have announced that they will ban the sale of internal combustion vehicles altogether after a certain date.[57] Beyond light-duty vehicles, urban bus fleets around the world are on track to electrify beyond 30% in Europe and the U.S., and almost 70% in China as early as 2030 (FIGURE 12).[58]

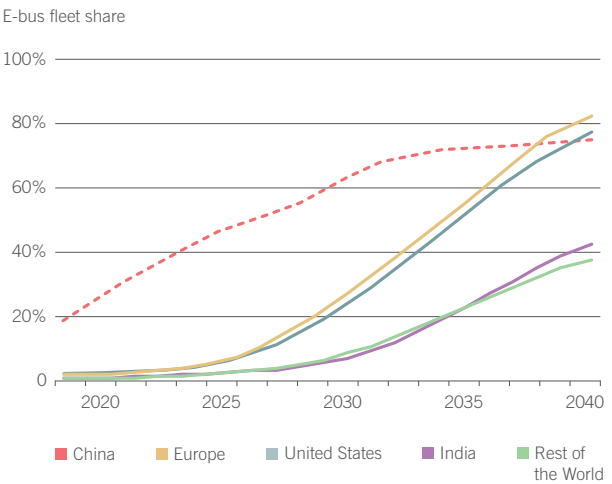
The evolving economics of EVs will help accelerate the transition already under way. Car manufacturers have already committed to invest $141 billion in electrification (FIGURE 13), while economies of scale are reducing manufacturing costs. Rising R&D and manufacturing capacity for lithium-ion batteries helped decrease per-unit costs by 85% between 2010 and 2018.[59] The combined growth in battery demand from the transport, power, and consumer electronics sectors is poised to drive battery costs down further. The average lithium-ion battery pack price is expected to fall below $100/kWh

FIGURE 11:
Global EV sales



Source: BNEF. Note: Commercial vehicles and low-speed EVs not included.

FIGURE 12:
Growth of global electric bus fleet share by region

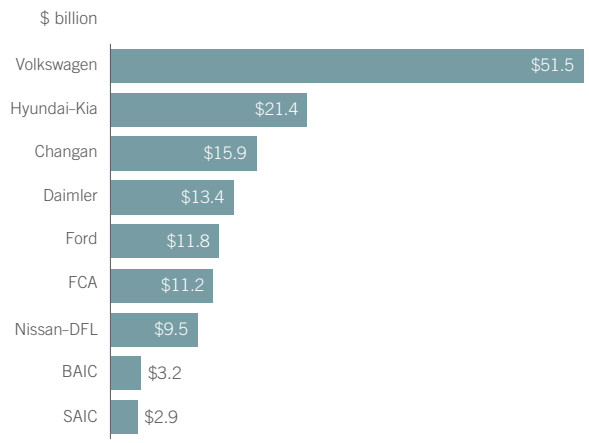


Source: BNEF. Note: Fleet share values for China refer to the total bus fleet.

56 BNEF, Electric Vehicles database.
57 Forbes, "2017: The year Europe got serious about killing the internal combustion engine," 22 December 2017.
58 BNEF, "Electric Vehicle Outlook 2019," May 2019.
59 BNEF, "2018 Lithium-Ion Battery Price Survey," 19 December 2018.

by 2024, down from $176/kWh in 2018, and $1,160/kWh in 2010.[60] Robust investments in EV-charging infrastructure — enabled by policy incentives — and the falling price of electricity also increase the attractiveness of EVs. As these trends continue to accelerate, battery-EVs are expected to reach cost parity with conventional internal combustion vehicles as early as 2022 in some markets, which could, in turn, drive more ambitious policy mandates for vehicle electrification.[61]

FIGURE 13:
Announced investment in vehicle electrification by select automakers



Source: BNEF, Marklines, company press releases. Note: Investment figures as of the first half of 2018. Announced investments typically refer to the 5-year periods starting in 2017 or 2018.

Despite faster sales of new EVs, annual transportation emissions will evolve more slowly. EV sales still accounted for a fraction of the 87 million passenger vehicles sold globally in 2018.[62] Although their share of new car sales is projected to increase to 30% in 2030 and 57% in 2040, EVs will account for just 9% and 30% of all passenger vehicles on the road in 2030 and 2040, respectively.[63] Other measures would be needed to accelerate turnover of the passenger vehicle fleet, for example, the "cash for clunkers" program that incentivized U.S. car owners to trade in older vehicles for more fuel-efficient alternatives.[64]

New business models and financing mechanisms have facilitated energy efficiency investments in the building and industrial sectors. Although energy efficiency measures typically result in overall savings, high up-front costs can create disincentives for their adoption. Energy service companies (ESCOs) help overcome this barrier by covering the up-front cost of efficiency investments, allowing consumers to pay back this cost over time through energy savings. In 2017, the value of the ESCO market had grown to $28.6 billion, with the majority of projects occurring in the commercial buildings and industrial sectors.[65] The U.S. Property Assessed Clean Energy (PACE) program, a financing mechanism that similarly allows for a longer-term repayment of energy efficiency measures, has mobilized more than $800 million for commercial upgrades in the U.S. and $5 billion for energy efficiency and renewable energy projects in the residential sector.[66]

The industrial and land-use sectors, including agriculture, have yet to draw significant low-carbon investment. In 2018, only 2% and 10% of green bond proceeds were earmarked for low-carbon projects in the industrial and land-use sectors, respectively.[67] Concurrently, heavy industry, heavy-duty transport, and land use contribute more than 50% of global annual emissions, with their emissions projected to grow as other parts of the economy, such as the power and buildings sectors and light-duty transport, become increasingly decarbonized.[68]

60 BNEF, "2018 Lithium-Ion Battery Price Survey," 19 December 2018.
61 BNEF, "When Will EVs Be Cheaper Than Conventional Vehicles?" 8 April 2019.
62 BNEF, "Electric Vehicle Outlook 2019," May 2019.
63 Ibid.
64 White House Council of Economic Advisers, "Did 'cash-for-clunkers' work as intended?," 5 April 2010.
65 IEA, Energy Service Companies.
66 Office of Energy Efficiency & Renewable Energy, Property Assessed Clean Energy Programs.
67 Climate Bonds Initiative, "Green Bonds: The State of the Market 2018," 2019.
68 Energy Transitions Commission, "Mission Possible: Reaching Net-Zero Carbon Emissions from Harder-to-Abate Sectors by Mid-Century," 2018.

Low-carbon production processes in energy-intensive sectors, such as steel, cement, and aluminum, have yet to become commercially viable. Factors limiting progress include the significant undepreciated value of high-carbon assets, the reluctance of governments to enforce emissions reductions regulations perceived to undermine the international competitiveness of local industry, and the use of exemptions and subsidies to soften the impact of climate policies. For example, under the European Union Emissions Trading Scheme (EU ETS), the manufacturing sector has received a share of its emission allowances for free, while entities in the power sector have to purchase allowances through auctions.[69] It is therefore notable that, while overall emissions in the EU fell 22% between 1990 and 2017, emissions increased slightly by 0.6% between 2016 and 2017, mainly from transport and industry.[70]

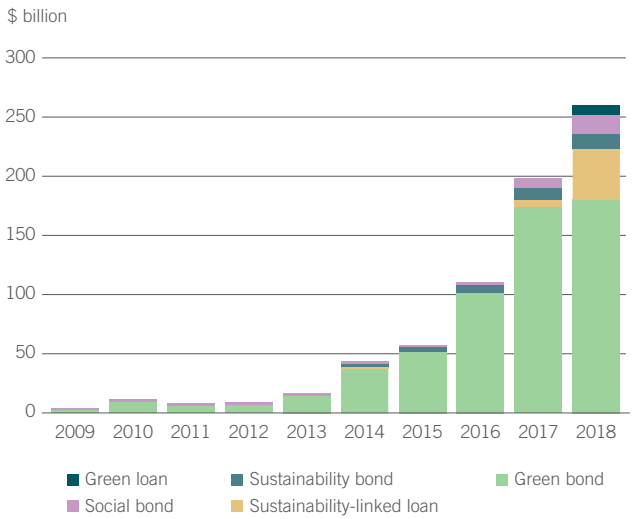
Several initiatives have recently emerged to drive emissions reductions in international sectors, such as aviation. Notable initiatives working to drive emissions reductions involve collaboration across public and private sectors to uphold international standards and develop global frameworks. For instance, the absence of a zero-carbon equivalent jet fuel, essential for decarbonizing long-haul flights, has made the aviation sector, which is responsible for 2% of global GHG emissions, particularly hard to abate.[71,72] As a result, the International Air Transport Association (IATA), the main industry association for airlines, adopted a carbon-neutral growth goal for 2020, which it will strive to achieve through advancing new technology, improving aircraft efficiency, improving infrastructure, and offsetting emissions.[73]

To support offsetting, the International Civil Aviation Organization (ICAO), the UN agency for aviation, adopted the Carbon Offsetting and Reduction Scheme (CORSIA). This program, beginning as voluntary to minimize market distortion, will eventually require member states to use emissions units from the carbon market to offset CO_2 emissions that cannot be reduced through sustainable aviation fuels and technological and operational improvements.[74]

Green finance is increasing, but its scope remains narrow

Investor appetite for green financial products has grown quickly but remains concentrated in tightly defined green bonds. The issuance of explicitly "green" or "sustainable" debt has grown from around $1 billion in 2009 to more than $260 billion in 2018 (FIGURE 14). The issuer

FIGURE 14:
Global issuance of sustainable debt finance



Source: BNEF.

69 European Commission. Allocation to Industrial Installations.
70 European Commission. Progress Made in Cutting Emissions.
71 Energy Transitions Commission, "Mission Possible: Reaching Net-Zero Carbon Emissions from Harder-to-Abate Sectors by Mid-Century," 2018.
72 IATA, "Fact Sheet: Climate Change & CORSIA," May 2018.
73 IATA, Climate Change.
74 ICAO, "Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA) — Frequently Asked Questions (FAQs)," updated as of 8 February 2019.

base of green bonds, which accounted for more than 70% of 2018 activity, has expanded rapidly beyond MDBs, which first issued green bonds, to include national and subnational governments as well as a broad spectrum of private-sector institutions, including utilities, corporations, and financial institutions.[75]

Green bonds issued to date have predominantly taken the form of "use of proceeds" bonds, in which money raised is earmarked for development of specific green assets. Use of proceeds green bonds can be backed by a single project or an aggregation of projects through asset-backed securities (ABS) and have mainly financed portfolios of clean energy and energy efficiency projects.[76] Nearly all issuers abide by voluntary frameworks, such as the Green Bond Principles, which specify eligible categories of projects and involve committing to reporting on the use of proceeds.[77] Most issuers also seek third-party verification from specialist or rating agencies that further confirm the environmental credentials of green bond issuances. These frameworks and assessments provide transparent assurance to investors about how their investments support low-carbon activities.

However, the rigor around standards for use of proceeds green bonds can also constrain their effectiveness in supporting the low-carbon transition. Green bonds, as currently defined in accepted standards, may not be able to support the complex corporate transformations that will be required in the low-carbon transition. For example, a power utility will typically use a combination of measures to meet its emissions reductions investments, such as increasing renewable energy capacity, improving efficiency, enhancing grid operations, decommissioning fossil fuel plants, and even shifting from coal to gas.

Corporate lending accounts for the other major category of green financing through capital markets. This market has grown quickly, with a record of $34.7 billion in sustainability-linked loans and $6.8 billion in green loans issued in 2018 from close to none in 2016.[78] Unlike bonds, which have a fixed coupon, sustainability-linked or green loans, typically provided by banks, offer a built-in incentive with a changing interest rate that rewards or penalizes organizations based on their sustainability objectives or performance — usually at the level of the whole organization rather than a specific project. One recent example of a green loan is a €1 billion revolving credit facility from a consortium of banks to Royal DSM, a Dutch health care corporation, where the interest rate is linked to its GHG efficiency, its energy efficiency, and the proportion of energy it sources from renewables.[79]

Climate is increasingly becoming mainstream for the financial sector and regulation

Private finance institutions have started factoring climate into their decision-making. As of September 2019, more than 830 organizations

> *"We need to take action, and we cannot and will not do this alone. We will globally cooperate with policymakers, the financial sector, academia, and other stakeholders to distill best practices in addressing climate-related risks."*
>
> Frank Elderson, Chair of the NGFS and De Nederlandsche Bank, April 2019

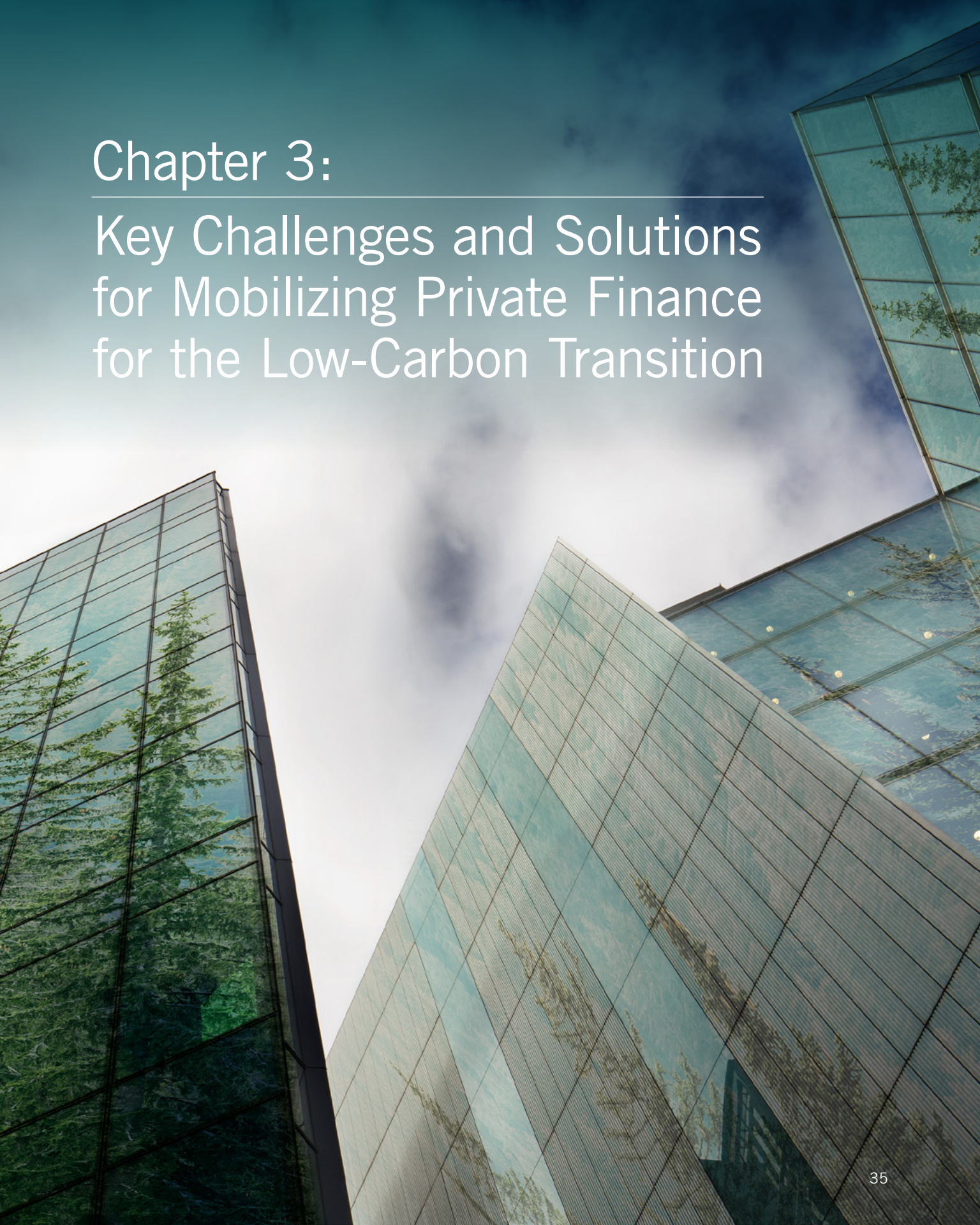
75 BNEF, Sustainable Debt database.
76 Climate Bonds Initiative, "Green Bonds: The State of the Market 2018," 2019.
77 International Capital Market Association, "Green Bond Principles," June 2018.
78 BNEF, Sustainable Debt database.
79 DSM, "DSM links Greenhouse Gas Emission Reduction to Interest Rate in New €1 Billion Revolving Credit Facility," [Press release], 30 May 2018.

have expressed their support for the Task Force on Climate-related Financial Disclosures (TCFD), a private sector–led taskforce established by the Financial Stability Board to help identify the information needed to assess and price climate-related risks and opportunities. Many TCFD supporters plan to enhance their climate-related disclosure within the next five years, helping increase the availability of climate-related information to investors, lenders, and insurers.[80,81] More than 340 investors with nearly $34 trillion in assets under management (AUM) have committed to engage the world's largest corporate GHG emitters to implement the TCFD recommendations as part of the Climate Action 100+ initiative.[82] In addition, several financial institutions have committed to work toward aligning their loan books or portfolios with a well-below 2°C trajectory, recognizing the role of finance in supporting the low-carbon transition.[83]

Beyond individual institutions, climate change is also increasingly factored into financial supervision as regulators acknowledge the risks climate change poses to financial stability. As of September 2019, more than 42 central banks and financial regulators from countries representing 44% of global GDP and two-thirds of global systemically important banks and insurers have joined the Network for Greening the Financial System (NGFS). In April 2019, the NGFS recommended that climate risks be integrated into both financial stability monitoring and supervision of individual institutions.[84] In some first-mover jurisdictions, regulators are already taking up these recommendations. Since 2015, even before the NGFS recommendations were published, Article 173 of France's Energy Transition Law has required institutional investors to report on how they incorporate ESG criteria, especially climate, into their investment policies.[85] In April 2019, the Bank of England issued a supervisory statement calling for UK banks and insurers to embed climate risks in corporate governance and risk management practices, as well as to improve climate-related disclosure.[86]

Some financial regulations have also created opportunities to finance the low-carbon transition. The EU has embarked on an effort to regulate various parts of the sustainable finance and is considering requiring asset managers to disclose their ESG integration. For banks, the EU is also considering a "green supporting factor" to alleviate capital requirements for green investments. It is also establishing a comprehensive taxonomy to define which activities are considered environmentally sustainable. In June 2019, a Technical Expert Group on Sustainable Finance appointed by the European Commission published a draft report outlining sustainable criteria by sector and subsector.[87] The EU report is likely to form the basis for legal requirements on green finance in the future.

80 TCFD, "TCFD Supporters," Last updated June 2019.
81 TCFD, "2019 Status Report," June 2019.
82 Ibid.
83 BBVA, BNP Paribas, Société Générale, Standard Chartered, and ING. "The Katowice Commitment," 4 December 2018.
84 NGFS, "A Call for Action: Climate Change as a Source of Financial Risk," 2019.
85 National Assembly of France, "Loi n° 2015-992 du 17 août 2015 relative à la transition énergétique pour la croissance verte," 18 August 2015.
86 Bank of England, "Enhancing banks' and insurers' approaches to managing the financial risks from climate change," Supervisory Statement 3/19, 15 April 2019.
87 EU Technical Expert Group on Sustainable Finance, "Taxonomy Technical Report," Brussels, June 2019.



Chapter 3:

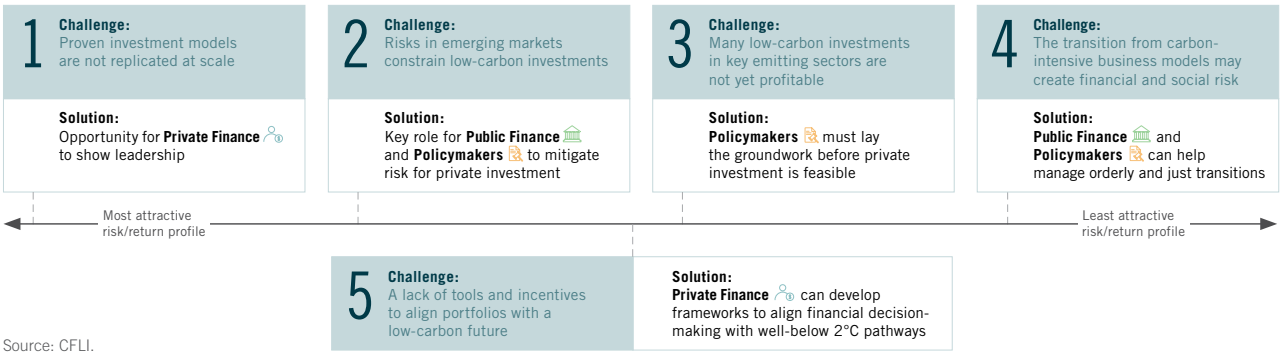
Key Challenges and Solutions for Mobilizing Private Finance for the Low-Carbon Transition

Chapter 3: Key Challenges and Solutions for Mobilizing Private Finance for the Low-Carbon Transition

This chapter describes five overarching challenges to mobilizing climate finance from a private finance perspective and the collaborative solutions needed to address them (FIGURE 15). These challenges address the need to facilitate greater low-carbon investment (Challenges 1, 2, and 3) while supporting the transition of carbon-intensive sectors (Challenge 4). Challenge 5, which relates to both objectives, describes the systematic adjustments the financial sector can make to better facilitate an ambitious and orderly transition.

The opportunity for leadership by private finance across these challenges depends, in part, on the availability of risk-adjusted returns matched to investor requirements. Instances where attractive risk-return ratios already exist (i.e., on the left side of the spectrum in FIGURE 15) offer greater opportunities for private-sector leadership to scale and replicate proven investment models. In cases where commercial investments offer revenue but uncertain or higher-risk returns, the private sector may work with public finance institutions and their blended finance, risk-sharing, and pipeline development tools. In still other cases, policymakers can develop regulatory frameworks and incentives that unlock private-sector investment in low-carbon solutions.

FIGURE 15:
Challenges and solutions to mobilize private finance in support of the low-carbon transition



Source: CFLI.

The solutions presented for each challenge, therefore, offer space for collaboration among private finance, public finance institutions, and policymakers (FIGURE 16**).** These solutions, while not intended to be comprehensive, highlight actionable opportunities to support the scale and acceleration needed to help limit global warming to well-below 2°C. Case studies for each solution highlight real-world action and demonstrate that action is not only possible but also already under way in various sectors and geographies.

FIGURE 16:
Categories of solutions: Private finance, public finance, and policymakers

PRIVATE FINANCE	Private finance solutions are those deployed by private entities on the investment chain illustrated in FIGURE 3, including corporations, project developers, banks, asset managers, and asset owners. While private finance is well positioned to play a significant role in facilitating emissions reductions, it must do so profitably. Privately financed projects and companies need to generate revenue, have risk-return profiles matched to investor requirements, and operate in conditions that are conducive to investment. The extent to which these conditions are met varies across sectors, technologies, and geographies.
PUBLIC FINANCE	Public finance encompasses both public finance institutions and public budgets. Public finance institutions such as DFIs can play an important role by acting as first movers in opening up new emerging markets, establishing market-based transactions structures, and preparing the ground for commercial investment to follow. Catalyzing private-sector capital is a core mandate of most DFIs, using risk-sharing tools such as partial guarantees, blended finance structures, project preparation facilities, and political risk insurance. Public budgets, on the other hand, can help improve the viability of low-carbon investments by increasing returns through subsidies and tax incentives or R&D funding for new technologies.
PUBLIC POLICY	Policymakers, whether local, national, or supranational, play a central role in guiding and supervising the transition to a low-carbon economy by setting targets, policies, technology standards, and regulations. Policy creates the structural conditions for private-sector engagement in the low-carbon transition, including the creation of frameworks to incentivize investment. Critical public policies also include creating fair, predictable, and transparent rules and processes — from broader target-setting to requirements for licensing and permitting.

