

WORLD BANK OUTLOOK

# 2050

STRATEGIC DIRECTIONS NOTE

Supporting Countries to Meet  
Long-Term Goals of Decarbonization



© 2020 International Bank for Reconstruction and Development / The World Bank

1818 H Street NW, Washington DC 20433

Telephone: 202-473-1000

Internet: [www.worldbank.org](http://www.worldbank.org)

This work is a product of the staff of The World Bank with external contributions. The findings, interpretations, and conclusions expressed in this work do not necessarily reflect the views of The World Bank, its Board of Executive Directors, or the governments they represent.

The World Bank does not guarantee the accuracy of the data included in this work. The boundaries, colors, denominations, and other information shown on any map in this work do not imply any judgment on the part of The World Bank concerning the legal status of any territory or the endorsement or acceptance of such boundaries.

#### **Rights and Permissions**

The material in this work is subject to copyright. Because The World Bank encourages dissemination of its knowledge, this work may be reproduced, in whole or in part, for noncommercial purposes as long as full attribution to this work is given

Attribution—Please cite the work as follows: Mukhi, Neha; Rana, Suneira; Mills-Knapp, Sara; Gessesse, Eskedar. 2020. World Bank Outlook 2050: Strategic Directions Note. Supporting Countries to Meet Long-term Goals of Decarbonization. World Bank, Washington, DC.

Any queries on rights and licenses, including subsidiary rights, should be addressed to World Bank Publications, The World Bank Group, 1818 H Street NW, Washington, DC 20433, USA; e-mail: [pubrights@worldbank.org](mailto:pubrights@worldbank.org)

Cover illustration and Design: Brad Amburn. Photos by Curt Carnemark/World Bank and Gerardo Pesantez/World Bank

---

# Table of Contents

Foreword	5
Acknowledgments	6
Abbreviations and Acronyms	7
<b>Executive Summary</b>	<b>8</b>
<b>1. Introduction</b>	<b>11</b>
1.1 Purpose and Audience	11
1.2 Scope and Structure	12
<b>2. Global Context</b>	<b>13</b>
2.1 Shifting Development Trends	13
2.2 Global Impacts of Climate Change	14
2.3 Climate Impacts on Key Sectors	16
2.3.1 Water	16
2.3.2 Food and agriculture	16
2.3.3 Energy	17
2.3.4 Transportation	17
2.4 Global Emissions Trends	18
2.4.1 Global GHG emissions from key sectors	18
2.4.2 Emission reduction pathways	19
2.4.3 Impact of COVID-19 on global emissions	20
2.4.4 Financing needs for decarbonization	20
<b>3. Climate Action and Long-Term Strategies</b>	<b>22</b>
3.1 Global Progress on Climate Change	22
3.2 Long-Term Strategies and Decarbonization	23
3.3 Benefits of Long-Term Climate Action	24
3.4 Climate Action: Challenges over the Long Term	25
3.4.1 Tensions and systemic challenges	25
3.4.2 Scenarios and uncertainties	27
<b>4. Climate Risks and Opportunities in Decarbonization for Financial Institutions</b>	<b>30</b>
4.1 Risks of Inaction	30
4.2 Opportunities in Decarbonization and Resilience	31
<b>5. The World Bank Outlook 2050 Initiative: Approach and Methodology</b>	<b>32</b>
<b>6. World Bank Priorities to Support Countries on Long-Term Decarbonization Goals</b>	<b>34</b>
<b>7. Economy-Wide Actions</b>	<b>35</b>
<b>7.1 Strategic Direction 1: Embed Long-Term Climate Priorities in Country Macroeconomic Frameworks</b>	<b>35</b>
7.1.1 World Bank engagement to date	35
7.1.2 New frontiers for lending and technical assistance	36
<b>7.2 Strategic Direction 2: Embed Long-Term Climate Planning in National Budgets and Expenditure Frameworks</b>	<b>37</b>
7.2.1 World Bank engagement to date	38
7.2.2 New frontiers for lending and technical assistance	38
<b>7.3 Strategic Direction 3: Embed Long-Term Climate Objectives in Financial Sector Regulations and Incentives</b>	<b>40</b>
7.3.1 World Bank engagement to date	41
7.3.2 New frontiers for lending and technical assistance	42

<b>7.4 Strategic Direction 4: Embed Long-Term Climate Objectives into Systems Planning</b>	44
7.4.1 World Bank engagement to date	44
7.4.2 New frontiers for lending and technical assistance	45
<b>8. Advancing Cross-Cutting Solutions</b>	48
<b>8.1 Priority Area 1: Transforming Food Systems</b>	51
8.1.1 World Bank engagement to date	52
8.1.2 New frontiers for lending and technical assistance	53
<b>8.2 Priority Area 2: Protecting Land-Based Ecosystems and Enhancing Carbon Sinks</b>	54
8.2.1 World Bank engagement to date	55
8.2.2 New frontiers for lending and technical assistance	56
<b>8.3 Priority Area 3: Transforming Energy Systems</b>	58
8.3.1 World Bank engagement to date	59
8.3.2 New frontiers for lending and technical assistance	60
<b>8.4 Priority Area 4: Transforming Mobility</b>	62
8.4.1 World Bank engagement to date	63
8.4.2 New frontiers for lending and technical assistance	64
<b>8.5 Priority Area 5: Building Low-Carbon, More Resilient Urban Areas</b>	66
8.5.1 World Bank engagement to date	67
8.5.2 New frontiers for lending and technical assistance	67
<b>8.6 Priority Area 6: Transforming Water Systems</b>	68
8.6.1 World Bank engagement to date	69
8.6.2 New frontiers for lending and technical assistance	70
<b>8.7 Priority Area 7: Transforming the Blue Economy</b>	72
8.7.1 World Bank engagement to date	73
8.7.2 New frontiers for lending and technical assistance	74
<b>8.8 Priority Area 8: Digital Transformation</b>	75
8.8.1 World Bank engagement to date	77
8.8.2 New frontiers for lending and technical assistance	77
<b>9. Resources and Capacity to Deliver on Long-Term Climate Priorities</b>	79
<b>9.1 Develop New Framework Tools and Approaches</b>	79
<b>9.2 Tailored Approaches for Regional and Country Implementation</b>	80
<b>9.3 Financing for Outlook 2050 Priorities</b>	80
<b>9.4 Aligning Short- and Medium-Term Crisis Response with Long-Term Priorities</b>	81
<b>9.5 Incentivize Internal Efforts to Support Long-Term Cross-Sectoral Climate Action</b>	82
<b>9.6 Build Internal Skills and Capacity to Respond to Country Demand</b>	82
<b>9.7 Global Strategic Partnerships</b>	82
<b>10. The Way Forward</b>	84
<b>10.1 Next Steps</b>	85
<b>References</b>	86
<b>Appendix A Outlook 2050: Approach and Methodology</b>	92

---

# Foreword

Climate change remains an acute threat to global development and shared prosperity. Its impacts are expected to intensify even as the world grapples with the COVID-19 crisis that is hitting health, livelihoods and economies. All countries—but particularly the poorest and most vulnerable—could now face the compound impacts of the twin challenges of climate and COVID, as we saw during Cyclone Amphan, where authorities in Bangladesh and India had to handle competing goals of evacuation and lockdown to keep communities safe.

As we support our clients in responding to and building back from the current economic challenges, we have a once-in-a-generation opportunity to help them align development pathways with the decarbonization of their economies. Doing so by mid-century, will be our surest way to secure a safer climate for all. And the best part: across most sectors and countries, these longer-term goals can also be met by tackling shorter term needs, including creating new jobs and markets and boosting economic growth.

*The World Bank Outlook 2050: Strategic Directions Note* is especially timely as it lays out economy-wide actions and cross-cutting solutions that can help economies decarbonize and develop sustainably. At the macro-economic level, this note identifies four pillars that can drive a ‘whole of economy’ approach to integrating long-term climate objectives: namely, macroeconomic frameworks, national budgets, financial sector regulations and incentives, and systems planning. It also examines eight cross-sectoral solutions that will drive this forward: food systems, land use, energy, mobility, urban areas, oceans, water, and digital transformation. Across each of these areas, the report details our approach with an overview of World Bank engagement to date and identifies potential new frontiers for country engagements, technical assistance, and lending.

Implementing these actions is in line with our efforts to integrate climate considerations into national policy planning, investment design, budgeting, public procurement and implementation and evaluation; and increase engagement with Ministries of Finance and Planning in the design and implementation of transformative low-carbon and climate-resilient policies. Cross-sectoral solutions, like those identified in this Note, will be key to supporting countries develop integrated mid-century low carbon and climate resilient strategies.

Looking ahead from this moment in 2020, it clear that supporting countries building back better means not only helping them reduce the multiple impacts of this crisis, but also laying the foundations for dealing with the next one. The climate challenge ahead cannot be underestimated. That is why undertaking long-term climate action today can help strengthen development progress already made and secure a safer, more prosperous future for billions.



**Juergen Voegele**

*Vice President for Sustainable Development*

World Bank

---

# Acknowledgments

The World Bank Outlook 2050: Strategic Directions Note was prepared by a team led by Neha Mukhi. The core team comprised Suneira Rana, Sara Mills-Knapp, and Eskedar Bahru Gessesse. This Strategic Directions Note benefitted from the hard work of Ana Bucher, Rissa Camins, Viviane Clement, Dominik Englert, S.Tambi Matambo, Afua Oguah, Alexandrina Platonova-Oquab, and Suphachol Suphachalasai.

The team is grateful for the guidance from Neeraj Prasad, Practice Manager, and the strategic vision and direction of Bernice K. Van Bronkhorst, Global Director of Climate Change Group under the leadership of Juergen Voegele, Vice President of Sustainable Development Group, World Bank. This work would not have been possible without the innovative thinking and future vision of John Roome and Stephen Hammer who were instrumental in the inception and design of the work.

The extended team was composed of Kazi Fateha Ahmed, Anam Basnet, Nikunj Prakash Beria, Vaaruni Eashwar, Oluwafemi Faleye, Ronald Halim, Andrea V. Prada Hernandez, Silke Heuser, Shibani Pandey, Angela Soriano Quevedo, Nuwan Suriyagoda, and Michael Vaislic.

The team is extremely thankful for the valuable technical guidance from the focal points across various Global Practices and Regional Vice-Presidential Units of the World Bank. This included Greg Browder, Raffaello Cervigni, Christophe Crepin, Ashraf El-Arini, Peter D. Ellis, Nathan Engle, Erick Fernandes, Eduardo Ferreira, Dirk Heine, Niels B. Holm-Nielsen, Shafick Hoossein, Ashok Kumar, Kanta Kumari, Stephen Ling, Luisa Masutti, Helena Naber, Ambar Narayan, Trang Van Nguyen, Grzegorz Peszko, Christian Peter, Mather Pfeiffenberger, Klas Sander, Lia Sieghart, Chandra Shekhar Sinha, Natalya Stankevich, and Jane Treadwell.

The team would like to acknowledge the following colleagues, who kindly agreed to serve as peer reviewers, for their invaluable feedback: Ademola Braimoh, Karan Capoor, Christian Eigen-Zucchi, Peter D. Ellis, Onur Erdem, Erick Fernandes, Adrian Fozzard, Chandrasekar Govindarajalu, Nagaraja Rao Harshadeep, Astrid Herdis Jacobsen, Sean Nelson, Kulwinder Singh Rao, Martijn Gert Jan Regelink, Diego Juan Rodriguez, Carlo Maria Rossotto, and Fiona Elizabeth Stewart.

Other valuable guidance was provided by Simon Black, Debabrata Chattopadhyay, Stephane Hallegatte, Christopher Head, Muthukumara Mani, Shagun Mehrotra, Marcelo Mena, Grzegorz Peszko, Marc Sadler, and Lia Sieghart. The foresight workshops were designed and conducted by Global Knowledge Initiative (GKI).

The team also greatly benefited from discussions with external experts, namely the 2050 Pathways Platform, the New Climate Economy, the National Renewable Energy Laboratory (NREL), who shared insights from their experience on long-term strategies for countries.

Visibility and launch of the report were supported by Ferzina Banaji, with Catherine Sear, Isabel Saldarriaga Arango, and Joana Francisca das Neves Lopes. The team thanks Chandni Dinakaran for her support in the publication process. This work would not have been possible without the guidance and unwavering support from Barbara Machado, Paula Garcia, Liberty Ramirez Espiritu, Beaulah Noble, and Vidya Mahesh.

*Editor:* Marion Davis

*Design:* Brad Amburn

# Abbreviations and Acronyms

<b>BAPPENAS</b>	Ministry of National Development Planning (Indonesia)	<b>IMO</b>	International Maritime Organization
<b>BAU</b>	Business as Usual	<b>IOPS</b>	International Organization of Pension Supervisors
<b>BECCS</b>	Bioenergy with Carbon Capture and Storage	<b>IoT</b>	Internet of Things
<b>BRT</b>	Bus Rapid Transit	<b>IOSCO</b>	International Organization of Securities Commissions
<b>CCPER</b>	Climate Change Public Expenditure Review	<b>IPCC</b>	International Panel on Climate Change
<b>CCUS</b>	Carbon Capture, Utilization, and Storage	<b>IRENA</b>	International Renewable Energy Agency
<b>CGIAR</b>	Consultative Group on International Agricultural Research	<b>ITF</b>	International Transport Forum
<b>CORSIA</b>	Carbon Offsetting and Reduction Scheme for International Aviation	<b>IUWM</b>	Integrated Urban Water Management
<b>CPF</b>	Country Partnership Framework	<b>LCDI</b>	Low Carbon Development Initiative (Indonesia)
<b>CSA</b>	Climate-smart Agriculture	<b>LDC</b>	Least Developed Country
<b>CSAIP</b>	Climate-smart Agricultural Investment Plan	<b>LTS</b>	Long-term Strategy
<b>CSP</b>	Concentrated Solar Power	<b>MDB</b>	Multilateral Development Bank
<b>DDPLAC</b>	Deep Decarbonization Pathways for Latin America and the Caribbean	<b>MIGA</b>	Multilateral Investment Guarantee Agency
<b>DE4A</b>	Digital Economy for Africa Moonshot	<b>MRV</b>	Monitoring, Reporting, and Verification
<b>DRFIP</b>	Disaster Risk Financing Insurance Program	<b>Mt CO<sub>2</sub></b>	Metric Tons of Carbon Dioxide
<b>EAPP</b>	Eastern Africa Power Pool	<b>MTEF</b>	Medium-term Expenditure Framework
<b>ERC</b>	Energy Research Center	<b>NGFS</b>	Network for Greening the Financial System
<b>ESCO</b>	Energy Service Company	<b>NDC</b>	Nationally Determined Contribution
<b>ESG</b>	Environmental, Social and Governance	<b>NGO</b>	Non-governmental Organization
<b>ETC</b>	Energy Transitions Commission	<b>OECD</b>	Organisation for Economic Co-operation and Development
<b>EV</b>	Electric Vehicle	<b>PBL</b>	Netherlands Environmental Assessment Agency
<b>FAO</b>	Food and Agriculture Organization of the United Nations	<b>PFM</b>	Public Financial Management
<b>FCPF</b>	Forest Carbon Partnership Facility	<b>PMEH</b>	Pollution Management and Environmental Health
<b>FCV</b>	Fragility, Conflict and Violence	<b>PPP</b>	Public-Private Partnership
<b>FIP</b>	Forest Investment Program	<b>PROFOR</b>	The Program on Forests
<b>FSAP</b>	Financial Sector Assessment Program	<b>PV</b>	Photovoltaic
<b>FSB</b>	Financial Stability Board	<b>REDD+</b>	Reducing Emissions from Deforestation and Forest Degradation (plus supporting roles)
<b>GDP</b>	Gross Domestic Product	<b>REIPPP</b>	Renewable Energy Independent Power Procurement Program (South Africa)
<b>GFDRR</b>	Global Facility for Disaster Risk Reduction	<b>SCD</b>	Strategic Country Diagnostics
<b>GHG</b>	Greenhouse Gas	<b>SDG</b>	Sustainable Development Goal
<b>GP</b>	Global Practice	<b>SEDAPAL</b>	Lima Water Service (Peru)
<b>GPS</b>	Global Program on Sustainability	<b>SIDS</b>	Small Island Developing State
<b>Gt CO<sub>2</sub>e</b>	Gigatons of Carbon Dioxide equivalent	<b>SOE</b>	State-owned Enterprise
<b>IAIS</b>	International Association of Insurance Supervisors	<b>SUV</b>	Sports Utility Vehicle
<b>IBRD</b>	International Bank for Reconstruction and Development	<b>TCFD</b>	Task Force on Climate-related Financial Disclosures
<b>ICAO</b>	International Civil Aviation Organization	<b>TWh</b>	Terawatt hour
<b>ICT</b>	Information and Communication Technology	<b>UNCTAD</b>	The United Nations Conference on Trade and Development
<b>IDA</b>	International Development Association	<b>UNDESA</b>	United Nations Department of Economic and Social Affairs
<b>IDCOL</b>	Infrastructure Development Company Limited (Bangladesh)	<b>UNEP</b>	United Nations Environment Programme
<b>IEA</b>	International Energy Agency	<b>UNFCCC</b>	UN Framework Convention on Climate Change
<b>IFC</b>	International Finance Corporation	<b>VAT</b>	Value Added Tax
<b>IHA</b>	International Hydropower Association	<b>WAVES</b>	Wealth Accounting and the Valuation of Ecosystem Services
<b>IMF</b>	International Monetary Fund		



## Executive Summary

Climate change poses huge risks to countries' long-term development, economic growth and stability. Already, droughts, heat waves, floods and other extreme events are causing enormous damage, often reversing hard-won development gains. In the medium and long term, it has critical implications for poverty, food security, health, productivity, and quality of life.

A bold economic transformation is needed to ensure a safe and prosperous future. The Paris Agreement laid the foundation, inviting countries to pledge immediate action to reduce emissions, then keep ratcheting up ambition to reach net-zero emissions by the second half of the century.

The World Bank is committed to helping countries realize the vision of the Paris Agreement, to reduce climate risk while alleviating poverty, building shared prosperity, and promoting sustainable development. It also recognizes its crucial role in aligning finance flows with a pathway toward low greenhouse gas (GHG) emissions and climate-resilient development.

Decarbonizing the global economy requires going well beyond the ambition of the first round of Nationally Determined Contributions (NDCs), which would only limit warming to 2.7–3.7°C. Indeed, a continued focus on short- and medium-term targets (such as 2020 or 2030) could keep countries from making the fundamental changes they need, and make decarbonization costlier and more difficult over the longer term.

That is why long-term strategies are crucial to ensuring that countries' near-term actions are consistent with their ultimate goals. They can help governments to recognize climate-related risks—both from direct impacts, and from the low-carbon transition itself, which could sharply devalue high-carbon assets. These strategies can help countries to unlock new economic opportunities, innovate, and create the jobs of the future.

The World Bank has a significant role to play in piloting and scaling up low-carbon solutions through appropriate programming of development finance and climate finance and the use of instruments that build enabling conditions, de-risk new technologies, and strengthen markets around these solutions.

This Outlook 2050 examines how the World Bank can help countries plan for and achieve long-term decarbonization: through country programs, technical assistance, lending, and knowledge products. It identifies key trends in technology, markets, financing instruments, and consumer priorities, and examines their implications for climate action, economic growth strategies and development. This will further help the World Bank deliver on its existing commitments to increase systemic impact in countries to address climate change.

As of May 2020, 16 countries and the European Union had submitted long-term strategies under the Paris Agreement. There are many ways to achieve net-zero emissions by the second half of the century; the most successful strategies will be tailored to the national context and fully embedded in broader development and fiscal policies and institutions. Uncertainty is unavoidable, but with expert help and appropriate tools, policy makers can weigh trade-offs and risks.



For the World Bank, supporting countries in a transition to long-term decarbonization requires us to not only look 3–5 years ahead, roughly equivalent to typical election cycles, but look decades ahead, and then work with our clients to determine the near- and mid-term implications. It will also mean supporting the implementation of economy-wide strategies as well as cross-sectoral initiatives, not only focusing on single-sector initiatives, such as individual energy or transportation projects.

Coinciding with a need for a major, global economic recovery—triggered by the COVID-19 pandemic—this ‘whole of economy’ approach to deliver better growth and a better climate could provide the sustainable and resilient foundation for countries as they build—or rebuild—their economies.

The Outlook 2050 approach prioritizes four economy-wide strategic directions:

- 1. Embed long-term climate priorities in country macroeconomic frameworks**, to ensure that those frameworks, which guide fiscal policy and major national investments, properly account for climate risks and the benefits of ambitious climate action.
- 2. Embed long-term climate planning in national budgets and expenditure frameworks**, to provide adequate budgetary support for climate action, optimize the overall allocation of public resources, and unlock private financial flows.
- 3. Embed long-term climate objectives in financial sector regulations and incentives**, to ensure that the sector is resilient both to climate change impacts and to low-carbon transition risks, and to mobilize finance for climate action.
- 4. Embed long-term climate objectives in systems planning**, to integrate climate with economic, social inclusion, and other objectives; assess cross-sectoral links and regional impacts; and identify trade-offs and synergies.

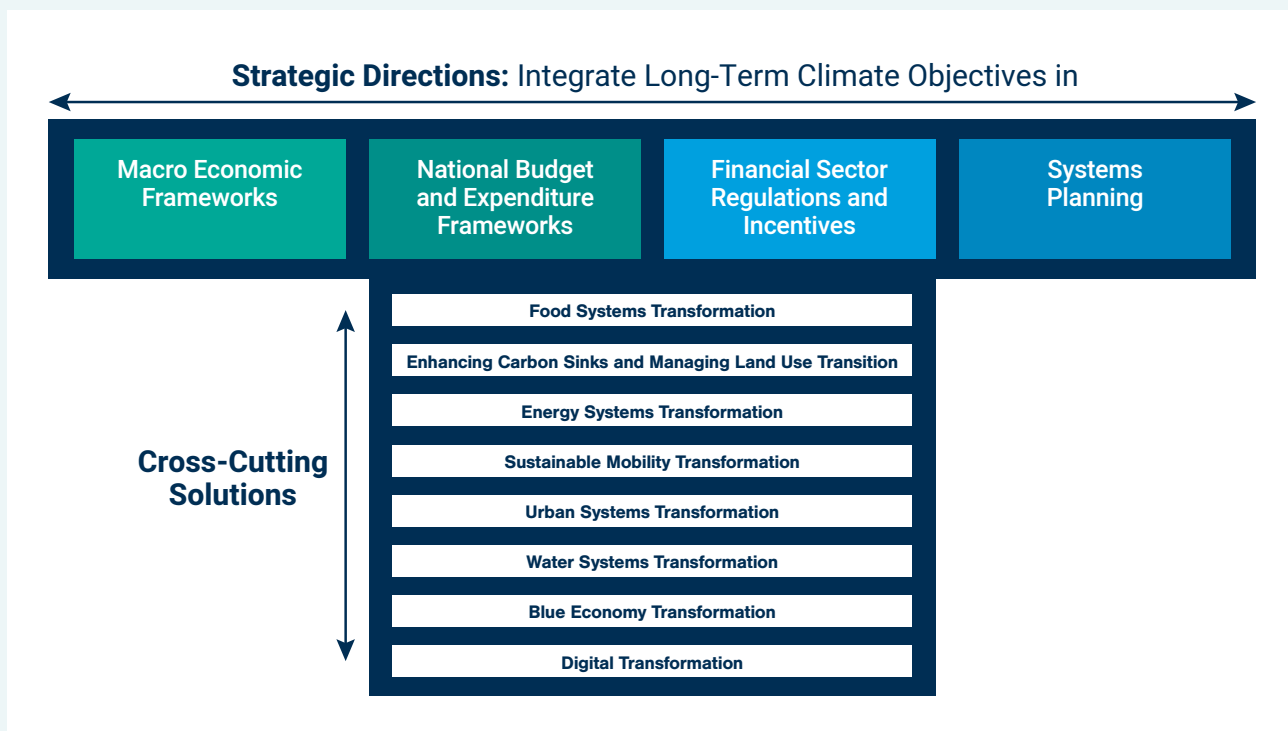
There are a number of sectors where climate impacts are at—or close to—tipping points. Tackling these with a long-term planning horizon offers both mitigation and adaptation benefits. Investing in these cross-sectoral opportunities can also be part of stimulus packages that shape a sustainable recovery. Opportunities to advance development and climate considerations together include:

- 1. Transforming food systems**, recognizing that food production and supply systems need to scale up dramatically in the coming decades, but that these are also a major source of emissions and highly vulnerable to climate change.
- 2. Protecting land-based ecosystems and carbon sinks**, including forests, which are crucial to sustaining human life, but are growing sources of GHG emissions due to land-use change and land degradation.
- 3. Transforming energy systems**, with a focus on decarbonizing and decentralizing the power sector, ensuring a plentiful supply of low-carbon electricity to meet growing demand, enhancing resource efficiency of energy production and use, and aligning power sector investments with climate goals.
- 4. Transforming mobility**, by reducing the need to travel through better land use planning and other strategies; shifting the modes by which people travel, especially away from private vehicle use; and reducing emissions from all transport modes through technological innovation.

5. **Building low-carbon, more resilient urban areas** that increase livability, recognizing that by 2050, more than two-thirds of the global population will live in cities, which are major sources of emissions and highly vulnerable to climate impacts.
6. **Transforming water systems**, which are already under growing pressure from climate change, play a central role in many sectors, and are a growing source of emissions.
7. **Transforming the ocean economy**, recognizing that the oceans directly support millions of livelihoods, provide vital ecosystems services, and absorb a large share of GHG emissions.
8. **Digital transformation**, to unleash the transformative power of digital technologies for both emission reduction and resilience across all sectors, and to reduce the digital sector's large and growing emissions.

The work outlined in this report will take time, but there are immediate opportunities to help countries shape a sustainable recovery. To date, the World Bank Group's assistance to fight COVID-19 has now reached 100 developing countries in May 2020, the largest and fastest crisis response in the Group's history. By helping countries build back better, focusing on longer-term pathways, we are not only supporting our clients' efforts to reduce the multiple impacts of this crisis: we are also helping to lay solid foundations for facing the next one.

#### Outlook 2050: Strategic Directions and Cross-Cutting Areas



# 01

## Introduction

**Climate change is a ‘whole of economy’ challenge, posing risks to economic growth and macroeconomic stability.** The current pace and scale of climate action are insufficient to limit the worst effects and ensure a safe and sustainable future. The challenge for countries is not just to stay the course on greenhouse gas (GHG) emission reduction efforts, but to embark on a long-term path to decarbonize the world economy and build communities’ resilience to future climate change. These actions will almost certainly be affected by the health and economic impacts of COVID-19.

**Climate change is also a global development challenge.** Droughts, heat waves, floods and other extreme events are wreaking ever more havoc. Between 1999 and 2018, there were more than 12,000 extreme weather events worldwide, killing about 495,000 people and causing economic losses equivalent to about US\$ 3.54 trillion (Eckstein et al. 2019). For many countries, a single disaster can wipe out a decade of hard-won development gains. The COVID-19 crisis has shown how a large enough shock can rapidly pull millions of people back into poverty; in the medium and long term, climate change could cause far worse hardship. It is clear that major investments in both mitigation and adaptation are sorely needed.

**Climate action in line with the Paris Agreement represents an enormous opportunity to advance the World Bank Group’s mission to reduce poverty, build shared prosperity, and promote sustainable development.** The Agreement aims to “strengthen the global response to the threat of climate change, in the context of sustainable development and efforts to eradicate poverty” (UNFCCC 2015). Achieving that vision poses significant challenges, however, as it requires nations to fundamentally rethink their economic growth strategies and development plans. For this they will need both finance and technical support from development partners such as the World Bank.

The World Bank Group is committed to helping its clients set and achieve ambitious climate goals. The Climate Change Action Plan 2016–2020 increased the share of finance for climate action and provided support for countries to lay out low-carbon, climate resilient development pathways (World Bank, IFC, and MIGA 2016). The 2025 Targets to Step up Climate Action (World Bank 2019a) deepen that commitment, with increased support for adaptation through an Action Plan on Climate Change Adaptation and Resilience (World Bank 2019b), the first plan of its kind. The World Bank has thus made important strides in integrating climate in its country engagements, but the focus so far has been mainly on the near term. A key next step is to develop an overarching long-term vision to achieve decarbonization and resilience by mid-century.<sup>1</sup>

---

### 1.1 Purpose and Audience

This *Outlook 2050* examines how the World Bank can meet client countries’ decarbonization needs through country programs, technical assistance, lending, and knowledge products.

1. The goal set out in the Paris Agreement is net zero carbon emissions by the second half of the century to keep warming below 2°C. It is important however to note that according to the Intergovernmental Panel on Climate Change (IPCC), limiting warming to 1.5°C will require achieving net-zero carbon emissions by 2050. This report will use the term “decarbonization” interchangeably with “net-zero carbon emissions”.

Given the initiative's forward focus, strong emphasis is also placed on future trends in technology, markets, financing instruments, and consumer priorities, and how they will intersect with climate action and country development. This will further help the World Bank deliver on its existing commitments to increase systemic impact in countries to address climate change (World Bank 2019a).

The analysis presented here is the product of many months of collaborations and discussions with a wide array of World Bank experts. It is meant to guide Regions and Global Practices, clients, shareholders, and development partners. It does not seek to ignore the COVID-19 pandemic which has reshaped the global financial landscape, as advanced and developing economies alike face staggering impacts. Yet the urgency of climate action has not diminished; if anything, this crisis warns us of the perils of inaction. As countries adapt to a radically altered economy, their recovery plans and stimulus packages present new opportunities to accelerate the shift toward a low-carbon and resilient future.

---

## 1.2 Scope and Structure

This Strategic Directions note focuses on World Bank engagement areas and includes some areas of joint work between the World Bank and the International Finance Corporation (IFC). Nine sections follow this introduction:

- » *Section 2* examines the global context of climate change, including climate change impacts and greenhouse gas emissions;
- » *Section 3* discusses global climate action, long-term strategies, the benefits of action, and challenges with implementation;
- » *Section 4* highlights risks and opportunities around decarbonization, especially for a development finance institution such as the World Bank;
- » *Section 5* summarizes the approach and methodology for the Outlook 2050;
- » *Sections 6, 7, 8* include the key actions put forward in the Outlook 2050 to support countries on long-term decarbonization goals;
- » *Section 9* highlights internal actions for the World Bank to enhance resources for implementation and its own capacity to deliver on the long-term priorities; and
- » *Section 10* proposes a way forward on implementation.

