

December 2020



Climate Finance Markets and the Real Economy

Sizing the Global Need and Defining
the Market Structure to Mobilize Capital

BCG BOSTON
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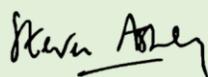
Foreword

Climate change poses economic and financial risks to the global economy. Efforts to mitigate against these risks and adapt to the changing climate will require a fundamental transformation of our global economy. The climate finance market structure must grow at an unprecedented scale, speed, and geographic scope, and this will require concerted and coordinated action by all stakeholders—the public sector, the real economy sectors, the financial sector, and the social sector. This report provides a roadmap (see section 5) for how to accelerate the evolution of climate finance and defines the roles capital market participants can play to facilitate this transition. Taken together, the recommendations enable the development of the climate finance market to grow to the \$3–5 trillion+ of investment per year that this report estimates will be required to achieve the ambitions set out in the Paris Agreement.

This report was commissioned to Boston Consulting Group (BCG) by the Global Financial Markets Association (GFMA) with active contribution by GFMA member firms representing capital markets activities globally. Written jointly by GFMA and BCG and advised by contributing member firms (listed on the right), the report is based on interviews conducted with more than 100 market participants globally, during the third quarter of 2020.

GFMA represents the common interests of the world’s leading financial and capital market participants to provide a collective voice on matters that support global capital markets. It also advocates on policies to address risks that have no borders, regional market developments that impact global capital markets, and policies that promote efficient cross-border capital flows to end users. GFMA efficiently connects savers and borrowers, thereby benefiting broader global economic growth. The Association for Financial Markets in Europe (AFME) located in London, Brussels, and Frankfurt; the Asia Securities Industry & Financial Markets Association (ASIFMA) in Hong Kong; and the Securities Industry and Financial Markets Association (SIFMA) in New York and Washington are, respectively, the European, Asian, and North American members of GFMA.

The cooperation of a representative global subset of our contributing member firms and individuals, as well as large corporates, asset managers, and climate think tanks that contributed their time toward the interviews and data gathering that form the basis of this report is greatly appreciated.



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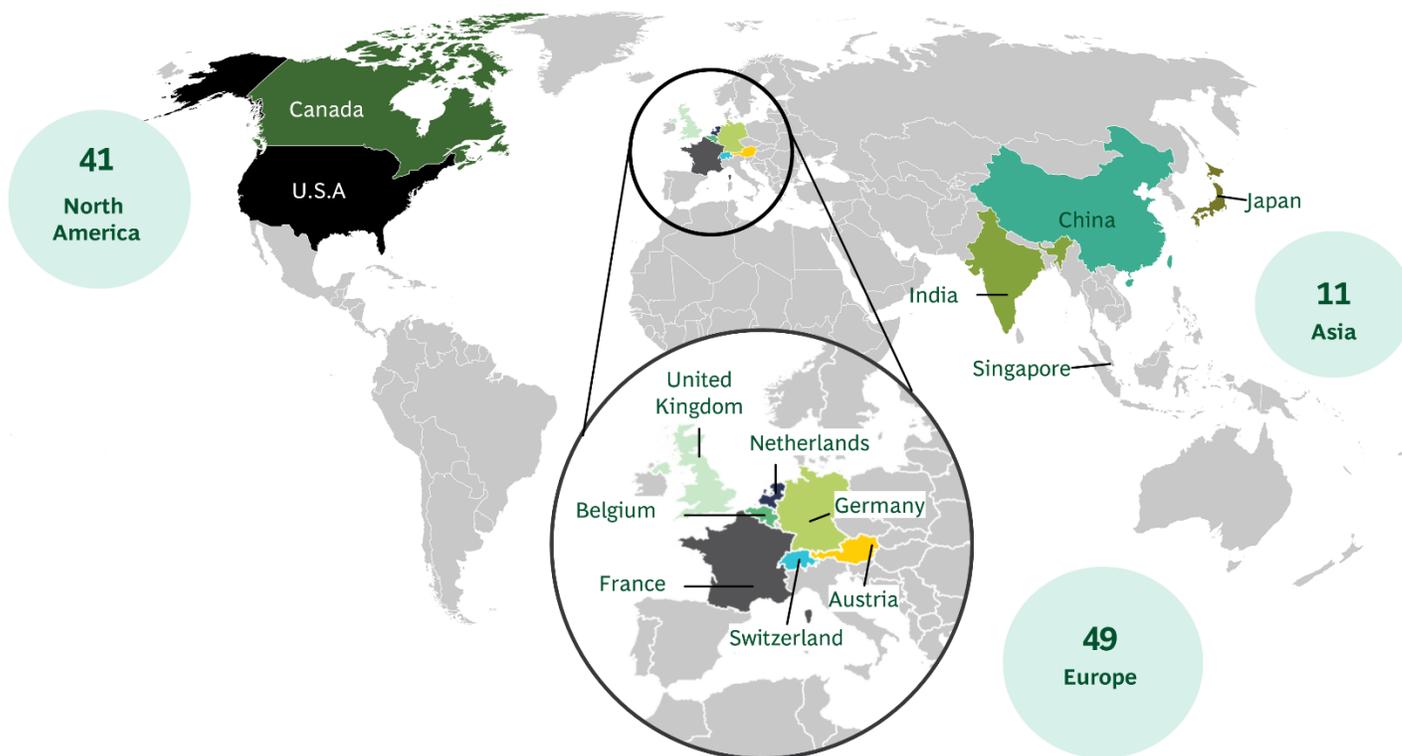


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100+ market participants interviewed across the globe



Banking & Capital Markets: roles including Directors of ESG Capital Markets, Head of Capital Markets, Head of Fixed Income Originations, Senior Vice President of Risk, Chief Sustainability Officer, COO of Sustainable Finance, Vice Chair of Investment Banking, Vice President Product Controller, Head of Energy sector, Regional Head of Investment Banking, Regional Head of ECM, Head of ESG Advisory and Solutions, Regional Heads of Debt and ECM, Regional Head of Capital Markets, Head of Capital Markets Strategy, Managing Director of Capital Markets, Vice President in Public and Sustainable Debt

Corporate executives: roles including CEO, CFO, Head of Sustainability, Industry Association CEO, Managing Director, Head of Group M&A, Head of Treasury & Investor Relations, Vice President of Financial Services, Regional Head of Performance and Sustainability, Upstream Strategy & Operations—across sectors including Energy, Chemicals, Steel, Cement, Buildings, Automotive, Aviation, Shipping, Food

Investors and Asset Managers: roles including Executive Director of Sustainable and Impact Investing, Head of Sustainable Investment, Head of Responsible Investing, Head of Sustainability Solutions, Director of Global Real Estate

Other market participants (standard setters, regulators, multilaterals, etc.): roles including Financial Institution Policy Lead, Senior Associate Director, Principal, Director of Climate-Aligned Finance, COO of a climate analytics firm, Head of Climate Finance, Manager of Blended Finance, Director Financial Strategies, Former Director of Sustainability, Climate Financing Specialist



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Executive Summary

The Global Financial Markets Association (GFMA) and Boston Consulting Group's (BCG) report "Climate Finance Markets and the Real Economy" provides a roadmap for how to accelerate the evolution of climate finance, and defines the role capital market participants can play to facilitate the transition to a low-carbon economy in line with their responsibilities to serve clients, investors, and the societies in which they operate. Taken together, the recommendations included within this report enable the development of the climate finance market to grow to the \$3–5 trillion+ of investment per year that this report estimates¹ will be required to achieve the ambitions set out in the Paris Agreement.

A \$100–150T+ investment need

The Paris Agreement calls for measures that will limit the global temperature rise to below 2°C from pre-industrial levels, and to pursue efforts to limit it to 1.5°C.² **Achieving this will require a fundamental transformation of our global economy.**

The Banking and Capital Markets sector plays a critical role in this transformation as an intermediary between the supply and demand for capital—as a lender, arranger, and investor. Success in mobilizing both public and private capital by the Banking and Capital Markets sector **to finance climate transition pathways will only be achieved by a holistic, complementary set of actions taken by the public sector, the social sector,³ the real economy, and the broader financial sector at an accelerated pace and larger scale in the early part of this decade.** According to the Intergovernmental Panel on Climate Change (IPCC), there is a finite budget remaining for additional emissions, ranging from 420 to 580 GtCO₂,⁴ which—to stay within this budget—will require emissions to decline from the current 53 GtCO₂e emissions⁵ per year by more than 50 percent by 2030⁶ and to net zero⁷

¹ Additional external references on investment estimates: UNEP \$1.5T; TCFD ~\$1T; IRENA \$3.8T; \$1.6–3.8T as per IPCC for energy systems alone; OECD estimates \$6.9T per year over next 15 years for <2°C for new infrastructure.

² In this report, a reference to "Paris-aligned" or "Paris ambition" or "Paris ambition-aligned" refers to an ambition of pursuing efforts to limit global temperature rise to 1.5°C.

³ Public sector includes multilateral organizations, development finance institutions; Social sector includes philanthropic donors, civil society and other Non-Governmental Organizations (NGOs).

⁴ Source: The Fifth Assessment Report of the United Nations Intergovernmental Panel on Climate Change.

⁵ Carbon dioxide-equivalent emissions, a measure used to compare the emissions from various greenhouse gases based on their global warming potential.

⁶ The Special Report on 1.5°C (SR15) released by the IPCC in 2018 confirmed that "In model pathways with no or limited overshoot of 1.5°C, global net anthropogenic CO₂ emissions decline by about 45% from 2010 levels by 2030 (40–60% interquartile range), reaching net zero around 2050 (2045–2055 interquartile range)."

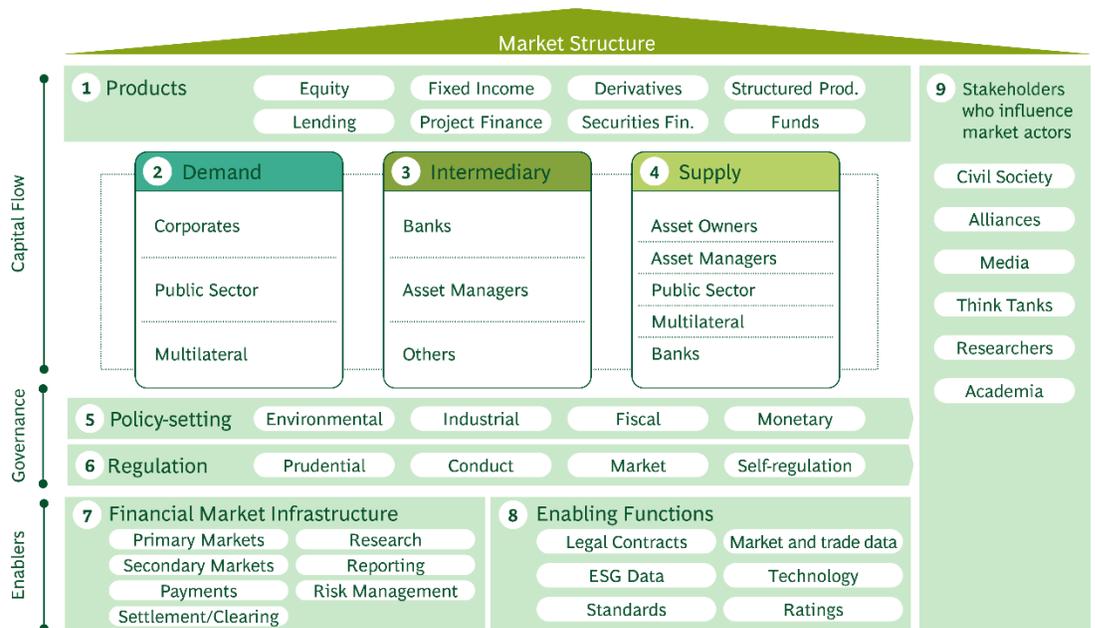
⁷ IPCC definition of net zero: a global balance between anthropogenic emissions by sources and removals by sinks of greenhouse gases.

emissions by 2050. To further emphasize the materiality to the real economy, more than 20 percent of global GDP could be at risk as a result of climate change-related impacts through physical changes in the environment by 2100.⁸

A key conclusion of this report is that the climate finance⁹ market structure (CFMS) must grow at an unprecedented scale, speed, and geographic scope. The volume of Climate-Aligned Finance (i.e., the financing that focuses on enabling climate change mitigation) that will be necessary to achieve a scenario of limiting temperature rise to 1.5° Celsius will have to grow to over \$100–150 trillion¹⁰ cumulative in the next three decades, representing an average investment of \$3–5 trillion+ per year globally for decarbonization of 10 sectors that represent 75 percent of global emissions.

Defining Climate Finance Market Structure (CFMS)

The term “Climate Finance Market Structure (CFMS)” is used to collectively define the range of financial market participants, products and financial instruments, policies and regulations, financial market infrastructure, and other enablers (e.g., legal contracts) that support capital markets activity for climate finance.

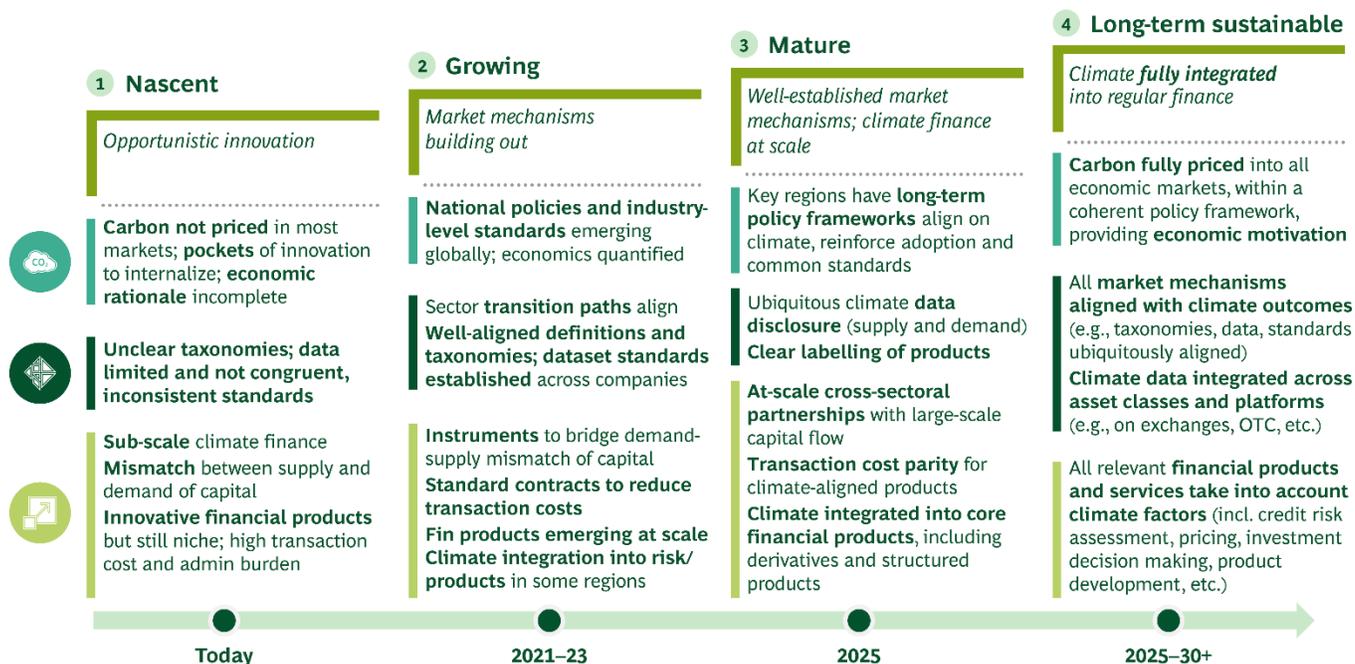


⁸ As per a 2020 study by Oxford Economics.

⁹ **Climate Finance** is defined as financing that supports the transition to a low-carbon and climate-resilient economy by enabling both climate change mitigation actions, especially the reduction of greenhouse gas emissions, and climate change adaptation actions promoting climate resilience of infrastructure and social and economic assets.

¹⁰ The **market sizing** in this report is on financing needs associated with mitigation (climate-aligned finance), but the recommendations cover aspects related to both climate mitigation and adaptation. Market sizing covers 10 sectors that account for ~75% of global GHG emissions. The sections on sector insights and associated annexes provide details on data sources and assumptions that underpin the estimates.

Capital Markets Vision: Evolution of Climate Finance Market Structure (CFMS)



The current market for climate finance is estimated to be approximately \$600 billion,¹¹ implying that an increase of more than five to eight times in the short term will be needed to support transition pathways to a low-carbon economy. The climate finance needs are also not linear over the next three decades—lack of urgent action today will result in significantly higher need for climate adaptation and mitigation investments in the future. The CFMS needs to evolve quickly, based on the recommendations within this report, to enable the significant climate finance need of \$3–5 trillion+ per year (~25 percent of the estimated \$15 trillion a year aggregate global financing pool) to be met.¹² This is achievable, but will require significant near-term action. It can be noted that the Banking and Capital Markets sector has made significant public commitments toward climate goals. This includes a range of commitments from banks to align portfolios with transition pathways to net zero by 2050, and/or financing targets linked to sector-specific sustainability considerations wherein banks have market expertise to help fast-track change. For example, an analysis of sustainable finance commitments made by banks globally shows at least \$4 trillion worth of sustainable finance

¹¹ Market estimated, on average over a two-year period 2017/2018, at \$579 billion, as per Climate Policy Initiative.

¹² Global financing pool is an estimate of aggregate debt, equity, and loans issued in a year (not outstanding).

commitments have been made for varying time frames (typically over the next 5–10 years), which translates to approximately \$700 billion in terms of annual commitments toward sustainable finance.¹³ The scale of financing needed urgently requires all actors to work together to aggressively unblock capital flows for climate finance needs.

A key risk to the scaling of the climate finance market is for policymakers and broader society to consider the role of financial market participants and the financial regulatory framework *independently* from the changes required in the broader economy and economic policy frameworks. **Overreliance on financial regulation—rather than a holistic roadmap including economy-wide actions—to mobilize capital for climate finance and/or the use of financial regulation as a means of incentivizing change in the real economy could result in financial institutions being unable to support real-economy actors in the transition.** Such risks include financing being directed at counterparties that are still economically uncompetitive due to an absence of carbon pricing and a lack of viable transition pathways for existing counterparties to begin their transitional activities. At worst, this could lead to substantial mis-pricing and financial stability risks, which would undermine the long-run ability of the financial system to direct finance to support region- and sector-specific transition pathways.

Five Imperatives for Serving Investment Needs of the Real Economy

(further details in section 3)

1. **The Need for Climate Finance to Scale for ALL Asset Classes:** Climate finance needs to be raised with a mix of instruments—an estimated **35 percent in equity, 44 percent in loans, and 21 percent in bonds.**¹⁴ While the markets for green bonds and loans, which rely on allocating capital based on designated "use of proceeds," has scaled significantly, **this mix highlights the need to scale to other asset classes including equity, structured finance, and bank-intermediated lending while clearly connecting capital market activities, such as derivatives and securities lending, to climate-related metrics and outcomes.** The inclusion of sustainability-linked instruments would also expand the potential financing options to align private finance with Paris-aligned temperature goals. But there is a growing recognition that the scale of financing will largely be sourced from vanilla equity and debt, rather than just "green label" instruments. Further, the development of financing structures to mobilize risk

¹³ Includes public commitments made by Goldman Sachs, JPMorgan Chase, Morgan Stanley, Citi, Wells Fargo, Bank of America, RBC, BMO, BNP Paribas, NatWest, HSBC, Societe Generale, Nomura, Deutsche Bank, Barclays, and Standard Chartered—within the last two years.

¹⁴ This has been estimated based on the expected mix in North America, Europe, and Asia.

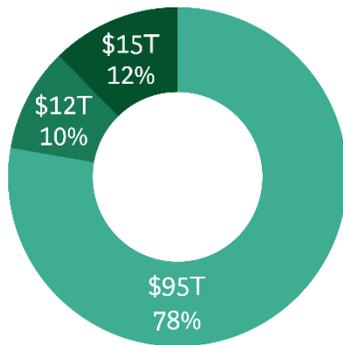
and equity capital for climate finance is necessary, requiring more risk-taking and patient capital to fund investments in early stage technologies and emerging markets.

2. **The Imperative for Global Public Sector Leadership:** Across several sectors, many decarbonization solutions are sub-scale and/or not cost competitive with conventional technologies absent a carbon price. Specifically, greenhouse gas (GHG) emissions are currently not sufficiently priced into markets, reducing the business case for investments that are required to accelerate the transition to a low-carbon economy. Low-carbon technologies are competing on an uneven playing field with legacy and frequently subsidized high-carbon activities. Policymakers will need to address this market failure by establishing sufficiently representative pricing, intentionally aligned carbon price levels, incentives supporting decarbonization, and environmental and industrial policies that align with reaching climate objectives. There is also a critical need for high-risk, patient capital for investments in sectors wherein decarbonization is dependent on technologies that are still in earlier stages of development, such as Iron & Steel, Heavy Road Transport, and Shipping. This will require the deployment of public capital in combination with private funding and innovative risk-sharing structures to support investment needs.

3. **The Most Significant Regional Investment Demand, Estimated at \$66 Trillion, Is in Asia:** This is driven to a large extent by the scale and pace of growth of Asia's economies, growing population, increasing urbanization, and rapid industrialization. For example, in sectors such as Shipping, a large part of the merchant fleet is owned by Asian investors or entities, and sectors such as Iron & Steel have large and growing markets given large-scale infrastructure development. This demand will require the development of more efficient and at-scale capital markets that support global mobilization of climate-aligned capital. There is expected to be a significant dependency on bank-intermediated lending in these markets. Further, mobilizing capital at this scale in Asia is likely to be challenging given COVID-19-related economic strains and constraints on institutional investor risk appetite for exposure to some emerging markets. Financial innovation in Asia may facilitate global funding channels as Asian markets open to foreign investors.

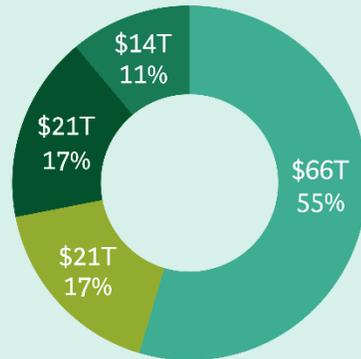
Summary of Investment Need

Common decarbonization themes across sectors



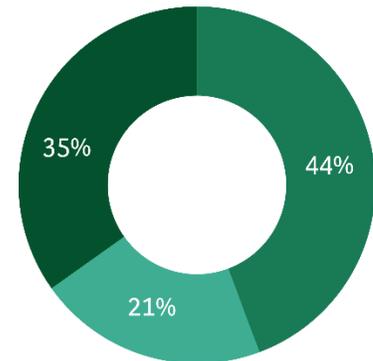
- Electrification & Renewables
- Efficiency & Circularity
- Alternative Technologies

Majority of investment need is in Asia



- Asia
- North America
- Europe
- Rest of World

Need for financing across asset classes



- Loan
- Bond
- Equity

Loans includes different types of loan financing structures such as bilateral lending, project finance, syndicated lending, etc.
Source: BCG Analysis

4. **The Largest Sectoral Investment Need (~\$95T) Is for Electrification of Technologies and Processes, and the Corresponding Switch from Fossil-Fuel-Based Power to Renewable Power:** This need is present in, for example, the Light and Heavy Road Transport, Buildings, and Power sectors. This represents a shift in energy systems away from traditional energy sources such as fossil fuels toward renewable energy. End-use sectors (such as Iron & Steel, Chemicals, Light/Heavy Road Transport, Shipping, Aviation, and Buildings) have traditionally leaned on conventional fuel sources such as oil, gas, and coal. The decarbonization of these sectors involves large-scale electrification, coupled with a shift in the Power sector toward renewable energy, and associated strengthening in grid flexibility and reliability (e.g., with deployment of energy storage) in order to realize emissions reductions. This electrification could also test many of the planet's limitations in new ways—for example, space for new infrastructure, raw materials, and recycling of end-of-life project waste. There is also a significant role across sectors for alternative technologies such as clean hydrogen and carbon capture. Meeting the financial needs of these decarbonization levers will require not only a significant scaling of the climate finance market but also changes in financial solutions and partnership models and the growth of new industries. However, it should be noted that while we pursue the collective ambition of a decarbonized global economy, it will require significant

technological advances—and the hydrocarbon sector will continue to play a critical role during this transition process.

5. **A Collaborative Multi-sector Effort to Address Transversal Risks and Opportunities:** Ten sectors¹⁵ account for approximately 75 percent of global GHG emissions. Decarbonization of these sectors will require development of new business models, investment, and collaboration across sectors. For example, the Energy sector is expected to play a critical role in the decarbonization of industry and transport through renewable electricity, alternative fuel production, and management of carbon capture utilization and storage (CCUS) sites. The development of an at-scale clean hydrogen industry will be essential to decarbonize sectors such as Iron & Steel, Heavy Road Transport, Aviation, and Shipping. Traditional industry sector boundaries will be stretched and leading firms will have to traverse across different sectors—for example, battery storage and mining. This will require large-scale cross-sectoral collaborations, mergers and acquisitions, and/or investments across all sectors over the period of transition.

Recommendations to Scale the Climate Finance Market Structure

Achieving the pace and scale of growth in climate finance will require fundamental changes to the current financial market structure to enable the needed efficiency, transparency, and scalability to address climate risks. This will require concerted and coordinated action by all stakeholders—the public sector, the real economy sectors, the Banking and Capital Markets sector, private and institutional investors and asset managers, and the social sector—to support the development of the CFMS.

The following capital markets participants' recommendations highlight an integral set of priority actions that, taken together, help facilitate the development and future of the CFMS. They were identified through interviews of 100+ capital markets leaders (comprising banks, investment banks, investors and asset managers, corporates, financial market infrastructures, innovators, standard-setting bodies, multilaterals, and regulators) during Q3 of 2020.

¹⁵ Power, Iron & Steel, Chemicals, Cement, Aviation, Shipping, Light Road Transport, Heavy Road Transport, Aviation, Shipping, Agriculture, and Buildings—these sectors have been included in the analysis in this report.

#1 (detailed in section 4.1.1): We recommend that **governments establish legally enforceable, comprehensive, and sufficiently high levels of GHG-emissions pricing ("carbon pricing") mechanisms such as a GHG tax or trading schemes**, with explicit forward-looking direction on price levels, implemented in a way that respects a "just transition," minimizing social and economic costs for those least able to bear them.

- Currently, GHG emissions, the externality of carbon-fueled products and services, are not sufficiently priced into markets and the real economy, adversely impacting the business case for investments that are required to accelerate the transition to a low-carbon economy and creating a major market failure. Low-carbon alternatives are competing on an uneven playing field with legacy high-carbon activities that at times benefit from government subsidies.
- **Addressing this market failure requires both swift action to establish a sufficiently high and internationally aligned carbon price in the short term and increases in future carbon price levels to incentivize investment in low-carbon technologies today.** At the same time, this not a complete solution. For several hard-to-abate sectors, carbon pricing alone is insufficient, as the abatement costs, based on current technologies, exceed the typical levels that have been achieved by carbon pricing. The High-Level Commission on Carbon Prices suggested a carbon price in the range of \$40–80/t in 2020 rising to \$50–100/t by 2030 for a 2°C target. **Current carbon pricing schemes only cover ~22 percent of global GHG emissions,¹⁶ with almost half of them priced at less than \$10/tCO₂e.** Where needed, governments should evaluate the establishment of carbon border adjustment mechanisms to provide a level playing field for trade and to prevent carbon leakage, in close consultation with industry and in a manner that accounts for differences in transition pathways between countries.
- For most countries, the cost of inaction and the economic opportunities from climate action are likely to be significant. A country-level benefit of (often) 1+ percent of GDP¹⁷ is estimated in addition to the collective, global business case of avoiding the 20+ percent GDP downside¹⁸ triggered by global warming.

¹⁶ World Bank State of Carbon Pricing 2020.

¹⁷ BCG publications: "The Economic Case for Combating Climate Change," "Flipping the Script on Climate Action."

¹⁸ As per a 2020 study by Oxford Economics in a scenario of global warming of 3°C by 2100.

#2 (detailed in section 4.1.2): We recommend that **governments commit to and implement effective and proportionate policies, fiscal programs, and legislative action** that will support achievement of the targets established in the Paris Agreement.

- **Stronger global goals on GHG emissions should be established**, together with appropriate corresponding transition pathways. Governments should commit to targets for their jurisdictions that align with Paris Agreement ambitions of limiting global warming this century to 1.5°C above pre-industrial levels, and translate these targets into national/regional environmental policies, industrial/sectoral policies, and fiscal and monetary programs. These policies, programs, and incentives should support and accelerate the development of low-carbon technologies needed to achieve Paris Agreement targets, several of which are not yet commercially viable. Further, governments should align their COVID-19 recovery funding and economic stimulus packages to pursue inclusive, sustainable, and green recovery—for example, given ongoing relief efforts from governments for the Aviation sector, they should consider including emissions targets and other covenants within COVID-19 relief packages in order to accelerate decarbonization.

#3 (detailed in section 4.1.3): We recommend that **governments and national/multilateral development banks motivate the mobilization of private sector capital through blended public/private finance solutions**.¹⁹

- There are three sources of risk that are disproportionately limiting the scale of the climate finance market. First, across several sectors, decarbonization solutions (e.g., production of low-carbon gases such as green hydrogen) are sub-scale and/or are not cost competitive with conventional technologies absent a carbon price. Second, several projects are not yet at scale and are small in number, leading to a lower overall volume of capital flow and need. This introduces barriers to attracting investors, particularly institutional investors that consider liquidity or minimum ticket sizes for rendering their investments economical. Third, financing of climate action in emerging markets is further constrained by sovereign, currency, and political risk factors.
- In order to de-risk capital outlay, concessionary capital (e.g., from public or private sources) must be deployed to mobilize additional capital for investment needs. **The public sector**

¹⁹ Blended finance is defined as the use of catalytic capital from public sector or philanthropic sources to increase private sector investment in sustainable development. Source: Convergence Blended Finance.

should dramatically scale up the supply of catalytic capital²⁰ to mobilize private sector capital and enable long-dated higher-risk capital flow. Further, government sponsorship of research and development, in combination with private sector capital and expertise (venture capital and private equity), can accelerate the development and commercialization of innovative technologies for a low-carbon economy.

#4 (detailed in section 4.1.4): We recommend **financial education and climate finance risk awareness building at an executive level to support corporates' ability to actively prioritize and accelerate their own preparations for a low-carbon future**, embedding this as a strategic imperative for their boards and senior management.²¹ The Banking and Capital Markets sector will be an important partner to corporates to both help navigate the risks and opportunities of climate change and mobilize appropriate financing solutions.

- Many industries and corporates are at different stages of understanding the implications of climate change on their business models and processes—both from a transition and physical risk perspective. Heightened expectations of institutional investors are driving the financial materiality of climate related risks and opportunities. **Leading companies are taking measures such as building strong accountability through boards and senior executives, establishing internal carbon pricing, and investing in innovation.** Growth in demand for financing of climate mitigation efforts by corporates, especially those with higher exposure to climate-related risks and opportunities, is an essential component for the development of more efficient and at-scale CFMS that supports global mobilization of climate-aligned capital.

#5 (detailed in section 4.1.5): We recommend that **corporates and their industry associations** coordinate and collaborate with the scientific community, standard-setting bodies, financial institutions, and governments to **accelerate the development and alignment of sector- and region-specific transition pathways** to achieve Paris Agreement climate goals, including viewpoints on where there is still evolution expected.

- The IPCC has determined global carbon budgets and pathways to achieving a 1.5°C target. **The translation of this global budget into sector- and region-specific budgets and pathways is a crucial next step that is yet to be aligned.** Alignment on these pathways will help deliver the clarity needed to drive climate action at scale from the real economy, and further enable

²⁰ Catalytic capital is defined by the MacArthur Foundation as “debt, equity, guarantees, and other investments that accept disproportionate risk and/or concessionary returns relative to a conventional investment in order to generate positive impact and enable third-party investment that otherwise would not be possible.”

²¹ In this report the term "corporate" refers to non-financial companies.

the creation of taxonomies and benchmark standards for climate finance. **Transition pathways should be based on inherent structural differences across different regions and factors such as geography, industrial mix, etc., and should be flexible to account for uncertainties of technological and scientific progress, and industry-specific solutions.**

#6 (detailed in section 4.2.1): We recommend **mandatory disclosure of corporate-specific, financially material, decision-relevant data relating to climate risks and opportunities.** Consistent global disclosure frameworks, developed in consultation with industry participants and with adequate runway for implementation, should help strengthen the transparency and comparability of climate risk data.

- **Market regulators, accounting standards boards, and exchanges,** in consultation with corporates, Banking and Capital Markets firms, and investors, **should continue to develop consistent climate-related disclosure frameworks** for financial and non-financial corporates that are **aligned with the Task Force on Climate-related Financial Disclosures (TCFD) recommendations and that provide a real benefit to providers and users of climate data.** They should continue efforts to accelerate adoption of these disclosure frameworks.
- To date, voluntary disclosure regimes such as TCFD have proven to be helpful in guiding both voluntary and mandatory disclosures that allow corporates and investors to take into account materiality to the sector and proportionality. **Climate disclosure regimes should balance the objectives of consistency and flexibility to reflect that materiality is corporate-specific and should reflect decision-relevant information for financing decisions.** This recognizes that corporates in similar sectors can be exposed to different material risks and opportunities, reflecting differences in individual business models and operating environments.
- Ultimately, **internationally consistent material disclosures may be needed, taking into consideration best practices emerging from existing standards and global frameworks,** to deliver comparable, comprehensive, decision-relevant climate data that is beneficial for the development of CFMS. Climate-related disclosures by banks have dependencies on non-financial corporate disclosures, and therefore, importantly, detailed banking disclosures and **regulatory reporting requirements for capital market participants should not front-run the adoption and capacity of corporates** to provide such financially material disclosures.
- **Recognizing some jurisdictions are taking a more accelerated approach—and where appropriate, mandating financially material disclosures** to facilitate transition of the real economy—policies should create appropriate incentives to encourage engagement with clients and investees on low-carbon pathways, and **reflect that not all sectors are at the same stage of preparedness for transition.** Regulated financial institutions have an important role

to play in partnering with clients on low-carbon solutions, particularly in sectors of the economy wherein **decision-relevant climate data may be less identifiable at this time.**

- We further believe that a **globally consistent approach to sustainability reporting is pivotal to prevent the proliferation of various emerging public and private reporting initiatives, which are often not aligned, make reporting costly and time-consuming for preparers, and are confusing and time-consuming to compare for users.** Financial and non-financial firms operating cross-border, in particular, face additional costs, complexity, and reduced **reliability of data due to lack of consistent frameworks.** Being aware that the administrative and economic costs of reporting would be significant (especially for micro-businesses), we believe that small and medium enterprises (SMEs) should be allowed to adopt a simplified standard, based on a very rigorous application of the materiality principle and corporate-specific exposure to risks that would reduce the number of metrics SMEs would report.

Scope of disclosures covered in the report

	Private companies	Public non-financial corporates	Banking and Capital Markets firms
Corporate reporting (e.g., annual reports) <i>Guidance: Accounting standards boards</i>			<i>Addressed in Section 4.2.1</i>
Corporate reporting by securities regulators <i>Guidance: Securities regulator</i>			
Climate financial disclosures <i>Guidance: TCFD</i>			
Exchange listing rules <i>Guidance: Exchanges</i>			
Regulatory reporting for financial institutions <i>Guidance: Prudential regulator</i>	<i>Not applicable</i>		<i>Addressed in Section 4.3</i>

#7 (detailed in section 4.2.2): We recommend that **the Banking and Capital Markets sector accelerate the development and scaling of a broad range of products and instruments in both public and private markets to meet the financing, investing, risk management, liquidity, and funding requirements of a range of market participants actively starting to transition.** The range of products and instruments should include syndicated and bilateral loans, bonds, equity,²² structured products, derivatives, project finance, and securities financing. In addition, we recommend that **regulators holistically assess any current regulatory barriers that prevent this process, and encourage the development** of these products and solutions.

- **The climate finance market needs to scale across all asset classes**—for instance, to bring more high-risk and patient capital (e.g., “green equity” that might represent equity capital from private and public sources that supports low-carbon technologies) to fund investments in early stage technologies, start-ups, and emerging market firms. Banks and capital markets firms should scale up the development of **blended finance structures in collaboration with the public and social sectors to mobilize private sector capital toward riskier investments.** Further, they should **scale the development of the derivatives market for climate risk mitigation and better allocation of risk, as well as the use of pooling and securitization.** In addition, the development of **securities financing markets (with climate-aligned instruments as collateral) will enhance market liquidity and lower the cost of funding for climate finance.**
- There is also a significant role for the Banking and Capital Markets sector to **go beyond financial support, actively engaging with their clients through promoting cross-sectoral initiatives.** This is particularly relevant in sectors that are highly dependent on other sectors for decarbonization—for example, the Iron & Steel sector that is likely to rely on clean hydrogen, or the Shipping sector that will rely on development of alternative fuels from sectors such as Chemicals and Energy.
- Many banks now have clear frameworks in place and have publicly disclosed commitments for significant balance sheet and financing capacity focused on assets that integrate Environmental, Social and Governance (ESG) factors. It is timely to rethink the approach and tools used to finance these commitments. Issuance across banks' entire liability structures (including non-equity capital) may be helpful in ensuring banks can continue to play their part in addressing environmental and social challenges. A globally consistent framework for banks to issue going and gone concern sustainable securities, including green capital instruments, is still lacking despite indications of strong investor appetite. An integral piece of the framework should be the inclusion of climate-aligned instruments to meet prudential

²² Including equity-like instruments, such as convertible bonds and hybrid capital.

requirements on a like-for-like basis with existing equity and hybrid capital when considering regulatory ratios (capital, funding, and liquidity) accelerating realignment of bank balance sheet capacity with climate ambition.

#8 (detailed in section 4.2.3): We recommend that the Banking and Capital Markets sector, standard-setting bodies, industry, policymakers, and financial regulators **collaborate to achieve consensus on a common global definition and set of principles concerning what constitutes climate finance**. This should be translated into **sector- and region-specific taxonomies** that are comparable, flexible for evolution in response to technological and scientific developments, and include climate-related performance indicators and targets that correspond to Paris-aligned transition pathways.

- The shortcomings of foundational elements—which include the current lack of (a) common global definition of climate finance, (b) consistent principles for the development of taxonomies, and (c) well-defined sector- and region-specific taxonomies—result in higher transaction costs, the exclusion of several transition activities, and, more broadly, a sense of confusion in the CFMS. **This report proposes a set of principles for the definition of taxonomies (see section 4.2.3).**
- Importantly, taxonomies must lead to **inclusion of a range of transition and enabling activities, and not focus purely on zero-carbon activities**. Excluding specific activities or sectors will pose a big risk to the successful achievement of an orderly transition. They should also be based on **common global principles, but be flexible in terms of regional and temporal variation**.
- Further, financial instruments such as green bonds and green loans often rely on a “use of proceeds” model, which requires issuers to use funds raised for qualifying projects. Although this is an important first step, the issuance volume of green bonds to date is a small percentage (~2 percent) of global fixed income issuance.²³ **Climate finance needs to scale beyond a “use of proceeds” approach to a broader taxonomy that is inclusive of all types of financial transactions—including equity, structured products, and derivatives, which are an important hedging tool for corporates—and include specific metrics and thresholds that enable achievement of climate goals**. Scaling of instruments such as sustainability-linked bonds and loans would expand the financing options to align private finance with Paris Agreement goals. **Further, there is growing recognition that climate finance must scale to**

²³ Estimated percentage of total global bond issuance labelled green in 2019. Includes government bonds, corporates (financial and non-financial), securitized products, covered bonds, municipals; Source: AFME.

cover all equity and debt rather than pure "green" label instruments, while doing so in a way that retains alignment to scientifically determined climate-related indicators and targets.

#9 (detailed in section 4.2.4): We recommend that as data becomes more available, **investors and asset managers continue to work toward accelerating integration of climate factors into their investment process, including integration of climate-related risk factors into risk and valuation models and frameworks.** We also support investors and asset managers **in their transition strategies for a Paris-aligned temperature scenario,** and GHG reductions through **engagement and stewardship with their portfolio companies.**

- Asset managers and investors recognize climate-related risk factors in investment and capital allocation decisions. However, such analysis is significantly hampered by the level of disclosures and data availability. By deepening the integration of climate-related risks into investment decisions and investor stewardship priorities, investors—particularly asset owners—play a key role in influencing both the risk-adjusted costs of capital and availability of capital, especially for carbon-intensive sectors and assets.

#10 (detailed in section 4.2.5): We recommend that the Banking and Capital Markets sector and other market participants **promote an innovation mindset in scaling climate finance.** Innovation in financial markets—including financial product innovation; leveraging geospatial data for climate risk and asset performance assessment; Artificial Intelligence/Natural Language Processing (AI/NLP) to transform unstructured reporting and disclosures to structured and comparable decision-relevant data; standardization of legal contract language and industry data models; advancements in scenario analysis and risk modeling; and tools and platforms to promote climate finance awareness and literacy—will be critical to scaling climate finance.

- The transition to a low-carbon economy will require an exponential increase in climate-aligned investments. Financial product innovation will play a critical role in the mobilization of a broad pool of capital, including active participation by retail investors in funding climate finance. Mobilization of retail investor funding will require standardization of definitions, taxonomies, and labels that can communicate the risk-return characteristics and potential alignment with climate ambition in a simple manner. Fintech solutions could, for example, enable retail investors to have easy access to their investment portfolios by security, a measure of how these are performing financially, and how the associated companies contribute to delivering climate finance. Financial product innovation for retail products must remain consistent with legal and conduct requirements and balance reputational risks for the providers of products as it is extended to the non-institutional market segment. The

Banking and Capital Market sector and the Wealth and Asset Management sector can play a critical role in investor education and awareness.

#11 (detailed in section 4.3.1): We recommend that **supervisors, policymakers, and regulators seek to mitigate the risk of market fragmentation²⁴ through increased use of ex-ante, globally consistent regulation²⁵ and ex-post supervisory tools to support the development of consistent regulatory drivers, or intended barriers, aligned with the pace of climate finance market developments** and broader change in economic policy.

- Climate change is a risk for the financial sector and, if not managed, could be a source of risk to financial stability. Regulation has a role in managing the macro- and micro-prudential risk associated with climate change. However, regulation should not be a substitute for change in broader industrial, environmental, and economic policy. Regulation should be globally consistent and aligned with the pace of climate-finance market developments. Pre-emptive and punitive regulation could hamper the scaling of climate finance markets, result in disorderly market price movements for impacted sectors, and constrain the flow of capital required to transition hard-to-abate sectors and regions.

#12 (detailed in section 4.3.2): We recommend that **the Banking and Capital Markets sector share best practices of climate risk management capabilities, as well as increase transparency of the integration of climate risk** within firms' governance, strategy, planning, resource allocation, and risk-adjusted performance management framework.²⁶

- Regulation is an important element in accelerating the evolution of the CFMS. It is important that regulation timelines consider the pace at which foundational capabilities required to fully comply, such as the provision of high-quality data, are also evolving.²⁷ Regulation should not drive toward simplistic "label-based" prudential surcharges or incentives (i.e., green is good, and brown is bad), but rather should be risk-based requirements reflective of the risk profile of the underlying exposure. And, finally, collaboration across the Banking and Capital Markets sector and regulators will be critical in order to support the development of leading practices in climate finance and risk management.

²⁴ FSB Report on Market Fragmentation (June 2019); and IOSCO Good Practices on Processes for Deference (June 2020).