1 Challenge: Proven investment models are not replicated at scale

Stable price signals, whether formed by markets alone or supported by subsidies, are central to all investments in power generation.[88] Tariffs and premiums that support clean energy generation projects have predominantly been awarded by governments, directly to project developers, or through utilities and agencies. The prospect of stable returns underpinned by subsidies or power purchase agreements (PPAs) has enabled $3.7 trillion of investments to flow into the clean energy sector between 2004 and 2018.[89] During this time, solar and wind generation technologies have grown cost-competitive with new fossil fuel generation in most markets (FIGURE 17).

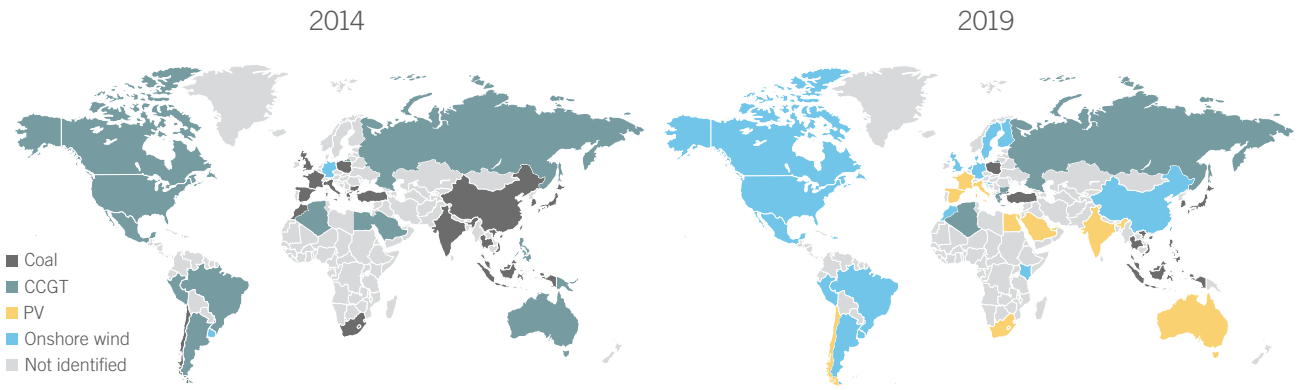
Expanding the success of stable revenue models

Despite this progress, opportunities to secure regulated revenue for projects have slowed in many mature markets with a track record of solar and wind deployment. In part, this contraction is due to policy reversals or uncertainty. In the EU, renewable capacity additions have stagnated as policymakers rolled back incentives, first as a result of greater budgetary discipline and then because some met their 2020 targets ahead of schedule.[90] However, even as these technologies grow cost-competitive on a levelized cost basis, they remain more capital intensive than most sources of conventional generation. Due to their cost structure, which makes them sensitive to the cost of capital, and their operational constraints, renewables can face substantial risks when competing in short-term wholesale power markets. Contracts awarded through competitive auctions can provide the long-term price signals needed to reduce risks — and therefore financing costs — of delivering emissions reductions in the power sector efficiently. While most European governments have adopted auctions, policymakers can further facilitate the development of renewables by establishing a stable legislative and regulatory framework to support long-term contracts among market participants. Such frameworks could jointly support government-backed tariffs or premiums and private-sector-led PPAs.

> *"The biggest challenge to mobilising climate finance is not the availability of capital but the lack of a sufficiently strong pipeline of investable projects. This is why we are investing earlier in the project lifecycle, de-risking projects, and directly developing the next generation of renewable energy and climate mitigation assets."*
>
> Shemara Wikramanayake, CEO, Macquarie, September 2019

88 The IEA estimates that more than 95% of investment in the power sector happens as a result of regulated revenue structures (IEA, "World Energy Investment 2018," 2018).
89 BNEF, Global Clean Energy Investment database.
90 Bloomberg News, "Around the World Buyer's Remorse Sets in for Costly Clean Power," 24 April 2019.

FIGURE 17:
Most competitive source of new utility-scale generation in 2014 and 2019



Source: BNEF. Note: Reflective of the cheapest benchmark project for each technology and market. CCGT = Combined cycle gas turbine.

Electricity consumers and electricity retailers, encouraged by the declining cost of renewables and their contribution to climate change mitigation, have started to stimulate new clean energy investments by procuring renewable electricity directly through corporate PPAs.[91] These corporate PPAs lock in a price agreement for periods of a few to up to 30 years, providing project developers and banks the revenue certainty needed to invest in clean energy.

> *"There is now not just growth in emerging markets [for renewables] but also for the first-time substitution of thermal generation in mature markets."*
>
> Francesco Starace, CEO, Enel, December 2018

The volume of clean power capacity contracted to corporate buyers annually has grown from around 1GW in 2013 to over 13GW in 2018 and now encompasses a broad range of corporate buyers.[92] In 2013, the corporate PPA market was dominated by large technology companies but has since grown more mainstream among financial institutions, industrial and telecommunications companies, and smaller players.[93] With just over 28GW of corporate PPAs signed as of June 2019, the U.S. is by far the largest market globally.[94] However, activity is spreading to other markets, in particular those with large power consumers. For example, in July 2019, AngloAmerican, a mining group, and Enel, an international utility, signed a PPA in Chile for the supply of up to 3TWh of clean electricity annually for 10 years, which will allow the mining company to meet its energy needs in Chile fully through clean energy.[95]

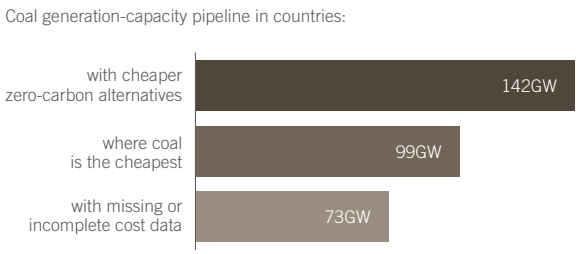
Prioritizing renewables where they can outcompete fossil fuels

The development of new coal-fired power plants continues even in markets where zero-carbon alternatives are already cost-competitive. Of the 314GW of coal pipeline in development globally as of early 2019, at least 142GW is being developed where solar, wind, nuclear, or (when available) hydro are more economical than the coal benchmark (FIGURE 18).

91 Wood Mackenzie, "Corporate procurement of wind and solar in the US 2018," 2018.
92 BNEF, "1H 2019 Corporate Energy Market Outlook," 28 January 2019.
93 RMI Business Renewables Center, "State of the Market Report 2018," 2018.
94 BNEF, "Prices, Tariffs & Auctions — Corporate PPA," June 2019.
95 Enel, "Enel Signs with AngloAmerican in Chile Group's Largest Renewable Energy Supply Deal," [Press release], 30 July 2019.

Most of this coal pipeline is located in emerging markets with growing power demand, such as China, Vietnam, and Turkey. Given the intermittency of solar and wind, investment in grid balancing services and infrastructure is often needed as their share in the electricity mix grows.[96] However, renewables combined with peaking generation from hydro, gas, biomass, and, increasingly, storage can already outcompete coal to increase baseload in many markets.[97] By prioritizing clean energy wherever it can outcompete carbon-intensive alternatives, policymakers and power-sector planners can help avoid new investments in large, long-lived carbon-intensive assets.

FIGURE 18:
Coal pipeline distribution by country group



Source: BNEF, Coalswarm. Note: Reflective of the lowest-cost benchmark for coal, wind, solar, nuclear, and hydro in markets with activity and resources.

Governments can support this deployment by adopting more ambitious clean energy targets, providing sufficient risk-sharing support for clean energy investors, and removing regulatory bottlenecks. Even in the most mature renewable energy markets, securing licenses and permits and potential litigation can still add significant time and expense to projects and, consequently, deter private investment. For instance, in 2018 and 2019, onshore wind auctions in Germany and France were undersubscribed as project developers struggled to secure permits for their projects.[98]

Developing the financial products needed to scale investment

As clean energy projects have increasingly come to resemble traditional infrastructure investments rather than risky alternatives, a larger pool of investment capital has emerged. However, project developers and banks are still responsible for the majority of financial flows, accounting for more than 65% of clean energy asset finance from 2009 to 2018.[99] Asset managers and asset owners still face challenges to investing in clean energy due to a lack of financial products suitable to the asset allocation approach of many larger investors.

Many asset owners and managers lack dedicated renewable energy investment teams, making direct investment in renewables difficult. Even for those that do have renewable energy investment teams, the small size of renewable energy projects can dissuade some investors. Asset managers and asset owners generally prefer to allocate larger sums per transaction than the typical clean energy investment opportunity allows. Over the last 10 years, the average new clean energy project investment has hovered around $50 million.[100] In comparison, a survey of pension funds and insurance companies suggests that a minimum asset finance deal size of $100 million is likely required for direct investment.[101]

96 Intermittency often only becomes an issue at very localized or very high rates of penetration. However, intermittency, as well as the notion that renewables cannot provide baseload power, has often led to continued support from policymakers for fossil fuel–based generation.

97 BNEF, "New Energy Outlook 2019," June 2019.

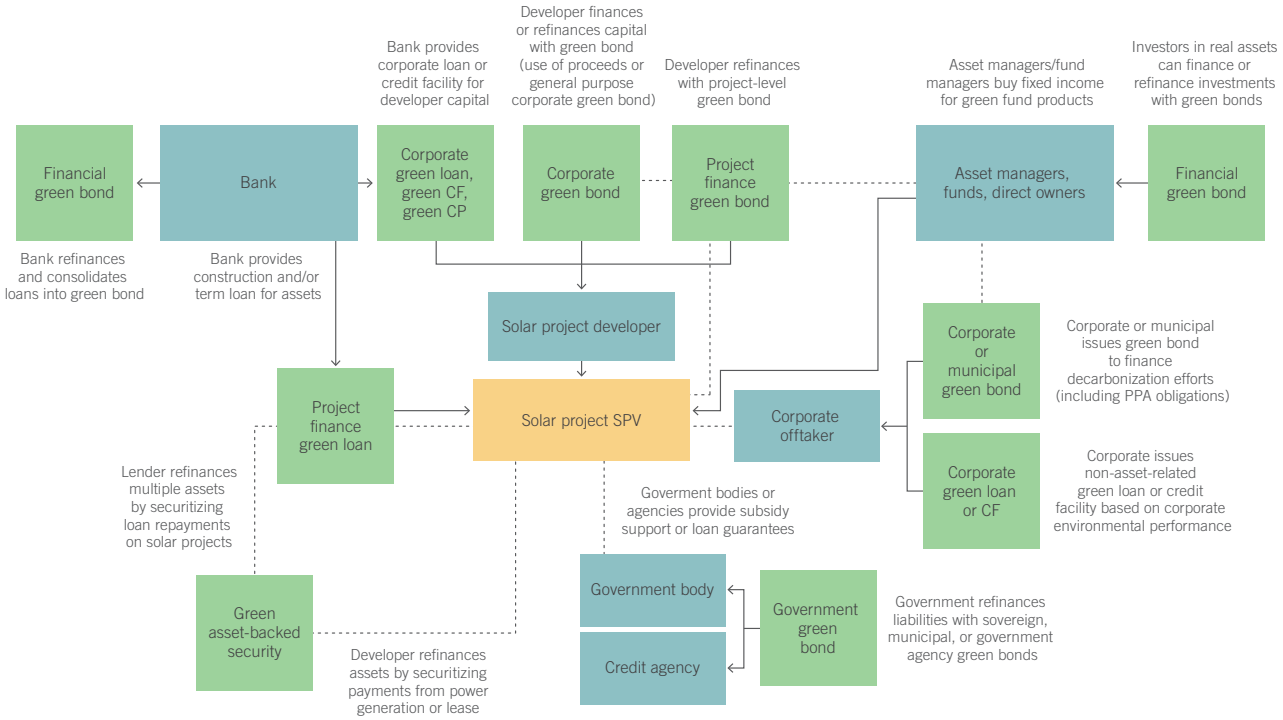
98 WindEurope, "Wind Energy in Europe in 2018: Trends and Statistics," February 2019.

99 BNEF, Global Clean Energy Investment database.

100 Ibid. Projects are often phased so that total project value may be higher. Asset finance for offshore wind projects can, however, reach several billions of dollars, making it a particularly attractive sector for large investors.

101 Climate Policy Initiative, "The Challenge of Institutional Investment in Renewable Energy," March 2013.

FIGURE 19:
Green financial products that can be linked to a solar project



Source: BNEF. Note: SPV = special purpose vehicle, CF = credit facility, CP = commercial paper.

In response to this constraint, project developers and banks have used securitization and bonds to aggregate clean energy investments into financial products, achieving a scale that enables larger investors to support smaller project sizes. FIGURE 19 highlights several ways by which investors across the investment chain can allocate capital to an example clean energy project.

For larger investors, the most common products have been green bonds. Green ABS, one type of green bond, provides institutional investors the opportunity to deploy capital to the smallest assets while allowing project developers to free up capital for new investments. ABS involves the bundling of existing financial assets into a bond, enabling investors to receive a share of the cash flows from the underlying assets. Clean energy project developers and investors have used ABS to diversify the portfolio of financing for smaller-scale, low-carbon assets, such as rooftop solar installations or energy efficiency improvements. In the U.S., for example, the PACE program has used ABS to support the long-term financing of energy efficiency improvements in residential and commercial buildings.[102]

[102] U.S. Department of Energy, "Property Assessed Clean Energy Programs."

Key solutions summary: Opportunity for private finance to show leadership

PRIVATE FINANCE

Key solution: Direct procurement of clean power by private energy consumers

Large electricity consumers in a broad range of markets and sectors can establish PPAs with project developers and utilities, especially where clean energy can deliver electricity at a lower cost than power procured from the grid. Depending on regulation, the electricity can be generated on site, delivered by the grid, or procured through a virtual PPA.

Barriers to scaling solutions

Many markets still lack the legislative and regulatory frameworks needed for corporate PPA activity, and, in some jurisdictions, PPAs are not permitted. Some corporate PPAs rely on the grid's transmission and distribution system operators to deliver electricity, requiring coordination with grid operators.

Project developers and debt providers may also face challenges in assessing the credit worthiness of individual corporate off-takers under PPAs, unlike in the case of feed-in tariffs and premiums that are often backed by government guarantees. Corporate PPA tenors may also be shorter than the 10- to 20-year contracts awarded by governments.

Sweden's renewables and corporate PPA success story

Sweden is one of the leading nations in clean electricity generation. The country reached its 2020 target of 50% of final energy from renewable sources eight years early and hit its original 2030 target in 2018.[103] The government is now aiming to reach 100% renewable energy generation by 2040.[104] Corporate PPAs have been one of the key drivers of clean energy investment in the market, representing over 1.5GW of capacity out of total installed renewable capacity of 29.1GW as of 2018.[105,106]

Corporate PPAs enable Swedish companies to lock in low, certain electricity prices. While Sweden's current surplus of electricity production has compressed power prices, the rapid growth in EVs, closure of several nuclear plants, and planned interconnections with other nations have the potential to increase future prices.[107] Corporate PPAs allow energy consumers to hedge against future price increases while providing clean energy investors the revenue certainty they need given currently low wholesale energy prices in Sweden.

Another key success factor in Sweden is the presence of large energy consumers, many of which use corporate PPAs to contribute to their climate targets. For example, Google, Amazon, and Facebook all have large data centers in the country and have signed PPAs for renewable energy.[108,109,110]

The Swedish market has also seen one of the longest-tenor PPAs signed to date anywhere in the world. In July 2018, Macquarie's Green Investment Group (GIG) and Norsk Hydro, one of the world's largest aluminum companies, announced a 29-year PPA to support the development of a 235MW onshore wind farm valued at €270 million.[111] This deal is only a portion of the almost 1GW of onshore wind PPAs sourced and structured by the GIG in Sweden as of June 2019.[112]

[103] Sweden.se, "Energy Use in Sweden" and World Economic Forum, "Sweden to reach its 2030 renewable energy target this year," 5 July 2018.
[104] Government Offices of Sweden, Ministry of the Environment and Energy, "Sweden's draft integrated national energy and climate plan," 17 January 2019.
[105] BNEF, "1H 2019 Corporate Energy Market Outlook," 28 January 2019.
[106] International Renewable Energy Agency (IRENA), "Insights on Renewables: Installed Capacity Trends."
[107] DLA Piper, "Rise of Corporate PPAs in the Nordics," September 2016.
[108] Ibid.
[109] Vattenfall, "Vattenfall and Facebook Sign Long-Term Deals for New Nordic Renewable Energy," [Press release], 23 May 2018.
[110] Wind Power Monthly, "Amazon adds trio to power data centres," 9 April 2019.
[111] Macquarie GIG, "Green Investment Group Reaches Financial Close on New 235MW PPA-Backed Onshore Wind Farm," [Press release], 19 July 2018.
[112] Macquarie GIG, "Green Investment Group Acquires Hornamossen Wind Farm," [Press release], 12 June 2019.

PRIVATE FINANCE

Key solution: Scale sustainable financial products accessible to institutional investors

The growing success of financial products that are labeled "green" or "sustainable" demonstrates that private-sector institutions within the investment chain can work together to scale up low-carbon finance. The securitization of clean energy project debt in bonds has allowed project developers to access capital markets for long-tenor, fixed-rate financing and expanded funding opportunities beyond the use of non-recourse loans.

Barriers to scaling solutions

A critical barrier to securitization is a lack of standardized projects and the investment documentation needed to structure attractive financial products. A lack of enabling regulation and underdeveloped financial markets in many locations can also create challenges. Use of proceeds instruments, the most common type of green bond today, entail transaction costs that can limit their scalability.

Solar securitization: Bundling solar assets for institutional investors

In 2013, Goldman Sachs structured the first rated securitization of solar energy globally through its JRE Mega Solar Project Bond Trust. The bond financed $13.5 million of project debt over 20 years with a rating from the Japan Credit Rating Agency ranging from A to BBB+.[113] The trust program has since expanded to $816,930,000.

The solar securitization market has also expanded in the U.S., where SolarCity, a solar energy company, issued $54.4 million in securities backed by solar assets and the associated contractual payments from customers.[114] By 2018, issuance of such solar ABS in the U.S. had reached more than $2.2 billion.[115] Most are securitizations of residential assets, e.g., rooftop solar. Bundling receivables from project developers into ABS frees up working capital and allows solar companies to invest in new installations.

Solar securitization has not been limited to industrialized countries. In late 2015, BBOXX, an off-grid solar company, closed a $500,000 deal with Oikocredit that bundled 2,500 solar leasing contracts signed by customers in Kenya.[116] More sub-Saharan African markets are expected to turn to securitization to help meet their energy access targets in the future.

[113] Goldman Sachs, "Goldman Sachs Targets $1 Billion Renewable Energy Bond Arrangement to Expand Clean Energy in Japan," [Press release], 26 May 2015.
[114] GTM, "SolarCity announces yield of securitized solar notes," 14 November 2013.
[115] M. Mendelsohn, "Raising capital in very large chunks: The rise of solar securitization," *PV Magazine*, 16 November 2018.
[116] *PV Magazine*, "BBOXX and Oikocredit bring securitization to African Off-grid Solar," 12 January 2016.

PUBLIC FINANCE

Key solution: Continue to support mechanisms that incentivize private investment

Particularly for new technologies and markets, public finance continues to play a central role in driving investment by providing revenue security. Lessons gathered from managing subsidy budgets for solar and wind can be applied to strategies for supporting newer technologies, such as battery storage, which will be critical for integrating intermittent renewable generation into the grid.

Barriers to scaling solutions

Subsidy bills can accrue rapidly and often require that governments develop clear funding plans to avoid situations where financing commitments made to investors become unmanageable. In markets where project developers require that PPAs be backed by a sovereign guarantee, governments may struggle to take up too many liabilities, as these can constrain their general financing capacity.

The rise and fall of Germany's clean electricity subsidies

Germany has been a global leader in clean energy development since its government set ambitious objectives for the sector in the *Energiewende* program.[117] Delivering the investment needed to meet Germany's clean energy goals required substantial public finance commitments.

From 2010 to 2017, the annual renewable energy subsidy budget increased from €8.2 billion to €24.4 billion.[118,119] The contribution of solar, wind, and biomass increased from 72.8TWh to 193.8TWh over a similar period.[120] To increase certainty that the subsidy budget would be consistently funded, the German government introduced a renewable energy surcharge on power prices that is reviewed annually.

However, it is possible that future subsidies to new solar and wind projects may be marginal or more frequently require zero premium on the wholesale power price, as they have in a number of European offshore wind auctions.[121] For example, in August 2018, no public incentive was paid to the PV projects that were procured in solar auctions because the wholesale power price never fell below the price guaranteed to PV projects.[122] Consequently, many private-sector players in Germany expect the annual subsidy budget for solar and wind to reduce sharply over the coming decade as more expensive projects reach the end of their feed-in tariff contracts and newer projects require little to no subsidies aside from low-revenue guarantees.[123]

117 Federal Foreign Office of Germany, The German Energiewende.

118 For 2010, see "Die Übertragungsnetzbetreiber Amprion, EnBW Transportnetze, Transpower und Vattenfall Europe Transmission veröffentlichen heute die EEG-Umlage für das Jahr 2010," [Press release], 15 October 2009.

119 For 2017, see "Prognose der EEG-Umlage 2017 nach AusglMechV," 14 October 2016.

120 BNEF, Country Profile: Germany.

121 Offshore wind auctions often do not just award the power price but also a fully permitted site and a grid connection funded by public finance.

122 *PV Magazine*, "Germany: Tendered PV projects need no public subsidy in August," 15 October 2018.

123 BNEF, "EU Green Subsidies Still Rising but More Bang for Buck," February 2018.

PUBLIC POLICY

Key solution: Set ambitious national clean energy goals that recognize the evolving technology landscape

Governments can set ambitious, long-term, and detailed intermediate clean energy targets that send a strong signal to the private sector. These include short- to medium-term goals for mature and cost-competitive clean energy technologies such as solar and wind. Policymakers can increase targets as technologies begin to perform better or become more competitive than initially envisioned.

Ensuring a stable policy environment, including clear permitting and land acquisition processes, is critical to preserving investor confidence. While policymakers can gradually phase out policy support schemes as technologies mature, it is critical to avoid retroactive cuts for already approved or financed projects.

Barriers to scaling solutions

Setting ambitious targets can be challenging when macroeconomic conditions and technologies are changing rapidly. Governments can be under pressure to revise incentives awarded to new low-carbon technologies in response to the need for more budgetary discipline during economic turmoil; however, such retroactive interventions lead to significant loss in investor confidence and litigation.