# 02

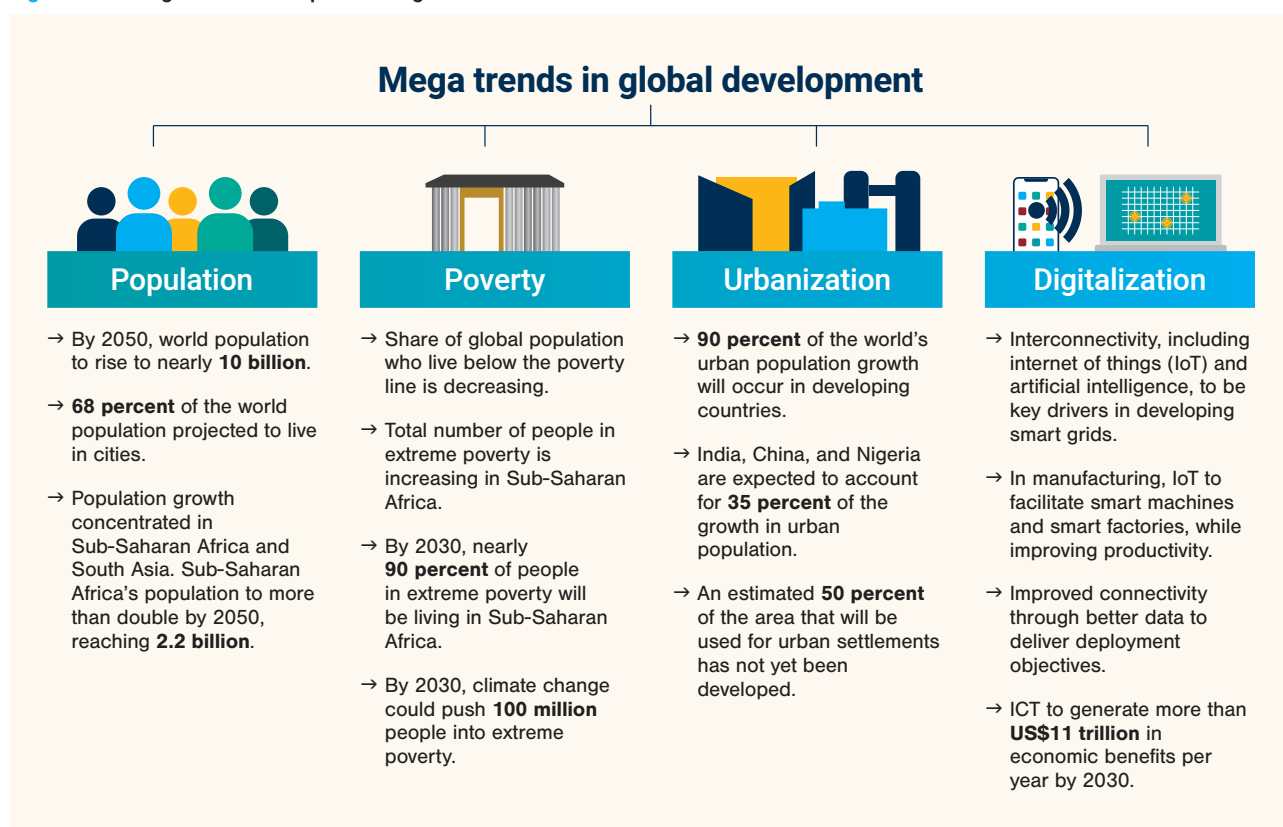
## Global Context

### 2.1 Shifting Development Trends

**The world will be dramatically different in 2050.** Nearly 10 billion people will live on Earth, more than two-thirds of them in cities; new technologies will transform many aspects of life and work; and even if we move quickly to decarbonize the economy, unavoidable climate change caused by past carbon emissions will reshape entire landscapes, shifting where and how food is produced and even where people can safely live (see Figures 1 and 2).

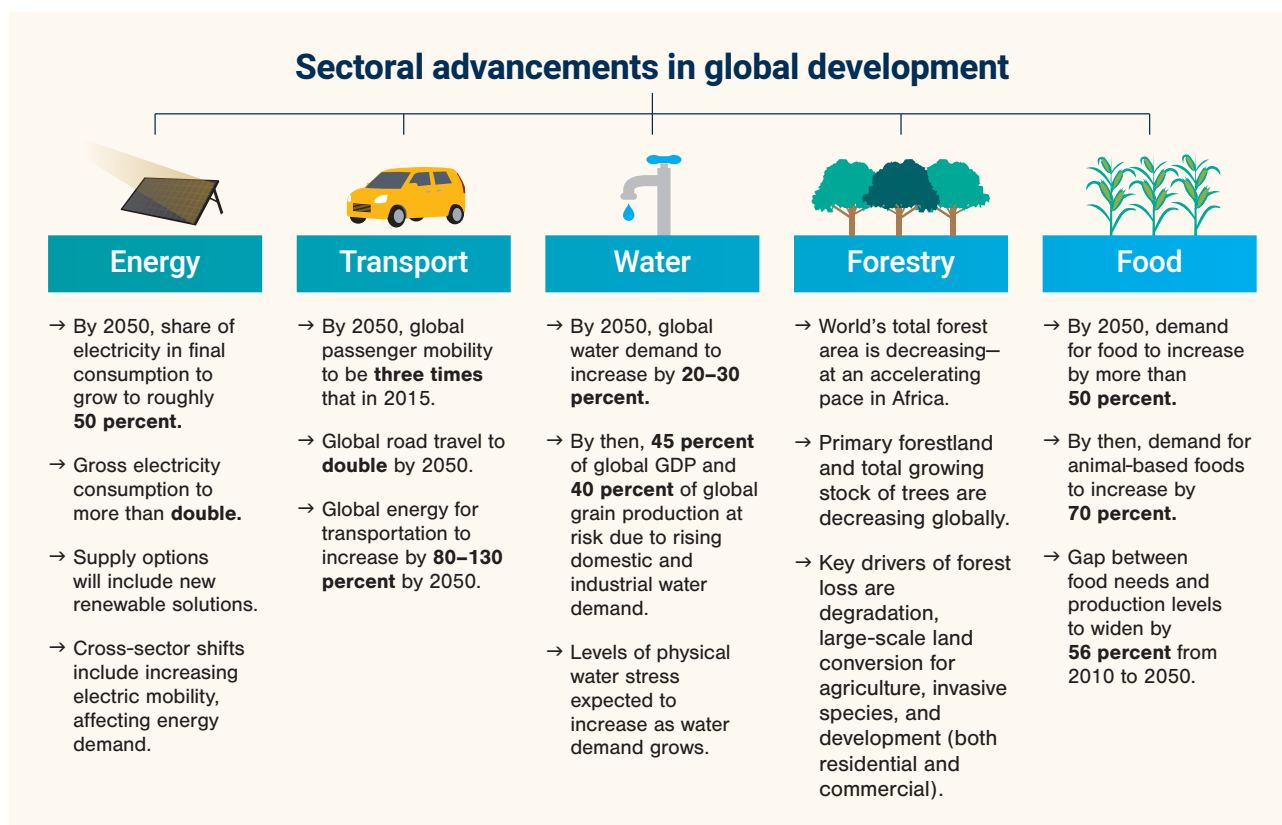
**Much of the infrastructure that will exist in 2050 has not been built yet.** Recent estimates indicate about US\$94 trillion of global infrastructure investment needs by 2040 (Global Infrastructure Hub and Oxford Economics 2017). For developing and emerging economies, this presents an ideal opportunity to build low-carbon, climate-resilient infrastructure. If, on the other hand, countries continue to invest in infrastructure that ‘locks in’ high emissions, they will further increase the stress on the planet’s resources and systems. Technological innovation and digital transformation will play crucial roles in shaping future development paths (Box 1).

Figure 1: Shifting Global Development: Mega Trends



Sources: Janssens-Maenhout et al. (2019), World Bank (2018b), Suzuki (2019), GeSI and Accenture Strategy (2015), and World Bank, IFC, and MIGA (2008).

Figure 2: Shifting Global Development: Sectoral Trends



Sources: IRENA (2018); ITF (2019); Mountford (2011); OECD (2012); Searchinger et al. (2018).

The choices that countries make today—and the longer-term development pathways they represent—have significant implications for how the World Bank invests its resources, the type of advice it provides to clients, and how it prioritizes its efforts to help countries achieve sustained, low-carbon economic growth and macroeconomic stability while accounting for climate change risks.

## 2.2 Global Impacts of Climate Change

**Climate change will transform the conditions under which ecosystems, economies and societies operate** (IPCC 2018). Temperatures will increase, more significantly in some places than in others. Precipitation will also be affected, and both droughts and heavy rains are likely to become more frequent and intense. Tropical cyclone activity will also intensify, and sea-level rise and storm surges could leave many coastal areas uninhabitable. Ecological responses—involving extinctions and migrations of both plant and animal species, as well as changing disease and pest dynamics—will disrupt the life-supporting function of current ecosystems, affecting the productivity of agriculture, fisheries, and forests.

**With each passing year, the risks of unabated climate change are mounting, threatening to reverse hard-won development progress.** Unless urgent action is taken, climate effects could by 2030 push an additional 100 million people into poverty (Hallegatte et al. 2016), reversing 25 years of progress during which more than one billion people have risen out of poverty (World Bank 2018a). By 2050, more than 143 million people in Latin America, South Asia, and Sub-Saharan Africa alone may be forced to migrate within their own countries to escape the slow-onset impacts of climate change (Rigaud et al. 2018).

**Climate change will exacerbate existing development challenges.** It will have critical implications for poverty, food security, health, quality of life, and economic productivity. A current example is offered by the desert locusts that are threatening crops and exacerbating food insecurity for the poor in the Horn of Africa, the Arabian Peninsula and southwest Asia. Conditions linked to climate change have enabled the insects to multiply exponentially (UNEP 2020). The COVID-19 pandemic is also hindering locust control due to disrupted supply chains, lockdowns and travel restrictions. (Climate change impacts on key sectors are considered in more detail in the next section.)

**A bold economic transformation is needed, but it must be well planned and implemented, to avoid negative impacts** (Carney 2018). Such a transformation requires systemic integration of climate goals across the economy, clearly addressing any trade-offs, especially for vulnerable populations. A transition that is too rapid or even abrupt could disrupt financial stability and existing social safety nets, for instance, potentially harming vulnerable populations and causing a backlash before the benefits can be realized. Labor and social justice groups and many researchers have developed extensive recommendations on how to achieve a ‘just transition’ that can inform countries’ efforts (Rosemberg 2017). Low-carbon, resilient solutions must not worsen financial and social structures; instead, they should be orderly and inclusive, providing benefits for all of society.

**National contexts vary greatly and will determine how challenging it is for each country to transition to a low-carbon, resilient future.** It is important to factor in political and economic issues, including real or perceived trade-offs, which will vary based on the local context. Effective communication strategies need to be developed to support the implementation of climate solutions and build public support for the long-term vision.

#### Box 1

### Technology and Digital Transformation for Climate Action

Technology is already playing a major role in advancing emission reduction efforts across regions. Multiple climate mitigation scenarios envisage technological innovation and digital transformation as key drivers of decarbonization throughout this century (Blanco et al. 2014; IEA 2017; Royal Dutch Shell 2018). Technology transfer will be crucial to ensure that all countries can make the most of these new opportunities to accelerate emission reduction worldwide.

New technologies provide opportunities to change how we produce goods, meet energy demand, and facilitate various economic activities. Not only can they increase resource efficiency and reduce consumption, but they also provide significant savings. McKinsey estimates that by 2035 transportation innovations, such as electric and autonomous vehicles and ride-sharing; smart technologies for home and commercial energy efficiency management; and renewable energy technologies together could generate US\$600 billion–1.2 trillion in savings, depending on how widely they are adopted (McKinsey Global Institute 2017). New plant-based alternatives to animal products, meanwhile, could reduce demand for land for livestock production by millions of square kilometers, reducing GHG emissions by up to 8 Gt CO<sub>2</sub>e (carbon dioxide equivalent) per year (IPCC 2019a).

The digital transformation is being felt across all social and economic systems. Adoption of sector-specific automation, widespread integrated and near-instantaneous digital interconnectivity (IoT), data analytics, and artificial intelligence are already increasing productivity and reducing emissions. In aviation, for example, big data analytics serves to optimize route planning and reduce fuel use. In forestry and agriculture, geographic information systems, remote sensing, and big data analysis facilitate sustainable land management (Wong 2014). A 2015 analysis found that information and communications technology (ICT) could help reduce GHG emissions by up to 20 percent by 2030 (GeSI and Accenture Strategy 2015). As discussed in greater detail in Section 8.8, because ICT is highly energy- and resource-intensive, it is crucial to improve energy efficiency and decarbonize the power supply to make the most of these technologies without increasing emissions from electricity use.

**Climate action will not only help countries prepare for or avoid the worst impacts, but it can also unlock new economic opportunities.** For instance, investing in resilient infrastructure in developing countries could deliver US\$4.2 trillion over the lifetime of new infrastructure, yielding an average of US\$4 in benefits per US\$1 invested (Hallegatte, Rentschler, and Rozenberg 2019). Making infrastructure more resilient avoids the need for later repairs or rebuilding and reduces the impact of disasters on livelihoods and people's well-being. By one estimate, a shift to low-carbon, resilient economies could create over 65 million net new jobs globally by 2030 (Global Commission on the Economy and Climate 2018).

---

## 2.3 Climate Impacts on Key Sectors

Climate change will affect human and natural systems in many ways, with potentially enormous impacts on several major sectors.

### 2.3.1 Water

Climate change, demographic shifts, and rapid economic growth will all intensify existing water issues. Without a shift toward a low-carbon economy, there could be 3.4–3.9°C of warming by the century's end (UNEP 2019), with catastrophic consequences. Climate change increases the likelihood of both droughts and extreme precipitation (IPCC 2018). In parts of the Middle East and North Africa, for example, rising temperatures and reduced rainfall could decrease water discharge by 15–45 percent in a warming scenario of 2°C or 75 percent in a 4°C scenario (Waha et al. 2017).

Extreme precipitation can cause floods and landslides that cost lives, destroy infrastructure and cause enormous economic damage. In 2020, Cyclone Amphan wrought havoc on Bangladesh and India; the previous year Cyclone Idai was one of the worst tropical cyclones ever to affect Africa and the Southern Hemisphere. Dominica, one of several Caribbean islands hit by Hurricanes Irma and Maria in 2017, suffered damages equivalent to 224 percent of its GDP.

### 2.3.2 Food and agriculture

Climate change affects the stability of food systems – including production, quality, availability, access and consumption. Higher temperatures, water scarcity, extreme events such as droughts and floods, and greater CO<sub>2</sub> concentrations in the atmosphere have already begun to affect staple crops around the world. For example, severe drought across Ethiopia in 2016–2017 resulted in widespread crop failure, and more than 10 million people required food aid.

Even with warming of less than 2°C by the 2050s, total crop production in Sub-Saharan Africa could be reduced by 10 percent (UNEP 2018). A 2019 UN report found that due to climate change, the number of undernourished people worldwide is rising again after decades of decline, with one in nine people suffering from hunger (FAO 2019). With warming of 1.2–1.9°C by 2050, the share of people who are undernourished is projected to increase by 25–90 percent from today's levels (World Bank 2014).

Food production is also heavily concentrated; just five regional 'breadbasket' areas account for about 60 percent of global grain production (McKinsey Global Institute 2020). If key production hubs are affected by climate hazards, staple foods could quickly become scarce, leading to price inflation that makes them unaffordable for many households. A recent analysis found that without adequate mitigation and adaptation action, the likelihood of an abrupt drop of more than 15 percent in the global supply of grain (wheat, maize, rice, soy) will double by



2030 and quadruple by 2050. This would lead to a doubling or more of grain commodity prices (McKinsey Global Institute 2020). Global crop prices are also expected to rise significantly for other reasons, such as population growth, income growth, and demand for biofuels. If global mean temperatures increase by 2.5°C by 2050, this could accelerate price increases by an additional 94–111 percent for wheat, 32–37 percent for rice, and 52–55 percent for maize (Nelson et al. 2010).

### 2.3.3 Energy

Entire power systems will be impacted by climate change and by efforts to reduce climate risk—from fuel supply, to generation, transmission and distribution. There are many uncertainties in how the energy sector as a whole will be affected, due to complicating factors such as population growth, behavior shifts, adaptation scenarios, and the rate of technology development, but there is wide agreement that projected climate change will increase energy use. Recent studies, factoring in uncertainties, show an increase of 25–58 percent by 2050 (Ruijven, Cian, and Wing 2019).

In many countries, climate change will drastically affect hydropower, a key source of clean energy. For example, countries such as Cameroon and Costa Rica generate three-quarters of their electricity from hydropower. Others, such as Nepal, Albania, Zambia, and Ethiopia, depend on it almost exclusively (World Bank n.d.). The power sector in these countries – and dozens of other nations where hydro is a major source of electricity – is vulnerable not only to drought (diminished flow) but, conversely, also to the consequences of extreme weather events, including heavy rainfall (IHA 2019). In some regions, including the Middle East, North Africa, Latin America and the Caribbean, extreme heat may reduce the efficiency of thermal electric systems and increase water requirements for cooling, putting more stress on water basins (Rodriguez et al. 2013). Storm-related damage can also shut down power grids. In less-developed countries, such risks are exacerbated by the increasing demand to which power systems are subject.

Growing demand for minerals and metals used in clean energy technologies, such as wind, solar power, and batteries for energy storage and electric vehicles (EVs), will pose their own transition risks, particularly on jobs and employment, as will the shift away from fossil fuels (Stanley et al. 2018). Impacts will also affect trade flows and linked revenues, national budget, and macroeconomic growth, especially in countries that are resource-rich and heavily reliant on carbon-intensive assets.

### 2.3.4 Transportation

Natural hazards affecting infrastructure are already major disrupters to households in low- and middle-income countries—costing households and businesses upwards of \$390 million per year, not including indirect costs (Hallegatte et al. 2019). Climate change cannot but increase these impacts and will affect transportation systems directly, through infrastructure damage, and indirectly, through changes in trade flows, agriculture, energy use, and settlement patterns.

Extreme weather events, storm surges and sea-level rise can cause flooding and damage port facilities, roads, railways, and bridges. Higher temperatures can cause road surfaces to soften and expand, creating ruts and potholes, and warp rail tracks, necessitating track repairs or speed restrictions to avoid derailments. A changing climate will also pose severe and immediate threats to transportation company supply chains, causing business disruptions. A World Bank study of transportation infrastructure in Vietnam found that road and railway failures due to climate change could result in daily economic losses of US\$1.9 million and US\$2.6 million, respectively, by 2050 (Oh et al. 2019).

## 2.4 Global Emissions Trends

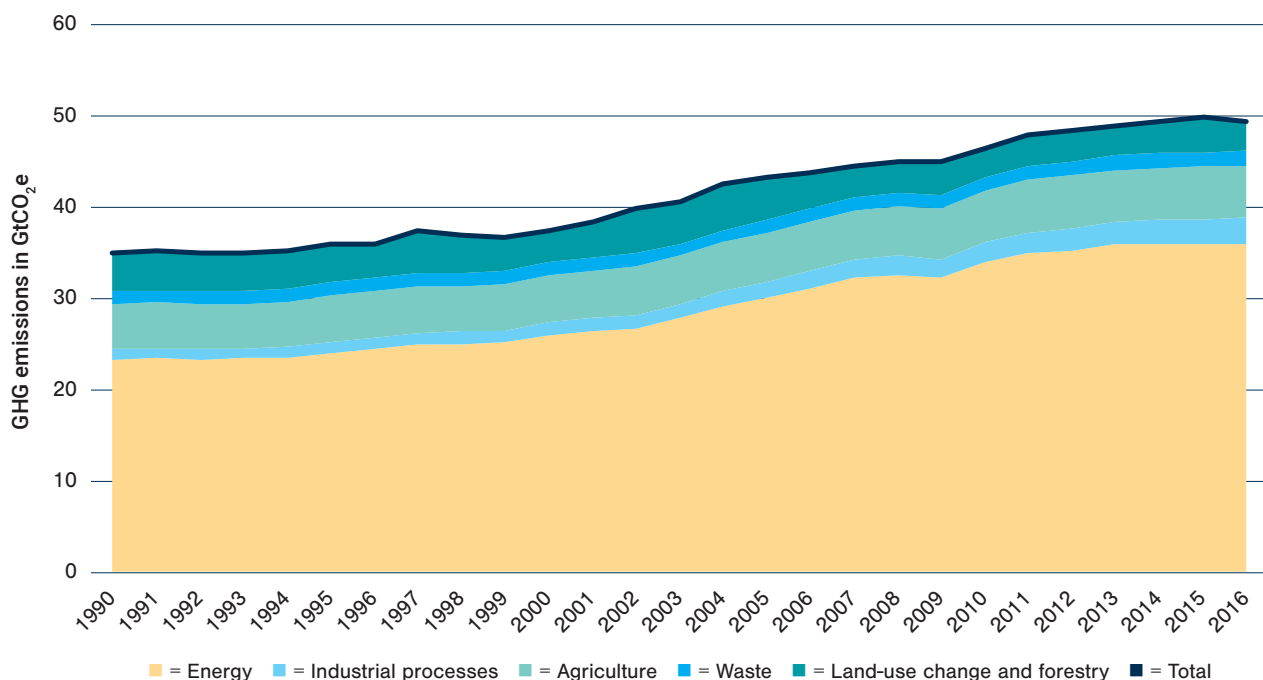
### 2.4.1 Global GHG emissions from key sectors

Global GHG emissions increased by 41 percent from 1990 to 2016—from 35.0 to 49.4 Gt CO<sub>2</sub>e per year (Climate Watch 2019). Emissions growth accelerated after 2000, with a 20 percent rise from 2000 to 2008 alone, and continued to rise (after a dip caused by that year’s financial crisis), peaking in 2015, at 49.9 Gt CO<sub>2</sub>e, before dropping slightly in 2016. Comprehensive GHG emission estimates for subsequent years are not available, but CO<sub>2</sub> data for 2017 and 2018 show emissions from fossil fuel combustion rising again (IEA 2019a), and that trend is likely to have continued until the COVID-19 pandemic shut down much of the global economy, as discussed further below (IEA 2020b).

As shown in Figure 3, energy use—burning fossil fuels for power generation, heat, and a wide range of uses across the economy—produces almost three-quarters of global GHG emissions, 36.0 Gt CO<sub>2</sub>e in 2016, and has been the main driver of emissions growth. Agriculture and land use change and forestry are also significant sources of emissions.

Growth in CO<sub>2</sub> emissions from fossil fuel combustion has mostly tracked global GDP growth, but flattened starting in 2013 (IEA 2019a). The International Energy Agency (IEA) closely monitors these emissions and has found that while in Organisation for Economic Co-operation and Development (OECD) member countries, they have declined since 2000, albeit slowly, in non-OECD countries, by contrast, they have risen steadily, surpassing OECD country levels in 2005 (now almost double). This reflects rising incomes and living standards, and shows most countries have yet to decouple development from emissions growth. Except for hydropower, which is a major energy source for some developing economies, the supply of renewable energy is still very limited. Despite more than quadrupling since 2000, solar and wind power still account for less than six percent of the share of primary energy provided by oil (IEA n.d.), with most capacity still concentrated in OECD countries. From a sectoral perspective, electricity and

Figure 3: Global Historical GHG Emissions by Sector



Source: Climate Watch (2019).

heat generation account for the largest share of fossil fuel CO<sub>2</sub> emissions, 13.6 Gt CO<sub>2</sub> in 2017 (IEA 2019a), but when emissions are allocated by end use, industry is the largest consumer, 14.16 Gt CO<sub>2</sub> (43 percent), followed by buildings, 8.67 Gt CO<sub>2</sub> (26 percent), and transport, 8.24 Gt CO<sub>2</sub> (25 percent).

The transportation sector accounted for about 16 percent of global GHG emissions in 2016 (Climate Watch 2019) and, as noted above, about 25 percent of global CO<sub>2</sub> emissions from fossil fuel combustion in 2017 (IEA 2019a). From 2010 to 2016 alone, GHG emissions from transportation rose by 12.5 percent, more than twice as fast as emissions overall (Climate Watch 2019). The high emissions from this sector are a result of dependence on oil, with 65 percent of global oil demand going to transportation (IPCC 2018). Personal vehicle ownership has also increased with rising incomes in developing countries, and the IEA has pointed to the growing market share of sport utility vehicles (SUVs) as a serious concern: 60 percent of the increase in the global car fleet since 2010 has been SUVs (Cozzi and Petropoulos 2019; IEA 2019b), and SUVs not only consume more fuel, but are harder to electrify than smaller cars.

Agriculture, forestry and other land use together produced about one fifth of global GHG emissions in 2016 (Climate Watch 2019). Agriculture is the largest contributor to non-CO<sub>2</sub> emissions, accounting for 41 percent of methane (CH<sub>4</sub>) and almost 12 percent of total GHG emissions in 2016. Agricultural GHG emissions include not only direct emissions, such as methane from cattle, but also emissions from fertilizer production and land use change. Between 2000 and 2016, agricultural emissions grew by a cumulative 14 percent—more slowly than emissions overall, but still a reflection of the difficulties that attend efforts to reduce emissions in this sector. GHG emissions from land use change and forestry, meanwhile, have fluctuated since 1990, rising as high as 5.0 Gt CO<sub>2</sub> in 2002 but also dropping periodically; in 2016, they reached their lowest level in a quarter-century, 3.2 Gt CO<sub>2</sub>, but pressure to convert land to agricultural uses remains strong (discussed in detail in Section 8.1).

Waste generation and management, including solid waste disposal and incineration, and wastewater handling have been responsible for about 3–4 percent of GHGs emissions over the past few decades (Climate Watch 2019). Of the GHG emissions from waste, about 90 percent consists of methane emitted from municipal solid waste disposal on land, and wastewater. Total GHG emissions from waste have increased over the past decade, but only slowly.

## 2.4.2 Emission reduction pathways

By the most recent estimate of the Intergovernmental Panel on Climate Change (IPCC), for a two-thirds chance of keeping global temperature increases below 1.5°C, total cumulative GHG emissions must remain below a threshold (or ‘budget’) of 420 Gt CO<sub>2</sub>, equivalent to about 10 years of emissions at current levels (IPCC 2018). The IPCC estimated that the power sector must be fully decarbonized by 2050 even to keep warming under 2°C, let alone 1.5°C. In the long term, the stringency of near-term climate policies, including efforts to reduce food demand and energy use in buildings and industry, will in turn determine how extensively CO<sub>2</sub> removal technologies will have to be used to meet climate targets. Overall, the key difference between 1.5°C and 2°C pathways is that staying under 1.5°C requires more rapid reductions in energy demand, faster electrification of energy end uses, and rapid decarbonization of electricity production.

There are various mitigation pathways that are consistent with the 1.5°C target, all of which would transform energy, land, and economic systems across the world. The IPCC notes that all share certain key characteristics, including a focus on comprehensive emissions reduction, with net CO<sub>2</sub> emissions peaking by 2030; an emphasis on rapid and deep decarbonization of the global energy supply in the near term; demand-side mitigation efforts across all end-use sectors, such as switching from fossil fuels to electricity in the transportation and residential sectors; substantial shifts in investment patterns, away from carbon-intensive energy production

and toward low-carbon alternatives; and adoption of CO<sub>2</sub> removal at scale—although the latter is a slightly less pressing need in pathways with a strong emphasis on energy efficiency and demand reduction (IPCC 2018).

### 2.4.3 Impact of COVID-19 on global emissions

The COVID-19 pandemic slowed global GHG emissions, starting in the first few months of 2020. For example, virus containment measures temporarily led to a 25 percent reduction in CO<sub>2</sub> emissions in China, and emissions remained below normal for more than two months (Evans 2020). It is difficult to quantify the longer-term impact of the crisis on GHG emissions, as the pandemic and associated economic shocks are still unfolding. Nonetheless, the IEA estimates that a significant drop in global oil demand, reduced electricity consumption, and limited industrial activity could reduce emissions by eight percent in 2020, to roughly 2010 levels (IEA 2020b). This would be the largest year-on-year decline recorded, six times larger than emission reductions resulting from the 2008 financial crisis.

The IEA also notes that the recovery may follow a rapid trajectory, depending on pandemic response measures implemented in the second half of 2020 as well as economic activities supported by stimulus packages (IEA 2020b). Emissions could rebound very quickly as countries restart economic activities. Green stimulus packages and recovery plans can help avert future carbon lock-in and keep the pandemic from derailing the low-carbon progress made so far.

The experience in 2008 offers potential lessons. The annual CO<sub>2</sub> emissions growth rate decreased by half in 2008 (to 1.7 percent, from 3.3 percent in 2007), mainly driven by the 0.6 percent drop in oil consumption that resulted from the economic slowdown and high oil prices at the time (PBL 2009). However, global emissions rebounded in 2010 due to emission growth in emerging economies, economic stabilization in developed economies, and an increase in the fossil fuel intensity of the world economy.

### 2.4.4 Financing needs for decarbonization

Global development priorities demand large investments. According to a UN estimate, an additional US\$2.5 trillion is needed just to help countries meet the Sustainable Development Goals (UNCTAD 2014). Sectors that are essential for achieving the SDGs, such as infrastructure, health, and food security, are significantly underfunded.

Similarly, climate mitigation and deep decarbonization across multiple sectors will require the unwavering engagement of public institutions, multilateral development banks (MDBs), and the private sector. Investments needed to implement commitments under NDCs amount to more than US\$1 trillion per year over the next 15 years, and achieving net-zero emissions by 2050 will require an estimated US\$50 trillion in investments (Morgan Stanley 2019). A recent analysis on infrastructure investment needs found that US\$6.3 trillion per year is needed until 2030 to meet SDGs, with an additional \$300 billion needed to make those investments compatible with the goals of the Paris Agreement (OECD, World Bank, and UNEP 2018). As an example within an individual sector, cumulative investments of at least US\$1 trillion will be needed between 2030 and 2050 to halve GHG emissions in the maritime industry, with another US\$400 billion needed for full decarbonization by 2050 (Krantz, Søgaard, and Smith 2020).

Public financing will not be sufficient to address all decarbonization goals, given the limited funds available as well as competing priorities in the health, education and social services sectors. MDB finance for climate change mitigation is similarly limited. For example, the World Bank Group's annual commitments are about US\$60 billion (World Bank 2019c). Private sector investment will thus be crucial to close the financing gap by seizing some of the opportunities

presented by climate-smart technologies. One study found US\$23 trillion in investment opportunities to finance the national climate action commitments of 21 emerging markets that represent 48 percent of global GHG emissions. These investment opportunities include green buildings in East Asia, clean energy in Africa, energy efficiency and transport in Eastern Europe, and resilient infrastructure in South Asia (IFC 2016). Such investment opportunities, offering US\$3–10 trillion in earnings (and taxes accordingly), would provide an economic value beyond their primary environmental function.

Overall, private capital expenditure is increasingly directed toward low-carbon technologies and green business models, such as renewable energy (Morgan Stanley 2019). Both governments and MDBs can play a role in unlocking further investments from the private sector. Notably, under its Maximizing Finance for Development agenda, the World Bank aims to leverage development finance to continue attracting private sector finance for climate action. Moreover, MDBs as a collective have also committed to mobilize private financing to support the SDGs through: (a) policy and technical assistance and capacity-building to improve market efficiency and attract private sector participation; and (b) direct investment to mobilize domestic private capital investments by enhancing the leverage and multiplier effect of their financing—that is, for every dollar of MDB investment in private sector operations, additional another 2–5 dollars of private investment are mobilized, adding US\$40–100 billion to development flows every year (MDBs 2015).