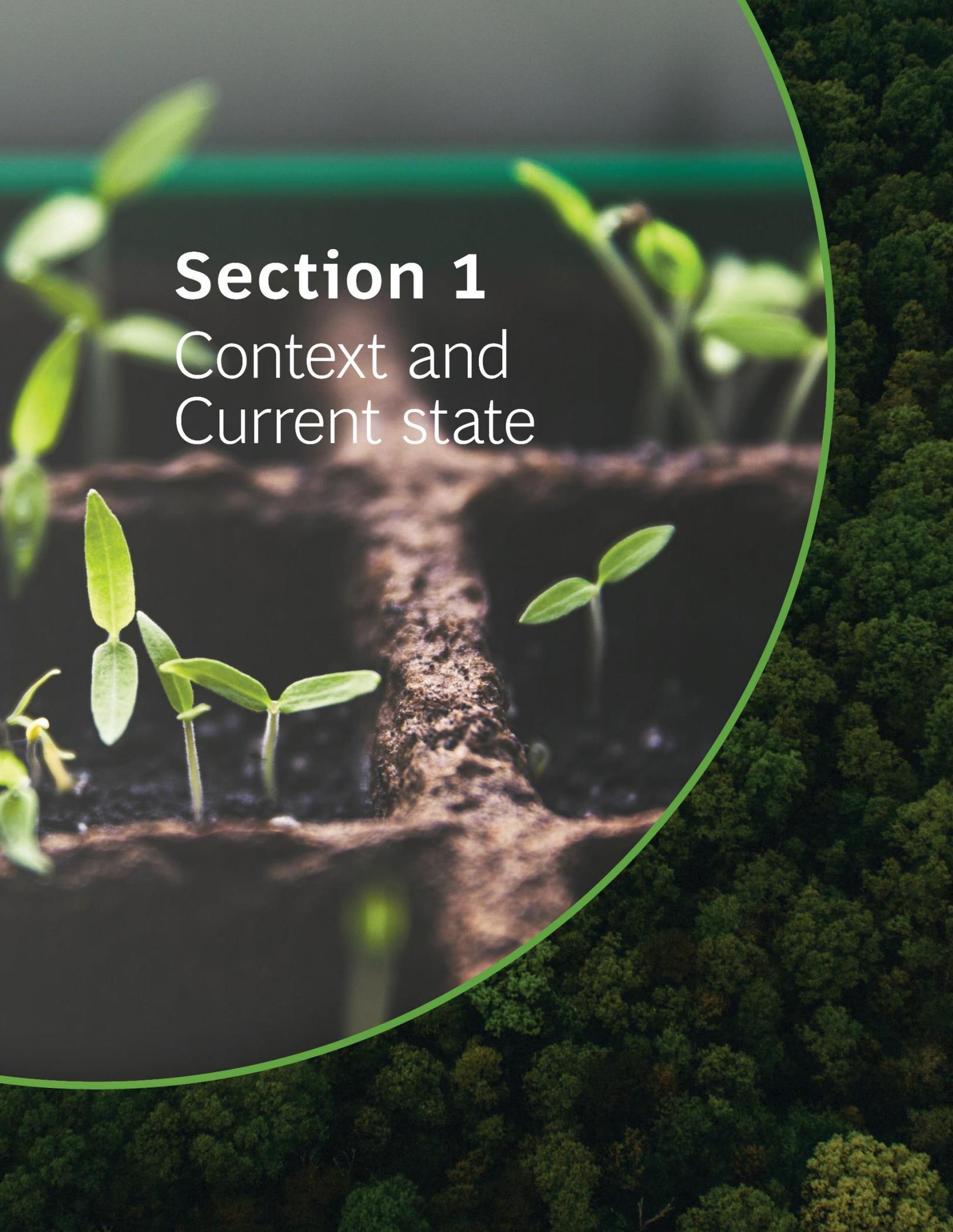
²⁵ Includes prudential, market, and conduct regulation.

²⁶ Subject to applicable international and national competition law regulation; Risk-adjusted performance management framework is defined as the management accounting framework used for internal and external measurement of financial performance (e.g., RAROC).

²⁷ Foundational capabilities include taxonomies, accounting and disclosure standards, data management (definitions, collection, aggregation, and reporting), methodology, and technology tools.

For further details, please see the core sections of this “Climate Finance Markets and the Real Economy” report for an in-depth analysis of the following areas:

1. **Context and Current State**
2. **Vision for At-Scale Climate Finance Market Structure:** Key characteristics of an at-scale and efficient Climate Finance Market Structure
3. **A \$100–150 Trillion Investment Need—Sectoral and Regional Insights and Implications:** Sector-specific insights and investment needs analysis including key decarbonization levers for sectors covering 75 percent of global GHG emissions, estimations of the capital requirements, and decomposition by region and instrument type. This report focuses on a subset of 10 sectors: Power, Iron & Steel, Cement, Chemicals, Light Road Transport, Heavy Road Transport, Aviation, Shipping, Agriculture, and Buildings
4. **Recommendations for Scaling Climate Finance:** Current state of development, key constraints that are limiting the growth of the climate finance market, and recommended priority actions to be taken by the different participants of the Climate Finance Market Structure
5. **Call to Action:** Summary of recommendations and sector insights, priority actions recommended for each stakeholder to achieve an at-scale and efficient Climate Finance Market Structure



Section 1

Context and
Current state

1 Section 1: Context and Current State

1.1 The Climate Imperative for Financial Institutions

Climate change poses economic and financial risks to the global economy. More than 20 percent of global GDP will be at risk by 2100.²⁸ The world is already approximately 1°C warmer than pre-industrial levels,²⁹ with widespread impact on economies, communities, and ecosystems. The current path of economic growth the world is on corresponds to a scenario of increasing temperatures by approximately 3°C above pre-industrial levels by 2100.³⁰ This scenario has devastating, irreversible impacts on human life.

The Paris Agreement aims to keep a global temperature rise this century well below 2 degrees Celsius above pre-industrial levels and to pursue efforts to limit the temperature increase even further to 1.5 degrees Celsius. Also, as per the IPCC, "Climate-related risks for natural and human systems are higher for global warming of 1.5°C than at present, but lower than at 2°C." **In order to achieve 1.5°C, global emissions will need to decline from the current approximately 53 GteqCO₂ emissions per year by more than 50 percent by 2030³¹ and to net zero³² emissions by 2050.³³** In this report, a reference to "Paris-aligned" or "Paris ambition" or "Paris ambition-aligned" refers to an ambition of pursuing efforts to limit global temperature rise to 1.5°C.

Meeting these targets will result in a significant reshaping of the global economy and have profound implications for financial markets. Financial markets will need to evolve in order to integrate climate-related risks and opportunities into strategies. There will also be significant opportunities for innovative new solutions that enable companies to transition in an orderly manner to a low-carbon future.

²⁸ As per a 2020 study by Oxford Economics in a scenario of global warming by 3°C by 2100; the original study has been used by noted organizations such as the IMF.

²⁹ IPCC SR15 report from 2018.

³⁰ As per Climate Action Tracker, 2.9°C is the median for current policy projections.

³¹ The Special Report on 1.5°C (SR15) released by the IPCC in 2018 confirmed that, "In model pathways with no or limited overshoot of 1.5°C, global net anthropogenic CO₂ emissions decline by about 45% from 2010 levels by 2030 (40–60% interquartile range), reaching net zero around 2050 (2045–2055 interquartile range)."

³² Intergovernmental Panel on Climate Change (IPCC) definition of net zero: a global balance between anthropogenic emissions by sources and removals by sinks of greenhouse gases.

³³ The Special Report on 1.5°C (SR15) released by the IPCC in 2018 confirmed that, in order to limit global warming to 1.5°C, we need to reach net-zero CO₂ emissions at the global level by mid-century.

1.2 The New Era of Climate Finance

Climate finance is defined as financing that supports the transition to a climate resilient economy by enabling mitigation actions, especially the reduction of GHG emissions, and adaptation initiatives promoting the climate resilience of infrastructure as well as generally of social and economic assets.³⁴ Climate finance can be further disaggregated into two components that are for the most part distinct:

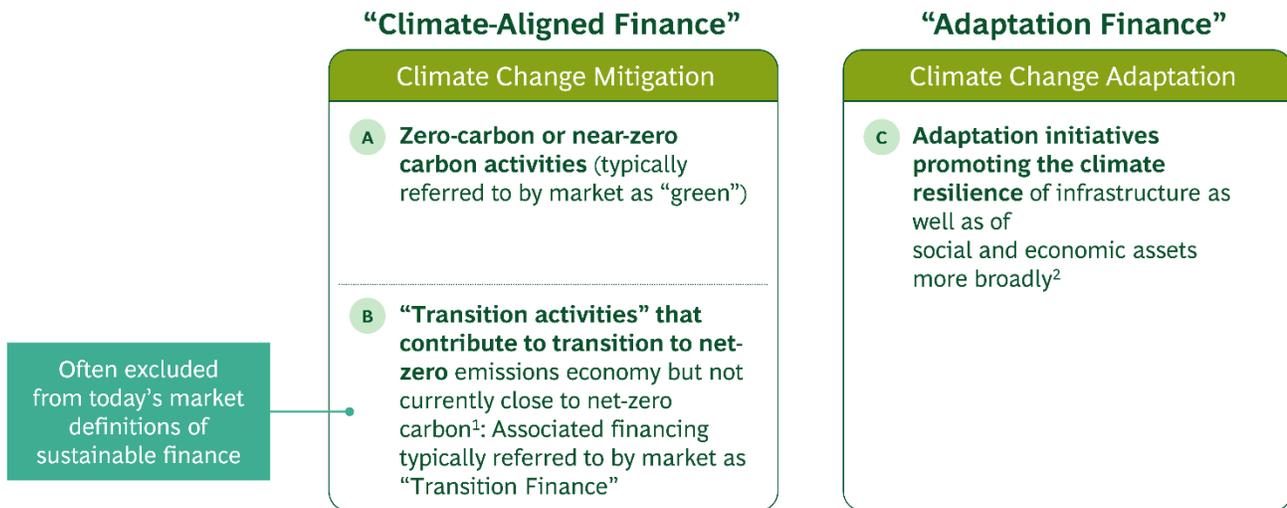
- **Climate-aligned finance—or finance that supports mitigation:** This refers to financing that enables actions that mitigate climate change (especially the reduction of GHG emissions) and aligns financing³⁵ with climate goals (e.g., the Paris Agreement ambition). Examples of climate-aligned finance include financing of electrification projects such as replacing internal combustion engine (ICE) fleet vehicles with electric vehicles (EVs), "greening the grid" by decommissioning high carbon emitting assets and replacing them with renewable electricity production, and deployment of novel technologies such as the production of steel using green hydrogen.
- **Finance that supports adaptation:** This refers to financing of adaptation initiatives that promote resilience of infrastructure, social, and economic assets to climate change and its consequences. Examples of this include construction of seawalls to improve resilience of seaside infrastructure, flood protection, and fire protection.

The primary focus of the market sizing in this report is on financing needs associated with mitigation (termed "climate-aligned finance"), but the report also provides recommendations for integration of both transition and physical risks (mitigation and adaptation).

³⁴ This report uses the definition as per ICMA as a starting point.

³⁵ As per the Center for Climate Aligned Finance at the Rocky Mountain Institute (RMI), this is the alignment of portfolio and activities to the decarbonization goals of the Paris Agreement. And to achieve "climate alignment," a financial institution must (1) understand current portfolio relative to a <2°C pathway and (2) commit to take the steps necessary to merge onto that pathway.

Components of Climate Finance



1. Defined as per definition in EU taxonomy; should show trajectory of performance that aligns with Paris Agreement-aligned transition pathways 2. As per ICMA definitions

Figure 1: Components of climate finance

1.3 The Climate Finance Market Structure (CFMS)

The development of climate finance is dependent on an ecosystem of market participants and structures that include, but are not limited to, the Banking and Capital Markets sector. The following exhibit visualizes the definition of market structure as it pertains to this report.

Defining Climate Finance Market Structure (CFMS)

The term “Climate Finance Market Structure (CFMS)” is used to collectively define the range of financial market participants, products and financial instruments, policies and regulations, financial market infrastructure, and other enablers (e.g., legal contracts) that support capital markets activity for climate finance.

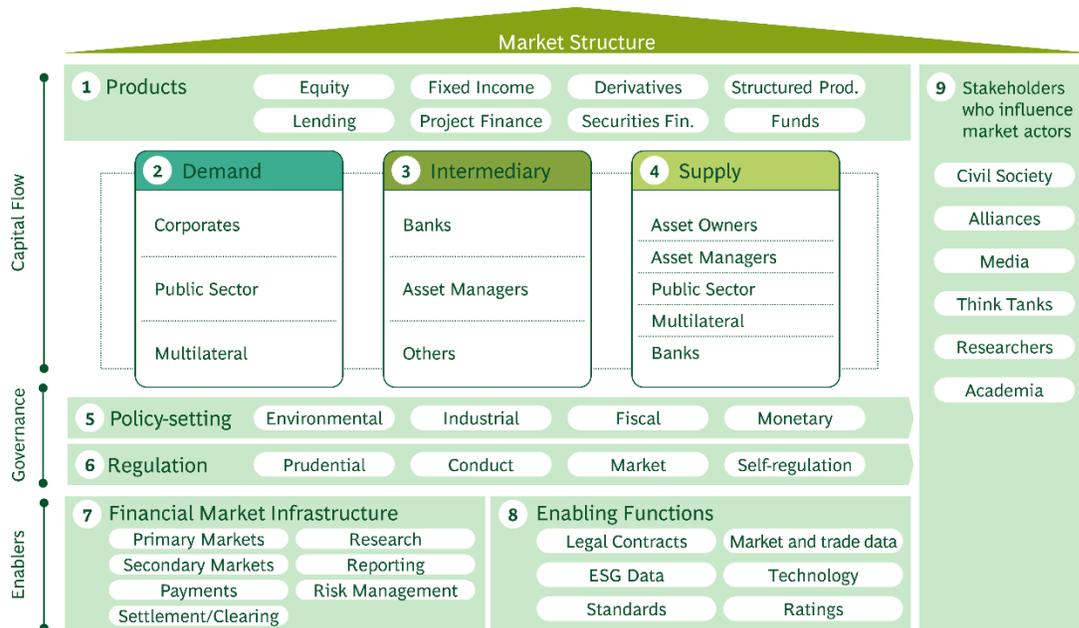


Figure 2: Defining Climate Finance Market Structure (CFMS)

In addition to the role of the Banking and Capital Markets sector—as lenders, arrangers, and investors—there is also expected to be a significant role for other financial services institutions. This includes fund managers and insurance investors, private equity firms, financial market infrastructure, development banks, multilaterals, and venture capital firms, which are expected to play key roles in providing the higher-risk patient capital needed for transition. In addition, pension and other asset owners and asset managers will play a key role as suppliers of capital through asset allocation.

1.4 The Current State of the Climate Finance Market

The market for climate finance is nascent, but growing quickly. The total size of the market for climate finance in 2018 (including mitigation and adaptation) was ~\$600 billion.³⁶ Of this, a large portion (~45 percent) was driven by the public sector, including governments and Development

³⁶ Climate Policy Initiative—Global Landscape of climate finance 2019.

Financial Institutions (DFIs). Within this market, certain asset classes such as green bonds have seen strong growth, reaching an annual issuance of approximately \$250 billion in 2019,³⁷ and \$260 billion in year-to-date 2020.³⁸ With sovereigns entering the market for green bonds, some expect the market to grow to \$1 trillion by the end of 2021.³⁹ As the market for climate finance matures, there is also expected to be a significant growth in other asset classes, including corporate lending, equity issuance, and secondary markets such as derivatives and structured products.

Market sizing

This scale is still far from the estimates of the need for financing that vary widely in a range of ~\$1–7 trillion+⁴⁰ per annum over the next 30 years in order to achieve the goals of the Paris Agreement. This report further estimates a range of approximately \$3–5 trillion+ and adds detail by sector and region (refer to Section 3 on sector insights). These estimates do vary widely, but will continue to increase each year as the world falls behind climate targets, further adding to needed adaptation investments as climate impacts become more pronounced.

The Banking and Capital Markets sector has made encouraging commitments toward climate goals.

This includes commitments from banks to align portfolios with a pathway to net zero by 2050, as well as financing targets linked to sustainability considerations. For example, an analysis of sustainable finance commitments made by banks globally shows at least \$4 trillion worth of total sustainable finance commitments made for varying time frames (typically over the next 5–10 years), which translates to approximately \$700 billion in terms of annual commitments toward sustainable finance.⁴¹ While this represents a large amount of capital, a key takeaway of this report is that even more will be needed—all stakeholders including private equity, governments, regulators, and corporates have a role to play collectively in the most globally coordinated manner possible.

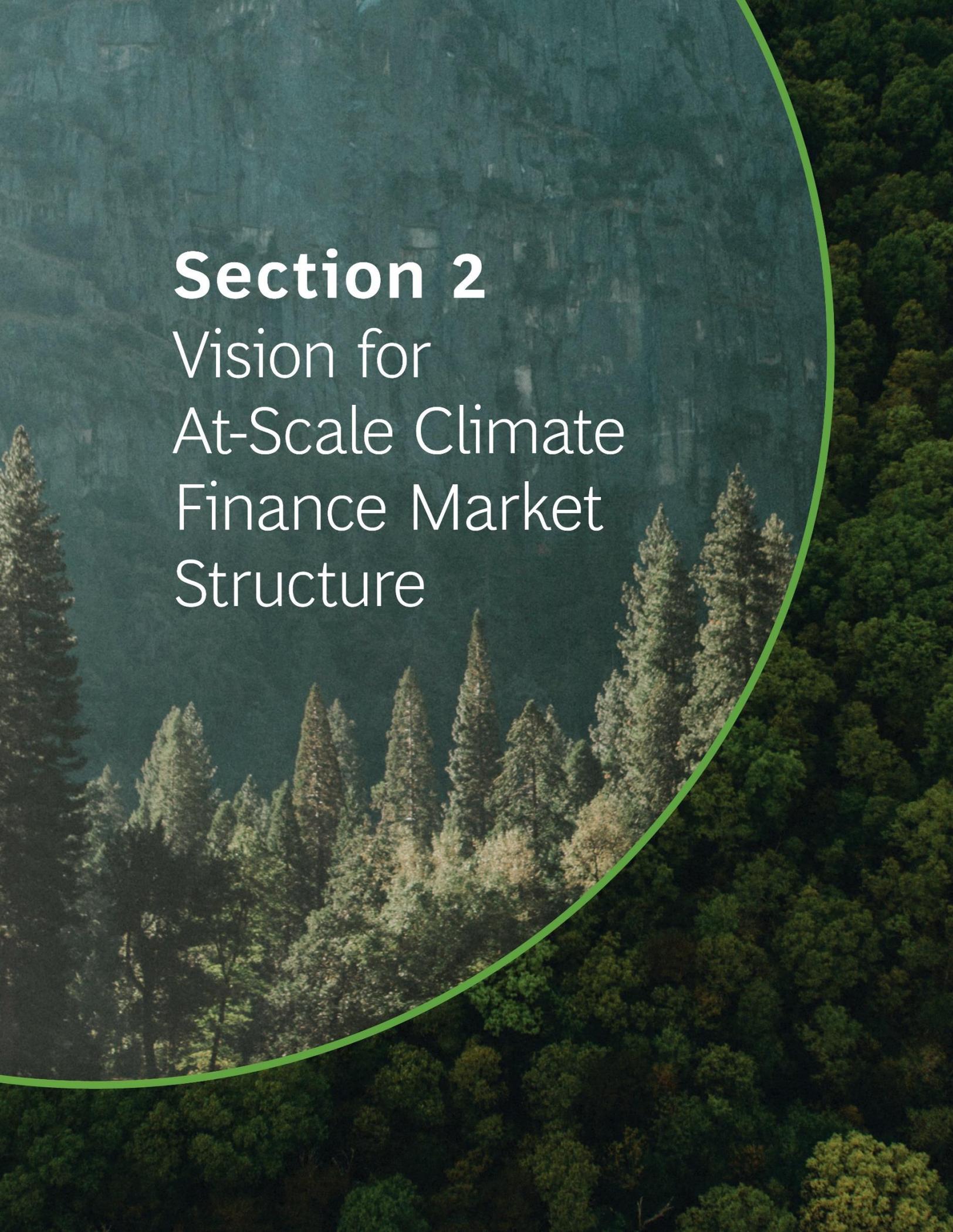
³⁷ Bloomberg; includes corporate and government bonds.

³⁸ Bloomberg, as of end Nov 2020, includes planned issuances for Dec 2020.

³⁹ As per AXA Investment Managers.

⁴⁰ UNEP estimates \$1.5 trillion; TCFD ~\$1 trillion, \$1.6–3.8 trillion as per IPCC for energy systems alone; OECD estimates investment needs of \$6.9 trillion per year over next 15 years for <2°C for new infrastructure.

⁴¹ Includes public commitments made by Goldman Sachs, JPMorgan Chase, Morgan Stanley, Citi, Wells Fargo, Bank of America, RBC, BMO, BNP Paribas, NatWest, HSBC, Societe Generale, Nomura, Deutsche Bank, Barclays, and Standard Chartered—within the last two years.

An aerial photograph of a dense forest, featuring a mix of tall, thin evergreen trees and shorter, denser deciduous trees. A large, semi-transparent circular graphic with a bright green border is overlaid on the left side of the image, framing the text.

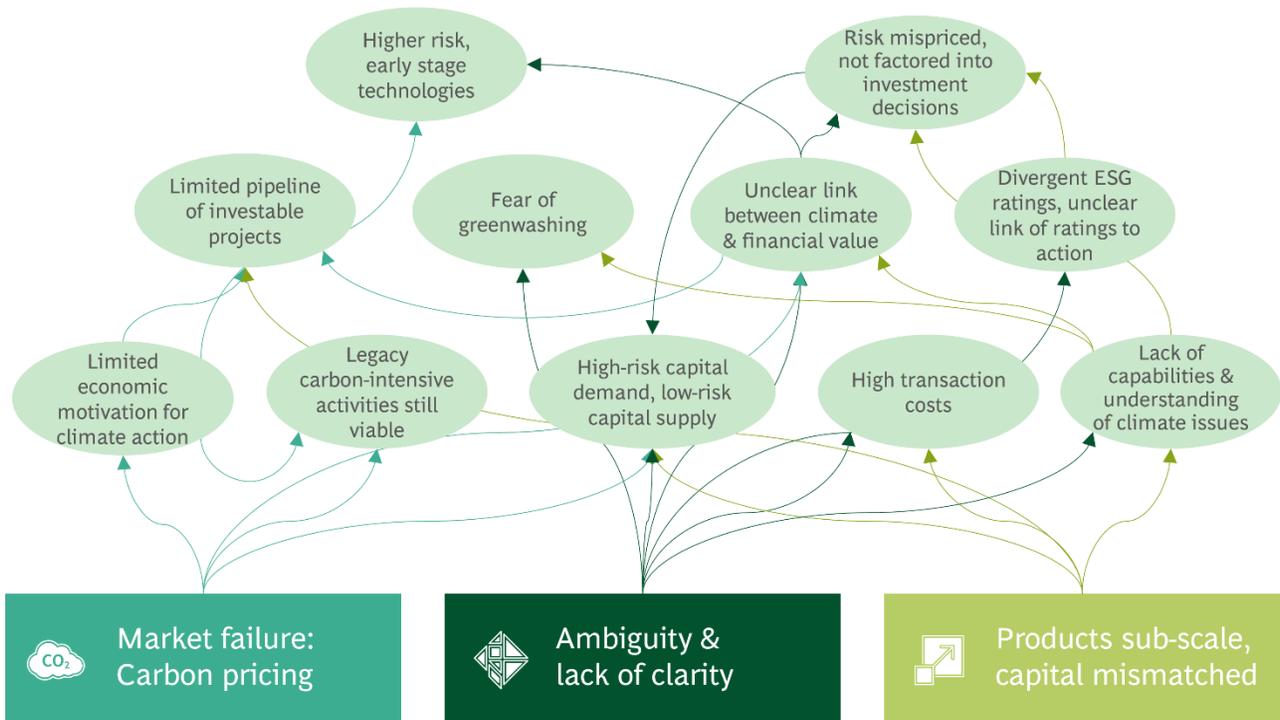
Section 2

Vision for
At-Scale Climate
Finance Market
Structure

2 Section 2: Vision for At-Scale Climate Finance Market Structure (CFMS)

There are **three underlying constraints** limiting the potential of the climate finance market.

Three core underlying root causes leading to an underdeveloped climate finance market structure



- **Carbon not sufficiently priced in markets** as an externality
- **Economics not providing motivation** for change
- **Limited public incentives**, lack of long-term commitments, and policies creating uncertainty
- **Unclear link** between climate and financial/strategic value
- **Insufficient demand** for sustainable products

- **Inconsistent and incomparable ESG data**—limited to mostly large corporates
- **Unclear understanding of transition pathways** by sector and region
- Unclear understanding of sustainable finance products & solutions; **unclear labelling**
- **Lack of common definitions & taxonomies** for climate/sustainable finance

- **Demand-supply mismatch** on risk-profile of capital supply and demand
- Financing solutions niche, **limited integration** into “core” financing activity
- **High transaction costs** for climate finance products
- **Lack of widespread capability** to integrate climate factors into products
- **Risk frameworks are short term** and do not account for climate risks

Figure 3: Root causes of an underdeveloped Climate Finance Market Structure

This report lays out a vision for **an optimal framework for a market in which climate finance reaches its full potential, overcoming the key constraints highlighted in the interviews.** This includes certain key characteristics (bulleted below) identifying how to overcome the current market barriers:

Resolution of the current market failure

- **GHG emissions are fully priced into both the real economy and markets, leading to climate action that is economically motivated,** and a level playing field that fully factors in the cost of emissions.
- **Public policy and incentives work efficiently and effectively to mobilize the maximum possible private sector capital** toward climate-aligned instruments. Subsidies for fossil fuels have been phased out, thus eliminating contradictory policy signals and a source of distorted price signals.

Clarity and transparency in climate finance markets

- **High-quality and comparable climate-related data** from the real economy (both on mitigation and adaptation) **is universally available and integrated across all financial asset classes and platforms**—to enable investors and financial market participants to make informed and climate-integrated decisions and allow for efficient primary and secondary markets with transparent data.
- **Definitions are globally aligned, and taxonomies⁴² are clearly defined** by sector and region.
- **Supporting market mechanisms,** such as credit risk ratings, data availability, taxonomies, and labels, are developed to the same level for climate-related factors as for other financial instruments.

Capital demand and supply matched; at-scale products and solutions

- **Capital flow is efficient, liquid, and at scale,** with a large market of issuers, investors, and intermediaries.

⁴² Taxonomies (e.g., on climate finance) are definitions (of climate finance) that aim to be comprehensive classification systems.

- **Flows and stocks of capital are aligned against Paris Agreement climate goals.** The methodologies for measuring and achieving this are well-developed and globally aligned, and have gained a sound track record.
- **All relevant financial products and services consider financially material, decision-relevant climate factors** in risk assessment, pricing, and investment decision-making. There is a **large secondary market** for activities and instruments associated with climate finance (derivatives, structured products, securities lending, etc.) that enhance market liquidity, price discovery, and risk allocation.

Capital Markets Vision: Evolution of Climate Finance Market Structure (CFMS)

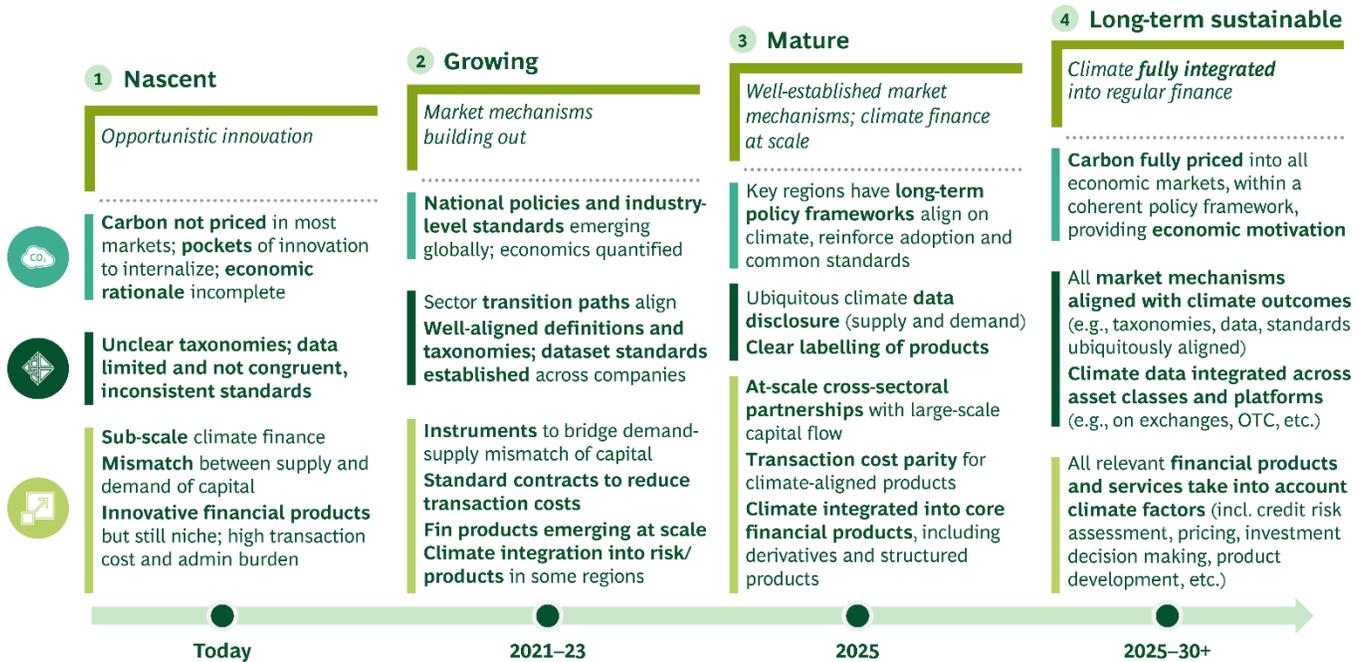


Figure 4: Vision for an at-scale Climate Finance Market Structure (CFMS)

This vision is not unrealistic. The COVID-19 pandemic has shown that resilience is critical for the economy. It has brought to the forefront the fact that non-financial risks can rapidly upend economies, financial markets, and livelihoods. With coordinated and collective action from all market participants, this vision is not only achievable but necessary to help prevent a potentially negative outcome for global and local economies, finance, and society at the hands of climate change.



Section 3

A \$100–150+ Trillion
Investment Need—
Sectoral and
Regional Insights
and Implications

3 Section 3: A \$100–150+ Trillion Investment Need—Sectoral and Regional Insights and Implications

3.1 Purpose of the Market Sizing and Sector-Specific Insights

The purpose of this market sizing effort is to provide more granular estimates of the amounts of different types of capital that are needed, by sector and asset class. In doing so, these estimates can enable policy makers, regulators, and other market actors to prioritize their strategies to grow specific market segments in which the opportunities for both climate impact and commercial opportunity are greatest.

These estimates build on existing aggregate market sizing efforts by **driving three additional levels of insights**:

1. Articulation of investment needs by sector and "lever" (i.e., the specific decarbonization technologies or activities by sector)
2. Estimation of the investment need at a regional level (i.e., North America, Europe, Asia, Rest of World)⁴³
3. Translation into implications for the Banking and Capital Markets sector, and estimation of the types of capital needed (i.e., bonds versus loans versus equity)

There are a few distinct **expected use cases for these sector-specific insights**:

- Providing insights for financial institutions as they establish and implement their sustainable finance strategies and commitments
- Sizing the risk profile of capital needed to feed into the development of products and instruments that would best suit different sectors
- Highlighting the areas that require engagement with and support from the public sector to enable investments and decarbonization

⁴³ For most sectors, North America includes Mexico, Europe includes Eastern Europe and Russia, and Asia includes Middle East; for sectors where the coverage is different due to data limitations, details are provided in the annex.

- Articulating nuances for sectors that might require ecosystem engagement (e.g., levers that require cross-sectoral coordination and investments, issues dealing with split incentives)

This market sizing estimates the type of capital needed to finance specific types of decarbonization levers, across different sectors. This includes the following (please refer to the annex section for details on methodology):

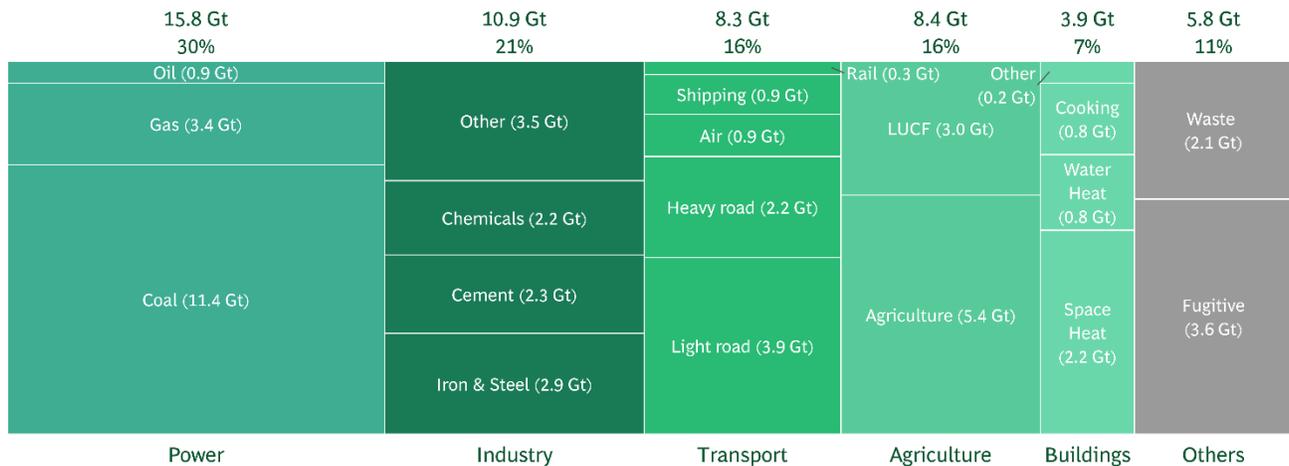
1. Investment needs are estimated by lever, leveraging existing industry reports where available to collect investment estimates, and supplementing with BCG estimations.
2. Translation of the investment needs to asset classes: For each sector, the investment need is translated, by lever, to a mix of bonds, loans, and equity. This assessment takes into account the current capital structure⁴⁴ of the sector expected to make investments and is further enhanced by inputs from secondary research and conversations with sector experts to understand expected sources of capital.
3. The estimates are further translated at a regional and lever level to capture nuances in market maturity, access to public markets, commercial readiness of the solutions, and relevance of new entrants.

This report focuses on 10 sectors (Power, Iron & Steel, Cement, Chemicals, Light Road Transport, Heavy Road Transport, Aviation, Shipping, Agriculture, and Buildings) that together account for approximately 75 percent of GHG emissions (see exhibit), and highlights the key industries that are likely to have a significant role in investing in these levers.

⁴⁴ Based on FY 2019 capital structure of publicly listed companies, sourced through CapIQ for regions in scope; analysis on equity values reflects book value and includes estimates of retained equity.

Estimated 53 Gt of CO₂ equivalent emissions in 2019

Gt CO₂e of global GHG emissions by sector, 2019



Source: European Environment Agency (EEA), Edgar 5.0 GHG inventory European Commission, World Resources Institute CAIT-database, International Energy Agency (IEA), Food and Agriculture organization of the UN (FAO), BCG analysis
 Note: De minimis rounding differences

Figure 5: GHG emissions by sector, 2019 estimates

What about oil & gas?

The oil & gas sector is a sector in transition. Of note, its scope-3 emissions⁴⁵ constitute a majority of the emissions considered in this report, including oil and gas used for power, production of chemicals, fuel in transport, and heating of space and water.

The transition to low carbon will require significant business-model reinvention from this sector in order to move toward sustainable economic activities. There is still a significant need for fossil fuels to serve the real economy, particularly in some regions, as the necessary technologies and credible pathways for energy transition develop. The transition will lead to long-term declines in

⁴⁵ Scope 3 emissions are the result of activities from assets not owned or controlled by the reporting organization, but that the organization indirectly impacts in its value chain.

demand for the core products of the sector,⁴⁶ including reductions in oil demand for transportation, a shift from gas to renewables for power, a shift from petrochemical feedstocks to renewable feedstocks in the Chemicals sector, a reduction in gas demand for heating in favor of electrification, and a broader shift from use of fossil-fuel-based energy generation to electrification and renewables. At the same time, there are opportunities in new markets such as renewable power, green and blue hydrogen production, carbon-capture markets, and synthetic- and bio-fuel production, as well as transition opportunities such as using gas to replace coal in the Power and Iron & Steel sectors.

This report touches on these transition opportunities in the section on sector decarbonization insights.

While this exercise aims to provide directional guidance on the magnitude and characteristics of capital needed, it should be emphasized that these numbers are likely to continue to evolve as technologies progress—and as transition pathways are more clearly defined and aligned by the broader ecosystem for sectors and regions. The sizing indicates the key areas of investment that would be needed to put the sector on a pathway that aligns with Paris Agreement ambitions. This is reflective of the need, however is not indicated as a projection of the market. Where feasible based on data availability, a 1.5°C pathway has been used. In several cases where the International Energy Agency's (IEA) Sustainable Development Scenario has been used, the technology mix changes have been accelerated in the analysis to reach 2070 levels by 2050 (since this is closer to net zero for the industry). These assumptions are specifically explained in the detailed methodology in the annex.

The investment need focuses on capital expenditures only and does not include operating expenses.

This chapter does not aim to be exhaustive; for each sector, there are potential additional decarbonization levers that have not been included given the uncertainty of whether they would align with required transition pathways. Alignment of transition pathways might open the door to a new range of investments that help drive down GHG emissions in a manner that is scientifically aligned toward the Paris Agreement ambitions. The section focuses on GHG mitigation levers rather than adaptation investments.

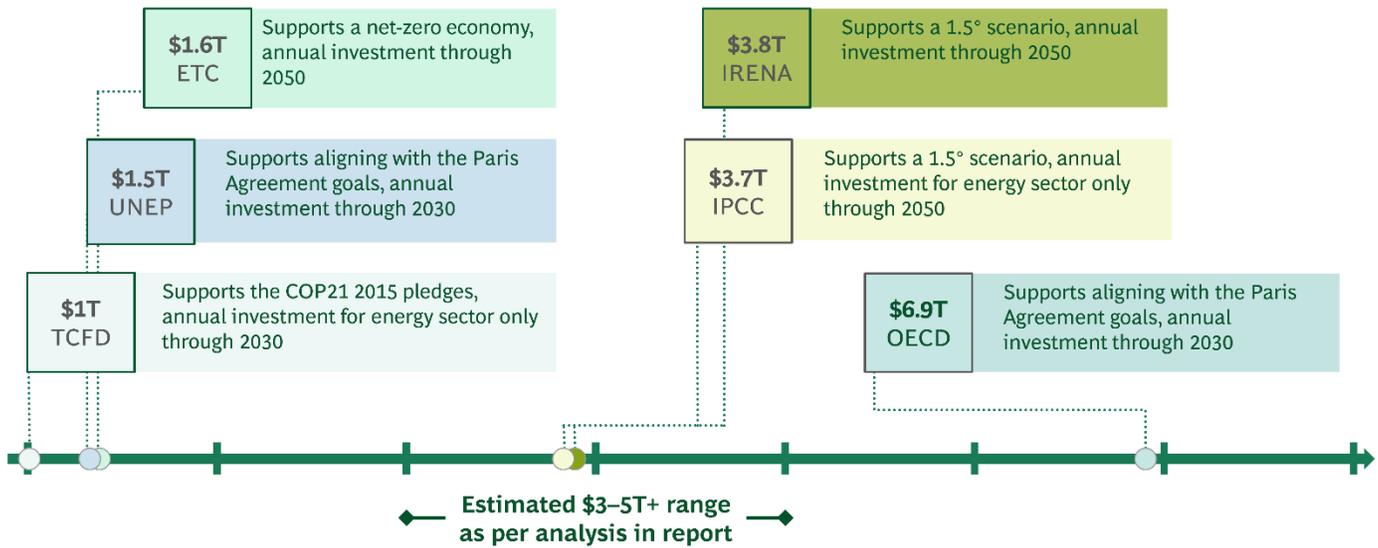
These would be important next steps to further enhance what is intended here as a starting point to first mobilize capital.

⁴⁶ IEA World Energy Outlook's "Net Zero by 2050" case shows declines in energy demand, including from coal, oil, and natural gas, over the next decade.

3.2 Investment Need for Achieving Paris Agreement Ambitions

An estimated ~\$100–150 trillion+ cumulative investment is needed globally through 2050 to achieve a 1.5°C target across the sectors in scope. On average, this equates to a \$3–5 trillion+ need per annum.

Investment estimates vary across different sources



Source: TCFD, ETC, IPCC, IRENA, OECD, UNEP, BCG Analysis

Figure 6: Investment estimates vary across different sources⁴⁷

⁴⁷ Refer to section 3.3 for details on investment estimations by sector, and annex for details on methodology.

Investment needs by sector: Summary

Theme (\$T)	Power	Iron & Steel	Cement	Chemicals	Transport	Aviation	Shipping	Agriculture	Buildings	Total across sectors
Electrification & renewables	56.7	---	---	<0.1	35.1	2.8	---	---	---	94.6
Efficiency & Circularity	---	0.7	0.4	0.2	4.0	0.2	0.7	0.6	5.3	12.1
Alternative Technologies	2.5	1.6	1.1	2.0	2.0	2.1	1.7	1.3	0.8	15.0
Total Investment	59.2	2.3	1.5	2.2	41.1	5.1	2.4	1.9	6.1	121.7
Region (\$T)										
North America	9.6	0.1	0.1	0.5	8.1	0.9	0.3	0.2	1.3	21.1
Europe	9.1	0.1	0.1	0.6	7.4	1.1	0.7	0.3	1.3	20.7
Asia	34.3	1.3	1.0	0.9	21.7	2.8	1.2	0.8	2.5	66.4
Rest of World	6.2	0.8	0.3	0.2	3.9	0.3	0.2	0.6	1.0	13.5
Total Investment	59.2	2.3	1.5	2.2	41.1	5.1	2.4	1.9	6.1	121.7
Instrument										
Loan	38%	56%	34%	32%	50%	66%	49%	47%	42%	44%
Bond	17%	20%	19%	29%	29%	20%	19%	4%	8%	21%
Equity	45%	24%	47%	39%	21%	14%	32%	49%	50%	35%
Total Investment	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Industries involved										
Energy	✓	✓			✓	✓	✓			
Power T&D	✓									
Cement			✓							
Iron & Steel		✓								
Chemicals				✓	✓		✓			
Auto & Trucking					✓					
Airlines						✓				
Shipping							✓			
Food & Beverage								✓		
Farming								✓		
Other									✓	

Source: BCG Analysis

Notes: De minimis rounding differences, T&D = Transmission & Distribution

Figure 7: Summary investment need by sector

There are five key insights that emerge from this market sizing effort:

1. **The Need for Climate Finance to Scale for ALL Asset Classes:** Climate finance needs to be raised with a mix of instruments—an estimated 21 percent in bonds, 44 percent in loans, and 35 percent in equity.⁴⁸
2. **A Collaborative Multi-sector Effort to Address Transversal Risks and Opportunities:** Decarbonization of sectors requires investment from and collaboration with other sectors. In the absence of this cross-sectoral coordination, incentives will be misaligned and decarbonization support mechanisms will be absent.
3. **The Most Significant Regional Investment Demand, Estimated at \$66 Trillion, Is in Asia:** This is driven to a large extent by the scale and pace of growth of Asian economies, growing population, increasing urbanization, and rapid industrialization.
4. **The Largest Sectoral Investment Need (of ~\$95T) Is for Electrification of Technologies and Processes, and the Corresponding Switch from Fossil-Fuel-Based Power to Renewable Power.** Key decarbonization themes that shape the nature of the demand for finance include (1) electrification and a switch to renewable energy, (2) deployment of alternative low-carbon technologies, and (3) greater efficiency and circularity.⁴⁹
5. **The Imperative for Public Sector Leadership:** The public sector will need to play a critical role in creating supportive policies and incentives such as carbon pricing mechanisms, tax credits and subsidies, and environmental/industrial policies to support commercial viability.

3.2.1 The Need for Climate Finance to Scale for ALL Asset Classes

Climate finance needs to be raised with a mix of instruments—an estimated 21 percent in bonds, 44 percent in loans, and 35 percent in equity.⁵⁰ Though the markets for green bonds and loans has seen significant growth, climate finance needs to scale across all asset classes including equity, structured finance, and bank-intermediated lending, while clearly connecting capital market activities, such as derivatives and securities lending, to climate-related metrics and outcomes. This need is significant in geographies where capital markets are not mature (e.g., Asia, excluding Japan and China).

⁴⁸ This has been estimated based of the expected mix in North America, Europe, and Asia.

⁴⁹ Circular economy based on designing out waste, keeping materials in use, for instance through recycling and reducing dependence on extraction of primary resources.

⁵⁰ This has been estimated based on expected mix in North America, Europe, and Asia. Loans includes different types of financing structures including bilateral lending, project finance, syndicated lending, etc.