The EU's comprehensive transition targets

The EU has been a leader in setting targets for its transition to a low-carbon economy. In 2009, member states set a 2020 target to cut GHG emissions by 20% against 1990 levels, reach 20% renewables in final energy consumption, and improve energy efficiency by 20%.[124] The renewables target is divided into sectoral targets for power, heat, and transport and backed by country-level targets. The EU expects to meet this goal — renewable energy produced 17.5% of the EU energy mix in 2017.[125]

In 2018, the EU member states reached an agreement on 2030 targets, committing to at least 40% emissions cuts against 1990 levels, 32% renewables in final energy consumption by 2030, and energy-efficiency improvement of 32.5% compared to 2007 levels.[126] The objective of reaching net-zero emissions by 2050 is also under consideration at the EU level, following adoption of the target by several member states, including the UK and France.[127]

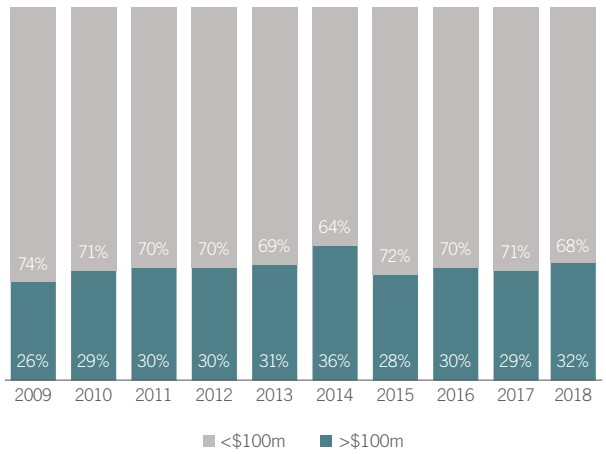
The regulation supporting the 2030 objectives draws on lessons learned over the last decade. Subsidies for mature technologies must be awarded through market-based support mechanisms, e.g., clean energy auctions. Permitting for projects should be facilitated and retroactive cuts to support are explicitly forbidden, meaning that investors can rely on EU institutions — which tend to operate with greater efficiency and authority than national courts or private litigation procedures — in the case of litigation related to retroactive policy changes that affect existing contracts.

[124] European Commission, 2020 climate & energy package.
[125] Eurostat, Share of renewable energy in gross final energy consumption.
[126] European Commission, 2030 climate & energy framework.
[127] Bloomberg News, "Merkel Seeks Momentum for Net Zero Emissions in Europe by 2050," 17 June 2019.

2 Challenge: Risks in emerging markets constrain low-carbon investments

Across the developing world, clean energy investment remains relatively low and concentrated in a few markets (FIGURE 20). Of the 103 countries analyzed by BNEF's Climatescope tool, less than one-third record more than $100 million in investment in a given year — roughly the amount needed to finance a single large-scale solar or wind project.[128] The 31 low-income countries, in particular, have accounted for just 0.1% of clean energy investment to date (FIGURE 8, Chapter 2).

FIGURE 20:
Percentage of Climatescope countries recording more than $100 million in clean energy asset finance in any year



Source: BNEF. Note: Clean energy investment data for 103 emerging markets.

Private investors interested in supporting clean energy in these markets have often faced challenges resulting from the lack of enabling policy frameworks, market risks, and other barriers to entry. Yet, because emerging markets represent the largest share of projected growth in emissions if unabated, resolving these challenges presents an important opportunity both for clean development and mitigating climate risk.

> *"Economic growth in Asia, Africa, the Middle East, and Latin America has improved billions of lives and created enormous new opportunities for businesses. Still, economic growth in emerging economies creates new challenges in how we address issues around trade, technology, intellectual property, capital markets, and common societal challenges, such as public health and climate change."*
>
> Michael R. Bloomberg, Founder, Bloomberg L.P., November 2018

[128] BNEF, Climatescope, "Emerging Markets Outlook 2018," 27 November 2018; Climatescope assesses investment conditions for clean energy in emerging markets based on a country's fundamentals (e.g., clean energy policies and power sector structure), opportunities (e.g., demand growth and price attractiveness), and experience (e.g., existing volumes of installed clean energy).

Creating enabling environments for clean energy investment

Creating an enabling environment for clean energy investment involves addressing a country's wider investment environment — macroeconomic stability, enforceability of contracts, currency convertibility and transferability, and other factors — as well as policy conditions specifically aimed at facilitating clean energy investment. Inadequate attention to these factors can either deter investment altogether or create a significant penalty due to high financing costs. Because of the critical importance of enabling environments to unlock private investment in emerging markets, the CFLI has compiled a list of investment readiness guidelines summarized in the box that follows.

The CFLI Investment Readiness Guidelines

CFLI has outlined guidelines on the fundamental and cross-cutting factors affecting climate finance in developing countries, a more detailed version of which is available in Appendix 1 and at bloomberg.com/cfli

Macroeconomic considerations

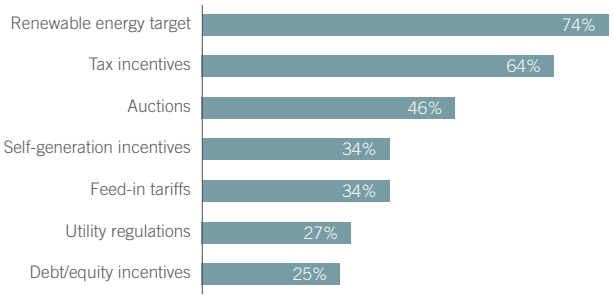
- Political and macroeconomic stability, including strong institutions with a track record of good governance and stable macroeconomic management
- Policy stability and reduction of policy risks, such as expropriation, sovereign breach of contract, or lack of availability of hard currency
- Deep local financial markets that can provide lending and other financial services
- Currency stability or availability of instruments to hedge currency risks in sufficient size and tenor
- Stable and predictable investment incentives for low-carbon solutions that signal a favorable business environment for the operator
- Political and government willingness, experience, and relevant technical skills to implement policies and engage with investors

Market considerations

- Cost-reflective energy prices, which may require the removal of energy subsidies for the incumbent fossil fuel industry
- PPAs of sufficient duration and incorporating protections required by international lenders
- Presence of creditworthy or credit-enhanced off-takers (e.g., backing of partial or full sovereign guarantees, liquidity facilities, and laws assuring funding for the electricity sector)
- Ownership and local content requirements that are mindful of foreign investors' and local communities' needs
- Clear and predictable licensing and permitting procedures
- Predictable local legal and dispute resolution frameworks and confidence contracts will be enforced promptly in local courts
- Power grid capacity, stability, and ability to handle intermittent power to reduce the likelihood of periodic, uncompensated curtailment of production
- Effective community engagement to ensure that local communities understand a project
- Markets of sufficient size to generate robust and relevant deal flow
- Experienced international contractors capable of delivering a project on time and on budget

National energy policies in emerging markets are often still focused on encouraging investment in large fossil fuel projects, and power sector development plans do not yet take into account the growing cost-competitiveness of clean energy generation.[129] Although almost three-quarters of emerging markets have adopted national renewable energy targets, concrete policies to support the investments needed to deliver on these targets are lagging (FIGURE 21). Examples of effective implementation policies include renewable energy auctions, which competitively procure and award fixed tariffs or premiums to projects.[130] Tax incentives that favor renewables, such as import duty exemptions for clean energy equipment, are popular but sometimes unenforced.

FIGURE 21:
Share of emerging markets employing various clean energy policies



Source: BNEF, Climatescope. Note: Analysis carried out on 103 emerging markets.

To facilitate private asset finance for renewables, electricity market regulation can allow independent power producers (IPPs) to generate and sell electricity. In many emerging markets, a single or a group of state-owned utilities are responsible for electricity generation, transmission, and distribution. Opening up generation to IPPs and developers allows countries to take advantage of competition, typically resulting in the procurement of lower-cost electricity while fostering the creation of local developers and associated jobs. Finally, renewable project developers need fair and organized access to the grid. This entails not only clear grid codes and regulation but also the technical capacity for the transmission grid and its operators to integrate and dispatch renewable power to avoid curtailment.

> *"The lack of capital markets access continues to hamper the flow of private capital toward emerging economies. Our goal is to complement existing capital from public financing, as well as private bank and multilateral funding, to bolster the growth of long-term capital markets supported by local, regional, and international institutional investors, which will ultimately help scale sustainable infrastructure in those markets."*
>
> John Greenwood, Co-Head of Project, Infrastructure, and Principal Finance, Goldman Sachs, September 2019

Managing project-specific risks

In any market, successful asset finance for renewables requires managing project-specific risks. In emerging markets, such risks can be magnified in ways that can exceed investors' risk tolerance in comparison to anticipated returns. In particular, emerging markets may face a higher risk of delays during development, currency volatility over the project lifetime, uncreditworthy power purchase counterparties, and increased instability of the socioeconomic context. Public and private actors can employ several strategies to mitigate these project-specific risks.

[129] BNEF, Climatescope, "Emerging Markets Outlook 2018," 27 November 2018 .

[130] The other policies shown in Figure 21 include tax incentives, such as the tax breaks for renewable projects in the Philippines; self-generation incentives, which generally support distributed renewable generation for consumption on site at, for example, businesses or industrial facilities; utility regulations, which can include renewable portfolio standards that mandate a certain share of renewables in a utility's generation mix; or debt/equity incentives, such as concessional lending for renewables.

Enhancing the standardization, bankability, and tenor of power purchase agreements

Standardized tariffs and PPAs, which offer clarity over the terms and conditions of a project's operations, can help attract a larger volume of private investment and reduce investment risk among new market participants. Only a quarter of emerging markets surveyed have standardized power purchasing terms and conditions for IPPs — but, on average, these countries have recorded around three times the volume of clean energy investment as those lacking strong standard agreements.[131]

Many important project risks can be addressed through the process of developing bankable PPAs. These contracts can address risks related to the delivery of electricity to the grid, currency volatility, creditworthiness of the counterparty, political stability, and dispute settlement. For example, an effective strategy to address foreign exchange risk is to denominate PPAs in currencies that are liquid and less volatile: outside of very large markets like China, India, or Brazil, almost all clean energy contracts signed to date are in U.S. dollars.[132]

Creating the conditions for longer-tenor PPAs is also critical. Investors require long-term revenue certainty to commit to the high up-front cost of a renewable energy project. Markets that offer PPAs with a tenor of 10 years or more attracted 98% of the $709 billion in new clean energy asset finance recorded in emerging markets between 2013 and 2017. Longer tenors also help developers secure the debt financing that allows them to recover the project's revenue earlier in its lifetime, thus freeing capital that can be deployed elsewhere.

Mitigating risks through national policy support

Not all project-specific risks can be addressed through strong PPAs. For example, risks could stem from the lack of a viable supply chain and workforce — which can potentially hinder project engineering, procurement, construction, or operations and maintenance. Conflicting regulation and roles of various authorities, political instability or corruption, failure by grid operators and regulators to complete work on time, or untested permitting processes can also affect the risk profile of a specific investment.

National policymakers can help mitigate some of these risks. In particular, clear planning and permitting processes can help ensure that projects do not suffer delays and can be commissioned on schedule. Several countries have helped facilitate this process through the "pre-development" of projects ahead of clean energy auctions. This pre-development support can include activities such as pre-defining sites or supporting the requisite studies and permits (e.g., grid, environmental impact, or geotechnical studies). For example, Egypt held renewable energy auctions for pre-defined solar sites, which resulted in record-low bid prices for 200MW of solar capacity in 2018.[133]

Deploying public and private financial instruments to mitigate risk

Public and private financial instruments and tools can also reduce investment risk. As described in the following section, DFIs can provide political risk insurance or use partial guarantees to mitigate off-taker risk (i.e., by helping to guarantee a portion of the payment in case of a default). Private finance instruments such as currency swaps can also mitigate the foreign exchange risk

131 BNEF, Climatescope, "Climatescope 2018 — Model," 27 November 2018.
132 BNEF, Climatescope, "Emerging Markets Outlook 2018," 27 November 2018.
133 IRENA and Clean Energy Ministerial, "Renewable Energy Auctions: A Guide to Design," Abu Dhabi, 2015.

of agreements signed with utilities that are paid in local currency. However, each of these risk mitigation tools often creates an additional cost, requiring careful evaluation and due diligence for each project.

Facilitating private-sector entry into new markets

Even under a conducive enabling environment, private investors may still find it challenging to enter new emerging markets. Entering a new market requires extensive due diligence and building relationships with local technical and financial partners, understanding local regulations and politics, and negotiating partnerships with labor markets and supply chains — all of which add to the initial cost of doing business in a new country. Partnering with a local project developer or equity investor with more experience in the market can help reduce this barrier to entry.

> *"We need to do more in mobilizing the private sector. Without the private sector, it would be impossible to achieve [the Sustainable Development] Goals. And a lot needs to be done in order to raise awareness and to show the opportunities that exist and to create mechanisms to reduce risks."*
>
> António Guterres, United Nations Secretary-General, June 2019

Given their development mandates and flexible financing tools, DFIs serve as important partners for private investors seeking to enter new countries with higher perceived risks. DFIs are frequently the first commercially oriented investors to enter a market and have played an important role in establishing standards, concessions and financing agreements, and other enabling policies (see box below).

Understanding the incentives and constraints of DFIs

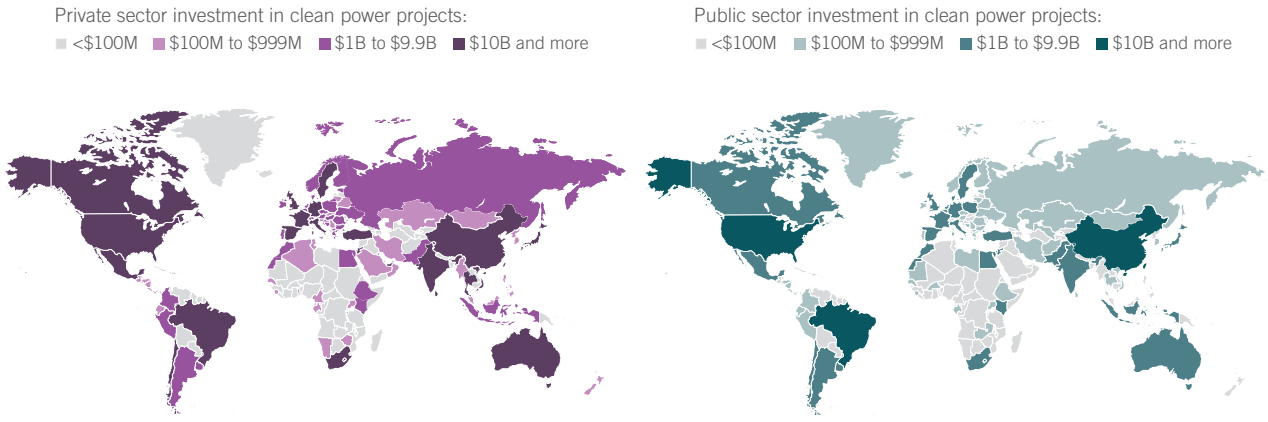
DFIs are encouraged to use their funding to help support self-sustaining growth in strategic sectors and in developing countries — including through risk sharing, expanding credit enhancements, and commercial financing when possible. However, certain incentives and constraints within DFIs may prevent the full implementation of strategies to crowd in private finance.[134]

DFIs still have a responsibility to their shareholders to earn a return and to balance their portfolios. Similarly, especially for DFIs that operate on more commercial terms, many are expected to maintain high credit ratings. As a result, DFIs cannot solely invest in the least-developed countries, fragile states, and countries with high debt, they must also invest in less risky markets where commercial investors may also be active (FIGURE 22).

In some DFIs, investment teams may be incentivized to deploy capital, as teams are rewarded based on the money invested. Between incentive structures and limited human resources, DFIs do not always seek out and structure risk-sharing instruments for private-sector partners. The incentive to deploy capital can also create challenges due to the lack of project pipelines in many markets. The small volume of investable projects can potentially lead to competition among DFIs or between DFIs and private finance. Even in cases where blended finance — the combining of concessional capital with more commercially oriented capital — is used, it is important to take approaches that avoid market distortions. Blended finance and the inexpensive financing costs that result from it have the potential to drive energy tariffs so low as to make the clean energy sector unattractive for private developers and commercial investment. Such low energy tariffs in one country can then set unviable expectations for other countries. Guidelines for blended finance are, therefore, important to avoid ongoing reliance on concessional capital — which can prevent the transition to commercial, undistorted markets.

[134] G20 IFA Working Group, "Principles of MDB's Strategy for Crowding in Private Sector Finance for Growth and Sustainable Development," April 2017.

FIGURE 22:
Geographic distribution of private and public sector investment in clean energy, 2009–2018



Source: BNEF. Note: Includes $2 trillion of disclosed investment in clean energy asset finance.

Harnessing the vast resources of the financial sector for low-carbon investment in emerging markets requires creating an attractive risk-adjusted return. DFIs have significant experience in successfully investing on market-based terms in developing countries, opening up markets, and paving the way for private capital. Investing alongside DFIs can reduce risk for private developers and investors as they benefit from the DFIs' experience and reputation, their preferred creditor status, and their risk-mitigation tools, e.g., political risk insurance. In addition, some DFIs offer technical assistance to support enabling regulatory frameworks, tendering processes, or the development of stronger local value chains that ultimately reduce the total cost of solar and wind projects, and increase the positive impact of projects on the local economy. DFIs can also help facilitate the shift to newer technologies such as battery storage that can help integrate a growing share of renewables or support reliable grid operation. In other markets where conditions are not yet conducive for private investment — concentrated in sub-Saharan Africa but also in Asia and Latin America — DFIs play an even more central role in pioneering clean energy transactions.

Key solutions summary: Key role for public finance and policymakers to mitigate risk for private investment

PRIVATE FINANCE

Key solution: Partner with local developers and support their growth

The private sector can scale up clean energy project investment in emerging markets that have transparent, stable, and comprehensive enabling policies.[135] International equity and debt investors also have the opportunity to invest in local developers or other companies along the value chain. Access to international investors can be vital for growing renewable energy industries in markets where local financing options may be limited. Investing in developers, rather than projects, can also offer higher returns and earlier-stage access to growth markets, as illustrated by the India example below.

Barriers to scaling solutions

Entry into each new market comes with entry costs for project developers, banks, and investors. For this reason, smaller markets or those outside a financial institution's broader geographic strategy can often be overlooked by investors.

India's clean energy boom and the rise of homegrown developers

The Indian renewable energy auctions market is the largest in the world. Auctioned capacity has increased by 68% since 2017 as the country moves closer to meeting its goal of installing 175GW of renewables by 2022.[136] In 2018 alone, India awarded a record 19GW of solar and wind capacity through auctions.[137]

This large pipeline of projects has created momentum to support the establishment and rapid growth of many companies across the renewables project value chain, including large Indian IPPs that are successfully competing with top international developers. Domestic players have won approximately two-thirds of projects awarded under auctions in the wind sector.[138] ReNew Power has emerged as the largest player, with 4.7GW of operational capacity and over 3GW of capacity in its development pipeline as of July 2019.[139]

Goldman Sachs was an early investor that supported ReNew Power's growth. In 2011, Goldman Sachs invested $60 million in ReNew Power, representing the first major equity investment in the developer, and provided cumulative funding of approximately $470 million at different stages of ReNew's growth cycle.[140] As ReNew Power grew, it attracted a network of institutional investors, including the Asian Development Bank (ADB), Canada Pension Plan Investment Board, Global Environment Facility (GEF), Japan's Energy for a new Era (JERA), and South Asia Clean Energy Fund.

In 2016, ReNew Power tapped into the domestic capital market through a first of its kind public-private partnership green bond issue. ReNew raised a 74 million ($1 million) rupee-denominated bond under a project bond guarantee facility set up by ADB and the India Infrastructure Finance Facility, which was established in 2012 to draw more institutional investors into critical infrastructure projects in India.[141]

continued on next page

[135] BNEF, Climatescope, "Emerging Markets Outlook 2018," 27 November 2018.
[136] BNEF, India country profile.
[137] BNEF, "1H 2019 India Market Outlook: Navigating the Hurdles," 31 January 2019.
[138] BNEF, "Indian Companies Win Big in Ultracompetitive Wind Auctions," January 2019.
[139] ReNew Power, accessed 6 August 2019, Home page.
[140] ReNew Power, Our milestones.
[141] Asian Development Bank (ADB), "Groundbreaking ADB Facility to Mobilize Finance for Critical India Infrastructure," [Press release], 21 September 2012.

Subsequently, ReNew Power worked with Goldman Sachs and other underwriters to tap into international investors. Using a unique financing structure, ReNew Power raised dollar-denominated green bonds through an independent offshore special purpose vehicle to purchase their rupee-denominated bonds, thereby reducing foreign exchange risk. This financing mechanism was leveraged to help grow ReNew's international green bond issuance to $475 million in 2017.[142] In March 2019, ReNew Power directly issued a dollar-denominated bond following changes to the Reserve Bank of India's rules on external commercial borrowings.[143] The successive issuances by ReNew Power illustrate the progression of capital markets and investor base diversification, as well as their role in supporting ReNew's growth.

[142] Allen & Overy, "Allen & Overy Helps Structure Innovative Bond Deal Giving Indian Issuers More Avenues to Raise Funding From the USD Debt Markets," [Press release].
[143] ReNew Power, "ReNew Power Concludes US$ 275 Million Green Bond Issue," [Press release], 7 March 2019.

PRIVATE FINANCE

Key solution: Partner with DFIs to develop financial products

Large buyers of fixed income products, such as asset owners, can partner with DFIs to encourage the issuance of bonds that match their investment requirements. To balance their portfolios, DFIs typically invest in a share of low-risk commercial-grade projects. By working in collaboration with DFIs to ensure their green bonds match private-sector benchmarks, institutional investors can scale financing to these lower-risk investments.

Barriers to scaling solutions

Investment benchmarks differ across investors, making it difficult to match green bond criteria to a wide range of investor requirements.

Through DFI partnerships, building a $1 billion green bond portfolio in three months

While ESG factors are increasingly integrated into equity investments, fixed income products that integrate ESG such as green bonds remain relatively niche. Borrowers can find green bonds complicated and costly to issue, while investors can be turned off by the "green premium" or lack of liquidity inherent in green bonds as opposed to traditional bonds. The Japanese Government Pension Investment Fund (GPIF) has faced additional complexities in integrating ESG into portfolio allocation decisions as it outsources management of its global equity and foreign fixed income portfolios to external asset managers. However, by partnering with DFIs, providing clear guidance to asset managers, and modifying passive external management guidelines, GPIF was able to grow its green bond portfolio to over $1 billion in a matter of months.

In response to the results of its 2018 joint study on "Incorporating ESG factors into fixed income investments," developed in partnership with the International Bank for Reconstruction and Development (IBRD) and the International Finance Corporation (IFC), GPIF took several steps to proactively direct more of its fixed income allocation into sustainable investments in green, social, and sustainability bonds.

First, GPIF revised its investment principles to explicitly state that fulfilling its stewardship responsibility entails integrating ESG throughout all asset classes. Second, it provided a concrete definition for "ESG Integration," requiring "all asset managers to systemically include ESG factors into investment analysis and investment decisions," to clarify uncertainty and convince skeptical asset managers of the merits of investing in ESG-related fixed income. The definition specifically stated that "GPIF regards investment in green and social bonds as one of the direct methods of ESG integration."