# 03

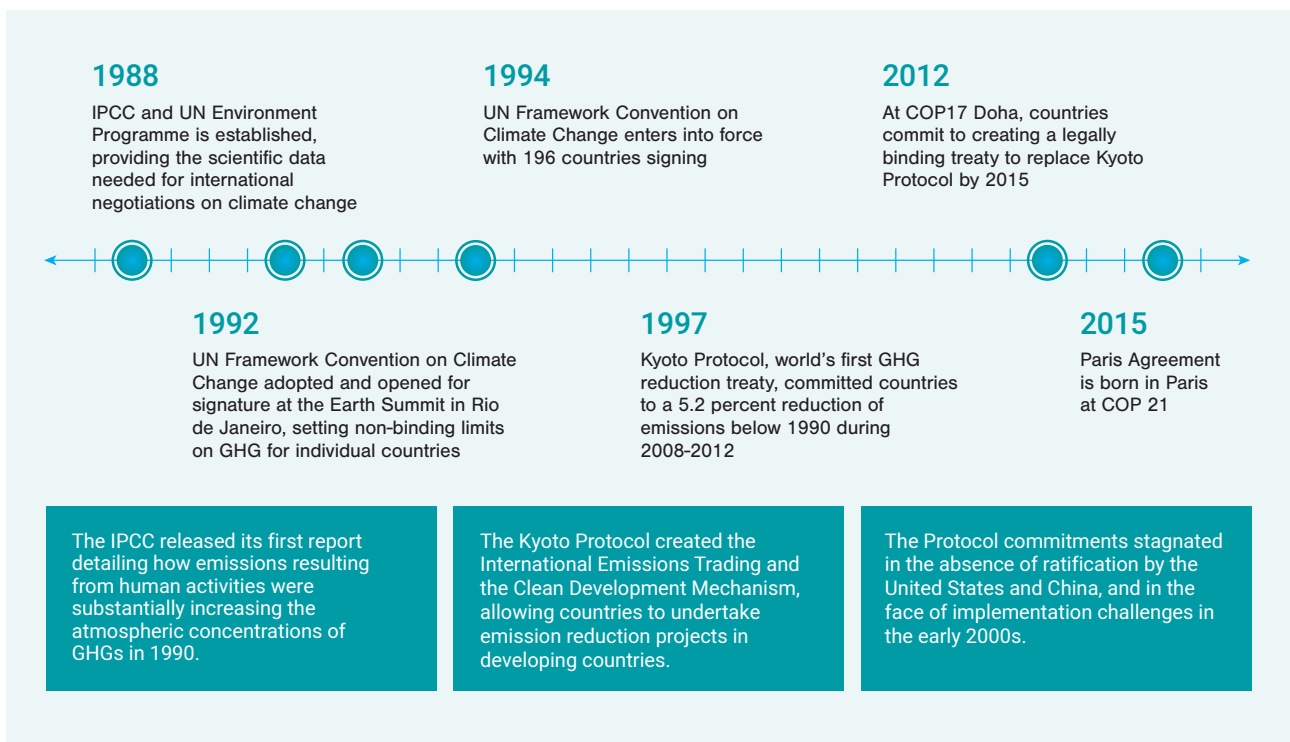
## Climate Action and Long-Term Strategies

### 3.1 Global Progress on Climate Change

**The priorities of climate action and sustainable development are inextricably linked, but they have mostly been addressed separately.** Both Agenda 21 and the UN Framework Convention on Climate Change (UNFCCC) emerged from the 1992 Earth Summit in Rio, where countries committed themselves to pursue economic development in ways that would protect the environment and avoid depleting resources. The agreements signed in Rio created major international institutions, each focused on its specific priorities and goals. This enabled the development of enormous expertise and institutional capacity in each field, but also limited opportunities for dialogue and collaboration.

**On the climate side, action has progressed slowly, with a series of discussions and commitments that built on one another to gradually achieve global agreement.** Figure 4 plots the progression of global climate discussions and commitments. The UNFCCC entered into force in 1994, and three years later, countries agreed on the Kyoto Protocol, with developed countries committing to reduce their emissions. That protocol also established market mechanisms that have provided financing for low-carbon development projects around the world. After failing to reach a major new agreement in Copenhagen in 2009, world leaders in 2012 committed to negotiating a new binding pact by 2015, culminating in that year's landmark Paris Agreement.

Figure 4: Global Climate Action Timeline



**Other major agreements in 2015—including the 2030 Agenda for Sustainable Development and the Sendai Framework for Disaster Risk Reduction—reflected explicit recognition of the close links between sustainable development, climate action, and disaster risk reduction.** It is now widely accepted that reducing climate risks in line with the Paris Agreement will make the SDGs more achievable and also help prevent catastrophic events that could reverse development gains. At the same time, when countries act on climate change, they benefit from clean air and water, healthy oceans, resilient cities, and sustainable food supplies and agricultural systems. There is also growing evidence that climate action can unlock new economic opportunities and jobs.

The Paris Agreement not only facilitated a bottom-up approach, with commitments from all countries (NDCs) but also a mechanism to ratchet up ambition every five years. It set a floor—but not a ceiling—for climate ambition, making it clear that countries should aim to limit temperature increase to 1.5°C and achieve net-zero emissions by the second half of the century.

---

## 3.2 Long-Term Strategies and Decarbonization

**The Paris Agreement is a bridge between today’s policies and a future with net-zero emissions.** Several modeling exercises at the global level have mapped out pathways to meet the Paris Agreement objectives. Though many countries already engage in long-term planning, the invitation to submit a long-term low-carbon development strategy (LTS) under the Paris Agreement helps to push near- and mid-term development plans further toward the goal of a climate-resilient, net-zero carbon future. The process of developing a long-term strategy allows countries to determine their ideal future scenario while meeting the SDGs and safeguarding the climate.

**The Paris Agreement also highlighted the scale of finance needed to achieve the goal of keeping warming below 2°C.** Article 2.1c commits parties to making finance flows consistent with a pathway toward low GHG emissions and climate-resilient development, which has spurred significant research to understand the practical implications and how to achieve that objective (Whitley et al. 2018). The World Bank recognizes and acts upon the deep relevance of Article 2.1c to its work with client countries.

**Countries have already begun to submit long-term strategies under the Paris Agreement, looking at escalating ambition in 2030–2050.** This provides a way to foster transparency and information-sharing and to build momentum toward more robust ambition and longer-term thinking. Several countries and subnational entities (regions, cities and companies) have started charting their long-term low-carbon development strategies in that spirit, going beyond their NDCs. Some of these countries are leading the way by adopting net-zero emission targets through legislation. Others have discussed similar targets or set out comparable intentions in a policy document.

**The first round of national pledges was deemed collectively too low, with projections showing that the commitments would still allow global warming of about 3°C by 2100.** A 2019 report by the United Nations Environment Programme (UNEP) found that most countries are not yet on a path that will enable them to meet their NDC commitments. Even if both conditional and unconditional NDCs are fully implemented by 2030, there will be a 29 Gt CO<sub>2</sub>e emissions gap compared with the least-cost pathway to limiting global warming to below 1.5°C. Indeed, global CO<sub>2</sub> emissions increased in 2017 after stabilizing between 2014 and 2016 and reached a record high in 2018 (UNEP 2019). If the emissions gap is not closed by 2030, UNEP predicts that keeping warming under 2°C will be impossible. Accordingly, the report highlights that 2020 is a critical year for strengthening NDCs, and that countries will need to increase their level of ambition threefold or fivefold to achieve the 2°C and 1.5°C goals, respectively. To

secure a safer climate, it is thus essential to raise near-term ambition and align national climate plans with long-term decarbonization pathways.

### 3.3 Benefits of Long-Term Climate Action

Mid-century climate strategies can align with short- and medium-term climate action by offering a long-term vision for a country's development. Such alignment can ensure that NDCs and decarbonization pathways are mutually consistent and avoid tensions and conflicts. It will enable countries to make sound development choices, avoid stranded assets (see section 4.1), ensure policy coherence, make their infrastructure more resilient, and avoid trade disagreements due to different climate policies. A promising example is Costa Rica's LTS, which outlines 10 focus areas to achieve net-zero emissions by 2050, including clear targets to be achieved prior to 2030, forming the basis for updating Costa Rica's NDC and national climate plan, described in Box 3 (Government of Costa Rica 2019a).

A holistic approach can also facilitate cooperation among different ministries, between government and civil society, and among trading partners. Ideally, NDCs and long-term decarbonization strategies should be rooted in development plans and policies, rather than emerging as isolated climate exercises. For example, Canada's LTS informs the pan-Canadian Framework for Clean Growth and Climate Change, a 2030 plan that could also inform Canada's NDC update. Canada also drew on a range of models to lay out a climate and development pathway to 2050. The modeling analysis was used to inform policies across timelines, ensuring mutual consistency.

#### Box 2

#### Long-Term Adaptation Action

**Climate change is already undermining development and increasing disaster risks. It will be impossible to achieve the SDGs without much stronger adaptation action. For many countries, the immediacy of climate risk has been a major motivator to reduce their emissions, even if they are relatively low. At the same time, countries are taking urgent action to reduce vulnerability.**

**The economic benefits of adaptation can be significant: a 2019 study found that investing in more resilient infrastructure in low- and middle-income countries would yield benefits of US\$4.2 trillion (Hallegatte et al. 2019). The Global Commission on Adaptation, meanwhile, has estimated that investing US\$1.8 trillion globally from 2020 to 2030 in five adaptation priorities—early warning systems, climate-resilient infrastructure, improved dryland agriculture, mangrove protection, and making water resources more resilient—could generate US\$7.1 trillion in net benefits (Global Commission on Adaptation 2019).**

**Embedding adaptation in long-term emission reduction strategies can help ensure that climate hazards do not hinder decarbonization and highlight synergies between adaptation, mitigation, and development. It can also help ensure that actions that provide short-term adaptation benefits do not increase emissions and thus exacerbate long-term climate risks. As with mitigation, adaptation strategies need to be incorporated into economic and sectoral planning. Lack of data and methodologies have hindered progress on that front, but more tools and resources are becoming available.**

**Launched in 2018 to encourage adaptation through technology, planning and investment, the Global Commission on Adaptation has become an important resource for governments and businesses. The World Bank's Action Plan on Climate Change Adaptation and Resilience further supports that work and is helping to mainstream adaptation in World Bank operations.**

**Though this report focuses mainly on achieving long-term decarbonization, it also proposes systemic mitigation action that avoids maladaptation and never increases vulnerability. This report highlights many opportunities to advance adaptation and mitigation together, through innovative long-term actions as well as effective policy measures that can also ensure sustainable development.**



## Costa Rica's Long-Term National Decarbonization Plan

Costa Rica launched its long-term national decarbonization plan in February 2019—among the first in the world to showcase a comprehensive roadmap and policy package to achieve net-zero emissions by 2050. The plan covers three periods: beginning (2018–2022), inflection point (2023–2030) and massive deployment (2031–2050).

It calls for the generation of all electricity from renewable sources by 2030, then making electricity the main source of energy for the transportation, residential, commercial, and industrial sectors by 2050. It also lays out country-wide solutions for solid waste management. The cost of implementation is currently estimated to be US\$6.5 billion over the next 11 years alone, to be shared between the private and public sectors.

Costa Rica built its plan through a combination of backcasting (goal-driven projections), open-source energy modeling tools, policy road maps, socioeconomic integration, and participatory processes.

Highlights include:

- » **Just transition:** The plan explicitly addresses social and economic issues such as a disconnect between growth and employment and insufficient investment in long-term infrastructure. It also notes that any negative impacts of a net-zero transition need to be anticipated, neutralized, and overcome through targeted measures and complementary policies. Stakeholder consultations are also seen as crucial to winning public support for these actions.
- » **Fiscal sustainability:** The plan recognizes the need to anticipate and compensate for fiscal impacts. For instance, widespread adoption of EVs would decrease revenues from fuel taxes. The plan identifies potential alternative fiscal measures (such as a uniform carbon price, extending the fuel tax to coal and natural gas, and extending VAT and import duties to fuel) to ensure fiscal sustainability.
- » **Cobenefits of climate action:** The plan also looks at synergies with development priorities such as sectoral competitiveness, operational efficiency, and public health. For example, transitioning to EVs would also improve air quality. Studies calculated net benefits of about US\$20 billion to the country by 2050, with lower operational costs, time saved when congestion is eased, reduced health impacts, and reduced accidents: all of which will soon comfortably offset the initially higher cost of EVs.
- » **Economic growth:** The LTS offers a road map to modernize the economy, generate jobs, and boost growth through production of goods and services with zero-carbon electricity and digital technologies. The National Development and Public Investment Plan (2018–2022) was aligned with the LTS, which will also serve as the basis for updating Costa Rica's NDC in 2020.

Sources: Government of Costa Rica (2019a; 2019b) IDB and DDPLAC (2019).

## 3.4 Climate Action: Challenges over the Long Term

### 3.4.1 Tensions and systemic challenges

**Longer time frames pose a challenge for financial institutions.** Development banks, including the World Bank, are supporting countries' NDCs, but they only look as far ahead as 2030. The banks often work in short-term planning cycles, typically three to five years. Thinking beyond the time frame covered by Strategic Country Diagnostics (SCDs), Country Partnership Frameworks (CPFs), and sector strategies—about five years—will pose a challenge. This is particularly evident when thinking about the transformational actions needed to achieve a low-carbon, resilient future, given that the existing incentives are aligned with immediate priorities.

**Long-term planning is challenging for governments as well.** Governments tend to align their own plans with electoral cycles, typically two to six years. Thus, as countries develop long-term decarbonization strategies, they will need to work backward, conceptually, to translate them

into near- and medium-term actions for routine incorporation into investment plans and national budgets. A promising example is a detailed planning exercise by Indonesia's Ministry of Planning in 2019 to integrate low-carbon growth in the country's National Medium-Term Development Plan 2020–2024 (see Box 4). This work showcases the synergies between economic growth and ambitious climate action.

**Climate policies need to be inclusive and explicitly address social and economic impacts.**

Tensions between social and climate goals have become more visible in recent years, and these experiences highlight the importance of careful planning, targeted implementation, and efficient communication of policy changes, especially when the benefits will take a long time to be visible. Box 5 delves deeper into the social dimensions of climate change. People with low incomes and marginalized communities are particularly vulnerable to climate change impacts, but they may also suffer disproportionately from economic shocks caused by climate policies.

**Effective long-term climate planning requires breaking out of institutional silos.** In many countries, economic planning is not usually integrated with the development of NDCs and long-term climate strategies. Instead, they are led by different ministries, often on different timelines, engaging with different sets of stakeholders. Successful long-term climate strategies will incorporate the perspectives of all key sectors before bringing them into national economic plans and sectoral plans.

**Box 4**

### **Low-Carbon Development in Indonesia: Integrating Climate Action in Development Plans**

The Government of Indonesia launched the Low Carbon Development Initiative (LCDI) to integrate climate action in its development agenda. LCDI aims to identify policies and investments that support economic growth and reduce poverty while also helping Indonesia reduce its GHG emissions.

Under the initiative, the Ministry of National Development Planning (BAPPENAS) conducted an analysis of the economic and environmental impact of low-carbon development policies that could be internalized in the country's National Medium-Term Development Plan 2020–2024. It was based on a set of macro-level, integrated, dynamic models that look at Indonesia's economy, social systems, and other human activities relative to the carrying capacity of natural systems (BAPPENAS 2019).

The result is an emissions pathway that is more ambitious than the country's conditional NDC, while delivering higher economic benefits. It includes ambitious policy measures on energy, efficiency, waste, forest management, and other food and land use issues. This pathway can:

- » Deliver a projected average GDP growth rate of six percent annually until 2045;
- » Reduce emissions by 43 percent by 2030, surpassing Indonesia's conditional targets in its NDC;
- » Reduce the emission intensity of the economy by more than one third by 2030, and by 60 percent by 2045 (relative to 2018).

**Beyond emission reductions:** The low-carbon pathway would also improve labor productivity, add millions of greener and better-paying jobs, reduce extreme poverty, prevent loss of forests, improve air quality, and help close gender and regional opportunity gaps. It also has a lower investment-to-GDP ratio than non-implementation ('business as usual'), and thus promises the country a better return on its investments.

**Implementation challenges:** The next step is to translate the policies and interventions identified in the LCDI planning exercise into the national budget for implementation. Indonesia also needs to reconcile its short- and medium-term climate objectives with long-term sustainable development planning. The LCDI analysis shows Indonesia's absolute GHG emissions rising in the long term even under the most ambitious scenario. This follows from the analysts' focus on what is technically and politically feasible today. Achieving true decarbonization would thus require a substantial transformation in Indonesia's institutional structure and governance approaches.

## Social Dimensions of Climate Policy

Climate policies result in a range of social and economic impacts on different communities, depending on the local context and on how policies are designed and implemented. For instance, while the low-carbon transition could deliver employment opportunities in renewable energy, other sectors will face job losses. China is expected to lay off 1.8 million coal and steel workers (15 percent of the workforce) in the coming years (ILO 2018).

There is wide consensus that climate action should not negatively impact poor countries and people. However, policies such as carbon taxes or prices may result in price increases that disproportionately affect the poor, who spend a larger share of their income on energy services and may lack access to low-carbon alternatives. Perceptions of fairness and the broader socioeconomic context will affect the acceptability and effectiveness of climate policies (Markkanen and Anger-Kraavi 2019).

In October 2019, for example, fuel subsidy cuts in Ecuador resulted in widespread protests when fuel prices almost doubled. Ecuador is particularly vulnerable to climate change, produces 0.11 percent of global GHG emissions and has pledged to derive 70 percent of its energy from renewable sources by 2030.

Long-term decarbonization hinges on effective policy design and sustained public engagement to ensure a just transition for all who are affected. It will require all stakeholders, including policy makers and civil society, to work together to identify potential negative outcomes at the local, national and global levels, paying specific attention to the most vulnerable within their communities. Proactively managing social displacement and effective governance will also be essential to help diversify the economy in regions where livelihoods will be affected by the transition. For instance, communities that depend on coal mining will need support to provide new economic opportunities and help workers make the shift.

Strategies such as subsidies, exemptions, and revenue recycling mechanisms targeted to low-income households can also make a major difference. Japan provides a good example. Since 1987, the government has provided long-term support to smooth the decline of the 'structurally depressed' textile and maritime sectors. This support involved reallocation of resources within and outside the depressed industries, financial aid to struggling firms, and minimizing impacts on labor (Robins and Rydge 2019).

**In an ideal scenario, countries will start with long-term climate strategies,** then develop short-term climate plans, then integrate both in national economic plans, macroeconomic policies, budget allocations and financial sector regulations. In practice, most countries started with short-term climate plans years ago, and will now have to align their short- and medium-term plans with their new long-term vision. The challenge for governments is to recognize that they cannot extend their current emission reduction efforts to 2050, because that is simply not ambitious enough to achieve decarbonization. Instead, they need to work backward from their 2050 goals.

### 3.4.2 Scenarios and uncertainties

**There are many pathways or scenarios that can lead to net-zero carbon by the second half of the century—but all entail significant uncertainties, which are exacerbated by climate change itself.** Decision-makers tend to like clear choices, but they understand that with longer time frames, uncertainty is unavoidable, especially with respect to fast-changing technologies and projections of future climate change impacts. This has often led governments to delay ambitious actions, and instead focus on more immediate and less uncertain strategies. That is no longer an option. It is imperative for countries to navigate these uncertainties and choose a pathway, accounting for trade-offs between different options as best they can. There are multiple tools to assist in decision-making. A key challenge is to reconcile the tensions between long-term and immediate priorities as well as broader systemic issues (see Figure 5). The Republic of Marshall Islands shows how this can be done. Shortly after releasing its long-term decarbonization strategy in 2018, the country aligned its NDC with its 2050 climate strategy.

As a Small Island Developing State (SIDS), its immediate priority is adaptation, but the country also laid out an ambitious emission reduction target for the short term (2025–30), with indicative milestones for 2035, in line with its 2050 vision (Fransen et al. 2019).

**Long-term strategic planning entails several uncertainties due to the long timeframe and complex, economy-wide scope.** Sixteen countries and the European Union had submitted long-term decarbonization strategies to the UNFCCC as of May 2020. A review of early submissions found they cited many of the same uncertainties about mitigation (see Figure 6), including: physical impacts of climate change and trajectory of GHG emissions; future technological

Figure 5: Challenges in Long-Term Climate Action

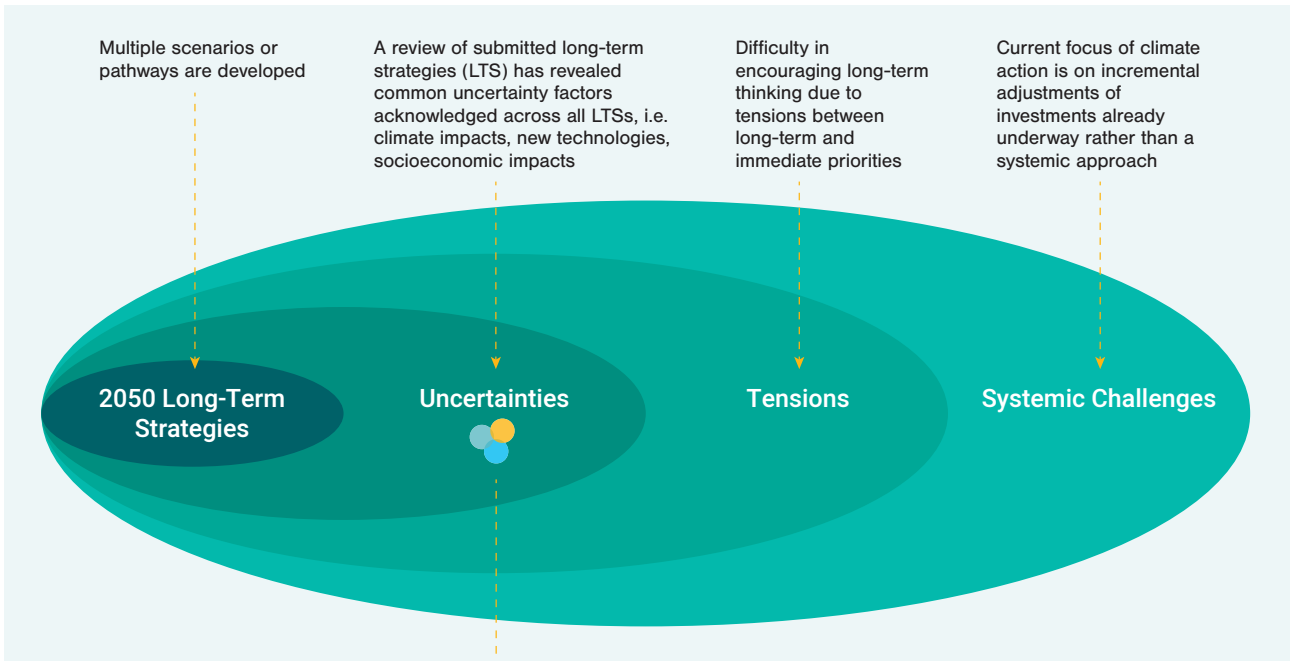
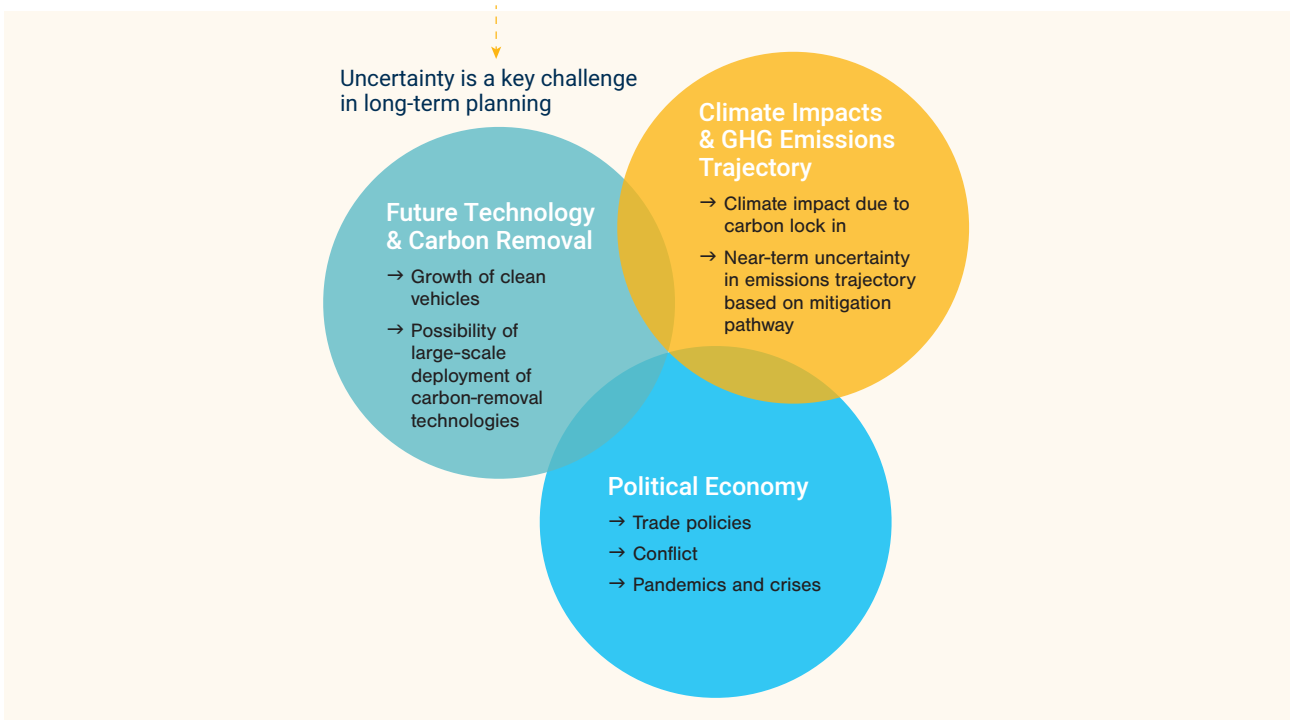


Figure 6: Common mitigation-related uncertainty factors acknowledged across long-term strategies



development and the availability of large-scale carbon removal technologies; politically driven economic perspectives underpinning trade policy; social unrest, conflict, pandemics, and other issues (Fransen et al. 2019). In effect, it becomes imperative in many contexts to consider uncertainties that are often quite independent of climate pressures, such as demand growth, land use, urbanization rates, utility costs, tariff structures, and trade policies. Several sectors are learning to manage climate and other uncertainties through careful analyses and tools such as decision trees (Chattopadhyay and Jordan 2015; Ray and Brown 2015).

**Modeling and analytical work can help in identifying and understanding various scenarios, but the pathway that is ultimately adopted is a political choice.** Sharp turns in climate policy after elections in the United States, Australia, and Brazil have shown how political polarization can derail climate action. Though some countries offer lessons on how to improve political durability, there are no universally applicable answers. For instance, the United Kingdom has been successful in establishing an independent Climate Change Committee that focuses on setting targets and remains independent from politics. Australia developed a similar committee but was unable to isolate its climate legislation from party politics. A long-term vision with broad-based support can help maintain continuity.

**A focus on short- and medium-term targets (such as 2020/2030) may limit mitigation actions to ‘low-hanging fruit,’ delaying much-needed transformational investments.** Without a longer-term outlook, countries may do too little to set out on a path to decarbonization, while continuing to make carbon-intensive investments. This could lead to ‘lock-in’, making it much more expensive to achieve the long-term objective of decarbonization in the second half of the century. Delayed action today will need to be offset by faster decarbonization later, meaning higher costs and stranded assets (Fay et al. 2015). Similarly, not considering future changes in climate and environment conditions may lead to large retrofitting or protection costs in the future, threatening development pathways.

**Countries face very large challenges if they are to achieve the structural transformation needed in the coming decades.** As shown in Indonesia (Box 4), even a highly ambitious scenario can fail to reduce emissions sufficiently to attain decarbonization. Although climate action is underway, driven by public policy and by shifts in preferences and behavior by individuals, firms, and investors, the current scale of action will prove insufficient unless bolstered by much greater investments.

# 04

## Climate Risks and Opportunities in Decarbonization for Financial Institutions

---

### 4.1 Risks of Inaction

**Financial institutions around the world increasingly recognize that climate change poses significant threats to poverty reduction and global development.** In 2015, Mark Carney, Governor of the Bank of England, made a strong case for climate action on the part of financial institutions to integrate climate risk considerations into their planning and investments (Carney 2015). He articulated the economic risks of climate change in two categories:

**Physical impacts** of climate change can destroy physical assets, sometimes erasing billions of dollars' worth of infrastructure and property. Whether it is a city laid to waste by a massive hurricane, or prime agricultural land made barren by an extended drought or by wildfires, the losses can be enormous. These impacts further lead to devaluation of these assets and adversely impact the financial stability and creditworthiness of borrowers (increasing bank liabilities).

**Low-carbon transition risks** arise due to changes in policy, technology, and investor and consumer preferences that can lead to the devaluation of high-carbon assets—for example, oil fields or coal mines—resulting in market destabilization, tighter financial conditions, and further economic losses. A low-carbon transition can ultimately lead those assets to become 'stranded'—with little or no financial value. Given the large share of capital market holdings tied to these sectors, especially from retirement savings and pension funds, this could cause a shock if the markets were to suddenly account for changes in asset prices. To ensure financial stability, it is crucial to integrate climate risks in systemic financial risk assessments and account for them in financial decision-making.

The financial sector is stepping up its efforts to lay the foundations for mainstreaming climate action. For example, In January 2019, the Bank of England announced that it will be the first regulator to stress-test its financial system against different climate pathways, including the catastrophic 'business as usual' scenario and the ideal transition to net-zero emissions by 2050, consistent with the UK's legislated objective. In April 2019, a coalition of 39 central banks, representing half the global economy, convened a working group on the effects of climate change on financial markets. In 2017, the Central Banks and Supervisors Network for Greening the Financial System (NGFS) was launched to mobilize mainstream finance to support the transition toward a sustainable economy by developing an environmental and climate risk management framework for the financial sector. The Task Force on Climate-Related Financial Disclosures (TCFD) was set up in 2015 by the Financial Stability Board (FSB) to develop voluntary, consistent climate-related financial risk disclosures for use by companies, banks, and investors in providing information to stakeholders. In 2019–2020, large financial firms such as Goldman Sachs, BlackRock, and JP Morgan announced their goals to include climate risks in their investment considerations.

---

## 4.2 Opportunities in Decarbonization and Resilience

**Climate action presents strategic investment opportunities for better development and growth that is inclusive and sustainable in the long term.** As countries work toward developing long-term decarbonization strategies, there will be growing demand for finance to implement them. Technologies and policies alike may pose several challenges for financing and implementation. MDBs such as the World Bank have a significant role to play in piloting and scaling up these solutions through appropriate programming of development finance and climate finance. They may use a range of instruments to build the enabling conditions, de-risk new technologies, and develop markets around these new solutions.

**Global climate action to date has mainly entailed bottom-up sectoral initiatives that are relatively fast and easy to implement.** This has resulted in incremental mitigation efforts within individual sectors, not the deep systemic shifts that are necessary for decarbonization and resilient development. Until recently, there has been little support for integrating climate action in macroeconomic planning, national budgets, and the financial sector. By mainstreaming climate action into these macro frameworks, governments can start to move beyond incremental efforts on mitigation and adaptation and seize bigger opportunities.

The Coalition of Finance Ministers for Climate Action is supporting that shift. Launched in April 2019, with governments from over 20 countries, it aims to drive stronger collective action, focusing on the unique capacity of finance ministers to address climate priorities. The Coalition endorsed a set of six common principles, known as the Helsinki Principles, that promote national climate action, especially through fiscal policy and the use of public finance. They were designed to support finance ministers to share best practices and experiences on macro, fiscal, and public financial management policies for low-carbon and climate-resilient growth. The Coalition aims to help countries mobilize and align the finance needed to implement their national climate action plans; establish best practices such as climate budgeting and strategies for green investment and procurement; and factor climate risks and vulnerabilities into members' economic planning. By December 2019, membership had grown to 51 countries, covering 30 percent of global GDP.

The World Bank will play a crucial role in helping countries to finance investments identified through long-term strategies and planning, and to integrate long-term climate objectives in the analytical work in SCD diagnostics and priorities in CPFs. This is a tremendous opportunity for the World Bank to ensure a move away from an incremental approach toward transformational climate action and a focus on overall development dividends that are ultimately integral to all operations.

# 05

## The World Bank Outlook 2050 Initiative: Approach and Methodology

The World Bank Outlook 2050 initiative was launched to lay out an approach for the World Bank to help countries achieve net-zero emissions and resilient development by the second half of the century. The initiative brings together teams from different sectors as well as global practices (GPs) and regional units to think strategically about how the world is changing and what the year 2050 could look like.