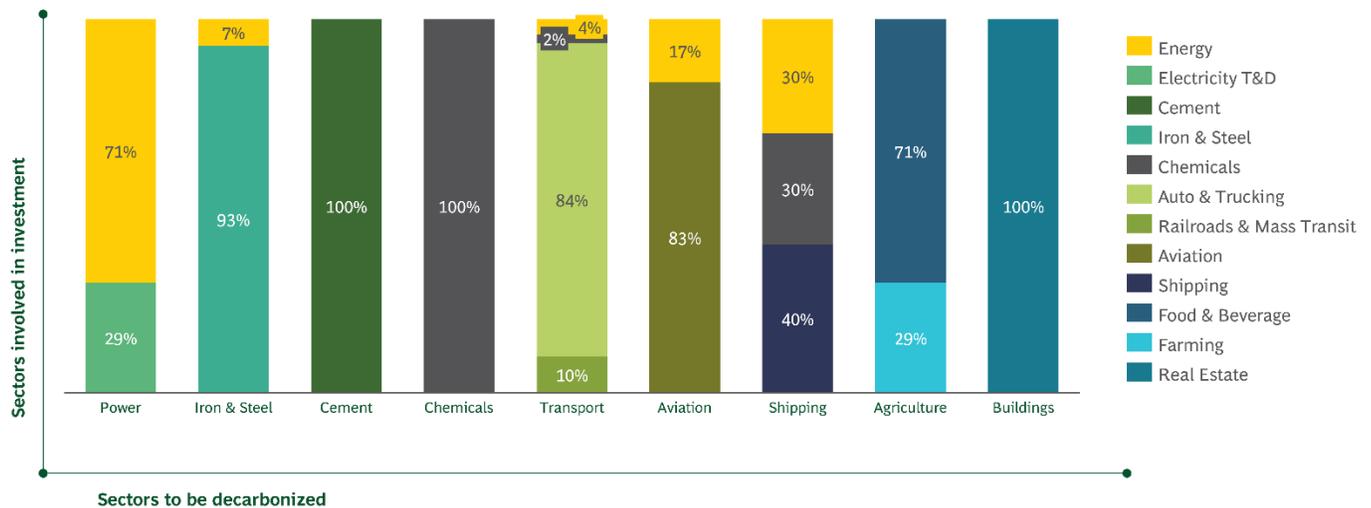
An evolution and scaling of climate finance beyond "use of proceeds" will help tie a broader range of financing activities to climate-related metrics. For example, in several sectors, the transition pathways may include activities that do not qualify as zero carbon or near-zero carbon. These activities are often excluded from green finance taxonomies, although they might still be important to achieve climate goals. Examples include efficiency measures across sectors such as Buildings and Chemicals, or the use of natural gas to replace coal in some regions. Further, an evolution of financial instruments beyond green bonds and loans would also enable expansion of the scope to financing that is not tied to a specific activity or project, but to, for example, an entity that has the commitment and potential to transition its activities and business model. This innovation is already being seen in the market with the rapid rise of instruments such as sustainability-linked bonds and loans.

There is also a critical need for high-risk, patient capital for investments in sectors wherein decarbonization is dependent on technologies that are still in earlier stages of development, such as Iron & Steel, Heavy Road Transport, and Shipping, and/or in riskier emerging markets. This need for risk capital is reflected in the high levels of estimated equity need, and also in the assessment of commercial viability of different decarbonization levers across sectors.

3.2.2 A Collaborative Multi-sector Effort to Address Transversal Risks and Opportunities

A successful transition requires significant collaboration across sectors. Decarbonization of any given sector will also require development of new business models, investments, and collaboration with other sectors. For example, the Energy sector is expected to play a critical role in the decarbonization of industry and transport through renewable electricity, alternative fuel production, and management of carbon capture utilization and storage (CCUS) sites. The development of an at-scale clean hydrogen industry will be essential to decarbonize sectors such as Iron & Steel and Shipping. Traditional industry-sector boundaries will be challenged, and leading firms will have to traverse different sectors. These interactions are likely to lead to opportunities for financial institutions to enable connections between their customers for an accelerated transition to low-carbon business models.

Decarbonization of sectors will require investment in and collaboration with other sectors

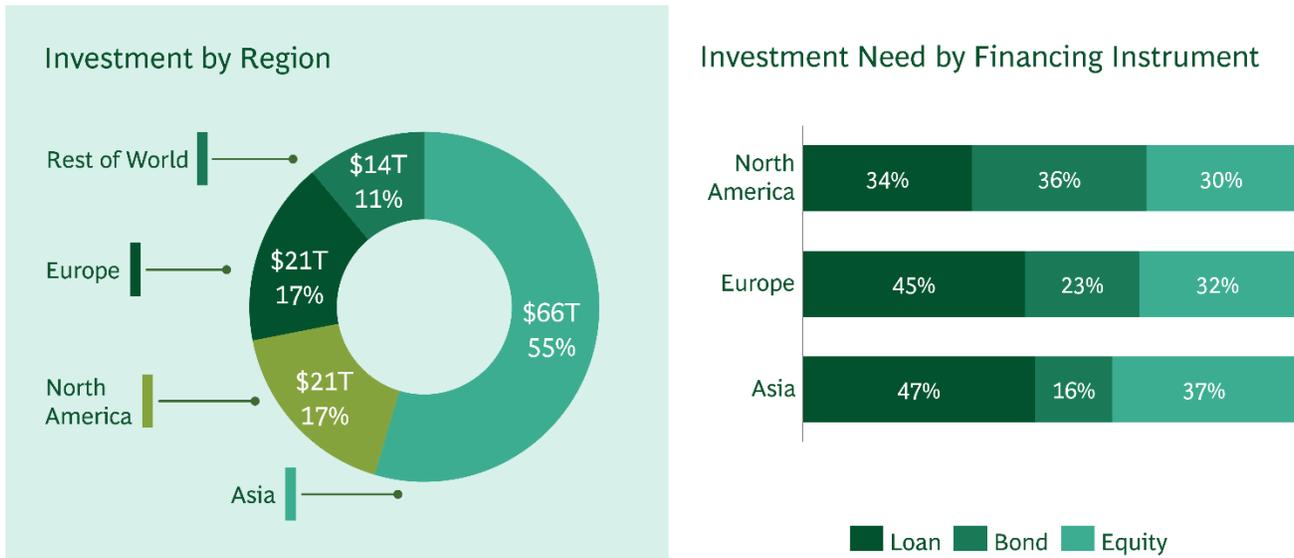


Source: BCG Analysis

Figure 8: Sectors to be decarbonized will need investment in other sectors

3.2.3 The Most Significant Regional Investment Demand, Estimated at \$66 Trillion, Is in Asia

Investment need by region and by financing instrument



Source: BCG Analysis
 Note: Loans includes different types of loan financing structures including bilateral lending, project finance, syndicated lending, etc.

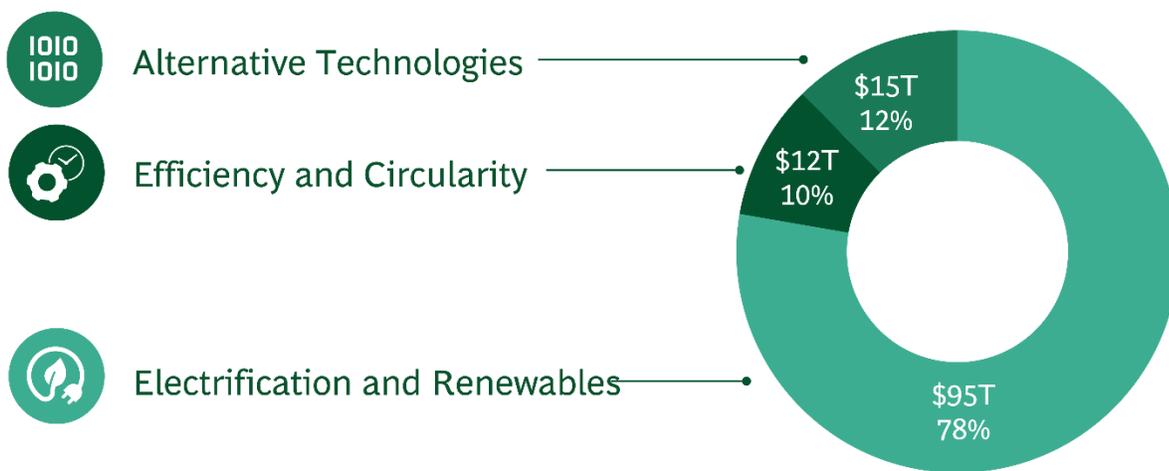
Figure 9: Regional investment need by financing instrument (loans, bonds, equity)

Across sectors, Asia represents the largest market for climate finance. This is driven to a large extent by the scale and pace of growth of Asian economies, growing populations, increasing urbanization, and rapid industrialization. Financial markets in the region are less liquid and therefore it is expected that bilateral lending will play a significant role in debt financing. Further, there is expected to be a significant role for equity issuances given new entrants and large-scale infrastructure finance requirements. The demand will require the development of a more efficient and at-scale financial market structure that supports global mobilization of climate-aligned capital.

With capital markets still developing in some of those jurisdictions, significant dependency on bank-intermediated lending, COVID-19-related economic strains, and constraints on institutional investor risk appetite for exposure to some emerging markets, mobilizing capital at this scale in emerging markets in Asia is likely to be a significant challenge.

3.2.4 The Largest Sectoral Investment Need (of ~\$95T) Is for Electrification of Technologies and Processes, and the Corresponding Switch from Fossil-Fuel-Based Power to Renewable Power

Investment need by decarbonization theme



Source: BCG Analysis

Figure 10: Investment need by decarbonization theme⁵¹

There are three consistent decarbonization themes emerging across sectors that drive implications for the types of finance required.

⁵¹ Power: Potential application of hydrogen toward power storage is embedded within the renewables & electrification investment need. Aviation: Alternative technologies estimate includes the use of rotors and all non-hydrogen related synthetic fuel production (85 percent of synthetic fuel production is assumed to be related to clean hydrogen). Transport: Hydrogen estimate includes the capex needed to produce hydrogen for synthetic fuel development, as well as the investment required to produce end-use hydrogen for fueling heavy-duty trucks. Twenty percent of synthetic fuel for heavy road transport is assumed to be related to hydrogen. Buildings: Improved efficiency of electric equipment (e.g., lighting) is captured as part of efficiency. Agriculture: Alternative technologies includes investment needed to develop protein substitutes to support the dietary shift away from meat.

- i. **Cross-sectoral need for electrification and renewable power generation (~\$95 trillion).** This theme represents the largest investment need, emblematic of a broader shift away from traditional energy sources such as fossil fuels and toward renewable energy. End-use sectors (such as Iron & Steel, Chemicals, Light/Heavy Road Transport, Shipping, Aviation, and Buildings) have traditionally leaned on conventional fuel sources such as oil, gas, and coal. The decarbonization of these sectors involves large-scale electrification, coupled with a shift in the Power sector toward renewable energy and associated strengthening in grid flexibility and reliability (e.g., with deployment of energy storage) in order to realize emissions reductions. Large-scale renewable power will also be critical for the production of sustainable fuels (e.g., green hydrogen, e-ammonia, synthetic fuels, etc.). Several of these technologies are also viable or fast becoming viable. Some forms of renewable energy (e.g., solar PV) are already commercially viable and cost competitive in several regions globally; and the electrification of transportation is rapidly becoming cost competitive and is seeing significant investments around the world—a trend that is expected to accelerate in the near future.
- ii. **There is a significant role for alternative technologies (~\$15 trillion) across sectors to achieve the target emissions reductions, though many are new technologies in early stages of development that vary in their current level of commercial viability.** In particular, CCUS and green hydrogen are cross-cutting, high-potential levers.⁵² These technologies are in nascent stages of development and often require high-risk equity capital. It is critical the public sector play a role in setting policies and incentives that align commercial action with the climate targets, and directly support investments through risk enhancement and blended finance solutions.
- iii. **Efficiency and circularity are likely to lead the transition (~\$12 trillion),⁵³** as these solutions are largely commercially viable and available at scale. There is significant potential for efficiency in sectors such as Chemicals, wherein process improvements can lead not only to GHG reductions but also to cost savings. Further, in sectors such as Iron & Steel, there is a big role for scrap recycling, which can help in decarbonization.

⁵² Note that the renewable power investment needed for the production of green hydrogen is considered under the theme (i.e., “Electrification and Renewables”).

⁵³ Circular economy based on designing out waste and keeping materials in use, for instance through recycling and reducing dependence on extraction of primary resources.

3.2.5 The Imperative for Public Sector Leadership

Across several sectors, many of the decarbonization solutions are sub-scale (e.g., biofuels and synthetic fuels) and/or are not cost competitive with conventional technologies. Within these sectors, **the public sector will need to play a critical role in creating supportive policy and incentives such as tax credits and subsidies to support commercial viability.** Wherever viability remains constrained, concessionary capital (e.g., public funding) will be needed in addition to private funding to support investment needs.

The public sector will also have a role to play in executing against climate targets through state owned enterprises (SOEs). This is particularly relevant in developing economies wherein SOEs are dominant as a result of highly regulated markets and relatively higher costs of capital for private sector competitors compared with advanced economies. There also needs to be consideration of the most efficient ways to raise capital for necessary investment wherever major utilities are state owned.

3.3 Sector-Specific Insights and Market Sizing of Investment Needs

The following pages detail financing requirements across each of the sector-specific transition pathways in detail, summarizing:

- GHG emissions profile;
- Decarbonization levers available, and an assessment on the commercial viability of those solutions;
- Current capital structure of the sector;
- Cumulative investment needs over the next three decades by instrument (loan, bond, or equity financing) through a regional lens; and
- Key implications for climate finance to support the transition.

3.3.1 Power

The Power sector emits 15.8 Gt of emission per annum, representing ~30 percent of total global emissions. The primary drivers of emissions are coal (72 percent) and oil and gas (28 percent).

The key decarbonization levers to enable this transition are:

- **Increase reliance on renewable energy sources.** Emissions in the Power sector are driven by reliance on fossil fuels to meet energy demand. To achieve decarbonization targets, it is critical that the Power sector rebalance toward renewable energy sources and away from fossil fuels. The cost of renewable energy has continued to decline and become cost competitive with fossil fuels, thereby increasing demand for and improving commercial viability of new projects.
- **Improve grid flexibility and reliability.** To mitigate the seasonality and variability risks associated with renewable energy, as well as address the expected demand increase for electricity due to electrification across other sectors, electricity providers will need to invest in enhancing network connections and improving grid flexibility. New solutions are also under development for energy storage (e.g., utility-scale batteries, hydrogen) that will require risk-bearing capital.
- **Invest in large-scale deployment of CCUS.** For remaining fossil fuel sources (e.g., coal plants), it is critical that CCUS be deployed to mitigate the emissions generated. The average life of a coal plant is ~40 years,⁵⁴ so implementing CCUS technology on both recent and new expected coal plants will be critical to achieving emissions reductions while they are still in operation.

Across these strategies, there is expected to be a ~\$59 trillion global investment need to reach decarbonization goals by 2050.⁵⁵ Over half of the global investment need is expected to be concentrated in Asia, given its rising energy demand and scale. The oil & gas and coal industries are expected to play a critical role in the decarbonization of power, through both development of CCUS infrastructure for remaining fossil fuel-based power generation and investment in and diversification

⁵⁴ National Association of Regulatory Utility Commissioners.

⁵⁵ This includes additional estimated demand from rapid scale-up of electrification (e.g., use of electric vehicles) and production of green hydrogen, and assumes more aggressive estimates than IEA's Sustainable Development Scenario, which doesn't achieve decarbonization by 2050.

of renewable energy production. Many of the required solutions and technologies are commercially viable; however, the projects are longer tenor and require both debt and equity investment upfront to support high capital expenditures. The Banking and Capital Markets sector can play a critical role in connecting private capital to these projects. One way is through innovative structures such as long-term corporate power purchase agreements, which would mitigate project risk for the financing provider while also enabling corporates to execute on their sustainability ambitions. CCUS is still not widely commercially viable today, and is expected to require public policy incentives (e.g., carbon pricing) to enable economic motivation for conventional power providers.

Power

15.8 Gt emissions per annum, ~30% global emissions



~\$59T estimated investment needed globally over 2020-2050

Sectors involved by lever Energy Power Transmission & Distribution

\$39T

Increase reliance on renewables

- Higher upfront capex investment for renewable plants with long-term savings on maintenance and opex
- Solar PV and onshore wind remain the most viable and prominent energy sources; ongoing efforts to broaden off-shore wind beyond the North Sea

\$17T

Improve grid flexibility & reliability

- Build new network connections/lines (e.g., north/south lines help mitigate seasonality)
- R&D for emerging technologies to support variable generation (e.g., energy storage), as well as off-shore grids and long-distance transmission

\$3T

Invest in large-scale development of CCUS infrastructure

- Critical for markets with newer coal plants e.g., China, South-East Asia
- Costs can be reduced through “hub” approach where shared infrastructure can support multiple sectors

Needs heavy subsidy Commercially viable

- LCOE at parity today in several regions; key bottleneck around supply variability

- Storage still not utility scale today; technology for off-shore & long-distance transmission improving

- Limited commercial viability, need for high carbon price or policies and incentives for large-scale deployment

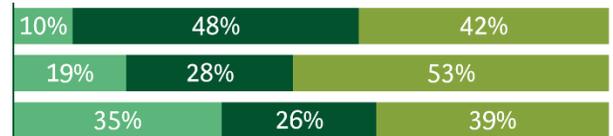
Current capital structure

Loan Bond Equity

Renewable Power



Electric Utilities



Investment need by region, by instrument

- Existing utilities players, thought the market is mature, are expected to need equity funding to support increased leverage given the scale of investment needed
- Renewable players in Europe rely more heavily on lending for debt financing, driving the resultant loan-to-bond ratio for investment opportunity
- Although grid improvements will largely be financed through debt, significant equity opportunity remains in Asia due to new market entrants in renewables

	Loans	Bonds	Equity
\$9.6T North America	\$2.5T	\$2.4T	\$4.7T
\$9.1T Europe	\$3.5T	\$1.3T	\$4.3T
\$34.3T Asia	\$14.4T	\$5.3T	\$14.6T
\$6.2T RoW			

Key implications for climate finance

- Need for significant investment across the value chain from power generation to transmission and distribution, including scaling of energy storage and grid flexibility and reliability
- Renewable energy commercially viable in several regions today, but long-tenor, project finance structures needed to support high upfront capex needs
- Significant need for high-risk/equity capital (e.g., in project equity or in storage solutions); opportunity to connect sources of high-risk capital
- Role for the financial sector beyond capital:
 - E.g., engaging corporates customers in new project investments and enabling customer sustainability ambitions through long-term Corporate Power Purchase Agreements
 - E.g., collaboration with the public sector, particularly in Asian power markets, to drive transition with state-owned enterprises

3.3.2 Iron & Steel

Steel is a basic raw material for almost all industries, and accounts for 2.9 Gt of GHG emissions annually (~6 percent of global emissions). However, the Iron & Steel sector faces a significant decarbonization challenge, with ~1.9 tonnes of scope-1 emissions released for every tonne of steel produced using an integrated blast furnace-basic oxygen furnace (BF-BOF) method. Shifting to alternative production processes will be key to decarbonizing the industry.

The key decarbonization levers to lower production emissions are:

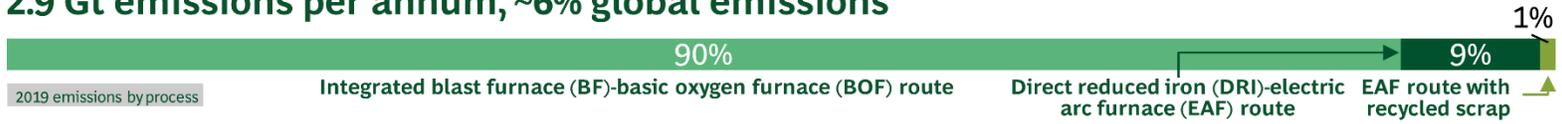
- **Maximize recycling and use of scrap steel.** The technology is readily available and cost competitive, but adoption is dependent on availability of high-quality scrap. The current level of secondary steel production is ~22 percent globally.
- **Use natural gas as a reducing agent.** Shift to use of direct reduced iron (DRI) fueled with natural gas to decrease (but not eliminate) CO₂ emissions. Technology is available but not yet cost competitive for most regions (+15 percent OPEX compared with the BF-BOF process).
- **Switch to H₂ in DRI process.** Technology is immature and not yet cost competitive (+45 percent OPEX when compared with fossil fuels). Adoption is additionally dependent on availability and cost of renewable electricity to produce green hydrogen.
- **Retrofit plants with CCUS.** CCUS remains a nascent technology that is not yet cost competitive globally, or widely deployed. Furthermore, it is not expected to completely decarbonize steel production, as only up to ~90 percent of carbon can be captured.

Across these strategies, there is expected to be a ~\$2.3 trillion global investment need to reach decarbonization goals by 2050. Over half of the global investment need is concentrated in Asia, due to its large share of global steel production, and high projected growth.

Given the high capital intensity, access to debt and equity markets is paramount to the sector. Hence, producers have taken action to establish credible ESG strategies and decarbonize their production processes. The sector as a whole continues to have a healthy access to capital markets; however, weaker producers may be forced to pay premium rates. Acquiring capital for transitioning to low-carbon technologies may require concessional rates through actions by the public sector. Beyond providing access to capital, the Banking and Capital Markets sector can help facilitate partnerships and collaboration along the iron and steel value chain and across sectors targeting similar solutions (e.g., CCUS technology, H₂ production).

Iron & Steel

2.9 Gt emissions per annum, ~6% global emissions



~\$2.3T estimated investment needed globally over 2020-2050

Sectors involved by lever Iron & Steel Energy

Investment	Lever	Description	Commercial Viability
\$0.7T	Iron & Steel	Increase use of recycled scrap <ul style="list-style-type: none"> Primary steel production via BOF can use scrap for up to 30% of metallic input, however secondary steel production from 100% scrap requires EAF Significant investment required to fund large scale shift to EAF process Estimate does not include recycling infrastructure investment needs 	Needs heavy subsidy
\$1.0T	Iron & Steel	Use natural gas as a reducing agent for virgin steel production <ul style="list-style-type: none"> Requires DRI-EAF, which only accounts for ~8% of global virgin steel production today and requires funding for large scale process shift Adoption dependent upon access and price of natural gas Useful as transition solution to reduce GHG emissions 	Commercially viable
\$0.1T	Energy	Switch to H₂ based reduction for virgin steel production <ul style="list-style-type: none"> Potential to substitute up to ~30% coal with H₂ in BF-BOF, or 100% of natural gas in DRI-EAF; investment required for H₂ electrolyzer Adoption dependent on adaptation of electrolyzers for use in steel production, as well as price of renewable electricity 	Commercially viable
\$0.5T	Iron & Steel	Retrofit plants with carbon capture, use and storage technology (CCUS) <ul style="list-style-type: none"> Steel sector will require investment to retrofit plant equipment Additional early-stage financing required for CO₂ capture R&D and infrastructure for transportation and storage 	Commercially viable

Current capital structure

Iron and Steel



Investment need by region, by instrument

- Global transition expected to be dominated by existing players that will look to access debt
- Debt will need to be balanced with equity to limit risk given that the sector is capital intensive and experiencing declining financial health
- Access to capital will require proven commercial viability and/or concessional rates
- Largest investment need in Asia given large share of global steel production, projected growth and inefficient current production processes
- Bond-to-loan ratio largely impacted by maturity of bond market in each region

	Loans	Bonds	Equity
\$0.1T North America	<\$0.1T	<\$0.1T	<\$0.1T
\$0.1T Europe	<\$0.1T	<\$0.1T	<\$0.1T
\$1.3T Asia	\$0.8T	\$0.2T	\$0.3T
\$0.8T RoW			

Key implications for climate finance

- Significant barriers to high capex required for rebuilding/refurbishing with limited cash flow to cover cost of capital for sector
- Financial sector support with long-term finance structures (~10-20 years) and innovative funding options (e.g., funding initiatives with border taxes or ETS sales)
- Need for substantial bridge funding to support transition while net zero emission solutions become commercially viable, given early stage of technology in the sector
- Potential role for financial sector to provide support beyond capital by promoting cross-sectoral partnerships to facilitate sharing of expertise and co-funding R&D for solutions that span sectors (e.g., CCUS, H₂ based reduction)

3.3.3 Cement

The Cement sector accounts for 2.3 Gt of GHG emissions annually (~4 percent of global emissions), driven by process emissions from clinker productions as well as emissions related to heating kilns and, to a lesser extent, the powering of other machinery in plants.

The key decarbonization levers to lower production emissions are:

- **Invest in and grow CCUS.** The majority of emissions in the Cement sector are process emissions, a result of the chemical reactions to produce clinker. While these emissions can be decreased through the introduction of alternative binders to reduce the clinker/cement ratio, they cannot be fully eliminated through this approach. Therefore, CCUS will be critical to capture the remaining CO₂ emissions for permanent storage or use in another sector.
- **Upgrade to and equip new plants with energy-efficient equipment.** Demand for cement will remain strong, particularly in developing regions, due to urbanization and expected investment in infrastructure. Therefore, it is critical that new production plants are equipped with efficient equipment (e.g., excess heat recovery) to reduce emissions while the alternative technologies previously described are scaled up and become commercially viable.
- **Increase use of alternative fuels and binders.** Coal is the primary fuel used in cement plants to power kilns (70 percent), followed by oil and natural gas.⁵⁶ Increasing the use of alternative fuels—mainly waste and other biomass—can reduce emissions, but is contingent on regional policy developments. Public policy will need to support the redirection of waste away from landfills and toward industrial plants, as well as to control the quality of the redirected waste. Alternative binders, to reduce the clinker/cement ratio, are another strategy for the Cement sector to leverage new technologies. These alternatives include synthetic materials, industrial by-products (e.g., fly ash from steel production), and natural resources (e.g., volcanic ash, limestone).

To decarbonize the sector, ~\$1.5 trillion investment is expected to be needed globally from 2020 to 2050. The near-term financing need, above and beyond the retrofits for efficiency, will be to support commercial pilots for CCUS and build out the necessary storage infrastructure. This early investment will be critical for broader implementation across the sector as time goes on. However, the

⁵⁶ IEA, Cement Technology Roadmap 2018.

technology is not widely commercially viable absent a sufficiently high carbon price. Without incentives or favorable policy from the public sector, concessionary capital will be required. For investment in cement plants and processes, the sector is sufficiently mature and has continued to consolidate in developed markets. The financing need is therefore expected to come primarily from existing players.

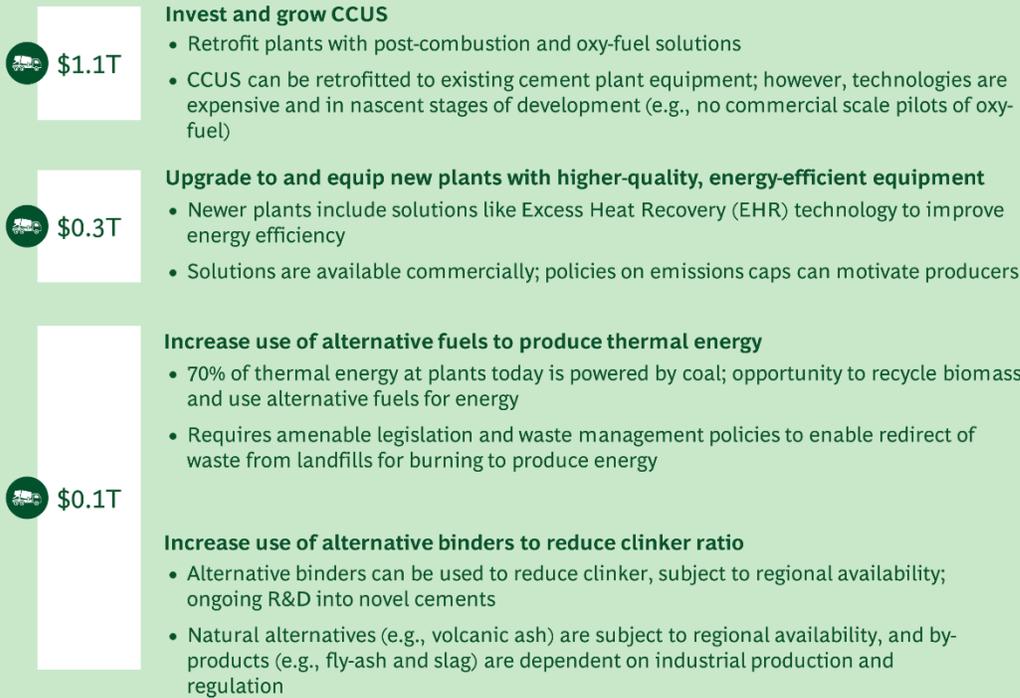
Cement

2.3 Gt emissions per annum, ~4% global emissions



~\$1.5T estimated investment needed globally over 2020-2050

Sectors involved by lever Cement



Current capital structure



Investment need by region, by instrument

- The cement industry is relatively mature and has already experienced consolidation trends in recent years; expectation is that large existing players will continue to drive regional production
- Going forward cement production will shift toward developing economies like Asia and Africa for infrastructure development needs, though China as a relative contributor will decrease (50% to 30% by 2050)
- Significant high-risk or concessionary capital likely needed to support CCUS pilots and implementations given high capex and low maturity

	Loans	Bonds	Equity
\$0.1T North America	<\$0.1T	<\$0.1T	<\$0.1T
\$0.1T Europe	<\$0.1T	<\$0.1T	\$0.1T
\$1.0T Asia	\$0.4T	\$0.1T	\$0.5T
\$0.3T RoW			

Key implications for climate finance

- CCUS: near-term focus on developing commercial-scale pilots and demonstrating product readiness; implementation into cement plants expected to occur once technologies are proven and scaled
- Investment contingent upon achievement of commercial viability, which will enable the flow of private capital; or provision of concessionary capital (e.g., public funding) where needed in the absence of commercial viability
- Existing players expected to primarily access debt markets to fund expansion and equipment upgrades, given mature nature of industry which has continued to consolidate.

3.3.4 Chemicals

The Chemicals sector releases 2.2 Gt per annum of carbon-equivalent emissions, representing ~4 percent of global emissions. The primary source of emissions from the Chemicals sector is the heat-intensive chemical reactions that are fueled with fossil fuel energy sources. The chemical reactions themselves are often carbon intensive, primarily those using fossil fuel-based feedstock.

The key decarbonization levers are:

- **Increasing process and energy usage efficiencies:** Most of the opportunity in this lever lies in increasing the energy usage efficiency of chemical production through heat recovery and transfer. This can be done by redesigning chemical production plants to capture thermal energy and enable the local transfer of the energy, to be used elsewhere. Another way is through improving the efficiency of heat-recovery and steam systems, or through upgrades of equipment in chemical plants.
- **Use alternative fuels and feedstock:** Instead of fossil fuels such as natural gas or coal, several chemicals can be produced with renewable feedstock or electrification. For example, instead of using natural gas as a feedstock to make clean hydrogen, electrolysis could be used to make green hydrogen, which is nearly carbon neutral. Additionally, chemical plants can be powered with renewable sources of electricity.
- **Deploy CCUS:** Build carbon capture, storage, and transport facilities in existing chemical production plants and have them installed in new ones.

An estimated investment of \$2.2 trillion is required to decarbonize the Chemicals sector in line with a 1.5°C climate target. Most of the investment is needed to scale the use of renewables, electrification, and CCUS, as these levers are expected to drive a majority of emissions reductions. Nearly half of the investment is required in the Asia-Pacific region, where chemical production is expected to accelerate, particularly in China and India. Production in this region is also coal based, which is more carbon intensive than natural gas-based production in North America and Europe.

Beyond this investment, there is an estimated investment need of approximately \$4–5 trillion⁵⁷ in capex to produce clean hydrogen, in the form of green H₂ (produced with electrolysis using renewable energy) and blue H₂ (produced with natural gas using CCUS). This is for demand from other sectors such as Aviation, Transport, Iron & Steel, and Shipping. Hydrogen demand is expected to reach ~500–600+ million tonnes annually by 2050, hence driving this large investment need. This investment is reflected in the respective sectors, and associated renewable energy investment is accounted for in the Power sector.

The capital-intensive nature of chemical production makes it a less likely target for new market entrants. In North America and Europe, a larger portion of debt financing is expected to come from bond issuances, while Asian players are expected to rely more on loans, given the differences in capital structure in these regions.

⁵⁷ This excludes the investment in renewable power, which is counted in the Power sector.

Chemicals

2.2 Gt emissions per annum, ~4% global emissions



~\$2.2T estimated investment needed globally over 2020-2050

Sectors involved by lever Chemicals

<p> \$0.2T</p> <p>Improve process and energy efficiency of chemical production</p> <ul style="list-style-type: none"> Significant room to reduce energy loss through better heat recovery systems, plant redesign to enable local heat transfer/capture Opportunity to increase efficiency of industrial steam systems 	<p>Needs heavy subsidy</p> <p>Commercially viable</p> <ul style="list-style-type: none"> Plant redesign, heat transfer/capture & steam system tech are more nascent compared to equipment upgrades
<p> \$0.9T</p> <p>Use alternative, lower-emission fuels and feedstocks</p> <ul style="list-style-type: none"> Use of electrification or renewable feedstocks/fuels (e.g., biomass) requires upfront investment to prepare plants for scaled production Green H₂ and NH₃ production most mature; expected to require large portion (~60%) of investment Electrification of steam crackers & bio-based chemicals need further R&D 	<ul style="list-style-type: none"> Higher costs when compared to conventional feedstocks; potential supply constraints
<p> \$1.1T</p> <p>Deploy CCUS technology</p> <ul style="list-style-type: none"> Investment to retrofit plant equipment Blue hydrogen (H₂ production w/ CCUS) expected to need large portion (~30%) of investment 	<ul style="list-style-type: none"> Proven technology for blue H₂ and blue ammonia, however not cost-competitive at scale; Practical application for other chemicals in nascent stages

Current capital structure



Investment need by region, by instrument

- Primarily driven by the investment need for clean Hydrogen – most H₂ today is still produced using natural gas, high capex required to enable Blue/Green H₂ tech
- Bulk of investment required from China and India where chemical production is to accelerate and current methods are coal based; regulatory pressure to decarbonize expected to grow
- Driven by EU's demand for Green Hydrogen production; EU remains a leader in ramping up technologies that will use Green H₂ to decarbonize various industrial sectors

	Loans	Bonds	Equity
\$0.5T North America	\$0.1T	\$0.3T	\$0.1T
\$0.6T Europe	\$0.1T	\$0.3T	\$0.2T
\$0.9T Asia	\$0.4T	\$0.1T	\$0.4T
\$0.2T RoW			

Key implications for climate finance

- Need for significant investment in early parts of chemicals value chain (~80% of emissions from extraction and refining of feedstock to produce chemicals)
- Opportunity to partner across industries like Oil & Gas, Transport, Aviation, Steel/Iron & Shipping that are expected to be involved in clean feedstock or fuels from a supply or demand perspective (e.g., for Green Hydrogen, Green Ammonia, etc.)
- Expected need to ramp up R&D investment for chemicals with less mature 'clean' solutions (e.g., Ethylene, Propylene, Nitric Acid) to ensure commercial viability

3.3.5 Light Road Transport

The Light Road Transport sector emitted about 3.9 Gt of GHG emissions in 2019 (~7 percent of global CO₂ emissions). The primary source of sectoral GHG emissions is passenger cars, which accounted for ~77 percent.⁵⁸

The key decarbonization levers are:

- **Develop and produce battery electric light-duty vehicles.** This is a proven technology, with many car manufacturers offering a variety of models. Moreover, battery costs have gone down by 85 percent since 2010, and are expected to further decrease with the support of battery electric vehicle (BEV) adoption—which is heavily dependent on improvements in battery density in order to increase the range and availability of charging infrastructure. This will further be dependent on the ability to sustainably source battery components and materials.
- **Develop and produce electric two/three wheelers.** Electric two/three wheelers are prevalent in China, India, and the ASEAN region. Further adoption is less dependent on advancements in battery density and public charging as the use case for them is focused on short-range transport.
- **Expand public charging infrastructure.** Public charging networks are already quite prevalent in Europe, North America, and China. However, further expansion faces a cause-effect dilemma, as financiers are hesitant to invest in charging stations where there is a limited customer demand. Hence, this issue needs to be addressed, with support from the government through specific schemes and mandates to build charging infrastructure along road corridors and fuel stations, and policies/incentives that encourage private sector investment from industries such as auto manufacturing and energy.
- **Mode shift to mass transit.** Further reduction in emissions will be achieved by relying more heavily on public transport. Significantly more investment in and supportive public policies on buses, trains, and railway tracks—and their electrification—are needed to accommodate and encourage the shift to mass transit. This is especially true in regions with high urbanization rates. Estimates show that these investments provide considerable returns

⁵⁸ Assumes Light Road Transport consists of passenger cars, buses and minibuses, light commercial vehicles, and two/three wheelers.

from savings in vehicle ownership, operating, and fuel costs from reduced vehicle use, along with travel-time and congestion savings.

Across these strategies, there is a \$9 trillion global investment need for net zero emissions by 2050. Over half of global investment need is concentrated in Asia due to regional need for manufacturing and purchasing of BEVs. Moreover, large regional public transport investments are needed given Asia's elevated urbanized population. In addition, there is a large consumer financing need for the purchase of BEVs.

The public sector plays a fundamental role in decarbonizing the Light Road Transport sector, and therefore must act.

First, governments must accelerate EV adoption with initiatives such as carbon pricing, tax rates adapted to tailpipe CO₂ emissions, public procurement schemes, and fiscal incentives for EV purchases.

Moreover, investments in battery production should be spurred to create a policy framework that reduces investment risks (e.g., provide clear signals on the deployment of charging infrastructure, fuel economy standards, and low- or zero-emission mandates).

The private sector is already responding to growing demand and policy signals. For example, the Climate Group's EV100 (70 large global businesses) has committed to 100 percent electric fleets and/or companywide rollout of EV charging by 2030. Around the globe, there are opportunities for the Banking and Capital Markets sector to cross-connect customers (e.g., oil & gas, and auto manufacturers) for partnership investment in electric charging infrastructure.

Light Road Transport

3.9 Gt emission per annum, ~7% global emissions



~\$9T estimated investment needed globally over 2020-2050

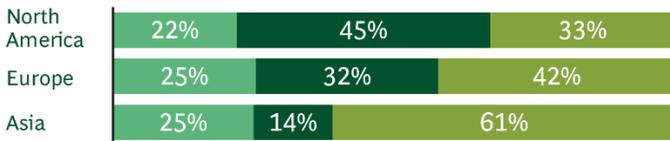
Sectors involved by lever Auto² Ground Transportation Energy

- \$3.6T** **Develop and produce electric light duty vehicles (excl. two/three wheelers)¹**
 - Investment in R&D, conversion/construction of factories to manufacture BEVs and components
 - Battery development and production estimated at ~15-25% of investment in long-term
In addition, financing for purchase of BEVs estimated at ~\$51T
- \$0.2T** **Develop and produce battery electric 2/3 wheelers**
 - Investment in R&D, conversion/construction of factories to manufacture electric 2/3 wheelers and components
 - Electric two/three-wheeler market expected to be concentrated in China, India and the ASEAN region
In addition, financing for purchase of electric 2/3 wheelers ~\$2.9T
- \$1.2T** **Expand public electric charging infrastructure**
 - Investment in public slow and fast charging stations
 - Need for public intervention to foster simultaneous investment in supply of charging infrastructure and demand for electric vehicles
In addition, investment in private slow charging infrastructure: ~\$0.8T
- \$4.0T** **Mode shift to mass transit**
 - Financing of public transportation infrastructure (e.g., buses, trains)
 - Lead to significant returns from savings in vehicle ownership, savings in operating and fuel costs from reduced vehicle use, along with travel time and congestion savings

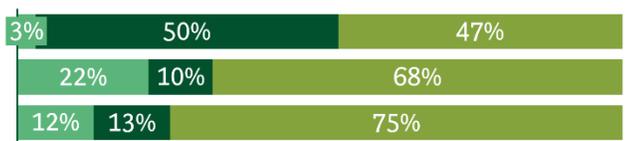


Current capital structure

Auto and Components²



Ground transport



Investment need by region, by instrument

- Largest investment needed in Asia primarily driven by high regional need for manufacturing of battery electric LVs and investments in public transport
- Public transport investment likely financed through project finance structures (SPVs), driving regional equity financing
- Significant financing needed in rest of world to expand public transport spurred by rapidly increasing urbanization rates

	Loans	Bonds	Equity
\$1.1T North America	\$0.3T	\$0.6T	\$0.2T
\$1.1T Europe	\$0.4T	\$0.4T	\$0.3T
\$4.9T Asia	\$1.6T	\$1.0T	\$2.3T
\$1.9T RoW			

Key implications for climate finance

- Strong dependency on public sector interventions to accelerate EV adoption (e.g., public procurement schemes, tax rates adapted to tailpipe CO₂ emissions, fiscal incentives on EVs)
- Opportunity to connect corporates across sectors for partnerships for investment in electric charging infrastructure (e.g., Oil & Gas and vehicle manufacturers)
- Strong corporate commitments for EV transition provide opportunity to drive EV adoption among corporate customers
- Key to enable sustainable battery industry scale-up to support the EV transition:
 - Public sector: policy frameworks to reduce investment risks, e.g., clear signals on deployment of charging infrastructure, low- or zero-emission mandates
 - Financial institutions: funding in battery manufacturing and linkage to sustainability requirement; connections within industry participants in battery production value chain
- PPPs expected to be key to catalyze private investment in public transport infrastructure as well as sharing risks across public and private sectors

1. Excludes all LCV used for the transport of goods 2. Auto and components (incl. motorcycles) **Note:** hydrogen refueling infrastructure not considered in the light transport sector but considered in the heavy transport sector **Sources:** EEA, European commission, World Resources Institute, FAO, IEA, OICA, Energy Transitions Commission, ICCT, Coalition for Urban Transitions, IHS Markit, UN. Market Research Future, CapitalIQ, wattev2buy, evobsession, Gasgoo AutoNews, Cleantechica, SinaAuto, Xinhuanews, Yiche, ifeng, BCG analysis

3.3.6 Heavy Road Transport

The Heavy Road Transport sector accounted for 2.2 Gt of GHG emissions in 2019 (~4 percent of global CO₂ emissions).

The key decarbonization levers are:

- **Develop, produce, and deploy battery electric commercial vehicles.** This is a proven technology, and mainly applicable for light commercial vehicles and intra-city transport. However, further adoption of BEVs is largely dependent on battery cost and density, and the availability of charging infrastructure.
- **Develop, produce, and deploy commercial fuel cell electric vehicles (FCEVs).** Fuel cell is an emerging underdeveloped technology that is mainly applicable for inter-city and medium- and heavy-duty commercial vehicles due to weight and high-power requirements. Currently, FCEVs comprise a negligibly small part of the global road fuel transport fleet, as the technology is not commercially viable due to high fuel-cell stack prices. Moreover, adoption is limited due to an underdeveloped hydrogen economy. However, interest in FCEVs is growing, with OEMs such as Daimler and Hyundai signaling a commitment to further developing the technology.
- **Produce clean hydrogen to meet industry demand and expand hydrogen refueling-station infrastructure.** Specifically, this refers to the production of hydrogen using fossil fuels and CCUS (blue hydrogen), and electrolysis with renewable energy (green hydrogen). Also, hydrogen refueling stations are currently available at only a relatively small scale. Further expansion is highly dependent on FCEV adoption. Hence, the sector faces a cause-effect dilemma, which needs to be addressed.
- **Use biofuels and synthetic fuels.** Use of road biofuels (e.g., biodiesel) is expected to accelerate in the medium term. However, feedstock needed for biodiesel faces supply constraints and competition from other sectors (e.g., Aviation). Synthetic fuels are less commercially advanced than biofuels, and will only become commercially viable in the long term. Further expansion of infrastructure is needed to produce the green hydrogen and synthetic fuels needed to meet future demand.

Across these strategies, there is a \$32 trillion global investment need to reach the 1.5°C target by 2050. Over half of global investment need is concentrated in Asia due to high regional need for manufacturing and purchasing of BEV and FCEV vehicles. Another relevant decarbonization lever is

platooning, which decreases fuel consumption using reduced air resistance. However, this lever is considered less capital intensive compared with the aforementioned levers. The trucking industry is subject to a high level of opaqueness, as many players are private, which creates challenges related to emission disclosures, and reduces the motivation to decarbonize. Hence, the public sector plays a fundamental role in accelerating the uptake of low-carbon alternative powertrains and fuels through the phasing out of ICE vehicles, subsidies on EVs, fuel taxes, etc. Large logistical players are already signaling a strong commitment to electrification. Many postal and package-delivery firms are committed to expanding their electric fleets through retrofits or outright purchases in the near future.