Because most of GPIF's fixed income portfolio is managed passively in line with the FTSE World Government Bond Index and the full value arising from sustainable activities is realized over a relatively long holding period, GPIF initially focused on increasing the volume of green bonds within this passive portfolio. In order to allow passive managers to make off-benchmark investments for the first time, GPIF modified its investment guidelines to permit these managers to invest in AAA-rated bonds issued by DFIs. The excess yield of DFI bonds over on-benchmark government bonds with the same rating enabled asset managers to fulfill their fiduciary duty while incorporating ESG, and helped to shift asset managers' perception of green bonds. Finally, to address the lack of liquidity and spike in demand for green bonds resulting from changes to the externally managed

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investment guidelines, in collaboration with IBRD and IFC, GPIF arranged preferential access to IBRD and IFC green bonds for its asset managers. This partnership alone mobilized more than $500 million of initial investment in green bonds issued by the World Bank Group.

GPIF built on the success of these actions and developed a similar agreement with the European Investment Bank (EIB) and the Asian Development Bank (ADB). Just three months later, GPIF's green bond holdings surged to over $1 billion.

While directly partnering with DFIs may be prohibitive for smaller asset owners, the steps taken by GPIF to incentivize asset managers to invest in green, social, and sustainability bonds while giving them confidence they are fulfilling their fiduciary duty can be used as a guide for asset owners of various sizes.

PUBLIC FINANCE

Key solution: Deploy de-risking, concessional finance, and pipeline tools to attract private investors to new markets

The manner in which DFIs fulfill their mandate to leverage private investment in emerging markets continues to evolve. Public-private collaboration has taken the form of joint investments in long-term infrastructure and green bonds but is expanding toward joint capitalization of development funds and the creation of more national green investment banks. In more mature markets and sectors, DFIs can unlock private capital by partnering with banks and asset managers to co-finance projects, progressively shifting the focus of their activity from deploying capital directly to providing less costly guarantees and other risk-sharing instruments. The progressive way DFIs can support clean energy asset finance is illustrated by the Chile case study below.

Barriers to scaling solutions

DFIs are often expected to provide returns to shareholders, balance portfolios, and maintain high credit ratings. As a result, many DFIs are obligated to ensure that they meet profit targets, price lending at market rates, and avoid distortive subsidies. These obligations have made it difficult for DFIs to invest solely in risky markets, despite the need to support the low-carbon transition in the world's lowest-income countries.

The successful transition from DFI funding to private capital in Chile

Chile's power sector, which has been deregulated since the 1980s, is considered one of the most sophisticated power markets in Latin America; private investment is encouraged across the sector, including in generation, transmission, and distribution. However, the country's power sector transition to clean energy began only recently. In 2013, when less than 5% of Chile's electricity came from renewables, the government imposed a 20% renewable portfolio mandate on utilities for 2025.[144] By 2018, the share of renewables had already more than tripled to reach 18% of generation.[145]

DFIs played a critical role in nurturing the growth of Chile's renewable energy sector after its renewable mandate was introduced. The first project to break the $100 million mark was the $260 million 101MW Amanecer Solar PV project, in which the IFC and the U.S. Overseas Private Investment Corporation (OPIC) provided $212.5 million in debt.[146] Since 2013, DFIs have paved the way for commercial lenders, with OPIC, the World Bank, and the Inter-American Development Bank having cumulatively deployed more than $1 billion in project lending.[147] DFIs' presence in the market has gradually been phased out, supplanted by interest from commercial banks, which provided over $900 million of clean energy funding in 2017 alone.[148] International utilities like Enel and AES have also since entered the market, providing more of the finance by tapping their own balance sheets.

Lending from DFIs has played an important role in stimulating solar and wind production in Chile's electricity market by helping clean energy developers secure attractive financing. In the Chilean auction system, renewables compete with fossil fuel generators. In the first tender, solar and wind projects won contracts to deliver just 7% of the auctioned generation volume.[149] In the tenders held since 2018, however, renewables outcompeted fossil fuels to win 100% of the contracts on offer. In emerging markets where local financing is often limited or comes at a premium, concessional finance provided by DFIs can reduce the time needed for solar and wind to become more cost-competitive than fossil fuels by four to seven years on average.[150]

144 BNEF, Climatescope 2018: Chile country profile, 2018.
145 Martin Libra; PVTech, accessed [31 July 2019], "Chile: Land of Opportunity for Renewable Energy," 31 October 2018.
146 Overseas Private Investment Corporation. "SunEdison, IFC and OPIC Close $212.5m Project Financing Arrangement for a 100 MW Solar Power Plant in Chile," [Press release], 10 September 2013.
147 BNEF, Climatescope 2018: Chile country profile, 2018.
148 BNEF, Investment & Valuation — Financing Deals database.
149 BNEF, Clean Technology Fund (CTF), "Clean Technology Fund and Concessional Finance: Lessons Learned and Strategies Moving Forward," February 2019.
150 Ibid.

PUBLIC POLICY

Key solution: Lay the regulatory foundations for clean energy development

Domestic policymakers play perhaps the most important role in stimulating private investment in clean energy through their work to improve enabling environments. Clear clean energy targets, regulatory frameworks that allow privately developed clean energy projects access to the electricity grid, and at least one major policy that directly incentivizes investment such as clean energy auctions or feed-in tariffs are typically needed to mobilize private investment. Domestic policymakers can also take steps to improve the general investment climate and support project development activities such as site selection and permitting procedures.

Policy reversals or renegotiations of tariffs, PPAs, tax incentives, or other agreements — particularly in the early stages of market development — can have a long-lasting negative impact on future investor interest. Where policy changes are necessary, grandfathering can be used to protect previous investments as illustrated in the Mexico case study below.

Barriers to scaling solutions

Introducing policy changes that can support the transition to a low-carbon economy requires technical expertise and a careful calculation of policy impacts on incumbent stakeholders, energy consumers, and taxpayers. Even mature economies in Western Europe that have reached a high share of renewable electricity experienced periods of policy turbulence as they implemented the policies needed to effectively incentivize clean energy development.

Creating an enabling environment for clean energy investment in Mexico

Mexico has historically relied heavily on fossil fuel–based generation, which still accounted for 81% of its electricity generation in 2017.[151] Like many emerging markets, it has also relied on a state-owned utility to make investments in and operate its electricity generation, transmission, and distribution systems.

However, in 2013, Mexico began to implement a comprehensive energy policy reform to incentivize greater investment in clean energy and improve the efficiency of the power system.[152] This energy reform included unbundling the national utility and allowing private-sector participation in electricity generation, as well as setting a renewable energy generation target of 35% by 2024.[153] To support the investment needed to meet this target, Mexico conducted auctions, which awarded 15-year U.S. dollar-denominated fixed PPAs to clean energy developers. Renewable energy projects were also awarded 20-year contracts for selling Clean Energy Certificates, providing a further source of revenue for investors.[154]

From 2016 to 2018, Mexico recorded $10.4 billion in clean energy investment from the three auction rounds held over the period, with the latest round resulting in record low prices for wind and solar PV.[155,156] Mexico has also successfully drawn private-sector investment from international project developers such as Enel, Engie, and Acciona and financing from international commercial banks. While Mexico's new government has announced its intention to review energy policy, it has also signaled its intention to respect previously awarded PPA contracts.[157]

151 BNEF, Mexico country profile.
152 Government of Mexico, "Reforma Energética," 20 December 2013.
153 BNEF, Mexico country profile.
154 Ibid.
155 BNEF, "Investment & Valuation — Clean Energy Investment," July 2017.
156 BNEF, "Mexico's Third Power Auction Results," December 2017.
157 *PV Magazine*, "No More Auctions for Solar and Renewables in Mexico," 12 March 2019.

3 Challenge: Many low-carbon investments in key emitting sectors are not yet profitable

Although renewable energy generation and EVs are growing increasingly cost-competitive, fewer viable alternatives exist in heavy industry, heavy-duty transport, and land use (including agriculture) that represent more than half of global emissions (see box on page 59).[158,159] In these sectors, some low-carbon solutions may be technologically viable, but no revenue models yet exist to support their large-scale deployment. In other cases, breakthrough low-carbon technologies are still in the R&D or demonstration phase. Increasing low-carbon investment for solutions that are currently technologically viable but not yet economical will likely require a mix of policy-driven approaches such as carbon pricing, subsidies, or regulation, complemented by private sector–led initiatives to foster demand for low-carbon products. For technologies that are not yet commercially viable, R&D and demonstration projects from both the public and private sector can help bring innovative products to the market, while publicly financed incentive structures can create a more acceptable return profile for higher-risk technologies.

Understanding the economic and technical challenges in heavy industry, heavy-duty transport, and agriculture

In many cases, reducing emissions in heavy industry, heavy-duty transport, and land use can entail changes in core production processes or require capital-intensive investments to replace specialized equipment. Some of the required low-carbon solutions may be technologically viable, but many are not yet economical due to their high capital costs and a lack of investment incentives. Further, given the capital invested in long-lived assets, it is often in the financial interest of corporations to resist cost increases and maintain existing cost structures.

> *"Support for investment and innovation would further enable steel's decarbonization as green steel becomes increasingly of interest to companies across the value chain."*
>
> Zoë Knight, Group Head, Centre of Sustainable Finance, HSBC, September 2019

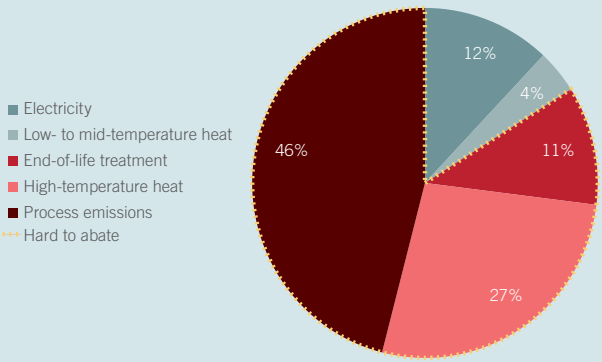
In addition, many key solutions for decarbonizing these sectors are not yet commercially proven. For example, the production of hydrogen — which can be used as a zero-carbon fuel in heavy-duty transport or to produce high-temperature heat in industrial applications — is currently costly and can require substantial infrastructure to support its deployment.[160] Similarly, CCS holds promise to control emissions in certain sectors, but thus far is largely limited to demonstration projects.[161]

158 Energy Transitions Commission, "Mission Possible: Reaching Net-Zero Carbon Emissions From Harder-to-Abate Sectors by Mid-Century," 2018.
159 IPCC, "Climate Change 2014: Synthesis Report," Geneva, 2014.
160 BNEF, "Hydrogen: The Economics of Storage," 10 July 2019.
161 Energy Transitions Commission, "Mission Possible: Reaching Net-Zero Carbon Emissions From Harder-to-Abate Sectors by Mid-Century," 2018.

Why certain sectors are harder to abate

Heavy industry, heavy-duty transport, and land use face substantial technical and/or financial challenges to transitioning to lower-carbon business models and operations. While demand-side measures can help reduce emissions in all of these sectors, reaching net zero will require more difficult supply-side solutions briefly outlined below.

FIGURE 23:
Sources of CO_2 emissions from the production of steel, plastics, and ammonia, 2015



Source: Material Economics. Note: 100% = 536Mt CO_2.

Heavy industry, such as cement, steel, plastics, and ammonia production, produces emissions through energy use, industrial processes, and end-of-life treatment (FIGURE 23).[162,163] The largest share of energy use typically stems from high-temperature heat, accounting for about 80% of total industrial energy use.[164] While electrification or CCS can reduce heat-related emissions, in most cases, these solutions are not yet economical. Low-emissions means of generating heat from burning hydrogen produced with renewable electricity is promising but not yet deployed at commercial scale. For process emissions, alternative chemistries are often not perfect substitutes, and they require fundamental changes to standard industrial processes. New approaches are generally capital intensive and are further hindered by the long life of existing industrial equipment.

Heavy-duty transport, including aviation, shipping, and heavy road transport, can achieve emissions reductions by improving logistics and operations, and transitioning off fossil fuels.[165] For road transport, electrification is likely to play a large role but still requires technical improvements in energy storage technologies. Shipping and aviation will require innovations in carbon-free liquid fuels, which are currently not commercially viable.

Agriculture, land use, and forestry emissions are largely process-driven.[166] Agricultural emissions come from many sources, including soil bacteria, livestock, and farm equipment. Reducing these emissions would require conventional farmers to alter their practices, yet few incentives exist for them to make this change. For land use and forestry, reducing emissions would involve preserving carbon sinks, for which revenue incentives need to be created.

162 Energy Transitions Commission, "Mission Possible: Reaching Net-Zero Carbon Emissions From Harder-to-Abate Sectors by Mid-Century," 2018.
163 Material Economics, "Industrial Transformation 2050: Pathways to Net Zero for EU Heavy Industry," 2019.
164 BNEF, "Industrial Heat: Deep Decarbonization Opportunities," 26 February 2019.
165 Energy Transitions Commission, "Mission Possible: Reaching Net-Zero Carbon Emissions From Harder-to-Abate Sectors by Mid-Century," 2018.
166 IPCC, "Climate Change 2014: Synthesis Report," Geneva, 2014.

The economics of low-carbon investments can be further distorted by inconsistent policies such as fossil fuel subsidies, particularly in sectors that rely on fossil fuels for heat and electricity (see box below). These subsidies, many of which are intended to support industrialization and economic development, often lead to inefficiencies as they can create disincentives to invest in otherwise profitable measures such as energy efficiency.

Fossil fuel subsidy reform: Leveling the playing field for low-carbon investment

The International Monetary Fund (IMF) estimates that global subsidies for fossil fuels totaled $296 billion in 2017, placing a significant strain on fiscal balances. If the untaxed negative externalities of fossil fuels are included, fossil fuels receive an estimated $5.3 trillion in public support.[167] By creating incentives for continued reliance on and inefficient use of fossil fuel energy, these subsidies can exacerbate climate-related transition risks and undermine the competitiveness of low-carbon investment opportunities. Further, despite the intention to provide affordable energy to lower-income households and promote industrialization, fossil fuel subsidies are often highly regressive and promote inefficiencies that hurt the long-run competitiveness of domestic industry.[168]

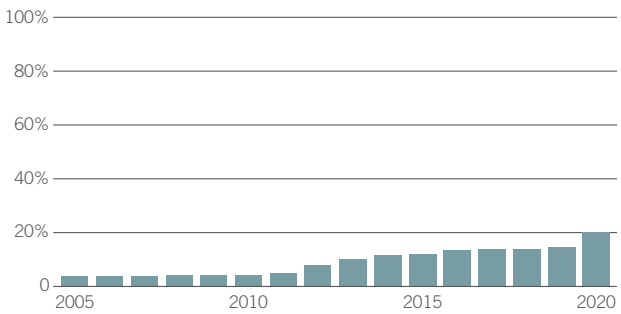
Given their negative impact on climate and economic development, there is growing consensus that phasing out fossil fuel subsidies is a key part of achieving an inclusive low-carbon transition. In 2009, members of the G20 pledged to phase out inefficient fossil fuel subsidies.[169] In 2017, investors and insurers representing more than $2.8 trillion in AUM issued a statement urging G20 members to do so by 2020.[170] Despite some progress in major markets like India and Indonesia, progress on subsidy reform has generally been slow due to political challenges. Subsidy reform often cannot happen overnight and requires a strategy that considers how industries and households can be supported as fossil fuel prices rise to market levels. Often such strategies involve using some of the savings from subsidy reform to implement social safety nets, such as targeted subsidies to low-income households. When implemented thoughtfully, fossil fuel subsidy removal can play a critical role in unlocking investment in low-carbon energy solutions.

167 IMF, "Global Fossil Fuel Subsidies Remain Large: An Update Based on Country-Level Estimates," May 2018.
168 J. Rentschler and M. Bazilian, "Reforming Fossil Fuel Subsidies: Drivers, Barriers and the State of Progress," *Climate Policy 17*, no. 7, 2016.
169 G20, "Leaders' Statement: The Pittsburgh Summit," 24-25 September 2009.
170 UNFCCC,"G20 Must Phase Out Fossil Fuel Subsidies by 2020," 15 February 2017.

Enacting policies to incentivize low-carbon investment

Beyond reforming fossil fuel subsidies, placing a price on carbon is often considered an efficient mechanism for policymakers to create incentives for low-carbon investments, particularly in cases where no other revenues exist to support investment. Jurisdictions across the globe have increasingly adopted carbon pricing policies — whether a carbon tax or the creation of a carbon market. By 2020, the World Bank expects that 20% of global emissions will be covered by a carbon pricing policy (FIGURE 24).[171]

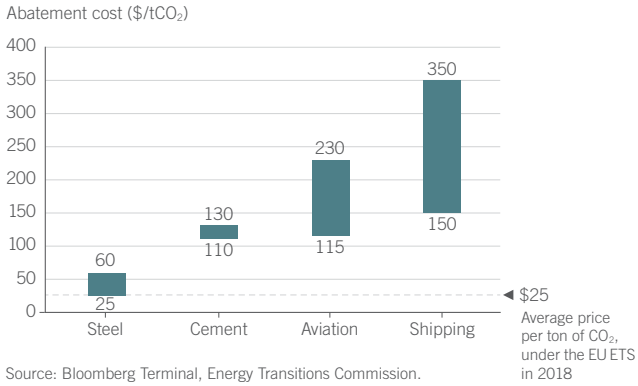
FIGURE 24:
Share of global emissions covered by a carbon-pricing policy



Source: World Bank.

However, carbon market prices have been too low to incentivize meaningful low-carbon investments in many sectors, with the global average in 2018 well below $1 per ton of CO_2.[172] Even the $25 per ton average price in the EU ETS in 2018 was well below the estimated marginal abatement cost required to motivate large-scale decarbonization in steel, cement, aviation, and shipping (FIGURE 25).[173]

FIGURE 25:
Abatement costs across selected industries compared with the average 2018 CO_2 price achieved in the EU ETS



Source: Bloomberg Terminal, Energy Transitions Commission.

Policymakers face challenges to increasing and maintaining the sufficiently stable carbon prices needed to make capital-intensive investments. Trade-exposed, energy-intensive industries or those that compete globally, such as commoditized manufacturing and international shipping, often oppose meaningful carbon pricing in specific jurisdictions because of concerns over their international competitiveness. Price volatility in cap-and-trade systems also inhibits long-term capital investment planning but can be difficult for policymakers to control. In the EU ETS, for example, the global financial crisis spurred a decline in economic output and associated emissions, driving carbon prices nearly to zero for a time.[174]

Given these carbon pricing challenges, a mix of policies — similar to those implemented to mobilize investment in clean energy — will likely be needed. Public procurement, for example through policies requiring low-carbon materials in public buildings, can help kick-start investment. Additionally, the public sector can procure emissions reductions from the private sector through "climate auctions," which award

171 World Bank, "State and Trends of Carbon Pricing 2019," Washington, D.C., 2019.
172 World Bank, "State and Trends of Carbon Pricing 2019," Washington, D.C., 2019 and Bloomberg Terminal.
173 Energy Transitions Commission, "Mission Possible: Reaching Net-Zero Carbon Emissions From Harder-to-Abate Sectors by Mid-Century," 2018.
174 European Commission, "Market Stability Reserve."

the most cost-competitive projects a guaranteed carbon price floor for each ton of emissions mitigated. In some cases, these auctions have been implemented alongside existing carbon markets, such as the World Bank's Pilot Auction Facility (PAF) or Australia's Emissions Reduction Fund, to provide a contract for difference to help investors hedge against volatile carbon prices.[175,176]

Regulatory standards can also help accelerate low-carbon investment. Performance-based standards that increase in stringency over time can facilitate uptake of low-carbon products. They also signal to corporations expectations of future pathways for emissions reductions. For example, in the transport sector, emissions-intensity standards have helped guide manufacturers to lower-emission vehicle models.[177]

Creating and meeting demand for low-carbon products

Private investors have also begun to explore low-carbon solutions in upstream industries and materials sectors in response to increasing end-user demand for more sustainable products. In a recent consumer survey, 66% of global consumers stated they were willing to pay more for sustainable goods.[178] Growing demand for sustainable consumer products has fostered industrial partnerships between actors along the production chain. For example, Apple has partnered with Rio Tinto and Alcoa, two major aluminum corporations, to commercialize a new process that can eliminate emissions from aluminum smelting.[179] This partnership will allow Apple to offer its customers more environmentally friendly electronic devices.

Corporations can also influence their supply chains to spur initial investments.[180] For example, vehicle manufacturers can help pool demand for low-carbon steel.[181] Corporate buyers can also facilitate the flow of financing to support low-carbon investments upstream in supply chains. In 2019, HSBC partnered with Walmart to provide improved sustainability-linked loans to Walmart suppliers who demonstrate progress in their sustainability ratings.[182] Such initiatives not only incentivize more sustainable supply chains but also promote transparency and climate-related disclosures.

To further encourage end-user demand and enhance the value of low-carbon materials, various industries are establishing labeling standards for lower-emissions products similar to the voluntary standards for organic agricultural products. For example, the steel industry has established ResponsibleSteel, an initiative to develop an internationally recognized certification for sustainable steel.[183]

Driving innovation in new low-carbon technologies

Setting industry and heavy-duty transport on a pathway to net-zero emissions will also require developing technologies that are not yet commercially proven. While some pure R&D is needed, activities that help bridge the gaps between demonstration and commercialization will be critical. One initiative seeking to enhance private support of early-stage technologies is the Breakthrough Energy Coalition.[184] This group of individual private investors, financial institutions, and corporations has committed to funding

175 World Bank, Pilot Auction Facility.

176 Australian Government Department of the Environment and Energy, "About the Climate Solutions Fund – Emissions Reduction Fund."

177 Transportation Research Board and National Research Council, "Effectiveness and Impact of Corporate Average Fuel Economy (CAFE) Standards," *National Academy Press,* Washington, D.C., 2002.

178 Nielsen, "Consumer-Goods Brands That Demonstrate Commitment to Sustainability Outperform Those That Don't," [Press release], 12 October 2015.

179 Apple, "Apple Paves the Way for Breakthrough Carbon-Free Aluminum Smelting Method," [Press release] 10 May 2018.

180 McKinsey & Company, "Starting at the Source: Sustainability in Supply Chains," November 2016.

181 Energy Transitions Commission, "Mission Possible: Reaching Net-Zero Carbon Emissions From Harder-to-Abate Sectors by Mid-Century," 2018.