Discussions covered future trends for technology, markets, financing instruments, and consumer priorities; the shifts needed to meet the goals of decarbonization and resilient development; and how this could affect country development trajectories. Of particular note was the question of potential trade-offs, and how World Bank support can be deployed effectively to soften adverse effects for clients. Figure 7 outlines the three areas for engagement to ensure the integration of long-term priorities on climate change and consideration of new investment areas (or phase-out of old investments), capacity and resources needed to support countries.

The World Bank embarked on an engagement plan based on a series of consultations (see Annex for detailed information on sectoral and cross-sectoral consultations). For each, a sectoral summary of World Bank-supported climate action was prepared, based on a portfolio review, along with a gap analysis identifying missed opportunities for climate action, and future sectoral trends based on a range of external scenarios.

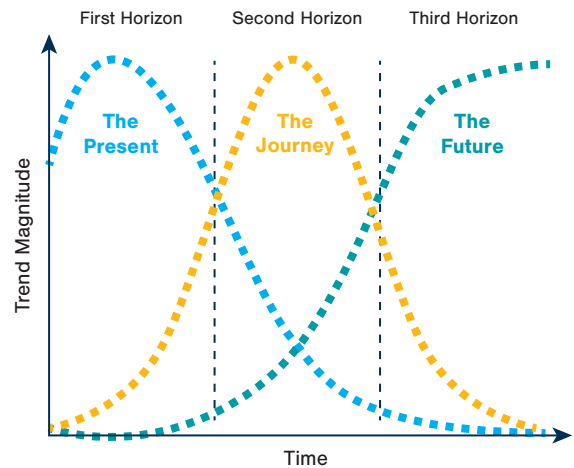


Figure 7: World Bank Engagement Areas Influenced by Climate Goals





The first consultation was organized with all sectoral and regional focal points from the Sustainable Development and Infrastructure Global Practices. Based on these cross-sectoral discussions, proposals for further, scalable climate actions were developed. These were incorporated into the 2025 World Bank Climate Action and Targets. After completion of all the sectoral consultations, a final cross-sectoral consultation was held where the sectoral teams identified and developed recommendations for future, long-term cross-sectoral priorities for climate action.

The team also held consultations with 11 sectors across the Sustainable Development, Infrastructure, Equitable Growth, Finance and Institutions practice groups, as well as with the SCD advisory group, to gain insights into integrating long-term climate priorities into World Bank country engagement strategies and operations. Each consultation examined the challenges in scaling up climate action with clients, how World Bank experts could support sectors in integrating long-term climate action, and the near- and medium-term strategies available to World Bank teams through current engagement models to support countries in meeting decarbonization objectives. These consultations were based on the 'Foresight Approach,' which invites participants to envision the most desirable future state they can imagine.

The consultations identified several opportunities for long-term climate action that are described in detail in Sections 7 and 8, including actions with high mitigation potential and ones that could support both adaptation and mitigation. They also emphasized the need to ensure adequate in-house expertise on climate and digital development and innovative financing to respond to country demand, which will be critical to boosting decarbonization efforts. A common priority was to develop structured approaches tailored to each country's economic, sectoral, and climate context.

# 06

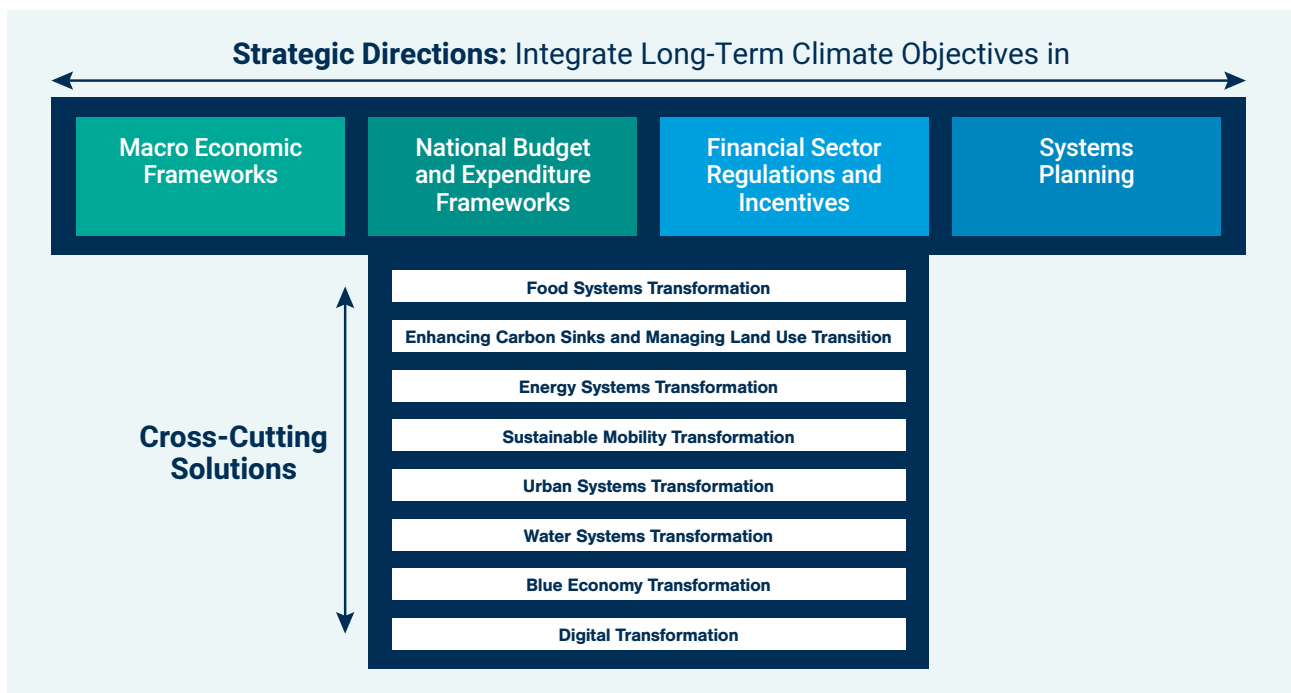
## World Bank Priorities to Support Countries on Long-Term Decarbonization Goals

The World Bank has identified four strategic directions that are seen as crucial to enabling a ‘whole of economy’ approach: to integrate long-term climate objectives in macroeconomic frameworks, national budgets, financial sector regulations, and systems-level planning. In addition, eight priority areas for action were identified, all cutting across multiple sectors: food systems, land use, oceans, energy, mobility, urban areas, water, and digital transformation. Figure 8 summarizes these strategic directions and cross-cutting priority areas. Section 7 presents an overview of the four economy-wide strategic directions; Section 8 examines the eight cross-cutting priority areas; and Section 9 focuses on the additional resources and capacity that will be needed within the World Bank to implement this ambitious agenda.

As noted in Section 4, climate action to date has tended to focus on smaller, incremental actions within individual sectors, sometimes with significant benefits, but still not transformational. World Bank operations have also focused on incremental sectoral actions, trying to extend the current trajectory of climate action rather than tackling systemic shifts at the problem definition stage so as to design development solutions with a long-term perspective.

Achieving decarbonization will require economies to embrace profound economic transformation, so climate action needs to be intrinsically connected with the choice and pace of economic growth activities. This is particularly the case as mitigation actions need to be embedded in all sectors of the economy. The priorities identified in the Outlook 2050 approach emphasize the need for a combination of top-down and bottom-up approaches to achieve deeper transformations. Fast-tracking economy-wide actions can help overcome the disconnect between economic planning and bottom-up sectoral mitigation efforts.

Figure 8: Outlook 2050: Strategic Directions and Cross-Cutting Areas



# 07

## Economy-Wide Actions

Support from the World Bank can be a catalyst for decarbonizing countries' economies not just at the project or sectoral level, but through systemic changes. This section looks at four economy-wide actions: macroeconomic frameworks and fiscal policies; national budgets and expenditure frameworks; financial sector regulations; and adopting a systems approach that creates an enabling environment for long-term climate action. The World Bank's proposed approach is thus to fast-track economy-wide actions to align long-term goals for economic growth and climate action. The cross-cutting actions described in Section 8 would also help ensure that the ambition of short-term actions is consistent with the long-term climate objectives.

---

### 7.1 Strategic Direction 1: Embed Long-Term Climate Priorities in Country Macroeconomic Frameworks

Climate change hazards can be chronic—long-term, gradual changes such as rising average temperatures, shifting precipitation patterns, and sea-level rise—or acute—such as extreme heat, droughts, wildfires, floods, and storms. Though the impacts are felt differently, both types can affect the entire economy (see Section 4). Conventional macroeconomic models do not adequately account for these risks or for natural resource constraints, however, and it is likely that they overestimate 'business as usual' global growth. As a result, they create few incentives to shift away from current carbon-intensive economic pathways.

A further challenge is that climate action so far has been driven mainly by sectoral regulations and public investments. Sectoral, project-based approaches are relatively easier to implement, but they are less cost-effective, and they cannot achieve the scale of action needed to meet the ambition of decarbonization and resilient development. The way to overcome this issue is to link sectoral approaches to economy-wide planning and policy development and embed them in fiscal reforms that provide incentives for appropriate private sector investments. Macroeconomic and fiscal policies are the central elements of a least-cost approach to climate action—but in most countries, those policies are currently based on models that either underestimate how climate change affects the economy, or completely ignore it.

Decarbonization objectives need to be integrated into all aspects of national planning and financing frameworks. A key first step is to build those objectives into the macroeconomic growth models that inform each country's fiscal planning, policies, and national budget and serve as inputs for sectoral models for planning investments. This will entail an analysis of all channels through which climate change affects different sectors, including both physical impacts and the impacts of a transition to a low-carbon economy, and internalizing the costs and benefits of low-carbon investment choices across sectors.

#### 7.1.1 World Bank engagement to date

The primary focus of World Bank engagement has been to ensure macroeconomic and fiscal stability for countries. However, to the extent that this work has not yet accounted for climate change risks, it has underestimated the potential for adverse impacts. Given the World Bank's

heavy focus on public investments, there has also been limited engagement on fiscal policies that create an enabling environment for climate-friendly investments through sources other than public finances.

Current engagement on fiscal policies focuses mainly on advisory work on removing energy subsidies. This is crucial, as fossil fuel subsidies are a significant fiscal burden and harm the climate. The methods used by different international organizations to measure subsidies vary in scope, magnitude, and time period, but the numbers are very large: from US\$400 billion (IEA 2019b) to US\$5.2 trillion (Coady et al. 2019); another study provides a range between US\$370 billion and US\$620 billion over the period 2010–2015 (OECD 2018). These issues need to be resolved in order to enable countries to better understand, track, and manage effective targeting of subsidies and providing incentives for low-carbon pathways. Further subsidy removal is essential to creating a level field for clean energy and conventional carbon-intensive fossil-based energy sources.

However, this limited engagement on climate-friendly fiscal policy is not sufficient to enable market transformation in favor of deeper mitigation investments. This reflects a broader pattern around the world: there are still few incentives for the private sector to make large investments in a low-carbon transition. As a result, climate action continues to rely heavily on public investments, increasing pressure on already scarce public resources.

### 7.1.2 New frontiers for lending and technical assistance

The World Bank will help client countries embed long-term climate goals and concerns in these key areas:

- » **Macroeconomic growth projections:** The World Bank will ensure that growth accounting exercises (for country support and internal assessments) factor in a low-carbon transition and adaptation and resilience at the macroeconomic planning stage. Conventionally, this is to a limited extent implemented through changes in the rate of capital depreciation. Other key effects now need to be integrated, including those on labor productivity and sector yields. Low-carbon transition costs for the economy should also be integrated in such a way that the models include pathways to meet NDC targets in the medium term and decarbonization in the long term (mid-century).
- » **Scaling up climate-informed macroeconomic assessment tools:** The World Bank is running pilots for integrating climate shocks and adaptation in its core macroeconomic and fiscal model (MFMod) and its toolbox for fiscal risk assessment. The tool for analyzing the debt sustainability of low-income countries now contains the capacity for stress-testing for the effects of natural disasters. There are also efforts to incorporate climate change in the medium-term fiscal framework (rather than the short-term annual focus). However, data and capacity constraints have hindered an effective scale-up of these features of the tool across client countries. Through cross-sectoral collaboration internally and with external partners, the World Bank will invest in developing the required data systems and technical capacity to scale up support to countries as they seek to integrate climate shocks—alongside adaptation for a low-carbon transition—into macroeconomic assessment tools.
- » **Strengthening country capacity to demand, adopt and implement climate-informed macro frameworks:** The integration of physical and transition risks and climate actions in SCD analytics will help develop and identify climate-informed priority actions for Bank engagement that are aligned with long-term

climate objectives. Typically, only a subset of these priorities are covered by a CPF (which defines World Bank engagement in the country), mainly driven by client demand. Country demand for climate priorities, especially on mitigation, has been limited, so these are often not included. It is thus important to build an analytical base that provides the rationale for integrating climate into macroeconomic frameworks and planning, to help countries understand the value of climate action and seek to include climate in their CPFs and their macroeconomic and sectoral plans. The World Bank will provide support for climate-informed macro frameworks to form the basis for country growth plans, NDCs and long-term decarbonization strategies. It will also facilitate international discussions to enable finance ministries to share relevant experience.

- » **Scaling up fiscal policy engagement for climate action:** The World Bank will scale up support to countries on identifying and implementing suitable fiscal policy instruments that incentivize and ramp up climate-friendly investments. This will include providing robust data on the cost and climate impacts of fiscal policies, to help evaluate their effectiveness and suitability. The World Bank will also provide assistance, tailored to client demand, on the design of such policies.

Fiscal policy is in principle a highly effective and equitable means of acting on climate change. However, it requires a stable political environment, as well as consistent and long-term institutional commitments to design and implement the necessary policies in a socially equitable way. As noted above, the World Bank's current engagement on fiscal policies focuses mainly on advisory work on removing energy subsidies. In addition to action on subsidy removal, it is vital that the World Bank scale up engagement on other fiscal policy instruments to ramp up investments in low-carbon alternatives. Examples of such instruments include a carbon tax on carbon-intensive fuels and products and 'feebate' schemes that accelerate the uptake of energy-efficient vehicles and equipment. In addition to making carbon-intensive investments unattractive and delivering cobenefits from low-carbon investments, carbon taxes also increase government revenue, increasing public funds available for green investments and other national priorities.

---

## 7.2 Strategic Direction 2: Embed Long-Term Climate Planning in National Budgets and Expenditure Frameworks

Investing in low-carbon transition pathways and protecting investments from climate-related extreme events requires strengthening national budgetary capacity, identifying resources for climate action, optimizing public resource allocation, and unlocking private financial flows.

As noted above, the first step is to develop climate-informed macroeconomic frameworks. The next step is to ensure that national budgets and plans account for climate-related expenditures and prioritize near-term investments that are aligned with long-term climate objectives. Although spending agencies across sectors may prioritize climate action, they tend to lack the levers to influence spending by other agencies. This may have an impact on the climate positive outcomes of their spending (due to the cross-sectoral nature of actions) and can impact the overall availability of resources for climate action. Therefore, action by central finance and planning agencies is critical to ensure that economy-wide objectives of climate change are adequately addressed and resourced. However, attempts to date to integrate climate strategies into national budget and plans have proved to be challenging.

Central finance and planning agencies rely on public financial management (PFM) systems to allocate resources across multiple agencies based on agreed strategic priorities—which should include climate objectives. However, there is very limited experience in allocating resources for climate priorities across sectors through PFM, or in accounting for physical climate risks and mitigation goals. Second, not all sectoral agencies integrate climate objectives into their spending priorities. As a new policy area, there is little guidance on how to incorporate climate considerations in national budget planning and allocation. This is partly due to limited experience with climate issues and capacity constraints in planning and finance ministries. Furthermore, most governments’ budgeting and planning cycles focus on short-term actions aligned with the terms served by elected officials, so they are not always conducive to long-term planning.

Climate change is an economy-wide challenge, so actions to address it cut across sectors and multiple agencies, making it harder to prioritize budget allocations. Long-term expenditure planning for climate action can be made more manageable by building short-term budgets as part of a road map of actions to meet long-term decarbonization objectives, integrated into sectoral plans. PFM systems can be adapted to support this. It is imperative to move beyond incremental climate action to systematically embed long-term climate objectives at all levels of policy planning, project design, implementation, monitoring, and evaluation. This will enable a ‘whole of government’ approach and provide a framework for increased synergies among different ministries. Success in mainstreaming long-term climate goals should be measured by the extent to which governmental spending is climate-informed, resulting in climate positive outcomes (World Bank 2019b).

A recent global assessment estimated that climate action could unlock US\$26 trillion globally in investments and create 65 million more jobs through 2030 (Global Commission on the Economy and Climate 2018). A significant share would be public investments relying on national budget allocations, and the rest would comprise private sector investments enabled by market signals derived from fiscal planning, expenditure policy, and budget priorities. Embedding long-term climate action in these processes requires a stable political environment and consistent and long-term institutional commitment. Government expenditures can be reinforced by fiscal policies such as environmental taxes and removing fossil fuel subsidies. Public investments in adaptation and resilience are also crucial. Waiting until climate impacts have occurred – especially extreme events and disasters—can result in a higher overall fiscal burden after disruptions of economic activity and long recovery periods.

## 7.2.1 World Bank engagement to date

The World Bank’s work in this field has mostly focused on support for climate budget tagging and expenditure reviews. This has been useful for ministries of finance and for planning agencies to understand national spending on climate-related priorities, and it provides building blocks for future climate budgeting. The World Bank has also developed a tool to support the integration of climate change considerations into public financial management. This work has been focused primarily on disaster preparedness and resilience, such as the PFM toolkit for the Caribbean countries to ensure the effective allocation of funds mobilized, especially of scarce climate finance.

## 7.2.2 New frontiers for lending and technical assistance

The World Bank will embed a climate change perspective in its work with national planning and finance agencies and provide support across its country programs in the following key areas, which are also aligned with the fourth of the Helsinki Principles (Coalition of Finance Ministers for Climate Action 2019):

- » **Climate change as a long-term objective in the national budget and expenditure framework:** The World Bank will support countries in integrating

climate change objectives into their national budget and medium-term expenditure framework (MTEF). The MTEF lays out allocations to spending agencies over a three- to five-year period, allowing adjustments in resource allocations within that period. Introducing climate change into this framework will signal the importance of climate action and provide certainty and predictability to agencies for their climate expenditure planning while allowing for adjustments across programs. This process can also enable prioritization of programs with climate benefits.

- » **Climate Change Public Expenditure Reviews (CCPERs):** The World Bank will scale up support to governments in assessing, monitoring, and reporting the climate impacts of public expenditures through expenditure reviews and by tagging climate-specific expenditures. We will work with finance ministries to develop frameworks requiring line ministries to report on their climate action, spending and outcomes. The CCPERs can also help identify cross-sectoral links to improve the cost-effectiveness of climate actions by coordinating across institutions. CCPERs should also be implemented for external finance for climate action to improve performance outcomes and accountability. Climate expenditure data obtained through CCPERs can inform future budget cycles and help ensure appropriate allocations across priorities.
  
- » **Public investment and asset management:** The World Bank will scale up support to countries to integrate climate considerations into decision-making for public investment design, appraisal, and asset management. This will entail developing a climate-informed framework for public investment and asset management to be applied consistently into portfolio-level planning and project-level appraisals for public investment projects. The framework will include climate risk screening and risk analysis to design resilient infrastructure and integrate shadow carbon prices to design mitigation investments. These assessments to inform public investment decisions should be rooted in policy directives and budget circulars that set a strategic vision for climate action. If central agencies have requirements for formal approval of new projects, this would provide a concrete opportunity to integrate climate-related criteria in decision-making on project selection and appraisal. Given that NDCs are mostly focused on public investments and regulations, it is critical for public investment management to integrate climate objectives. Further, because infrastructure tends to be immediately and drastically hit by extreme events, this forces countries to spend most of their capital on rebuilding and repairing assets instead of making new investments. The World Bank will also work with countries to integrate climate objectives into public asset management policies and practices.
  
- » **Access to climate finance and public financial management:** Several countries face considerable fiscal constraints in finding resources for new low-carbon and resilient investments. External climate funds such as the Green Climate Fund, Climate Investment Funds, and the Global Environmental Facility are sources of international public finance. The World Bank will scale up its support to countries to strengthen public financial systems, thus enhancing their capacity to attract external climate finance from both multilateral and bilateral sources and use it more effectively. Given the scarcity of public funding, there is also a need to mobilize private sector finance to fill the gap. This aligns with the World Bank's Maximizing Finance for Development agenda as well. Governments can also mobilize financing from markets on attractive terms by issuing 'green' or sustainability-linked bonds that commit them to implement climate change policies. The World Bank will scale up support to countries on accessing finance from markets using such innovative instruments.

- » **Green public procurement:** The World Bank will support clients in integrating climate and broader sustainability considerations in decision-making for public procurement. Green procurement can enable a measurable reduction of the environmental footprint of government activities on solid waste, air pollution, water pollution, and GHG emissions. It can also provide cost savings by reducing inputs such as energy, water, and materials. Green procurement can be used to facilitate the development of green industries, create green performance standards, and conduct life-cycle assessments. Efforts to scale up green procurement will require clear market signals through policies and goals (for example, regulations and design standards) and revision of procurement guidelines to enable swift implementation. This should be complemented by assessments of agencies' performance on green procurement and evaluations of the effectiveness of initiatives in meeting policy goals. These approaches tend to be suited to the procurement of products and goods; new strategies will be needed for services, which make up a large share of government procurement.
  
- » **Incentives for subnational climate action:** The World Bank will support countries in developing incentives that help scale up intergovernmental climate-related fiscal transfers to subnational governments, state-owned enterprises and other agencies to integrate climate change in their plans or corporate objectives—for example, local governments undertaking mitigation actions. This should further be complemented by the development and implementation of reporting procedures and standards for progress on subnational climate action.
  
- » **Climate risks and state-owned enterprises:** The World Bank will support countries in development of frameworks that help state-owned enterprises (SOEs) assess and account for the physical and transition risks of climate change. To enable successful implementation, tailored tools and data sources will need to be made available, along with training programs to develop institutional capacity. Climate risks can have significant financial impacts on SOEs, affecting public revenues and service delivery. The infrastructure sectors in many developing countries are dominated by SOEs, such as energy and water utilities, transport networks, and industrial units. These sectors are also responsible for a large share of national GHG emissions. Thus, it is important to support countries in appropriate climate risk assessment, underpinned by relevant disclosure of SOE activity, so as to inform corporate strategy and future investments.

---

### 7.3 Strategic Direction 3: Embed Long-Term Climate Objectives in Financial Sector Regulations and Incentives

Climate change poses a dual challenge to the financial sector: to mitigate and manage climate risks, and to align capital flows with climate goals. Much remains to be done on both fronts; to date, the sector has mainly addressed risks from the physical impacts of climate change, which are substantial, but they have yet to fully factor in the risks from a low-carbon transition and related policies.

The world's fossil fuel reserves are a paramount concern. These far exceed what can be combusted within a 2°C climate budget (IEA 2020a). Partially exploited reserves and related infrastructure could ultimately become 'stranded' assets that rapidly lose their value. Many institutional investors are also under intense pressure to divest from fossil fuels. In 2019, Norway's sovereign wealth fund, the world's largest, announced that it would sell off more than US\$10 billion of stocks in companies whose activities relate to fossil fuels (Nikel 2019). Given the large



share of capital market holdings tied to carbon-intensive sectors, especially from retirement savings and pension funds, there could be a real shock to the markets if the value of high-carbon assets were to be adjusted suddenly to reflect expectations of a net-zero carbon future.

To ensure financial stability, it is crucial to integrate climate transition risks into systemic financial risk assessments and account for them in financial decision-making. Currently there is no systemic assessment of such risks, and firms do not disclose their climate risk exposure. Many firms seem unaware of their carbon footprint or of the risk of their assets being stranded. In cases where firms do disclose this information, reporting is usually inconsistent across industries or geographies. The UK-based CDP (formerly known as the Carbon Disclosure Project) tries to address this challenge by providing consistent metrics that are easy to access, compare and benchmark. In 2018, the CDP updated its disclosure platform to align with the recommendations of the Task Force on Climate-related Financial Disclosures (TCFD). In 2019, the CDP reported that over 700 companies with significant environmental impact had not disclosed critical environmental information (CDP 2019). Very few investors have the information and tools to factor in the climate exposure of their investment portfolios.

The financial system can help manage climate risks and mobilize capital for climate action for financial stability. Integrating climate elements in financial sectors has two objectives: 1) a climate-resilient financial sector (that is, climate action for financial stability), and 2) mobilizing green finance for alignment with adaptation and mitigation objectives.

As noted earlier, climate change also represents a significant investment opportunity – with one study (IFC 2016) estimating US\$23 trillion in investment potential based on the NDCs of a selected number of emerging markets by 2030 alone. Climate exposure disclosures can help shift investor decisions in favor of low-carbon investments. Catering to these investor choices, the green financial market—which comprises green bonds, green indexes, and decarbonized investment portfolios, among others—offers a variety of investment options with low climate exposure. However, the effective use of these instruments is usually hindered by a lack of stringent standards for green bonds, limited climate mitigation policies, and delays in emission reduction policy and political decisions. Thus, it is imperative to strengthen oversight by providing the appropriate instruments to disclose and manage climate risks. Central banks and other financial sector regulators, along with finance ministries, have a key role to play in making climate action a priority.

### **7.3.1 World Bank engagement to date**

The World Bank has worked with countries to provide financial market solutions to address physical impacts of climate change through the Disaster Risk Financing Insurance Program (DRFI) and risk modeling for physical risks of climate change. The program supports four main beneficiary groups: governments; farmers; homeowners and small and medium enterprises; and the poorest and most vulnerable. Its priority areas include sovereign disaster risk finance, market development, analytics, knowledge management and global partnerships.

The World Bank is currently providing support to regulators and supervisors to better manage climate-related and environmental risks and opportunities for the financial sector. The work plan has several key components: risk diagnostics and stress-testing, including Financial Sector Assessment Programs (FSAPs); technical support to regulators and supervisors, including global engagement with the Network for Greening the Financial System (NGFS); capacity building with leading domestic institutional investors in emerging markets; and work to develop new financial instruments and green financial markets.

New programs to support countries in addressing low-carbon transition risks to the financial sector are being developed. These include:

- » **The Financial Sector Assessment Programs (FSAPs)**, a joint effort by the World Bank and the International Monetary Fund (IMF), entail regular assessments of a country's financial stability and relevant advice to ministers of finance and central bank governors globally. A specific module has been introduced to assess climate risk and opportunities. Four countries have now been assessed (South Africa – ongoing, Philippines, Bangladesh, Trinidad and Tobago). This well-funded program will continue to focus meticulously on assessing transition risks, and offering guidance on their management, alongside ways to address green finance barriers.
- » **The Global Program on Sustainability (GPS)** is a joint initiative run by the Environment Division of the World Bank, in collaboration with the Finance, Competitiveness, and Innovation team. The focus is on embedding sustainable finance considerations, including natural capital, into markets.
- » **30by30zero program** is a joint World Bank/International Finance Corporation (IFC) initiative which aims at 30 percent green lending by 2030 with zero climate risk for a selection of four countries. It gives countries support at three levels: policy level (supervisory actions and regulations, taxonomies); market level (green bond support); and financial institution level (direct technical assistance for banks and investors on how to manage climate risk and target green investment). The program is linked to roughly US\$1.2 billion in lending from the IFC.

### 7.3.2 New frontiers for lending and technical assistance

Effective regulation of the financial sector is central to support for climate action. The World Bank can help countries strengthen climate-related regulations and maintain potential and actual investor confidence. It is well positioned to support countries in creating sustained low-carbon economic growth and macroeconomic stability while accounting for climate change risk and financial stability.

**Financial sector regulations for banking and beyond:** A key role for the World Bank is to ensure that evolving international regulatory standards are implemented appropriately in the context of emerging markets, to ensure stability but not stifle their development. This work needs to go beyond the banking sector (including state-owned banks), embedding climate risk assessment into non-bank financial sector regulations covering the insurance and pension sectors. It should also cover new areas, such as microfinance, which constitute a major part of the financial system in many emerging markets, and have yet to adapt to the climate risks to which they remain highly exposed. It remains to be seen whether regulatory support can go beyond disclosure to prudential requirements—including capital requirements and collateral requirements which favor green investments. If so, suitable mechanisms must be devised. Regulators around the world are still demanding further evidence that green investments represent materially lower risk. Work on climate risk assessment within credit rating agencies—including for sovereign bond analysis—is another area where the World Bank can provide data and analysis.

**Innovative financial instruments:** Innovations are also required in terms of financial instruments and how to use blended finance tools to incentivize private financing. The focus needs to move beyond the renewable energy sector, which has witnessed notable successes—such as the Renewable Energy Independent Power Procurement Program (REIPPP) program in South Africa, or the Infrastructure Development Company Limited (IDCOL) in Bangladesh—to urban projects, transportation, forestry, and climate-smart agriculture. The growing success of and lessons learned from the green bond market can be broadened into other financial instruments—from sustainability-linked loans and securitized products, to targeting equity funds and indexes

and related products which can shift capital at scale. Green mortgages are a good example of how a financial sector product can be a strong catalyst for action in the real estate sector (as has been the case particularly in Europe). Finally, more support for the greening of financial systems can be provided through development policy operations that integrate green finance and climate risk management to better leverage World Bank's unique competitive advantages.

**Regulatory work on stress-testing, reporting and disclosures:** The World Bank will support countries in the development and implementation of climate-related stress-testing and disclosures for the financial sector. This will entail designing a harmonized approach for disclosure rules that is rigorous and user-friendly. The Task Force on Climate-related Financial Disclosures (TCFD) and Network for Greening the Financial System (NGFS) have been working on the development of these approaches. The World Bank will support countries in improving their understanding and management of climate-related financial risks, specifically for capital providers (banks, insurers, asset managers). It will include support for countries on stress-testing of portfolios against different climate pathways. These approaches are still at an early stage, but will be very widely implemented when further developed. The World Bank will provide technical support to regulators to design and implement supervisory approaches to assess and manage climate and environmental risks. It will also support capacity building efforts for successful implementation of disclosure rules. In addition, it will provide support for the design and implementation of green and sustainable taxonomies—that is, categorization of green activities that can help measure green finance flows and label financial instruments. The joint World Bank/IFC program launched in Colombia in 2020 provides a blueprint for future engagements, covering work on a national taxonomy; climate stress-testing and reporting guidelines for the banking sector; and support for incorporating environmental, social and governance (ESG) risks into non-banking (pensions and insurance) regulation and the methodologies of domestic institutional investors. Further to a request by Morocco's Bank Al-Maghrib, a program is under development to provide similar support there, and additional country requests are pending (including in Asia and in Latin America). These programs are jointly designed and implemented with World Bank Group partners, including the IFC, the World Bank Treasury and the Environment Sector/Global Practice.

**Support international networks:** The World Bank provides support to several high-profile international networks that will prove crucial for harmonizing sustainable finance standards globally and embedding these practices into financial markets. The World Bank's role is to ensure that emerging implementation is handled in an appropriate and proportionate fashion. For example, since 2018 the World Bank has been an observer to the Network for Greening the Financial System (NGFS), a group of central banks and supervisors from 46 countries that share best practices on and contribute to the development of environment and climate risk management in the financial sector. The World Bank will use recommendations by the NGFS (including the work on the market dynamics group) in capacity building missions in client countries, while promoting the new knowledge it generated in interactions with the NGFS. Support is also being provided under the fifth of the Helsinki Principles (Coalition of Finance Ministers for Climate Action 2019), which tackles how government support and incentives can be used to attract private sector finance for climate action. The World Bank will work with other financial sector standard-setters to help embed climate considerations into their works programs and international guidance—including the Basel Committee for banks, International Organization of Securities Commissions (IOSCO) for the securities sector, the International Association of Insurance Supervisors (IAIS) for insurance, and the OECD/International Organization of Pension Supervisors (IOPS) for work on the pension sector.