Heavy Road Transport



2.2 Gt emission per annum, ~4% global emissions

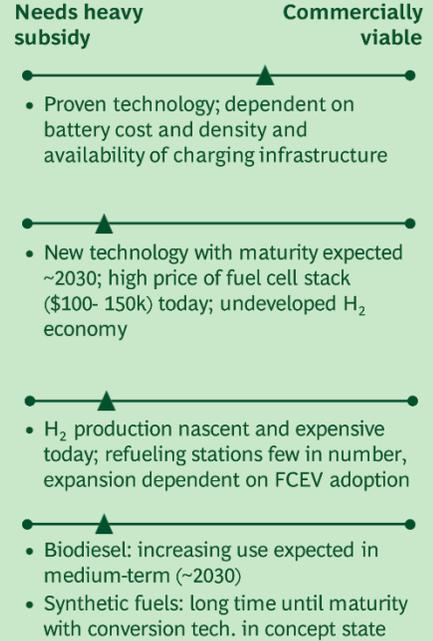


~\$32T estimated investment needed globally over 2020-2050

(of which ~\$28T required for purchasing FCEV and BEV commercial vehicles)

Sectors involved by lever Auto² Trucking Energy Chemicals

- \$1.1T** **Develop and produce battery electric commercial vehicles¹**
 - Investment in R&D, conversion/construction of factories to manufacture BEVs and components
- \$16.4T** **Purchase battery electric commercial vehicles to replace or expand fleet**
 - Technology most relevant for intra-city transport and light commercial vehicles
- \$0.8T** **Develop and produce fuel cell electric commercial vehicles¹**
 - Investment in R&D, conversion/construction of factories to manufacture FCEVs and components
- \$11.8T** **Purchase fuel cell electric commercial vehicles to replace or expand fleet¹**
 - Technology relevant for inter-city and medium & heavy-duty commercial vehicles due to distance, weight and power requirements
- \$1.8T** **Expand production of hydrogen; build out hydrogen refueling infrastructure¹**
 - Investment in hydrogen refueling network, including distribution and retail
 - Need for PPPs and industry JVs to foster simultaneous growth in demand and supply
- \$0.2T** **Use of biofuels and synthetic fuels**
 - Biofuels: scale production of biodiesel; biomass supply limitations and cross-industry competition
 - Synthetic fuels: scale green hydrogen and e-diesel production infrastructure (estimate excludes capex in renewables)



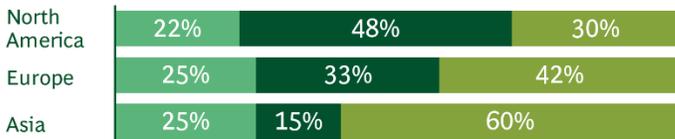
Other key decarbonization levers:

Use of autonomous driving to improve fuel efficiency; better supply chain optimizations

- Reduce fuel consumption through the use of platooning, accommodated by autonomous driving; technology expected to be ready for highway use in 2030
- Optimize utilization and supply chain efficiency through better route planning, asset utilization, etc.

Current capital structure

Auto and Components²



Trucking



Investment need by region, by instrument

- Majority of funding required for trucking industry to expand/replace fleet with BEVs and FCEVs (expected to be existing players financing through debt)
- Largest need in Asia primarily driven by high regional need and growth for vehicles
- Portion of equity financing driven by new entrants likely participating in BEVs and FCEVs manufacturing (e.g., Tesla)
- Elevated equity financing expected in Asia due to high observed equity issuances in the ground freight & logistics sector, and auto/auto component sectors

	Loans	Bonds	Equity
\$7.1T North America	\$3.1T	\$3.5T	\$0.5T
\$6.2T Europe	\$3.4T	\$2.2T	\$0.6T
\$16.7T Asia	\$9.9T	\$2.9T	\$3.9T
\$2.1T RoW			

Key implications for climate finance

- Strong need for public sector interventions & engagement to accelerate uptake of low-carbon powertrains and fuels (e.g., bans on ICE, subsidies, fuel taxes etc.)
- Opportunity to connect corporates across sectors for partnerships for investment in hydrogen refueling infrastructure (e.g., Oil & Gas and CV manufacturers)
- Opportunity to finance expansion of corporate LCV fleets in the near term as logistical players (Amazon, DHL, FedEx, etc.) have made electrification pledges
- Opportunities to support buildout of green hydrogen sector as a cross-sectoral lever
- Significant portion of trucking companies are private leading to challenges in emission disclosures and lowering the motivation to decarbonize

1. Includes: CVs used for transport of goods (LCV, MDT, HDT) and excludes pure off-highway vehicles (agriculture, construction, etc.), buses, cars and LCVs not used for transport of goods 2. auto and components (excl. motorcycles) **Note:** electric charging infrastructure and buses not considered in the heavy transport sector but will be considered in the light transport sector **Sources:** EEA, European commission, WRI, FAO, IEA, IHS Markit, ETC, ACEA, OICA, Hydrogen Council, NREL, ICCT, the Royal Society, ESU-Services, Capital IQ, BCG Analysis

3.3.7 Aviation

Aviation accounted for ~0.9 Gt of GHG emissions in 2019 (~2 percent of global emissions). The primary source of sectoral GHG emissions is passenger-related operations at 86 percent, with freighter operations contributing only the remaining 14 percent.

The key decarbonization levers are:

- **Improve the efficiency of the global fleet.** This can be achieved through fleet renewal and retrofitting new technologies in older aircraft. Given that decarbonization technologies related to engines, aerodynamics, weight, and control systems are readily available, this is a relevant lever in the short term.
- **Use sustainable aviation fuel (SAF).** Jet biofuel use is very limited, with production only able to meet less than 0.1 percent of total demand. Barriers for further adoption include regulatory shortcomings, availability of financing, and feedstock costs and accessibility. Therefore, aviation biofuels are not cost competitive, as prices are two to eight times higher compared with A1 jet fuel prices. To ensure accelerated adoption, rapid upscaling is needed, with the HEFA (hydroprocessed esters and fatty acids) production pathway being the best near-term option. At the same time, availability of required biomass will be a key issue to consider. Synthetic jet fuels will only be commercially viable in the long term, with current prices two to five times higher than A1 jet fuel prices. However, synthetic-fuel economics heavily depend on renewable energy prices. Thus, further expansion of renewable energy and green hydrogen infrastructure is needed to bridge the cost gap. Future adoption of CORSIA (Carbon Offsetting and Reduction Scheme for International Aviation) might also lead to potential improvements in SAF economics.
- **Deploy aircraft with next-generation propulsion technologies.** Next-generation propulsion technologies such as open-rotor, hybrid-electric, full-electric, and hydrogen-combustion are still in nascent stages of development. Electrification in aviation faces two challenges. First, batteries and fuel-cell systems are less energy dense than jet fuel, leading to significant added weight and limitations on range. Second, moving to electricity requires a different propulsion system (e.g., propellers). It is expected that the aforementioned technologies will become available post-2030.

There are two additional, albeit less capital intensive, key decarbonization levers for the Aviation sector. One is demand management of passenger aviation through behavioral changes to reduce aviation emissions (e.g., replacing a significant portion of business flights and all flights less than 1 hour long). Associated capital-intensive investments in infrastructure (e.g., buildout of railway networks) have not been calculated in this analysis. Another is enhancements in air traffic management systems, which optimize flight distance, climb/descent profiles, and airport operations in order to reduce emissions.

Across the levers listed, there is an estimated \$5.1 trillion global investment need for a 1.5°C scenario. This assumes a significant role for demand management. If one were to assume 2070 SAF adoption and demand put forward by the IEA Sustainable Development Scenario already by 2050, the total global investment need would amount to ~\$6.1 trillion. In this alternative scenario, a total of \$2.3 trillion would be necessary for the buildup of biofuel and synthetic fuel infrastructure. However, this is not the assumption given the high expected cost and investment. A significant portion of investment (~40 percent) is concentrated in Asia, driven by high expected regional traffic.

Given ongoing relief efforts for the Aviation sector, governments should consider including emissions targets as well as policies and subsidies within COVID-19 relief packages in order to accelerate decarbonization. Furthermore, government incentives and investments are expected to be key in improving the economics of SAF and encourage investment in SAF infrastructure. Subsidies, carbon pricing, and measures around SAF offtake contracts will help spur activity in the SAF space. Moreover, governments play an important role in ensuring high safety standards around SAF use. While less polluting, SAFs could result in unanticipated corrosion and failure of fuel under different pressure and temperature conditions due to altitude. Hence, governmental involvement in testing and certification of SAF (e.g., National Renewable Energy Laboratory (NREL) testing) is crucial to minimize the risk of fatalities.

In the private sector, collaboration across the entire SAF value chain is equally important to make the technology commercially viable and bridge the cost gap. For the Banking and Capital Markets sector, there is an opportunity to leverage customer relationships across sectors to de-risk investments in SAF infrastructure by ensuring long-term offtake contracts between airlines and SAF producers. Lastly, lenders should consider organizing and establishing a framework to fully integrate climate considerations into lending decisions (e.g., Poseidon Principles⁵⁹ in the Shipping sector).

⁵⁹ <https://www.poseidonprinciples.org/>.

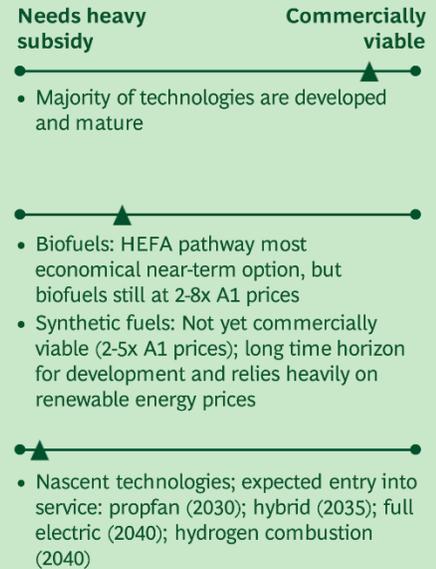
0.9 Gt emissions per annum, ~2% global emissions



~\$5.1T estimated investment needed globally over 2020-2050

Sectors involved by lever Airlines Energy

- Improve efficiency of fleet** \$0.2T
 - Improvements related to engines, aerodynamics, weight and control systems to enhance efficiency
 - Replace fleet with new gen. aircraft and/or retrofit technology (estimate excludes purchase of new fleet (~\$4.5T), considered BAU, will require agreed-to transition pathways and thresholds)
- Use Sustainable Aviation Fuels (SAF)** \$0.9T
 - Biofuels: build facilities and scale capacity; feedstock supply constraint must be solved to ensure long-term viability
 - Synthetic fuels: scale infrastructure to produce green hydrogen and e-fuels (estimate excl. renewables investing)
 - Development is dependent on partnerships between players in entire fuel value chain
- Deploy aircraft with next generation propulsion technologies** \$4.0T
 - Next-gen propulsion systems: open rotor, hybrid-electric, full electric and hydrogen combustion (estimate excludes R&D investment)
 - Full electric likely only for short-haul due to limited energy density



Other key decarbonization levers:

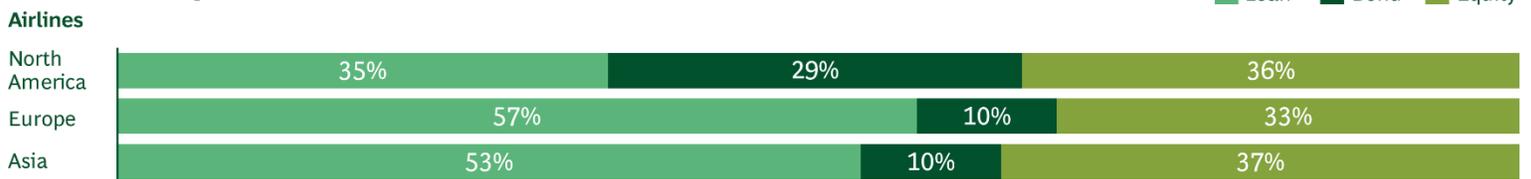
Upgrade air traffic management systems

- Optimize flight distance, climb/descent profiles and enhance airport operations

Demand management in passenger aviation

- Reduce global passenger aviation demand (e.g., through behavioral changes, phasing out short-haul flights, and reducing long-haul flights and flights for business purposes)

Current capital structure



Investment need by region, by instrument

- Largest investment need in Asia driven by highest expected future regional traffic
- Capex in sustainable aviation fuels partially financed through equity (project finance structures expected)
- Largest source of funding is debt as airlines are likely to tap into debt capital markets to finance retrofits and aircraft with next generation propulsion systems

	Loans	Bonds	Equity
\$0.9T North America	\$0.4T	\$0.4T	\$0.1T
\$1.1T Europe	\$0.8T	\$0.2T	\$0.1T
\$2.8T Asia	\$2.0T	\$0.4T	\$0.4T
\$0.3T RoW			

Key implications for climate finance

- Fleet efficiency improvements: development of climate finance solutions likely to need measurable efficiency thresholds for new aircraft and retrofits
- Need for cross-sector collaboration across fuel value chain for SAF scale-up: Agriculture, Chemicals, Power and Oil & Gas sectors
- Sustainable aviation fuels (SAF), opportunity for financial sector to leverage customer relationships across sectors to scale and de-risk capex investments
 - Sustainable supply of feedstock: offtake contracts between supplier of feedstock and SAF producers for de-risking
 - Scaled production of SAFs: offtake contracts between airlines and SAF producers
- Important role for the public sector to ensure high safety standards around use of SAFs (e.g., involvement in testing and certification)
- Critical need for governments subsidies, carbon pricing, measures around SAF offtake, to improve SAF economics
- Accelerated decarbonization through incorporation of emissions criteria and targets by governments in COVID-19 relief packages for aviation sector

3.3.8 Shipping

Shipping is one of the lowest-emitting freight transport modes by tonne/kilometer; however, the sector accounted for ~0.9 Gt of GHG emissions in 2019 (~2 percent global emissions), and faces considerable decarbonization challenges. The primary sources of sectoral GHG emissions are container ships (23 percent), bulk carriers (19 percent), and oil tankers (13 percent). The sector has set a long-term target of 50 percent reduction in net GHG emissions by 2050, relative to 2008.

The key decarbonization levers are:

- **Improve ship efficiency.** Ship efficiency can be further optimized by integrating technologies related to hull design, drag reduction, on-board power systems, and exhaust treatment. These technologies are, however, at varying levels of technological maturity.
- **Improve operational efficiency.** This is realized by implementing digital solutions that optimize routing and speed, engine, energy systems, and hull-performance operations. While technologies are relatively new and still being tested, this lever is relevant in the short term.
- **Use of alternative fuels.** E-fuels such as e-ammonia, hydrogen, and e-methanol are only viable in the long term and require significant scaling of land-based infrastructure (e.g., hydrogen production, ammonia synthesis, and the storage and bunkering of infrastructure). Alternative fuels with potential in the medium term are liquefied natural gas (LNG) and biodiesel, but they should only be considered transition fuels until long-term alternatives such as e-ammonia are adopted.

Across these strategies, there is an estimated \$2.4 trillion global investment need to reach net zero emissions by 2050. More than 50 percent investment is expected to be concentrated in Asia, driven by a large share of the global merchant fleet in China, and a high future bunkering demand in Asia, requiring significant investment in regional fuel infrastructure.

The public sector plays a central role in improving long-term e-fuel economics. Subsidies, carbon pricing, lender protections and measures around e-fuel offtake contracts, and blended finance instruments are expected to encourage investment and close the cost gap. Further, a large part of financing is expected to come from bilateral lending, as a significant proportion of ship owners and operators are private companies with limited access to capital markets. Lastly, there is a role for the Banking and Capital Markets sector to engage with companies in decarbonization targets and disclosures. This is especially relevant for shipping, given the high degree of private ownership, which creates challenges in emission disclosures and ambitions.

Shipping



0.9 Gt emissions per annum, ~2% global emissions



~\$2.4T estimated investment needed globally over 2020-2050

Sectors involved by lever: Marine Freight Transport, Energy, Chemicals

- Improve ship efficiency**
 - Investment to implement technologies related to drag reduction, exhaust treatment and power systems in global fleet
 - Several technologies require R&D with commercial readiness in short-medium term (R&D capex not considered in investment estimate)
- Improve operational efficiency**
 - Digital solutions to optimize routing, speed, engine, energy systems, hull performance
 - Will require measurement and enforcement of decarbonization outcomes to ensure alignment with decarbonization pathways
 - Technologies under development by large marine players
- Use fuel alternatives**
 - Financing for vessels with new fuel sources (e.g., engines and on-board storage)
 - Investment in land-based infrastructure (e.g., H₂, fuel production and storage facilities) needed for e-ammonia, H₂ or e-methanol as alternative zero carbon fuel
 - Estimated capex split: H₂ production \$0.7T (assumed for O&G sector), Ammonia synthesis/storage/distribution \$0.7T (Chemicals), on-board engines & storage ~\$0.2T (Marine Freight)

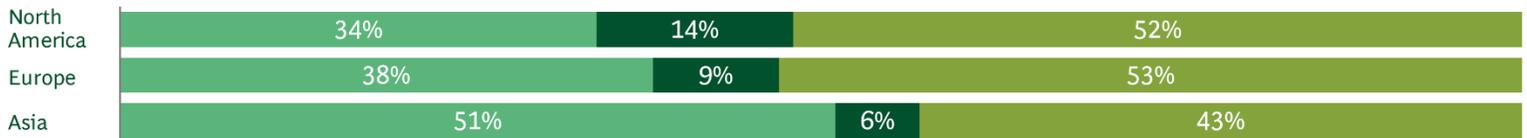
Needs heavy subsidy vs Commercially viable

- Some technologies available today, while others need further development in medium-term
- Relatively new concepts, being tested in market
- E-ammonia, H₂ or e-methanol: not viable, needs heavy incentives and policies to support

Current capital structure

Loan Bond Equity

Marine Freight Transport



Investment need by region, by instrument

- Largest investment needed in Asia:
 - Establish fuel infrastructure to meet high regional forecasted bunkering demand
 - Large share of world merchant fleet owned by China
- Equity financing significant for alternative fuels due to expected project finance structures related to fuel infrastructure assets

	Loans	Bonds	Equity
\$0.3T North America	\$0.1T	\$0.1T	\$0.1T
\$0.7T Europe	\$0.3T	\$0.2T	\$0.2T
\$1.2T Asia	\$0.7T	\$0.1T	\$0.4T
\$0.2T RoW			

Key implications for climate finance

- Improvements in operational & ship efficiency most viable in short-term: climate finance solutions likely to need measurable efficiency thresholds
- Opportunities in optimizing chartering contracts between ship operator and owners through benefit sharing schemes for ship efficiency technologies
- Key to have partnerships across the value chain for alternative fuel development: Shipping, Chemicals, Power and Oil & Gas sectors
- Opportunity for financial sector to leverage customer relationships across sectors to drive partnerships to de-risk capex investments in e-fuel infrastructure (e.g., e-ammonia) through long-term offtake contracts in shipping sector
 - Critical role for governments in making e-fuels viable through subsidies, carbon pricing, measures around e-fuel offtake
- Significant need for bilateral lending; 35% and 25% of top 20 ship owners and operators, respectively, are private, with limited access to capital markets
- Lenders should scale use of Poseidon Principles and fully integrate climate consideration into lending decision (e.g., regularly measure carbon intensity and assess climate alignment). Especially relevant for shipping due to significant private ownership, leading to challenges in emission disclosure and risk assessment
- Public-private partnerships and blended finance expected to be important and gaining traction, e.g., EIB has initiated Green Shipping Financing Programme (€750M) and signed framework agreements with ABN AMRO, ING and Société Générale

3.3.9 Agriculture

Agriculture is a highly fragmented sector that will face increasing challenges to provide safe and nutritious food to a population that will likely grow from 7.5 billion to nearly 10 billion people by 2050. In parallel, this sector faces considerable decarbonization challenges, as it emits 5.4 Gt of CO₂ per annum (~10 percent of global CO₂ emissions; note that this sector analysis excludes land use change and forestation). The primary sources of sectoral CO₂ emissions are enteric fermentation (42 percent) and manure management (23 percent).

The key capital-intensive decarbonization levers are:

- **Shift consumer diets from meat to plant-based and cultured alternatives.** This is expected to reduce CO₂ emissions and will require the development of plant-based and cultured-meat alternatives.
- **Improve manure management.** This is expected to reduce methane by 40 percent per annum with the use of (large-scale down to micro-scale) anaerobic digesters by farmers.
- **Adopt regenerative agriculture—specifically no-till farming.** This is expected to reduce carbon emissions through soil sequestration of carbon.

Across these strategies, there is an estimated \$1.9 trillion global investment need over the next three decades. Other decarbonization levers such as reducing food waste, applying regenerative agriculture practices (e.g., crop rotations), and adapting animal feed are less capital intensive and will help dramatically reduce GHG emissions. Across these levers, there is a critical role for the public sector in provision of incentives, support programs, and policies to help accelerate decarbonization.

The development of the alternative meat industry is expected to rely mainly on equity initially, given the early stage of maturity, and progressively shift to debt instruments once this industry reaches a degree of maturity. While the alternative meat industry has been shown to be commercially viable, there is a large dependency on a shift in consumer consumption behavior, which is needed to drive the growth of this industry.

There are some challenges that need to be overcome in order to finance the decarbonization of the Agriculture sector.

First, considering the high degree of fragmentation of this sector (75 percent of farms are smaller than 1 hectare), the role of capital markets is likely to be limited to intermediaries between originators and investors. This may also require innovative approaches such as partnerships with such entities as equipment suppliers, food and beverage companies, microfinance entities, mobile finance service providers, and local intermediaries such as government.

Access to debt and equity may be challenging for this sector considering the lack of scale and high-risk/low-return profiles, and there is a strong need for public sector capital and policy incentives (e.g., tax credits) to drive commercial viability for technologies needed for manure management and no-till farming. Pooling approaches with third-party entities (e.g., leasing, power purchase agreements (PPAs) for anaerobic digester systems) or cross-sectoral initiatives (e.g., solar companies financing biogas infrastructure) are also options to consider.

In addition, there is a "split-incentive" issue between benefits accruing to landowners and action needed from farmers. This may require engagement with both parties in order to facilitate a low-carbon transition.

Finally, the measurement of carbon impact is a key challenge in itself, and will require technological innovation such as satellite imagery and digital solutions.

Agriculture



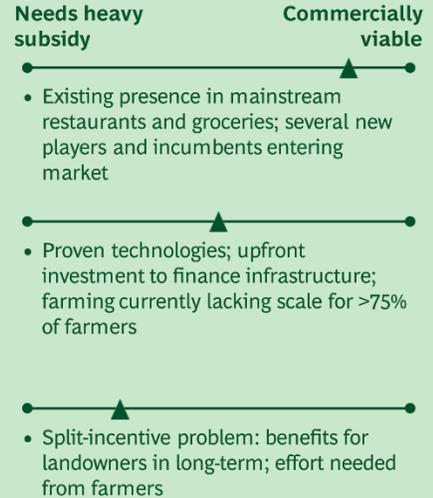
5.4 Gt emissions per annum, ~10% global emissions



~\$1.9T estimated investment needed globally over 2020-2050

Sectors involved by lever ✕ Food & Beverage 🌱 Farming

- ✕ **\$1.3T**
 - Shift diets toward alternative proteins (plant based and cultured meat)**
 - Investment to increase capacity for production and distribution of artificial/based plant meat to replace 30% of meat in 2050
 - Imperative to drive change in consumer demand and dietary trends
- 🌱 **\$0.5T**
 - Improve manure management**
 - Infrastructure (e.g., anaerobic digester – AD) for farmers to reduce GHG emission from manure (storage and handling) and produce biogas
 - 3rd party ownership (investment, operation) emerging as an option
 - Key to consider other ESG dimensions like animal welfare
- 🌱 **\$0.1T**
 - Adopt regenerative agriculture, specifically no till farming**
 - Financing new machinery for farmers for no-till farming
 - Long-term impact of this technology is still debated



Other key decarbonization levers:

- Apply other regenerative agriculture processes and practices (e.g., crop rotations)
- Reduce food waste (33% of all the food produced goes to waste form production, transportation to storage)
- Reduce enteric fermentation through animal feed, methane food pills – e.g., 3-nitrooxypropan
- Adopt fertilizers with increased Nitrogen Use Efficiency

Current capital structure

Food and Beverage



- Large share of farming market lacks access to banking solutions and capital markets (75% of farmers have <1ha, financing primarily through lending from banks, MDBs, equipment and input suppliers, cooperatives and microfinance, and informal financing; persistent financing gap)
- Small share of intensive agriculture (2% of land; 15% of value) has access to various finance solutions

Investment need by region, by instrument

- Alternative meat industry expected to be initially funded by equity capital; assumed over time to shift to mix of capital similar to existing F&B industry
- Need for significant growth of alternative meat in Asia driving higher volumes of equity estimations
- Manure management equipment assumed to be funded with debt, but may require equity capital depending on emergence of new business models like clustered AD
- Significant lending assumed for no-till equipment purchase given direct role of farmers

	Loans	Bonds	Equity
\$0.2T North America	\$0.1T	<\$0.1T	\$0.1T
\$0.3T Europe	\$0.2T	<\$0.1T	\$0.1T
\$0.8T Asia	\$0.4T	<\$0.1T	\$0.4T
\$0.6T RoW			

Key implications for climate finance

- Potential role for large financial institutions in supporting/financing through partnerships (e.g., equipment suppliers for captive finance solutions, F&B companies for long-term purchase agreements, multilaterals, microfinance, mobile finance services, local intermediaries and governments)
 - Strong need for public sector capital and policy incentives to support farmers in transition (e.g., through subsidies, blended finance solutions, tax incentives, etc.)
- Innovative structures like cluster financing (e.g., pooling of multiple AD deployments with lease/PPA)–with cross-sectoral potential (e.g., solar companies financing AD)
- Engagement with both landowners and operators may be needed to drive regenerative practices, given issues of split-incentives
- Measurement of carbon impacts challenging and likely to need technological innovation
- Significant potential for capital markets activity in emerging alternative meat industry (e.g., through acquisitions, JVs, new entrants)

3.3.10 Buildings

The Buildings sector is responsible for 3.9 Gt of CO₂ of scope-1 emissions, or ~7 percent of global CO₂ emissions, primarily through space heating with fossil fuel-based technology (~2.2 Gt of CO₂), while water heating and cooking contribute to a lesser degree (~0.8 Gt of CO₂ each). Furthermore, there are scope-2 emissions from the wide array of electrical equipment used in buildings.

The key decarbonization levers are:

- **Reduce heating and cooling demand with advanced building envelope design.** There is significant potential to reduce energy needed for heating and cooling (up to 40 percent). Technology is available but requires stringent building codes for new and refurbished buildings to maximize adoption.
- **Replace and electrify conventional heating.** Equipment upgrades with commercially available advanced heating systems can immediately improve energy efficiency and lower emissions. However, in the long term, widespread adoption of electric heat pumps and renewable heating devices will be required to fully decarbonize the sector.
- **Develop system-level district heating and cooling.** Upgraded and optimized district heating and cooling systems that utilize waste heat and renewable resources can further improve heat efficiency to lower emissions, particularly in fast-growing economies with significant urban development. Additional levers include onsite renewable energy generation for commercial spaces.
- **Shift to higher efficiency and electric cooking.** This involves a transition in developing economies from traditional biomass to more efficient technologies, and further development and deployment of electric cooking appliances.
- **Increase efficiency of electrical equipment.** Deployment of best-available technology and continuous improvements to lighting, appliance, and equipment efficiency will help limit electricity demand.

Across these strategies, there is expected to be a ~\$10.7 trillion global investment need to reach decarbonization goals by 2050 (including the ~\$4.6 trillion estimate for residential investments made by retail consumers). An estimated 20 percent of the investment need will be in North America and Europe each, and 40 percent of the investment is expected to be required in Asia. Many regional

factors will impact immediate priorities to decarbonize the sector, including climate, population, average household size and income, and regional economic development, among others.

The Buildings sector has different ownership structures that vary by region. In several regions, there is a high proportion of ownership by private equity, pension funds, and REITs (real estate investment trusts), particularly for commercial and non-retail residential real estate such as multi-family dwellings. This leads to a significant expected need for debt instruments such as lending for upgrading existing buildings and/or financing new buildings that would meet the requirements to align with climate goals. In Asia, there is a significant role for real estate developers that operate across the lifecycle of real estate development, ownership, and operations.

Policymakers and regulators must also do their part to accelerate decarbonization, including collaborating with the real estate community to align on a building standards framework that integrates emission considerations in accordance with Paris Agreement ambitions. In addition, a large proportion of investment is expected from the retail market, which depends on public sector incentives such as efficiency programs and new instruments (e.g., green mortgages and green lines of credit); however, given the focus on capital markets and primary issuance, this investment has been excluded from the instrument mix analysis.

Buildings

3.9 Gt emissions per annum, ~7% global emissions

2019 Scope 1 emissions



+ Scope 2 emissions from through consumption of electricity by the huge array of electrical devices used in buildings (e.g., lighting, air conditioners, heat pumps, appliances, etc.) provide an additional 6.8 Gt of CO₂

~\$6.1T estimated investment needed globally over 2020-2050

(in addition, ~\$4.6T estimated for residential investments made by retail consumers, excluded from analysis)

Sectors involved by lever Real Estate Investors



Increase efficiency of electric equipment

- Advanced high-efficiency lighting, appliances and cooling systems to reduce energy demand; sensors and controls for electrical equipment to further reduce energy consumption



Reduce heating/cooling demand with advanced building envelope design

- High performance windows, insulation, sealing, etc. to reduce heat loss; reflective surfaces, passive solar design, etc. to reduce cooling needs
- Includes investment for low-energy new builds and to refurbish existing structures



Replace conventional heating with advanced, low carbon technology and electrification

- Condensing boilers, high-efficiency gas-fired water heaters and high-efficiency biomass heaters to reduce energy consumption in the near-term
- In the long-term, widespread adoption of high-performance electric heat pumps and solar thermal technology



Develop system-level district heating/cooling

- Investment to improve efficiency of older systems and/or shift energy supply to heat waste or renewable energy
- Additionally, development of new systems in priority areas



Shift to higher efficiency cooking technologies

- In developing countries, a shift from traditional biomass to more efficient technologies (e.g., advanced biomass cook stoves)
- R&D required to improve efficiency of modern electric cooking appliances

Needs heavy subsidy Commercially viable

- Cost-effective, commercially available technology; continued R&D required
- Viable technology with short payback periods; however, limited adoption due to lack of awareness and downtime caused by renovations
- Viable and cost-effective options; more advanced technology (e.g., cold climate and small-scale heat pumps) require further R&D
- Viable in areas with major urban development or high heat density
- Requires access to waste heat or renewable energy
- Commercially available, however significant CAPEX and OPEX costs

Current capital structure¹

Commercial REITs



Residential REITs



■ Loan ■ Bond ■ Equity

Real Estate Development



Investment need by region, by instrument

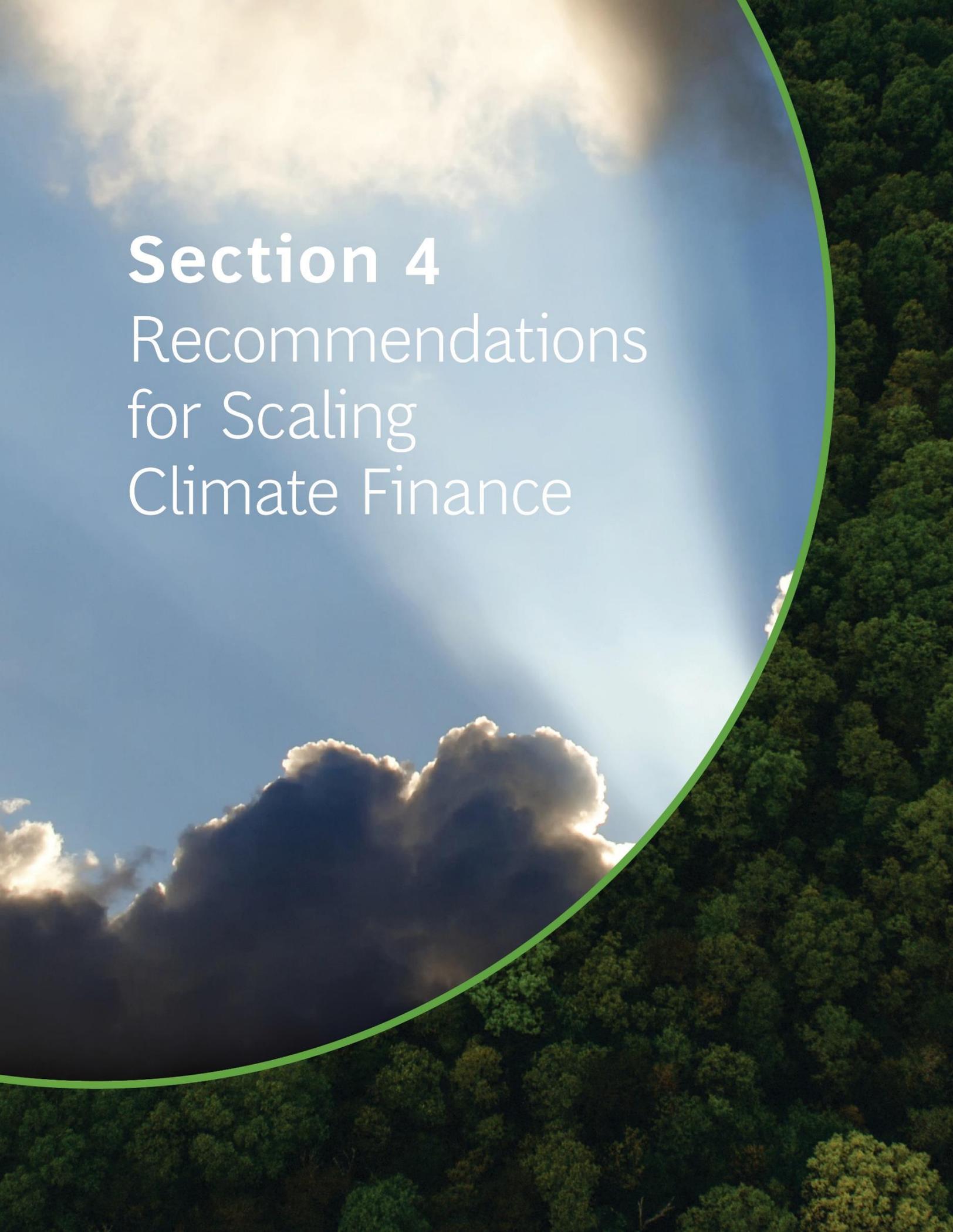
- Largest investment need in Asia due to economic growth and urbanization in China, India and Southeast Asia
- Higher reliance of debt use North America driven by ownership profile (PE and Pension funds), which use higher leverage than European and Asian counterparts
- Large role for equity in European market as Residential REITs exhibit high utilization of equity in capital structure
- Minor use of bonds as loans are more commonly used in Real Estate market to leverage investments

	Loans	Bonds	Equity
\$1.3T North America	\$0.7T	\$0.1T	\$0.5T
\$1.3T Europe	\$0.6T	\$0.1T	\$0.6T
\$2.5T Asia	\$0.9T	\$0.1T	\$1.5T
\$1.0T RoW			

Key implications for climate finance

- Opportunity to finance R&D for higher-performing, cost-effective heating technology, depending on regions and climates (e.g., extreme cold climate heat pumps)
- Important role for the public sector to encourage accelerated adoption of decarbonization technologies through programs/incentives
- Need for engagement with private equity, pension funds, and REITs (e.g., for commercial and non-retail residential real estate) given high ownership levels
- Collaboration essential, between real estate community and policymakers, on building standards frameworks integrating emission alignment with climate targets
- Cross-sectoral efforts needed across industrial, power and building sectors on levers like waste heat utilization
- Effort needed to drive adoption of best-available-technologies at a much faster rate; including systems-level policies, product standards and labelling programs, widespread education, financing options that promote adoption

¹ Private equity and pension funds are also important investor group; assumed funding structure: NA (25% equity, 75% loans); Asia and Europe (40% equity, 60% loans)
Sources: EEA, European commission, World Resources Institute, FAO, IEA Transition to Sustainable Buildings, IEA Energy Technology Perspectives, ETC Mission Possible Building Heating, CAIT, NAREIT, NCREIF, RCA, National Association of Realtors, RERC, KPMG, Bank of International Settlements, Federal Reserve of St. Louis, PERE News, CapitalIQ, BCG analysis



Section 4

Recommendations
for Scaling
Climate Finance



4 Section 4: Recommendations for Scaling Climate Finance

4.1 **Motivating capital: Addressing Market Failures in Order to Accelerate Climate Action from the Real Economy and Enhance the Flow of Climate-Aligned Capital**

We recommend that governments deploy four levers (carbon pricing, environmental and industrial policies, fiscal and monetary incentives, and use of public financing and blended capital) to further motivate the flow of capital to the real economy in order to finance the climate transition. The market for climate finance cannot reach the scale needed without urgent action from policymakers.

4.1.1 We recommend that governments establish legally enforceable, comprehensive, and sufficiently high levels of GHG-emissions pricing (carbon pricing) mechanisms such as GHG tax or trading schemes, with explicit forward-looking direction on price levels, implemented in a way that respects a “just transition,” minimizing social and economic costs for those least able to bear them.

Context

Carbon dioxide and other GHGs cause negative externalities (indirect costs to individuals and society) that are not sufficiently priced into the real economy or markets. This has **led to a systemic market failure, wherein the true cost of products and services is not fully accounted for, and hence not paid for.** These unpriced externalities are unevenly distributed across economic sectors and jurisdictions, leading to significant market inefficiencies and distortions. As a result, **there is an uneven playing field between low-carbon and high-carbon activities.**

As noted in the U.S. Commodity Futures Trading Commission (CFTC) report *Managing Climate Risk in the U.S. Financial System*, “Financial markets will only be able to channel resources efficiently to activities that reduce greenhouse gas emissions if an economy-wide price on carbon is in place at a

level that reflects the true social cost of those emissions. Addressing climate change will require policy frameworks that incentivize the fair and effective reduction of GHG emissions. In the absence of such a price, financial markets will operate suboptimally, and capital will continue to flow in the wrong direction, rather than toward accelerating the transition to a net-zero emissions economy.”⁶⁰

The International Monetary Fund (IMF) has also noted, “Of the various mitigation strategies to reduce fossil fuel CO₂ emissions, carbon taxes—levied on the supply of fossil fuels in proportion to their carbon content—are the most powerful and efficient, because they allow firms and households to find the lowest-cost ways of reducing energy use and shifting towards cleaner alternatives.”⁶¹

The lack of a stated cost for carbon also leads to the often-cited symptoms of a sub-scale climate finance market, such as a limited pipeline of bankable projects, challenged economic viability for projects, higher risk levels, and the inability of the Banking and Capital Markets sector and the real economy to effectively manage the risks and opportunities arising from climate change—as well as efforts to avoid it. It is important to note that carbon pricing addresses the topic of climate mitigation and consequent transition, but does not address the issue of adaptation and physical risks.

⁶⁰ <https://www.cftc.gov/sites/default/files/2020-09/9-9-20%20Report%20of%20the%20Subcommittee%20on%20Climate-Related%20Market%20Risk%20-%20Managing%20Climate%20Risk%20in%20the%20U.S.%20Financial%20System%20for%20posting.pdf>.

⁶¹ IMF Fiscal Monitor, Oct 2019.

In this report, the World Bank’s definition of “carbon pricing” is used in its State of Carbon Pricing 2020: **initiatives that put an explicit price on GHG emissions expressed in a monetary unit per tonne of carbon dioxide equivalent (tCO₂e)**. There are different mechanisms for establishing a carbon price (note that this report doesn't aim to provide guidance on the specific mechanism that should be used):

- Establishment of a carbon tax—taxes, levies, and excise duties that explicitly state a price on carbon; removal of carbon subsidies
- Introduction of carbon border adjustment mechanisms—to mitigate potential "carbon leakage" (see details below)
- Emissions trading system (ETS)—policy instruments wherein covered entities face compliance obligations for their GHG emissions and can trade emission units to meet these obligations, typically through:
 - Cap-and-trade (total cap on volume of emissions for a given section of the economy, with emissions units auctioned or allocated); and
 - Baseline-and-credit (baselines set for regulated emitters; emitters with emissions above their designated baseline need to surrender credits for emissions above their baseline).

In addition to these, there are a few mechanisms that can result in pricing for carbon, including carbon-crediting mechanisms (initiatives that issue tradable emission units to actors that voluntarily implement emission-reduction activities additional to “business as usual” operations), results-based climate finance (funds disbursement upon achieving a pre-agreed set of climate results), and internal carbon pricing (as a tool used within organizations to guide decision-making). This topic is discussed further in Section 4.1.4.

What it will take for carbon pricing to succeed

One of the most important factors for success is **to have an adequately high and globally aligned carbon price** that reflects the true social and environmental cost of carbon, and helps make the cost of legacy activities that are not aligned with the Paris Agreement objectives increasingly reflective of the full cost, including negative externalities. In that sense, carbon pricing is an effective means to enhance the transparency of economic decisions. The IMF has stated that limiting global warming

to 2°C or less requires ambitious policy measures, such as an immediate global carbon price that would rise rapidly to \$75 per tonne of CO₂ in 2030.⁶² The High-Level Commission on Carbon Prices concluded in 2017 that a carbon price in 2020 in the range of \$40–80/t rising to \$50–100/t by 2030 would be consistent with meeting the temperature targets in the Paris Agreement. The Climate Leadership Council, an international policy institute founded in collaboration with business leaders, also has a gradually rising carbon fee as part of its four-pillar plan, starting from \$40 and rising at a rate of 5 percent above inflation.⁶³ A commitment to raise prices over time also leads investors to anticipate future price increases, thereby accelerating decarbonization at a speed faster than the price itself might drive.

“There is a lack of investment opportunities with attractive returns, but if we had a carbon tax or price, that dynamic would change overnight.”

—Banking executive

“Carbon dioxide needs to get a price. [We] need the incentives for a market-based pull and push.”

—Chemical company executive

“Price the externality—[this] will definitely accelerate the change.”

—Investor

Still, this not a complete solution. For several carbon-intensive sectors, carbon pricing alone will be insufficient as the abatement costs exceed the typical levels that have been achieved by carbon pricing. For example, in Cement, the estimated cost of decarbonization is about \$110–130 per tonne of CO₂.⁶⁴ As such, complementary incentives from the public sector will be required for the development and deployment of low-carbon technologies. This is discussed in greater detail in the chapter on public sector incentives (4.1.2).

⁶² IMF Fiscal Monitor, Oct 2019.

⁶³ <https://clcouncil.org/our-plan/>.

⁶⁴ ETC Mission Possible 2018.

“[There is a] massive cost of transformation, and a five to seven-year time period of investment... it will take a carbon price of \$100 to \$150 to get it to work... and complete decarbonization using hydrogen might require an even higher range.”

—Steel sector executive

Approaches to carbon pricing are at various stages of maturity across sectors. For example, in the food and beverage industry, where there are significant carbon emissions embedded in agricultural supply chains, there is ongoing dialogue on the impact of carbon pricing on farmers, and the associated challenges of measurement of carbon data.

Additionally, **governments should consider the overall net impact of existing taxes, subsidies, and mandates in relation to a carbon price to mitigate unintended economic dislocations.** Implementation of policies that affect basic commodity prices must involve extensive stakeholder consultations and considerations of revenue use. According to the IMF, the **revenues from carbon taxes should, among other things, be redistributed to low-income households, support disproportionately affected workers and communities, support weaker economies, and fund investment in clean infrastructure.** As per the Business Roundtable, policies should be implemented in such a way as to “minimize social and economic costs for those least able to bear them.”⁶⁵

Another key issue is the uneven application of carbon pricing internationally (see more in the section on “Current state of carbon pricing”). This leads to **the potential issue of carbon leakage, wherein industries relocate to countries with less-ambitious carbon policies.** A mechanism to prevent and limit carbon leakage from relocation of industries to countries with less-ambitious carbon policies is the **introduction of border carbon adjustment mechanisms.** For example, as per the EU Green Deal’s proposal on such a mechanism, “Europe’s efforts to go climate-neutral by 2050 could be undermined by lack of ambition by our international partners. This would mean a risk of carbon leakage. This occurs when companies transfer production to countries that are less strict about emissions. In such case global emissions would not be reduced. This new mechanism would counteract this risk by putting a carbon price on imports of certain goods from outside the EU.”⁶⁶ Further progress on this front may be on the horizon given recent developments in the global arena, including the strong

⁶⁵ <https://www.businessroundtable.org/climate>.