182 HSBC, "HSBC and Walmart Partner to Drive Sustainability of Business," 18 Apr 2019.

183 ResponsibleSteel, "Who We Are."

184 Breakthrough Energy Coalition, "Our Commitment."

Upstream and downstream support for innovation

The deployment of more complex technologies will require coordinated approaches among R&D efforts, policies that support deployment of new technologies, and private finance. Combining upstream support with strong deployment incentives helps create the conditions for innovation and cost reductions through iterative design improvements, learning by doing, and economies of scale. In China, the government is working to replicate its successful incubation of the battery storage industry in the hydrogen fuel cell industry. In addition to ongoing R&D efforts in both public and private institutions, China is planning to subsidize the large-scale deployment of hydrogen cars and invest in hydrogen refueling infrastructure.[185] In response to coordinated government support, vehicle manufacturers, gas suppliers, and other private-sector institutions have also begun to target the sector with announced investments totaling more than $17 billion as of June 2019.[186]

innovative ideas and companies that emerge from Mission Innovation — an initiative of 24 major countries and the European Commission to double clean energy R&D investments.[187] The Breakthrough Energy Coalition identified a shortlist of key technologies with breakthrough potential, including hydrogen and advanced manufacturing technologies for industry, as well as carbon capture, utilization and storage, and solar fuels.[188]

Risk sharing between public and private institutions in specific sectors can also help bridge the gap between demonstration and commercialization. In the HYBRIT partnership, steel producer SSAB, iron ore extractor LKAB, power company Vattenfall, and the Swedish government have joined forces to create a fossil-fuel-free steel plant that replaces coking coal with hydrogen.[189] The entities behind HYBRIT expect that low-carbon steel will eventually become cost-competitive with conventional steel because of a continued drop in energy prices and increasing carbon prices in the EU ETS.

Improving access to finance in the agricultural sector

Unlike heavy industry and heavy-duty transport, solutions for reducing emissions in the agricultural sector are well established yet face several structural challenges to their implementation. First, agricultural emissions stem from a diverse array of activities, including livestock management, fertilizer use, fuel consumption for agricultural machinery, and manure.[190] Agriculture also often contributes to emissions in the forestry sector, as expansion of farmlands can encroach on these natural carbon sinks. The extent to which each of these activities contributes to emissions varies by farm,

> *"Benchmarking energy use in agriculture would have many differences to the property sector, but that system drove significant change and improved emissions. We want to see something similar come to farming."*
>
> Rory Lonergan, Executive Director, Clean Energy Finance Corporation, February 2018

185 Bloomberg Opinion, "China's Hydrogen Economy Is Coming," 23 March 2019.
186 Bloomberg News, "China's Hydrogen Vehicle Dream Chased With $17 Billion of Funding," 27 June 2019.
187 Mission Innovation, Overview.
188 Breakthrough Energy, "Advancing the Landscape of Clean Energy Innovation," February 2019.
189 SSAB, LKAB, Vattenfall "SSAB, LKAB and Vattenfall to Build a Globally-Unique Pilot Plant for Fossil-Free Steel," [Press release], 1 February 2018.
190 World Resources Institute (WRI), "Everything You Need to Know About Agricultural Emissions," 29 May 2014.

and there is no one-size-fits all solution. As a result, there is often a lack of data and knowledge among farmers and investors regarding the potential solutions for reducing climate impact. Second, many activities are small in scale, making them difficult to access for larger investors. Finally, although some low-carbon solutions may be profitable, many farmers lack access to working and investment capital to implement these low-carbon solutions. Investors may view agriculture as yielding lower margins while carrying higher risks compared with investments in other sectors. Particularly in emerging markets, many smallholder farms are highly distributed — often facing high transaction costs to obtain financing — and cannot provide collateral for loans even where local financing may be available.[191]

Various lending platforms and financial products, often through public-private partnerships, have emerged to address these challenges. For example, the Tropical Landscape Financing Facility (TLFF), a partnership among UN Environment, BNP Paribas, and ADM Capital, aims to scale up financing for small shareholder farms in Indonesia.[192] BNP Paribas structures loans, which can be backed by a partial guarantee from a public finance institution, into bonds in order to unlock commercially priced long-term financing for small rural projects. In its inaugural transaction in 2018, TLFF issued a $95 million bond to support sustainable rubber production.[193] Structuring agriculture investments into bonds can help overcome challenges related to transaction size and lack of information, as green bond standards help establish criteria for defining which projects contribute to addressing climate change.

> *"Millions of farmers, companies, consumers, and every government on the planet will have to make changes to meet the global food challenge. At every level, the food system must be linked to climate strategies as well as ecosystem protections and economic prosperity."*
>
> Andrew Steer, President & CEO, World Resource Institute, July 2019

191 World Bank Group, "Making Climate Finance Work in Agriculture," Washington, DC, 2016.
192 Tropical Landscapes Finance Facility (TLFF), "Leveraging Private Finance for Public Good."
193 TLFF, "Project: PT Royal Lestari Utama," 26 Feb 2019.

Key solutions summary: Policymakers must lay the groundwork before private investment is feasible

PRIVATE FINANCE

Key solution: Foster transparency and collaboration across the supply chain to accelerate uptake of low-carbon alternatives

The private sector can continue to forge partnerships to increase transparency around low-carbon solutions — and their value — in the supply chains of commoditized industries. For example, corporations can collaborate to develop industry-wide standards for low-carbon products, helping to lay the foundation for greater demand for these goods. The private sector can also work to develop benchmarks for low-carbon practices, facilitating the flow of financing to low-carbon business models in sectors where information on sustainability measures and their potential benefits is often not available.

Finally, corporations and consumers, through their purchasing power, can drive demand for low-carbon materials or products, creating an incentive for suppliers to invest in emissions reduction measures.

Barriers to scaling solutions

Although consumer demand for low-carbon products is increasing, this remains niche and insufficient to drive investments at scale. Further, partnerships across supply chains can be difficult as certain industries are highly fragmented.

Developing standards and benchmarks to unlock investment in agriculture

Macquarie has recently partnered with the Clean Energy Finance Corporation (CEFC), Australia's national green bank, and the Commonwealth Scientific and Industrial Research Organization (CSIRO), a leading scientific institution, to create the Energy, Emissions and Efficiency Advisory Committee (3EAC).[194] This first of its kind initiative was created to support innovation and sustainable farm management practices across the agricultural sector in Australia. The 3EAC aims to promote actions that reduce the energy and emissions intensity of agriculture, ultimately supporting increased productivity. A key objective of the 3EAC is to develop benchmarks for these activities consistent with 2°C temperature trajectories, increasing data and transparency around sustainable farming practices.[195]

This tripartite arrangement combines the regulatory and public interest roles of the government, the scientific expertise of the CSIRO, and the operational understanding of Macquarie as Australia's largest agricultural investment manager. This partnership was catalyzed by CEFC's equity investment in Macquarie's latest carbon reduction–focused agricultural fund. The fund aims to not only influence emissions directly through its on-farm work but also to demonstrate that low-emissions and climate-adapted farming can be conducted without compromising objectives and returns.

[194] CEFC, "CEFC in Finance First to Target Energy Efficiency and Sustainability in Australian Farming Sector," [Press release], 21 February 2018.
[195] Ibid.

Underwriting the first green bonds for protected agriculture

While the issuance of green bonds has grown rapidly overall, green bonds for agriculture and forestry have lagged behind at only 10% of the total green bond market, primarily due to the few methodologies that define "green" agriculture and other land-use investments.[196] To expand financing opportunities, the Climate Bonds Initiative, in partnership with the Inter-American Development Bank, developed criteria for protected agriculture in Mexico under the Climate Bonds Standard.[197,198]

As a result, in 2018, Mexico's Trust Funds for Rural Development, a development finance institution that supports agriculture, became the first institution to issue a green bond for protected agriculture.[199] HSBC, which was the third-largest underwriter of green bonds in 2018, served as joint underwriter, in a total deal that comprised three floating rate–note tranches, including a three-year green-labeled bond for 2.5 billion Mexican pesos (approximately $132 million).[200,201] Overall, this project was successful due to the partnership between several entities across the private and public sectors, including a DFI, a national development bank, and a commercial bank, as well as standards that helped drive transparency and attract underwriters.

196 Climate Bonds Initiative, "Bonds and Climate Change: The State of The Market 2018," 2018.

197 The use of proceeds of bonds for protected agriculture include the establishment, acquisition, expansion, or ongoing management of protected agriculture facilities including greenhouses, shade houses, systems for isolation, precision fertilizers, as well as air and light control systems, precision plant nutrition systems, and insect protection. (Climate Bonds Initiative, "Protected Agriculture in Mexico.")

198 Climate Bonds Initiative, "Protected Agriculture Bonds: Mexico — Criteria document," May 2019.

199 Fideicomisos Instituidos en Relación con la Agricultura (FIRA), Interamerican Development Bank (IDB), CBI, "FIRA Receives First Climate Bonds Certification to issue Green Bonds for Protected Agriculture Projects in Mexico," [Press release], 21 May 2019.

200 Climate Bonds Initiative, Green Bonds Underwriters League Table, 2018.

201 Climate Bonds Initiative, Green Bond Fact Sheet: FIRA.

PUBLIC FINANCE

Key solution: Support R&D and deployment of new technologies using public budgets

Public funding can be essential to the development of new technologies whose long R&D life cycles are difficult to support on corporate timescales. Public budgets can also support the commercialization of technologies through subsidy mechanisms and risk-sharing models like loan guarantees.

Barriers to scaling solutions

Public funding is limited, and the pathway from government support to full commercial viability can be difficult to navigate. The use of taxpayer funds to support higher-risk, early-stage technologies with significant climate mitigation potential has occasionally led to controversy and public opposition.

Climate auctions: Supporting emissions reductions in the face of uncertain carbon prices

The World Bank's PAF is a public finance instrument that provides revenues for low-carbon projects in the waste and nitric acid production sectors.[202] The PAF was implemented alongside the Clean Development Mechanism (CDM), an international market for carbon offsets. The PAF demonstrated an efficient, market-based method of allocating grant-based subsidies at a time when carbon prices had largely collapsed under the CDM. These climate auctions competitively awarded low-carbon projects a "put option," giving successful project developers the right, but not the obligation, to sell their emissions reductions to the PAF at a strike price discovered in the auction.

A key success factor of the PAF was that it offered a guaranteed floor price per ton of GHG reduced, which provided investors greater revenue certainty at a time of low and uncertain carbon prices. At the same time, the use of competitive auctions helped ensure that public finance was allocated cost-efficiently, as only the most cost-competitive bidders received price guarantees through the PAF.

The PAF ran three auctions between July 2015 and January 2017. Over these rounds, it allocated up to $54 million, with the potential to abate 20.6 million tons of CO_2 and, therefore, an implied subsidy of under $2.50 per ton CO_2.[203,204] This model is currently being replicated by Germany to support investments to reduce emissions from nitric acid plants in emerging economies.[205] More broadly, the auctioned carbon price floor holds promise as an efficient and transparent means to allocate some of the $11 to $13 billion in annual grant-based support provided by developed countries for climate action in the developing world.[206]

202 Pilot Auction Facility (PAF), "About the PAF."
203 World Bank, "World Bank Pilot Auction Facility Mobilizes Private Capital for Climate Action," [Press release], 18 December 2018.
204 Pilot Auction Facility (PAF),"About the PAF."
205 Nitric Acid Climate Action Group, "Financial Support."
206 Oxfam International, "Climate Finance Shadow Report 2018," May 2018.

PUBLIC POLICY

Key solution: Craft policies and regulations designed to bring new technologies to market

The broad application of stable, long-range carbon pricing schemes across major economies could level the playing field for trade-exposed, high-carbon industries such as steel and cement and spur more long-term investment in alternative industrial production processes. Phasing out policies like fossil fuel subsidies would also contribute to making certain efficiency investments attractive. In addition, public procurement, incentive schemes, and product standards can support the development of markets for low-carbon products.

Barriers to scaling solutions

Given the global nature of many industries, there may be opposition to local regulation or carbon pricing that impacts a corporation's global competitiveness. Cross-regional or international carbon pricing schemes can require large and costly governance structures. The adverse effect of carbon prices on consumers can also make their introduction less attractive to governments.

The United Nations' REDD+ program offers growing opportunities for private-sector investment

The Reducing Emissions from Deforestation and Forest Degradation in Developing Countries (REDD+) incentivizes developing countries to conserve and enhance forest carbon stocks, decrease deforestation and degradation, and sustainably manage forests.[207] REDD+ creates a financial value for the carbon stored in forests, providing results-based payments to countries for actions that reduce forest carbon emissions. These payments can come from higher-income countries interested in funding climate action in developing nations or from private investors looking to offset their own emissions.[208] The UN plays a central role in REDD+ by supporting developing countries in designing effective REDD+ projects and systems to estimate and monitor emissions reductions — two critical elements in creating international investor confidence in the program.

Public finance awarded through bilateral agreements and multilateral funds has accounted for almost 90% of investment in REDD+ projects; however, the private sector is becoming an increasingly important source of funding.[209] Between 2009 and 2014, private investors contributed $36 million to the development of REDD+ country strategies and $381 million to carbon offset projects.[210]

In 2013, Allianz invested in Rimba Raya, the largest REDD+ project in the world.[211] The investment helps support the conservation of a nearly 65,000-hectare natural reserve in Indonesia that avoids more than 130 million tons of emissions.[212] Quality and verifiability of the emissions reporting are key success factors of Rimba Raya, allowing Allianz and other Rimba Raya investors such as Microsoft to credibly use the carbon credits to meet their carbon neutrality goals. Rimba Raya was the first REDD+ project validated under the Verified Carbon Standard and the first to obtain a Triple Gold Climate, Community and Biodiversity Standards rating.[213]

207 REDD+ Web Platform, "Warsaw Framework for REDD+."
208 UN-REDD Programme,"About REDD+," 2019.
209 Center for Global Development, "The State of REDD+ Finance," Working Paper 387, September 2014, updated May 2015.
210 Environmental Defense Fund, "Mapping Forest Finance," 2018.
211 Allianz, "Allianz Steps Up Investment in Climate Protection," [Press release], 20 August 2013.
212 Rimba Raya, "What Is Rimba Raya?"
213 Ibid.

4 Challenge: The transition away from carbon-intensive business models may create financial and social risk

Many assets in the real economy are long-lived, ranging from around 15 years for cars and buses to 50 years for fossil fuel power plants to 100 years or more for buildings (see box on page 70). As a result, the financing and investment decisions of the past can lock in carbon emissions well into the future. "Committed" emissions from existing fossil fuel–based assets in the power, industrial, and transport sectors are already incompatible with a 1.5°C trajectory.[214]

The transition to a low-carbon economy will need to address the fate of these existing carbon-intensive industries and assets. The importance of engineering a just transition for workers and affected communities is now broadly understood. Curtailing the economic lifetimes of power plants, factories, and vehicles also poses the possibility of financial losses for those who invested equity or debt on the assumption of long-term operating revenues. More broadly, the corporations that manufacture, own, and operate these assets often have long-standing business models reliant on carbon-intensive industries and equipment.

The financial sector can play an important role in facilitating the transformation of carbon-intensive sectors by offering financing solutions to businesses as they undertake the low-carbon transition. The public sector can facilitate an orderly transition by supporting affected communities and by creating clear policy frameworks to allow the private sector to plan for the phase out of the most carbon-intensive assets.

Managing the retirement of coal-fired power plants

Breaking carbon lock-in will require some carbon-intensive assets to be retired early while transforming the corporations, utilities, and enterprises whose business models are based on their operation. However, as early retirement reduces the returns anticipated at the time of initial investment and creates additional costs of decommissioning, losses in financial value could follow.

> *"As active investors, we wanted to offer an equity product that not only allows investors to tackle climate risks but also to benefit the investment opportunities represented by the energy transition helping to contribute to a 'just transition' that is also mindful of its social dimensions."*
>
> Isabel Reuss, Global Head of Socially Responsible Investment Research, Allianz Global Investors, February 2019

[214] D. Tong et al., "Committed Emissions From Existing Energy Infrastructure Jeopardize 1.5°C Climate Target," *Nature*, 2019; This study assumes that assets would operate according to historical average lifetimes.

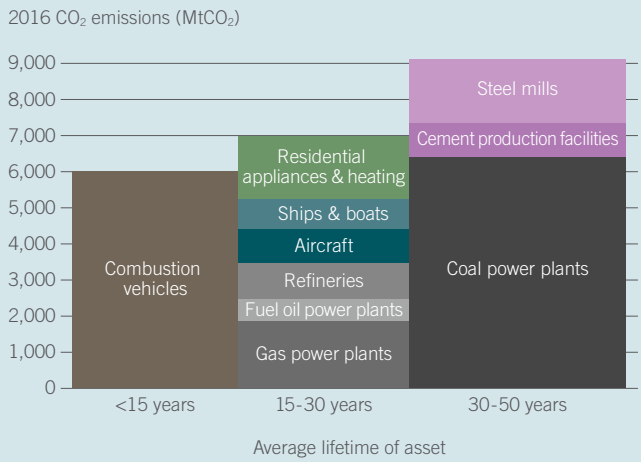
The challenge of managing early retirement is already a reality for coal-fired power plants, which are among the longest-lived and most carbon-intensive assets. In places such as the U.S. and Europe, economic forces are leading to reductions in coal-fired power generation — many of which are older, less efficient facilities — due to lower natural gas and renewable energy costs, and the advent of battery storage. U.S. power providers shuttered coal plants at a record rate in 2018; electricity generated from coal fell by 36% between 2008 and 2017.[215,216] Coal use for energy in the EU also fell by 36% over the same period.[217]

The market-driven reduction in coal generation alone is unlikely to achieve the pace of phase-out needed. Unabated coal-fired power generation (i.e., generation without CCS) would need to be phased out entirely by 2050 to achieve the goals of the Paris Agreement and require the retirement of about 1,200GW of existing coal-fired capacity before the end of its economic lifetime.[220] A large share of these retirements would be in high-income countries and newly industrialized countries — particularly China, which operates the largest number of coal-fired power plants today. To speed up the coal transition, some countries have implemented coal phase-out policies, which can help create certainty for corporations and investors to proactively plan for the transition away from coal. However, phase-out policies have been developed only for a small share of the existing global coal fleet (FIGURE 27).

The carbon lock-in of long-lived assets

The long lifetime of assets in the real economy — such as power plants, steel mills, vehicles, and buildings — and the carbon intensity of those assets together contribute to carbon lock-in. FIGURE 26 illustrates the average lifetime of assets and the quantity of annualized GHG they contribute to the atmosphere.[218] Carbon lock-in is also promoted by the desire to preserve jobs associated with sectors like coal mining and fossil fuel transport. These broader societal and economic factors can drive political opposition to the phase-out of carbon-intensive assets and the introduction of more cost-effective, low-carbon alternatives.[219]

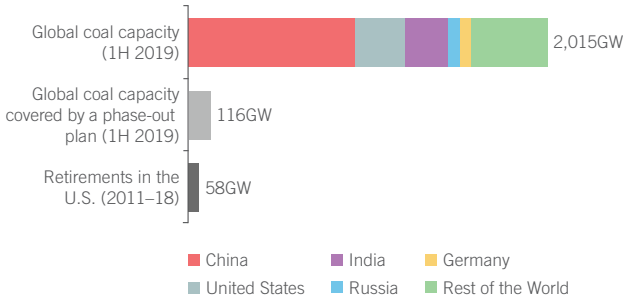
FIGURE 26:
CO_2 emissions and typical lifetime of different assets



Source: Rocky Mountain Institute.

215 BNEF, "U.S. Coal Plan Retirements Near All-Time High," 8 November 2018.
216 BNEF, U.S. Country Profile.
217 Eurostat, "Supply, Transformation and Consumption of Solid Fossil Fuels."
218 P. Erickson, S. Kartha, M. Lazarus, and K. Tempest, "Assessing Carbon Lock-In," *Environmental Research Letters* 10, no. 8, 2015.
219 G. Unruh, "Understanding Carbon Lock-In," *Energy Policy 28*, no. 12, 2000.
220 Rocky Mountain Institute (RMI), "Managing the Coal Capital Transition: Collaborative Opportunities for Asset Owners, Policymakers, and Environmental Advocates," Basalt, CO, 2018.

FIGURE 27:
Global coal generation capacity by country, covered by phase-outs, and retired in the U.S.



Source: BNEF, Coalswarm.

Where phase-out plans exist, they usually encompass a range of elements, including regulatory action and support for a just transition for workers (see box below). For example, Germany's recent commitment to phase out coal power by 2038 is supported by a clear decommissioning roadmap, compensation payments to households that may face higher energy bills as a result of the phase-out, and €40 billion in public resources to invest in the regions that will be most affected by the policy.[221,222]

> *"The impact on total jobs of the energy transition is expected to be positive. However, there will be asymmetric effects across regions and sectors, and we need to be ready for that. The deep transformation of the economy needs to be managed well to avoid social and regional disparities, notably in areas that might face transition challenges in the short term."*
>
> Maroš Šefcovic, Vice-President of the European Commission for the Energy Union, June 2019

Coal phase-out and a just transition for labor

Although the benefits of the low-carbon transition will far outweigh the costs, the structural change implied in this transition will need to be proactively managed to ensure these benefits are inclusive. As the global economy transitions away from high-carbon assets to low-carbon alternatives due to market forces or regulatory interventions, workers and communities that rely on these assets must be supported, in what has been coined a "just transition." To provide guidance on implementing an equitable transition, the International Labour Organization has published a set of guidelines outlining principles for implementing a just transition to a sustainable and carbon-neutral economy. These guidelines cite social dialogue, social protection, rights at work, and employment as four key pillars of an inclusive transition.[223]

The just transition will require strong, coordinated action among governments, communities, investors, and businesses. Public policies that link climate, macroeconomic, industrial, and labor policies can help lay the foundation for inclusive growth, both through short-term programs that mitigate negative impacts on workers and communities (e.g., income support) and through longer-term industrial strategies or retraining programs. Investors, recognizing the long-term value of inclusive growth, can also integrate social factors into their investment strategies or how they engage with corporations.[224] All of these must be done in consultation and offer transparent dialogue with the communities undergoing a transition.

[221] Federal Ministry for Economic Affairs and Energy, Germany, "Commission on Growth, Structural Change and Unemployment: Final Report," January 2019.
[222] Financial Times, "Germany to Spend €40bn to Soften Blow From Coal Closures," 22 May 2019.
[223] International Labour Organization (ILO). "Guidelines for a Just Transition Towards Environmentally Sustainable Economies and Societies for All," 2015.
[224] N. Robins, V. Brunsting, and D. Wood, "Climate Change and the Just Transition: A Guide for Investor Action," Grantham Research Institute on Climate Change and the Environment, 2018.