**Sustainable Finance and Environmental Social and Governance (ESG) Integration:** The World Bank is already working to create a more sustainable global financial sector that better integrates ESG criteria, particularly related to climate change. A central component of that work is providing investors with improved country-level sustainability information including through the ESG Sovereign Portal. The World Bank will focus on promoting green finance through

support for investor practices, providing technical assistance to leading institutional investors in emerging markets to help them become leaders and catalysts for change in their own regions. In this regard, the team has already started working with the Government Pension Fund in Thailand.

**Mobilizing and ‘blending’ finance:** Concerted efforts are needed to overcome the impediments to mobilizing private capital. This includes: 1) information asymmetry that needs to be addressed in order to lower transaction costs (such as in project origination and preparation) and correct the perceived high risks; 2) scalability of sustainable investment and standardization of practice, which calls for joint efforts by multiple stakeholders; and 3) challenges to match these different investors with the risk-adjusted returns they seek and allocate the ‘social returns’ through new fund structures. Blended finance projects have to date summoned disappointing levels of private finance, and have not yet directed capital to emerging markets at sufficient scale to tackle rising climate needs. Institutional investors prefer to invest through an infrastructure fund or other externally managed vehicles, and to invest in equity rather than issuing debt. Public actors already use a variety of approaches to mobilize and catalyze institutional investment in sustainable infrastructure. The three most prevalent risk mitigants are loans, co-investments and cornerstone stakes, that is, co-investments with a majority stake taken by a public actor such as a green investment bank. Blending will need to incorporate a range of interventions: i) spending on public policies, regulations and institutional reforms supportive of private sector financing of SDGs; ii) standardized investment instruments and vehicles incorporating SDG performance objectives (such as impact bonds); and iii) grants or concessional capital to bridge the potential risk/return gap for traditional commercial investors.

---

## 7.4 Strategic Direction 4: Embed Long-Term Climate Objectives into Systems Planning

Climate action and sustainable development are inextricably linked. This is why the Paris Agreement explicitly places its climate goals in the context of sustainable development and poverty reduction, and the SDGs explicitly include climate action. For countries, this means that climate and development strategies need not only to achieve their respective goals, but also to avoid significant trade-offs and unintended consequences. Long-term climate strategies thus need to integrate economic growth, social inclusion, and climate and environmental sustainability objectives. They also need to account for impacts across programs or sectors that can undermine progress on one objective in pursuit of another.

A systems approach that assesses cross-sectoral links, regional impacts, and other factors can be effective in addressing multiple objectives and accounting for interconnected components, so it is well-suited for developing long-term strategies. Transformational climate action also requires a systems approach to designing and implementing projects. Such systemic thinking accounts for both trade-offs and synergies among stated development objectives, meeting the needs of both society and the planet by relying on the integrated use of different resources, technologies, or processes while avoiding short-sighted competition among them.

### 7.4.1 World Bank engagement to date

The World Bank Group’s current country engagement strategy, introduced in 2013, involves two steps: (1) Strategic Country Diagnostics (SCDs) and (2) Country Partnership Frameworks (CPFs). The SCD, which serves as the analytical foundation for the CPF, focuses on identifying country development priorities for the next four to six years. It takes into account the expected impact of actions during this period as well as the longer-term impacts of actions on a country’s progress toward national development goals and overall poverty reduction and shared prosperity. It includes diagnostics that combine the perspectives of growth, inclusion, and

sustainability. Recognizing that climate change poses a threat to the development progress made over the past several decades, the World Bank is seeking to mainstream climate change into both SCDs and CPFs, which can then be translated into specific projects and actions.

An early-stage assessment of SCDs and CPFs by the Independent Evaluation Group (IEG) found that SCDs have addressed climate change, but could have gone deeper (World Bank 2016c). For the most part, early-stage efforts to integrate climate change in SCDs focused on ensuring alignment of SCD priorities with NDCs. Given that the NDCs are not ambitious enough to meet the climate goals, mere alignment of SCDs with NDCs will not suffice, and a more in-depth assessment of climate change in SCDs is needed if the World Bank's country engagement priorities are to be adequately climate-informed.

Sectoral engagement in countries also requires a prioritization of investments that can be achieved through sectoral planning. In many countries, sectoral planning analysis has long been adopted as an upstream analysis mainly for the power sector, to develop sectoral master plans to inform investment decisions. However, these planning approaches tend, at best, to look as far as the medium term (generally 10–15 years) and do not adequately integrate climate goals for adaptation and mitigation. Further, they do not fully account for cross-sectoral links; for example, power system planning will commonly disregard the energy-water nexus and electric mobility, and upstream fuel supply issues, or downstream energy access. The World Bank has used sectoral planning tools to inform country engagement (again, the power sector is an example). However, the use of these tools is not consistent across countries or sectors and suffers from the same gaps as highlighted for country sectoral planning. Recent efforts have been directed toward developing and scaling up the use of power system master plans to inform country and regional engagement (see Box 6, for example). However, these need to be enhanced to incorporate a long-term focus on climate goals that outstrip countries' existing energy policies, NDC commitments, and cross-sectoral links. Similar approaches need to be developed and adopted for other sector in combination with economy-wide systems planning.

As sectoral plans build on national plans and macroeconomic models, a disconnect arises when the climate perspective is adopted only at one level. Sectoral planning efforts tend to be more climate-informed than macroeconomic and national budget planning. This can create challenges when line ministries request allocations for climate-informed investments. Aligning sectoral planning with national and macroeconomic planning and fully mainstreaming climate concerns will allow better integration of the long-term vision based on macroeconomic priorities. This will enable governments and financing agencies, including the development banks, to invest in projects that are aligned with the long-term vision and minimize trade-offs across sectors.

## 7.4.2 New frontiers for lending and technical assistance

The World Bank will work to integrate climate-informed systems planning into all levels of engagement programs to inform investment decisions and expand from project-focused incremental climate action to a broader systems approach. The World Bank will design, adopt, and further support clients to adopt a climate-informed, systems-level approach to development solutions. Specific actions include:

- » **Developing long-term strategies using a systems approach.** Based on client demand, the World Bank will support countries in crafting long-term strategies for decarbonization and resilient development. It will adopt a systems approach for the whole economy, engaging with central planning agencies along with ministries of finance to ensure buy-in and resource allocation for implementation. Several countries have initiated or completed long-term climate strategies, but many have yet to begin. Country efforts have been constrained in many cases by a lack of appropriate tools and resources and by limited capacity, among

## Eastern Africa Power Pool: Making the Case for Regional Power System Integration and Emission Reduction

Interest in cross-border power trade has been growing across Africa over the past two decades. Established in 2005, the Eastern Africa Power Pool (EAPP), which includes Burundi, the Democratic Republic of Congo, Djibouti, Egypt, Ethiopia, Kenya, Libya, Rwanda, Sudan, Tanzania, and Uganda, has overcome initial barriers to system integration and is now ready to assess the potential for and practical challenges of system integration and cross-border trade.

A recent World Bank analysis used a least-cost generation and transmission capacity expansion model to assess the economics and CO<sub>2</sub> emission reduction potential of different levels of power system integration between countries in the EAPP, Eritrea and South Sudan. The analysis compared two core scenarios of integration with the current level of limited trade or ‘business as usual’ (BAU) for 2020–2030: (1) ‘shallow’ integration, wherein each country in the EAPP retains its autonomy and interconnections are limited to existing and committed transmission lines, and (2) ‘tight’ integration, with generation and interconnection optimized across the entire region.

Overall, the analysis found a multitude of benefits from increased regional system integration. Accounting for generation and transmission system expenditure, fuel, and trade costs as well as value of unmet demand, there are significant financial gains: ‘Shallow’ integration would reduce system costs by 3.7 percent relative to BAU, with net benefits of US\$7.6 billion over 2020–2030. ‘Tight’ integration would reduce system costs by nine percent relative to BAU, with net benefits of US\$18.6 billion.

Emission reductions and power system integration: The analysis also showed that a 30 percent CO<sub>2</sub> emission reduction target by 2030 can be achieved at a lower cost with increased system integration. ‘Tight’ integration in particular would be the most efficient option, reducing the cost of emission reductions by a factor of 3.8 relative to BAU. Limited cross-border interconnection and trade under ‘shallow’ integration, meanwhile, would push some countries (for example, Egypt, Libya, and Tanzania) to continue relying on fossil fuels and invest in domestic renewable resources (hydropower as well as solar, wind, and geothermal) to reduce CO<sub>2</sub> emissions over the first few years of the planning period. However, by giving countries greater access to hydropower through cross-border trade, ‘tight’ integration could reduce emissions by 55 Mt CO<sub>2</sub> over 2020–2030 with US\$9.3 billion less in generation investment compared with ‘shallow’ integration (see Figure A and B below).

Figure A: Cumulative CO<sub>2</sub> Emissions and Generation Investment in the EAPP under Different Scenarios

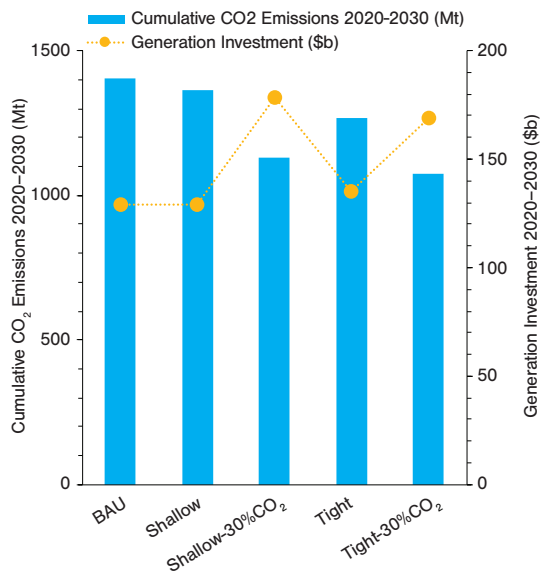
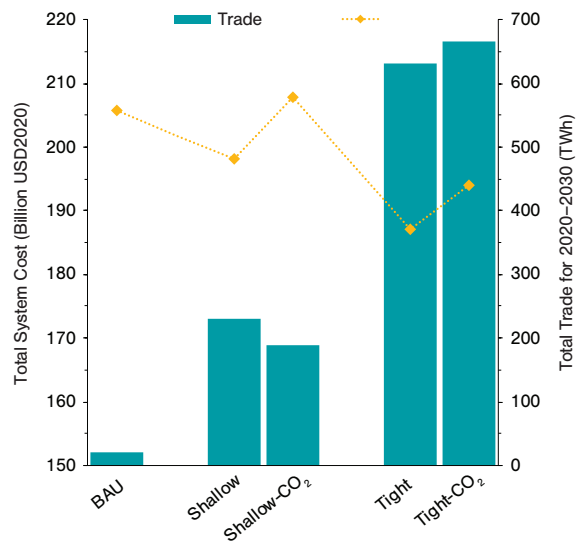


Figure B: Total System Costs and Trade Volume under Different Scenarios



continued on next page

*continued from previous page*

**A regional approach to climate change mitigation and adaptation:** The study also revealed that greater integration provides an opportunity for countries to deploy system-wide adaptation and mitigation measures at a lower cost. For example, higher integration can help limit the potential impact of climate change and drought, a high climate risk in the region that affects hydropower generation capacity. In particular, higher trade flexibility that permits adjustments in the volume and direction of trade could allow 89 percent of BAU benefits (that is, US\$16.6 billion in system cost reductions in the ‘tight’ scenario with extreme droughts, compared with US\$18.6 billion without extreme droughts) to be retained even under extreme droughts that lead to 20–30 percent lower hydropower availability. The study also concluded that greater penetration of low-cost renewable energy can deliver a reduction in overall system cost under ‘tight’ integration. For example, with increased trade between Ethiopia, Sudan, and Egypt, Egypt could invest in additional variable renewable resources such as wind and solar photovoltaics, reduce gas use, and meet increasing demand at lower costs. Overall, the analysis found a strong economic and climate case for regional trade. It illustrated that with increased system integration, EAPP can enhance its power system resilience, take advantage of more domestic renewable resources, and reduce CO<sub>2</sub> emissions at a significantly lower cost.

**Next steps:** The study recommends that EAPP member utilities focus on soft infrastructure initially to start reaping the benefits of power system integration. These include improving operational and commercial readiness by putting in place policies and procedures for optimal economic trade.

*Source: Chattopadhyay and Remy (2020).*

other factors. The COVID-19 pandemic further intensifies these challenges, as countries are focused on public health and emergency economic measures. However, as countries work to develop economic stimulus packages, a long-term systems approach that integrates multiple objectives will be crucial so as to preclude unchecked reversion to unsustainable growth paths.

- » **Building capacity and tools for systems-level planning.** The World Bank will work with countries to support the development of tools and data for systems planning and framework approaches. This will further help in the development of country national plans and long-term strategies for decarbonization and resilience.
- » **Strategic Country Diagnostics (SCDs) to integrate climate-informed systems planning:** The World Bank will ensure that SCDs are based on climate-informed system approaches that integrate long-term climate and economic objectives. This will likely require new analytical tools, because very limited work has been undertaken to integrate climate change in macroeconomic models. Though there is significant interest from countries in integrating adaptation needs in SCDs and informing engagement priorities, the same does not necessarily hold true for decarbonization goals. This is mainly due to the limitations of existing frameworks to model and articulate the low-carbon transition risks faced by each country. Addressing these limitations will help ensure that near- and medium-term priorities are aligned with long-term objectives for both decarbonization and resilience.
- » **Climate-informed integrated resource planning for sectoral/cross-sectoral engagement.** The World Bank will support countries in the development and strengthening of sectoral plans that account for integrated resources and their interdependencies. These would ideally be used in combination with economy-wide, climate-informed system planning to develop detailed sectoral road maps for policy action and investments. The World Bank will also begin using these integrated resource plans more consistently and effectively to inform sectoral engagement.

# 08

## Advancing Cross-Cutting Solutions

**Cross-sectoral climate action is critical to achieving decarbonization and resilience.**

Climate change is increasingly disrupting key sectors and systems in countries' economies—from food production, to water and energy supply, to transport, to the effective functioning of cities. These systems often involve multiple sectors, and so will the adaptation and mitigation solutions they need. Yet to date, climate action—especially mitigation—has mainly advanced along sectoral lines. Moving from siloed approaches to systemic and cross-sectoral solutions will achieve better results more cost-effectively. Given that countries' development priorities are also often cross-sectoral, a systems approach to climate priorities can help the World Bank and its client countries to identify significant opportunities that also inform sectoral policies.

**Understanding interactions among sectors can help policy makers identify synergies and avoid unintended negative impacts.**

This is true within development more broadly, and even more so for climate action. If the goal is to reduce CO<sub>2</sub> emissions from vehicles, for example, one way is to promote electrification; another is to use more biofuels. If the latter leads many farmers to stop growing food so they can grow biofuel feedstock, that may affect food security. If transportation is electrified but the power supply derives mainly from coal or oil, any emission reductions might be offset by increases in the power sector. Mitigation and adaptation actions, too, can be synergistic or cause unintended harm in other sectors, as shown in Box 6. By identifying synergies and cross-sectoral cobenefits, policy makers can select strategies that yield the greatest overall benefits for development and the climate, and avoid shifting costs from one sector to another through unpriced externalities. Even if actions are then taken within individual sectors, the strategies will be more cost-effective for the economy as a whole.

**Cross-sectoral climate action requires effective coordination and catalytic financing, both of which must be scaled up within the World Bank's operations and engagement with clients.**

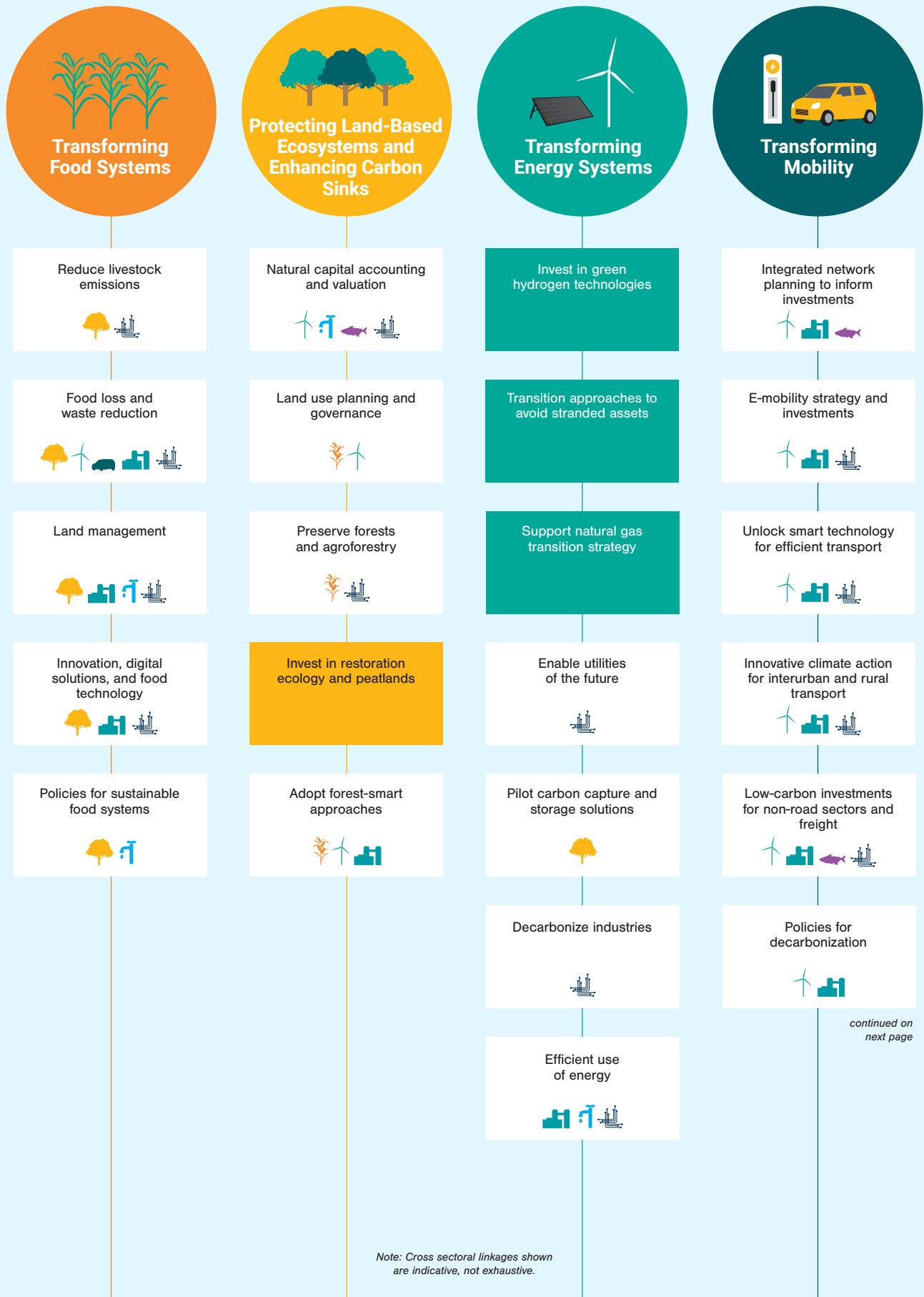
Countries' capacity for cross-sectoral planning and analysis may be limited by the lack of a targeted national plan, weak cross-ministerial coordination, and misaligned incentives. Though the World Bank's attention to cross-sectoral issues has improved, its engagement with clients still tends to track with sectoral and ministerial lines. Breaking out of these patterns will require deliberate efforts both to build countries' capacity to address cross-sectoral issues, and to finance transformative initiatives that take a more holistic approach to climate and development.

**The World Bank has identified several cross-sectoral opportunities and priority areas as part of its 2050 decarbonization agenda.**

As shown in Figure 9, even when they arise within a specific sector, they require cross-sectoral interaction and planning to maximize synergies and avoid conflicts across sectors. Single-sector projects developed without consideration of broader perspectives and potential impacts come at a considerable cost and will no longer be considered to be viable options. Thus, the Bank's support for decarbonization will be heavily focused on synergies among interconnected sectors, especially in the key priority areas.

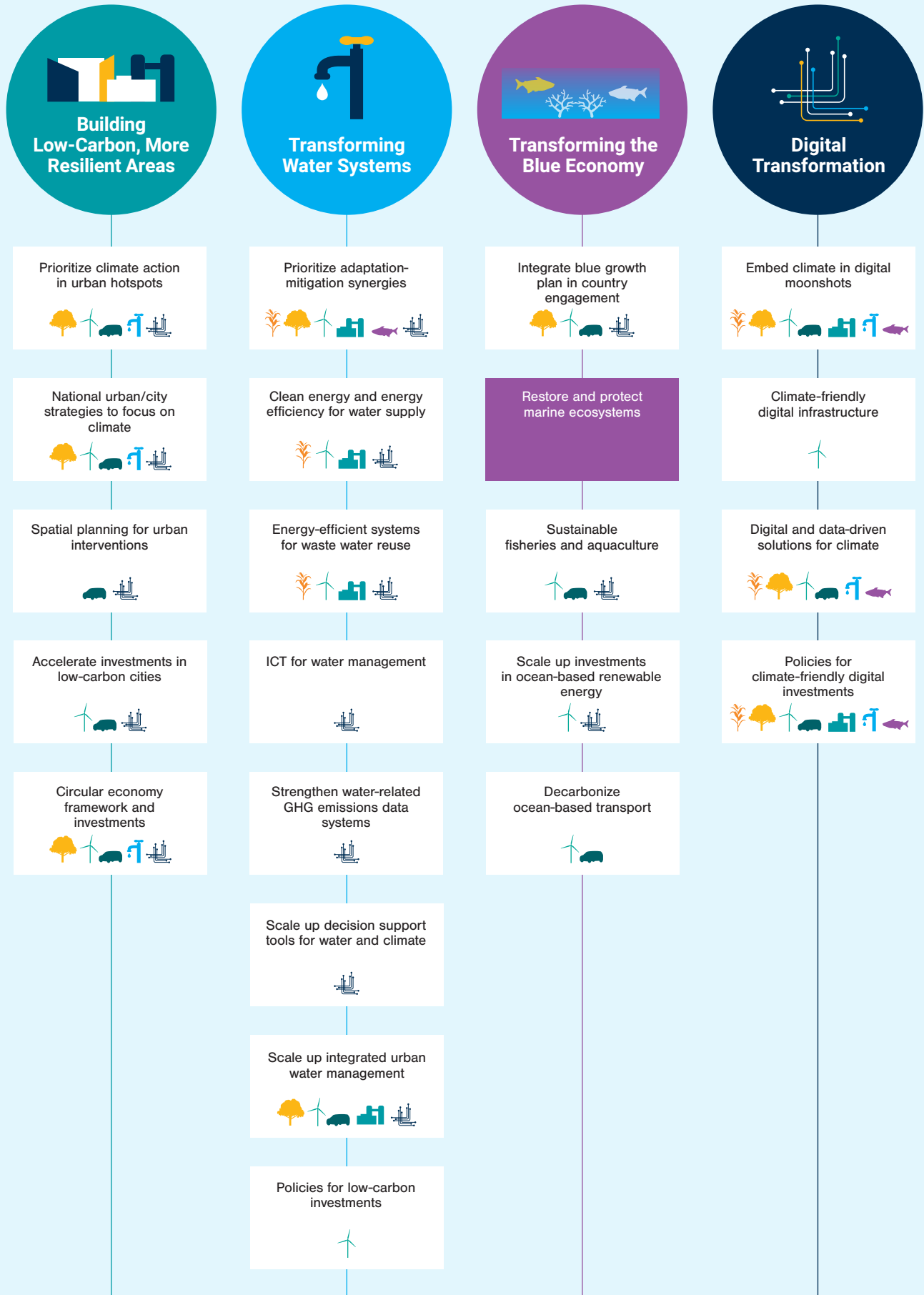


Figure 9: World Bank Cross-Cutting Priority Areas for Long-Term Decarbonization and Resilience



**Integrated planning and policies across sectors for decarbonization and resilience →**

Figure 9: World Bank Cross-Cutting Priority Areas for Long-Term Decarbonization and Resilience (continued)



← Integrated planning and policies across sectors for decarbonization and resilience

## 8.1 Priority Area 1: Transforming Food Systems

**Food production needs to scale up dramatically to meet growing demand due to population growth, higher incomes, and diet changes.** By 2050, the world's food systems will need to increase their output by almost 50 percent from 2010 levels (FAO 2009). Achieving this without significantly increasing GHG emissions, water consumption, land use change, and pollution—and, in fact, reducing them—will require major shifts along the entirety of food supply chains. The COVID-19 crisis has also exposed substantial vulnerabilities even in wealthy countries' food systems. With climate change threatening even greater disruptions, it is clear that 'business as usual' is no longer an option.

**Agriculture, forestry, and land use together account for almost a quarter of global GHG emissions** (Smith et al. 2014). For many developing countries, the share is even greater, especially if their per capita energy use is still low, or they have a low-carbon energy supply. More than half of these emissions come from farming and livestock—both directly, such as methane from cattle, and indirectly, from soil management, fertilizer production and various steps in the supply chain. The rest are from land use and land use change (discussed further in the next section). This section considers emissions within the food supply chain, derived mainly from livestock production and food waste. Indeed, as

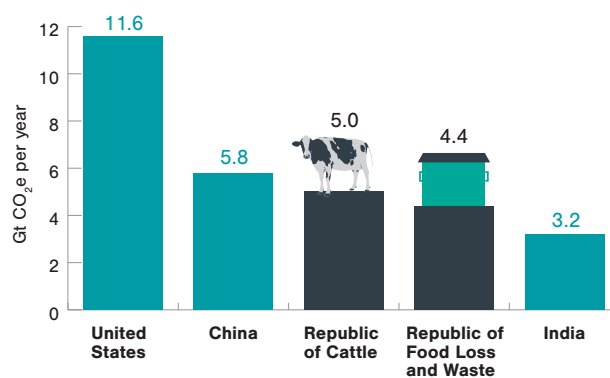
shown in Figure 10, global GHG emissions from cattle alone, 5.0 Gt CO<sub>2</sub>e, exceed the total 2016 emissions of every country except China and the United States, and so do emissions from food loss and waste, 4.4 Gt CO<sub>2</sub>e (Climate Watch 2019; Scialabba 2015; FAO n.d.).

**Addressing fertilizer misuse and overuse is an important opportunity for efforts to reduce emissions.** Not only is fertilizer production a major source of emissions; heavy use of fertilizer also results in significant emissions of nitrous oxide (N<sub>2</sub>O) from agricultural soils. Agriculture and related land uses produce about 60 percent of global nitrous oxide emissions through fertilizers and the burning of crop residues (Herrero et al. 2016). Global fertilizer consumption grew by 24 percent from 2002 to 2012, from 133 Mt to 187 Mt of nutrients—though use per hectare varies dramatically by country, reflecting differences in agricultural practices, technology use, and access to fertilizer (FAO 2017). Using fertilizer more effectively and efficiently has cross-sectoral benefits: not only would it reduce emissions associated with fertilizer production and N<sub>2</sub>O from soils, but also reduce water pollution and eutrophication (see Priority Areas 6 and 7) and prevent the degradation of agricultural land, reducing the need to convert new land to agricultural uses.

In high-income countries such as the United Kingdom, a large share of the food system's emissions occur after leaving the farm (related to storage, transport and food waste); in China, fertilizer manufacture plays the largest role (Gilbert 2012); in many poor countries, post-harvest losses on farms are a significant factor (Scialabba 2015).

Policy makers have largely overlooked agriculture in the global effort to slow climate change, but the Paris Agreement has opened the door to new solutions. Since 2015, the vast majority of countries have committed to reducing emissions from agriculture and from related land use

**Figure 10: Greenhouse Gas Emissions from Cattle and Food Loss and Waste vs. Top-Emitting Countries**



Sources: Country emissions from Climate Watch (2019); cattle emissions from FAO (n.d.); food waste emissions from Scialabba (2015). Note that this is not an exact comparison, as the cattle and food waste data are older than the country data.

and land conversions. In the first round of NDCs, 78 percent of countries included crop and livestock production practices in their mitigation pledges, including countries at all levels of development, which collectively represent 92 percent of global GHG emissions from agriculture (FAO 2016).

### 8.1.1 World Bank engagement to date

**The World Bank's Climate-Smart Agriculture (CSA) program offers a highly effective approach to achieving a 'triple win' of increased productivity, enhanced resilience, and reduced emissions.** Building on existing knowledge and proven technologies and principles of sustainable agriculture, but with an explicit focus on climate, CSA systematically identifies synergies and trade-offs between productivity, adaptation, and mitigation; increases countries' capacity to transform agricultural systems; and provides finance to close resource gaps. Through CSA, the Bank aims to improve food and nutrition security and boost the incomes of 75 percent of the world's poor who live in rural areas. It is also reducing vulnerability to drought, pests, disease, and other shocks. By applying techniques that improve soil condition and carbon storage, CSA thus enables more food to be produced with fewer GHG emissions and reduces demand for new cropland. Cutting-edge technologies play a key role as well. For example, the Bank's Agriculture Observatory uses NASA and other satellite platforms in combination with ground stations to provide real-time weather data at high spatial resolution to stakeholders across the agricultural value chain. Similarly, the Morocco Inclusive Green Growth project has increased access to agrometeorological information and to resilience-building technologies such as direct seeders, in support of the national green growth agenda.

**The World Bank's agriculture programs have been scaling up the Climate Smart Agricultural Investment Plans (CSAIPs), with a strong focus on countries affected by fragility and violence.** The CSAIPs prioritize proactive approaches to managing and reducing climate risks, including through agrometeorological information and improved agricultural services. In the near and medium term, the World Bank agriculture team aims to engage more farmers in 'disruptive and digital agriculture' approaches that facilitate access to services such as integrated weather and market information, insurance, and various financial services.

**Scaling up climate action in the World Bank's agriculture and food engagement entails several challenges.** To date, most of the work on CSA has focused on technical assistance embedded in financing packages to build capacity and enabling systems in client countries. At the same time, the World Bank has provided support for sustainable intensification for agricultural productivity and improved rice cultivation methods. In many countries, crop yield growth has stagnated nonetheless. Added to this is the continued unsustainable use of limited resources such as water and soil. A shift in investments is needed to achieve higher efficiency. In countries where agriculture is still a major employer, the shift will also require a delicate balance to protect livelihoods.

**Several adoption constraints and inevitable trade-offs limit the technical mitigation potential of CSA.** Investments in capacity building and knowledge dissemination are critical to enable effective implementation and adoption of integrated CSA measures. Trade-offs often arise between the CSA's 'triple win' pillars of productivity, resilience, and mitigation—for example, between soil health, energy consumption with irrigation, and nitrogen emissions due to fertilizer use (Sova et al. 2018). There is a clear need to deepen World Bank action on mitigation—strengthening action on reducing GHG emissions from fertilizer production and use and from livestock, and expanding action to the consumption side (for example, food waste and dietary shifts).

**Despite the large share of emissions from livestock, very little mitigation action has occurred to date.** World Bank engagement with livestock issues has also been limited. This is due to a combination of factors, including limited experience of successful strategies, and

limited resources and capacity dedicated to this area. Given the scale of emissions, livestock management for GHG reduction requires deeper attention and allocation of resources.