⁶⁶ <https://ec.europa.eu/info/law/better-regulation/have-your-say/initiatives/12228-EU-Green-Deal-carbon-border-adjustment-mechanism->

stance on climate action by the incoming Biden administration in the United States, and the recent pledge by China to achieve net zero by 2060.

While carbon border adjustment mechanisms have a strong theoretical basis, their implementation is expected to be challenging. There are several obstacles to overcome, including calculating carbon content, maintaining compliance with World Trade Organization (WTO) rules, ensuring foreign businesses do not develop ways to circumvent the taxes, and determining the scope of implementation (sectoral coverage, inclusion of intermediate goods, etc.). There is also the additional challenge that **different countries will transition in different ways, so direct comparability in terms of competitive impact will need to be well-considered before a border adjustment on such countries is implemented**. This also opens up the potential for misuse of such mechanisms for enabling trade wars, and hence must be designed with abundant caution so as to not make it a general tariff mechanism. Importantly, a carbon border adjustment mechanism should not be implemented in a way such that it is perceived as a punitive measure by developing countries. Due to the potential for unintended consequences, any such mechanism must be designed with due consultations with sector- and region-specific industry and capital markets participants.

Despite these challenges, several experts on the topic have argued that carbon border adjustments are the cornerstone of a strong carbon pricing mechanism that can also help further global discussions and the establishment of carbon pricing. For example, the Climate Leadership Council incorporates carbon border adjustment through rebates and taxes as one of its plan's four pillars, including a corollary mechanism of rebates for carbon fees already paid for exports to countries without comparable carbon pricing systems.⁶⁷

Another issue to consider is the use of fossil fuel subsidies. The IMF has estimated fossil fuel subsidies (defined as fuel consumption times the gap between existing and efficient prices) of \$4.7 trillion (or 6.3 percent of global GDP), which were projected to reach \$5.2 trillion (6.5 percent of GDP) in 2017.⁶⁸ It is important to note that this estimation counts both “pre-tax” subsidies (difference between consumer price and cost of supplying fuel, estimated at ~\$0.3 trillion in 2017) and “post-tax” subsidies (difference between consumer price and “efficient prices,” which include environmental and social costs such as local air pollution, global warming, etc.). As per the IMF,

⁶⁷ <https://clcouncil.org/our-plan/>.

⁶⁸ IMF 2019: Global Fossil Fuel Subsidies Remain Large: An Update Based on Country-Level Estimates.

“Efficient fossil fuel pricing in 2015 would have lowered global carbon emissions by 28 percent and fossil fuel air pollution deaths by 46 percent, and increased government revenue by 3.8 percent of GDP.”⁶⁸

The value of pre-tax subsidies was ~\$0.3 trillion in 2017. As per the Overseas Development Institute (ODI) in 2018, G7 governments continue to provide at least \$100 billion each year in supporting the production and consumption of fossil fuels. In order to promote alignment with emission-reduction goals, it is important for governments to consider these current levels of subsidies and explore alternative mechanisms to efficiently achieve their intended benefits, while reorienting policies that may create direct or indirect subsidies for high-carbon-intensity activities. Governments could consider, where feasible and in line with development objectives, if and how these subsidies could be applied to low-carbon technologies and sources of energy.

Current state of carbon pricing

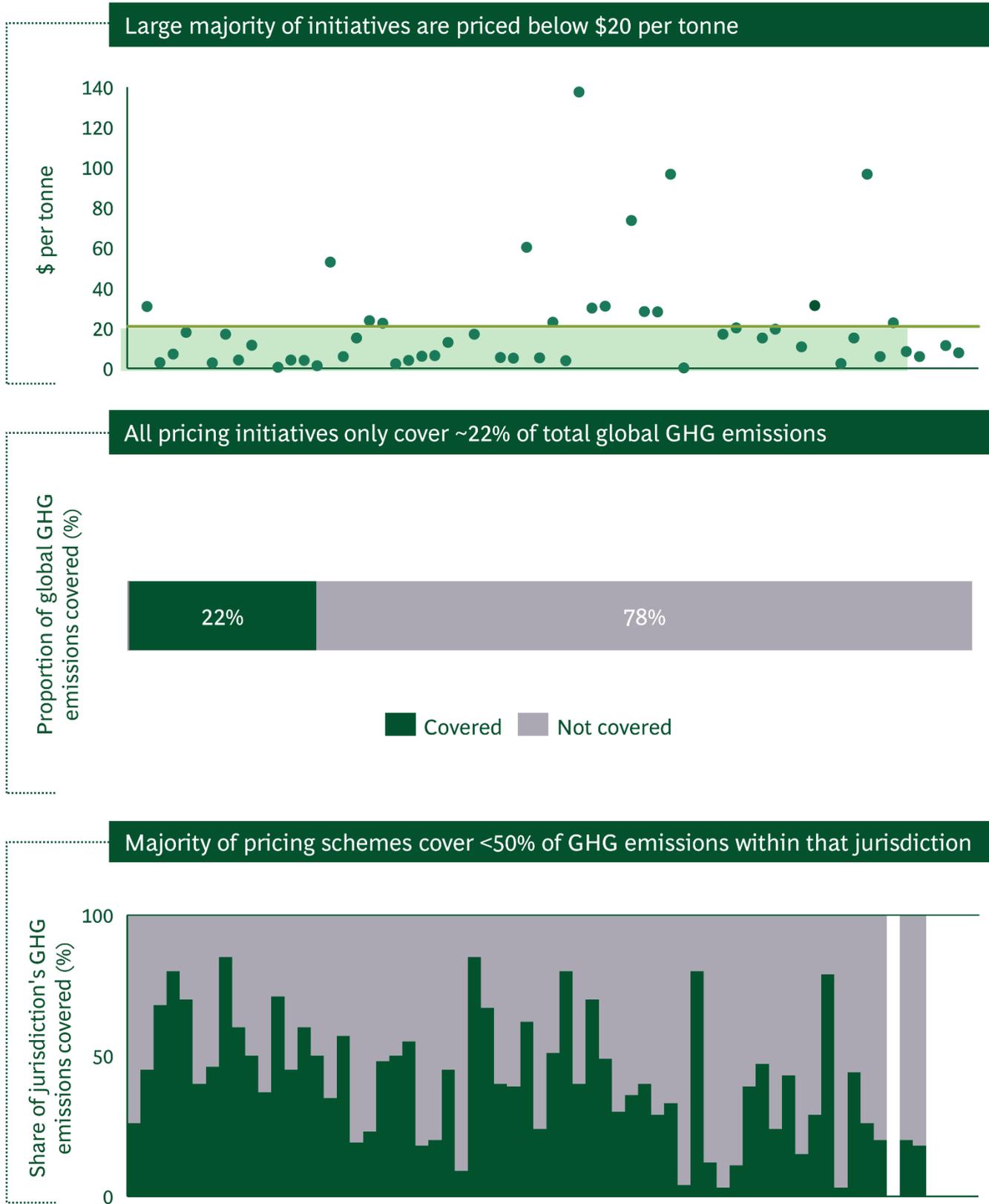
Carbon pricing policies operate or are scheduled to operate in 78 countries, states, provinces, and cities that cover about 22 percent of global GHG emissions (as per World Bank 2020). However, only six jurisdictions set a price over \$40/tonne, and **almost half of the covered emissions are priced at less than \$10/tCO₂e**. In addition, the majority of these pricing schemes **cover less than half of GHG emissions** within each jurisdiction, highlighting a gap in the coverage of carbon pricing where it exists.

There are distinct nuances on a region-by-region basis as well. In the EU, significant progress has already been made with the Emissions Trading System (ETS) that was established in 2005, and with an ongoing discussion of the potential development of a carbon border tax. Emissions from sectors covered by the system are expected to be **21 percent lower by 2020 than in 2005**.⁶⁹ In the U.S., there are some states that already have state-level carbon pricing, and recent developments (e.g., the CFTC recommendations in “Managing Climate Risk in the US Financial System” and the House Democrats’ ambitious proposal on climate action, including a steer toward net zero by 2050) show momentum toward the establishment of a carbon pricing scheme.

In Asia, given the diversity of jurisdictions and the political landscape, the feasibility of achieving a universal and sufficiently high carbon price is challenging; however, there are several efforts underway in China, Vietnam, Thailand, Indonesia, and other countries to establish ETS/carbon-tax schemes. Recent announcements by China regarding achieving net zero by 2060 could bring accelerated developments on this front.

⁶⁹ European Commission.

Carbon price initiatives in place today



Note: Horizontal axis represents individual carbon pricing initiatives in the first and third chart
Source: World Bank Dataset

Figure 11: Current state of carbon pricing

In conversations with 100+ interviewees—representing a cross-section of market participants, including corporates, banks, and asset managers and owners—there was a **strong support for carbon pricing as one of the most effective actions to enable rapid scaling of climate action and climate finance.**

“Carbon pricing is likely a necessary condition to reach the Paris Agreement. [Without it] legacy activities are not uneconomical.”

—Banking executive

“Effective carbon pricing can provide greater certainty for businesses, and better market signals and drivers to guide behavior change across both industries and new funds to further accelerate and drive the transition to a net zero future.”

—Global technology company

“We need a carbon tax for final products... without it, this will not be possible.”

—Steel sector executive

“Best thing to do would be to price carbon.”

—Investor

In addition, business leaders have publicly supported the establishment of carbon pricing mechanisms. For instance, the Business Roundtable (an association of chief executive officers from America’s leading companies) has recently publicly announced it “supports a market-based emissions reduction strategy that includes a price on carbon.”⁷⁰

⁷⁰

<https://www.businessroundtable.org/climate#:~:text=Business%20Roundtable%20supports%20a%20market,any%20specific%20market%2Dbased%20mechanism.&text=%E2%97%97%20Placing%20a%20price%20on%20carbon>.

Recommendations

We recommend that **governments establish legally enforceable, comprehensive, and sufficiently high levels of GHG-emissions pricing ("carbon pricing") mechanisms such as a GHG tax or trading schemes**, with explicit forward-looking direction on price levels, implemented in a way that respects a "just transition," minimizing social and economic costs for those least able to bear them.

The Banking and Capital Markets sector sees carbon pricing as a supportive tool to motivate climate action and enable the scaling of the climate finance market.

Governments should establish a **sufficiently high carbon price, with long-term direction**, to help resolve investor uncertainty and promote corporate climate action to be able to meet the necessary transition pathways to achieve Paris Agreement goals. They should also provide direction and make commitments to ramp up prices over time, which would further enable investors to anticipate future price increases, thereby accelerating decarbonization at an even faster pace than that achieved at initial or current levels. Pricing should be established in a manner that covers all key carbon-intensive sectors.

In addition, we recommend that, as part of a broader carbon pricing policy, governments **support the transition to renewable energy, and reexamine subsidies provided to high- and low-carbon technologies, for instance by phasing out fossil fuel subsidies** (or equalizing subsidies with those for renewable energy) and replacing them as needed with policies that achieve the intended societal impact (e.g., on food prices) without subsidizing GHG emissions. Several international institutions, including the G20, the IEA, and the Organization of Economic Cooperation and Development (OECD), have also called for the phase-out of fossil fuel subsidies.⁷¹ Governments should also avoid, where possible, the overlaying of other similarly titled energy taxes that send potentially confusing signals to the marketplace by considering overall tax incidence on energy.

Where needed, governments should evaluate the **establishment of border-tax mechanisms** to provide a level playing field for trade, and prevent carbon leakage. The costs and benefits of such

⁷¹ EESI 2019: Fact Sheet: Fossil Fuel Subsidies: A Closer Look at Tax Breaks and Societal Costs.

mechanisms on the economy and international trade should be carefully weighed, with close collaboration and consultation with industry. The mechanisms should be designed in a manner that accounts for potential differences in transition pathways between countries. Global coordination and transparency on carbon pricing between jurisdictions is encouraged to minimize excessive use of border adjustments. This should also be accompanied by rebates wherever carbon fees for exports to countries with less-ambitious or no carbon pricing systems have been paid.

In addition to the establishment of carbon pricing, there is also an important role for the development and scaling up of voluntary carbon credit markets globally. These represent carbon-equivalent emissions that are reduced, avoided, or sequestered from projects applying an approved carbon credit methodology and can enable organizations to offset emissions not yet eliminated, or contribute to the removal of GHG from the atmosphere. Estimates indicate that the voluntary carbon markets need to grow by more than 15 times by 2030.⁷² At the same time, it is critical to note that carbon credits are not substitutes for emissions reductions by corporations, and hence do not preclude the establishment of a carbon pricing regime—which is one of the most critical levers to price-in the externalities associated with GHG emissions—and correct for a market failure.

⁷² As per IIF's taskforce for scaling voluntary carbon markets.

4.1.2 We recommend that **governments commit to and implement effective and proportionate policies, fiscal programs, and legislative action that will support achievement of the targets established in the Paris Agreement.**

Context

Net zero commitments

Achieving the ambition of the Paris Agreement, i.e. limiting global warming to 1.5°C, requires achieving global net zero emissions by 2050.⁷³ Governments are increasingly making commitments in line with these targets. As per the Climate Ambition Alliance, there are 120 countries, 452 cities, 22 regions, and more than 1,100 companies that have joined the alliance on the initiative for net zero by 2050.⁷⁴ Notable recent additions include Japan and China, the world’s largest GHG emitter globally by absolute numbers, which has set a target for 2060. Several countries (e.g., Denmark, France, New Zealand, Sweden, and the UK) have gone further by enshrining net zero emissions targets into legislation, while others (e.g., Spain, Fiji, Chile) have proposed such laws.⁷⁵ The EU has proposed legislation (EU Climate Law) to achieve net zero by 2050. In its 2030 Climate Target Plan, the European Union has also proposed aggressive short-term targets to reduce GHG emissions by at least 55 percent by 2030, setting a path to becoming climate neutral by 2050. The incoming Biden administration has proposed a net zero by 2050 commitment, and is expected to be a big impetus to climate action in the United States.

However, public commitments to a Paris-aligned pathway have not yet been made by some of the largest-emitting countries or some of the highest per capita emitters.

Environmental and industrial policies

Scaling climate finance will also require countries and sub-national jurisdictions to develop and enforce actionable environmental and industrial policies. A lack of these policies, or their enforcement, creates uncertainties that stifle investment flows. The design of these policies must balance local concerns and GHG reduction commitments.⁷⁶ Many countries, sub-national regions, and cities have taken these steps in select sectors and topics. As an example of industrial policy, the

⁷³ The Special Report on 1.5°C (SR15) released by the Intergovernmental Panel on Climate Change (IPCC) in 2018 confirmed that, in order to limit global warming to 1.5°C, we need to reach net-zero CO₂ emissions at the global level by mid-century.

⁷⁴ UNFCCC; <https://climateaction.unfccc.int/?coopinitid=94>; as of October 20, 2020.

⁷⁵ World Bank – State of Carbon Pricing 2020.

⁷⁶ Note that this report doesn’t endorse specific economic/industrial policies in this regard.

United Kingdom implemented a policy of banning the sale of internal combustion engine (ICE) vehicles that run on fossil fuels by 2040, which was pulled forward to 2035, and enhanced to include bans on hybrid vehicles—and there is ongoing discussion around implementing the ban even sooner

“Industry alone can make some headway, but if you marry it with policy—then it is enormously powerful; e.g., in the auto industry—if we were to say ‘all new cars from 2025 would be fully electric,’ this would force real change.”

—Banking executive

in 2030 as part of a series of clean energy policies related to a green economic coronavirus pandemic recovery plan. Interviewees for this report cited this law as an example of one that has been effective at spurring financial institutions to accelerate new financing solutions for the transition away from ICE vehicles. Similarly, France’s proposed 2040 ban and Norway’s pending 2025 ban have been instrumental in driving significant investment in EV manufacturing—an estimated \$150 billion planned by European automakers over the next 5–10 years.⁷⁷

Fiscal incentives

Several low-carbon technologies needed to achieve Paris Agreement targets are not yet commercially viable, creating a barrier for commercial lenders and investors to provide the capital needed to grow and scale them.

There are several potential factors that constrain the commercial viability of emerging climate technologies. Many require significant upfront capital investment and have long, uncertain payback periods. In addition, several are early stage technologies that have not reached commercial scale. The lack of carbon pricing and value differentiation by a large number of buyers further limits the potential for these technologies to compete with legacy technologies.

Even with a sufficiently high carbon price, **during the transition period, governments have an essential role to close this investment gap through the provision of fiscal incentives that drive**

⁷⁷ As per Reuters analysis of global automakers.

economic viability. The consistency and enforcement of these incentives are what would drive bankability.

Specifically, as shown in the chapters on sector-specific insights, there are a few technologies that provide solutions across industry sectors but have low commercial viability in several applications. For example, **green hydrogen and CCUS are technologies that are often not commercially viable without a sufficiently high carbon price, yet are instrumental in decarbonizing several sectors** (including Power, Iron & Steel, Chemicals, Light/Heavy Road Transport, Aviation, Shipping, and Buildings, among others).

“Green hydrogen is critical for hard-to-abate sectors; but there's a long path towards this—more than 10 years; public sector investment is important here.”

—Investor

“Now renewable energy has an affordable and competitive price level, but there's a transition period where supportive policies and incentives are needed, then you can let the market work.”

—Steel executive

“Who's picking up the bill—that's the key issue... Industry is not in a position to invest; [we] need supportive policies for early adoption of biofuels; without government support it will be very tough.”

—Airline executive

Much like initial government support for renewable energy such as wind and solar has helped the industry flourish to the point these technologies are now among the cheapest around more than two-thirds of the world, **specific government incentives are recommended to support the development of these cross-cutting decarbonization solutions.** These could include subsidies such as investment or production tax credits, accelerated amortizations, and incentives (such as capital gains) on green financial instruments to make these investments more economically viable in the medium term.

Recommendations

We recommend that **governments commit to and implement effective and proportionate policies, fiscal programs, and legislative action** that will support achievement of the targets established in the Paris Agreement.

Governments should align **existing and new long-term commitments** with the ambitions of the Paris Agreement (e.g., net zero), and translate these commitments into conducive framework conditions, such as national and regional environmental and industrial policies, to support the acceleration of the climate finance market.

Governments can further stimulate financing for essential climate-related investments through:

- **Introducing and enforcing policies and laws that induce shifts** toward low-carbon technologies;
- **Dramatically scaling up incentives in early stage decarbonization technologies** such as green hydrogen, CCUS, battery storage, etc. to accelerate commercial viability;
- **Aligning their COVID-19 recovery funding and economic stimulus packages to pursue sustainable and green recovery** through grants, tax relief, loan guarantees, spending and revenue support, etc.; and
- **Implementing medium-term subsidies such as investment tax credits or accelerated amortizations in technology investments that have high upfront investments and longer payback periods** to make these investments more economically viable.

4.1.3 We recommend that **governments and national/multilateral development banks motivate the mobilization of private sector capital through blended public/private finance solutions.**

Context

A resounding theme from interviewees of this report is the need for forms of capital that can more effectively de-risk investments in climate action.

In some sectors, there are considerable technology and policy risks associated with early stage decarbonization technologies and uncertain technological pathways. For example, in Aviation, it is unclear as to what extent sustainable aviation fuels (SAFs) will be used for decarbonization—and which specific SAF (e.g., HEFA-based biofuel versus synthetic fuels) will be dominant. Similarly, in Heavy Road Transport, it isn't yet clear how the future market will be divided between BEVs and hydrogen fuel-cell vehicles. Financing of climate action in emerging markets is further constrained by sovereign, currency, and political risk factors.

Further, several projects are not yet at scale and are small in numbers, leading to a lower overall volume of capital flow and need. This introduces barriers to attracting investors, particularly institutional investors that look for minimum ticket size in deals.

Governments and the social sector can address these constraints through offering more and better-structured forms of catalytic capital.⁷⁸ For example, the International Finance Corporation and the Clean Technology Fund helped demonstrate viability of solar in Thailand; and the SDG500, an investment platform launched earlier this year in Davos, is set to invest \$500 million in businesses working capital to achieve the global sustainable development goals. The funds will be used to make debt and equity investments in early stage businesses in emerging and frontier markets.

⁷⁸ Catalytic capital is defined by the MacArthur Foundation as “debt, equity, guarantees, and other investments that accept disproportionate risk and/or concessionary returns relative to a conventional investment in order to generate positive impact and enable third-party investment that otherwise would not be possible.”

Blended finance as a tool to de-risk decarbonization and mobilize capital

Convergence, a multi-stakeholder platform to promote blended finance, defines the term as "the use of catalytic capital from public sector or philanthropic sources to increase private sector investment in sustainable development."⁷⁹ The OECD defines blended finance as "the strategic use of development finance for the mobilization of additional finance towards sustainable development in developing countries." The market for blended finance—approximately \$150 billion of capital committed in developing countries in 2018—is still small compared with overall capital flows.⁸⁰

The **EU Green Deal Investment Plan** is a strong example of public sector balance sheets being used to mobilize private sector capital. It has the goal of mobilizing at least EUR 1 trillion (~\$1.2 trillion) of private and public sustainable investments over the course of 10 years. This represents 25 percent of all EU funding for climate measures. The **InvestEU Fund, a central part of the investment plan, uses an EU budget guarantee to mobilize at least EUR 650 billion (~\$770 billion) in additional investment (of all types) between 2021 and 2027**, and targets four main policy areas: sustainable infrastructure; research, innovation, and digitization; small and medium businesses; and social investment and skills.⁸¹ And 30 percent of InvestEU projects are expected to fight climate change.

The EU has put in place additional mechanisms that work with InvestEU to provide earlier stage blended capital. An example of this is the **EU Innovation Fund**. With the objective of **driving clean innovative technologies toward the market**, the fund focuses on large flagship projects in low-carbon technologies and processes in energy-intensive industries, CCUS, renewable energy, and energy storage—and is funded by the EU ETS.⁸² The fund is expected to reach EUR 10 billion (~\$12 billion), depending on carbon price levels.

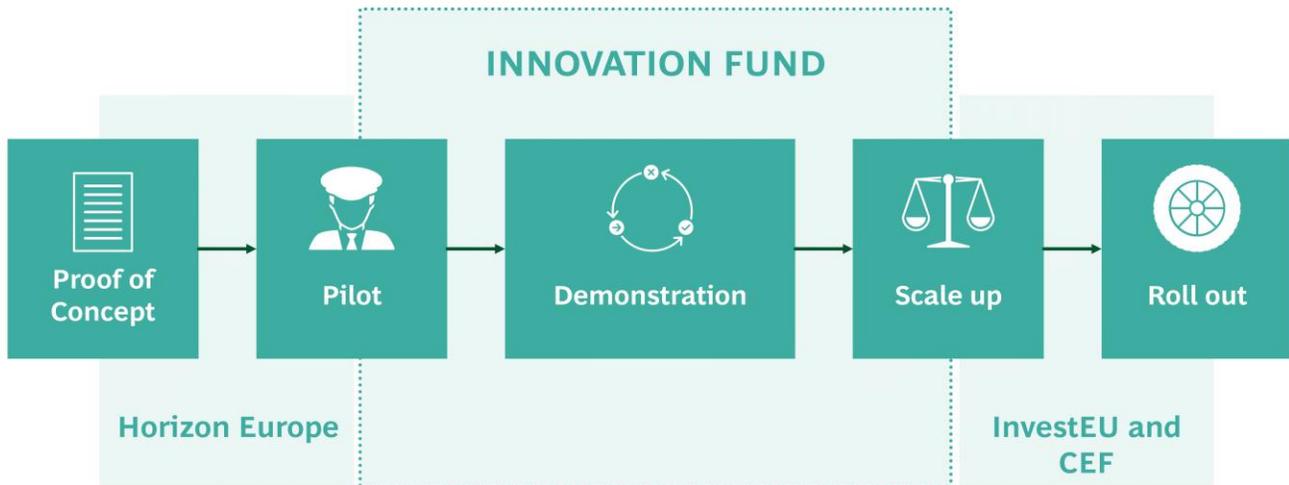
⁷⁹ As per Convergence Finance.

⁸⁰ Definition and market estimates from Convergence Finance.

⁸¹ European Commission; European Green Deal "Investing in a Climate-Neutral and Circular Economy."

⁸² Emissions Trading System.

Additional EU funding mechanisms



Source: European Commission

Figure 12: Additional EU funding mechanisms

Recommendations

Conversations with 100+ executives from real-economy corporates, financial services institutions, and investors revealed a resonant theme around the need for public sector capital to aid investment in decarbonization.

“Governments need to come in to take some long-term risk; but have to get the private sector and corporate sector involved—[governments] need to be involved in owning and growing the solution.”

—Banking executive

We recommend that **governments and national/multilateral development banks motivate the mobilization of private sector capital through blended public/private finance solutions.**

There is a massive investment need for decarbonization technologies. **Governments and multilaterals globally should dramatically scale up the use of catalytic capital in order to mobilize private sector capital. Wherever needed, governments should further set up financing facilities and/or institutions that have the authority to deploy concessional capital (e.g., first-loss tranches or alternative risk-mitigating capital).** Specifically, they should also expand the use of such instruments for transition activities that may not traditionally be included as part of green financing, but would fall within a scientifically aligned transition pathway for sectors.

- National governments should provide more flexible forms of concessional capital both through domestic institutions for national efforts and bilateral and multinational development finance institutions.
- Banks should increase their role as originators of blended finance transaction opportunities to augment the deal flow created by the supranational institutions.
- Multilaterals and development financial institutions should scale up vehicles to aggregate and deploy concessional capital in pursuit of climate-related objectives (i.e., facilities that deploy risk guarantees, concessionary equity or mezzanine capital, PPAs, and other mechanisms).
- Foundations and bilateral donors should provide both essential technical assistance pre-investment (to create a more robust pipeline opportunities) and market-building efforts.
- Governments should increase the amount and structure of the concessionary capital that is available for blended finance transactions, both through bilateral and multilateral financial institutions.
- Foundations should more aggressively deploy not only their programmatic disbursements but also their balance sheets in accelerating the availability of catalytic forms of capital for climate solutions.

The Banking and Capital Markets sector, institutional investors, and corporates should further collaborate with governments, central banks, and multilaterals to establish efficient structures suited to the industry, decarbonization technologies, and business models of the future. Financial institutions should also increase their efforts to originate deals that could be well-suited for blended transactions with public and social sector entities such as development banks.

4.1.4 We recommend financial education and climate finance risk awareness-building at an executive level to support corporates' ability to actively prioritize and accelerate their own preparations for a low-carbon future, embedding this as a strategic imperative for the board and senior management. The Banking and Capital Markets sector will be an important partner to corporates to both help navigate the risks and opportunities of climate change and mobilize appropriate financing solutions.

Context

Climate change is increasingly considered a material topic across several sectors. Companies, both public and private, are facing increased scrutiny and pressure from multiple stakeholders, including investors, regulators, customers, employees, and broader civic actors such as non-governmental organizations (NGOs). As a result, companies are increasingly integrating climate factors into core business strategy and decision-making around product development, operations, supply chains, pricing, etc.

However, companies in many industries are still at early stages of understanding the implications of climate change on their business models and processes—both from a transition and physical-risk perspective.

In some cases, the transition to a low-carbon economy brings with it significant business-model implications. As discussed in section 3, for example, in the oil & gas industry, the demand for their core products is expected to decrease as global energy systems transition to low-carbon alternatives.⁸³ Another case in point is the automotive industry, which is expected to undergo widespread electrification over the next few decades. These changes will require a business-model reinvention.

That said, companies in several sectors stand to realize significant potential benefits from navigating the transition well. There are several decarbonization levers that are commercially viable, including efficiency levers that can help reduce cost (e.g., in the Chemicals sector) and new technologies that have seen commercial success already (e.g., renewable power, EVs, etc.). For several sectors, these opportunities pose significant revenue potential (e.g., for the Oil & Gas and Chemicals sectors for alternative renewable fuels).

⁸³ IEA World Energy Outlook's "Net Zero by 2050" case shows declines in energy demand, including from coal, oil, and natural gas, over the next decade.

To navigate these transitions, companies will need to **evaluate their exposures and refine business models to be ready for a low-carbon future**. These changes can be further enabled by board and leadership accountability and buy-in; redesigned business line strategies; and operational changes for collection, monitoring, and processing of climate data, talent development, and governance and operating-model changes. Section 3 provides insights on the levers for the subset of 10 sectors, including Power, Iron & Steel, Cement, Chemicals, Light Road Transport, Heavy Road Transport, Aviation, Shipping, Agriculture, and Buildings.

While the trend is in the right direction, the scale of integration of climate factors in business operations and strategy requires further acceleration. For example, if we were to use rates of TCFD disclosure as a yardstick for progress, the proportion of companies that disclose information aligned with TCFD-recommended disclosures is still very low (only 24 percent of companies on board oversight; 17 percent on integration into risk management; 35 percent on climate-related metrics; 33 percent on climate-related targets; 7 percent on resilience of strategy).⁸⁴

In addition, interviews with corporates highlight several of these core challenges.

“We're early in our journey compared to many of our big customers, and haven't taken advantage of what's out there.”

—Global food company executive

“Companies need to ensure they add a chief sustainability officer or similar role, educate their boards on materiality, and incorporate addressing these risks into the culture.”

—Global technology firm executive

“There needs to be stronger involvement with the finance function [on sustainable finance]. CFOs need more awareness.”

—Cement Association executive

⁸⁴ TCFD 2020 Status Report.

Another key enabler is the **establishment of an internal carbon price in decision-making and cost allocations**. This is especially relevant wherever there is not an existing external carbon price. Several companies have started doing this already in their strategic planning, risk management, internal transfer pricing, and business casing. Internal carbon pricing is a powerful tool that can effectively be integrated into existing business practices without significant effort. It is important, however, that such an internal price be established at a sufficiently high level (see Section 4.1.1 for benchmarks on price levels) in order to drive changes in decision-making.

“[In our scenario analysis] we look at a large jump in carbon price or carbon tax and how it would impact a portfolio, its credit risk on a client-by-client basis.”

—Banking executive

“We had an internal carbon price of \$40, but it has never shifted the financial decision... it never got to that point... only around \$100 will really start to bite.”

—Former sustainability executive at international O&G company

There remains a role for government and wider civil society in addressing transition planning for SMEs and corporates that face information or management resource constraints. Initiatives to raise knowledge levels among smaller firms and open pathways to transition for affected companies would improve the resiliency of the small corporate sector and unlock potential growth opportunities that would otherwise be missed.

Recommendations

We recommend **financial education and climate finance risk awareness building at an executive level to support corporates' ability to actively prioritize and accelerate their own preparations for a low-carbon future**, embedding this as a strategic imperative for their boards and senior management. The Banking and Capital Markets sector will be an important partner to corporates to both help navigate the risks and opportunities of climate change and mobilize appropriate financing solutions.

Many industries and corporates are still at early stages of understanding the implications of climate change on their business models and processes—from both a transition and physical risk perspective. Heightened expectations of institutional investors are driving the financial materiality of climate-related risks and opportunities. **Leading companies are taking measures such as building strong accountability through boards and senior executives, establishing internal carbon pricing, and investing in innovation.** Growth in demand for financing of climate mitigation efforts by corporates, especially those with higher exposure to climate-related risks and opportunities, is an essential component for the development of more efficient and at-scale CFMS that supports global mobilization of climate-aligned capital.

Importantly, we recommend that all corporates **evaluate the impact of climate change on their business models in the long term**—including transition risks arising from a move toward a low-carbon economy in the future, as well as physical risks arising from climate change. They should pursue full compliance with TCFD recommendations, invest in supporting analytical and measurement capabilities, and aim to establish linkages between climate-related factors and associated financial risks and opportunities.

We recommend that corporates **actively pursue business-model innovations to drive low-carbon activities and facilitate resilience to climate change, doing so in collaboration with their finance providers to ensure their financing needs are met.**

Proactive steps corporates could take to further support their near-term voluntary transition include:

- **Establishment of an internal carbon pricing mechanism, where material**—integrated into strategic planning, operational planning, transfer pricing, and risk management—to build an understanding of key trigger points that would materially change their strategic decisions;
- **Engagement with their boards and shareholders to discuss and balance** short-term return expectations versus long-term business strategy, and accordingly align governance and operating models to introduce accountability on carbon; and
- **Elevation of climate risk management in their organizations, and establishment of data practices** in partnership with their financial services providers that would facilitate both internal risk management and disclosures to the Banking and Capital Markets sector.

4.1.5 We recommend that **corporates and their industry associations** coordinate and collaborate with the scientific community, standard-setting bodies, financial institutions, and governments to **accelerate the development of sector- and region-specific transition pathways** to achieve Paris Agreement climate goals, including viewpoints on where there is still evolution expected.

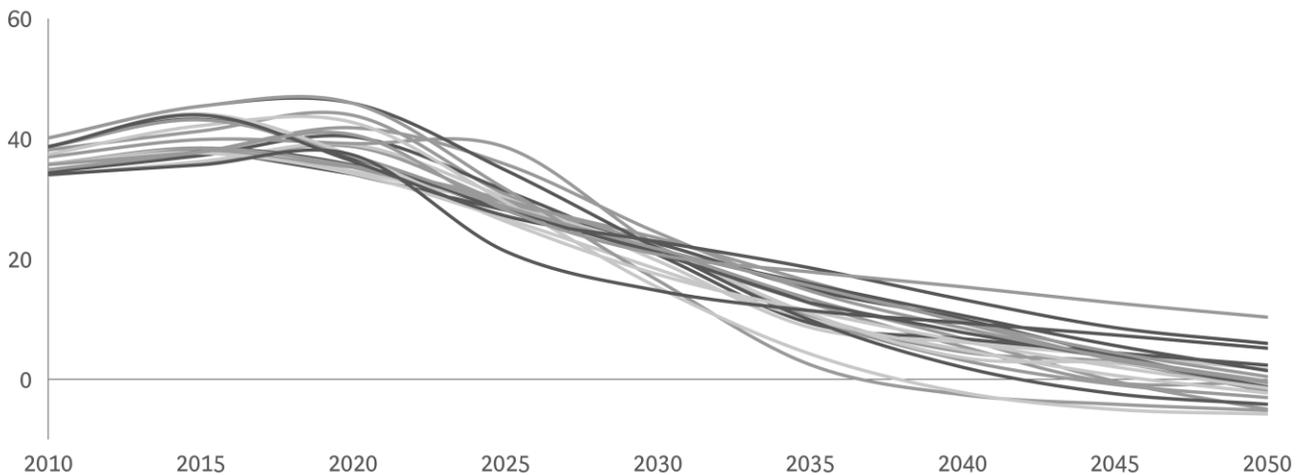
Context

The Paris Agreement objectives call for pursuing efforts to limit global temperature rise to 1.5°C.⁸⁵ This translates into a scientifically determined “carbon budget” that represents how much carbon can be emitted in order to avoid a given temperature rise, which is globally reported on by the Intergovernmental Panel on Climate Change (IPCC) on a regular basis for different temperature scenarios. For a 1.5°C ambition, this translates to achieving net zero emissions at a global scale by 2050.

IPCC SR15 integrated assessment models (IAM) for a 1.5°C scenario

IAMC 1.5°C Ensemble

GtCO₂e



Source: IPCC

Figure 13: IPCC SR15 integrated assessment models (IAM) for a 1.5°C low-overshoot scenario

⁸⁵ <https://unfccc.int/process-and-meetings/the-paris-agreement/the-paris-agreement>.

However, the next step—the translation of that global budget into sector- and region-specific budgets and pathways—is a crucial one. While decarbonization technologies are known within the different sectors, there is a **lack of alignment on these transition pathways**. This is further exacerbated by the transition pathways, carbon targets, and technologies **that vary not only by sector, but also by region**, as this is influenced by several factors including nationally determined contributions, the state of development of the economy, and the trade-offs to be made versus other UN Sustainable Development Goals (e.g., socioeconomic development). As a result, the financing and lending activity remains constrained due to the uncertainties that surround the financial return of key projects and technologies.

The European Union has taken significant steps in this direction through the creation of the EU Taxonomy, which incorporates metrics and thresholds on a sector-by-sector basis (see Section 4.2.3 for more detail). This report acknowledges the recent work of the International Platform for Sustainable Finance in establishing a joint working group to compare existing taxonomies and examine commonalities, which could potentially pave the way for mutual recognition of individual taxonomies.

Additionally, there are several **initiatives that enable corporates to set science-based climate targets**. A prominent example is the Science Based Targets initiative (SBTi), which is a target-setting entity, and collaboration between the WWF, UN Global Compact, World Resources Institute, and the Carbon Disclosure Project (CDP). SBTi developed the Sectoral Decarbonization Approach, a methodology that leverages sector pathways from the IEA to create intensity targets for companies that are aligned with climate science.⁸⁶ Adoption of SBTi’s target-setting approach is growing fast, with 1,040 companies having committed as of November 2020 to taking science-based climate action, and 498 companies having already approved science-based targets. Even with this adoption, at a global scale, it remains a small portion of all corporates.

The lack of alignment and understanding of these transition pathways leads to **two key constraints to the scaling of climate action and climate finance**:

⁸⁶ <https://sciencebasedtargets.org/sector-development/>.

- **Inaction by companies:** Uncertainty on the pathways and time horizons diminishes the imperative to make major investments in the near term.
- **Lack of alignment on taxonomies for determining capital stocks and flows that qualify as climate aligned** (see recommendation on taxonomy in Section 4.2 for detail).

Recommendations

We recommend that **corporates and industry associations** coordinate and collaborate with the scientific community, standard-setting bodies, and governments to **accelerate the development of and alignment on sector- and region-specific transition pathways** to achieve Paris Agreement climate goals, including viewpoints on where there is still evolution expected.

Further, we recommend that corporates continue to **establish science-based targets** in order to set their businesses on a pathway to alignment with global climate goals.

4.2 Financial Market Structure Changes: Structural Changes to Make the Climate Finance Market More Efficient, Transparent, and Scalable

4.2.1 We recommend **mandatory disclosure of corporate-specific financially material, decision-relevant data relating to climate-related risks and opportunities**. Consistent global disclosure frameworks, developed in consultation with industry participants and with adequate runway for implementation, should help strengthen the transparency and comparability of climate risk data.

Context

The climate-related risks and opportunities to which a company is exposed, as well as the strategies the company is taking to address them, is increasingly recognized as financially material information.⁸⁷ This sentiment has been expressed by a growing chorus of stakeholders, including investors (e.g., Larry Fink’s 2020 Letter to Shareholder that states, “Climate Risk Is Investment Risk”),⁸⁸ industry-led organizations (e.g., the World Economic Forum International Business Council’s *Measuring Stakeholder Capitalism* report that notes “the interrelation of economic, environmental and social factors is increasingly material to long-term enterprise value creation”),⁸⁹ regulators (e.g., IOSCO’s recent statement that “sustainability issues in general, and climate-related issues in particular, pose important challenges in meeting the core objectives—investor protection, market efficiency, and mitigation of systemic risks—making these issues relevant from a regulatory perspective”),⁹⁰ credit ratings agencies, and accounting standards boards (e.g., the International Accounting Standards Board’s (IASB) recent guidance on climate-related disclosures that notes that as investors increase the stated importance of climate change in investment decisions, these risks become increasingly financially material to companies).⁹¹

⁸⁷ <https://www.iosco.org/library/pubdocs/pdf/IOSCOPD652.pdf>.

⁸⁸ <https://www.blackrock.com/us/individual/larry-fink-ceo-letter>.

⁸⁹ http://www3.weforum.org/docs/WEF_IBC_Measuring_Stakeholder_Capitalism_Report_2020.pdf.

⁹⁰ <https://www.iosco.org/library/pubdocs/pdf/IOSCOPD652.pdf>.

⁹¹ <https://cdn.ifrs.org/-/media/feature/news/2019/november/in-brief-climate-change-nick-anderson.pdf?la=en/>.

Scope of disclosures covered in the report

	Private companies	Public non-financial corporates	Banking and Capital Markets firms
Corporate reporting (e.g., annual reports) <i>Guidance: Accounting standards boards</i>	Addressed in Section 4.2.1	Addressed in Section 4.2.1	Addressed in Section 4.2.1
Corporate reporting by securities regulators <i>Guidance: Securities regulator</i>			
Climate financial disclosures <i>Guidance: TCFD</i>			
Exchange listing rules <i>Guidance: Exchanges</i>	Not applicable	Not applicable	Addressed in Section 4.3
Regulatory reporting for financial institutions <i>Guidance: Prudential regulator</i>			

Figure 14: Disclosures discussed in this report

Despite the positive momentum fueling adoption of these standards, disclosure of climate-related risks and opportunities by companies remains inadequate for banks and non-banks to comprehensively integrate climate-related information into financing decisions, creating a major impediment for the development of the climate finance market structure. Multiple reports have cataloged the many ways climate-related performance data by companies is deficient.⁹² Three of the most consistent themes that surfaced in interviews for this report are:

- **Lack of comparability:** The diversity of reporting frameworks creates costly burdens on issuers and obfuscates insights into climate-related risks and opportunities that could inform financing decisions.
- **Lack of insight into forward-looking opportunities and risks:** Analysis of the basis of historical GHG emissions is insufficient to inform forward-looking financing decisions. The

⁹² See <https://www.gao.gov/products/gao-20-530>; <https://www.iosco.org/library/pubdocs/pdf/IOSCOPD652.pdf>.

development of more rigorous forward-looking disclosures will require both clear science-based standards toward which companies can align their strategies, and articulation of meaningful interim targets of progress toward those long-term goals.

- **Lack of coverage:** While support for TCFD is growing (i.e., the number of organizations expressing support for TCFD has grown to exceed 1,500 globally, including 1,340 companies with a combined market capitalization of \$12.6 trillion, and financial institutions responsible for assets of \$150 trillion),⁹³ only about 35 percent of companies disclose information on climate-related metrics aligned with TCFD recommendations. This challenge is particularly acute for privately held and smaller companies.

At this critical juncture, it is evermore imperative for policymakers and regulators to coordinate internationally to achieve greater alignment and consistency across disclosure standards. Not only would this further build investor confidence and increase flows toward green and sustainable projects and activities, it is vital for there to be a concerted effort in the overall transition to a global low-carbon economy, especially given that the impact of climate change is felt globally. This would further help to pre-emptively mitigate uneven cost absorption by any single jurisdiction as a result of fragmentation.

The GFMA *Global Sustainable Finance Survey* identified in July 2019 that regulatory hurdles would have a material impact on the pace of development of the market structure for sustainable finance.⁹⁴ As this report further identifies, a key risk to the scaling of the climate finance market is that policymakers and broader society consider the roles of financial market participants and the financial regulatory framework independently from the changes required in the real economy and economic policy frameworks to align with Paris Agreement targets.

Potential pathways forward

There are several potential pathways to remedy the lack of sufficient climate-related data, each with its own merits and potential drawbacks.

- **Market-based solutions.** There is growing momentum around efforts to harness the influence of institutional investors and asset managers as asset allocators and stewards. Platforms

⁹³ 2020 TCFD Status Report.

⁹⁴ <https://www.gfma.org/wp-content/uploads/2019/06/gfma-sustainable-finance-survey-report-july-2019.pdf>.

such as the Net Zero Asset Owner Alliance, One Planet Summit SWF Summit, and Climate Action 100+ seek to harness the “market-shaping” role of asset allocators to drive improvements in climate-related disclosures. The advantage of these efforts is they work through existing market mechanisms, and over time have the potential to influence the cost of capital of companies that fail to provide quality climate-related disclosures. These mechanisms enable a nuanced and constructive approach that is tailored to a sector or individual company. This increases the chances the data is relevant enough to be useful in informing financing decisions. Activist shareholders, emboldened by recent successful resolutions to compel more transparent climate disclosures, are also increasingly employing this strategy. It is not clear whether market-based mechanisms alone will be sufficient to drive increases in consistent, comparable disclosure rates at the pace needed by financial institutions. A further complication is institutional investors and asset managers are not aligned on which specific frameworks should be requested (i.e., some asset managers prescribe the use of SASB (Sustainability Accounting Standards Board), while others only ask for alignment with TCFD, etc.).⁹⁵

- **Accounting standards.** IASB has issued guidance that material climate change risks should be included in International Financial Reporting Standards (IFRS) financial disclosures, noting that “qualitative external factors, such as the industry in which the company operates, and investor expectations may make some risks ‘material’ and may warrant disclosures in financial statements, regardless of their numerical impact.”⁹⁶ The guidance notes that as investor expectations increase, the materiality of climate risks will also likely increase, thus triggering a greater need for companies to disclose these risks in financial statements. Efforts by IFRS to consult on the integration of sustainability factors will help to facilitate the operationalization of these efforts. A key challenge for climate issuance is how to maintain existing standards of materiality for financial reporting standards, with climate reporting that is material over a longer time frame.
- **Double Materiality:** It is a foundational concept in the development of reporting frameworks in the EU. This concept is embedded in the first iteration of the Non-Financial Reporting Directive (NFRD), which purports that financial materiality is one side of the coin when considering the development of corporate reporting standards, and the “impacts” of corporate activity on environmental/climate/social issues is the second side of materiality. It is also reflected in the recent Sustainable Finance Disclosure Regulation (SFDR), which

⁹⁵ <https://morrrowsodali.com/uploads/insights/attachments/ae189c6414e1ef6b0eed5b7372ecb385.pdf>.