Changes to public utility regulatory frameworks can also incentivize the early retirement of coal plants owned by generators that sell electricity at regulated prices. For example, regulated utilities can use rate-reduction bonds to refinance remaining debt on coal-fired power plants. The utilities can issue low interest rate bonds backed by securitized future cash flows from ratepayers to finance the decommissioning of coal assets. This approach, known as coal securitization, is currently gaining momentum in the U.S. in areas with a large legacy coal industry such as Colorado and Michigan.[225]

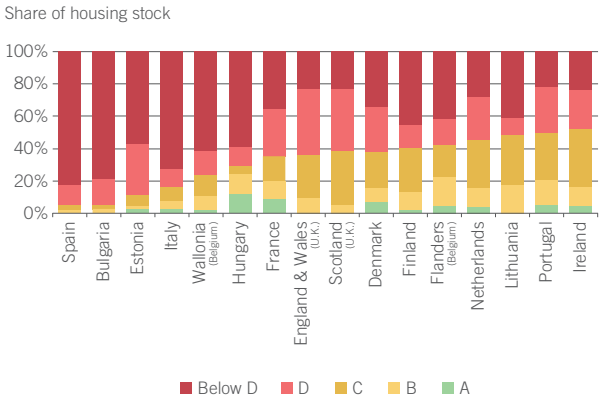
> *"Creative financing mechanisms that exist today can ensure that consumers pay lower rates as we move to renewables and help provide for a transition that is just and fair both for workers and for communities directly impacted."*
>
> Jared Polis, Governor, State of Colorado, speaking on coal transition, January 2019

Transforming utilities in highly regulated environments, for example where a single public organization has a monopoly in the power sector, often requires targets to be paired with adjustments to regulated tariffs or budget transfers to finance new investments. Selling ratepayer-backed bonds to investors can allow utilities to recover the value of their investment, while retiring certain assets and reducing the potential cost to ratepayers.[226]

Incentivizing building retrofits

Buildings are among the longest-lived assets in the real economy, and their energy consumption for heating, cooling, and electricity are significant sources of GHG emissions. While decarbonizing the electricity supply can help reduce some of these emissions, many heating systems directly burn fossil fuels such as natural gas, fuel oil, and propane. In addition, while efficiency standards for new buildings are now common, older units are often not subject to energy-efficiency regulation. In Europe, 80% of the buildings that will exist in 2050 already exist today, many of which have low energy-efficiency ratings (FIGURE 28).[227,228]

FIGURE 28:
Efficiency ratings of housing stock in Europe



Source: Building Performance Institute of Europe. Note: This figure shows energy efficiency ratings according to Energy Performing Certificate (EPC) class. The EPC label is an EU-wide standard that captures the energy efficiency of a home with regards to both heating and electricity consumption. EPC ratings are on a scale from A to G, with A being the most efficient. Calculation methods may vary among countries.

Deep building retrofits that combine the electrification of energy end-use with energy-efficiency improvements can help reduce emissions from the existing building stock. Zero-carbon heating is both feasible and commercially available through electrically powered heat pumps.[229] However, the practice of retrofitting old buildings with heat pumps is relatively uncommon due to high upfront costs, including the need to improve insulation to make heat pumps work efficiently.

[225] Renewable Energy World, "Power Plant Securitization: Coming to a State Capitol Near You," 28 May 2019.
[226] U. Varadarajan, D. Posner, and J. Fisher, "Harnessing Financial Tools to Transform the Electric Sector," Sierra Club, November 2018.
[227] European Commission, "The Commission Presents Strategy for a Climate Neutral Europe by 2050 — Questions and Answers," [Fact sheet], Brussels, 28 November 2018.
[228] Buildings Performance Institute Europe (BPIE), "97% of Buildings in the EU Need to Be Upgraded," 2018.
[229] Heat pumps extract heat from ambient air (air source) or from the ground (ground source); if the electricity they consume is emissions-free, then they produce no emissions.

> *"Transition bonds would allow the quality of the green bond market to avoid being diluted by issuances where the environmental benefit of projects being financed is less clear. The concept of the green bond has been proven, and it is here to stay, but that market is now at a crossroads."*
>
> Yo Takatsuki, Head of ESG Research and Active Ownership, AXA Investment Managers, June 2019

Further, such energy-efficiency investments may be challenging, as the benefits from savings in energy bills accrue to tenants, who may not own the building itself.

Governments have begun to roll out policies to incentivize retrofits, such as low- or zero-interest loan programs for retrofit investments and efficiency mandates for existing buildings.[230] For example, New York City passed legislation requiring landlords to retrofit buildings with new energy-efficient windows, heating and cooling systems, and insulation beginning in 2024.[231]

Private finance institutions have also begun to realize opportunities in building retrofits. Research has shown that mortgages on more efficient homes have lower default rates, and the market value of efficient homes often increases at higher than average rates.[232] Around 90 banks, industry associations, research centers, and other stakeholders from across Europe support the work of the Energy Efficient Mortgages Initiative, which promotes the use of low- or zero-interest loans to homeowners for energy-efficient building renovations.[233]

Supporting corporations in the low-carbon transition

Moving from individual assets to the corporate level, businesses that have been traditionally invested in emissions-intensive industries are starting to transition their activities in anticipation of a low-carbon future. Many electric utilities have already invested in a low-carbon transition, and several oil and gas companies have also begun to diversify. For example, clean energy projects and assets accounted for around 90% of Enel's €8.5 billion capital expenditure and €16.2 billion earnings before interest, tax, depreciation, and amortization in 2018, which saw a 3.8% rise compared with the prior year.[234] In the oil and gas industry, Royal Dutch Shell expects to invest $1 to $2 billion per year in its "new energy solutions," which include natural gas, wind, solar, hydrogen, biofuels, and nature-based solutions, and recently declared an ambition to double this to $4 billion per year.[235] The French multinational oil and gas company, Total, plans to increase investment in low-carbon technologies from around 3% of total capital expenditure to 20% of its asset base over the next 20 years.[236,237]

> *"By focusing on sustainability and innovation, as well as on the industrial and financial aspects of the business model, Enel can respond in a positive and flexible way to change, ultimately creating long-term shared value for all stakeholders."*
>
> Francesco Starace, CEO, Enel, September 2018

230 IEA, "Energy Efficiency Policies: Buildings."
231 New York City Councilmatic, "Introduction 1253-2018," 2018.
232 University of North Carolina Center for Community Capital, Institute for Market Transformation, "Home Energy Efficiency and Mortgage Risks," March 2013.
233 Energy Efficient Mortgages Initiative: Market Stakeholders.
234 Greentech Media, "Enel's clean energy strategy pays off with increase in earnings," 13 February 2019.
235 Royal Dutch Shell, "Energy Transition Report," April 2018.
236 *The Guardian*, "Shell says it wants to double green energy investment," 26 December 2018.
237 Total, "Integrating Climate Into Strategy," 25 September, 2018.

Key solutions summary: Public finance and policymakers can help manage orderly and just transitions

PRIVATE FINANCE

Key solution: Private-sector financial products can help industry execute a low-carbon transition

Building on the success of green and sustainable investments to date, investors and lenders can develop a wider range of financing to support companies that have adopted ambitious transition goals. Ultimately, this will create a virtuous cycle with more money invested in clean companies, which creates more appetite for this transition — lowering financing costs and ultimately leading to more investment.

Corporations and investors can also support the just transition of communities and workers by incorporating social criteria into their investment decisions, investing in retraining programs, and recognizing the long-term value of inclusive growth.

Barriers to scaling solutions

Early retirement of assets such as relatively new coal-fired power plants will inevitably lead to some loss of financial value — this prospect drives the political economy of opposition to climate policy. At the corporate level, fundamental changes may be required for those whose business models are built on fossil fuels. Such transformation is inherently challenging, and corporations will need to develop in-house expertise and institutional agility to successfully transition in competitive markets.

Investing in corporate transitions

Some corporations are able to invest profits from existing carbon-intensive activities to fund their low-carbon transition, but for others, support from the financial sector can be critical. Ørsted (formerly DONG Energy) is a power utility that has significantly changed its business model over the last five years, transitioning out of its fossil fuel generation business to become the world leader in offshore wind. As a consequence, the company's market capitalization doubled between June 2016 and June 2019. Private-sector capital played a key role in Ørsted's transformative journey into becoming a clean energy company. The Goldman Sachs Merchant Banking Division made an investment alongside other banks when the government conducted a public auction process for investors and helped provide capital for the company to scale and transition to other geographies.[238] Ørsted tapped into a range of private-sector financings (including equity markets through an initial public offering and two green bonds). The Danish government has continued to retain majority ownership and, alongside private capital, has helped the utility expand its footprint to become one of the largest wind energy developers globally.

[238] Ørsted, "Goldman Sachs, ATP and PFA to Invest DKK 11 Billion in DONG Energy A/S — Final Agreement Expected to Be Concluded Before the End of 2013," [Press release], 2 October 2013.

Transition and sustainability bonds

As green bonds may not be accessible for companies in carbon-intensive sectors such as oil and gas or heavy industry, transition bonds offer the opportunity to use proceeds for a wider range of activities. Such activities could include alternative fuels for aircrafts, co-generation, or energy-efficiency improvements in industry. In 2019, Snam, an Italian natural gas company, issued what it called a "Climate Action Bond." This transition bond will be used to finance biomethane, energy efficiency, and investments to reduce the environmental impact of Snam's activities.[239]

In addition, rather than use of proceeds bonds, sustainability-linked corporate bonds can help mobilize more mainstream corporate finance for longer-term transition strategies. Enel has established a global platform for Sustainable Development Goal (SDG) corporate bonds, which are bonds linked to key sustainability goals of the long-term strategy of the company.[240] Such bonds would differ from those bonds (such as green bonds) that narrowly focus on use of proceeds. They would include in their terms a coupon step-up to incentivize Enel to meet its renewable energy deployment goals and its target to exit coal power generation by a certain date.

Supporting the transition of fossil fuel assets and workers

Enel has adopted an ambitious transition strategy that aims for carbon neutrality by 2050 and that achieves transformative changes in its 86GW generation fleet and in its almost 70,000-person workforce.

An innovative component of its transition, Enel's "Futur-e" project aims to find new purposes for 23 decommissioned thermal power plants and an unused mining site distributed across Italy.[241] Enel organizes tenders to identify conversion projects for the various sites, creating new development opportunities in these areas. Project selection focuses on financial viability — the projects must be self-sustaining — circular economy, innovation, and the fit with the needs of the local community. A jury brings together academics, local stakeholders from government, business and civil society, and representatives from Enel to select winning projects.[242]

Complementing Enel's efforts on repurposing fossil fuel assets are its programs to help its staff navigate the transition. The utility's human resource strategy recognizes that the changes in the energy sector call for new professional profiles and skills, as well as an important cultural and organizational change. A change management and digital skills program is aiming to reach 100% of Enel's employees by 2020.[243]

239 Snam, "Snam: Successfully Launched the First Climate Action Bond in Europe," [Press release], 21 February 2019.
240 Enel, Bond disclaimer.
241 Enel, "Futur-e Project Description," 2019.
242 Enel, "Economica Circolare e Sostenibilità," 2019.
243 Enel, "2018–2020 Sustainability Plan."

PUBLIC FINANCE

Key solution: Public finance can support the just transition of communities

In the near term, public budgets can provide direct support to households and workers affected by the transition while also investing in longer-term industrial strategies and retraining programs.

Barriers to scaling solutions

Public finance is inherently limited, and opinions vary as to whether and how taxpayer funds should be used to fund redistribution mechanisms and compensation for industrial transitions.

EU member states mobilize carbon market revenues for the transition

The EU ETS is the largest emissions-trading scheme in the world, covering approximately 11,000 power plants and manufacturing facilities across the EU, Iceland, Lichtenstein, and Norway.[244] Under EU ETS rules, all participating countries are required to use at least half of the revenue raised from selling emissions allowances to finance further climate action. The European Commission estimated that member states generated €11.8 billion in revenue between 2013 and 2015, 67% of which went toward funding climate and energy policy measures in the EU and 8% to support international efforts such as the Green Climate Fund.[245] The majority of the funds were used to support work in clean energy (40.6%), energy efficiency (27.4%), and clean transport (10.9%).

The 2015 reform of the EU ETS directly addressed the challenge of a just transition. Under the new rules, a new Modernisation Fund financed from the auctioning of EU ETS allowances was created to support investments in regions whose economies depend on fossil fuels.[246] The fund will invest in the redeployment, re-skilling, and upskilling of workers; education; job-seeking initiatives; and clean energy, energy-efficiency, and storage projects. The fund is anticipated to begin operating in early 2021. The European Commission also created the Platform for Coal Regions in Transition that helps Europe's coal-dependent regions implement successful transition strategies and to better access the wide but often complex range of EU funding available to them.[247] As of July 2019, the platform has supported 18 pilot regions across eight member states.

[244] European Commission, "Report on the Functioning of the European Carbon Market," 17 December 2018.
[245] European Commission, "Analysis of the Use of Auction Revenues by the Member States," 2017.
[246] European Commission, "Innovation and Modernisation Fund," 21 May 2019.
[247] European Commission, "Platform on Coal and Carbon-Intensive Regions — Terms of Reference," 2017.

PUBLIC POLICY

Key solution: Create the regulatory frameworks to enable a managed capital exit from high-emissions assets

Government policy can create the enabling frameworks and incentives for owners and operators of carbon-intensive assets to engineer a transition away from high-carbon assets. This can be done through regulating the closure of carbon-intensive assets and legislation or the introduction of standards applied to existing assets. Such measures can be designed to offer a path for investors to decommission or retrofit carbon-intensive assets and avoid uncertainty for owners and operators as facilities are retired.

Barriers to scaling solutions

A key challenge to these policies is political opposition from owners of carbon-intensive assets and affected communities.

Sweden's climate-neutrality goal drives industry leadership to strengthen competitiveness

In order to align domestic emissions with the temperature goals of the Paris Agreement, Sweden passed climate change legislation with the goal of becoming climate neutral by 2045. To ensure continued economic growth concurrent with steady emissions reductions, the government engaged the private sector to map out transition plans. A number of industries across Sweden, including cement, construction, aviation, and shipping, produced detailed road maps describing when and how they will become fossil fuel free.[248] These road maps outlined the technological solutions and investments needed and the key obstacles the Swedish government can resolve to support this transition, outlining side-by-side industry commitments and public policy requests. For example, the construction industry identified a series of government actions that would create the conditions for its transformation through financing, risk-sharing, support for innovation, and public procurement. The heavy-duty transport sector identified improvements in EU-level climate policies, public investment in biofuels, and a fuel tax as strategies to facilitate the greening of road transport.[249]

[248] Fossil Free Sweden, "Roadmap for Fossil Free Competitiveness: A Summary of Roadmaps From Swedish Business Sectors," 2018.
[249] Ibid.

5 Challenge: A lack of tools and incentives to align financial portfolios with a low-carbon future

A core objective of the 2015 Paris Agreement is "making finance flows consistent with a pathway towards low greenhouse gas emissions and climate-resilient development."[250] Indeed, achieving net-zero emissions by mid-century in the real economy will also require a transition within the financial sector to more systematically account for climate change considerations in lending and investment decisions. Several initiatives have begun to explore the analytic and practical implications of "Paris alignment" or "climate alignment" for the evolution of loan books and investment portfolios of private financial institutions.

Institutions striving to steer their portfolios into alignment with well-below 2°C pathways face considerable challenges, beginning with significant data gaps in assessing climate-related risks and opportunities in their portfolio projects and companies. Where decision-useful data is available, it can be difficult to integrate and standardize such information across risk management, strategy, and client engagement functions. Second, while several methodological approaches to portfolio alignment are under development within the financial sector, these can be challenging to navigate. Also, these methodologies do not always resolve fundamental questions such as how to attribute emissions in financial portfolios or how to set emissions reduction pathways for sectors. Third, underlying these barriers are systemic challenges such as a focus on short-term financial incentives, the practical challenges of rebalancing portfolios given a limited universe of low-carbon investment opportunities, and the reality that capital reallocation away from high-carbon holdings may just result in a shuffling of assets between portfolios — rather than driving emissions reductions in the real economy.

Despite these challenges, financial institutions are increasingly interested in exploring opportunities for climate alignment and a rich network of initiatives, methodologies, and frameworks are quickly emerging. While these initiatives lay the groundwork for significant progress in overcoming existing barriers to climate alignment, they are often applied to only one sector or kind of financial institution. To encourage a holistic approach that considers the integrated investment chain, financial institutions can collaborate to develop a consistent framework for climate alignment in support of the low-carbon transition.

> *"Recent progress in disclosure, risk management, and return optimization is creating a path to a New Horizon. A virtuous circle is becoming possible where companies disclose more information, investors make better informed decisions, and sustainable investment goes mainstream."*
>
> Mark Carney, Governor, Bank of England, March 2019

[250] UNFCCC, "The Paris Agreement," 2015.

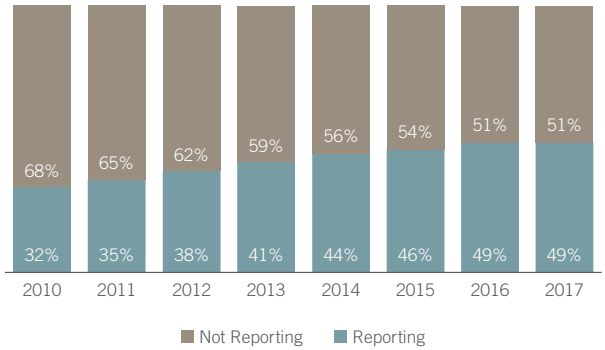
Overcoming data challenges

Private-sector institutions have often cited a lack of adequate decision-useful information on both climate alignment metrics and potential material climate-related information. Without widespread availability of such information, financial decision-makers cannot assess climate-related impacts for a single sector or asset class, let alone across an entire portfolio.

Increasing availability of climate-related data

Climate-related reporting is not yet mainstream across all industries and regions.[251] Even the most mainstream metrics, such as GHG emissions, are not universally disclosed by corporations in the real economy. The share of MSCI world index companies — collectively around 60% of world market capitalization — that disclose their GHG emissions has stalled at around 50% in recent years (FIGURE 29).

FIGURE 29:
MSCI World's constituent companies reporting GHG emissions



Source: Bloomberg Terminal. Note: Using MSCI World composition as of 2Q 2019.

[251] TCFD, "Task Force on Climate-related Financial Disclosures: Status Report," June 2019.

However, several efforts to improve the availability and quality of climate-related information are under way, notably through the efforts of the TCFD (see box below). The recommendations of the TCFD are increasingly recognized as the standard for effective voluntary disclosure of climate-related information and have broad support from financial institutions and across the private and public sectors. TCFD also bridges the financial and corporate sectors, and its recommendations are increasingly adopted by corporations as varied as electric utilities and chemical producers.[252,253,254] Investors need climate-related financial disclosures to evaluate a corporation's commitment to managing climate-related risks and capitalizing on opportunities — and to allow them to factor those commitments into their portfolio management strategies.

The TCFD and mainstreaming climate-related disclosure

Spearheaded by Bank of England Governor and former Financial Stability Board Chair Mark Carney and chaired by Michael Bloomberg, the TCFD was the first private-sector-led initiative working to develop consistent climate-related financial disclosures to inform investing, lending, and underwriting decisions. The task force developed four widely adoptable recommendations on climate-related financial disclosures that are applicable to public companies and financial institutions across sectors and jurisdictions.[255]

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

As of September 2019, more than 830 organizations have expressed their support for the TCFD including more than 370 financial firms responsible for assets of over $118 trillion.[256] Other organizations include corporations, trade associations, stock exchanges, central banks, regulators, and national governments.

[252] World Business Council on Sustainable Development (WBCSD), "Disclosure In a Time of Transition: Climate-related Financial Disclosure and the Opportunity for the Electric Utilities Sector," 16 July 2019.
[253] WBCSD, "Climate-related Financial Disclosure By Chemical Sector Companies: Implementing the TCFD Recommendations," 16 July 2019.
[254] See also Enel, "Annual Report," 2018.
[255] TCFD, "Final Report: Recommendations of the Task Force on Climate-related Financial Disclosures," June 2017.
[256] TCFD, "Task Force on Climate-related Financial Disclosures: Status Report," June 2019.

Synthesizing and interpreting climate-related data

Specialists such as Carbon Delta, One Concern, and Jupiter Intelligence, among others, have developed tools to help financial institutions measure and interpret disclosed physical and transition risks. However, many of these tools are still evolving and often lack standardization across metrics, scenarios, and scope.[257] The TCFD has also provided recommendations for conducting scenario analyses, which help organizations understand the potential impacts of climate change on their businesses, strategies, and financial performance, allowing them to better plan for and improve their resilience to climate risks.[258]

Credit rating agencies also play a role in encouraging the consideration of climate-related risks and opportunities throughout the financial system. The threats to supply chains, infrastructure, and organizations' profitability from climate change are increasingly considered relevant to a borrower's creditworthiness. For instance, following California's deadliest and most destructive wildfire, sparked by electrical transmission lines owned and operated by Pacific Gas and Electric, Moody's Investors Service downgraded the utility's credit rating to Baa3 from Baa2 — the second-lowest level of investment grade.[259] Subsequently, S&P Global Ratings downgraded California's top three investor-owned power utilities, stating that without sufficient regulatory protections, these companies "will continue to experience catastrophic wildfires because of climate change."[260]

Although credit ratings could serve as a powerful tool, climate-related risks and opportunities are not yet fully or transparently integrated into mainstream credit rating methodologies. Several rating agencies offer separate ESG ratings for companies and sovereigns, or separate frameworks, such as a recent proposal from Moody's to assess climate-related transition risk. Incorporating material climate-related information into mainstream rating methodologies would result in the consideration of climate risk, to some extent, in every financial decision made using credit ratings.

> *"We want to be more transparent to the market about how we assess carbon transition risk. We've had feedback from the market that investors want to be able to differentiate between companies and their peers."*
>
> James Leaton, VP, Senior Credit Officer, Climate Risk, Moody's, May 2019

Designing climate alignment methodologies for financial portfolios

Beyond the available quantity and quality of climate-related data, financial institutions face methodological barriers to aligning their portfolios with a below 2°C trajectory. These barriers include differing approaches to portfolio alignment, challenges to establishing emissions attribution, and uncertainties in using technological transition pathways to evaluate future emissions reduction potential.

Appropriate alignment metrics are critical for steering reductions in portfolio emissions. Metrics commonly used for assessing alignment fall into two categories: (1) backward-looking emissions benchmarks associated with investment portfolios or loan books, and (2) forward-looking benchmarks that evaluate potential strategies for reducing investors' portfolio emissions and the associated transition risk.

257 United Nations Environment Programme Finance Initiative, "Changing Course," May 2019.
258 TCFD, "Technical Supplement: The Use of Scenario Analysis in Disclosure of Climate-related Risks and Opportunities," June 2017.
259 Bloomberg News, "PG&E Credit Cut to Brink of Junk by Moody's on Wildfire Risk," 15 November 2018.
260 S&P Global, "S&P Downgrades SDG&E, SoCalEd, Edison International on Wildfire, Climate Risk," 22 January 2019.

Backward-looking approaches to assess alignment and reduce portfolio emissions, such as carbon footprinting, have the advantage of relying on historical data rather than projections. Bloomberg's Decarbonization Tracker, for example, uses this approach to measure reductions in emissions intensity of the world's largest power utilities.[261]

Conversely, several financial institutions use forward-looking analyses to understand portfolio alignment since this approach is based on emissions-reduction opportunities and can reward organizations based on their strategies for the low-carbon transition. For example, Goldman Sachs has worked with the San Francisco Employees' Retirement System to design a framework to assess how oil and gas reserve owners are positioned for climate risk and is exploring opportunities to apply this forward-looking approach to other sectors and industries. The Transition Pathway Initiative, led by asset owners and supported by asset managers, aims to improve forward-looking analysis by creating tools that assess a corporation's preparedness for the low-carbon transition.[262]

Attributing emissions

In conducting a carbon footprint analysis of a portfolio or loan book, financial institutions can face challenges in attributing emissions as falling within or outside their portfolios. For example, no standard methodology currently exists for dividing a corporation's emissions between shareholders and bondholders, which can lead to double counting of emissions.[263] For unlisted asset classes, such as private equity, the tools for evaluating portfolio alignment are even less developed. Private equity firms collect differing levels of environmental data and typically make that information available only to existing investors or to prospective investors who have requested it. This challenge can, therefore, make it difficult for an asset owner to evaluate different private equity funds based on their environmental performance in relation to both operational impact and business strategy.