## 8.1.2 New frontiers for lending and technical assistance

Taking a holistic view that highlights linkages across sectors and between mitigation and adaptation, World Bank teams propose a vision for food systems that prioritizes expanding climate-smart agriculture, sustainable agricultural intensification, technology-enabled decarbonization, food waste reduction, and enhanced carbon sinks.

**Reducing emissions from livestock:** The World Bank will scale up engagement on sustainable livestock production, covering the entire value chain of farming, processing, and consumption. Strategies to reduce enteric fermentation emissions by improving animal diets to facilitate digestion will yield productivity gains, as improved diets will reduce the loss of calories (Haque 2018). The World Bank will focus on improving the quality of animal diets and the overall health of livestock. These changes will help lower emissions per unit of product, improve the productivity of the herds, and allow smaller animal populations to support sustained production levels. Additionally, the World Bank will prioritize activities that encourage diversifying animal and feed crop varieties to increase resilience to a changing climate, and encourage improved manure storage in industrialized livestock systems.

**Food loss and waste reduction:** The World Bank will launch new efforts to reduce food losses and waste all along the food system, and thus reduce GHG emissions while increasing food availability and reducing pressure on natural resources. It will focus on methods to reduce upstream waste, and the use of more effective handling and storage units. Preconsumer food losses are enormous in poorer countries, so reducing on-farm losses and facilitating the prompt and safe transport of food to consumers will boost the food supply in places that most desperately need it. For postharvest handling and storage, the Bank will prioritize support for investments in infrastructure for energy transportation, storage, sustainable cooling, access to markets and adoption of cost-effective techniques, such as the use of solar dryers and evaporative coolers. It will also focus on removing barriers to adopting these techniques by increasing awareness and education through extension services and aid programs for farmers.

**Land management to avoid degradation, rehabilitate degraded lands, and protect soil carbon:** Sustainable agriculture intensification will be critical to meeting the growing demand for food while limiting pressures on natural resources. The World Bank will enhance support for sustainable agriculture intensification to reduce pressure on increased demand for agriculture inputs, especially land. This will further reduce the conversion of grazing lands and forested lands for agriculture production, thus protecting soil carbon. These actions are included in the CSA Investment Programs now under development, which the World Bank will scale up. The World Bank will also help to create enabling conditions for the deployment and application of improved crop varieties and farming practices. Rehabilitation of degraded lands presents another major opportunity to increase productive use and enhance carbon sinks. The World Bank will support countries in rehabilitating degraded land, to improve carbon storage, reduce the need for land conversion, and increase food production.

**Innovation in agricultural practices, digital solutions and food technology:** The World Bank will support pilots for innovative techniques such as vertical farming for 'smart' crop varieties that use less inputs such as water and fertilizers. The World Bank will also support investments in innovations and digital technologies for developing stress-tolerant varieties, improving crop breeding programs, and managing existing farmland. Digital technologies can allow farmers to closely monitor their fields and manage nutrients and irrigation with great precision, maximizing efficiency. Cutting-edge science can also accelerate the development of plant varieties that are more productive and more resilient to heat, drought, and other climate change impacts.

Innovations in food technology, meanwhile, especially in the production of plant-based meat substitutes, can transform food sources by reducing demand for meat and thus reducing GHG emissions from livestock.

**Enabling policy frameworks to support scaled-up investment in sustainable food systems:**

The World Bank will adopt a strategic approach toward agricultural and rural transformation through a coherent package of policy change, institutional strengthening, and realigning of public investments in agriculture to attain fundamental improvements in the policy regime, increased private investment in agriculture, and improved climate outcomes. It will also focus on enhancing domestic capacity to develop integrated pathways across agronomy, nutrition, climatology, and economics toward sustainable food systems.

**Support for new policies to realign incentives:** On the demand side, the World Bank will work with clients to incentivize sustainable, diversified diets; address drivers of increased meat consumption; and manage pressure on food supply chains caused by shifts in livelihoods, such as migration from rural areas to cities. On the supply side, it will help reform misguided agricultural policies that encourage unsustainable intensification and the overuse of natural resources. This may include reducing insurance subsidies that create perverse incentives, market price supports, and input subsidies, as well as advocating for a carbon tax for the livestock industry. Policies will also emphasize the deployment and application of efficient farming practices, infrastructure investments, access to high-quality agriculture inputs, outcome-based farmer incentives, and knowledge transfer systems that help farmers increase productivity sustainably.

---

## 8.2 Priority Area 2: Protecting Land-Based Ecosystems and Enhancing Carbon Sinks

**Land-based ecosystems, including forests, are crucial to supporting human life.** They sustain livelihoods, support essential biodiversity, and provide food, freshwater, shelter, and fuel for communities (FAO and UNEP 2020). They also regulate the quality of air, water, and soil; sequester carbon; and provide protection from diseases and extreme weather events such as floods. Land use change fundamentally alters ecosystems and the vital services they provide. Yet population growth, urbanization, and global demand for cash crops all create immense pressure to clear more land. As forests are cleared and peatlands are drained, large amounts of carbon storage are lost.

**Climate change poses major threats to land-based ecosystems and increases pressure to convert more land to agricultural uses.** Current levels of global warming have been associated with increased water scarcity, soil erosion, vegetation loss, wildfire damage, permafrost thawing, coastal degradation, and declining tropical crop yields (IPCC 2019a). Croplands, forests, grasslands, and rangelands around the world have been losing productivity, and soil erosion, desertification, and water scarcity all pose significant threats to agriculture. Extreme weather events including heatwaves, droughts, storms, and floods have devastated many landscapes, contributing to land degradation and desertification.

**Land-based ecosystems are major carbon sinks, but land use and land degradation are also growing sources of GHG emissions.** There is significant technical mitigation potential in protecting and restoring forests. Sustainable forest management aimed at providing timber, fiber, biomass, and other ecosystem services can lower GHG emissions and contribute to adaptation (IPCC 2019a). However, there are competing priorities even within mitigation. Most notably, bioenergy for carbon capture and storage (BECCS) is a major part of many scenarios for achieving net-zero emissions, and producing the necessary feedstock could further increase pressures on the land (Harper et al. 2018) Modelled scenarios limiting global

warming to 1.5°C and 2°C show a wide range of possible futures for forest cover, from a two million km<sup>2</sup> reduction, to a 12 million km<sup>2</sup> increase by 2050 relative to 2010. These projections also show land usage of up to seven million km<sup>2</sup> for bioenergy in 2050 (IPCC 2019a). Without careful management, pathways with significant land conversion could entail large negative impacts on water supply, biodiversity, and food security, as well as increased land degradation and desertification. On the other hand, applying best practices in land management, such as managing dryland salinity, enhancing biocontrol and biodiversity, and enhancing soil carbon sequestration, could have multiple benefits.

**Sustainable land management is essential to maintain and restore carbon sinks and build resilience to climate change impacts.** Improved management of croplands and forests to avoid degradation and increase soil organic carbon content can reduce demand for further land conversion. As noted in the previous section, it is also crucial to increase agricultural productivity, minimize food losses and waste, and promote less resource-intensive diets (that is, more plant-based) to reduce the pressure to convert more land for crop and livestock production.

### 8.2.1 World Bank engagement to date

**The World Bank works directly with countries to build readiness and technical capacity for scaled-up action in protecting and restoring landscapes.** Recently efforts have shifted from readiness toward implementation of programs that deliver carbon sequestration and benefits to local and indigenous communities.

The Forest Carbon Partnership Facility (FCPF) is a global partnership of governments, businesses, civil society, and indigenous peoples focused on reducing emissions from deforestation and forest degradation; conserving forest carbon stocks; sustainably managing forests; and enhancing forest carbon stocks in developing countries – activities commonly referred to as REDD+ (FCPF 2018). The World Bank is the Trustee of the FCPF’s Readiness Fund and Carbon Fund, and provides secretariat services through a Facility Management Team. The team works with other units of the World Bank to assist REDD+ countries to prepare and implement proposals. The program has focused on building readiness through support to governance, transparency, and strengthening ties with indigenous communities and women, who play a central role in resource protection. As of December 2019, four Emission Reduction Payment Agreements have been signed as the program moves toward implementation of payments for ecosystem services.

The Forest Investment Program (FIP), established by the World Bank in 2009, aims to address the drivers of deforestation and forest degradation by supporting developing countries’ efforts and promoting sustainable forest management. FIP provides financing to developing countries to build institutional capacity and for public and private investments that are identified through REDD+ readiness strategies. In September 2019, FIP had a total of US\$737.7 million in cumulative funding (CIF 2019).

The World Bank has also successfully scaled up implementation of the Forest Action Plan (FAP) FY16–20 in concert with the FCPF (World Bank 2016a). This includes creating a large-scale, multisector program promoting ‘forest-smart development’; mobilizing relevant IBRD/IDA REDD+ financing in 10 target countries; and preparing Country Forestry Notes in seven countries that will lead to detailed plans for sustainable land use management.

**The World Bank’s comparative advantage is to work directly with governments to identify and leverage financing beyond public sources to scale up impact.** The new ProGreen Trust Fund, established in 2019, supports countries’ efforts to improve livelihoods while tackling declining biodiversity, loss of forests, deteriorating land fertility, and increasing risks. It is well placed to scale up its integrated approach to landscape management. This approach will go

beyond sustainable forest management to include supporting a reorientation of national policies (fiscal, regulatory, governance) to create an incentive structure that values natural capital. The Bank has also established a Multi-Donor Trust Fund for Pollution Management and Environmental Health (PMEH) to promote more systematic and effective responses to deadly and costly air pollution. This will be replaced by the forthcoming Trust Fund on pollution management.

**Carbon credits and similar incentives have not been enough to prevent significant continued land use change in many countries.** Further low credit issuance by other land use projects highlights the challenges in developing these types of carbon offset projects, which often have complex mitigation quantification approaches and high monitoring, reporting, and verification (MRV) costs. The FCPF, the PROFOR Trust Fund, and the Forest Action Plan FY16–20 provide sound frameworks for scaling up action. PROFOR’s analytical work and programs in support of FAP implementation have contributed to an enhanced understanding of forest resilience and innovative approaches, to help manage trade-offs, enable forest restoration, and strengthen forest governance. PROFOR knowledge programs have helped client countries to develop integrated landscape programs, identify forest-smart solutions, and contribute to their NDCs. Additionally, the Global Environment Facility (GEF) is well-positioned to support countries implement and facilitate coordinated investments in sustainable land management practices. Over the last decade, GEF investments have supported implementation of sustainable land management and created an enabling environment to support the adoption of voluntary land degradation neutrality targets.

**Countries need more capacity building and more finance.** The data and monitoring tools needed to monitor illegal logging and combat corruption have improved greatly, for example, but there is a need to strengthen capacity to use them. Financing also needs to be scaled up, as official development assistance and other public funds provide only a small fraction of the estimated US\$70–160 billion per year needed for sustainable forest management worldwide (Tuukka et al. 2014). Yet as of 2014, cumulative private sector investment in REDD+ demonstration projects was estimated to be only US\$600–800 million. Within the World Bank, a large share of available resources is dedicated through trust funds, and financing is contingent on the boundaries and preferences of the funds’ governing bodies, which may vary from those laid out for IBRD/IDA funds.

## 8.2.2 New frontiers for lending and technical assistance

Taking a holistic view that highlights linkages across sectors and between mitigation and adaptation, World Bank teams propose a vision for protecting land-based ecosystems and enhancing carbon sinks that creates a strong enabling environment; supports targeted interventions in forestry and land management; and engages multiple sectors to protect ecosystems.

**Natural capital accounting and valuation:** Low-income countries depend on natural capital for 47 percent of their wealth, yet this capital is being depleted regardless of the consequences for national wealth and human capital (Lange, Wodon, and Carey 2018). Building on the earlier WAVES (Wealth Accounting and Valuation of Ecosystem Services) program, the World Bank has established the Global Program on Sustainability, which promotes the generation and use of reliable data on natural capital and ecosystem services, including global data and tools, country-level support for natural capital accounting, and sustainable finance. This program will channel increased support to countries in measuring and valuing natural capital and ecosystem services and in using such information for decision-making and for financing sustainable development efforts, including through projects cofinanced by the Bank. New frontiers to be explored through work in this area include:

- » Supporting improvements in data collection, monitoring and reporting of a wider range of natural assets (in addition to land and forests, water, fisheries, renewable



energy resources) and of ecosystem services (such as coastal protection, soil retention, regulation of water flows, and carbon capture and storage);

- » Promoting the use of natural capital accounting to properly assess trade-offs in natural resource management and to design nature-based solutions for countries' NDCs, including through incentives such as payments for ecosystem services and through mobilization of green finance.

**Provide tools and technical assistance to support land use planning and governance:**

The World Bank will provide tools and guidance on clarifying land ownership and tenure, developing rural environmental cadasters, and strengthening land administration institutions. We will support government agencies with tools to identify critical land uses that supports the growth of key economic activities (such as agriculture and mining) while conserving the highest-value natural forests and ecosystems – those with high biodiversity that are critical for ecosystem services.

**Preserving forests and agroforestry:** The World Bank will support policies that preserve forests through monitoring and enforcement on a large scale, enabled through advances in digital technology and drones that have made monitoring much easier and more efficient. To advance this agenda, it will finance protected area systems, a landscape approach to agriculture, sustainable agricultural intensification, and payments for environmental services. In addition, it will seek to work with clients to reorient agricultural subsidies toward social safety nets in an effort to halt the conversion of forests into agricultural land and focus on reforestation or forest regrowth.

**Invest in restoration ecology and peatlands:** The World Bank will support clients in building comprehensive regulatory frameworks with incentives to promote restorative ecology, including to protect peatlands, which are crucial for sequestering carbon. Multiple demands for use of land will need to be balanced against preservation needs. Capturing the increased value in land that has been restored (through valuation of ecosystem services like biodiversity offsets), can introduce economic incentives for landowners. Eco-restoration concessions could be a model worth exploring: these were piloted in Indonesia, for example, as a market-oriented instrument to counter deforestation processes and to restore forest ecosystems. The World Bank will focus on building the policy and regulatory frameworks to support this next level of innovative financing.

**Strengthening cross-sector collaboration to adopt forest-smart approaches:** The World Bank will scale up an integrated approach to land use management by helping countries improve coordination and planning among the sectors that drive land use change and may harm forests and other ecosystems through unsustainable practices. This includes engagement with agriculture, mining, tourism, energy, and infrastructure projects that drive demand for land conversion. Supported approaches will include:

- » *Implementing climate-smart agriculture through a landscape approach*, explicitly addressing interactions between croplands, surrounding ecosystems, and human settlements. This not only enhances both the mitigation and adaptation potential of CSA, but also engages the broader community in sustainable land management, as diverse stakeholders recognize how they benefit.
- » *Provide forest-smart mining guidance and analytical tools* to relevant countries to integrate planning and implementation of mining operations with broader landscape approaches.
- » *Promote nature-based tourism* as an alternative livelihood activity in and around conservation areas.

- » *Scale up clean cooking technologies* to reduce biomass use for household energy and the resulting pressure on forests; off-grid energy solutions in rural areas can also provide significant benefits.
- » *Scale up infrastructure investments in rural areas* to provide improved access to markets for sustainably sourced products and nature-based tourism, and expand options for supporting livelihoods.

---

## 8.3 Priority Area 3: Transforming Energy Systems

**The energy sector—burning fossil fuels for power generation, heat, and a wide range of uses across the economy—produces almost three-quarters of global GHG emissions, 36.0 Gt CO<sub>2</sub>e in 2016 (Climate Watch 2019).** Clean electricity is central to decarbonization, and so are measures to stop burning fossil fuels for heat and to decarbonize transportation and industry. Energy demand continues to grow as countries industrialize and living standards rise. In a warming world with increasing heat waves, the use of electricity for cooling is also a growing concern, as it can put significant stress on the power grid and drives up emissions. Indeed, CO<sub>2</sub> emissions from electricity demand for cooling have tripled since 1990, to 1.1 Gt CO<sub>2</sub> (IEA 2019b).

**Three major trends will shape opportunities in the energy sector: electrification, decarbonization, and decentralization.** The power sector is changing rapidly, driven by growing demand, new technologies, and policies and regulations designed to reduce GHG emissions and air pollution. Population growth, rising incomes, and rapid urbanization are expected to drive significant increases in energy demand. As living standards improve, households will own and use more appliances, driving up power usage. Many activities that now involve direct burning of fossil fuels—for heat, industrial processes, and motor vehicles, for example—are being electrified, further driving power demand. Overall, electricity demand is projected to rise by 63 percent to 2040, with 90 percent of global growth occurring in developing economies (IEA 2019b). These shifts have enormous implications for the power sector, which will need to ramp up production while simultaneously reducing GHG emissions.

**Decentralized, or distributed, generation technologies are making it easier to bring clean electricity to rural areas quickly and cost-effectively.** They can also increase resilience to climate change impacts, especially storms and extreme weather events. For those who already have electricity, decentralized generation can provide power even after a major disruption to the grid. For those without electricity, getting it through off-grid and mini-grid options can open up new livelihoods, increase access to education, and connect them to information (such as regular weather forecasts and storm warnings) to protect them from extreme events. It is becoming clear that the central utility model is no longer the only viable approach. New advances in energy technology, digital infrastructure, and payment systems are enabling decentralized solutions to reach the end user faster and more cost-effectively, in places to which the grid would probably not be extended for several decades.

**Aligning power sector development with long-term decarbonization and resilience goals will require concerted efforts by policy makers, national infrastructure planners, developers, and financiers.** Power infrastructure is long-lived, so investments made now may serve to shape the sector for 20, 30 or 40 years. Decarbonization could become cost-prohibitive for countries if large portions of existing infrastructure are stranded. Achieving a successful energy transition will require infrastructure that is adaptable, reliable, and affordable. Existing energy infrastructure has been built over decades with trillions of dollars of investments. If countries do not consider how their energy infrastructure investments fit with their long-term climate goals, they will miss a crucial opportunity.

**Low-carbon power generation solutions may conflict with other sectors' needs.** Offshore wind and other ocean-based renewables may face strong resistance from coastal communities, for example, because of the likely effect on tourism and fisheries, with possible disruption of ocean ecosystems. Bioenergy with carbon capture and storage (BECCS) could theoretically offset emissions on a large scale, potentially using retrofitted fossil-fueled power plants, but it would also dramatically increase pressure on agricultural land, pose challenges to food security, and drive more land use change. On the other hand, choices made in decarbonizing the transportation sector could increase electricity demand—for example, if instead of promoting public transport or car-sharing, policy makers relied heavily on privately owned EVs.

**There is a gap between the expectation of a fast, renewables-driven energy transition and the reality of today's energy systems.** According to the International Energy Agency, reliance on fossil fuels remains high (IEA 2019b). The IEA has found that solar photovoltaics (PV) and some other renewable power technologies are turning initial policy and financial support into large-scale deployment and are on course to attract large amounts of investment. However, transforming the entire energy system will require progress across a much wider range of energy technologies, including energy efficiency; carbon capture, utilization, and storage (CCUS); hydrogen power; and others. It will also require action across all sectors, not just electricity.

**The SDGs and the Paris Agreement have provided a strong foundation to develop sustainable infrastructure investments over the next decade, but global investments do not reflect this.** According to recent estimates, capital spending on oil, gas, and coal supply actually bounced back in 2018, while investments in energy efficiency and renewables stalled. There are clear signals of a growing mismatch between current trends, which may reflect changes in the market signals sent by some governments, and the paths to meeting the Paris Agreement and the SDGs (IEA 2019b).

**COVID-19 will significantly affect global energy investments in 2020.** The pandemic has temporarily reduced GHG emissions, but it is also expected to slow the transformation of energy systems. Sharp reductions in the movement of people and goods, combined with shutdowns and an economic slowdown, reduced energy demand and energy companies' revenues. This has weakened companies' ability to invest, so energy investment is expected to drop by about US\$400 billion, or one fifth – the largest decline in energy investment on record (IEA 2020c). Though fossil fuel supply investments have been hit hardest, the entire sector has been disrupted, with renewable power project investments expected to fall by about 10 percent, for instance, with more significant declines in distributed solar (IEA 2020). In this context, a top priority for the Bank will be to help countries align NDC action plans and investments with the mid-century objective of decarbonization.

### 8.3.1 World Bank engagement to date

**The World Bank is uniquely placed to drive innovative thinking, take a systems approach to planning, and integrate cross-sectoral approaches.** It has a unique capability to help convene, coordinate, and plan national and regional development strategies to support the decarbonization of the energy sector, particularly in developing economies. The Bank has a long track record of supporting the expansion of energy access, both on- and off-grid, and rural and urban electrification. Over the past decade, this has been driven by an increased emphasis on the integration of renewable energy across regions. The World Bank has already been successful in supporting renewable energy, integrating renewables into power grids, improving the energy efficiency of utilities (in concert with demand side efficiency), and expanding electricity access and reliability. One such example is the solar home system program financed in rural Bangladesh in 2003. Starting as pilot to tackle the challenge of reliability, high costs, and access to grid power, the program scaled up to become the most

dynamic off-grid electrification program in the world. An adaptable project design, learning from international experiences, and integrating local know-how were contributing factors to the project's success, which benefitted more than 15 million people and increased renewable energy generation capacity (Elahi et al. 2014).

**The World Bank has also made excellent progress in introducing new technologies and innovative business models.** These include

battery storage systems, offshore wind, energy efficient lighting and appliances, and sustainable cooling. In this context, the World Bank attracted private sector investments, helped to introduce competitive procurement approaches, and promoted the development of local industry. For instance, the Bank supported a solar power plant project in Morocco to maximize the



Noor Concentrated Solar Power Plant in Morocco supplies clean energy to millions of beneficiaries. –Dana Smillie/World Bank

use of renewable resources and limit emissions by using a public-private partnership (PPP) arrangement that integrated support from international finance institutions (World Bank 2011). The project had a transformational effect by demonstrating the viability of concentrated solar power (CSP) generation in emerging economies and contributing to a significant drop in costs.

**As part of its support for clean energy transition, the World Bank has also been supporting energy efficiency improvements.** This has included direct investments and policy reforms in buildings, district heating, and public lighting, but limited engagement in industry. Through financial innovation and policy support, it has helped clients improve energy performance in the residential and public sectors, and more broadly through engagement with financial intermediaries. Based on experience so far, it is clear that successful implementation and scaling up of energy efficiency programs requires long-term engagement, financing tailored to the local context, strong policies, regulations, and in some cases, incentives. The World Bank has supported transformative projects in multiple regions, such as the India Energy Efficiency Scale-Up Program, which combined direct investments and de-risking instruments to enhance access to commercial financing. Similarly, in China, the Bank and Global Environment Facility (GEF) have been working to help the country move to market-based approaches for energy conservation, such as the energy service company (ESCO) model and energy efficiency financing mechanisms.

**High costs and a lack of enabling regulatory and policy frameworks are hindering the scale-up of new clean technologies and innovation.** Therefore, increased World Bank support will be needed to support countries on long-term planning to further inform the development of enabling policies and investment plans for clean energy. Large existing fossil fuel assets that are at the risk of being stranded during the clean energy transition also hinder the expansion of renewables. In addition, the World Bank needs to focus on better integrating climate risks, resilience, and energy-efficient procurement in its own investments to avoid higher lifetime costs. More focus is also needed on cross-sectoral interactions.

### 8.3.2 New frontiers for lending and technical assistance

Taking into account the enormous role of energy systems across countries' economies, and the many cross-sectoral interactions that arise in decarbonizing the energy supply and building resilience, the World Bank teams propose a vision that addresses both supply- and demand-

side issues, highlights the risk of stranded assets, carefully considers cross-sectoral impacts, and leverage new technologies.

**Investing in green hydrogen technologies:** Countries considering hydrogen applications will benefit from technical assistance support, including pilot project funding through the Bank's financing instruments. The World Bank will scale up global green hydrogen initiatives and develop key partnerships among industry experts and financiers to promote global thought leadership and share best practices on design, implementation, and risk management. This will require building internal technical and operational capacity on hydrogen-based systems. The World Bank will also commit resources and raise new funds for a global facility to build client capacity and scale up investments in green hydrogen systems.

**Accelerating transition approaches to avoid stranded assets:** Achieving decarbonization goals will require a major energy transition, including phasing out coal in many regions. There is a need to carefully manage the potential impacts on people, the environment, and the economy. This will entail supporting countries to avoid stranded assets, decommission high-carbon infrastructure, or if feasible, repurpose it for other productive uses. Dedicated efforts are needed to manage the social and economic impacts on workers in fossil fuel industries to ensure a just transition, as well as to address any environmental issues (for example, handling waste and leftover materials). Based on the World Bank's experience in supporting coal-producing countries in their energy transitions, concerted efforts through a global program could be very helpful. Such a program could bring together initiatives by different regions to carefully manage coal sector transitions by supporting a comprehensive package of technical, social, and environmental measures.

**Support a natural gas transition strategy:** Although the long-term objective is to have a net-zero carbon energy system, the transition toward that goal still needs to ensure an affordable and reliable energy supply. In this context, many countries have adopted natural gas as part of their energy mix and transition pathways. The World Bank will support planning of energy market reforms with natural gas trading and regional integration to improve power systems flexibility. An important area is the use of natural gas to improve power system flexibility and district heating systems, especially where the alternative is coal, as a result of limited potential for renewable energy.

**Enable the 'utilities of the future':** The future of the central utility model is unclear, as new ways of producing and consuming electricity are advancing rapidly and the potential for distributed energy resources continues to grow. The World Bank will support countries in developing electricity business models to adapt to these shifts in the sector. This will entail rethinking sector engagement in terms of regulation, pricing, markets, financing, and cybersecurity, while meeting the goals of electrification, reliability, and decarbonization based on country context and locations.

**Pilot carbon capture and storage solutions:** The transition to a carbon-neutral economy will require substantial innovation. Given that some sources of emissions are extremely difficult to eliminate (for example, chemical and construction material industries, air travel, and agriculture), many decarbonization scenarios envision the widespread use of CCUS and BECCS even after 2050 to compensate for continued emissions (IPCC 2014a). These technologies require extensive investments in research and pilot projects. The World Bank will support BECCS and CCUS projects by funding capacity building, technical assistance, and demonstration programs, as appropriate for each country. Key constraints include absence of clear climate change related incentives such as carbon price to mitigate required upfront investments and safety considerations. It will thus develop effective financing strategies to enable the implementation of pilot projects with appropriate measures to ensure technology and performance risk management. Importantly, it will also support policies that address institutional and financial barriers to encourage such nascent technologies.

**Support technology and innovation to decarbonize industries:** The World Bank will support climate action in industries aimed at reducing energy use and emissions and enhancing overall resource use efficiency. Technological innovation has the potential to advance decarbonization across multiple industries through promoting circularity in supply chains and remanufacturing, electrification of industrial processes (powered by clean energy), deployment of frontier technologies such as green hydrogen, and integration of digital technology advancements to enhance efficiency. Actions promoting resource use efficiency and the circular economy present opportunities for adaptation synergies, such as reduced water use in water-stressed regions. The World Bank will deepen its expertise and experience in these areas to enable decarbonization of industries through policy support and innovative financing to attract private sector investments.

**Deployment of innovative technologies for efficient use of energy:** Technological progress in materials science is offering promising new sustainable materials. Examples include energy-generating nanomaterials that can be applied to transport infrastructure; transparent, nanocrystal photovoltaic windows; energy-absorbing paint; and sustainable concrete made from solid waste. These technologies are in different stages of development and commercial adoption. The World Bank will support countries through enabling policies and direct financing to reduce the energy footprint of infrastructure and enhance resilience.

---

## 8.4 Priority Area 4: Transforming Mobility

**The transportation sector produces a quarter of global CO<sub>2</sub> emissions from fuel combustion** (IEA 2019a). Under a ‘business as usual’ scenario, this figure is expected to grow up to 60 percent by 2050 relative to 2015 levels, driven mainly by a tripling of demand for freight and non-urban passenger transport (ITF 2019). About 82 percent of total transportation emissions in 2015 occurred within countries, of which about 90 percent involved road vehicles. Aviation accounted for six percent of transportation GHG emissions, and shipping for 11 percent. By 2050, road transportation emissions are projected to rise by 63 percent. Emissions from aviation are projected to double or quadruple by 2050, while shipping emissions may increase by 50 to 250 percent in the absence of further mitigation action (Sustainable Mobility for All 2019).

**Aligning transportation with 2050 decarbonization goals will require a sustainability transformation.** Transportation systems will need to change in three major ways. First, the need to travel will need to be reduced through better land use planning; compact, transit-oriented urban development; and cultural changes, such as broader embrace of remote work and meetings (a realm in which COVID-19 has rapidly advanced progress). Second, the modes by which people travel will need to change dramatically, shifting from large-scale use of private vehicles to mass transit, supplemented by car-sharing and walking, biking and other non-motorized options. Third, the GHG footprint of all transport modes will need to be dramatically reduced through improved efficiency, direct electrification (or e-mobility) where practical, and production of low- and zero-carbon fuels using renewable energy for longer-distance travel.

**Ambition matters—and planning and collaboration across sectors and countries will be crucial.** Transportation features prominently in NDCs, as many countries recognize the sector as a major source of emissions. However, achieving large-scale emission reductions will require ambitious measures to improve efficiency, reduce demand for travel, adopt new technologies, and shift more trips to zero-carbon transportation modes. Market-based mechanisms have a role to play, such as the Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA), developed by the International Civil Aviation Organization (ICAO) and adopted in October 2016 (ICAO n.d.). The International Maritime Organization (IMO) in 2018 set a target to reduce GHG emissions by at least 50 percent relative to 2008 levels by 2050, and

to decarbonize international shipping “as a matter of urgency... as soon as possible in this century” (IMO 2018).

**The interdependency between transportation and other sectors makes climate action more complex and challenging.** With progress in global development, rising incomes have driven up car ownership, and this trend will continue as economies move into middle- and high-income levels. Shifting this tide will require changing cultural norms that associate car ownership with higher economic status. Transportation needs also reflect urban development patterns: such as cities that are compact, well-connected, with mixed-use and walkable neighborhoods, or, by contrast, those dispersed over large areas necessitating widespread use of personal vehicles. The climate benefits of EVs are closely linked to the carbon content of the local energy supply. As COVID-19 has shown, public health concerns can abruptly shift transportation needs and preferences, sharply reducing transit ridership. The nature of the transportation sector, with numerous mobile sources of emissions, also makes mitigation a network challenge, which is harder to address than discrete project-based solutions. In this context, achieving long-term decarbonization goals will require sweeping changes across the entire sector. Institutions such as the World Bank will play crucial roles in that effort.

#### 8.4.1 World Bank engagement to date

**The World Bank has been successful in developing climate-smart urban transport solutions.** So far, mitigation activities have included establishing air quality monitoring systems, implementing conversions to cleaner fuels, technologies and vehicles, establishing vehicle emissions inspection facilities, and supporting upstream environmental policies and capacity building of relevant institutions. Bank projects have already reported enhanced environmental regulation and capacity in Brazil, China, and Mexico. The Bank has also been scaling up support for resilient transport systems to improve sustainability and performance of transport infrastructure, including bus rapid transit (BRT) and metro systems. This involves improving the accessibility and efficiency provided by transport services without increasing GHG emissions. For instance, in Peru, the World Bank-funded ‘El Metropolitano’ bus service reduced GHG emissions by 33 percent (World Bank 2017b).