⁹⁶ <https://cdn.ifrs.org/-/media/feature/news/2019/november/in-brief-climate-change-nick-anderson.pdf?la=en>.

primarily covers the entity and product-level disclosures introduced for asset managers, and is linked to the EU Taxonomy.

- **Voluntary adoption of industry-led standards.** There are also a growing number of industry-led efforts to define frameworks and drive adoption through voluntary measures. SASB, GRI and CDP's efforts to harmonize their frameworks, the recommendations of the TCFD, and the World Economic Forum International Business Council's proposal⁹⁷ for adoption of a specific set of ESG indicators are examples of industry-led efforts that are receiving endorsement from a growing number of companies. The advantage of such voluntary efforts is, by virtue of being industry-led, they reflect the convictions of what is material to some industry leaders. Some challenges to the voluntary approach are: unless performed across a wide-enough coalition of industries, adoption will still be sub-scale; the structure, transparency, and accountability of the governance bodies that oversee these standards may be limited; and, while voluntary adoption may eventually lead to a tipping point of widespread adoption, the timeline of reaching ubiquity is uncertain.
- **Stock exchanges.** Stock exchanges can play an important role in driving adoption of ESG disclosures by considering the materiality of climate-related governance, performance, and activities as part of listing requirements where appropriate to the listed corporate. Examples include the Hong Kong Stock Exchange's recent introduction of new ESG disclosure requirements.⁹⁸ These measures can dramatically speed adoption by publicly listed companies, but do not address the lack of disclosures by those that are not listed.
- **Legislation and regulation.** A more prescriptive route to solving these challenges is for governments to pass legislation requiring corporates, financial institutions, or both to provide climate-related disclosures. Recent examples include the United Kingdom's announcement to make TCFD-aligned disclosures "fully mandatory across the economy by 2025;"⁹⁹ New Zealand's legislative proposal requiring climate-risk reporting by financial institutions in line with TCFD regulations for banks, asset managers, and insurers; and France's Energy Transition Law, which includes Article 173 that describes the disclosure requirements of listed companies and investors. A report published by CDSB (Climate Disclosure Standards Board) and CDP (Carbon Disclosure Project) finds that adherence to TCFD could be achieved through minor adjustments to legislation in Canada, France, and Italy, with feasible

⁹⁷ http://www3.weforum.org/docs/WEF_IBC_Measuring_Stakeholder_Capitalism_Report_2020.pdf.

⁹⁸ https://www.hkex.com.hk/Listing/Rules-and-Guidance/Environmental-Social-and-Governance?sc_lang=en.

⁹⁹ <https://www.gov.uk/government/news/chancellor-sets-out-ambition-for-future-of-uk-financial-services>.

pathways also identified for Germany, the UK, and Japan.¹⁰⁰ Where introduced, mandatory disclosure obligations should always be aligned for financial and non-financial corporates (in the way TCFD intends), thereby ensuring financial institutions have access to the data they need in order to meet their own disclosure requirements.

Financial regulators are also increasingly taking steps to offer clearer guidelines and, in some cases, requirements for climate-related disclosures. Most notable is the Bank of England's Prudential Regulation Authority (PRA).¹⁰¹ Efforts are underway in several other jurisdictions, and momentum is expected to continue. For example, the Network for Greening the Financial System (NGFS) has called for supervisors to “expect financial institutions to disclose information and metrics on the climate-related and environmental risks they are exposed to, their potential impact on the safety and soundness of the institution and how they manage those risks.”¹⁰²

As regulators and supervisors strengthen their respective disclosure requirements, it will be important that they do so in a manner that reflects the fact that both financial institutions and issuers often operate across multiple countries and sectors. While a recent survey of securities regulators found limited appetite for a harmonized international framework for ESG disclosures (including climate-related disclosures), there was broader ambition for coordination, such as the better exchange of information across national efforts, and better transparency across the various frameworks.¹⁰³

Jurisdictions that have pursued mandated requirements offer some early insights into how these measures can be translated into the desired impacts. For example, since 2017, certain large European companies have been required by the EU's NFRD to prepare a “non-financial statement.” A review of NFRD is underway. CDSB conducted an analysis of NFRD by reviewing a sample of the reports from 50 of the largest issuers and found “substantive improvements are still required in the quality, comparability and coherence of disclosures in order for the Directive to achieve its objective of providing investors and wider stakeholders with relevant, consistent and decision-useful

¹⁰⁰ https://www.cdsb.net/sites/default/files/roadmap_for_adopting_the_tcf_d_recommendations.pdf.

¹⁰¹ <https://www.bankofengland.co.uk/-/media/boe/files/prudential-regulation/letter/2020/managing-the-financial-risks-from-climate-change.pdf>.

¹⁰² https://www.ngfs.net/sites/default/files/medias/documents/ngfs_guide_for_supervisors.pdf.

¹⁰³ <https://www.iosco.org/library/pubdocs/pdf/IOSCOPD652.pdf>.

disclosures.”¹⁰⁴ The review recommended that the non-financial report be in the mainstream report. It clarified that businesses should have to disclose the risks they are exposed to, provide greater clarity on key terms such as materiality, and embed TCFD recommendations into the directive. Ensuring provisions are also made for compliance and implementation will also be important.

Importantly, detailed banking disclosures and regulatory reporting requirements for capital market participants should not front-run the adoption and capacity of corporates to provide such disclosures. **It will be equally crucial that any corporate reporting requirements—and, subsequently, further reporting requirements on banks and other financial institutions—be aligned in terms of the scope and detail of the information required.** Efforts, such as those by the IFRS, to refine climate performance data standards based on materiality will lay the foundation for more useful data to inform financing decisions.

Recommendations:

We recommend **mandatory disclosure of corporate-specific financially material, decision-relevant data relating to climate risks and opportunities.** Consistent global disclosure frameworks, developed in consultation with industry participants and with adequate runway for implementation, should help strengthen the transparency and comparability of climate risk data.

- **Market regulators, accounting standards boards, and exchanges,** in consultation with corporates, Banking and Capital Markets firms, and investors, should **continue to develop consistent climate-related disclosure frameworks** for financial and non-financial corporates that are **aligned with TCFD recommendations and that provide a real benefit to providers and users of climate data.** They should continue efforts to accelerate adoption of these disclosure frameworks.
- To date, voluntary disclosure regimes such as TCFD have proven to be helpful in guiding both voluntary and mandatory disclosures that allow corporates and investors to take into account materiality to the sector and proportionality. **Climate disclosure regimes should balance the objectives of consistency and flexibility to reflect that materiality is corporate-specific and should reflect decision-relevant information for financing decisions.** This recognizes that

¹⁰⁴ https://www.cdsb.net/sites/default/files/falling_short_report_double_page_spread.pdf.

corporates in similar sectors can be exposed to different material risks and opportunities, reflecting differences in individual business models and operating environments.

- Ultimately, **internationally consistent material disclosures may be needed, taking into consideration of best practices emerging from existing standards and global frameworks,**¹⁰⁵ to deliver comparable, comprehensive, decision-relevant climate data that is beneficial for the development of CFMS. Climate-related disclosures by banks have dependencies on non-financial corporate disclosures; and, importantly, detailed banking disclosures and **regulatory reporting requirements for capital market participants should not front-run the adoption and capacity of corporates** to provide such financially material disclosures.
- **Recognizing some jurisdictions are taking a more accelerated approach—and where appropriate, mandating financially material disclosures** to facilitate transition of the real economy—policies should create appropriate incentives to encourage engagement with clients and investees on low-carbon pathways, and **reflect that not all sectors are at the same stage of preparedness for transition.** Regulated financial institutions have an important role to play in partnering with clients on low-carbon solutions, particularly in sectors of the economy wherein **decision-relevant climate data may be less identifiable at this time.**
- We further believe that a **globally consistent approach to sustainability reporting is pivotal to prevent the proliferation of various emerging public and private reporting initiatives, which are often not aligned, make reporting costly and time-consuming for preparers, and are confusing and time-consuming to compare for users.** Financial and non-financial firms operating cross-border, in particular, face additional costs, complexity, and **reduced reliability of data due to lack of consistent frameworks.** Being aware that the administrative and economic costs of reporting would be significant (especially for micro-businesses), we believe that SMEs should be allowed to adopt a simplified standard, based on a very rigorous application of the materiality principle and corporate-specific exposure to risks, that would reduce the number of metrics SMEs would report.

¹⁰⁵ For example, the recommendations by the Task Force on Climate-related Financial Disclosures (TCFD), the Sustainability Accounting Standards Board (SASB) framework, and the Global Reporting Initiative (GRI).

4.2.2 We recommend that **the Banking and Capital Markets sector accelerate the development and scaling of a broad range of products and instruments in both public and private markets to meet the financing, investing, risk management, liquidity, and funding requirements of a range of market participants actively starting to transition.** In addition, we recommend that **regulators holistically assess any current regulatory barriers that prevent this process, and encourage the development of these products and solutions.**

Context

Interviewees, both corporates and banks, highlighted the lack of appropriate products and capital matching their risk-return profiles as key constraints.

There are three areas where better capital intermediation is needed to facilitate greater investment:

- **Early stage technologies** that are still high risk and need patient long-term capital;
- **Emerging markets** with associated sovereign, political, and currency risks, and a lack of sufficient data and information; and
- **Smaller-scale projects**, as many projects are too small in scale for investors seeking larger ticket size to reduce transaction costs.

"There is a disconnect between the type of capital that is needed: high risk, patient capital."

—Steel sector executive

"If I could fix one thing it would be credit worthiness of emerging market debt. So much of this is sub-investment grade. It would have the biggest impact and highest return."

—Banking executive

"There is a fundamental mismatch between risk profile and type of capital you're looking for. We have money in pension funds, and they don't want the higher risk—fundamental disconnect between where the financial sector can go versus where it wants to go."

—Banking executive

"Appropriate size of deal is required. If investments aren't big enough, [issuers] give up issuing the green bond. [These are] very frequent conversations."

—Banking executive

Proposed solutions

These issues require new structural innovations in the climate finance market. Many have already started emerging, but will need to adjust significantly in order to meet the scale of the investment needed to achieve climate goals.

Mobilize new sources of patient, higher-risk capital from private sources: There are a growing number of clients, particularly among family offices, wealth management clients, venture capital, and private equity, who seek to invest their capital in ways that are aligned with their values and a multigenerational time frame. Banks, especially those with wealth management business lines, have a significant role to play in developing the structures and products that would enable these investors to do so.

Scale the use of blended finance instruments with increased supply of catalytic capital to more effectively mobilize additional private capital: Blended finance structures are playing an increasingly important role in mobilizing new, additional private capital for climate mitigation and adaptation. However, the scale of this market pales in comparison with the total investment need. Further, the public and social sectors should provide more, and better-structured, forms of catalytic capital.¹⁰⁶ Catalytic capital is particularly needed to offset the technology risks associated with early stage technologies that are required in several sectors to achieve a Paris-aligned pathway. It is also needed to address the sovereign, currency, and political risks involved with financing climate action in emerging markets.

Introduce new sources of capital and instruments to mobilize finance for the growing market for transition finance: Blended finance transactions have almost exclusively focused on activities and companies that qualify as green investments. However, there is a growing recognition of the finance required for activities and companies that would not qualify as "green" but still generate significant reductions in GHG.

¹⁰⁶ Catalytic capital is defined by the MacArthur Foundation as “debt, equity, guarantees, and other investments that accept disproportionate risk and/or concessionary returns relative to a conventional investment in order to generate positive impact and enable third-party investment that otherwise would not be possible.”

Scale use of pooling and securitization: A key structural constraint is a lack of intermediation between numerous smaller-scale projects on the one hand, and the desire for large deals with lower risk levels on the other. This is not a straightforward task, and it will require bespoke partnerships and the use of digital solutions. In addition, it will be important to explore ways to reach supply chains and SMEs that still require financing solutions, particularly for industries wherein significant carbon sits in supply chains. Further, consistency of taxonomies and Key Performance Indicators (KPIs) will be important to enable the pooling of different loans (e.g., sustainability linked loans).

Grow the derivatives market for climate risk mitigation and allocation of risk to most appropriate financial market participants: Derivatives markets provide risk management tools for businesses and investors. They also enhance transparency and price discovery through mechanisms such as the provision of forward information. Some examples of how the derivatives market could develop to assist in climate risk mitigation include:¹⁰⁷

- Hedging risks related to climate factors (e.g., weather derivatives);
- Facilitating transparency, price discovery, and market efficiency;
- Supporting the development of the climate transition finance market by offering associated hedging solutions (e.g., currency swaps for emerging markets);
- Supporting the development of carbon pricing markets;
- Contributing toward long-termism (e.g., forward trajectory of carbon prices or expected shifts in public policy); and
- Aligning incentives around counterparties by offering products that have underlying KPIs linked to climate-related disclosures (e.g., foreign currency swaps with payouts linked to sustainability KPIs).

Several derivatives transactions (e.g., hedging of currency exposure to projects that are low carbon) have been conducted in the markets. Similarly, sustainability-linked derivatives that transfer risk associated with sustainability-linked loans and bonds can be transferred to financial intermediaries. These derivatives can support the greater flow of capital toward sustainable investments. However,

¹⁰⁷ Derivatives in Sustainable Finance, CEPS-ECMI Study, Centre for European Policy Studies.

they are still early stage, with significant potential for innovation, standardization, and mainstreaming as the market for sustainable finance and climate finance evolves. Derivatives markets are unlikely to grow until there is consistency in data standards, indices, and legal contracts.

Much as derivatives can be used to hedge traditional risks (e.g., currency risks), they can also be used to hedge ESG or climate risks. One example is credit derivatives (single name or basket) employed to manage the credit risk of sectors or counterparties whose financial results may suffer as a result of physical or transition risk. This type of instrument can be used by banks or institutional investors as a potential alternative to direct investment in underlying assets.

Critically, derivatives can help provide transparency around market pricing and risk because they help convert information into market-established pricing of risks. This is highly beneficial in enabling better assessment of climate risk and stronger management of portfolios. This also enables new hedging opportunities (e.g., commodity derivatives to manage changing risk appetite in the mining industry) that increase allocational efficiency and decrease price volatility.

Additionally, derivatives can offer firms tools to manage their business risks for the long term by smoothing volatility. This can also address potential scarcity and mispricing in bond markets (e.g., through accessing more liquid derivative markets as opposed to trading in illiquid or fragmented markets that may exist for sustainable bonds).

Bank intermediated lending and financing will be a key source of climate-aligned investments. Innovation in bank capital and funding instruments, structures, legal frameworks, capital, and funding and liquidity regulatory rules will be critical to support the growth of climate finance markets.

- Many banks now have frameworks in place and have publicly disclosed commitments for significant balance sheet and financing capacity focused on assets that integrate ESG factors. It is timely to rethink the approach and tools used to finance these commitments.
- Issuance across banks' entire liability structure (including non-equity capital) may be helpful in ensuring they are able to continue to play their part in addressing environmental and social challenges. A globally consistent framework for banks to issue going-and-gone-concern sustainable securities, including green capital instruments, is still lacking despite indications

of strong investor appetite. An integral piece of the framework should be the inclusion of climate-aligned instruments to meet prudential requirements on a like-for-like basis with existing equity and hybrid capital when considering regulatory ratios (capital, funding, and liquidity) will accelerate realignment of bank balance sheet capacity with climate ambition.

- Inclusion of climate-aligned securities from specific issuers (e.g., multilateral development banks) as part of high-quality liquid asset (HQLA) buffer calibration, subject to a ceiling (i.e., no more than a specific percentage of the HQLA buffer will align liquidity resources toward scaling climate finance). In determining the eligibility criteria to include specific climate-aligned finance instruments, the regulators should take into account central bank eligibility, market risk, and liquidity risk of the underlying instruments.

Role of the securities financing market:

The securities financing market can play a critical role in enhancing secondary market liquidity, price discovery, and market discipline. Eligibility of climate finance instruments (e.g., green and transition-aligned bonds and equities) as part of securities financing—through their eligibility for securities lending and in collateral pools—will lower the cost of funding and accelerate the pace of investments by corporates.

Climate finance instruments, including equities, should be treated no differently than other instruments in terms of eligibility both for securities lending and as collateral. Separate infrastructures and exchanges for green securities should be avoided, as such a separation could lead to market inefficiencies and increased costs borne by end investors. Rather, existing settlement infrastructures and exchanges should be enhanced through operational and prudential regulatory measures.

If climate finance equities are carved out of securities lending, either by not being available for lending or being ineligible in collateral pools, then climate finance equities will be disadvantaged from a liquidity perspective.

The size of the securities financing markets is estimated to be \$2.6 trillion (on-loan balances, as of June 30, 2019). Equities and government bonds are the predominant asset class for securities on-loan or made available by institutional investors. Corporate bonds are a smaller proportion of the securities financing markets. Securities financing markets based on underlying climate finance instruments are in early stages of development. And those associated with transition-aligned securities will need to grow exponentially to support at-scale involvement by institutional investors.

Lack of consensus on the eligibility criteria for instruments to be categorized as climate aligned is a key impediment to the growth of securities financing markets. Global alignment on climate finance definition, principles, and region- and sector-specific transition pathways and taxonomies will be critical for the development of securities financing markets. The transition pathways and taxonomies will both accelerate the development of indices to be used as a reference for collateral eligibility criteria and improve fungibility across “eligible” climate-finance instruments.

New and emerging green labelling bodies (e.g., Febelfin (Belgium), LuxFlag (Luxembourg), and Green Economy Mark (UK)) should consider recognizing securities lending as an integral and acceptable efficient portfolio management (EPM) technique for asset owners to deploy, confirming the compatibility of securities lending with climate finance objectives. Securities lending is expressly included within existing regulatory frameworks, specifically the portfolio optimization and EPM techniques prescribed by fund regulations, such as UCITS and AIFMD. Therefore, green-labelling bodies should align with these existing regulations when setting out acceptance criteria to asset owners in order to further support climate-aligned portfolios.

Eligibility of climate finance products and financial instruments for central bank facilities (funding, credit, and liquidity facilities) will enhance their secondary market liquidity. In addition, eligibility of climate finance instruments as collateral in securities lending and derivatives transactions (initial and variation margin) will improve collateral velocity and market liquidity. The eligibility of climate finance instruments as collateral should be based on the underlying risk profile of the instruments.

Broadly based regulator-led taxonomies should be developed to allow effective and consistent collateral screening. These taxonomies will enable banks and other financial institutions to effectively build scalable products that support increased volumes within the climate finance market in a cost-effective way for end investors.

Regulators should consider the collateral framework for securities lending transactions and specifically consider acceptability of the broad universe of general collateral on a pledged basis against the lending of climate finance equities. In contrast to collateral provided by title transfer, pledged collateral does not involve a transfer of legal title to the lender of securities, and the lender does not become the legal shareholder of equities posted as collateral. Liquidity for climate finance equities would be increased if policymakers were to carve pledge collateral out of the scope of ESG disclosures (such an outcome would be consistent with market-adopted interpretations under existing regulatory frameworks, such as Shareholder Rights Directive II and the EU Transparency Directive).

Where a lender of securities receives the benefit of a lending agent indemnity, in the event of borrower default, the lender would receive cash following liquidation by the lending agent of the

pledged collateral; the collateral itself would not be title transferred to the lender. In order to maximize liquidity for climate finance equities, policymakers should seek to differentiate between pledge and title transfer collateral when considering the scope of equivalent collateral for securities lending transactions.

As investors incorporate a climate-risk and transition-readiness lens to their investment decisions, securities financing markets will be critical in supporting (i) liquid markets for climate finance instruments and (ii) “short” strategies associated with non-transition-aligned assets. This will be important for market discipline, price discovery, and market signaling on transition-readiness of a corporate for a low-carbon economy. Such market signals (e.g., open short positions) can be combined with other risk factors (e.g., quality of disclosures) to improve sustainability ratings. Short-selling can be utilized as an effective market integrity tool for rooting out greenwashing.

One of the key levers of influence institutional investors have on their portfolio companies is exercised via voting rights. Institutional investors are increasingly prescriptive (stocks to lend, proportion to lend, and when to recall) in their securities financing strategies based on a climate transition lens. Investors are keen to understand the impact of their securities financing activities on their voting rights and ability to influence management teams on climate transition. Securities lending, while involving the transfer of voting rights from the lender to the borrower, also operates under the market convention that securities can be recalled at any time by a lender (unless a lender commits to a term transaction and expressly foregoes the right to recall under the industry master agreement). Therefore, on the basis that, in respect of open transactions, lent securities are always recallable, we can conclude that non-termed securities lending transactions are compatible with ESG principles on voting and stewardship. Institutional investors should establish clear internal policies on voting and engagement and reflect these policies within the parameters of their securities lending program by prescribing their voting and recall criteria to their lending agent or internal securities lending trading desk.

Recommendations:

We recommend that **the Banking and Capital Markets sector accelerate the development and scaling of a broad range of products and instruments in both public and private markets to meet the financing, investing, risk management, liquidity, and funding requirements of a range of market participants actively starting to transition.** The range of products and instruments should include syndicated and bilateral loans, bonds, equity, structured products, derivatives, project finance, and securities financing. In addition, we recommend that **regulators holistically assess**

any current regulatory barriers that prevent this process, and encourage the development of these products and solutions.

New sources of patient, higher-risk capital from private sources should be mobilized.

- Banks should deploy their financial advisors to increase awareness and educate their clients on these opportunities, and at the same time continue to develop financial products that match this kind of capital for those clients interested in high-impact investment opportunities.
- Banks' structuring capabilities coupled with integration of financial innovation solutions could help them design products, instruments, and indices that can support retail investors who want to direct capital toward climate finance investment opportunities.

The use of blended finance instruments that more effectively mobilize additional private capital should be scaled, with an increased supply of catalytic capital.

- Banks should increase their role as originators of blended finance transaction opportunities to augment the deal flow created by the supranational institutions.

New sources of capital and instruments to mobilize finance for the growing market for transition finance should be introduced.

- The Banking and Capital Markets sector, standard-setting bodies, industry, policymakers, and financial regulators should define clear climate-aligned-finance and climate-finance taxonomies that would enable a greater flow of capital (particularly higher-risk, concessionary capital) toward activities that will be required for transition in some of the harder-to-abate sectors (see 4.2.1).
- To reflect the integration of sustainability in banks' business models, and to incentivize greater allocation of balance sheet to ESG assets, we see the need to define and harmonize the concept of "sustainable bonds" for banks. Global standard-setting bodies should set out a framework to clarify regulatory capital treatment expectations for the issuance of bank liabilities. This would further ensure banks remain investable in this area across the full range of securities they issue (OpCo senior, Hold Co. senior, Additional Tier 1 and Tier 2).

The use of pooling and securitization should be scaled.

- Banks, in their role as issuers, underwriters, and providers of additional support (e.g., credit enhancement, liquidity support), should scale pooling and securitization of smaller financing transactions.

The derivatives market for climate risk mitigation and allocation of risk to most appropriate financial market participants should be expanded.

- The Banking and Capital Markets sector should work to establish a robust derivatives market for climate solutions and climate risk hedging. It should further establish partnerships with multilaterals and insurance providers to provide sovereign, currency, and political hedging to mitigate risks for emerging market investments.
- Regulators and market infrastructure should be proactive in considering the potential changes to both trading environments and the composition of commodities markets, and the growth of climate-related product markets from decreased fossil fuel volumes and higher volumes of low-carbon power and raw materials used for a Paris-aligned economy. Specific attention should be paid to modelling methodologies for margin requirements and regulatory approvals.

There is also a significant role for the Banking and Capital Markets sector to **go beyond financial support, actively engaging with their clients by promoting cross-sectoral initiatives**. This is particularly relevant in sectors that are highly dependent on other sectors for decarbonization—for example, the Iron & Steel sector, which is likely to rely on clean hydrogen; or the Shipping sector, which will rely on the development of alternative fuels from sectors such as Chemicals and Energy.

4.2.3 We recommend that the Banking and Capital Markets sector, standard-setting bodies, industry, policymakers, and financial regulators **collaborate to achieve consensus on a common global definition and set of principles concerning what constitutes climate finance**. This should be translated into **sector- and region-specific taxonomies** that are comparable, flexible for evolution in response to technological and scientific developments, and include climate-related performance indicators and targets that correspond to Paris-aligned transition pathways.

Context

There is no common global definition of the term “sustainable finance,” or its constituent themes and topics. There is also no **common global definition of “climate finance” or “climate-aligned finance.”** And the interchangeable use of terms such as “climate,” “green,” and “sustainable” only adds confusion and complexity.

“Definition is something we have been discussing for a long time—[it is] still not aligned. Everyone tries to come up with something new—everyone [should] align names and categories of investments.”

—Institutional investor

“There is no consistent definition of ‘ESG.’ Definitions are very misunderstood today. We are missing a common language and direction.”

—Banking executive

“We need one common language for politics, regulators, and industry sectors to be able to communicate with each other.”

—Banking executive

Interviews with leaders in the real economy, Banking and Capital Markets sectors, and investors revealed a near consensus on the need for common definitions and language. The existing lack of clarity emerged as a key barrier to achieving an at-scale market that facilitates the financing of activities aligned with sustainability goals and ambitions (these challenges are described in the subsection on market challenges). Taxonomies play a crucial role in encouraging finance flows to economic activities consistent with a Paris-aligned economy, particularly for investors who may lack detailed analytical resources to assess climate alignment of a particular corporate or economic activity. **For climate finance to achieve the pace of growth and scale needed, the expectation is that a vast majority of financing for climate transition will occur beyond traditional "green" labelled instruments, requiring the specification of clear and inclusive definitions and taxonomies.**

Current ways of defining climate finance

A May 2020 ICMA paper synthesizes commonly used definitions of the different forms of sustainable finance, and proposes a set of high-level definitions that build on current market usage and official sector terminology.¹⁰⁸

This report uses that definition as a starting point for defining the topic of climate finance and climate-aligned finance. Climate finance is defined as financing that supports the transition to a climate-resilient economy by enabling mitigation actions, especially the reduction of GHG emissions, and adaptation initiatives promoting the climate resilience of infrastructure as well as generally of social and economic assets.

Climate finance can be divided into two components that are for the most part distinct:

- **Climate-aligned finance—or finance that supports mitigation:** This refers to financing that enables actions that mitigate climate change (especially the reduction of GHG emissions) and aligns financing¹⁰⁹ with climate goals (e.g., the Paris Agreement ambition). Examples of climate-aligned finance include financing of electrification projects such as replacing combustion engine fleet vehicles with EVs, "greening the grid" by decommissioning high

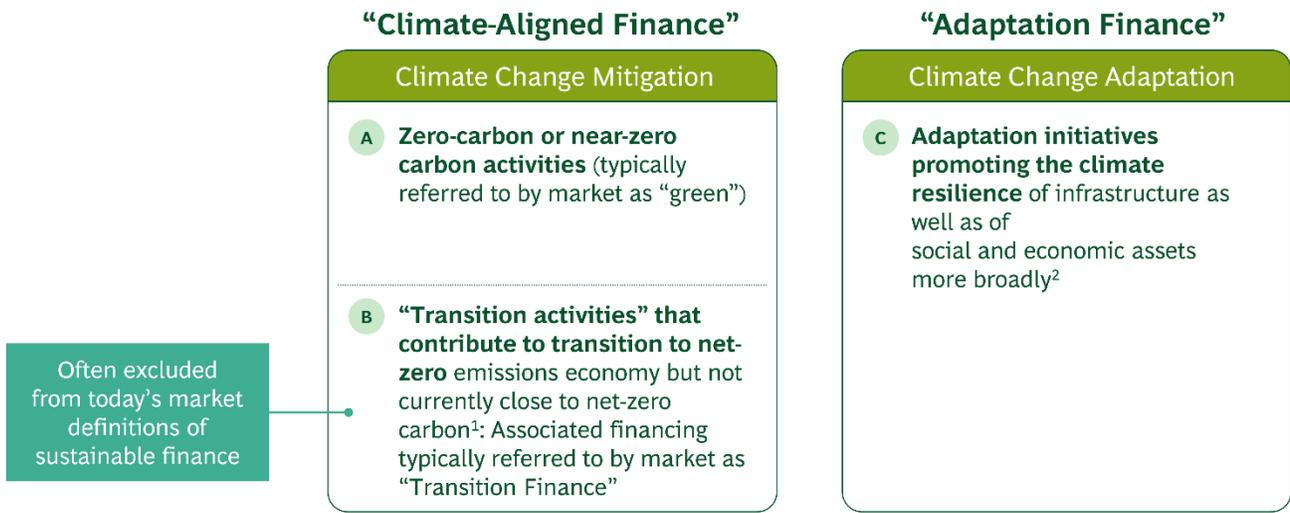
¹⁰⁸ ICMA – Sustainable Finance: High-level definitions, May 2020.

¹⁰⁹ As per the Center for Climate Aligned Finance at the Rocky Mountain Institute (RMI), this is the alignment of portfolio and activities to the decarbonization goals of the Paris Agreement. And to achieve "climate alignment," a financial institution must (1) understand current portfolio relative to a <2°C pathway and (2) commit to take the steps necessary to merge onto that pathway.

carbon emitting assets and replacing them with renewable electricity production, and deployment of novel technologies such as the production of steel using green hydrogen.

- **Finance that supports adaptation:** This refers to financing of adaptation initiatives that promote resilience of infrastructure, social, and economic assets to climate change and its consequences. Examples of this include construction of seawalls to improve resilience of seaside infrastructure, flood protection, and fire protection.

Components of Climate Finance



1. Defined as per definition in EU taxonomy; should show trajectory of performance that aligns with Paris Agreement-aligned transition pathways 2. As per ICMA definitions

Figure 15: Proposed definition of components of climate finance

While this report focuses on the topic of climate finance, the recommendation on definition and taxonomies more broadly applies to the topic of sustainable finance.

What is a taxonomy?

Sustainable finance taxonomy: definitions of sustainable finance that aim to be comprehensive classification systems¹¹⁰

There can be several objectives of a taxonomy—depending on the definition of sustainable finance—including:

- Assessing stocks or flows of investments against specific objectives (such as alignment with Paris Agreement goals);
- Helping the flow of investment capital to a sustainable economy;
- Increasing market confidence by avoiding greenwashing; or
- Serving as a basis for developing incentives and policies for sustainable finance.

As per the OECD, “There are two dimensions to a taxonomy: the system itself in all its complexity, and the final product (boiled down to its pragmatic essentials) as it will be used by financial market participants and other users. Users of taxonomies and definitions are not necessarily interested in understanding why a given metric or threshold must be used for an activity. Rather, they will use the taxonomies and definitions as a final product and screen activities to determine eligibility under the taxonomy.”¹¹⁰

Current state of taxonomies

There are a range of taxonomies that have been created or are in the process of being created across various jurisdictions. Please see the box for details on the EU Taxonomy and other taxonomies.

EU Taxonomy

The EU put forward a regulation in May 2018 on the establishment of a framework to facilitate sustainable investment that was adopted by EU co-legislators in December 2019. This regulation will enter into effect

¹¹⁰ As per the OECD paper from Oct 2020, “Developing Sustainable Finance Definitions & Taxonomies,” which has been used as a source for detailed information about the taxonomies described in this report.

in stages over the next three years. The Technical Expert Group on Sustainable Finance¹¹¹ has developed principles, metrics, and thresholds for substantial contributions to climate change adaptation and mitigation for 72 economic activities across several sectors.

The regulation defines criteria for economic activities, but not for financial products. It is important to note that **the emerging EU Taxonomy includes not just low-carbon economic activities but also “transition” and “enabling” activities**. Transition activities are those that contribute to a transition to net zero emissions by 2050 but are not currently close to net zero emissions levels. They must show that they can significantly enhance their performance beyond the industry average—and these thresholds for compliance will tend toward zero over time. Enabling activities are those that facilitate the improvement of environmental performance to a fairly demanding level in other sectors of the economy, and are evaluated on a sector-by-sector basis (such as the manufacture of wind turbine blades).

The EU Taxonomy has been analyzed to understand the stringency of its thresholds. Current research suggests that only a modest share of investments in infrastructure and equipment may be compliant with the current draft. For example, the estimated shares for manufacturing industries in Norway that are compliant is well below 5 percent.¹¹²

Examples of select taxonomies in other jurisdictions

In addition to the EU Taxonomy, there are several other taxonomies that are currently being defined in other jurisdictions as well.

- **Japan’s taxonomy:** While there is no legislative definition that falls into the strict category of a taxonomy, there are guidelines on sustainable finance issued by Japanese authorities that are principle based and contain indicative metrics guidance, but no eligibility thresholds. Japan has a set of green bond guidelines that are consistent with the ICMA Green Bond principles, initially put forth in 2017, and subsequently updated in 2020 to the “2020 Green Bond, Green Loan and Sustainability Linked Loan Guidelines.”
- **Chinese taxonomy:** In contrast to the EU, and similar to Japan, in China there is no legislative definition that falls into the strict category of a taxonomy. Green credit regulations provide some metrics, but no thresholds, and green bond regulations don’t contain metrics or thresholds. There are three main frameworks for green finance definitions: the “Guiding Catalogue for the Green

¹¹¹ Established by the European Commission in 2018 to assist it in the development of a unified classification system for sustainable economic activities and methodologies for low-carbon indices, an EU green bond standard and on metrics for climate-related disclosure.

¹¹² As per OECD paper from Oct 2020, “Developing Sustainable Finance Definitions & Taxonomies,” which has been used as a source for detailed information about the taxonomies described in this report.

Industry,” green credit guidelines, and the “Green Bond Endorsed Project Catalogue.” This last one is often referred to as the Chinese green bond taxonomy; however, it does not align with ICMA standards. In 2019, \$24 billion of Chinese issuances of labeled green bonds were not in line with international green bond definitions.¹¹³

- **French taxonomy:** In France, there are four pieces of legislation that define sustainable finance, including the Green Fin label for investment funds, which is based on the Climate Bonds Initiative taxonomy. In November 2019, France announced support for implementation of the EU Taxonomy by French financial actors as soon as 2021.
- In addition, there are other taxonomies globally—for example the **Malaysian** taxonomy, the **Dutch** taxonomy, and the **Canadian** taxonomy, which is under development.

Market challenges that arise from a lack of common definitions and consistent principles for taxonomies

The lack of alignment of technical definitions, and the proliferation of distinct types of taxonomies (some based on instrument type, some related to activities) has led to **three key challenges** that are making the financial markets inefficient and sub-scale:

¹¹³ Climate Bonds Initiative 2019 Green Bond Market Summary, Feb 2020.

1. **Higher transaction costs:** Higher costs of issuances are due to a lack of standardized processes and contracts, the need for third-party verification, more effort required, and the higher cost of structuring transactions, as well as the higher cost for investors to monitor and track. Clarity on taxonomy would be an important step toward simplifying the process, creating more standardized contracts, and hence mitigating some of these costs. According to interviews with market participants, premiums associated with current green financial instruments, or “greeniums,” are emerging in several markets; however, they are mostly erased as a result of these higher transaction costs.

“We have high transaction costs today [for sustainable finance instruments], and banks/bookrunners have to pay for it. We need standardization—for example, on what gets disclosed upfront.”

—Banking executive

“Occasionally [we see a] slight pricing benefit—however, the amount of administrative burden, reporting, ongoing maintenance eats up all the advantages. Sometimes it is still net positive but not a strong business case.”

—Banking executive

2. **Exclusion of transition activities and resulting lower flow of capital for transition:** Financing so far has focused mostly on the ends of the spectrum (i.e., financing low-carbon “green” economic activities and excluding high-carbon-intensity “brown” activities). A viewpoint that includes the transition potential of firms and assets of activities is often lacking—and hence this remains a “static” viewpoint. Instead of the “green” or “brown” classification of the primary sector in which a company operates, it is its commitment and ability to adapt its business model that should determine the classification of its economic activity. This

transition is critical to achieving Paris Agreement objectives. The lack of clear inclusion of transition activities leads to lower issuances and the curtailing of transition activity.

“From the investor perspective, if you're an institutional investor, 'green' looks good. Coal to natural gas is equally important—but looks less green. Transition has many phases that are equally important. A transition finance framework will open up a lot of opportunities.”

—Banking executive

“Transition bonds are key, they will take off, [but we] need definitions. [It is] much more complicated, [we] need to look at transition pathways by industry and there are big reputational risks and criticism. Having a standard would be a comfort to issuers.”

—Banking executive

3. **Confusion and fear of perceptions of greenwashing:** The proliferation of standards and taxonomies is creating confusion and complexity in navigating the market—and compounding fears of potential greenwashing. This is leading to hesitation on the part of investors, particularly due to potential legal, reputational, and fiduciary risks. A clear set of taxonomies would help codify standards, mitigate this complexity, and enable greater capital flows.

Key design principles for a definition and taxonomies

In conversations with over 100 interviewees across a range of market participants (including corporates, financial institutions, investors, and other market participants), **seven key design principles emerged as critical to the definition of climate-aligned finance and associated taxonomies:**

1. **There should be consistent global principles underpinning the development of taxonomies.** Financial transactions in the space of climate finance (and sustainable finance) are global in nature across the value chain of capital from supply from investors through intermediaries such as asset managers and banks to demand from real-economy sectors and corporates. These instruments are traded at a global level as well. As such, it is critical for there to be a

common global language and a common set of globally consistent principles underpinning the development of sector- and region-specific taxonomies that permit seamless and efficient transactions and flows of capital.¹¹⁴

2. **Taxonomies should be based on common global principles, but must be flexible in terms of both regional and temporal variation.** A set of principles should be aligned globally (e.g., climate-aligned finance can be based on the principle of activities and entities that align with the Paris Agreement ambition of limiting warming to 1.5°C), but it is not feasible to have one common global taxonomy because **transition pathways are expected to vary by region and sector.** Further, as climate science and thresholds continue to evolve based on scientific consensus through the IPCC, these taxonomies should maintain flexibility and the ability to evolve with subsequent versions. It is important to note that they should **align with the definition of sector- and region-specific transition pathways,** and be developed in collaboration with real-economy sectors and jurisdictions (see recommendation in 4.1.5). The EU Platform on Sustainable Finance is a strong example of facilitating dialogue and cooperation with key stakeholders.

“There’s a push for global consistency... that is overambitious; [we] need to adjust these taxonomies by country, each country hitting its own climate objectives... Consistent approaches, but highly tailored.”

—Banking executive

3. Global principles for a taxonomy should be applicable **not only to the use of proceeds but also more broadly to entities, their economic activities, and their initiatives.** A key principle of any taxonomy is that it should at a minimum enable classification of all financing transactions and activities for the relevant sector and/or region. This would, for instance, expand the eligibility to operating capital for taxonomy-aligned enterprises that require operating capital rather than project finance. An example set of principles is seen in the joint framework developed by Climate Bonds Initiative and Credit Suisse in the whitepaper “Financing Credible Transitions.”¹¹⁵

¹¹⁴ The recent establishment of a working group co-led by the EU and China to explore common ground in taxonomies globally is an important step in this direction.

¹¹⁵ <https://www.climatebonds.net/transition-finance/fin-credible-transitions>.

4. **Taxonomies must lead to inclusion of a range of transition and enabling activities, and not focus purely on zero-carbon activities.** While the end objective of this exercise is to get to net zero by 2050, there are steps along the way that align scientifically to a pathway that limits the global economy’s emissions to the scientifically allotted and dynamically updated carbon budget. A definition of climate-aligned finance and associated taxonomies must include both low-carbon activities and entities—but also take a **forward-looking viewpoint to be inclusive of firms, their assets, and their activities that have the commitment and potential for transition within scientifically determined thresholds**, with an understanding that the post-zero world will consist almost exclusively of “purist” near-zero carbon activities. Excluding specific activities or sectors would pose a big risk to the successful achievement of an orderly transition.

“The concept of transition finance is very important. We have to move away from the bad/good divide and tick-box mentality. The beauty of transition finance [is that it] achieves more systemic change.”

—Banking executive

“If the transition towards a low-carbon economy is to be realized, all sorts of transition activities will be required to be supported, and thus the market needs to develop understanding of these ‘shades of green.’”

—Banking executive

5. **Taxonomies should be objective and algorithmic, not subjective or based on opinions.** They should therefore include specific climate-related indicators (such as carbon intensity) and well-defined thresholds. These thresholds should vary by region and sector based on transition pathways defined for each sector and region.

“Everyone has to have a comparable number, and show performance in comparable ways... a simple way that people on the street can understand it. **There should be ESG Excel sheets, not documents.**”

—Asset manager

“Investors are hesitant to get products they may think may be termed greenwashing; Having a standard taxonomy is very important to have the numerical criteria to distinguish ‘is it green or not?’”

—Banking executive

6. **Taxonomies should aim to minimize administrative burden through a focus on the core set of decision-relevant metrics.** This should balance ease of use of the taxonomy with the robustness needed to assess climate (or other ESG) impacts. In order to scale effectively, due attention must be paid to the degree of administrative burden the taxonomy would create. This principle also relates to the recommendation on data and disclosures (see 4.2.1).
7. **Finally, the taxonomies should not be static, and should allow for flexibility to merge with additional ESG topics over time—to be inclusive of a broader classification of sustainable finance, and to account for changing understanding and materiality of ESG topics.** Climate finance should not exist in a void separate from other ESG topics, particularly as they evolve and interact with each other. This must be considered at a regional level. The topic of climate change, and specifically climate mitigation, is ahead of several other ESG topics in terms of maturity of understanding, data availability, measurement methodology, and risk integration. As understanding and materiality of ESG topics advance, a “sustainable finance” taxonomy should evolve and integrate these topics over time. For example, the EU Taxonomy currently focuses mostly on environmental topics, and takes a minimum-safeguards approach to social and governance issues. However, the European Commission is required to publish a report by the end of 2021 on extending the scope of the taxonomy to include social objectives.

7 proposed principles for creation of definition and taxonomies

-  **Common global definition and set of principles:** Common global language for “Climate Finance” and its components; and common set of globally aligned principles for associated taxonomies
-  **Applicability of definitions and taxonomies beyond just use-of-proceeds:** To entities, their economic activities, and their initiatives—in order to allow classification of all financing transactions and activities
-  **Flexibility in regional and temporal variation:** To align with differences in transition pathways by region and by sector, yet globally coordinated to align with scientific consensus (i.e., from IPCC)
-  **Inclusive of transition and enabling activities that are scientifically eligible; not focused only on zero- or near-zero carbon activities:** To ensure classification is forward looking and inclusive
-  **Objective and algorithmic in nature:** Including indicators and well-defined thresholds, not subjective or based on opinions
-  **Focus on metrics that are needed to assess eligibility for taxonomy, no overhead data:** Balance ease of use (no excess administrative burden) with robustness needed to assess climate impact
-  **Dynamic, flexible to expand to and merge with additional ESG topics over time:** To allow for broadening definition of “Sustainable Finance” over time; to account for changing understanding and materiality

Figure 16: Proposed principles for definition of taxonomy

Recommendations

We recommend that the Banking and Capital Markets sector, standard-setting bodies, industry, policymakers, and financial regulators **collaborate to achieve consensus on a common global definition and set of principles concerning what constitutes climate finance**. This should be translated into **sector- and region-specific taxonomies** that are comparable, flexible for evolution in response to technological and scientific developments, and include climate-related performance indicators and targets that correspond to Paris-aligned transition pathways.

It is a good sign that there is significant activity in the space of taxonomies, as this highlights the increased understanding that a common language in the world of sustainable finance is needed. However, there is a risk of undermining the ultimate objective of achieving an efficient and scalable path toward net zero. While a phase of “proliferation” of taxonomies and definitions is to be expected, it is important that, for the key reasons highlighted earlier, the definitions of climate

finance and principles for developing taxonomies be made consistent wherever feasible through international cooperation and knowledge sharing. For example, the European Commission has set up the International Platform on Sustainable Finance (IPSF), which several non-EU jurisdictions have already joined. This platform will act as a forum to discuss international coordination of sustainable finance definitions.¹¹⁶ A key consideration is how to bridge inconsistencies of taxonomy definitions and eligibility criteria to avoid regulatory market fragmentation of sustainable finance markets.