Determining sectoral transition pathways

Institutions that adopt forward-looking alignment methodologies must rely on assumptions about rates of technological development and the allocation of emissions-reduction efforts across sectors and geographies. This task is technically complex and inherently uncertain given the many ways to legitimately solve for a well-below 2°C trajectory given assumptions about different rates of decarbonization in, for example, power generation versus transportation or emerging versus developed markets. Some financial institutions have adopted the International Energy Agency (IEA) future emissions scenarios as a standard. However, IEA scenarios are not fully applicable to industries outside of the energy sector, and their assumptions are not currently public. Other entities are developing their own open source methods for aligning portfolios with a low-carbon transition. These include an initiative for commercial banks, led by the Dutch bank ING in partnership with the 2° Investing Initiative, and one for asset owners, led by the Institutional Investors Group on Climate Change (IIGCC).[264,265]

Furthermore, forward-looking benchmarking approaches rely on access to corporations' business and decarbonization plans as a way to evaluate their use of technological transition pathways. At present, gaining access to decision-useful information comes at a high transaction cost.

[261] Bloomberg Philanthropies, "Michael Bloomberg Calls for Leadership From Utility Sector in Global Decarbonization Efforts," 25 March 2019.
[262] London School of Economics, Transition Pathway Initiative.
[263] Principles for Responsible Investment, "How Measuring a Portfolio Carbon Footprint Can Help,"2015.
[264] ING, "ING's Terra Approach."
[265] Institutional Investors' Group on Climate Change, "European Investors Launch Project to Support Alignment of Portfolios to the Paris Agreement," [Press release], 2 May 2019.

Working toward portfolio alignment

Assuming methodological challenges can be adequately addressed, financial institutions also face practical challenges, including an inadequate supply of low-carbon investments with which to attempt to rebalance portfolios, a mismatch between the short-term incentive structures of the financial sector with the long-term implications of climate change, and questions about the effectiveness of capital reallocation strategies in driving down actual emissions.

> *"GPIF is convinced that ESG integration is critical in its fixed income portfolio. GPIF regards investment in green bonds as a direct method of ESG integration. Our aspiration is to make green bonds mainstream investment products, which would mobilise more capital to sustainable projects or support to make issuers' business portfolios become more sustainable."*
>
> Hiromichi Mizuno, Executive Managing Director and CIO, GPIF, September 2019

Expanding low-carbon investment opportunities

The large-scale realignment of existing global investment portfolios with global temperature goals faces limitations on the supply of available low-carbon investments with which portfolios can be rebalanced. Most of the economy and, therefore, corporations, equities, and other asset classes are still largely misaligned with a well-below 2°C trajectory. This creates an important practical constraint on the ability of financial institutions to transform their portfolios (see box below).

Addressing some of these challenges will require expanding the scope of current climate alignment initiatives. Many initiatives are focused on the goal of a fully aligned portfolio, rather than the means of supporting the global economy to transition to a well-below 2°C pathway. Instead of focusing on rebalancing portfolios, greater emphasis could be placed on key levers for transition.

One such lever could be the construction of transition indices. Existing low-carbon indices are primarily composed of "deep green" investment opportunities, such as shares of renewable energy companies. However, by narrowly defining "green," these indices neglect to account for corporations in high-carbon sectors that have adopted low-carbon strategies. Therefore, transition indices composed of these corporations — choosing those, for example, with the highest rates of improvement in their carbon intensity — would enable investors to more easily allocate capital to those preparing for the low-carbon economy.

Climate alignment is limited by broader macroeconomics

AXA, the French multinational insurance company, completed a thorough assessment of the "warming potential" of its portfolio, including corporate issuers (equity and debt), sovereign issuers, and real assets (direct property, commercial real estate loans, and infrastructure debt). The results of this analysis, summarized in its 2019 Climate Report, indicated that the portfolio's warming potential was not aligned with the temperature goals of the Paris Agreement. AXA concluded that while proactive investors can make some progress through capital reallocation, their ability to fully align their portfolios while maintaining other standards related to risk-return and diversification is limited without greater availability of investment opportunities in climate-aligned companies and assets.[266]

[266] AXA, "2019 Climate Report," July 2019.

Aligning decision-making with climate considerations

A fundamental challenge underlying the effort to align portfolios with temperature goals is the misalignment of time horizons. In a 2015 speech, Bank of England Governor Mark Carney coined this challenge "the tragedy of the horizon," whereby climate-related risks that could result in material financial impacts over the longer term are often not considered material today due to short time horizons for both regulators and financial market actors.[267] In addition, while asset managers and asset owners are increasingly integrating climate-related factors into their investment decisions, these are often still considered separate and secondary to considerations of financial return. However, this trend is changing — a recent survey of institutional investors showed that 81% of asset owners and 68% of asset managers now consider climate risks material to their portfolios.[268]

Capital reallocation does not necessarily result in emissions reductions

Even if financial institutions overcome other challenges, portfolio alignment does not necessarily result in emissions reductions in the real economy. Assets sold by one investor can be purchased by another and simply held on a different balance sheet. Similarly, where commercial banks implement exclusions in their lending activities, carbon-intensive corporations and projects can often obtain financing from another bank (albeit at potential higher financing cost). From a global emissions reduction standpoint, it would be more effective for investors to identify and support relevant transition strategies while considering financial risk to help finance the transition of emissions-intensive industries.

> *"We consider investor engagement as a key tool to help support and accelerate a company's transition process."*
>
> Lise Moret, Head of Climate Strategy, AXA Investment Managers, June 2019

Such assistance is often provided through soft engagement based on strong working relationships between financial institutions and the clients they serve. Asset managers and asset owners may also use shareholder votes to drive progress on climate issues and low-carbon transition strategies. One example of climate-related engagement is the Climate Action 100+ initiative, a group of investors who have set out to engage the 100 companies that contribute the greatest portion of GHG emissions — up to two-thirds of all industrial emissions — plus an additional 61 firms.[269] Signatories currently include more than 320 institutional investors representing more than $33 trillion in AUM. In response to their efforts, some commodity and mining companies have pledged to cap their production of coal, oil producers have agreed to emissions reduction targets tied to executive compensation, and energy companies have increased the ambition of their climate targets.[270]

[267] M. Carney, "Breaking the Tragedy of the Horizon: Climate Change and Financial Stability," Bank of England [Speech], London, 29 September 2015.
[268] OECD, "Integrating Climate Change-Related Factors in Institutional Investment," February 2018.
[269] Climate Action 100+,"Global Investors Driving Business Transition."
[270] Climate Action 100+, "News and Events."

Key solutions summary: Private finance can develop frameworks to align financial decision-making with well-below 2°C pathways

PRIVATE FINANCE

Key solution: A framework for incorporating the low-carbon transition into strategy, capital allocation, and client engagement

Banks, asset managers, and asset owners can continue to incorporate consideration of climate-related risks and opportunities into governance, strategy, and financial decision-making.

Financial institutions across the investment chain can also work to align financial portfolios with climate targets, including substantive efforts by lenders and investors to engage with corporations on climate-related objectives and transition strategies.

To facilitate material progress on both fronts, leading financial institutions can develop a harmonized framework for supporting the low-carbon transition through appropriately pricing risks and opportunities, providing guidance on alignment methodologies, and working with corporations to develop and support realistic industry-specific transition pathways.

Finally, credit rating agencies can transparently integrate material climate-related information into their methodologies, allowing the private sector to steer capital accordingly.

Barriers to scaling solutions

The barriers to adequately integrating climate-related risks and opportunities into financing and portfolio management practices include a lack of transparency and a lack of methodologies for assessing impacts. In addition, there are practical challenges such as the quantity of suitable low-carbon investments across asset classes.

Private financial institutions are developing standardized methods for aligning portfolios and loan books with a well-below 2°C future

Various efforts have emerged to assess and steer portfolios and loan books into alignment with global temperature goals and sectoral emissions reduction targets. Several of these efforts are summarized below.

Platform Carbon Accounting Financials (PCAF) was launched in 2015 by 14 Dutch financial institutions to provide an open source methodology to measure the carbon footprint of their investments and loans across eight asset classes. PCAF's report provides a carbon accounting approach, describing methodologies for listed equities, project finance, government bonds, mortgages, corporate finance, and real estate.[271]

The Terra Approach. ING, in partnership with 2° Investing Initiative, developed the Terra Approach to support the bank's goal of starting to steer its €600 billion lending portfolio toward Paris alignment by 2025. This sectoral approach analyzes climate-related portfolio risks and opportunities, and focuses on past and future corporate lending in energy, transport, steel, cement, residential mortgages, and commercial real estate by evaluating the technological shift needed across these sectors to achieve global temperature goals.[272] In an effort to lead change throughout the banking sector, ING has joined with four other banks — BBVA, BNP Paribas, Société Générale, and Standard Chartered — to develop open source methods and tools for measuring the alignment of lending portfolios with the goals of the Paris Agreement.[273]

The Poseidon Principles. The Poseidon Principles is the first global sector–specific climate alignment agreement among financial institutions. Launched in June 2019 by 11 banks representing $100 billion in senior shipping debt, the Poseidon model combines backward-looking assessment of climate alignment with forward-looking climate alignment targets as well as the establishment of a forum —the Poseidon Principles Association — for the development of relevant technical and climate expertise by financial institutions and other expert stakeholders.[274]

Institutional Investors Group on Climate Change. In May 2019, six institutional investors (AP2, Brunel Pension Partnership, Church of England Pensions Board, LGPS Central, PKA, and TPT Retirement Solutions) led by IIGCC announced a new initiative that will develop definitions and approaches for aligning portfolios with the objectives of the Paris Agreement. This initiative is working to develop sector- and asset class–specific approaches for portfolio alignment that could become a standard for asset owners.[275]

Moody's Carbon Transition Assessment: A tool for assessing transition risk

Moody's intends to launch a tool for assessing the carbon transition risk of listed corporations.[276] The assessment considers four risk components: an organization's current carbon profile, exposure to technology risk, risk mitigation strategies, and long-term exposure to rapid low-carbon transition scenarios. This assessment is not a credit rating but is, instead, intended to lay the groundwork to assess the relative exposure to climate-related risks of various corporations and how these may affect their creditworthiness. Importantly, it takes into account not only a corporation's current exposure but also its longer-term climate strategy.

271 Platform Carbon Accounting Financials, "Developing Carbon Accounting Methodology for the Financial Sector," 29 November 2018.
272 ING, "ING's Terra Approach."
273 BBVA, BNP Paribas, Société Générale, Standard Chartered, and ING. "The Katowice Commitment," 4 December 2018.
274 Poseidon Principles, "A Global Framework for Responsible Ship Finance."
275 IIGCC "European Investors Launch Project to Support Alignment of Portfolios to the Paris Agreement," [Press release], 2 May 2019.
276 Moody's Investors Service, "Moody's Requests Feedback on a New Carbon Transition Risk Assessment Tool for Rated Companies," 7 May 2019.

PUBLIC FINANCE

Key solution: Setting best practices for integrating climate factors into portfolio management

Public and multilateral financial institutions — notably development banks, SWFs, and government pension funds — are themselves major investors. Their sovereign shareholders can lead by example by ensuring that these institutions move to align portfolios with well-below 2°C pathways. MDBs and DFIs have charted a leadership path on Paris alignment, while SWFs and government pension funds can also integrate climate-related factors into their portfolio management activities.

DFIs also can play an important role in helping to set minimum standards and in creating new asset classes in emerging markets. The World Bank Group and the European Investment Bank coined green bonds in 2007 and 2008.[277] DFIs could continue to identify new ways to help harness capital markets for climate goals.

Barriers to scaling solutions

Public finance institutions are often bound by a similar obligation to deliver returns on investment for their shareholders, and they face the same lack of tools and information to transition their portfolios to more low-carbon investments.

MDBs develop joint framework to guide Paris alignment

Following up on the 2017 commitment made by the MDBs and the International Development Finance Club to align financial flows with the objectives of the Paris Agreement, MDBs recently announced a joint framework to begin aligning their activities with the temperature goals of the Paris Agreement. The joint framework is comprised of six building blocks, which include (1) aligning operations with mitigation goals and assessing operations against climate-related transition risks and opportunities; (2) aligning operations with climate-resilience goals; (3) ramping up climate finance; (4) providing capacity-building support for countries and other clients; (5) improving monitoring and reporting; and (6) aligning internal operations and policies with the objectives of the Paris Agreement.[278] The MDBs plan to report back at the 2019 UNFCCC Conference of the Parties in Chile on their progress.[279]

This framework demonstrates the MDBs' leadership on climate, moving beyond aligning financial flows to repositioning their activities and operations in line with globally agreed-upon temperature goals. These six building blocks can provide an important framework for other financial institutions to employ as they explore opportunities to align their activities with global temperature goals.

[277] World Bank, "World Bank Marks 10-Year Green Bond Anniversary With Landmark Issuance US$1.3 Billion Issuances Bring World Bank Green Bond Program to US$12.6 Billion," [Press release], 13 November 2018.

[278] African Development Bank Group, Asian Development Bank, Asian Infrastructure Investment Bank, European Bank for Reconstruction and Development, European Investment Bank, Inter-American Development Bank Group, Islamic Development Bank, New Development Bank, and World Bank Group (IFC, MIGA, World Bank), "The MDBs' Alignment Approach to the Objectives of the Paris Agreement: Working Together to Catalyse Low-Emissions and Climate-Resilient Development," 3 December 2018.

[279] World Bank, "Multilateral Development Banks (MDBs) Announced a Joint Framework for Aligning Their Activities with the Goals of the Paris Agreement," 3 December 2018.

Norges Bank's evolving holistic view on portfolio alignment

Norges Bank, Norway's central bank, one of the founding members of the NGFS, and the manager of the $1 trillion Norwegian SWF, has implemented several policies that align with the network's recommendations to integrate sustainability factors into central bank operations and portfolio management. In its role as a central bank, it has conducted analyses of the relationship between technological developments, climate policy, and banks' credit risk, and has raised the idea of including climate risk in bank stress tests.[280] In its role as manager of Norway's SWF, it has implemented comprehensive exclusionary policies that prohibit investment in entities that derive more than 30% of their operations or income from coal, companies that are responsible for severe environmental damage, and those that contribute to "unacceptable" GHG emissions.[281]

One Planet Sovereign Wealth Fund Framework & asset manager framework

The One Planet Sovereign Wealth Fund Framework brings together the SWFs of Abu Dhabi, Kuwait, New Zealand, Norway, Saudi Arabia, and Qatar. Together, they have outlined three principles to accelerate the integration of climate change analysis into the management of their large, long-term, and diversified asset pools: (1) building in climate change considerations that are aligned with the SWFs' investment horizon into decision-making; (2) encouraging companies to address material climate change issues in their governance, business strategy, planning, risk management, and public reporting; and (3) integrating considerations of climate-related risks and opportunities into investment management.[282] The SWF framework was complemented with an Asset Manager Initiative in July 2019 whereby a group of asset managers, including Amundi, BlackRock, BNP Paribas, Goldman Sachs, HSBC, Natixis, Northern Trust, and State Street Global Advisors committed to support the SWFs in delivering on their framework.[283]

[280] Norges Bank, "Consultation response: NOU 2018:17 / Climate risk and the Norwegian economy," 15 March 2019.

[281] Office of the Norwegian Prime Minister, "Guidelines for Observation and Exclusion From the Government Pension Fund Global," Adopted 18 December 2014, amended December 2015, February 2016, and January 2017.

[282] One Planet SWFs, "One Planet SWF Framework launch statement", [Press Release], 6 July 2018.

[283] One Planet SWFs, "Asset Managers Endorse the One Planet SWF Framework," 10 July 2019.

PUBLIC POLICY

Key solution: Incorporating climate into relevant financial regulation and supervision

Central banks and financial regulators can continue to promote a better understanding of climate-related risks and their potential financial implications. For example, they can assess the exposure of their domestic financial systems to climate-related risks, conduct climate stress tests, and engage with financial institutions to ensure these risks are understood. They can also help encourage climate-related financial disclosure, for example, in alignment with TCFD recommendations.

Policymakers can also develop standards and taxonomies to bring greater transparency about which activities are aligned with the low-carbon transition. Recent progress on this front includes the work of the EU Technical Expert Group on sustainable finance, which has proposed a taxonomy to define what counts as an environmentally sustainable economic activity.[284]

Barriers to scaling solutions

The actions of central banks and regulators are limited by their mandates, which vary across countries.

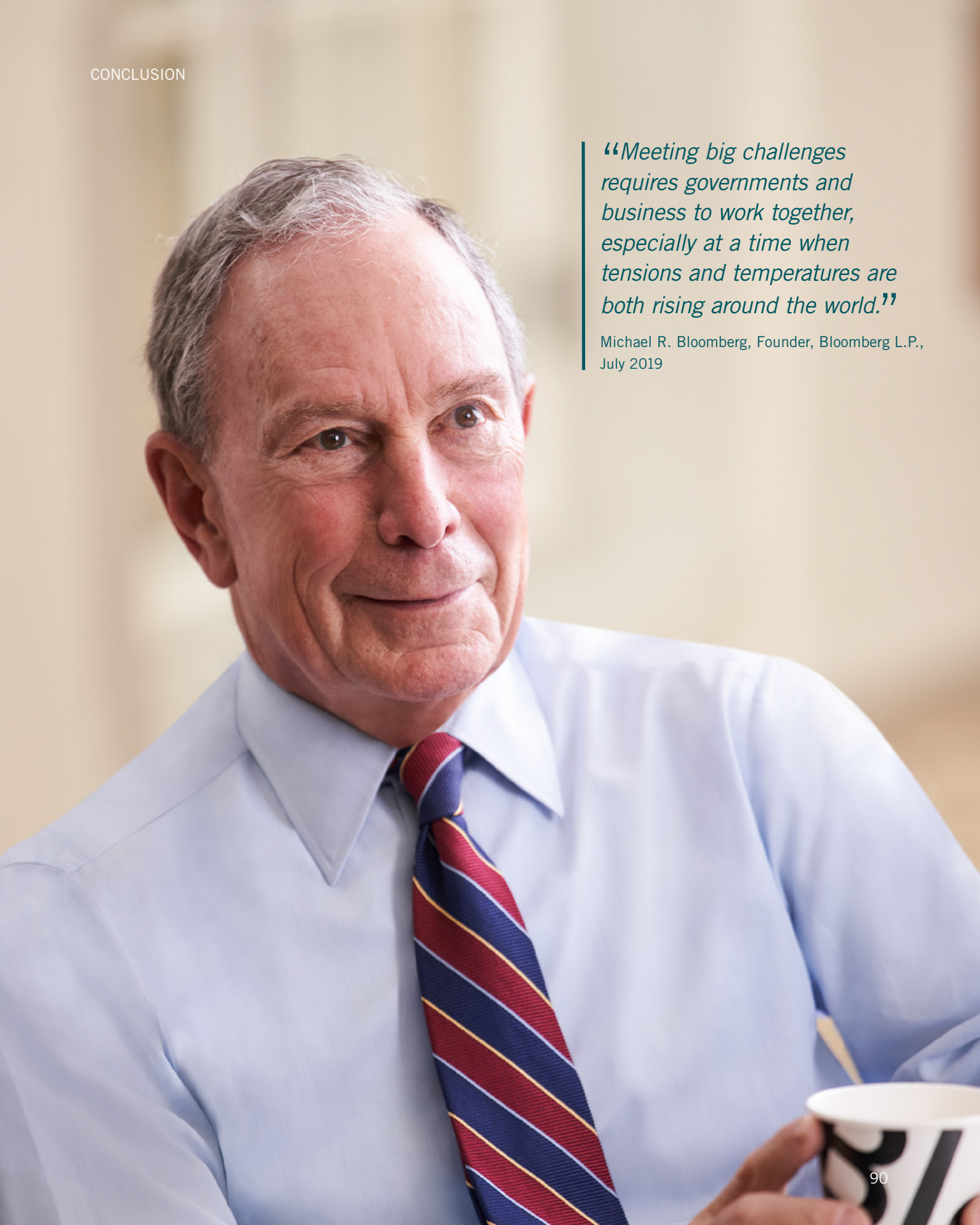
The Bank of England stress tests for climate resilience

A survey conducted by the Bank of England determined that only 10% of banks were "comprehensively" managing and taking a sufficiently long-term view of climate-related risks.[285] In response, the Bank of England announced that it will incorporate climate resilience into the supervision of banks and insurers and into the bank's stress tests of the UK financial system, starting with the insurance sector.[286,287] Incorporating climate change into stress tests will help assess how the financial system would cope with different climate-related transition and physical risks. In addition, incorporation into the supervision process will provide the opportunity for the Bank of England to better understand how individual banks are managing climate risk. The Bank of England follows the lead of the Bank of Netherlands in incorporating climate change into its financial stability tests.[288]

The NGFS provides guidance to public finance institutions to account for climate-related risk

The NGFS, launched in December 2017, gathers central banks and supervisors who are committed to better understanding and managing the financial risks and opportunities of climate change.[289] Since its creation, the organization has grown from eight founding members to 42 members across five continents. Recommendations issued by the NGFS provide a framework for central banks, supervisors, policymakers, and financial institutions to integrate climate-related risks into financial stability monitoring and micro-supervision and the consideration of sustainability factors into central banks' own-portfolio management.[290] Although voluntary, these recommendations provide important guidance for public finance, supervisory, and regulatory entities to account for climate-related risk.

284 EU Technical Expert Group on Sustainable Finance, "Taxonomy Technical Report," June 2019.
285 Bank of England, "PRA Review Finds That 70% of Banks Recognise That Climate Change Poses Financial Risks," 26 September 2018.
286 Bank of England, "Enhancing Banks' And Insurers' Approaches To Managing The Financial Risks From Climate Change," Supervisory Statement 3/19, 15 April 2019.
287 M. Carney, "A New Horizon," Bank of England [Speech], Brussels, 21 March 2019.
288 De Nederlandsche Bank, "An Energy Transition Risk Stress Tests for the Financial System of the Netherlands," 2018.
289 Network for Greening the Financial System, "About Us."
290 Network for Greening the Financial System, "A call for action: Climate change as a source of financial risk," April 2019.



> *"Meeting big challenges requires governments and business to work together, especially at a time when tensions and temperatures are both rising around the world."*
>
> Michael R. Bloomberg, Founder, Bloomberg L.P., July 2019

Conclusion: Financing the Low-Carbon Transition Requires Strategic Partnerships

The scale of the necessary low-carbon transition is unprecedented and will span all sectors and geographies. There is growing interest within the financial sector in supporting this transition and the significant shift in capital needed to align financial flows with a well-below 2°C pathway. However, the mobilization of private investment at the scale and pace needed to realize global temperature goals faces major constraints, summarized in this report within five major challenges. While the challenges may seem daunting, the countries and organizations that are already charting a course toward a low-carbon economy demonstrate that opportunities also abound in the transition.

Scalable solutions to address each of the five challenges in this report are available for implementation by private- and public-sector actors, many of which are made possible through strategic partnerships across the financial system.