El Metropolitano BRT in Lima provides sustainable mobility. –Thomas S./Flickr

**Pilot projects are demonstrating what is possible around the world.** The China GEF–World Bank Urban Transport Partnership supported 14 pilot cities on sustainable transport solutions. Activities included developing BRT systems, improving public transit service, increasing non-motorized transportation, developing transit demand management schemes, and designing transit-oriented development plans. On completion of the pilot, more than 60 non-pilot cities showed interest in implementing similar urban transport investment plans. Further, emissions over 10 years in pilot cities were lower than previous forecasts by 3.93 Mt CO<sub>2</sub> (World Bank 2017b). The Bank is also starting to consolidate assessments of the impact of its rail program, reviving work in water transport, and promoting low-carbon trucking. We have begun to enhance decarbonization and resilience across all forms of transport infrastructure and expand technical assistance activities for non-road sectors such as aviation, marine, railways, and

intermodal connectivity, which is particularly important for logistics activities. The Kunming Urban Rail Project and Nanchang Urban Rail Project in China are good examples of initiatives that promote multi-modal integration that contributed to climate change mitigation.

**The World Bank recognizes that building resiliency is also crucial for the transportation sector.** This is a priority especially for Small Island Developing States, which are highly vulnerable to storm surges and other extreme events that threaten core infrastructure (Dos Anjos Ribeiro Cordeiro et al. 2017). The Bank has developed an engagement strategy to improve resilience across the life cycle of transport infrastructure; identify new projects and investments; and build cross-sectoral partnerships to mainstream resilience expertise into the transport sector. The Pacific Climate-Resilient Transport Program, for instance, combines infrastructure investments, such as building roads to provide alternative routes that can be used if a key corridor is inaccessible, and capacity building activities to help countries adopt resilient design standards and useful tools and to strengthen institutions.

**The World Bank's engagement in transportation has helped put climate change on the agenda, but several challenges remain.** It is difficult to significantly reduce emissions in this sector, and the World Bank's mitigation portfolio for transportation to date has been limited to urban mass transit projects, with very limited engagement on other modes. Efforts to date have often been limited to specific project areas instead of inducing systemic change in the country's mobility concept. Reviews of the World Bank's transport investments have found that projects with a comprehensive approach, including upstream and downstream support, were more likely to yield citywide environmental sustainability (World Bank 2017b). Advancements in digital technologies offer new opportunities—as yet only sparsely harnessed—for better planning and operation of the transport sector so as to further reduce the carbon footprint.

#### 8.4.2 New frontiers for lending and technical assistance

World Bank teams propose to pursue a future vision of the transportation sector that would achieve universal access to mobility, take an integrated network approach to transport in cities, use technology to support improvements, and ensure policy shifts to decouple emissions growth from GDP and mobility. Decarbonizing the transport sector depends on wide-scale adoption of new technologies, industrial policy to make green technologies economically viable for mass deployment, and concerted efforts in the legal, regulatory, and policy spheres to align incentives in favor of this transformation.

**Integrated network planning to inform investments:** The World Bank will expand its engagement from the current project-based approach (for example, BRT in a city) to a broader systemic approach (mobility systems in a country or subnational region), where investments are strategically identified and prioritized in a holistic process that considers interactions with other modes of travel (such as walking or biking). This will include a thorough assessment of the interface between a country's energy and transportation needs, aiming to reduce dependence on oil. The World Bank will help clients conduct network planning exercises across all subsectors before investing in new infrastructure. It will continue focusing on urban mass transit and will simultaneously enhance its engagement in rail, aviation, and shipping through advisory and investment support.

**Increased policy engagement:** The World Bank will scale up support for countries to identify and address externalities from transportation, including CO<sub>2</sub> emissions, air pollution, land use, noise, fatalities, and others, to create an enabling environment for low-carbon investments. It will also support policies that incentivize low-carbon modes for personal mobility and for freight and logistics. It will provide support in quantifying the development cobenefits of low-carbon transportation solutions. It will also increase capacity building efforts for transport ministries, especially in client countries with high expected growth of demand for mobility services, to fill



knowledge gaps and train technical staff on collecting data, cost-benefit analysis, and integrating climate mitigation and resilience considerations into transport network and national planning. It will engage finance ministries in low-carbon transportation planning, and vigorously promote collaboration with private investors to mobilize urgently needed private sector financing.

**Developing an electric mobility strategy and rapidly scale up investments:** The World Bank will develop its own e-mobility engagement strategy, factoring in foundational principles to consider while financing and implementing policies and projects in countries. Internally coordinating with the energy and urban teams and, on the client side, with relevant line ministries, it will also support client countries in developing their own e-mobility strategies and implementation plans. The strategy will cover support for electric vehicle supply chain, complementary investments in charging infrastructure, road network planning, and the policy and financing environments required to implement targeted solutions.

**Unlocking smart technology for efficient transport:** The World Bank will leverage advances in vehicle technology, digital technology, and data analysis to help remove market barriers and bring in private sector financing to help countries transform their transport sector. It will develop its knowledge base using 'big data' and real-time data, developing products on the economic feasibility of technological innovations for low-carbon transport and partnering with key institutions to develop the concepts that will enable clients to rapidly adopt low-carbon mobility. It will offer financial instruments to de-risk investments in new technologies or markets that investors would not otherwise consider. The World Bank will finance pilots for new technologies that demonstrate the technical feasibility and economic viability of disruptive low-carbon technologies that improve transport efficiency and overall sustainable mobility. Autonomous vehicles, for example, could revolutionize the way we travel through better efficiency, with fewer vehicles on the road, and fewer crashes. Digital technologies will also play a major role and enable new vehicles, new mobility services and business models (for example, ride share models), a different use of mobility assets, predictive maintenance, safer driving, and behavior changes among consumers to further improve efficiency and reduce emissions.

**Innovative climate action for interurban and rural transport:** As noted above, roughly 90 percent of domestic transport emissions involve road transport (ITF 2019). Opportunities to abate future demand are limited, as car use and freight are driven by economic growth and higher demand for mobility, particularly in emerging economies (ETC 2018). Thus, deep decarbonization of road transport requires a substantial shift in the nature of transport demand, major upgrades to energy efficiency, modal shifts, and quick transitions in the energy mix used (UNEP 2019). To this end, the World Bank will support technological innovation and pilot approaches and de-risking of new technologies for commercial adoption. It will enhance its lending and technical assistance portfolio to extend the supply of basic low-carbon transport services in rural areas and improve access to urban centers. It will also engage with client countries, subnational entities, and local NGOs to identify the rural areas with the strongest transport demand and the largest potential for developing low-carbon solutions.

**Low-carbon investments for non-road sectors and for freight:** The World Bank will seek strategic partnerships with ICAO, IMO and other leaders in subsectors in which it has not previously engaged, and work also with finance ministries to support comprehensive planning for low-carbon transportation, enhance cross-sectoral collaboration, and mobilize private sector financing. It will scale up investment in less polluting modes, such as railways and inland waterways, and thereby encourage modal shifts, especially in freight and logistics. In these investments, the World Bank will promote energy-efficient technologies and designs, digitalization, fleet scrappage, retrofits, and replacement. It will support improvements in heavy freight through ambitious standards for fuel efficiency and CO<sub>2</sub> emissions. It will also encourage alternative fuels through supporting policies such as pricing mechanisms, stricter emissions standards, zero-emissions zones and recharging infrastructure.

---

## 8.5 Priority Area 5: Building Low-Carbon, More Resilient Urban Areas

**By 2050, 68 percent of the global population will live in urban areas, up from 56 percent today** (UN 2018). That represents an additional 2.5 billion people in cities, with close to 90 percent of this growth taking place in Asia and Africa. Economic activity is already concentrated in urban areas, and by mid-century, cities will account for the vast majority of global GDP growth. This rapid urbanization has huge implications for how we plan future infrastructure in the energy, transportation, and water sectors. It also has consequences for how we design urban buildings, green spaces, and public services, which in turn will affect GHG emissions. Without further action to tackle climate change, GHG emissions attributable to urban buildings, transport, and waste could reach 17.3 billion tCO<sub>2</sub>e in 2050 (Coalition for Urban Transitions 2019).

**Income, demographics, location, density, urban design, and economic systems are key emission drivers in urban centers**, reflecting both the specificity of urban scale emissions and their commonality with national-scale drivers. Urbanization patterns (that is, urban form and structure) also highly influence urban GHG emissions due to strong links to energy, waste, land use, density, and overall efficiencies of a city (Seto et al. 2014). The interventions needed to reduce emissions will differ, however, depending on whether a city is established and mature, or actively developing. The latter need to quickly respond to the needs of their growing populations, but through careful design and planning, they can meet those needs, adopting low-carbon approaches and avoiding ‘lock-in’ of emissions through infrastructure that creates car dependency. In mature cities, meanwhile, fundamental changes to infrastructure may be more expensive—though still possible—but the main focus of interventions may be on retrofitting and upgrading existing buildings and infrastructure to reduce energy demand.

**Urban areas are also particularly vulnerable to climate change impacts**, including floods (when large swaths of impervious area hinder drainage) and extreme heat (resulting from urban ‘heat island’ effects relieved by relatively little green space). As the COVID-19 pandemic has demonstrated, densely populated urban areas are particularly vulnerable to the spread of new diseases. The clustering of cities worldwide on coastlines and riverfronts also makes them particularly vulnerable to storm-surge damage. Given all these vulnerabilities, and the magnitude of investments channeled to building and growing cities, they have a very strong interest in mitigating climate risks even as they adapt to reduce their vulnerability.

**Fast-growing cities urgently need support to ensure they can meet their residents’ needs and avoid locking into harmful patterns.** To date urbanization has increased economic growth and lowered poverty. However, in many developing cities, population growth has far outpaced the expansion of urban infrastructure and services, resulting in congestion and increased pollution and, in some countries, creating large marginalized communities who live in dire and unsafe conditions. Cross-sectoral, integrated planning can help set developing cities on a resilient and low-carbon path, with a focus on livability. The key will be to act quickly, before rapid urbanization locks in high-emission growth. Compact cities need less energy and fewer vehicles, and offer greater mobility, because passenger density is sufficient to make public transit financially viable. The goal is therefore to deliver efficient urban forms without undermining the livability of urban areas.

**Transformational change will require national urban strategies on climate action.** It is imperative for cities to have access to tools both for managing density to increase livability as well as for reducing GHG emissions. This transformation will entail a complete shift in the existing built urban form, and a mainstreaming of climate change mitigation and resilience into cross-sectoral planning. National governments have a key role to play in providing resources, an enabling policy environment, and expert guidance. The World Bank can support the development and implementation of national urban strategies and the necessary cross-

sectoral collaboration. New and different approaches are needed to better incentivize longer-term, climate-informed spatial and other strategic planning in cities.

**A low-carbon, resilient urban transformation will require a complex, multi-level approach to creating successful systems change.** The World Bank's work on urban transformation will focus on creating climate-smart cities, with data-driven spatial planning and strategies and incentives to reduce consumption and especially waste. It is crucial to remember that cities do not operate in isolation, but are inextricably tied to national and regional networks of economic flows, goods, and services. This complexity presents challenges and opportunities, and requires moving from a sector-focused, project-level approach to a better integrated, systemic one.

### 8.5.1 World Bank engagement to date

**With significant expertise in climate-smart cities, the World Bank has the commitment and expertise to support a low-carbon, resilient urban transformation.** Climate cobenefits assessments for projects have helped raise awareness of climate change risks and opportunities. From a climate perspective, the emphasis has been on adaptation, especially post-disaster resilience, with little focus on mitigation action. Significant progress has also been made on post-disaster resilience enabled through dedicated grant resources such as the Global Facility for Disaster Risk Reduction (GFDRR) to build national and local capacity, improve enabling systems such as early warning systems, and invest in the resilience of communities and infrastructure. On the mitigation side, the World Bank's urban investments to date have mainly focused on solid waste management, which has a very small share of the portfolio. The World Bank is now well placed to expand mitigation engagement across all urban engagements, going beyond screening and advisory services toward transformative action through policy frameworks, planning, and investments. For example, the World Bank supported a composting facility in Lahore, Pakistan, through market development and the sale of emission reduction credits under the Kyoto Protocol. The activities resulted in reductions of 150,000 t CO<sub>2</sub>e.

**The World Bank faces several challenges that limit progress on achieving low-carbon urban transformation.** Urban operations are driven by client demand, and national governments' interest in urban climate action is still limited. The lack of a comprehensive approach that is anchored in integrated urban planning has resulted in a piecemeal approach to urban investments. Moreover, the World Bank is unable to lend directly to cities (municipalities), since funds are usually channeled through a country's finance and line ministries. Funding also tends to be project- or sector-focused, making it difficult for the World Bank to influence integrated city actions. Another issue is that municipal bodies usually lack the creditworthiness and access to finance (outside of government allocations) to implement such actions through external financing.

### 8.5.2 New frontiers for lending and technical assistance

Recognizing that urban transformation is inherently cross-sectoral, and that cities have urgent adaptation needs that they must address simultaneously with mitigation, the World Bank teams propose an approach that prioritizes comprehensive national urban strategies, improved spatial planning, and 'circular economy' solutions to reduce waste, building on existing engagements.

**Prioritize climate action in urban 'hotspots':** The World Bank will invest in rapidly urbanizing areas or 'urban hotspots', where urban form and infrastructure are not yet locked in and where the potential is highest for bending the emission curve. Given that most of the infrastructure needed for the year 2050 is yet to be built, particularly in developing countries, this represents a significant opportunity to develop more sustainable, efficient, and low-carbon infrastructure. However, sustainable implementation is a challenge in these cities, due to weak governance and limited technical, financial, and institutional capacities. To this end, the World Bank will

develop an assessment identifying these hotspots and delving into the challenges of low-carbon development for different urban contexts. Specific offerings such as targeted financing will be developed for newly identified hotspot cities.

**Develop national urban strategies to focus on climate:** The World Bank will develop an engagement model for cities similar to its Country Partnership Frameworks, which use systematic diagnostics to drive priority investments in client countries. Applying this model to the city level, the World Bank will encourage cities to think beyond project-based approaches and identify cross-sectoral priorities. City diagnostics and partnership strategies will create specific agreements with urban areas that bring an integrated planning approach to identify priorities for urban investments. The frameworks will prioritize planning for climate-smart urban growth, supporting compact and transit-friendly development, and avoiding sprawl and a lock-in of high carbon emission patterns. Such approaches will be piloted in select urban hotspots to develop engagement models and planning templates. World Bank teams will be trained to support the application of this framework in cities, preparing local administrators for the use of integrated planning tools within priority-setting processes.

**Prioritize spatial planning for urban interventions:** Spatial planning is a key mechanism for integrating low-carbon and resilient development. It can be challenging to align that process with climate goals and urban investment plans. The World Bank will support such systemic change through a focus on livability, and the use of data and digital technology. It will use climate mitigation and adaptation data, risk analysis, and climate targets as inputs and decision-making drivers, along with the development goals and priorities in urban spatial planning. It will also closely integrate transport planning with spatial planning to improve city design in favor of improved transportation demand management.

**Accelerate investments in low-carbon cities:** The World Bank will prioritize investments and promote livability and sustainable density in cities. It will support knowledge-sharing on urban development models, including infill development, mixed-use neighborhoods, pedestrian areas, and urban green space, to help countries and cities identify models to meet their own needs. It will deploy new technologies that support low-carbon and resilient development in a number of ways, such as the adoption of building materials and designs that minimize cooling needs, artificial intelligence to improve efficiency of public transport, and ‘smart’ streetlights to save electricity.

**Develop circular economy framework for implementation:** Cities are responsible for more than 85 percent of global GDP, about 75 percent of natural resource consumption and about 50 percent of global waste (Coalition for Urban Transitions 2019). Moreover, cities are responsible for about 60–80 percent of global GHG emissions. Embedded in this challenge lie significant opportunities for the circular economy. The circular economy model aims to use waste streams as a source of secondary resources and to recover waste for reuse and recycling. The World Bank is therefore developing a roadmap to guide cities on circular economy approaches. The roadmap will provide a framework for technical assistance to support cities in understanding the interaction between urban form, infrastructure development, economic opportunities, and waste. This will further be used to identify and support investments in increasing circularity in urban areas.

---

## 8.6 Priority Area 6: Transforming Water Systems

**Climate change poses major threats to the world’s water systems, with broad implications for many countries’ economies.** Rising temperatures, droughts, floods, saltwater intrusion in groundwater due to sea-level rise, increased evaporation rates, and related impacts are

already being felt, though they manifest very differently across countries and regions (IPCC 2014b). Higher average temperatures and changes in precipitation are projected to affect the availability of water resources through changes in rainfall distribution, soil moisture, glaciers, and groundwater flows. These are expected to lead to further deterioration of water quality. This is particularly concerning because global water use continues to rise steadily with a growing population and economic development, even as groundwater depletion has increased; by one estimate, the world could face a 40 percent water deficit by 2030 (UN-Water 2020). By 2050, worldwide water demand is projected to increase by 20–30 percent, with the share of the global population experiencing water stress for at least one month of the year rising from one third to 58 percent, or up to 5.7 billion people (Boretti and Rosa 2019). Water scarcity, exacerbated by climate change, could hinder economic growth, spur migration, and spark conflict. Parts of North Africa and the Middle East, for instance, could see growth rates decline by as much as six percent of GDP by 2050 (FAO and World Bank Group 2018) as a result of water-related losses in agriculture, health, income, and land. This can be exacerbated by poor water management policies.

**The water sector is also a significant contributor to global emissions.** Water systems use energy to extract, transport, and treat water, and to treat wastewater (to the extent that it is treated, as in many places, raw sewage is released into waterways, not only polluting the water, but also producing methane emissions). Energy use in the water sector is expected to double by 2040, mainly due to increasing desalination of seawater (UN-Water 2020).

**Water plays a central role in a wide range of sectors, from energy, to agriculture and food production, to health.** In a changing climate, many of those sectors will be putting additional pressure on water systems; for example, there will be increased demand for irrigation for crops to compensate for changes in precipitation and increased heat, and the power sector will need more water for cooling. There is a strong need for an enabling environment for managing water resources at the local, national, and international levels, with higher efficiency in water supply and use and enhanced resilience of water systems.

### 8.6.1 World Bank engagement to date

The World Bank has been successful in bringing climate adaptation and resilience action in its water sector engagements. In particular, it has focused on integrating climate variability into water resource management, wastewater reuse, climate-smart agriculture, and agricultural water management, including efficiency in irrigation, groundwater management, water quality, and solar energy for irrigation. It has also engaged in transboundary programs, ‘climate-proofing’ of fisheries, flood management, and integrated watershed management. In its work on the ocean economy, discussed further in the next section, the Bank has highlighted the importance of good watershed management and wastewater treatment to reduce waste and pollutants flowing into the oceans. It has also addressed the significant use of water for cooling in power plants. The Bank’s Thirsty Energy initiative partnered with the Energy Research Center (ERC) of the University of Cape Town to incorporate water constraints in an energy planning tool. The energy-water nexus analysis found that when factoring in water supply infrastructure costs, dry cooling is deemed best for most power plants. This has significant implications for



Solar powered pumps help reduce irrigation costs in Bangladesh.  
—Dominic Chavez/World Bank

the energy sector's water needs (World Bank 2017a). In recent years, water sector investments have also started integrating climate mitigation actions, mainly in projects focused on water supply and wastewater treatment systems, but with slow progress.

**There is significant potential to scale up climate action in the World Bank's water sector engagement.** Some work has been undertaken in flood management in cities, for instance, but there is significant scope to do more. Mitigation action needs to be significantly ramped up relating to water use efficiency, water subsidies, mitigation-based advocacy, and mainstreaming energy efficiency in water projects, through use of renewables, loss reduction in water distribution systems, and efficient pumping. Mitigation technologies need to be better integrated into projects – such as renewables to power irrigation pumps and water treatment systems, efficient pumps across all water end-uses, and digital technologies to optimize water use. Significant challenges need to be overcome to scale up actions with mitigation-adaptation synergies, in cross-sectoral water related investments, and in nature-based solutions and green infrastructure. Overall, the Bank envisions a future in which public demand drives progress toward resilient and efficient water resource management; new methods of data collection would analyze water data and optimize decarbonization and resilience in water investments; and new low-carbon technologies help meet rising demand.

## 8.6.2 New frontiers for lending and technical assistance

Recognizing the enormous importance of water resources across countries' economies, and the significant interactions between mitigation and adaptation in the water sector, the World Bank teams propose a vision for water systems decarbonization that focuses heavily on cross-sectoral interactions and finding synergies to advance multiple climate and development goals.

**Prioritize opportunities with adaptation-mitigation synergies:** Water is a natural resource heavily affected by climate change, making adaptation the most critical issue for the sector. However, as noted above, the sector is also a growing source of GHG emissions. To address this dual challenge, the World Bank will establish clear priorities in SCDs and CPFs on financing water projects at the adaptation-mitigation nexus. Specifically, it will prioritize actions with dual benefits, such as renewable energy-powered desalination plants in water-scarce regions as well as solar-powered groundwater pumping, while accounting for risks such as overabstraction due to unregulated water pumping. Additionally, the World Bank will prioritize efficient water use in utilities and water resources, reducing system losses, and floating solar PV. It will also develop the underlying analytics on (energy-water) nexus investment opportunities to provide guidance and incentives for task teams and clients to identify and develop suitable projects.

**Clean energy and energy efficiency for water treatment and supply systems:** The growing water demand and increasing stress on water systems can further lead to measures that increase GHG emission from the water sector. In addition to the actions with synergies described above, there are multiple opportunities for mitigation actions in the water sector, mainly by reducing energy use. The World Bank will support the integration of renewable energy and zero-energy, gravity-based systems to power irrigation, drainage, water treatment, and water supply systems to help reverse the trend of increasing GHG emissions. Additionally, it will support countries in reducing losses in irrigation and water supply through system rehabilitation and upgrades, and help them deploy energy-efficient equipment throughout the treatment and supply system.

**Develop energy-efficient systems for wastewater reuse and resource recovery:** Wastewater treatment can be very energy-intensive, and anaerobic treatment technologies can also produce high GHG emissions if biogas capture is not implemented. Wastewater conversion can also generate more energy than is required to treat it. The World Bank will invest in energy-efficient wastewater treatment systems, and will support the rehabilitation and construction of wastewater treatment networks by exploring low-impact and water-sensitive interventions. Additionally, the

World Bank will invest in energy-efficient systems that enhance resource recovery and reuse from wastewater treatment plants. This will enable wastewater plants to generate a large portion of the energy they need with their own resources.

**Scale up use of data and information technologies to manage water demand:** The World Bank will invest in data-driven approaches to identify and implement demand-response measures for water use to lower water consumption and associated GHG emissions. This would entail smart meters for consumers (industrial and residential) to monitor their consumption, and incentives under the program to lower consumption (especially since reduced bills may not offer sufficient motivation when the water tariff is modest). These technologies also help utilities with efficient billing to consumers.

**Standardize water-related GHG emissions data systems:** The World Bank will spearhead the development of a global water sector database to help identify GHG mitigation opportunities related to water losses and the energy intensity of water services. This will entail standardizing data collection for water related GHG emissions and analyses of water-related energy use across sectors (agriculture, urban, industry, power) and supply system efficiency, especially in urban water systems. The World Bank will also invest in data platforms (such as a free and accessible mobile phone application) that would aggregate data from a variety of reputable sources, analyze them, and create an easily accessible 'dashboard' for understanding trends in water use and availability.

**Scale up the use of decision support tools for climate-friendly water sector investments:** The World Bank has developed a Decision Tree Framework that provides project planners with limited resources with a cost-effective and efficient method for demonstrating the robustness of a project to climate change (Ray and Brown 2015). Such tools have also helped SEDAPAL, the water utility serving Lima, Peru, to draw on state-of-the-art methods for decision-making under deep uncertainty. These methods have provided methods for analyzing the performance of a water utility over a wide range of plausible future scenarios and then developing effective strategies across these futures. The Bank will scale up support for mainstreaming planning tools like this one in countries and within its own teams working on project design. This will optimize decarbonization and resilience in water investments to be incorporated in project planning and design. With this information, countries and project teams can better understand and rank the available options for integrating climate concerns.

**Scale up the integrated urban water management approach:** IUWM supports municipalities in addressing key water challenges by working across sectors and spatial boundaries to find optimal infrastructure solutions considering all water services. Such an integrated planning approach also presents an excellent tool to embed low-carbon solutions and their associated costs when developing investment plans. The Bank has already started to adopt this approach. For example, over the last three decades, the Bank-funded Espirito Santo Water and Coastal Pollution Management Projects in Brazil have moved from mere water supply and sanitation access to improving the environmental sustainability of services and integrating water resources management into related sectors. The World Bank will scale up this approach in all urban operations and mainstream it by integrating the urban water cycle (water supply, sanitation, wastewater reuse, nutrient and energy recovery from waste, stormwater management) with municipal agendas for urban development as well as river basin management to maximize socioeconomic and environmental benefits in an equitable manner. This will be done by tailoring the approach to the specific challenges of each urban area; engaging in effective participatory approaches involving multiple sectors; developing an iterative process with a long-term vision; and ensuring that decisions are backed by sound scientific and technical analysis.

**Enable policies for low-carbon investments in the water sector:** The World Bank will scale up support to countries on policy frameworks that target GHG reduction in the water sector. This

will entail policies and incentives for utilities to integrate renewable energy in their operations and make energy efficiency improvements. The Bank will also support countries in designing incentives for consumers to reduce water use and adopt energy-efficient equipment such as pumps for agricultural, residential, and industrial consumers. Such policies will also create a demand for digital technology and data-driven approaches informed by analytics that can lead to efficient water consumption.

---

## 8.7 Priority Area 7: Transforming the Blue Economy

**The ocean or ‘blue’ economy, if measured as a country, would be the seventh largest in the world** (Hoegh-Guldberg 2015). More than a third of the world’s population lives in coastal areas. The oceans directly support millions of livelihoods, and they provide food, employment, energy, recreation, and vital ecosystems services. The ocean economy comprises multiple, highly diverse sectors: from fisheries and aquaculture, to transport, to energy and mining, to tourism. Effective management seeks economic growth, social inclusion and improved livelihoods while ensuring environmental sustainability of the oceans and coastal areas (World Bank and UN DESA 2017).

**While the ocean absorbs roughly 30 percent of CO<sub>2</sub> emissions, blue economy activities produce a significant amount of GHG emissions** (Hoegh-Guldberg et al. 2019). There are no global estimates of GHG emissions from all ocean sectors, as there has been little focus in aggregating emissions across sectors to date, but it is possible to identify some of the largest sources:

- » *Maritime transport and shipping*: Current GHG emissions from this sector are roughly 1 Gt CO<sub>2</sub>e per year and represent about 3 percent of global anthropogenic CO<sub>2</sub> emissions; demand is likely to grow by three percent annually, leading to a doubling of emissions by 2050 (Hoegh-Guldberg et al. 2019).
- » *Loss and degradation of coastal ecosystems*: Coastal ecosystems cover only 2–6 percent of the area covered by inland forests, but they sequester carbon dioxide at much higher rates. Given the high rate of sequestration, estimates indicate that emissions from the decline and destruction of mangroves, salt marshes, and other coastal ecosystems can be as high as 10 percent of total emissions from deforestation globally, even though mangroves account for only 0.7 percent of tropical forest area (Griscom et al. 2017).
- » *Fisheries and aquaculture operation*: Global fishing accounts for roughly four percent of global food system production emissions (Hoegh-Guldberg et al. 2019). Analysis of aquaculture emissions is limited, but research has shown that fish feed is the largest source of emissions in aquaculture production. In some countries, aquaculture has also become a major driver of coastal ecosystems degradation. For example, in several Asian countries, shrimp farming has led to impacts such as mangrove degradation, loss of biodiversity, sedimentation, saltwater intrusion, and pollution (Ashton 2008).

**Ocean ecosystems are extremely vulnerable to climate change impacts.** Ocean acidification (resulting from increased CO<sub>2</sub> concentrations), warming waters and deoxygenation have already resulted in coral bleaching, shifts in fish migration patterns, and changes in fish stocks (Hoegh-Guldberg, Pendleton, and Kaup 2019). Many shellfish may be unable to withstand continued acidification. Sea-level rise is also increasingly affecting coastal areas all over the world, including in low-lying islands, causing massive damage during storm surges, but also slowly



eroding the coast and, through saltwater intrusion, reducing the water supply and threatening freshwater ecosystems. Communities living close to coastal environments are particularly vulnerable to the hazards of climate change (IPCC 2019b).

**Oceans continue to be carbon sinks, but maintaining and increasing ocean carbon storage will require concerted effort, guided by dialogue across countries and sectors.**

Recent research shows that there is significant potential for oceans to play a role in closing the mitigation gap through carbon sequestration while also enhancing resilience of ocean ecosystems (Hoegh-Guldberg, Chopin, et al. 2019)] As a carbon sink, oceans could potentially reduce total global GHG emissions by more than 11 Gt CO<sub>2</sub> per year by 2050, which is similar to China's total emissions in 2018. This would close the emissions gap in a 2°C pathway by 25 percent by 2050. Meeting this ambitious mitigation goal will require a broad, integrated planning effort from all coastal nations in order to overcome the challenges the sector faces. Coastal ecosystems also play a critical role in adaptation and resilience. Coral reefs and mangroves can significantly attenuate wave energy. Mangrove habitats also act as soil builders in coastal areas, which is critical for wave attenuation, coastal-erosion control, and ensuring adaptation to sea level rise (Powell et al. 2019).

**The sectors involved in the blue economy have competing interests that may be difficult to balance—and trade-offs also arise in the context of climate action.**

It is particularly crucial to consider cross-sectoral and environmental impacts, and not just work with individual sectors. Actions that provide benefits in multiple sectors or advance both mitigation and adaptation should be prioritized. For example, there may be significant interest in expanding fisheries and aquaculture to support new livelihoods and provide less GHG-intensive sources of animal protein to meet demand from a growing global population. However, about 35 percent of fish stocks monitored by the UN Food and Agriculture Organization are being fished beyond biologically sustainable levels (FAO 2020). The emissions and environmental impacts of aquaculture also pose threats to coastal ecosystems and human health. Thus, such projects should be evaluated with great care. Protecting and restoring mangroves can also provide multiple benefits: protection from storm surges, carbon storage, healthier ecosystems, and more productive fisheries. Another factor to consider is the governance of individual sectors. For instance, global shipping is mainly overseen by the International Maritime Organization (IMO), limiting national governments' ability to regulate the industry or try to reduce its emissions.

### 8.7.1 World Bank engagement to date

The World Bank has had significant, but fragmented engagement in the blue economy for decades. It has leveraged over US\$1 billion in investments in fisheries through the Global Program on Fisheries. It has worked with countries on ocean waste management and pollution, shipping and ports, coastal tourism, and offshore renewable energy. From a climate perspective, a large share of the Bank's work has focused on adaptation and building resilience to coastal disasters, because this is a strong and growing area of immediate client demand. In 2018, an umbrella program was launched to offer a more comprehensive approach to the blue economy: PROBLUE, a multi-donor trust fund worth about US\$5 billion, with an additional US\$1.65 billion expected. So far, the fund has initiated over 30



New fisheries in Africa provide more jobs and improve livelihoods. –Arne Hoel/World Bank

analytical activities and partnered with more than 60 countries to build sustainable ocean economies. Its principal areas of focus include improved fisheries governance, marine pollution management, sustainability of oceanic sectors (including shipping and renewable energy), and seascape management.

**The World Bank's greatest strength in transforming the blue economy is leveraging its convening power to address problems that transcend national boundaries and require regional collaboration.** Sustainable management of ocean resources requires collaboration across countries and across the public and private sectors, on an unprecedented scale. The Bank has successfully developed the Africa Regional Fisheries Program, the Southwest Indian Ocean Fisheries Program, and the West Africa Coastal Areas Management Program. These programs showcase innovation at the regional level to promote collaboration and knowledge exchange on the blue economy.