This report recommends **that legislators and regulators across jurisdictions, standard-setting bodies, and market participants adopt common global definitions of climate finance, climate-aligned finance, and sustainable finance—and align on consistent principles and frameworks for associated taxonomies.** In the absence of legislative action, the Banking and Capital Markets sector and other market participants should strive to drive this agenda.

Further, **each jurisdiction should develop a clear sector-specific and region-specific taxonomy with well-defined indicators and metrics aligned to transition pathways that are consistent with achieving Paris Agreement ambitions** for climate-aligned finance.

In jurisdictions where there is no ongoing activity on this front, legislators, standard-setting bodies, and market participants should engage in international dialogue to start the process of developing sustainable finance and climate-aligned finance taxonomies in collaboration with other jurisdictions globally.

¹¹⁶ https://ec.europa.eu/info/business-economy-euro/banking-and-finance/sustainable-finance/international-platform-sustainable-finance_en.

4.2.4 We recommend that as data becomes more available, investors and asset managers continue to work toward accelerating integration of climate factors into their investment process, including integration of climate-related risk factors into risk and valuation models and frameworks. We also support investors and asset managers in their transition strategies for a Paris-aligned temperature scenario, and GHG reductions through engagement and stewardship with their portfolio companies.

Context

Investors, asset managers, and asset owners are among the most critical partners of private sector climate transition. Shareholder action and engagement have driven many corporates to elevate the topic of climate change in their business strategies, and drive leadership accountability on the topic. This is evidenced in several public examples of leadership changes and large-scale divestments, and a steep rise in the global stock of sustainable investments.¹¹⁷ Research also shows that corporate outperformance in carbon intensity is correlated with valuation premiums.¹¹⁸

TCFD-aligned reporting by asset managers and owners that are signatories of the Principles for Responsible Investment (PRI) increased significantly between 2019 and 2020, largely driven by the PRI's move to require TCFD reporting in 2020.¹¹⁹ This is particularly evident in high degrees of disclosure in the categories of Board Oversight; Risks and Opportunities; and Risk Identification, Assessment, and Management Processes.

The investor community is also increasingly making public commitments regarding climate. The UN-convened **Net Zero Asset Owners Alliance, composed of 30 of the world's largest institutional investors with assets under management worth \$5 trillion, represents united investor action to align portfolios to a 1.5°C scenario.** As per this alliance, "The members of the Alliance commit to transitioning their investment portfolios to net-zero GHG emissions by 2050 consistent with a maximum temperature rise of 1.5°C above pre-industrial temperatures, taking into account the best available scientific knowledge including the findings of the IPCC, and regularly reporting on progress,

¹¹⁷ Estimated \$30.6 trillion in 2018, 34 percent higher versus 2016, as per Global Sustainable Investment Alliance.

¹¹⁸ BCG Value Sciences analysis.

¹¹⁹ 2020 TCFD Status Report.

including establishing intermediate targets every five years in line with Paris Agreement Article 4.9.”¹²⁰ As per the United Nations Environment Programme Finance Initiative (UNEPFI), “Alliance members are sounding a very loud signal to the thousands of companies they own that deep emissions cuts are required. They will work with those willing to adjust their business models, and do not wish to engage in a divestment exercise.”¹²¹

In addition, in October 2020, the Net-Zero Asset Owner Alliance made a commitment to make deep GHG emissions reductions linked with their portfolio companies by 16 to 29 percent by 2025 versus 2019.¹²² The individual members will be setting their own portfolio targets in the first quarter of 2021.

In a similar vein, many asset managers and owners are making bold public commitments and supporting actions to engage with their portfolio companies to drive transition toward a low-carbon economy. The adoption of ESG-aligned changes in EU legislation affecting UCITS, MiFID II, AIFMD, and the Sustainable Finance Disclosure Regulation has complemented a drive in the Asset Management industry, with ESG-related product disclosure and scrutiny of investee companies for their climate and sustainability performance and disclosures.

At the same time, there are challenges. As per a TCFD status report, for the asset manager and owner sectors, there are still low degrees of reporting related to the weighted carbon intensities, with climate-related metrics having disclosure levels of 30 percent for asset managers and 37 percent for asset owners. Importantly, **only 9 percent of asset managers and 12 percent of asset owners have disclosures on climate-related targets.** Furthermore, **44 percent of asset managers and 39 percent of asset owners have sufficient disclosures on integration of climate into overall risk management.**

¹²⁰ <https://www.unepfi.org/news/industries/investment/at-climate-action-summit-today-12-of-worlds-largest-investors-make-unprecedented-commitment-to-net-zero-emissions/>.

¹²¹ <https://www.unepfi.org/news/industries/investment/net-zero-asset-owner-alliance-sets-unprecedented-5-year-portfolio-decarbonization-targets/>.

¹²² <https://www.unepfi.org/news/industries/investment/net-zero-asset-owner-alliance-sets-unprecedented-5-year-portfolio-decarbonization-targets/>.

"[Regarding investors] value-at-risk stress tests have not been done. Many take it for granted that markets are efficient, but if you unpack the models, they consider positive terminal value on coal-fired power stations

—Climate think tank executive

Integration of climate into risk frameworks is critical to ensure **climate risks, both physical and transition, are appropriately priced into the cost of capital**, in particular for legacy carbon-intensive activities. There is concern in the market that this integration is insufficient—leading to mispricing of risk, particularly for legacy assets that do not have appropriately estimated terminal values.

Recommendations

We recommend that as data becomes more available **investors and asset managers continue to work toward accelerating integration of climate factors into their investment process, including integration of climate-related risk factors into risk models and frameworks**. We also support investors and asset managers **in their transition strategies for a Paris-aligned temperature scenario**, and GHG reductions through **engagement and stewardship with their portfolio companies**.

Asset managers and investors recognize climate-related risk factors in investment and capital allocation decisions. However, such analysis is significantly hampered by the level of disclosures and data availability. By deepening the integration of climate-related risks into investment decisions and investor stewardship priorities, investors—particularly asset owners—play a key role in influencing both the risk-adjusted costs of capital and the availability of capital, especially for carbon-intensive sectors and assets.

4.2.5 We recommend that the Banking and Capital Markets sector, and other market participants **promote an innovation mindset in scaling climate finance.** Innovation in financial markets—including financial product innovation; leveraging geospatial data for climate risk and asset performance assessment; AI/NLP to transform unstructured reporting and disclosures to structured and comparable decision-relevant-data; standardization of legal contract language and industry data models; advancements in scenario analysis and risk modeling; and tools and platforms to promote climate finance awareness and literacy—will be critical to scaling climate finance.

Context

Transitioning to a low-carbon economy will **require acceleration of innovation across all real-economy sectors**, including renewable energy, carbon capture, clean hydrogen, grid modernization, and energy storage. Equally important will be financial product innovation—more specifically, the mobilizing of a significant pool of capital across a broad range of retail and institutional investors—to meet the significant investment requirements to transition to a low-carbon economy.

In 2019, total assets under management (AUM) grew by 15 percent to \$89 trillion, of which retail clients were the fastest-growing segment, with assets rising by 19 percent.¹²³ In 2020, the uncertainty of COVID-19 has resulted in a decline in consumer spending and an increase in savings rates, resulting in a further increase in retail AUM. Financial product innovation that focuses on design of products and instruments, and market structures to mobilize a broad pool of retail investor funding, will be critical to scale climate finance.

Mobilization of retail investor funding would require standardization of definitions, taxonomies, and labels that can communicate the risk-return characteristics and potential alignment with climate ambition in a simple manner. Fintech solutions could, for example, enable retail investors to have easy access to their investment portfolios by security and measures of both how they are performing financially and how the associated companies contribute to delivering climate finance. The BCG Global Asset Management 2020 report noted, “Taking a page from consumer-packaged goods companies, leading players are bringing the customer voice into the product development cycle,

¹²³ BCG Global Asset Management 2020 – Protect, Adapt and Innovate – see https://image-src.bcg.com/Images/BCG-Global-Asset-Management-2020-May-2020-r_tcm9-247209.pdf.

actively co-creating strategies with clients—in the retail channel through model portfolios, and in the institutional channel through customized separately managed accounts (SMAs). This practice makes it possible to design products that address client values in areas such as ESG investing, as well as offering the ability to select and deselect industries, companies, and geographies across asset classes.”¹²³

Financial product innovation for retail products must remain consistent with legal and conduct requirements and balance reputational risks for the providers of products as it is extended to the non-institutional market segment. Both the Banking and Capital Markets sector and Wealth and Asset Management sector can play a critical role in investor education and awareness. In addition to expanding the investor pool to retail clients, we highlight the importance of financial innovation in structured products, derivatives, and securities financing markets (see more detail in section 4.2.2).

Artificial Intelligence/Machine Learning (AI/ML) technology is already playing a critical role in the transition to a low-carbon economy across clean power, smart cities and homes, smart transport systems, sustainable land-use, and sustainable production and consumption.¹²⁴ The World Economic Forum (WEF) report “Harnessing Artificial Intelligence for the Earth” highlights a number of use cases, including optimized energy system forecasting, smart grids for electricity, prediction of solar flares to protect power grids, smart traffic light and parking systems, sustainable building design, precision agriculture and nutrition, optimization of industrial machinery and manufacturing, AI-enabled electric cars, on-demand shared transport mobility, etc.

AI/ML technology is increasingly playing a significant role in the Banking and Capital Markets sector—and is used for credit and investment decisions, electronic trading, trade surveillance, legal contracts, regulatory compliance, and operational efficiency. Firms should reassess their use of AI/ML with a climate finance lens and explore opportunities to leverage AI/ML technology across the entire value chain, factoring in the risks associated with AI/ML.

One of the main challenges highlighted in the interviews was translating unstructured climate disclosures to meaningful decision-relevant information. Natural Language Processing (NLP) can

¹²⁴ Harnessing Artificial Intelligence for the Earth, World Economic Forum, January 2018.

play a significant role in extracting relevant data points from public disclosures and then translating them into a structured data set. The information, thus extracted, can serve as inputs in risk assessment, pricing, and capital allocation decisions. AI/ML models can also rank disclosures from corporates (e.g., score) based on the quality of information to drive improvements in disclosure standards over time.

Interviews highlighted the increasing use of geospatial data for climate risk assessment—more specifically, the assessment of physical risk from climate events on infrastructure.¹²⁵ Innovation in climate risk assessment and modeling will require rapid advancement in integration of location data of physical assets (infrastructure), exposure and sensitivity to climate risk factors, and projection of climate risk factors (e.g., essential climate variables). Outcomes of the assessment will be important inputs in physical risk assessment, credit decisioning, portfolio management, pricing, and capital allocation decisions. Interviews confirmed that the Banking and Capital Markets sector is making rapid progress in integration of geospatial data in risk assessment for critical sectors (e.g., industry and buildings).

Recommendations

We recommend that the Banking and Capital Markets sector, and other market participations **promote an innovation mindset in scaling climate finance**. Innovation in financial markets—including financial product innovation; leveraging geospatial data for climate risk and asset performance assessment; AI/NLP to transform unstructured reporting and disclosures to structured and comparable decision relevant-data; standardization of legal contract language and industry data models; advancements in scenario analysis and risk modeling; and tools and platforms to promote climate finance awareness and literacy—will be critical to scaling climate finance.

The transition to low-carbon economy will require an exponential increase in climate-aligned investments. Financial product innovation will play a critical role in the mobilization of a broad pool of capital, including active participation by retail investors in funding climate finance. Mobilization of retail investor funding will require standardization of definitions, taxonomies, and labels that can

¹²⁵ Geospatial technology refers to all of the technology used to acquire, manipulate, and store geographic information.

communicate the risk-return characteristics and potential alignment with climate ambition in a simple manner. Fintech solutions could, for example, enable retail investors to have easy access to their investment portfolios by security, a measure of how these are performing financially, and how the associated companies contribute to delivering climate finance. Financial product innovation should be balanced with legal, reputational, and conduct risk for the providers of products as it is extended to the non-institutional market segment. The Banking and Capital Market sector and the Wealth and Asset Management sector can play a critical role in investor education and awareness.

4.3 Climate Risk Management Framework: Actions Needed to Incorporate Climate Factors into Risk Management Frameworks

4.3.1 We recommend that **supervisors, policymakers, and regulators seek to mitigate risk of market fragmentation¹²⁶ through increased use of ex-ante, globally consistent regulation and ex-post supervisory tools to support the development of consistent regulatory drivers, or intended barriers, aligned with the pace of climate-finance market developments and broader change in economic policy.**

Climate change is a risk for the financial sector and, if not managed, could be a source of risk to financial stability. Regulation has a role in managing the macro- and micro-prudential risks associated with climate change. However, regulation should not be a substitute for change in broader industrial, environmental, and economic policy. Leveraging regulation as a policy-transmission mechanism could have unintended consequences, including migration of high-emission financing to the unregulated sector. Regulation should be globally harmonized and aligned with the pace of climate-finance market developments. Pre-emptive and punitive regulation could hamper the scaling of climate finance markets, result in disorderly market price movements for impacted sectors, and constrain the flow of capital required to transition hard-to-abate sectors and regions.

Context

Globally, regulators have taken note of the financial stability, monetary policy, and financial regulation implications of climate change—and are taking action.

The Network for Greening the Financial System (NGFS), a grouping of central banks and supervisors now counting 75 members and 13 observers, has noted that “climate-related risks are a source of financial risks. It is therefore within the mandates of central banks and supervisors to ensure the financial system is resilient to these risks.”¹²⁷ The NGFS and its members have sponsored initiatives to integrate climate-related and environmental risks into their scope, and sponsored research and

¹²⁶ FSB Report on Market Fragmentation (June 2019); and IOSCO Good Practices on Processes for Deference (June 2020).

¹²⁷ Retrieved from https://www.banque-france.fr/sites/default/files/media/2019/04/17/ngfs_first_comprehensive_report_-_17042019_0.pdf.

many discussion forums on best practices. The NGFS has taken a lead role in the production of climate scenarios “that explore the impacts of climate change and climate policy with the aim of providing a common reference framework.”¹²⁸

The European Central Bank (ECB) has published guidance on how banks within its jurisdiction might be expected to safely and prudently manage and disclose climate-related risks. The ECB’s guidance aims to be a basis for supervisory dialogue rather than be binding, but firms are already acting on its relatively comprehensive recommended approach of incorporating climate risk considerations into their risk management frameworks, and to eventually quantify these risks within their capital adequacy framework. In addition, the EU Disclosure Regulation will require financial market participants and financial advisers to provide investors with certain ESG-related information regarding financial products in order to enable investors to make informed investment decisions based on ESG factors.

The Prudential Regulation Authority (PRA) in the UK may be said to have gone further to mandate evidence of an implementation plan for compliance with SS3/19 by 2021, which requires firms to “address the financial risks from climate change through their existing risk management frameworks, in line with their board-approved risk appetite, while recognizing that the nature of the risks requires a strategic approach.”¹²⁹

The PRA is not alone in expecting firms to develop approaches to identify, assess, manage, report, and disclose climate-related financial risks as part of their enterprise risk management framework—indeed, MAS, APRA, Banque de France, and BaFin have also issued similar guidance.

¹²⁸ https://www.ngfs.net/sites/default/files/medias/documents/820184_ngfs_scenarios_final_version_v6.pdf.

¹²⁹ SS3/19 can be accessed here: <https://www.bankofengland.co.uk/-/media/boe/files/prudential-regulation/supervisory-statement/2019/ss319>. The requirement to show evidence of progress by 2021 can be accessed here: <https://www.bankofengland.co.uk/-/media/boe/files/prudential-regulation/letter/2020/managing-the-financial-risks-from-climate-change.pdf>.

Global Regulatory Guidance

Regulator	Guidance	Timing	Regulator	Guidance	Timing
Danmarks Nationalbank	Analysis: Climate change can have a spillover effect on financial stability	Nov-20	Bundesanstalt fuer Finanzdienstleistungsaufsicht (BaFin)	Guidance notice on dealing with sustainability risks	Dec-19
ACPR	Scenarios and main assumptions of the ACPR pilot climate exercise	Jul-20	De Nederlandsche Bank	Good Practice: Integration of climate-related risk considerations into banks' risk management	Nov-19
Banque de France/ACPR	Working paper: Climate-Related Scenarios for Financial Stability Assessment: An Application to France	Jul-20	Bank Negara Malaysia	Guidance document: Value-based Intermediation Financing and Investment Impact Assessment Framework	Nov-19
Monetary Authority of Singapore	Consultation paper: Proposed guidelines on environmental risk management (banks)	Jun-20	Network for Greening the Financial System	Technical document: A sustainable and responsible investment guide for central banks' portfolio management	Oct-19
Hong Kong Monetary Authority	White Paper on Green and Sustainable Banking	Jun-20	Bank of England	Supervisory Statement 3/19: Enhancing banks' and insurers' approaches to managing the financial risks from climate change	Apr-19
European Central Bank	Guide on climate-related and environmental risks - Supervisory expectations relating to risk management and disclosure	May-20	Network for Greening the Financial System	First comprehensive report - A call for action - Climate change as a source of financial risk	Apr-19
Bank of Canada	Staff Discussion Paper: Scenario Analysis and the Economic and Financial Risks from Climate Change	May-20	APRA	Information paper: Climate change: Awareness to action	Mar-19
Basel Committee on Banking Supervision	Climate-Related Financial Risks: A Survey on Current Initiatives	Apr-20	Association of Banks in Singapore	Guidelines on Responsible Financing	Jun-18
APRA	Understanding and managing the financial risks of climate change	Feb-20	United Nations Environment Programme Finance Initiative	Extending our Horizons: Assessing Credit Risk and Opportunity in a Changing Climate	Apr-18
Bank of England	Discussion Paper: The 2021 biennial exploratory scenario on the financial risks from climate change	Dec-19	France - Ministry of the Environment, Energy and Marine Affairs, Ministry of Economy and Finance	Article 173 of the French Law on Energy Transition and Green Growth	Aug-15
Climate Disclosure Standard Boards	CDSB Framework for reporting environmental and climate change information - Advancing and aligning disclosure of environmental information in mainstream reports	Dec-19			

Figure 17: Global regulatory guidance

The November 2020 Financial Stability Report of the U.S. Federal Reserve acknowledges that “climate change, which increases the likelihood of dislocations and disruptions in the economy, is likely to increase financial shocks and financial system vulnerabilities that could further amplify these shocks.” The report also highlights that the Federal Reserve is “evaluating and investing in ways to deepen its understanding of the full scope of implications of climate change for markets, financial exposures, and interconnections between markets and financial institutions.” It also shows heightened supervisory expectations wherein the supervisors should “expect banks to have systems in place that appropriately identify, measure, control, and monitor all of their material risks, which for many banks are likely to extend to climate risks.”¹³⁰

Further, in response to a question on the role of regulators related to climate change, Jerome Powell, chairman of the Federal Reserve, acknowledged that climate change is a material risk for the financial system, “The science and art of incorporating climate change into our thinking about

¹³⁰ Financial Stability Report (November 2020) can be accessed here: <https://www.federalreserve.gov/publications/files/financial-stability-report-20201109.pdf>.

financial regulation is relatively new ... we are in early stages of getting up to speed, working with our central bank colleagues and other colleagues around the world to try to think about how this can be part of our framework.”¹³¹ Lael Brainard, governor of the Board of the U.S. Federal Reserve, also noted, “Congress has assigned the Federal Reserve specific responsibilities in monetary policy, financial stability, financial regulation and supervision, community and consumer affairs, and payments. Climate risks may touch each of these.”¹³² Finally, on November 10, 2020, Randal Quarles, governor of the Board of the U.S. Federal Reserve, told lawmakers that the Federal Reserve has requested membership to NGFS.¹³³

In September 2020, the Market Risk Advisory Committee of the CFTC published the report “Managing Climate Risk in the U.S. Financial System,” which highlighted several key recommendations for U.S. regulators, including “bank and nonbank financial firms to address climate-related financial risks through their existing risk management framework in a way that is appropriately governed by corporate management,” and “pilot climate risk stress testing as is being undertaken in other jurisdictions and as recommended by the NGFS.”¹³⁴

President-elect Joe Biden has elevated climate change as one of the top priorities of his administration, and is likely to create a special White House office to coordinate domestic and economic policy, including investment, regulation, and inter-agency coordination.

The Banking and Capital Markets sector has generally responded favorably to the heightened focus on climate and environmental risk by regulators. Interviewees confirmed that regulators have played—and should continue to play—a key role in helping provide guidance, particularly on best practices related to disclosures, taxonomies, data, risk management frameworks, scenario analysis and stress testing, and risk reporting.

Regulators are aware of the need to continually engage with banks and other regulated firms, as best practices and the “art of the possible” evolve. The NGFS itself has warned that there cannot be

¹³¹ <https://www.federalreserve.gov/mediacenter/files/FOMCpresconf20201105.pdf>.

¹³² Brainard, Lael. (2019, November 8th). Why Climate Change Matters for Monetary Policy and Financial Stability. Retrieved from <https://www.federalreserve.gov/newsevents/speech/brainard20191108a.htm>.

¹³³ <https://www.reuters.com/article/us-climate-change-fed/fed-moves-closer-to-joining-global-peers-in-climate-change-fight-idUSKBN27T2RB>.

¹³⁴ <https://www.cftc.gov/sites/default/files/2020-09/9-9-20%20Report%20of%20the%20Subcommittee%20on%20Climate-Related%20Market%20Risk%20-%20Managing%20Climate%20Risk%20in%20the%20U.S.%20Financial%20System%20for%20posting.pdf>.

a “one-size-fits-all solution for supervisors,” particularly as “financial markets and legislative frameworks ... are at different stages of integrating climate-related and environmental risks.” The NGFS recognizes that “metrics and methodologies for sound risks analysis must be developed further for different groups of assets and exposures,” and there is a continuing need for “collective leadership and globally coordinated action.”¹³⁵

Among the common themes in the emerging regulations are categorization of climate risk into physical and transition risk; assessment of the impact of climate risk on business models, industry sectors, geography, products and services, and clients; risk governance; embedding of climate risk in business strategy, planning, and risk appetite; development of risk identification, measurement, and stress testing and scenario analysis capabilities; and reporting.

However, interviewees also noted several areas where there is **lack of harmonization of regulatory guidance and expectations**, including

- The role of central banks and financial regulation in addressing climate change;
- Applicability of guidance to less-significant institutions;
- Definitions of materiality, in the context of climate change (e.g., scopes 1, 2, and 3);
- Expectations on timing for specific capabilities and comprehensive roadmap;
- Plausibility and severity of climate risk scenario and modeling methodology;
- Integration of climate risk assessment in short- to medium-term business planning;
- Assessing the impact of climate risk on financial resources (capital, funding, and liquidity);
- Fiduciary responsibilities and conduct risk for asset managers; and
- Standards on risk disclosures.

A cross-cutting issue is data; global standard setters are currently undergoing literature reviews to help identify which data is decision-relevant, and where to source it.

¹³⁵ https://www.ngfs.net/sites/default/files/medias/documents/ngfs_guide_for_supervisors.pdf.

Financial institutions operate across different regulatory regimes, and face potentially inconsistent guidance; expectations and timing; and differences between prudential, market, and conduct regulation. **Ambitious short-term and disjointed compliance timelines may lead to tactical solutions and suboptimal outcomes.** Further, financial institutions also operate in a diverse range of political, public-policy, and economic environments with different levels of awareness, engagement, and urgency on the issue of climate change. For example, European banks with significant operations in emerging markets (e.g., Asia or Africa) are likely to face significant challenges in addressing heightened home-regulatory requirements.

Interviewees also emphasized that regulators should be aware that **financial institutions still face many challenges in climate risk management**—the lack of data and the ability to quantify risks among them.

Climate-risk measurement has a significant dependency on the availability of exposure and sensitivity to climate risk data at an industry sector, region, and, most importantly, client level. Climate-risk disclosures are at a nascent stage in developed markets, and nonexistent in emerging markets or private companies. Disclosures are of varying quality and granularity, not comparable, and backward looking—and do not provide enough information on the future trajectory of climate risk (exposure, sensitivity, and mitigation and/or adaptation plans). The ability of banks to assess the robustness of their clients' climate risk mitigation and transition plans, and thereby their risk profiles, is dependent on a broader consensus on principles for taxonomies and transition pathways (by sector and region). Several banks have confirmed that they have initiated bespoke data-collection efforts—with mixed success—to assess the exposure and sensitivity of clients and counterparties to climate risk, and incorporate those assessments as part of the credit-risk management process. Some interviewees also encouraged the Banking and Capital Markets sector to explore innovative solutions based on common standards for sourcing and sharing climate-risk-relevant data across the banking industry to reduce the administrative burden of data provisioning on corporates.

Interviewees highlighted that an existing risk management framework, tools, and methodologies will need to be adapted for climate risk. This challenge in integrating climate risk within the enterprise risk management (ERM) framework is due to the current risk management paradigm being based on risk factors derived from historical data, a focus on quantitative risk management, and back-testing of modeled results. Integrated Assessment Models (IAMs) aim to link the climate risk scenarios to economic impact at a portfolio level (sector/geography), but they are not suitable for

granular client-level risk assessment. Emerging risks with low-frequency events are hard to measure and manage with a similar tool set. With COVID-19, firms are starting to refocus on non-financial risks, while “black-swan” events have the potential speed and severity to seriously challenge their financial and operational resiliency.

Interviewees welcomed a phased approach to the integration of climate risk into the prudential framework. As an example, the Hong Kong Monetary Authority (HKMA) has presented a three-phased approach toward “green and sustainable banking,” wherein Phase I sees the development of a common framework to assess a “greenness baseline,” and technical support is obtained; Phase II is where supervisory expectations are aligned through a consultative process; and Phase III is where banks’ progress in meeting targets is monitored. Given the nascent stage of climate risk management, the interviewees recommended a phased, principles-based, and flexible regulatory approach that evolves with the underlying climate finance market.

A key risk—that **pursuing banking regulation for policy transmission does not manifest in such a way as to distort markets or behavior—remains.** Regulation should not encourage a scenario wherein transition financing transactions are diverted to lightly or unregulated markets, resulting in adverse competitive outcomes for regulated institutions. Regulation should not result in a broadening list of exclusionary sectors, regions, or clients (e.g., coal) that are deemed “brown” or “hard-to-abate” leading to financial distress in specific sectors as a result of disorderly recalibration of risk appetite across the Banking and Capital Markets sector.

Regulators should exercise caution in adjusting quantitative risk metrics, such as risk-weighted assets or other prudential regulation levers, through qualitative model overlays in order to pursue policy goals such as combating climate change. Interviewees highlighted that climate risk assessment and capital adequacy should continue to be based on the underlying risk profile of the exposures, rather than simplistic risk labelling (i.e., green is good, brown is bad).

In conclusion, the interviewees proposed that **policymakers should holistically assess whether financial regulation is the most efficient or desired lever to drive change,** as opposed to industrial, economic, or environmental policy. Changing financial regulation without the necessary realignment of the broader policy environment may have unforeseen undesired outcomes, such as reducing the flow of capital to the firms that are most in need of it to transition to a lower-carbon business model.

Recommendations

We recommend that supervisors, policymakers, and regulators seek to mitigate the risk of market fragmentation¹³⁶ through increased use of ex-ante, globally consistent regulation¹³⁷ and ex-post supervisory tools to support the development of consistent regulatory drivers, or intended barriers, aligned with the pace of climate finance market developments and broader change in economic policy.

- Financial regulators should drive toward **global consistency of regulatory principles and frameworks**—and alignment of prudential, market, and conduct regulation—to avoid potential regulatory arbitrage across jurisdictions, or across segments of the Banking and Capital Markets sector.
- Regulators should provide clear guidance to financial institutions and detailed guidance to supervisors. They should coordinate with regulated financial institutions to develop best practices for climate risk management (including integration of climate considerations into their risk management, investment, and lending decisions); business strategies; financial planning stress-testing and scenario analysis; and reporting and disclosures.
- In defining the timelines for integrating climate risks into the risk management framework, regulators should acknowledge that the **existing risk management framework, tools, and capabilities will take time to be adapted for climate risk management**. Plus, the availability of data and maturity of risk measurement methodologies are still in early stages of development.
- Financial regulation should not be an alternative to lack of progress on carbon pricing, environmental and economic policy, and fiscal incentives. In attempting to mitigate the impact of climate-related risks on financial stability, regulators should recognize that attempting to mitigate climate change via financial regulation may be a blunt instrument that leads to unintended consequences—and should only do so after extensive consultation.
- Lastly, this report recommends that regulators continue to invest in primary research related to leading climate risk practices in coordination with the private sector. It also encourages the work of forums such as the NGFS, the Basel Committee, and the Climate Financial Risk Forum to identify best practices both at a global level and within specific markets.

¹³⁶ FSB Report on Market Fragmentation (June 2019); and IOSCO Good Practices on Processes for Deference (June 2020).

¹³⁷ Includes prudential, market and conduct regulation.

4.3.2 We recommend that **the Banking and Capital Markets sector share best practices of climate risk management capabilities, as well as increase transparency of the integration of climate risk within firms' governance, strategy, planning, resource allocation, and risk-adjusted performance management framework.**¹³⁸

Context

It is in the self-interest of financial institutions to manage the risks of climate change, and to make it part of their overall risk management framework. **The financial services industry is not a direct material contributor of GHG emissions (Scope 1).** Its climate and environmental impact is limited to energy and water consumption in buildings, waste, and travel. Several global financial institutions have made commitments to use renewable energy, reduce energy and water consumption, reclaim water from recycled sources, and improve energy efficiency of their buildings. In addition, financial services firms are also exposed to physical risks (e.g., facilities prone to flooding) that could have a potential impact on their operational resiliency and business continuity planning (operational risk).

The main impact of climate risk on the Banking and Capital Markets sector is the result of its financial intermediation role in the economy. It is the outcome of its advising, lending, originating, syndicating, pooling, investing, managing assets, and hedging activities. More broadly, it is a result of its intermediation between the supply and demand for capital. Its clients' exposure and sensitivity to climate risk (physical and transition) is transmitted to the Banking and Capital Markets sector through a range of second-order risk drivers, including but not limited to a higher likelihood of default; lower valuation of collateral; disorderly market price changes; decline in market liquidity of assets; higher haircut on collateral; legal and reputational risk of financing high-GHG-emission or hard-to-abate sectors and clients; fiduciary risk of decline in value of assets under management (AUM); conduct risk from mis-selling or mislabeling "green" and "transition" products and instruments; and increase in insurance losses, etc. Several banks have initiated enterprise-wide initiatives to identify the key sources of climate risk impact (risk identification), starting with credit risk and eventually expanding to all material financial and non-financial risks.

¹³⁸ Subject to applicable international and national competition law regulation; Risk-adjusted performance management framework is defined as internal risk-return performance metrics (e.g., risk adjusted return on capital or RAROC) that are used for capital allocation decisions.

Banking and Capital Markets firms have highlighted heightened expectations on climate risk management and disclosures by institutional investors, regulators, and boards of directors. In response, several leading Banking and Capital Markets firms have released TCFD disclosures, commitments to Paris-aligned financing targets, and, in some cases, detailed sustainable finance frameworks that outline the eligibility criteria of assets to be classified as Paris-aligned financing.

In response to heightened expectations, leading financial institutions have provided updates to their boards of directors on climate risk assessment, and have not defined climate risk as a separate risk, but as embedded in existing categories of credit, market, and operational risks. Approaches to managing climate risk have previously been qualitative and have focused on exclusionary or position statements—for example, not to directly finance new coal-fired power plant projects, in any location.

Beyond exclusionary statements, most financial institutions are in early stages of assessing the impact of climate risk on geography or country, industry sector, and client/counterparty limits.

Climate risk was also highlighted as a significant business risk. The inability to manage through the transition could result in a significant loss of revenue, specifically for financial institutions that have a significant exposure to geographies, and industry sectors that have a high-sensitivity to climate risk (e.g., oil & gas or real-estate portfolios with a high risk of flooding). Financial institutions are in early stages of assessing the long-term impact of climate risk on their business strategies, but they have not made any material changes in response to climate risk. Financial institutions have highlighted that climate change is both a risk and an opportunity, and several firms are in early stages of sizing the opportunity, aligning their business strategy and operating model, and developing capabilities for climate finance. They are focusing on asset management and corporate and investment banking.

Financial services firms have highlighted significant challenges in embedding climate risk management in short- to medium-term business and financial planning, capital allocation, and performance management frameworks. The mismatch between the long-dated climate risk assessment time horizon (up to 30 years) and the short-term business strategy and planning focus (less than three years) is a significant challenge in embedding climate risk. The average life of a corporate loan is three to five years, resulting in a timing mismatch between the maturity profile of exposure and climate risk scenario. However, recent policy actions to hasten transitional actions for key industries have made transition risk more immediate for affected corporates' economic impacts and transition plans—but the timeline mismatch is still a key factor in the hard-to-abate sectors.

The lack of a carbon price also results in a systemic mispricing of climate risk—embedding climate risk prematurely in pricing (e.g., loan pricing) could be a competitive disadvantage. Financial services firms are starting to integrate climate risk considerations into long-dated exposures (e.g., project finance) and approvals of material transactions. Climate risk considerations are starting to be incorporated into active credit portfolio management decisions, although the inability to hedge the risk is a key constraint.

In emerging markets, climate risk is interrelated to sovereign, currency, legal, and reputational risk. As highlighted in section 3, climate change is a significant challenge for Asia, Africa, and South America. Capital markets, more broadly, are less developed in emerging markets, thereby leading to a higher dependency on bank intermediated funding. Corporates in emerging markets are dependent on USD (and other G5 currency) funding and cross-currency swap markets due to the relatively small scale of local currency funding markets. In addition, in several cases, emerging markets are also faced with weak corporate governance, high foreign currency risk, and an unstable political environment with corruption. COVID-19 has further adversely impacted the fiscal and public finance position of many countries in the emerging markets. **Financial services firms need an integrated framework that will consider the impact of climate risk in the context of other material risks (e.g., sovereign, FX, legal, and reputational), especially in the context of climate finance for emerging markets.**

Climate risk, if it is assessed to be a material risk for a firm, is generally overseen by the Board Risk Committee and ESG/Sustainability Risk Management Forum (at an executive management level). The executive-level committee is led by the chief risk officer (CRO) and has representation from all the major business lines. This committee is responsible for approving climate risk management policy, stress-testing scenarios, and significant transactions with exposure to climate risk factors. Climate risk management (second line of defense) is part of the broader ESG or sustainability risk management capability, reporting to the CRO. Financial institutions are in early stages of defining and operationalizing the three lines of defense for climate risk management—and roles and responsibilities across business lines, climate finance (or sustainable finance), climate risk management, and internal audit are at a formative stage. Most banks have not concluded that climate risk management warrants being set up as a separate risk discipline (such as credit, market, operational, or liquidity risk), but are in early stages of assessing the impact of climate risk on other material risk categories. Financial institutions are prioritizing embedding climate risk management within the credit risk management framework, focusing on corporate and counterparty credit risk,

and specific sectors and portfolios, such as oil and gas, commercial and residential real estate, shipping, etc.

Financial services firms have highlighted that a material proportion of climate risk management efforts are allocated to addressing rapidly evolving global regulatory requirements. This often results in tactical solutions rather than investment in long-run core capabilities.

Recommendations

We recommend that **the Banking and Capital Markets sector share best practices of climate risk management capabilities, as well as increase transparency of the integration of climate risk** within firms' governance, strategy, planning, resource allocation, and risk-adjusted performance management framework.

The Banking and Capital Markets sector should continue to accelerate the development of climate risk management capabilities; integrate climate risk as part of the financial institutions' governance, strategy, planning, resource allocation, and risk-adjusted performance management framework;¹³⁹ and collaborate across the private and public sectors to align on data, methodology, and disclosures.

The sector should collectively set an example of best practices in climate risk disclosures based on quantitative and qualitative metrics, and provide forward-looking guidance. In addition, Banking and Capital Markets firms should develop and communicate their approaches for tracking progress against their public climate commitments. Common standards will ensure comparability of results across the Banking and Capital Markets sector, and avoid unexplained double-counting across the industry.

The Banking and Capital Markets sector, rating agencies, and data and technology service providers should agree on a common set of data standards and definitions—and a common set of platforms (e.g., client onboarding)—to enable the collection and dissemination of climate exposure and sensitivity information. This would reduce the duplication of effort and significant data

¹³⁹ Embedding climate risk factors in the risk-adjusted performance management metrics, such as RAROC (risk adjusted return on capital) will ensure that capital allocation, pricing, and portfolio management decisions factor in the impact of climate risk factors. For example, in our interviews, a number of banks emphasized that climate risk factors are a qualitative overlay rather than embedded in the risk-adjusted performance management framework.

provisioning cost that is likely to be incurred by the corporate sector. Where possible, the Banking and Capital Markets sector should leverage advanced technology solutions (e.g., NLP) to transform unstructured disclosure data to structured climate risk data (e.g., exposure, sensitivity, transition path, mitigation, and adaptation plans).

An aerial photograph showing a dirt road that winds through a lush, green landscape. The road is reddish-brown and curves through a mix of dense, dark green forest and lighter green, grassy hills. The scene is captured from a high angle, looking down at the road as it meanders through the terrain. The overall atmosphere is natural and serene.

Section 5

Call to Action

5 Section 5: Call to Action

This report has outlined a massive need to scale the climate finance market. Each stakeholder has a key role to play in facilitating the growth of capital. The following is a summary of the recommendations, sector insights, and priority actions recommended for each stakeholder. With coordinated action and ongoing collaboration among the multiple stakeholder groups highlighted in this report, the market for climate finance can thrive in the next decade.

"Climate Finance and the Real Economy": Recommendations to Scale the Climate Finance Market Structure

Motivating capital



- 1** We recommend that **governments establish legally enforceable, comprehensive, and sufficiently high levels of GHG-emissions pricing ("carbon pricing") mechanisms such as a GHG tax or trading schemes**, with explicit forward-looking direction on price levels, implemented in a way that respects a "just transition," minimizing social and economic costs for those least able to bear them.
(detailed in section 4.1.1)
- 2** We recommend that **governments commit to and implement effective and proportionate policies, fiscal programs, and legislative action** that will support achievement of the targets established in the Paris Agreement.
(detailed in section 4.1.2)
- 3** We recommend that **governments and national/multilateral development banks motivate the mobilization of private sector capital through blended public/private finance solutions**.
(detailed in section 4.1.3)
- 4** We recommend **financial education and climate finance risk awareness building at an executive level to support corporates' ability to actively prioritize and accelerate their own preparations for a low-carbon future**, embedding this as a strategic imperative for their boards and senior management. The Banking and Capital Markets sector will be an important partner to corporates to both help navigate the risks and opportunities of climate change and mobilize appropriate financing solutions.
(detailed in section 4.1.4)
- 5** We recommend that **corporates and their industry associations** coordinate and collaborate with the scientific community, standard-setting bodies, financial institutions, and governments to **accelerate the development and alignment of sector- and region-specific transition pathways** to achieve Paris Agreement climate goals, including viewpoints on where there is still evolution expected.
(detailed in section 4.1.5)

Figure 18: Summary of recommendations (contd. on next page)

Financial Market Structure Changes



6 We recommend **mandatory disclosure of corporate-specific financially material, decision-relevant data relating to climate risks and opportunities**. Consistent global disclosure frameworks, developed in consultation with industry participants and with adequate runway for implementation, should help strengthen the transparency and comparability of climate risk data.

(detailed in section 4.2.1)

7 We recommend that **the Banking and Capital Markets sector accelerate the development and scaling of a broad range of products and instruments in both public and private markets to meet the financing, investing, hedging, market liquidity, and funding requirements of a range of market participants actively starting to transition**. The range of products and instruments should include syndicated and bilateral loans, bonds, equity, structured products, derivatives, and asset-level financing. In addition, we recommend that **regulators holistically assess any current regulatory barriers that prevent this process, and encourage the development** of these products and solutions.

(detailed in section 4.2.2)

8 We recommend that the Banking and Capital Markets sector, standard-setting bodies, industry, policymakers, and financial regulators **collaborate to achieve consensus on a common global definition and set of principles concerning what constitutes climate finance**. This should be translated into **sector- and region-specific taxonomies** that are comparable, flexible for evolution in response to technological and scientific developments, and include climate-related performance indicators and targets that correspond to Paris-aligned transition pathways.

(detailed in section 4.2.3)

9 We recommend that as data becomes more available, **investors and asset managers continue to work toward accelerating integration of climate factors into their investment process, including integration of climate-related risk factors into risk and valuation models and frameworks**. We also support investors and asset managers **in their transition strategies for a Paris-aligned temperature scenario**, and GHG reductions through **engagement and stewardship with their portfolio companies**.

(detailed in section 4.2.4)

10 We recommend that the Banking and Capital markets sector, and other market participations **promote an innovation mindset in scaling climate finance**. Innovation in financial markets, including financial product innovation, leveraging geospatial data for climate risk and asset performance assessment, AI/NLP to transform unstructured reporting and disclosures to structured and comparable decision relevant-data, standardization of legal contract language and industry data models, advancements in scenario analysis and risk modeling, and tools and platforms to promote climate finance awareness and literacy will be critical to scaling climate finance.

(detailed in section 4.2.5)

Climate Risk Management Framework



11 We recommend that **supervisors, policymakers, and regulators seek to mitigate the risk of market fragmentation through increased use of ex-ante, globally consistent regulation and ex-post supervisory tools to support the development of consistent regulatory drivers, or intended barriers, aligned with the pace of climate finance market developments** and broader change in economic policy.

(detailed in section 4.3.1)

12 We recommend that **the Banking and Capital Markets sector share best practices of climate risk management capabilities, as well as increase transparency of the integration of climate risk** within firms' governance, strategy planning, resource allocation, and risk adjusted performance management framework.

(detailed in section 4.3.2)

Coordinated action needed from all stakeholders (1/2)

Recommendations by market participant



Public Sector & Multi-laterals

- **Establish legally enforceable, comprehensive, and sufficiently high levels of GHG-emissions pricing ("carbon pricing")** mechanisms such as GHG tax or trading schemes, with explicit forward-looking direction on price levels, implemented in a way that respects a "just transition," minimizing social and economic costs for those least able to bear them.
- **Evaluate establishment of carbon border adjustment mechanisms to provide a level playing field for trade and to prevent carbon leakage**, in close collaboration and consultation with industry, in a manner that accounts for differences in transition pathways between countries.
- **Accelerate the development and alignment of sector- and region-specific transition pathways** to achieve Paris Agreement climate goals, in close collaboration with the scientific community, standard-setting bodies, financial institutions, corporates, and their industry associations.
- **Commit to and implement effective and proportionate policies, fiscal programs, and legislative action** that will support achievement of Paris Agreement targets; **align COVID-19 recovery funding and economic stimulus packages** to pursue inclusive forms of sustainable and green recovery.
- **Motivate the mobilization of private sector capital through blended public/private finance solutions.**
- **Dramatically scale up the supply of catalytic capital** that can help mobilize private sector capital and enable long-dated higher-risk capital flow.
- **Increase government sponsorship of research and development**, in combination with private sector capital and expertise (venture capital and private equity), to accelerate the development and commercialization of innovative technologies for a low-carbon economy.

- **Partner with corporates to help navigate the risks and opportunities** of climate change, to mobilize appropriate financing solutions, and to promote cross-sectoral initiatives.
- **Accelerate the development and scaling of a broad range of products and instruments** in both public and private markets to meet the financing, investing, hedging, market liquidity, and funding requirements of a range of market participants actively starting to transition.
- **Support development of consistent climate-related disclosures aligned with TCFD recommendations**; continue efforts to accelerate adoption of these disclosures.
- **Promote an innovation mindset in scaling climate finance**, particularly in financial innovations including financial product innovation, standardization of legal contract language and industry data models, innovation in scenario analysis and risk modeling, and tools and platforms to promote climate finance awareness and literacy.
- **Share best practices on climate risk management capabilities; as well as increase transparency of the integration of climate risk** within firms' governance, strategy planning, resource allocation, and risk adjusted performance management framework.
- **Collaborate** with standard-setting bodies, industry, policymakers, and financial regulators to **achieve consensus on a common global definition and set of principles** concerning climate finance, and **translate these into sector- and region-specific taxonomies.**



Banking & Capital Markets firms

- **Actively prioritize and accelerate their preparations for a low-carbon future**, embedding this as a strategic imperative for their boards and senior management.
- **Explore proactive steps to further support their transition**, through internal carbon pricing mechanism where material, engagement with boards and shareholders to discuss and balance short-term return expectations vs. long-term business strategy, elevation of climate risk management in their organizations, and data practices in partnership with their financial services providers.
- **Accelerate the development and alignment of sector- and region-specific transition pathways** to achieve Paris Agreement climate goals, in close collaboration with their industry associations, the scientific community, standard-setting bodies, financial institutions, and governments.
- **Support development of consistent climate-related disclosures aligned with TCFD recommendations**; continue efforts to accelerate adoption of these disclosures.