Solutions to Challenge 1: Proven investment models are not replicated at scale

Renewable energy policies — the most successful of which have provided stable revenues for renewable energy generation — have driven significant cost reductions in wind and solar technologies, making them cost-competitive with fossil fuel generation in many markets. The private sector can directly benefit from the competitiveness of renewables by procuring low-cost clean power through corporate PPAs and creating financial products that expand low-carbon investment opportunities to larger investors. Further accelerating the deployment of clean energy will require the public sector to implement even more ambitious renewable energy targets, as well as policies that have proven successful, such as auctions, guaranteed revenues, and measures that facilitate project development.

Solutions to Challenge 2: Risks in emerging markets constrain low-carbon investments

While the majority of low-carbon investment has flowed to high-income countries and China, certain emerging markets have proven successful in attracting capital. Leadership by national policymakers, working in tandem with DFIs to create the conditions needed to attract private investment, can help expand this success to other emerging markets. Alongside the introduction of a comprehensive set of enabling policies, governments and investors can build on the

extensive experience of DFIs in delivering technical assistance, building project pipelines, and managing risk in emerging markets.

Solutions to Challenge 3: Many low-carbon investments in key emitting sectors are not yet profitable

Supporting the commercial viability of low-carbon solutions in the industrial, heavy-duty transport, and agricultural sectors will require a mix of public policies — including investment incentives, public procurement, standards, and carbon pricing — to create clear investment signals. Collaboration in R&D and public-private risk sharing in bringing early-stage, low-carbon technologies to market will also be needed to shift these sectors toward net-zero emissions.

Solutions to Challenge 4: The transition from carbon-intensive business models may create financial and social risk

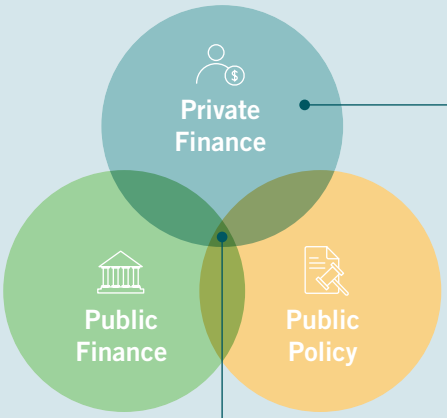
The ongoing transformation of carbon-intensive sectors highlights that rapid transitions are best managed when corporations, financial institutions, and policymakers work in concert to support an orderly transition. Corporations with carbon-intensive business models can work with investors to transition their businesses to low-carbon strategies. Governments can support the transition of communities and workers whose livelihoods are currently reliant on carbon-intensive sectors by developing programs that spur investment in alternative sectors, reskill affected workers, or provide them with compensation.

Solutions to Challenge 5: A lack of tools and incentives to align portfolios with a low-carbon future

A growing number of stakeholders, including the NGFS and TCFD, are working to make material climate-related information a key dimension of decision-making in the financial sector. However, mobilizing the investment chain to align with a low-carbon economy will require the development of sector- and geography-specific transition pathways, as well as benchmarks to evaluate progress on their alignment with well-below 2°C pathways. It will also necessitate the implementation of approaches, such as engagement strategies and financial products to support the transition, to ensure that portfolio alignment efforts lead to change in the real economy.

Summary of solutions: Key partnerships for financing the low-carbon future

The private sector can take the lead in helping resolve many of the primary challenges preventing the mobilization of private finance for low-carbon solutions. However, this report also highlights that private finance cannot act alone. Working in concert, the firms and institutions across the financial system, public finance, and public policy all have a role to play in harnessing the power of financial markets and delivering the ambitious transitions needed to address climate change.



Key private-sector partnerships

Financial products that support the transition. Financial institutions can develop a wider range of financial products to support companies that have adopted ambitious goals to align their strategies and operations with the low-carbon transition.

Approaches for climate alignment. Organizations across the investment chain can work together to develop approaches for aligning financial decision-making with the goals of the Paris Agreement.

Key private-public partnerships

Unlocking capital in emerging markets. Financial institutions can demonstrate their interest in bringing low-carbon solutions to emerging markets. Collaboration with DFIs and policymakers can help develop environments conducive to low-carbon investment in emerging markets, thus broadening opportunities for private investment.

Bringing innovative technologies to market. Governments can support the development of innovative technologies through funding for R&D, while public-private risk sharing and collaboration can help bring early-stage, low-carbon technologies to market.

Realizing an orderly and just transition. Private finance, public finance, and policymakers can collaborate on ensuring a well-managed transition with clear policy frameworks, private-sector transitions, and support for just transition for communities and workers.

Appendix

Appendix 1: CFLI Unlocking Capital – Investment Readiness Guidelines

Introduction

The CFLI Investment Readiness Guidelines are intended to facilitate discussion among financial institutions, project developers, investors, and government representatives on critical factors for mobilizing private finance for low-carbon solutions in developing countries. These Guidelines are not intended to supersede firm- or fund-level investment criteria for developing countries but are instead meant to provide a set of initial gating factors for consideration.

These Guidelines are based on the experience of lenders and other financial investors in these markets over the past decade. They represent the most fundamental and cross-cutting factors affecting investment. While the Guidelines are intended to be considered in their entirety, prioritization of specific policy prescriptions will vary greatly depending on the economic, legal, political, and financial development of a particular country.

Although investment decision-making is complex and dependent on contextual circumstances, which can vary widely from country to country, these factors may closely correlate with decreased project risk and increased likelihood of a project's consideration by investment teams.

Macroeconomic considerations

Political and macroeconomic stability and economic growth prospects

The presence of strong institutions with a track record of good governance and the commitment and capacity to provide stable macroeconomic management is a major factor for investors as are sound macroeconomic policies to drive broad-based growth and provide investors with broad assurance of the financial sustainability of their investments. Investors also require reliable data on the macroeconomic state of the economy (banking-sector health, employment numbers, etc.) to support their own reporting requirements.

Policy stability

Policy risks, such as expropriation, sovereign breach of contract, or lack of availability of hard currency, are crucially important considerations for investors. Low-carbon projects are particularly vulnerable to policy risk, such as the ability to predict and rely on stable tariffs, due to declining input costs and a reliance on government subsidies. The risk of policy reversals or renegotiations is often the single biggest concern of most investors in developing countries, particularly when such policies can be altered legally with ease by government agencies. These risks can only be partially covered through international political risk insurance.

Financial market depth

The existence of a local bank market that can provide both lending and other financial services, such as currency, interest rate swaps, access to listed markets, and even support for a robust green bond market, are important for international investors. The challenge of limited local commercial banking experience and capabilities, such as the lack of long-term fixed rate non-recourse debt, and limited liquidity in local debt and equity markets can be a hindrance for investors.

Currency stability

Mismatches between the currency denomination of a project's costs and the denomination of its revenues present extra costs and risks when neither local nor international markets provide the instruments needed to hedge those risks in sufficient size and tenor. This is particularly problematic in countries with volatile currency exchange rates and where significant current account deficits leave those currencies vulnerable to devaluation. Structures that are available to partially hedge local currencies tend to be inefficient and expensive. The degree to which a country can peg its currency to a hard currency or denominate project revenues in a hard currency is thus an important consideration.

Government commitment to stable and predictable investment incentives for low-carbon solutions

In addition to strong public government support, a variety of incentives and policies may signal a favorable business environment for the operator and, therefore, the investor. These signals may include establishing renewable energy targets and strategies, setting emission reduction targets, or revising far-reaching Nationally Determined Commitments. Other clear and tangible signals include establishing specific financial incentives, such as tax incentives or preferential treatment on import duties, and the establishment of clearly organized auctions, tenders, or feed-in tariffs.

Political will and execution capacity

Strong policy support and clear rules and regulation are important, but equally important are the willingness, experience, and relevant technical skills to implement those policies and engage with investors. Most developing countries have little experience negotiating and executing international commercial agreements and technical assistance may be necessary until project development, engineering, technical, and commercial experience is gained. The willingness and ability of the host country and its population (pensions, entrepreneurs, sovereign wealth funds, development banks, etc.) to invest alongside international investors on pari passu or junior terms can also demonstrate local will and execution capacity, as well as local and non-local financial alignment.

Market considerations

Cost-reflective energy prices

Ensuring that power generators can charge the necessary cost-reflective tariffs is crucial to enabling private investment to flow to low-carbon sectors. In many cases, this will require the removal of energy subsidies for the incumbent fossil fuel industry such that retail energy prices may rise to reflect their true costs.

Power Purchase Agreements (PPAs) incorporating protections required by international lenders

PPAs must be of sufficient duration to match the tenor of financing required. International public and private sector lenders also often require that off-taker payments are denominated in dollars or euros, which can be challenging for off-takers whose income is in local currency. Additional elements typically required by lenders include agreement to settle any disputes in a neutral, offshore location, and other standard protections for the developer and its lenders. As the market develops, standardization of PPAs across the market becomes increasingly important to investors and developers.

Creditworthy or credit-enhanced off-takers

In most countries, the power off-taker is a government utility requiring some credit enhancement to support its payment obligations to the power producer. Such support may come in the form of partial or full sovereign guarantees (where possible within sovereign debt capacity limits), liquidity facilities, and laws assuring funding for the electricity sector. The stronger the PPA, the more likely the lender will accept something less than a full sovereign guarantee.

Ownership and local content requirements that are mindful of foreign investors' and local communities' needs

In some jurisdictions, foreign investment is limited to minority stakes, whereas investors may seek control. The relative paucity of well-capitalized local partners with relevant experience can be a barrier to developing a successful project. Similarly, while investors generally seek to work with local communities and source as much as possible from local markets, in some cases, government requirements concerning restrictive local content, if they materially impinge on the quality or economics of the project, can stymie investment.

Clear and predictable licensing and permitting procedures

The assurance that necessary licenses and permits will be awarded based on a fair, efficient, and predictable process is crucial to developers and their investors. Establishing land titles in markets where traditional land tenure is practiced is often costly and time-consuming, contributing to the uncertainty that is so problematic for investors. In some countries, governments provide a pre-permitting site, specifications, and license auctioned as part of a PPA.

Enforceability of contracts

Businesses require predictable local legal frameworks and confidence that contracts will be enforced promptly in local courts. Effective dispute resolution mechanisms are also essential to giving business confidence to enter into relationships with new businesses and partners in foreign markets.

Power grid capacity, stability, and ability to handle intermittent power

In many countries the national power grid has limited capacity to absorb new power and/or lacks the flexibility to be able to handle the intermittent power that is generated by most renewable energy sources. This can result in renewable energy plants being required to reduce their production, most of the time without compensation for such curtailment. A clear agreement is needed between decision makers who grant permits and licenses, private developers, and grid operators regarding necessary grid improvements, completion dates, and relation between those grid improvements and proposed renewable energy projects.

Effective community engagement

Ensuring that local communities are consulted effectively before construction as well as on an ongoing basis is important to the success of a low-carbon project. Developers and lenders conduct their own community engagement, but governments can help de-risk projects ex-ante by taking an active role in facilitating that engagement.

Size of the market and relevant deal flow

Smaller markets do not necessarily present greater risk, but generally offer less opportunity for financial institutions to reach economies of scale in their financing activities. These countries also present less opportunity for development of robust green bond markets. Regional integration may address this challenge but creates new credit, structuring, and legal complexity. An institution's existing relationship in a smaller country or the intensity of a small country's commitment to a particular policy agenda may offset the difficulty of sourcing deals in a smaller market.

High quality engineering, procurement, and construction (EPC) contractors

The lack of availability of a sufficient number of high-quality, reliable developers and EPC contractors with strong, relevant experience and capabilities is a significant challenge to building new renewable energy generating capacity in emerging markets. While ongoing operations and maintenance capabilities are often available locally, it is important for investors to be able to rely on experienced international contractors who are willing to invest and capable of successfully delivering a project on time and on budget.

Appendix 2: Glossary

Asset class A specific category of financial assets with similar characteristics, such as equities and bonds. Typically, financial portfolios are constructed of a mix of asset classes, and analytical approaches are specific to an asset class.

Asset in the real economy A physical (not financial) asset that produces goods or renders services in the real economy. Physical assets also have a monetary value and are owned either by corporations, individuals, or the public sector. Examples include buildings, factories, vehicles, and power plants.

Asset manager A firm that invests capital on behalf of end-investors.

Asset owner An end-investor of capital. The largest asset owners include public and private pension funds, sovereign wealth funds, and insurers; other kinds include endowments and family offices.

Assets under management The total market value of financial assets overseen by an institutional investor.

Balance sheet A ledger recording the assets (physical and financial), liabilities, and capital of a corporation or bank at a particular point in time.

Bank A financial institution that uses money from depositors or investors to lend to individuals and companies. Investment banks oversee the issuance of bonds and shares, and act as trading houses.

Blended finance A form of financing that uses concessional capital from development finance institutions to de-risk investments in emerging markets and thereby mobilize private capital toward sustainable development. Most blended finance initiatives involve partnerships between DFIs and private financial institutions.

Bondholder The owner of a bond issued by a corporation or country. As a bond is a form of debt, bondholders are creditors.

Carbon footprint A measure of the carbon dioxide or other greenhouse gas emissions associated with a particular activity or asset. In this report, carbon footprint is often applied to an investment, a portfolio, or an asset in the real economy.

Carbon-intensive Activities or assets associated with large amounts of greenhouse gas emissions that are thus misaligned with the low-carbon transition.

Clean energy/Renewable energy Zero-emissions energy technologies that convert renewable resources, such as sunlight, wind, and water flow, into usable forms of energy, such as heat and electricity.

Corporate lending Loans, usually by banks, to corporations.

Corporations In this report, private-sector non-financial companies. Corporations can be publicly listed, in which case their shares are traded on exchanges (but still owned by private investors), or privately held. This report does not touch on government-owned companies, usually known as state-owned enterprises.

Creditworthiness The reliability of a borrower. In the case of bank lending, it is usually assessed by a bank itself. For large, publicly listed corporations, it is usually assessed using standardized ratings from credit rating agencies.

Deregulated electricity markets Countries or regions in which multiple power producers sell electricity in competitive markets, or "wholesale markets." In these cases, the electric grid operator is independent and does not directly own generation assets. Electricity can also be sold to end-consumers through competitive processes (i.e., competitive "retail markets") where consumers can choose their suppliers.

Developed economies Countries that are characterized as high income according to the World Bank's country classification.

Development finance institution (DFI) Government development agencies or the private-sector arms of multilateral development banks that work to advance sustainable economic development in developing countries by providing equity, long-term finance, risk mitigation, and other tools that stimulate investment in development. DFIs operate as public-sector, mission-driven investment banks and are mandated to be financially self-sufficient.

Disclosure The act of releasing all relevant corporate information that may influence an investment decision. In this report, disclosure is often discussed in relation to climate-related financial disclosure.

Emerging economies Countries that are characterized as low-income, lower-middle income, and upper-middle income according to the World Bank's country classification.

Emissions trading system (ETS) A market-based policy mechanism that places a cap on total emissions in a specific country, region, or sector. Based on this cap, individual entities are allocated permits that allow them to produce a certain amount of emissions. These permits can be traded among emitters, allowing emitters that can reduce emissions at a lower cost to sell permits to emitters with higher costs. This market mechanism helps ensure cost-effective reduction of emissions.

Externalities The cost or benefit of a good or service that is incurred by a third party that is not adequately captured in its price. In the context of climate change, emissions are considered an environmental externality, as the cost of their impact on climate change is generally not captured in market prices.

Feed-in tariff A policy mechanism that provides a specified payment, or tariff, per unit of renewable electricity produced over a designated period of time. Unlike an auction, this price is set by a policymaker, rather than competitively in an auction process. A feed-in tariff can be fixed, as in an auction, or it can provide a premium over a wholesale electricity tariff.

Financial assets A non-physical asset that is usually either a form of debt or a share of ownership. Financial assets include equities, bonds, and loans.

Financial institution Any organization in the financial sector that offers or manages capital, including banks, insurers, asset managers, and asset owners.

Financial product A specific product for an end-investor, usually made by a financial institution. Often refers to funds (which, in turn, contain assets like equities and bonds).

Financial system The financial sector and the system around it, including financial regulation, central banks, and connections with the non-financial sector.

Greenhouse gas emissions (GHG emissions)/ emissions The release of gases that trap heat in the atmosphere and therefore contribute to climate change. GHGs include carbon dioxide, methane, nitrous oxide, and fluorinated gases.

High-income country Countries with a gross national income per capita of more than $12,056 in 2017, in line with the World Bank's country classification.

Institutional investor Any investing entity that is not an individual. Encompasses both asset managers and asset owners.

Investment chain In this report, this term refers to the interactions between financial firms, especially in regard to the sequence by which physical assets are financed and packaged into financial assets — from project developers and corporations to banks to institutional investors.

Investor Any entity that puts money into buying financial or physical assets with the expectation of achieving a profit.

Just transition A framework that broadly refers to the principles, processes, and practices to ensure improvements such as inclusivity of growth, preservation of livelihoods, support for decent work opportunities and community stability, and social protection in the transition to a low-carbon economy.

Levelized cost of electricity (LCOE) The net present value of the cost of generating electricity, per unit of electricity generated, for the lifetime of an asset; used to compare the cost of energy from various sources.

Loan book A bank's portfolio of loans to companies and individuals.

Low-carbon In this report, economic activities or assets that result in lower GHGs, as compared with other activities and assets.

Low-carbon transition The process of moving to a trajectory that would limit average global temperature rise to well-below 2°C compared with preindustrial levels. The low-carbon transition can refer to transitions within individual entities, industries, economic sectors, countries, or the global economy.

Low-income country Countries with a gross national income per capita of less than $995 in 2017, in line with the World Bank's country classification.

Middle-income country Countries with a gross national income per capita between $996 and $12,055 in 2017, in line with the World Bank's country classification.

Pension fund A fund that manages pension contributions for eventual payout, therefore usually has a long-term investment horizon (of several decades).

Physical risk In this report, the risks associated with the physical impacts of climate change. Physical risks can be event-driven (acute) such as increased severity of extreme weather events (e.g., cyclones, droughts, floods, and fires). It can also relate to longer-term shifts (chronic) in precipitation and temperature, and increased variability in weather patterns (e.g., sea-level rise).

Portfolio A collection of assets. In this report, the collection of financial assets owned by an investor or the loan book of a bank.

Power purchasing agreement (PPA) A contract between a producer of electricity and a buyer that stipulates the commercial terms of electricity sales between the two parties. In this report, PPAs are typically long-term contracts awarded to independent power producers that provide a fixed priced per unit of renewable energy generated over a specified time period.

Private equity An industry composed of funds and investors that invest in unlisted, privately held companies, usually selling them onward within a 5-year horizon.

Private sector The part of the economy not under direct government control. In this report, both financial and non-financial companies.

Public finance Sources of finance provided by public entities, including development finance institutions, sovereign wealth funds, and governments, usually derived from income raised through taxes. Public finance is usually meant to achieve social, political, or environmental goals rather than produce a profit, so it can finance loss-making propositions or help subsidize private finance.

Regulated electricity markets Countries or regions in which a single entity (e.g., an electric utility) owns and operates electricity generation, transmission, and distribution assets, and sells electricity directly to end consumers. In these markets, the utility, which is frequently a vertically integrated monopoly, is often under regulation that guides its operations, e.g., tariff setting. There are also various degrees of regulated electricity markets. For example, in some markets, additional power producers are allowed to generate and sell electricity directly to the vertically integrated utility.

Renewable energy auction A policy mechanism involving the competitive procurement of renewable energy generation. Bidders offer a price per unit of electricity and volume of renewable energy capacity. Successful bidders are offered a power purchasing agreement, which guarantees a fixed price per unit of electricity generated. This price is known as the "strike price," or the price at which the auction cleared.

Renewable portfolio standard (RPS) A policy that requires electricity providers to supply a certain portion of electricity from renewable energy sources.

Scenario analysis A process for identifying and assessing a potential range of outcomes of future events under conditions of uncertainty. In the case of climate change, for example, scenarios allow an organization to explore and develop an understanding of how the physical and transition risks of climate change may affect its businesses, strategies, and financial performance over time.

Shareholder The owner of a share of equity in a corporation who has a say in how the corporation is managed.

Sovereign wealth fund A state-owned investment fund, usually with a very long-term investment horizon to provide a financial cushion for the country or sub-national entity.

Transition risks Risks associated with the transition to a lower-carbon global economy, the most common of which relate to policy and legal actions, technology changes, market responses, and reputational considerations.

Transition strategy The short- and long-term strategy to manage climate-related risks and opportunities associated with the transition to a lower-carbon economy in order to address climate change. In this report, it usually refers to corporations' strategies.

Virtual PPA (VPPA) Within a VPPA contract, the corporate buyer does not own and is not responsible for the physical electricity generated by the project. The VPPA is purely a financial transaction, exchanging a fixed-price cash flow for a variable-priced cash flow and renewable energy certificates.

Zero carbon Technologies or economic activities that do not emit any greenhouse gases. In the context of the power sector, this includes power-generation technologies such as wind, solar, nuclear, and hydropower.

Appendix 3: Abbreviations

3EAC	Energy, Emissions, and Efficiency Advisory Committee
ABS	asset-backed securities
ADB	Asian Development Bank
AUM	assets under management
BNEF	BloombergNEF
CCS	carbon capture and storage
CDM	clean development mechanism
CEFC	Clean Energy Finance Corporation
CFLI	Climate Finance Leadership Initiative
CO_2	carbon dioxide
CORSIA	Carbon Offsetting and Reduction Scheme
CSIRO	Commonwealth Scientific and Industrial Research Organisation
DFI	development finance institution
EPC	Energy Performance Certificate
ESCO	energy service company
ESG	environmental, social, and governance
ETS	emissions trading scheme
EU	European Union
EV	electric vehicle
FIRA	Fideicomisos Instituidos en Relación con la Agricultura (Trust Funds for Rural Development)
GDP	gross domestic product
GEF	Global Environment Facility
GHG	greenhouse gas
GPIF	Government Pension Investment Fund
GW	gigawatt
IATA	International Air Transport Association
ICAO	International Civil Aviation Organization
IEA	International Energy Agency
IFC	International Finance Corporation
IIGCC	Institutional Investors Group on Climate Change
IMF	International Monetary Fund
IPCC	Intergovernmental Panel on Climate Change
IPP	independent power producer
LCOE	levelized cost of electricity
MDB	multilateral development bank

NGFS	Network for Greening the Financial System
OECD	Organization for Economic Cooperation and Development
OPIC	Overseas Private Investment Corporation
PACE	Property Assessed Clean Energy program
PAF	Pilot Auction Facility
PCAF	Platform Carbon Accounting Financials
PPA	power purchasing agreement
PV	photovoltaic [solar panel]
R&D	research and development
REDD+	Reducing Emissions from Deforestation and Forest Degradation in Developing Countries
SDG	Sustainable Development Goal
SPV	special purpose vehicle
SWF	sovereign wealth fund
TCFD	Task Force on Climate-related Financial Disclosures
TLFF	Tropical Landscape Financing Facility
TW	terawatts
UN	United Nations
UNFCCC	United Nations Framework Convention on Climate Change

Appendix 4: Table of Figures

Additional information on CFLI member actions is available at **bloomberg.com/cfli**

We gratefully acknowledge the contributions of BloombergNEF, a leading provider of research on energy and sustainability, and Rocky Mountain Institute, a global nonprofit organization that accelerates the energy transition from fossil fuels to efficiency and renewables using market-based solutions, to the development of the CFLI report.