Corporates

Coordinated action needed from all stakeholders (2/2)

Recommendations by market participant

- **Mandate disclosures for corporate-specific financially material, decision-relevant data** relating to climate-related risks and opportunities.
- **Encourage the development of new climate finance products and solutions** and holistically assess any current regulatory barriers that prevent this process.
- **Mitigate risk of market fragmentation** through increased use of ex-ante, globally consistent regulation and ex-post supervisory tools to support the development of consistent regulatory drivers, or intended barriers, aligned with the pace of climate-finance market developments, and broader change in economic policy.



Regulators



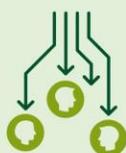
Investors
& Asset
Managers

- Continue to work toward **accelerating integration of climate factors into their investment process, including integration of climate-related risk factors into risk models and frameworks.**
- Continue to work toward **transition strategies for a Paris-aligned temperature scenario**, and **GHG reductions through engagement and stewardship** with their portfolio companies.
- Continue efforts to **accelerate adoption of disclosure frameworks.**

- **Facilitate multi-stakeholder efforts to accelerate the development and alignment of sector- and region-specific transition pathways** to achieve Paris Agreement climate goals.
- **Facilitate efforts to (1) achieve consensus on a common global definition and set of principles** concerning climate finance; and (2) **translate to sector- and region-specific taxonomies.**
- **Continue to develop consistent climate-related disclosures for financial and non-financial corporates** that are aligned with TCFD recommendations; and continue efforts to accelerate adoption of these disclosure frameworks.



Standard
setting bodies
and industry
associations¹



Market
infrastructure
& enablers²

- Technology firms: **support digital innovations that will accelerate climate finance market development** such as geospatial data providers that enhance climate risk, or Natural Language Processing (NLP) products that transform unstructured reporting and disclosures to structured decision-relevant data.
- Stock exchanges: **play an important role in driving adoption of ESG disclosures by considering the materiality of climate-related governance, performance, and activities** as part of listing requirements where appropriate to the listed corporate.
- Credit ratings agencies: **continue efforts to align on more consistent ways to integrate climate related data** into credit ratings.

- Social sector investors and funders: **scale up the supply of catalytic capital** that can help mobilize private sector capital and enable long-dated higher-risk capital flow; and **further the development of blended finance structures** in collaboration with the public sector to mobilize private sector capital toward riskier investments.
- Research organizations: **continue to play essential roles in accelerating the development and commercialization of innovative technologies** for a low-carbon economy.
- Environmental organizations: **continue to drive awareness of understanding the implications of climate change on business models and processes**—both from a transition and physical risk perspective.



Social Sector,
Research

1. Including accounting standard bodies, sustainability standard organizations, industry associations, climate science community; 2. Including technology firms, stock exchanges, credit rating agencies, and other market enablers

A \$100–150+ Trillion Investment Need—Sectoral Insights and Implications (1/3)

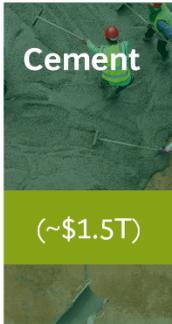
Sector	Key decarbonization levers	Key implications for climate finance
 <p>Power</p> <p>(~\$59T)</p>	<ul style="list-style-type: none"> • Increase reliance on renewables (~\$39T): high upfront capex investments for renewable energy generation • Improve grid flexibility & reliability (~\$17T): New network connections, energy storage • Invest in development of CCUS (~\$3T): for coal power plants 	<ul style="list-style-type: none"> • Significant investment across value chain from power generation to transmission and distribution • Renewable energy commercially viable in several regions today, but long-tenor, project finance structures needed to support high upfront capex needs • Need for high-risk/equity capital (e.g., in project equity or in storage solutions) • Role for the financial sector beyond capital: engaging corporates customers through Corporate Power Purchase Agreements, collaboration with the public sector for state-owned enterprises
 <p>Iron & Steel</p> <p>(~\$2.3T)</p>	<ul style="list-style-type: none"> • Increase use of recycled scrap steel (~\$0.7T): including buildout of EAF facilities • Use of natural gas as reducing agent (~\$1.0T): installation of DRI-EAF facilities • Switch to H2-based reduction (~\$0.1T): substitute fossil fuels • Retrofit plants with CCUS (~\$0.5T): R&D and installation of CCUS 	<ul style="list-style-type: none"> • Constraints in industry with limited cash flow to cover cost of capital • Financial sector support need with long-term finance structures and innovative funding options (e.g., funding initiatives with border taxes or ETS sales) • Need for substantial bridge funding to support transition while net zero emission solutions become commercially viable • Potential role for financial sector beyond capital by promoting cross-sectoral partnerships (e.g., for CCUS, H2 based reduction)
 <p>Cement</p> <p>(~\$1.5T)</p>	<ul style="list-style-type: none"> • Invest in CCUS (~\$1.1T): retrofits for existing cement plant equipment • Update plants with energy-efficient equipment (~\$0.3T): including heat recovery • Increase use of alternate fuels & binders (~\$0.1T): switch from coal as fuel, reduce clinker 	<ul style="list-style-type: none"> • Near-term focus on developing commercial-scale pilots and demonstrating product readiness for CCUS; investment contingent upon achievement of commercial viability or provision of concessionary capital (e.g., public funding) where needed • Existing players expected to primarily access debt markets to fund expansion and equipment upgrades, given mature nature of industry
 <p>Chemicals</p> <p>(~\$2.2T)</p>	<ul style="list-style-type: none"> • Improve process & energy efficiency (~\$0.2T): heat recovery, industrial efficiency • Use alternative fuel and feedstocks (~\$0.9T): electrification, green hydrogen & ammonia production • Deploy CCUS (~\$1.1T): large need expected for production of blue hydrogen, and production in Asia 	<ul style="list-style-type: none"> • Need for significant investment in early parts of chemicals value chain (~80% of emissions from extraction and refining of feedstock) • Opportunity to partner across industries such as Oil & Gas, Transport, Aviation, Steel/Iron & Shipping that are expected to be involved in clean feedstock or fuels (e.g., Green Hydrogen, Green Ammonia, etc.) • Need expected to ramp up on R&D investment for chemicals with less mature 'clean' solutions

Figure 20: Summary of sector insights (contd. on following pages)

A \$100–150+ Trillion Investment Need—Sectoral Insights and Implications (2/3)

Sector	Key decarbonization levers	Key implications for climate finance
 <p data-bbox="138 365 282 474">Light road transport</p> <p data-bbox="167 705 250 737">(~\$9T)</p>	<ul data-bbox="305 344 748 800" style="list-style-type: none"> • Develop electric vehicles (~\$3.6T): R&D, conversion, construction of factories for vehicles and components • Develop electric 2/3 wheelers (~\$0.2T): R&D, conversion, construction of factories for vehicles and components • Expand public charging infrastructure (~\$1.2T): to support growth of EVs • Mode shift to mass transit (~\$4.0T): buildout of public transportation infrastructure 	<ul data-bbox="786 344 1495 779" style="list-style-type: none"> • Strong dependency on public sector interventions to accelerate EV adoption - (e.g., taxes, fiscal incentives) • Opportunity to connect corporates across sectors for partnerships in charging infrastructure (e.g., Oil & Gas and vehicle manufacturers) • Strong corporate commitments for EV transition provide opportunity to drive EV adoption • Key to enable sustainable battery industry scale-up to support the EV transition: including policy frameworks to reduce investment risks, funding of sustainable battery manufacturing • PPPs expected to be key to catalyze private investment in public transport infrastructure
 <p data-bbox="138 875 282 984">Heavy road transport</p> <p data-bbox="167 1251 250 1283">(~\$32T)</p>	<ul data-bbox="305 854 748 1346" style="list-style-type: none"> • Develop & deploy battery electric commercial vehicles (~\$17.5T): largely for lighter and shorter-distance applications • Develop & deploy hydrogen fuel-cell electric commercial vehicles (~\$12.6T): R&D, conversion, construction of factories, purchase of vehicles • Produce hydrogen and build refueling infrastructure (~\$1.8T): as fuel for hydrogen fuel-cell vehicles • Use of biofuels & synthetic fuels (~\$0.2T): as substitutes for fossil fuels in ICE vehicles 	<ul data-bbox="786 854 1495 1346" style="list-style-type: none"> • Strong need for public sector interventions & engagement to accelerate uptake of low-carbon powertrains and fuels (e.g., ban on ICE vehicles, subsidies, blended finance, fuel taxes etc.) • Opportunity to connect corporates across sectors for partnerships for investment in hydrogen refueling infrastructure (e.g., Oil & Gas and CV manufacturers) • Opportunity to finance expansion of corporate electric LCV fleets in the near future as logistical players (Amazon, DHL, FedEx, etc.) have made pledges • Opportunities to support buildout of green hydrogen sector as a cross-sectoral lever • Significant portion of trucking companies are private leading to challenges in emission disclosures and lowering the motivation to decarbonize
 <p data-bbox="138 1421 282 1453">Aviation</p> <p data-bbox="167 1839 250 1871">(~\$5.1T)</p>	<ul data-bbox="305 1400 748 1692" style="list-style-type: none"> • Improve fleet efficiency (~\$0.2T): through retrofits • Use Sustainable Aviation Fuels (~\$0.9T): to replace fossil fuel as low-carbon alternative • Deploy next-gen propulsion technologies (~\$4.0T): including use of open-rotor, hybrid-electric, hydrogen, etc. 	<ul data-bbox="786 1400 1495 1938" style="list-style-type: none"> • Key to have measurable efficiency thresholds for fleet efficiency improvements for new aircraft and retrofits • Sustainable aviation fuels (SAF): opportunity for financial sector to leverage customer relationships across sectors to scale and de-risk capex investments (e.g., across fuel value chain including Agriculture, Chemicals, Power, and Oil & Gas sectors) • Offtake contracts between supplier of feedstock, SAF producers, and consumers important for scale • Important role for the public sector to ensure high safety standards around use of SAFs • Critical need for governments subsidies, carbon pricing, etc. to improve SAF economics • Accelerated decarbonization through incorporation of emissions criteria and targets by governments in COVID-19 relief packages for aviation sector

A \$100–150+ Trillion Investment Need—Sectoral Insights and Implications (3/3)

Sector	Key decarbonization levers	Key implications for climate finance
 <p>Shipping</p> <p>(~\$2.4T)</p>	<ul style="list-style-type: none"> • Improve ship efficiency (~\$0.6T): technologies related to drag reduction, exhaust treatment, etc. • Improve operational efficiency (~\$0.1T): digital solutions to optimize route and speed, ship performance • Use of low-carbon fuel alternatives (~\$1.7T): engines using clean fuel such as e-ammonia, and investment in land-based infrastructure for production and storage 	<ul style="list-style-type: none"> • Operational and ship efficiency viable in short-term: finance enabled by measurable efficiency thresholds • Opportunities in optimizing chartering contracts between operator and owners through benefit sharing • Partnerships across the value chain important for alternative fuel development; opportunity for financial sector to leverage relationships across sectors • Critical role for governments in making e-fuels viable • Significant need for bilateral lending given private ownership with limited access to capital markets • Need to scale use of Poseidon Principles and integrate climate consideration into lending decision; critical since private ownership limits disclosure • PPPs and blended finance expected to be important and gaining traction
 <p>Agriculture</p> <p>(~\$1.9T)</p>	<ul style="list-style-type: none"> • Shift diets towards plant-based and cultured meat (~\$1.3T): will require driving change in consumer behavior • Improve manure management (~\$0.5T): through infrastructure such as anaerobic digesters (AD) • Adopt regenerative farming practice (~\$0.1T): for investment in no-till farming equipment 	<ul style="list-style-type: none"> • Strong need for public sector capital and policy incentives to support farmers in transition • Potential role for financial institutions in supporting/financing through partnerships (e.g., with equipment suppliers, F&B companies, multilaterals, microfinance and mobile finance services, local intermediaries & governments) • Innovative structures such as cluster financing (e.g., for pooling of multiple AD deployments with lease/PPA)—cross-sectoral potential (e.g., with solar companies) • Engagement with both landowners and operators to drive regenerative practices, given split-incentives • Measurement of carbon challenging and likely to need technological innovation • Significant potential for capital markets activity in emerging alternative meat industry (e.g., through acquisitions, JVs, new entrants)
 <p>Buildings</p> <p>(~\$6.1T + ~\$4.6T for retail residential)</p>	<ul style="list-style-type: none"> • Increase efficiency of electric equipment (~\$3.8T) • Reduce heating/cooling energy demand (~\$1.5T): through building design & retrofits • Replace and electrify conventional heating (~\$0.7T): with efficient and electric alternatives • Develop system-level district heating & cooling (~\$0.1T) • Shift to efficient cooking technologies (<\$0.1T) 	<ul style="list-style-type: none"> • Finance for R&D for higher-performing, cost-effective heating technology (e.g., cold climate heat pumps) • Important for public sector to encourage accelerated adoption through programs/incentives • Need for engagement with private equity, pension funds, and REITs given high ownership levels • Collaboration between real estate community and policymakers on standards integrating emissions • Cross-sectoral efforts across industrial, power, and buildings for co-generation and waste heat utilization • Effort needed to drive technology adoption, e.g., through policies, product standards and labelling programs, education, etc.

Annex: Glossary, Market Sizing Methodology, and Assumptions

Glossary of terms used in the report

Banking and Capital Markets sector: Specific to "sell side" firms and does not include insurance and asset-management companies.

blended finance: Use of catalytic capital from public sector or philanthropic sources to increase private sector investment in sustainable development.

blue hydrogen: Hydrogen produced using natural gas, employing CCUS technology to capture resulting CO₂ emissions.

catalytic capital: Debt, equity, guarantees, and other investments that accept disproportionate risk and/or concessionary returns relative to a conventional investment in order to generate positive impact and enable third-party investment that otherwise would not be possible.

CCUS: Carbon capture, utilization, and storage. This technology enables the capture of CO₂ emissions from industrial processes and the permanent storage of the captured carbon and/or reuse for other products (e.g., alternative fuels).

climate finance: Financing that supports the transition to a climate-resilient economy by enabling mitigation actions, especially the reduction of GHG emissions, and adaptation initiatives promoting the climate resilience of infrastructure as well as generally of social and economic assets.

climate-aligned finance: Financing that enables actions that mitigate climate change (especially the reduction of GHG emissions) and aligns financing with climate goals.

corporates: Non-financial companies.

financial services sector: The entirety of the financial services industry, including banks, asset managers, insurance companies, financial market utilities, etc.

GHG: Greenhouse gas.

green hydrogen: Hydrogen produced using electrolysis of water, powered by renewable electricity.

interviewees: Individuals at firms interviewed for this report.

Paris Agreement: The Paris Agreement's central aim is to strengthen the global response to the threat of climate change by keeping global temperature rise this century to well below 2 degrees

Celsius above pre-industrial levels, and to pursue efforts to limit the temperature increase even further to 1.5 degrees Celsius. The Paris Agreement opened for signature on April 22, 2016.

public sector: Governments, multilateral organizations, and development finance institutions.

regulators: Prudential, market, and conduct regulators (not including self-regulatory bodies).

scope-1 Emissions: Direct emissions from owned or controlled sources.

scope-2 Emissions: Indirect emissions from the generation of purchased electricity, steam, heating, and cooling consumed by the reporting company.

scope-3 Emissions: All other indirect emissions that occur across a company's value chain.

social sector: Philanthropic donors, civil society and other Non-Governmental Organizations (NGOs).

standard-setting bodies: Supranational or national bodies that establish guidelines, principles, or standards (e.g., Basel Committee, IOSCO, SASB).

Methodology and purpose for market sizing

The purpose of this market sizing effort is to provide more granular estimates of the amounts of different types of capital that are needed, by sector and asset class. In doing so, these estimates can enable policy makers, regulators, and other market actors to prioritize their strategies to grow specific market segments where the opportunities for both climate impact and commercial opportunity are greatest.

This market sizing estimates the type of capital needed to finance specific types of decarbonization levers, across different sectors. This includes:

- **Estimation of investment needs by lever:** Where available, existing industry reports (e.g., IEA, IRENA) were leveraged to collect investment estimates; wherever these were unavailable, the investment need was estimated using BCG insights and analysis, in particular to estimate the lever-level and region-level breakdowns of the investments. Further, each lever was tagged to the industry that is likely to be involved in making that specific investment.
- **Capital structure of sectors:** In order to translate the investment needs to asset classes, the first step was to understand the capital structure of the industry today. The analysis looks at the industry involved for each decarbonization lever, and not just for the overall sector. The

analysis uses the FY 2019 capital structure of publicly listed companies in each region. Note that the dataset for equity looks at book value and includes retained earnings.

- **Translation of investment need to capital sources:** For each sector, the analysis translates the investment need, by decarbonization lever, to a mix of bonds, loans, and equity. The current view of capital structure by industry is used as a starting point. This is modified based on estimates of the proportion of investment, for each decarbonization lever, that would require new entrants—versus being borne by existing players—based on research and conversations with sector experts.
 - For the proportion of investments attributed to existing players, the allocation is first done between debt and equity based on capital flow mix (sourced from Refinitiv; debt issuances includes bond issuances and syndicated lending). Further the debt mix is disaggregated into bonds versus loans based on the capital structure of the industry.
 - For the proportion attributed to new entrants, the allocation is done between equity, loans, and bonds based on the capital structure of the industry.

The estimates are created at a regional and lever level to capture nuances in market maturity, access to public markets, commercial readiness of the solutions, and relevance of new entrants. Further, a triangulation has been done to calculate the impact of these estimated issuances over the next three decades on the leverage ratios of the industry. If the debt-to-equity ratios change significantly, original allocations have been re-assessed at the lever level to maintain reasonable changes in leverage ratios.

Details on methodology used for sizing investment need to decarbonize each sector

For all sectors

Methodology to determine asset class allocation

For new entrants, it was assumed that the funding structure resembles the current capital structure of incumbent players. For incumbent players, it was assumed that they primarily access debt markets for funding as opposed to new rights issues. The proportion of equity issuance for existing players was based on the 2017–2019 cumulative volumes for Syndicated Lending, DCM and ECM in each region for the respective sectors (i.e., the contribution of equity to total regional issuances). The offsetting adjustment to debt was applied proportionally to loans and bonds based on their capital structure today.

Power

Methodology to estimate total global investment need

Global investment need was estimated by leveraging estimates from the IEA and IRENA to inform an accelerated scenario in which ~90 percent of electricity is powered by renewable and nuclear sources by 2050.

Methodology to estimate regional capex need

The IEA and IRENA estimates included estimates by region. The regional capex need for Middle East includes North Africa.

Methodology to determine asset class allocation

It was assumed that three industries will be involved in capital expenditure: renewable electricity, electric utilities, and conventional fossil-fuel companies (in the case of CCUS). The capital structure of each peer set in each region was averaged for year-end 2019 using reported data for all publicly listed companies as reported through CapIQ. In total, more than 1,500 companies across sectors informed the analysis.

Sources and references

International Energy Agency (IEA): Energy Technology Perspectives 2020; Energy Technology Perspectives 2017; World Energy Outlook 2020; World Energy Outlook 2019; World Energy Investment 2020; World Energy Investment 2019; International Renewable Energy Agency (IRENA): Global Renewables Outlook 2020; Investment Needs for a Low-Carbon Energy System 2017; Energy

Transitions Commission (ETC): Mission Possible 2020; Bloomberg New Energy Finance (BNEF): New Energy Outlook 2019; CapIQ (Capital IQ); BCG Analysis.

Iron & Steel

Methodology to estimate total global investment need

The annual global steel production needed to meet the IEA's sustainable development scenario (SDS), by production route, was estimated in the 2020 IEA Energy Technology Perspective and the 2020 IEA Iron and Steel Technology Roadmap. To determine global steel production by process route that is needed to achieve net zero emissions by 2050, the production route mix for SDS 2070 was used for our 2050 estimation.

Additionally, the following assumptions were made. First, technology that is expected to see a decrease in use for steel production by 2050, such as BF-BOF and SR-BOF, will not require further investment and therefore was excluded. Second, BF-BOF with CCUS will only require retrofitting of current BF-BOF technology. Third, SR-BOF with CCUS and DRI-EAF with CCUS will require investment in SR-BOF or DRI-EAF in addition to the cost of retrofitting due to minimal steel production through SR-BOF and DRI-EAF processes today.

Methodology to determine regional investment need

The SDS 2050 production process mix was estimated for each major steel-producing region in the 2020 IEA Iron & Steel Technology Roadmap (incl. United States, European Union, China, India, Middle East).

Methodology to determine asset class allocation

It was assumed that two core industries will be involved in capital expenditure: Iron and Steel; and Oil, Gas, and Consumable Fuel. The capital structure of each sector peer set within each region was averaged for year-end 2019 using reported data for all publicly listed companies as reported through CapIQ.

Sources and references

European Environment Agency (EEA); Edgar 5.0 GHG inventory, European Commission; World Resources Institute CAIT-database; International Energy Agency (IEA); Food and Agriculture organization of the UN (FAO); CAIT; IEA; ETC Mission Possible Report 2018; IEA Energy Technology Perspective 2020; World Steel Organization; IEA Iron and Steel Technology Roadmap 2020; CapIQ; BCG Analysis.

Cement

Methodology to estimate total global investment need

The global investment need was estimated by leveraging estimates from the IEA Cement Technology Roadmap with overlaid assumptions to increase CCUS capture rate (>60 percent) and include the cost of transport and storage for CCUS.

Methodology to estimate regional capex need

The investment need was allocated to each region based on its relative contribution to the global emissions levels.

Methodology to determine asset class allocation

It was assumed that the cement industry will be involved in capital expenditure. The capital structure of each peer set in each region was averaged for year-end 2019 using reported data for all publicly listed companies as reported through CapIQ. In total, more than 250 companies informed the analysis.

Sources and references

International Energy Agency (IEA): Energy Technology Perspectives 2020; Energy Technology Perspectives 2017; World Energy Outlook 2020; World Energy Outlook 2019; Cement Technology Roadmap; Transforming Industry through CCUS; CCUS in Clean Energy Transitions; International Renewable Energy Agency (IRENA): Investment Needs for a Low-Carbon Energy System; Energy Transitions Commission (ETC): Mission Possible 2020; Missing Possible Cement; Material Economics: Industrial Transformation to 2050; Global CCS Institute: Is CCS expensive? 2020; Global costs of carbon capture and storage 2017; Chatham House: Making Concrete Change 2018; CapIQ; BCG Analysis.

Chemicals

Methodology to estimate total global investment need

The total expected production of major petrochemicals and hydrogen was based on the expected production and capital expenditure per lever. Input from experts along with industry and scientific reports were leveraged to develop these estimates; analysis was performed by chemical type for a selection of chemicals that contribute the majority of emissions (ammonia, hydrogen, methanol, ethylene and propylene, nitric acid, and others).

Methodology to estimate regional investment need

The regional investment need for the remaining levers was based on regional production and demand statistics. It was assumed that the regional investment breakdown is based on where production is expected to be most concentrated.

Methodology to determine asset class allocation

It was assumed that only the Chemicals sector will be involved in capital expenditure. The capital structure of each peer set in each region was averaged for year-end 2019 using reported data for all publicly listed companies as reported through CapIQ.

Sources and references

European Environment Agency (EEA); Edgar 5.0 GHG inventory, European Commission; World Resources Institute CAIT-database; International Energy Agency (IEA); Food and Agriculture organization of the UN (FAO); IEA: Tech Perspectives 2020 Report, Future of Hydrogen report, IEA 2020 Report, Heavy Industry Report 2019; World Economic Forum article written by CTO of BASF (2020); Science Based Targets (2018); European Commission Industry Decarbonization report 2018; IHS Markit Chemical fact pages; Ammonia Industry (independent consultancy); Methanol Case studies; Italian Association of Chemical Engineering; University of Oxford study; International Journal of GHG; Bloomberg news; Merchant Research and Consulting; Sandia National Laboratories: Global Hydrogen Resource Analysis; IHS Chemical Bulletin: The changing face of the global methanol industry; IHS Markit: Global Propylene Market Motivated to Change; IHS Markit: Ethylene – Global; IHS Markit: Chemical Economics Handbook; BCG analysis.

Light Road Transport

Methodology to estimate total global investment need

Development and production of battery electric light duty vehicles (excl. 2/3 wheelers): The investment in development and production of BEVs was based on IHS Markit data. Only light vehicles exclusively used for the transport of passengers were considered, whereas vehicles used for the transport of goods were considered in the Heavy Road Transport sector. BEV sales were estimated over the period 2020–2050 for the European, Chinese, and U.S. regions. It was assumed that starting in 2035 (Europe) and 2040 (China and U.S.), exclusively BEVs will be sold and proportional sales of BEVs are assumed to grow linearly toward the end state. Regional sales figures were scaled based on OICA and ACEA LV sales statistics to determine BEVs sales for the regions Asia, Europe, North America, and Rest of World. Long-term list prices were estimated based on the Energy Transitions Commission estimate, and a fixed percentage rate was assumed to

estimate capex related to the development and production of battery electric LVs and their related components.

Expansion of public electric-charging infrastructure: The investment in public electric charging infrastructure was based on estimates from the Energy Transition Commission. It was assumed that the investment need for public fast and slow charging will be borne by industries. Private charging is assumed to be financed by consumers. The breakdown of public versus private charging infrastructure capex is based on the weighted average cost of installed private and public chargers. The ratio of chargers/EV is based on 2030 estimates from IEA, whereas cost assumptions were taken from ICCT.

Mode shift to mass transit: The investment in public transports was based on estimates from Coalition for Urban Transitions.

Development and production of battery electric 2/3 wheelers: The investment in the development and production of electric 2/3 wheelers was based on IEA estimates regarding total sales of battery electric 2/3 wheelers in 2019 and 2030 (as per SDS scenario). Sales were assumed to linearly grow over period 2019–2030, with similar growth rate until 2050 (market primarily concentrated in emerging markets, hence no tapering of CAGR was assumed). Lastly, sales were multiplied by an average list price, and a fixed percentage was applied to capture capex related to the development and production of battery electric LVs and their related components.

Methodology to estimate regional investment need

Expansion of public electric charging infrastructure: Regional investment was based on the calculated regional battery electric LV fleet in 2050, based on data from IHS Markit. The regional useful life of BEVs was obtained from the IEA. Lastly, region fleet sizes in Europe, U.S., and China were scaled based OICA and IEA LV sales statistics to determine the fleet size in North America, Asia, and Rest of World.

Mode shift to mass transit: Regional investment was estimated based on the UN's forecasted urban population in 2050.

Development and production of battery electric 2/3 wheelers: Regional investment was based on a 2018 regional market share breakdown of the global electric two-wheeler market, as per estimates from Market Research Future. The regional investment need for Asia includes Oceania and excludes the Middle East.

Methodology to determine asset class allocation

It was assumed that three industries will be involved in capital expenditure: Auto and component manufacturers, Railroad, and Oil, Gas, and Consumable Fuels. The capital structure of each peer set in each region was averaged for year-end 2019 using reported data for all publicly listed companies as reported through CapIQ. In total, more than 1,000 companies across sectors informed the Light Road Transport sector analysis.

Sources and references

European Environment Agency (EEA); Edgar 5.0 GHG inventory, European Commission; World Resources Institute CAIT-database; International Energy Agency (IEA); Food and Agriculture organization of the UN (FAO); IEA: Energy Technology Perspectives 2020; IHS Markit; IEA: World Energy Investment 2020; OICA: 2019 passenger car sales statistic; Energy Transitions Commission: Making Mission Possible: Delivering a Net-Zero Economy (2020); IEA: Global EV Outlook 2020; IEA: Global EV Outlook 2019; ICCT: Estimating electric vehicle charging infrastructure costs across major U.S. metropolitan areas; Coalition for Urban Transitions: Climate Emergency: Urban Opportunity; Market Research Future: Global Electric Two-Wheeler Market Research Report (2020); watev2buy; evobsession; Gasgoo AutoNews; Cleantecnica; SinaAuto; Xinhuanews; Yiche; ifeng; Market Research Future: Global Electric Three-Wheeler Market Research Report (2020); CapIQ; BCG Analysis.

Heavy Road Transport

Methodology to estimate total global investment need

Development and production of battery electric commercial vehicles: The estimation of investment in the development and production of BEVs was based on data from IHS Markit. The analysis only includes trucks used for goods transport. Hence, pure off-highway vehicles (agriculture, construction, etc.), buses, cars, and light commercial vehicles not used for the transport of goods were out of scope. Total BEVs sales were estimated for the regions of Europe, China, and U.S. It was assumed that starting in 2035 (Europe) and 2040 (China and U.S.) exclusively BEVs and fuel cell electric commercial vehicles (FCEVs) will be sold, with yearly proportions assumed to grown linearly toward end state. Regional sales volumes in China, U.S., and Europe were scaled based OICA and ACEA CV production statistics to determine BEV sales in the regions Asia, Europe, North America, and Rest of World. Lastly, regional sales were multiplied by a long-term list price, and a fixed percentage was applied to capture investments related to the development and production of BEVs and their related components.

Purchase of battery electric commercial vehicles: The investment in the purchase of BEVs was assumed to equal the sales value of BEVs.

Development and production of fuel cell electric commercial vehicles: The investment in the development and production of FCEVs was based on the same methodology and assumptions used for the lever "Development and production of battery electric commercial vehicles."

Purchase of fuel cell electric commercial vehicles: The investment in the purchase of FCEVs was assumed to equal the sales value of fuel cell electric CVs.

Production of clean hydrogen to meet industry decarbonization demand: The investment in the production of clean hydrogen was based on expected production volume of blue or green H₂ demanded by the Heavy Road Transport sector, as per IEA 2020 Technology perspectives.

Expansion of hydrogen refueling station infrastructure: The investment in hydrogen refueling stations was based on the calculated regional fleet size of FCEV CVs. Sales estimates were based on data from IHS Markit. The regional useful life of FCEVs was based on internal estimates. Fleet sizes for Europe, China, and U.S. were scaled based on ACEA and OICA regional CV production statistics to determine total fleet sizes for Europe, Asia, North America, and Rest of World. Estimates about the cost and ratio of large refueling stations per FCEV were obtained from the Hydrogen Council. Moreover, estimates around HRS useful life were sourced from NREL.

Use of biofuels and synthetic fuels: The investment related to biofuels and synthetic fuels was based on total demand for biofuel and synthetic fuels in 2050, which was assumed to equal the IEA projected demand in 2070 in the Sustainable Development Scenario, to estimate a 1.5C pathway. Economics of HEFA production plants were assumed as per ICCT and ESU Services estimates; for synthetic fuels, estimates were used from the Royal Society. Moreover, an exchange rate of \$1.2 per €1 and a 30-year lifetime for a synthetic fuel production facility, similar as for biofuels, were assumed.

Methodology to estimate regional investment need

The regional investment need for biofuels and synthetic fuel was based on relative size of the regional fleets with internal combustion engines in 2040 (considered in IHS Markit data).

The regional investment need for Asia includes Oceania and excludes the Middle East.

Methodology to determine asset class allocation

It was assumed that four industries will be involved in capital expenditure: Auto and Components (excluding motorcycles); Trucking; Oil, Gas, and Consumable Fuels; and Chemicals. The capital structure of each peer set in each region was averaged for year-end 2019 using reported data for all publicly listed companies as reported through CapIQ. In total, more than 1,000 companies across sectors informed the Heavy Road Transport sector analysis.

Sources and references

European Environment Agency (EEA); Edgar 5.0 GHG inventory, European Commission; World Resources Institute CAIT-database; International Energy Agency (IEA); Food and Agriculture organization of the UN (FAO); IEA: Energy Technology Perspectives 2020 IHS Markit; ACEA: World commercial vehicle production; OICA: 2019 production statistics; Hydrogen Council: Hydrogen scaling up: A sustainable pathway for the global energy transition (2017); National Renewable Energy Laboratory: Hydrogen Station Cost Estimate: Comparing Hydrogen Station Cost Calculator Results with other Recent Estimates; IEA: Energy Technology Perspectives 2020; ICCT: The cost of supporting alternative jet fuels in the European Union; The Royal Society: Sustainable synthetic carbon based fuels for transport; ESU – Services: Life cycle inventories of oil refinery processing and products; CapIQ; Statista: Global plug-in electric vehicle market share between January and June 2020, by main producer; BCG analysis.

Aviation

Methodology to estimate total global investment need

Improve efficiency of fleet: The investment in fleet efficiency improvement was split in two parts: fleet renewal and technology retrofits. Regarding fleet renewal, aircraft were categorized in four classes: regional, small, medium, and large. For the category regional, global aircraft deliveries over the period of 2020–2030 were estimated and the deliveries were proportionally scaled for the period 2031–2050. Small, medium, and large global aircraft deliveries were estimated by Airbus for the period 2020–2038. The deliveries per category for the period of 2039–2050 were proportionally scaled. For all aircraft classes, the price per aircraft was assumed at current market prices, and a discount was assumed for all aircraft purchases to reflect actual prices paid by airlines.

Regarding technology retrofits, investment was sized based on estimates from experts regarding retrofits related to airframe aerodynamics, airframe weight, re-engine, advanced aerodynamics, and advanced materials. Moreover, an assumption was made on total spending on decarbonization retrofits as a percentage of original equipment purchase value.

Use of sustainable aviation fuels: The investment in biofuels and synthetic fuels was based on total demand in 2050, which was assumed to equal the IEA estimates in 2050 (SDS scenario). For biofuels, cost and capacity of facilities were based on estimates from ICCT and ESU Services. For synthetic fuels, cost estimates per facility were as per the Royal Society. Moreover, an exchange rate of \$1.2 per €1 and a 30-year lifetime for a synthetic and biofuel fuel production facility was assumed as per ICCT and ESU-Services estimates.

Deployment of aircraft with next-generation propulsion technologies: The investment in aircraft with next-generation propulsion technologies considers four technologies: open rotors, hybrid electric, full electric, and hydrogen combustion engines. The total number of aircraft deliveries for the period of 2030–2050 was estimated. Moreover, breakdown of deliveries per aircraft class was estimated (e.g., percentage of wide-bodies). Current weighted average list prices of wide-body, narrow-body, and regional jets was assumed, and a discount was applied to reflect typical market practice.

Methodology to estimate regional investment need

For all levers, the same methodology was applied to calculate the regional Investment. Global investment need was allocated by region based on forecasted passenger and freight traffic in 2035. IATA world scheduled passenger and freight traffic by region of airline domicile in 2019 was used as a starting point, and forecasts of long-term CAGRs for passenger traffic per region were used to determine the percentage of global traffic per region in 2035. The regional investment need for North America excludes Mexico. The regional investment need for Asia includes Oceania and excludes the Middle East.

Methodology to determine asset class allocation

It was assumed that two industries will be involved in capital expenditure: Airlines; and Oil, Gas, and Consumable fuels. The capital structure of each peer set in each region was averaged for year-end 2019 using reported data for all publicly listed companies as reported through CapIQ. In total, more than 1,000 companies across sectors informed the Aviation sector analysis.

Sources and references

European Environment Agency (EEA); Edgar 5.0 GHG inventory, European Commission; World Resources Institute CAIT-database; International Energy Agency (IEA); Food and Agriculture organization of the UN (FAO); ICCT: CO₂ emissions from commercial aviation: 2013, 2018, and 2019; Oliver Wyman: Bigger fleet. Bigger Challenges (2020); Airbus: Global Market Forecast (GMF) for 2019–2038; IEA: Energy Technology Perspectives (2020); ICCT: The cost of supporting alternative jet fuels in the European Union; The Royal Society: Sustainable synthetic carbon based fuels for transport; ESU – Services: Life cycle inventories of oil refinery processing and products; Airbus:

AIRBUS AIRCRAFT 2018 AVERAGE LIST PRICES; IATA WATS+ World Air Transport Statistics (2019); IATA Air Passenger Forecast Global Report (April 2020); CapIQ; NIB: The Green Hydrogen Economy in the Northern Netherlands; BCG Analysis.

Shipping

Methodology to estimate total global investment need

Improve operational efficiency: The investment in operational efficiency was based on BCG estimates of the total global market for digital solutions in shipping. For the period of 2020–2027, a growth rate was assumed as per estimates from Transparency Market Research. For the period of 2027–2050, the market was assumed to grow at a fixed percentage annually.

Improve ship efficiency: The investment in ship efficiency-related technologies was based on BCG estimates of the market size and growth rate (stable versus positive) of individual ship efficiency technologies. Stable and positive technologies were assumed to grow at different rates as per BCG estimates over the period of 2020–2050. Moreover, as several technologies are still relatively new/growing concepts, it was assumed that a selection will only be available in 2025. Lastly, market size of exhaust treatment technologies were assumed to linearly decrease to 0 by 2050 starting from 2030 as hydrogen-/ammonia-powered ships are assumed to enter into operation.

Use of fuel alternatives: The investment in alternative fuels for shipping was based on UMAS estimates related to decarbonizing shipping by 2050.

Methodology to estimate regional capex need

For the levers "Improve operational efficiency" and "Improve ship efficiency," regional investment need was based on the share of the world merchant fleet value by region of beneficial ownership in 2019, provided by UNCTAD. For the lever "Use of fuel alternatives," regional investment need was based on forecasted bunkering demand per region as per estimates from the Platts report and the global bunkering fuel consumption market report from LPI. The regional investment need for Asia fuel alternatives includes Oceania and excludes the Middle East.

Methodology to determine asset class allocation

It was assumed that four industries will be involved in capital expenditure: Marine Freight Transport; Oil, Gas, and Consumable fuels; Chemicals; and Electric Utilities (exclusively in the European market). The capital structure of each peer set in each region was averaged for year-end 2019 using reported data for all publicly listed companies as reported through CapIQ. In total, more than 1,000 companies across sectors informed the Shipping sector analysis.

Sources and references

European Environment Agency (EEA); Edgar 5.0 GHG inventory, European Commission; World Resources Institute CAIT-database; International Energy Agency (IEA); Food and Agriculture organization of the UN (FAO); ICCT: Greenhouse Gas Emissions From Global Shipping, 2013–2015; BCG Analysis; Hellenics Shipping News: Shipping industry to expand digital transformation with \$38.4 billion investment; OECD: Looking to 2060: Long-term global growth prospects - Bloomberg Brief; UMAS: Aggregate investment for the decarbonisation of the shipping industry; Global Maritime Forum: The scale of investment needed to decarbonize international shipping; UNCTAD; Clarkson Research Platts report (2019); Global Bunker Fuel Consumption Market Report LPI; CapIQ; BCG Analysis.

Agriculture

Methodology to estimate total global investment need

Dietary shift from animal meat to plant-based and cultured meat: The investment was estimated based on expectations for total meat industry investment need through 2050 and an assumption that 30 percent of the market share would belong to alternative meat producers (IPCC).

Adopt regenerative agriculture, specifically no till farming: The investment was estimated based on inputs from scientific publications on adoption rates for no-till farming, equipment investment cost, and amount of impacted cropland.

Improve manure management: The investment was estimated based on inputs from scientific publications on the number of livestock and technology costs (e.g., anaerobic digester).

Methodology to estimate regional investment need

The investment need was allocated to each region based on its number and size of farms, agricultural area, and quantity of livestock. However, for no till farming, the analysis takes into consideration the current adoption rate of regenerative agriculture practices in order to assess the potential of adoption for each region. The regional investment need for Asia excludes the Middle East. The regional investment need for Europe no till farming excludes Eastern Europe.

Methodology to determine asset class allocation

The allocation of asset classes for alternative meats was done assuming the industry evolves to a capital structure similar to the food processing industry. For the other levers, a significant role of loan financing was assumed for the purchase of equipment by farmers. This assumption should be

further evolved in case new business models emerge at scale for manure management and no-till farming.

Sources and references

European Environment Agency (EEA); Edgar 5.0 GHG inventory, European Commission; World Resources Institute CAIT-database; International Energy Agency (IEA); Food and Agriculture organization of the UN (FAO); IPCC: Special Report on climate change, desertification, land degradation, sustainable land management, food security, and greenhouse gas fluxes in terrestrial ecosystems; IPCC report, 2019; The Importance of Reducing Animal Product Consumption and Wasted Food in Mitigating Catastrophic Climate Change (2015); Crijns-Graus et al., “Marginal greenhouse gas abatement curves”; Frank et al., “Structural change as a key”; Benjamin J. DeAngelo et al., “Methane and nitrous oxide mitigation in agriculture”; International Association for Energy Economics, 2006, Volume 27, pp. 89–108, jstor.org; Reducing the environmental impact of methane emissions from dairy farms by anaerobic digestion of cattle waste (2011); "To what extent can zero tillage lead to a reduction in greenhouse gas emissions from temperate soils?" Scientific Reports, April 4, 2014, Volume 4, nature.com; FAO publication, Overview of the Worldwide Spread of Conservation Agriculture; CapIQ; BCG Analysis.

Buildings

Methodology to estimate total global investment need

The additional global investment need for the Building sector to meet the 2°C scenario (2DS) was estimated in the IEA Transition to Sustainable Buildings Roadmap. The investment need was scaled with the use of a scenario multiplier to account for a more aggressive scenario in which temperature rise is held below 2 degrees (B2DS). The scenario multiplier was calculated by dividing the total additional investment need for the B2DS by the total additional investment need for the 2DS, which were each estimated in the 2017 IEA Energy Technology Perspectives (note: the B2DS achieves net zero emissions by 2060; therefore, to determine the investment needed to achieve net zero emissions by 2050, the B2DS 2060 investment values were used for 2050). The global investment need was broken down across levers in both the residential and commercial sub-sectors in the IEA Transition to Sustainable Buildings Roadmap (note: The residential sub-sector refers to all private dwellings, including apartments and houses, while the commercial sub-sector includes all buildings related to services, education, health, hospitality, public and other non-residential sectors but excludes industrial premises). The investment need for space and water heating was broken down across the conventional heating lever and the district heating lever was based on the heating equipment sales share in the SDS, estimated in the 2020 IEA Energy Technology Perspectives (note: The SDS achieves net zero emissions by 2070. To determine heating

equipment sales share by process that is needed to achieve net zero emissions by 2050, the equipment sales share for SDS 2070 was used for 2050 estimation).

Methodology to determine regional capex need

The regional investment need was calculated with the energy estimated to be saved by end use in each region in the 2DS relative to baseline in the IEA Transition to Sustainable Buildings Roadmap. Regions analyzed include United States, European Union, China, and India. To determine the investment need for North America, Europe, and Asia, a regional multiplier was applied to the investments calculated for each country analyzed. The regional multiplier was calculated by dividing the annual energy consumption of North America, Europe, and Asia by the energy consumption of buildings in each analyzed country, which was estimated in the IEA Transition to Sustainable Buildings Roadmap. The regional capex need for Asia includes Oceania.

Methodology to determine asset class allocation

It was assumed that several industries will be involved in capital expenditure for commercial real estate: Private equity funds, pension funds, commercial REITS, real estate development, retailing, industrials, hotels, restaurants & leisure, health care, and total market (entire universe of public companies). It was assumed that the capital expenditure for residential real estate would be similar to the residential REITs industry. The capital structure of each peer set in each region was averaged for year-end 2019 using reported data for all publicly listed companies as reported through CapIQ. In total, more than 1,000 companies across sectors informed the Buildings sector analysis.

Sources and references

European Environment Agency (EEA); Edgar 5.0 GHG inventory, European Commission; World Resources Institute CAIT-database; International Energy Agency (IEA); Food and Agriculture organization of the UN (FAO); CAIT; IEA; ETC; IEA Transition to Sustainable Buildings Roadmap; IEA Energy Technology perspectives 2017; CapIQ; NAREIT; NCREIF; RCA; National Association of Realtors; RERC: Expectations & Market Realities in Real Estate 2020; National Association of Realtors: Commercial Lending Report (2019); NREV; EPRA: Real Estate in the Real Economy (2018); KPMG: Property Lending Barometer 2020; Bank of International Settlements: Cross-border commercial real estate investment in Asia-Pacific; PERE News; Federal Reserve of St. Louis: Homeownership Rate for the United States; Trading Economics; India 2011 Census; BPS Statistics Indonesia; BCG Analysis.

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Sizing the Global Need and Defining
the Market Structure to Mobilize Capital