**Small Island Developing States (SIDS), Least Developed Countries (LDCs) and countries affected by fragility, conflict and violence (FCV) have particularly high stakes in the blue economy.** This targeted focus on the blue economy will go a long way in tackling poverty, food and energy security, employment, economic growth, ocean health, and the sustainable use of ocean resources. The World Bank will need to present blue economy approaches in a framework similar to green growth, as drivers to increase economic growth sustainably to reduce poverty in SIDS, FCVs, and LDCs. However, a framework for 'blue growth' has not yet been fully defined, and there is a lack of global data and research on what a sustainable blue economy would look like, or how it would affect World Bank clients.

**The largest opportunities for emissions reductions by 2050 are in ocean-based renewable energy and ocean-based transport** (Hoegh-Guldberg et al. 2019). Notably, these opportunities may not reduce emissions from the existing ocean economy, but rather offset or reduce emissions elsewhere—for instance, by replacing fossil-fueled energy with offshore wind or tidal energy.

## 8.7.2 New frontiers for lending and technical assistance

Recognizing the complexity of the ocean economy and the many sectors it involves, the World Bank teams propose a vision for engagement that emphasizes synergies between adaptation and mitigation and supports sustainable development across multiple sectors.

**Integrate blue growth plan within SCDs and CPFs:** For coastal countries, especially those with significant blue economies, the World Bank's SCDs and CPFs should include analysis of coastal and maritime industries and the creation of a long-term blue growth plan for sustainable and integrated management of oceans. The latter should be tailored to the country's unique circumstances and consider ocean-based renewable energy, improved port operations, piloting of shipping innovations that reduce emissions, integrated land use and coastal protection planning, and fisheries and aquaculture management. The blue economy is highly vulnerable to climate change and also a large source of GHG emissions, so both adaptation and mitigation are crucial. To address this dual challenge, the World Bank will establish clear priorities in country engagement strategies on financing new practices and approaches for mitigation and adaptation, especially exploring synergies. Countries are still exploring how this new area will affect their economies. Therefore, the World Bank will support the development of tools and successful implementation models to support country action. These tools will promote holistic and integrated planning of oceanic, coastal, and marine sectors underpinned by appropriate policies, and effective regulatory and institutional platforms.

**Restore and protect coastal and marine ecosystems (blue carbon):** Existing ecosystem protection opportunities are viable for most coastal communities, because they are cost-effective nature-based solutions that can be rolled out immediately. There is significant

efficiency in these solutions, as many would yield significant adaptation cobenefits, and their potential sequestration rates per hectare are up to 10 times larger than land sequestration (Hoegh-Guldberg et al. 2019). However, 20–50 percent of the world’s mangrove, seagrass, and salt marsh areas have been destroyed. The Bank will advocate for the inclusion of nature-based solutions for ecosystem protection and restoration in NDCs and long-term strategies. It will invest in the creation of conservation areas to protect remaining ecosystems. It will also explore and recommend innovative financing to value and pay for ecosystem services that are provided by the seascape.

**Fisheries and aquaculture:** Action on fisheries under the PROBLUE program includes reducing overexploitation of fish stocks, and improving aquaculture. The World Bank will support research on sustainable fish feed sources. It will also scale up support for and investments in fishery improvements that reduce emissions from vessels and operations to ensure sustainable fisheries and aquaculture. Further, the Bank will support prevention of marine pollution from land-based sources and marine sectors and improving sustainability of coastal tourism.

**Scale up investments in ocean-based renewable energy:** There are significant opportunities in offshore wind, tidal, and wave power; floating photovoltaic systems; and energy exchange systems for heating and cooling. Overall, ocean-based renewable energy contributes less than 0.3 percent to global electricity generation (Hoegh-Guldberg et al. 2019). However, the technologies are proven at scale and ready for deployment as soon as policy and regulatory regimes begin to incentivize it. The theoretical potential of offshore wind energy alone could meet all future projected electricity demands; after adjusting for economic constraints, estimates of the potential for proven ocean-based renewables (off-shore wind and tidal and wave energy) could contribute 760–5400 TWh per year by 2050. The Bank will also support regulatory frameworks that incentivize investments in ocean-based renewables, such as carbon taxes, innovative PPA structures, private sector incentives, and so forth. Currently the high investment cost of projects is prohibitive to widespread scale-up of ocean-based renewables. Research programs will help identify and explore options for minimizing environmental and ecosystem impacts, including deep water siting of ocean-based renewables and the scale-up of installations and mapping of global opportunities. The World Bank Group has already begun this process by launching a new program in 2019 to fast-track the adoption of offshore wind energy in developing countries. It will help emerging markets assess their offshore wind potential and provide technical assistance to develop a growing pipeline of projects that are ready for investment by renewable energy developers (Dutton et al. 2019).

**Fully decarbonize ocean-based transport:** As mentioned in Section 8.4, the IMO has adopted an objective to reduce emissions by at least 50 percent by 2050. However, a more ambitious target will need to be set to meet Paris Agreement goals. A full phase-out of emissions from the sector would be needed, requiring development of low- or zero-carbon fuels. The Bank will support countries on advocacy, and policy frameworks to incentivize development of zero-emission fuels for shipping and attract private sector investments.

---

## 8.8 Priority Area 8: Digital Transformation

**The digital revolution affects human life and the physical world in ever-changing ways.** Rapid development of digital technology presents both an opportunity and a challenge with respect to climate change. On the one hand, digitalization is already transforming the global economy by unleashing transformational upgrades in every industry. For example, digital transformations in the energy sector are improving the performance of energy generation resulting in reduced emissions. In the aviation sector, big data analytics optimizes route planning and helps pilots make in-flight decisions that result in reduced fuel use. Moreover,

evidence shows that information and communications technology (ICT) can enable up to a 20 percent reduction of global CO<sub>2</sub>e emissions by 2030 from 2015 levels (GeSI and Accenture Strategy 2015).

**Digital technologies are also significant drivers of energy demand.** The digital ecosystem includes host servers in data centers, network infrastructure (satellites, transmission media, and such), access points (for example, 3G base stations, modems and wifi) and devices (computers, mobile devices, artificial intelligence devices), all of which consume a large amount of energy. Data centers and blockchain validation processes tend to be extremely energy- and resource-intensive. The huge growth in personal computing and mobile use has contributed substantially to energy usage and emissions. It is crucial to ensure that a clean supply of energy and sustained gains in energy efficiency balance overall energy demand growth for such technologies over the coming decades.

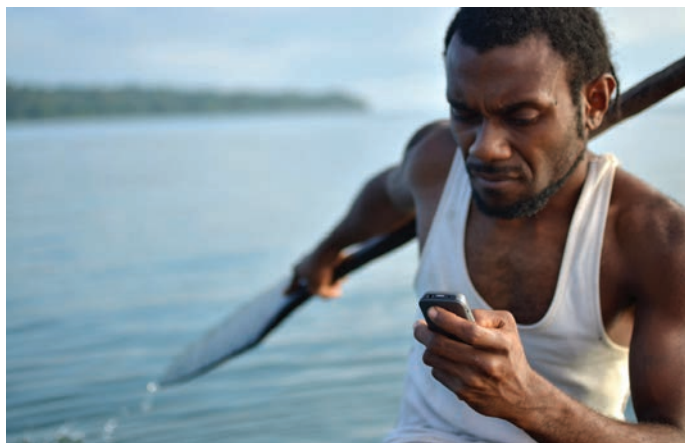
**Emission reduction efforts to date have been narrowly focused.** So far most of the attention has gone to the energy and environmental performance of data centers (host servers). However, they are only one component of the digital ecosystem. The servers, infrastructure, software, and devices used in delivery produce a direct impact on the natural world, and energy use is further driven by people consuming digital products. Therefore, the role of energy-efficient digital products and processes and energy transition toward renewables for use in manufacturing of digital products and powering consumption cannot be ignored.

**Demand for digital infrastructure is expected to increase, resulting in significant energy consumption.** While global estimates vary widely, due to methodological differences and data limitations, some evidence suggests that the overall carbon emissions from the digital ecosystem have increased from 2.5 percent to 3.7 percent between 2013 and 2018 (The Shift Project 2019). With only half of the world population online and the demand for connectivity continuing to grow, there will be increased pressure on existing physical infrastructure and the planet. So far, economies have prioritized innovations aimed at safeguarding physical systems from climate disasters. However, the COVID-19 crisis has revealed that such efforts have not sufficiently enhanced societal access. The pandemic has thus given a fresh boost to digital development. It has resulted in wider acceptance of online services, increased online connectivity between diverse industries, and accelerated digital innovation in the health sector to address the public health crisis. Companies and industries are starting to use the cloud, artificial intelligence and big data to adjust their business models and build new ones in response to the pandemic. Countries will also need to fast track the construction of new digital infrastructure and reduce regulations to manage the demand. All this will require a significant amount of energy input. Prior to the pandemic, the ICT sector's share of the global carbon footprint was already expected to reach about 7– 8.5 percent in 2025, and the energy intensity of ICT was growing by 4 percent a year, even as other sectors found ways to reduce their energy use (The Shift Project 2019). The current crisis will further exacerbate the pressure on energy demand.

**It is clear that technology and the data it generates will have a key role to play in the long term by providing development solutions, supporting a shift to low-carbon infrastructure, and responding to market shifts and consumer preferences.** There is a great opportunity to leverage the digital revolution to drive low-carbon and resilient economic growth. To realize this potential of GHG reductions through technologies, we need to harness technologies at different levels of development. Cloud computing, first-generation industrial automation, advancements in sustainable engineering of materials, and 3G, 4G and 5G mobile networks, among others, already serve as a foundation for big efficiency gains across sectors. With the right policy frameworks and strong climate leadership, these technologies will be instrumental to moving society toward a circular and lean economy, focused on growing service value while reducing GHG emissions, waste, and pollution.

### 8.8.1 World Bank engagement to date

**The World Bank is uniquely positioned to provide financing and technical support to leverage digitalization in the decarbonization of key sectors.** Scaling up digital infrastructure platforms and solutions, tools, and enabling environment interventions such as regulations, architectures, skills, and institutional adaptation are all necessary to address climate challenges. The World Bank, through its past and recent lending and technical advisory projects, has already started contributing to mitigation and adaptation efforts. For example, in terms of digital infrastructure the World Bank has been involved in setting up green data centers in Bhutan that consume minimal power in both operations and maintenance equipment. This equipment can be reused and consequently reduces e-waste. The World Bank has also started to enhance government efficiencies by promoting real-time data-sharing, encouraging e-governance techniques, and enabling use of open access data and information sources for knowledge sharing. The initiatives designed to implement consolidation of small government data servers to a 'Government Cloud' in Moldova has increased both energy and resource efficiencies. In Sri Lanka, the provision of digital public services (such as filing taxes, obtaining information, education, health care) has reduced citizens' need to travel, thus reducing emissions from transportation.



Improved mobile connectivity in Vanuatu helps fishermen and farmers deliver goods on time. –Tom Perry/World Bank

**Certain challenges within the sector are barriers to climate action.** Given the World Bank's limited expertise on the GHG footprint of digital investments and their vulnerability to physical impacts of climate change, better data are needed to support decision-making and planning for projects to combat climate change. The World Bank has not hitherto focused on climate action through investments in digital development or implementation of climate corporate commitments. Moreover, sectoral engagement (across all sectors) with countries is typically risk-averse when it comes to new technologies, and overall there is limited policy engagement to enable climate-friendly digital development. Stronger leadership in digital development is therefore needed to drive the mainstreaming of climate change in this sector.

### 8.8.2 New frontiers for lending and technical assistance

The World Bank teams' vision is to use digital technologies to achieve decarbonization and resilience in key sectors while pursuing carbon neutrality for the digital sector itself. The Bank will aim to promote anticipatory action; ensure that digital development is fully realized and accessible to all; and make digital development user-centered and the enabler of the shared and circular economy.

**Embed climate in Digital Economy/Digital Moonshots:** The Bank is spearheading several regional Digital Economy initiatives that aim to unlock new pathways for inclusive growth, innovation, job creation, service delivery, and poverty reduction by enabling widespread access to digital technologies. For example, the Digital Economy for Africa (DE4A) Moonshot aims by 2030 to digitally connect every individual, business, and government in Africa and ensure each is digitally enabled and ready to thrive in the digital economy. Similar initiatives are currently under development for South Asia and the Caribbean. However, there is a need to revise the action plan and integrate climate into the different pillars and activities. To this end,

the Bank will introduce an internal approach to include climate impacts at the design stage of digital projects and action plans. Specifically, it will focus on developing climate-friendly digital infrastructure (for example, renewable energy-powered efficient data centers) as well as digital and data-driven solutions for climate (for example, big data for crop management, smart meters). The COVID-19 crisis has made this even more critical as digital strategies are being accelerated globally to improve connectivity and ensure business continuity.

**Climate-friendly digital infrastructure:** The World Bank will ensure that investments in the digital ecosystem are enhanced to integrate resource efficiency and overall sustainability. This would include ensuring renewable energy powered data centers with energy-efficient servers. The World Bank's support to countries on digital governance and digitalization of sectors will incorporate energy and environmental performance as decision-making criteria in policies for procurement and use of digital devices and products. This will also include lifecycle management programs that ensure proper waste handling and disposal of digital equipment and infrastructure at end of life.

**Digital and data-driven solutions for climate change:** As noted above, the digital revolution will be critical to higher efficiency across sectors, thus reducing their GHG footprint. The World Bank will dedicate efforts to identify and pilot such digital technology solutions across sectors and invest in the accompanying systems for successful adoption and implementation of these solutions, consisting of data, infrastructure, rapid analytics, and real-time insights. Examples include systems that help leverage advances in mobile technologies, smart sensors, and data analysis to share insights into digital approaches to sectoral efficiency. These systems offer a more complete picture of infrastructure performance, production systems, natural resources, and consumer patterns and preferences to inform the development of data-driven solutions. Such solutions might include big data for crop management, smart irrigation for efficient agricultural water use, smart meters for electricity demand response, smart city infrastructure and artificial intelligence for real-time pollution monitoring and management, smart sensors for optimization of traffic flows, methods to green the ICT sector, and an IoT for fleet management and optimization of routes, among others. The World Bank will also support leveraging of big data and digital technologies for improving the collection and analysis of climate and weather data that can further enable climate-informed sectoral action. In addition, digital technologies that support production of low-carbon materials are rapidly advancing. The World Bank will identify potential technology solutions with best outcomes to scale up. Along with the digital advancements, it will be important to ensure the adoption of appropriate e-waste management approaches.

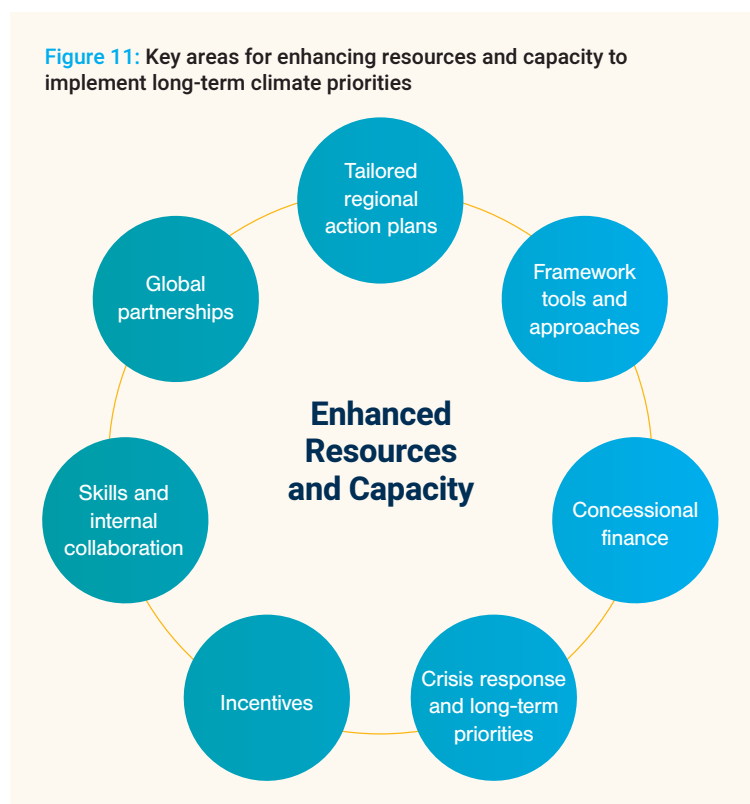
**Enabling policies for climate-friendly digital investments:** Overall, the World Bank's engagement on policies to enable digital development has been very limited. Although this is a significant gap, it also presents an opportunity to integrate climate and sustainability criteria into policy frameworks and decision-making for digitalization. The World Bank will support the removal of entry barriers such as cost, regulatory restrictions, and tariffs for new digital service providers to better integrate sustainable choices in digital development across all sectors within client countries for the entire digital ecosystem. It will facilitate knowledge exchange of climate-friendly ICT models among client countries to encourage enabling policies that accelerate the penetration of new digital development initiatives and players in support of decarbonization. Finally, it will encourage financing and technical support that prompts client countries to recognize digital development as a strategic driver of growth in other sectors and the mainstay of a strong low-carbon economy.

# 09

## Resources and Capacity to Deliver on Long-Term Climate Priorities

The strategic directions and cross-cutting priorities outlined in Sections 7 and 8 reflect the ambition needed to achieve net-zero emissions by 2050. Realizing this vision will require expanding the Bank’s internal capacity as well as increased financing. As noted in Section 2, the estimated investment needs embedded in the NDCs exceed US\$1 trillion per year over the next 15 years (IFC 2016), while World Bank Group annual commitments are about US\$60 billion (World Bank 2019c). A recent analysis of infrastructure investment needs also estimates that US\$6.3 trillion per year is needed until 2030 to meet the SDGs, with another US\$300 billion needed to make this investment compatible with the goals of the Paris Agreement (OECD, World Bank, and UNEP 2018). Mobilizing World Bank resources and capacity to catalyze action and leverage private sector investments to achieve long-term climate priorities will require efforts in several key areas, which are outlined below and summarized in Figure 11.

Figure 11: Key areas for enhancing resources and capacity to implement long-term climate priorities



### 9.1 Develop New Framework Tools and Approaches

The World Bank will develop a strong analytical base, in partnership with external experts, to help countries address trade-offs between economic growth and climate objectives and build an actionable path for ambitious climate investments. It will promote assessments that identify opportunities for projects to advance development goals while also reducing GHG emissions and building resilience. Given the diversity of the World Bank’s client countries, it will also develop a combination of strategic global, regional, and country approaches to address major low-carbon transition gaps (see Box 6).

To support country action on both the Strategic Directions and Cross-Cutting Areas, the World Bank will collaborate with partners to develop framework tools that can be used by a wide

range of countries and tailored to specific contexts. These tools will include climate-informed economy-wide and sectoral system-level planning tools that are interlinked, integrate cross-sectoral planning, and ensure a long-term development focus beyond a country's existing near-term policies and NDC commitments. These would also be useful for SCDs. The World Bank will develop integrated resource plans more consistently and effectively to support countries and to inform its own country engagements. A range of additional tools will be critical to advance progress, such as climate-informed macroeconomic growth models, integrated urban planning framework, climate risk accountability frameworks for state-owned enterprises, and others. These have been identified in Sections 7 and 8. Significant work will be needed, especially to fast-track implementation of actions under the four Strategic Directions, as there is limited experience on integrating climate objectives in these areas. As noted in Section 7, actions proposed under the strategic directions have some overlaps with the Helsinki Principles adopted in 2019 by the Coalition of Finance Ministers for Climate Action, which will help in developing, piloting and scaling up these tools in partnership with countries that are members of the coalition.

---

## 9.2 Tailored Approaches for Regional and Country Implementation

Mitigation action will be country-specific and will be identified at the country and regional levels as appropriate. The Bank will work to operationalize the Outlook 2050 priorities for delivery through regional and country programs. Efforts are under way to integrate these into regional climate business plans and develop context-specific World Bank targets and indicators for implementation. These regional plans provide a framework for tailored approaches and prioritization of actions that are supported through programmatic or stand-alone financing for policies and projects.

The regional climate plans are usually developed for a five-year period. Priorities under each five-year plan will be identified within the context of long-term priorities for the region or country to allow for recalibration of actions based on periodic review of plan progress.

As regional action progresses, a further concentration of efforts may be needed in Sub-Saharan Africa, which will be the primary focus for the World Bank's work on extreme poverty and is also very vulnerable to climate change. The World Bank will also need to find approaches to support many countries that will in the next few years develop to the point where they are no longer eligible for traditional concessional funding. For example, in high-income countries, the Bank works through Reimbursable Advisory Services and Advisory and Analytical Services to provide the requested advisory support that can be used by policy makers to inform decision-making.

---

## 9.3 Financing for Outlook 2050 Priorities

Significant additional resources for long-term climate action will need to be mainstreamed across the World Bank's country programs through regional and sectoral units:

- » **Grant funding for upstream support:** The World Bank will integrate these priorities into business plans for various sectoral and climate trust funds. The new Climate Support Facility trust fund, for example, will include support for long-term strategies, among others. This will help unlock grant resources for upstream work, such as support for the development of integrated long-term strategies. These resources will also help countries to define climate action priorities for investment planning based on their long-term strategies.



- » **Concessional finance for implementation:** As climate mitigation is a global public good, it is important to make concessional resources available to developing countries to undertake climate-friendly investments. This is even more important for long-term climate action, as it requires much more than the incremental investments that are often made. For example, the World Bank's Global Public Goods Fund already provides such concessional resources for middle-income countries. To incentivize long-term climate actions, the World Bank will work to scale up concessional finance resources for both project preparation and implementation.
- » **Scaling up policy support:** Given the size of the World Bank's resources compared to the investment needs for long-term climate action, it is important that support be designed to leverage other sources and maximize domestic resource mobilization. For example, financing instruments for policy reforms help to create a positive investment climate to catalyze decarbonization investments.
- » **Scale up innovative financing:** The World Bank will need to scale up innovative financing for the range of new investments areas to support countries in meeting decarbonization goals to bring in substantial private sector investment, and mobilize domestic resources in line with its Maximizing Finance for Development agenda. Many of the actions proposed as priorities are entirely new areas or solutions, which will be financed with the goal of scaling up market adoption. The World Bank has a unique competitive advantage in the provision of this support, which would include financing to address market barriers, de-risking solutions, and others. Additional financing avenues include green finance, such as green bonds, and SDG-linked bonds to raise capital for decarbonization investments.

---

## 9.4 Aligning Short- and Medium-Term Crisis Response with Long-Term Priorities

Over the decades, the World Bank has supported countries in responding to economic and financial crises, food and fuel price shocks, natural disasters, pandemics, and more. The Bank's Global Crisis Response Platform (World Bank 2016b) highlights three types of crises: climate change and related natural disasters; fragility and conflict, as well as mass displacement of people; and pandemics. Today we are seeing crises of all three types, wiping away decades of hard-earned economic and social gains.

Every crisis response offers an opportunity to build back better towards a more sustainable future. The World Bank strives to embed lessons from previous crises to strengthen its support for current and future crises. Crisis risk management must also recognize that effective solutions often require cross-sectoral interventions—for example, responding to the refugee crisis clearly required integrated investments in safety, housing, health, education, jobs, and economic development. Similarly, in the current pandemic, support for countries can include climate-friendly solutions with benefits across sectors. For example, rapid electrification of health facilities could help with the near-term COVID-19 response and also help grow off-grid solar and mini-grids, which have seen a slowdown in investments. In the medium term, budget support to countries to help with economic recovery can embed low-carbon infrastructure investments and support digitalization. Further, liquidity facilities that are being established to support utilities struggling due to collapse in revenues during COVID-19 crisis could require integration of climate-related disclosures by recipient utilities. The decline in fossil fuel prices and consumption caused by the pandemic present an excellent opportunity to reduce subsidies accompanied by a suite of policy measures to accelerate the energy transition. As

large volumes of public financing are channeled into economies around the world, catalyzing private sector investments, it is important to ensure that they enable the transformation needed to achieve decarbonization and resilience.

---

## 9.5 Incentivize Internal Efforts to Support Long-Term Cross-Sectoral Climate Action

Cross-sectoral projects tend to be more resource-intensive than sectoral projects of comparable magnitude. To incentivize cross-sectoral climate action, the Bank can create internal incentives for project development by recognizing initiatives and projects by teams. The Bank can create dedicated cross-sectoral working groups comprising staff from different backgrounds, charged with advancing action along cross-sectoral priorities. This will also require budget allocations to ensure that country programs deliver on cross-sectoral priorities. Integrating long-term climate priorities in economy-wide actions also faces the challenge of limited client demand. The World Bank can incentivize teams to develop innovative ways of making the case for climate mainstreaming, supported by robust analyses to help clients understand the synergies between long-term climate action and development goals.

Another key driver for mainstreaming climate in World Bank operations has been climate-related finance tracking through cobenefits assessments linked to climate targets adopted by the institution. However, the methodology for assessing climate-related finance (MDBs 2019) focuses mainly on sectoral climate actions and does not include the economy-wide actions included under the Strategic Directions. Updating the methodology to include these actions as contributing to climate mitigation will further incentivize their inclusion in country programs. The Bank will work with other MDBs to update the joint methodology to include the proposed economy-wide activities and cross-cutting actions.

---

## 9.6 Build Internal Skills and Capacity to Respond to Country Demand

Delivering on the Outlook 2050 priorities will require deepening of expertise to integrate system-level planning, drive innovation, and mainstream long-term climate action across regions and sector teams. The Bank will further strengthen its internal systems, resources and deepen skills to equip its teams to support country action on long-term climate priorities. This includes creating dedicated cross-sector workstreams across all regional and sector units. The World Bank will also deepen climate expertise in long-term cross-sectoral investments through trainings and knowledge exchange with other external partners to improve understanding of links between sectoral investments. There is also a need to develop frameworks to build internal capacity and to inform World Bank engagement with client countries on the design of long-term strategies. In addition, the World Bank will develop resource materials for teams to conduct SCDs that integrate a systems approach and embed long-term climate change goals. Internal capacity will also need to be developed in the new areas for investment identified in Sections 7 and 8 to provide robust advisory and investment support to clients.

---

## 9.7 Global Strategic Partnerships

It is important to identify the next generation of finance and technical work for long-term climate action, in partnership with international agencies, centers of excellence, and other external organizations. For example, the Bank's work with the Consultative Group on International

Agricultural Research (CGIAR) Platform for Big Data in Agriculture as well as private and public sector global weather data providers highlights the importance of strategic alliances. These partnerships are helping to monitor agriculture production systems, providing datasets for advanced analytics linking agricultural meteorology, crop and livestock performance, and a variety of socioeconomic and socio-political metrics for decision support.

Similarly, the Bank's engagement in partnerships such as the Coalition of Finance Ministers for Climate Action, as a key member, and the Network for Greening the Finance System, as an observer, is informing the dialogue globally and may be instrumental for catalyzing climate action. These partnerships help forge joint efforts to improve understanding of key challenges and devise innovative solutions. To this end, the World Bank will develop and deepen strategic partnerships with other MDBs, the private sector, commercial banks, NGOs, and innovative private companies pursuing climate-friendly solutions to support decarbonization and resilience pathways for countries.

# 10

## The Way Forward

Implementing the strategic directions and cross-cutting priority actions identified in the previous sections requires building an entire ecosystem to effectively enable significant investments in technologies, infrastructure, and specific sectoral innovations. Current levels of financing are not enough to achieve decarbonization by 2050. Thus, it is imperative for countries to create their own systems to use concessional finance strategically and maximize use of their own resources to mobilize private sector finance. The Bank can help countries advance action on policies, institutions, regulations, and global trade to move forward on the priorities identified in the Outlook 2050. Key factors will include:

**Demand for change:** There is wide recognition of the enormity of the challenge of decarbonizing economies while continuing progress on stated development goals. However, the usual path is to focus on the least-cost options for mitigation. The policies needed to deliver decarbonization will only be approved and sustained if there is broad political commitment cutting across all levels of leadership and governance, rather than a single ministry or agency. That support will only materialize in a given country when there is a social consensus behind official recognition that decarbonization is in the interest of the country and all its people. Knowledge, communication, analysis, and incentives from government, the private sector, and financial institutions will all play a part.

**Policies:** National and subnational policies, embedded across institutions, play a key role in shaping incentives, public and private sector action, political contexts, and complementary policy choices in a way that encourages long-term emissions reductions. Economy-wide market policies for climate mitigation tend to be more cost-effective than sectoral policies, but they are harder to implement, owing to economic choices driven by political considerations. Sectoral policies may also be required to overcome sector-specific market failures. Sectoral and cross-sectoral approaches allow for complementary policies as well. In the transport sector, for example, policies that raise the cost of carbon-intensive transport modes are more effective when backed by public investment in viable low-carbon alternatives. The ability to develop and implement long-term climate strategies requires a specific set of skills, knowledge, and tools. To effectively prioritize long-term action, countries need to build internal capacity to analyze the implications of climate change, evaluate policies from a climate perspective, and leverage external and private funding.

**Regulations:** Regulatory approaches are vital in shaping climate action. Direct regulations, when enforced, can significantly limit GHG emissions by directing incentives toward clean innovations and setting performance and low-carbon standards for existing technologies. Regulation that focus on sectoral activity instead of emissions can spur markets to innovate – for example, renewable portfolio standards, energy-efficient building codes, vehicle fuel efficiency standards, curtailing deforestation, and controlled land use. Over the long term, embedding climate change in regulatory approaches such as energy efficiency standards, offset mechanisms, and carbon pricing will drive significant structural changes and further reduce emissions. For instance, a carbon price not only reduces the total costs of reducing GHG emissions, but also levels the playing field between carbon-intensive and low-carbon measures and economies, addressing competitiveness concerns. Regulations can also help mitigate the negative impacts of carbon pricing by adapting the design of the policy and using carbon revenues to offset any detrimental impacts. For example, savings from the removal of fossil fuel subsidies can be allocated to vulnerable groups, resulting in an economically efficient and environmentally effective climate policy. Sector-specific regulations,

such as greening building codes, can complement market-based approaches and incentivize climate-friendly technologies. Countries must choose long-term climate regulations and policy instruments carefully to ensure complementarity and cost-effectiveness.

**Institutions:** An effective response to the climate challenge requires action across the public and private sectors, and cannot be addressed by environmental agencies alone. Effective institutions are crucial. Several cross-sectoral difficulties may emerge (such as siloed ministries, conflicting regulations) that need to be properly assessed. The nature and design of institutions affect the feasibility, financing, choice of policy options, and capacities required to tackle long-term climate mitigation measures. Institutions can facilitate transitions to low-carbon pathways by shaping incentives, effectively communicating policy choices, and encouraging new stakeholders and industries to engage in the decision-making process. This is vital for countries to prevent carbon lock-in and avoid high-carbon pathways. National governments face the challenge to establish an institutional framework that enables various levels of government to effectively address climate change. In the absence of specific institutional arrangements, climate change will not be given the necessary consideration in decision-making.

**Global trade:** The links between trade and climate change are less explored, with climate and trade policy makers working in silos. There is mounting concern about competitiveness, carbon leakage (see below), and decarbonizing of supply chains across different jurisdictions: these issues need to be addressed. Climate policy differences among trading partners can affect the competitiveness of suppliers. For example, in energy-intensive sectors exposed to the vicissitudes of trade, a key problem for a producer or supplier could be a limited ability to pass on or distribute any increased cost burden arising from a carbon tax. Furthermore, stringent climate policies in some countries can shift carbon-intensive production to countries with lax climate policies, resulting in ‘carbon leakage.’ Just as climate policies can affect trade among countries, trade policies can limit market access and the transfer of climate-friendly technologies. Meaningful progress on trade-climate linkages requires focused attention on breaking down policy silos. Countries must ensure more systemic interaction on the trade and climate nexus, among international organizations, businesses, and civil society stakeholders. Policy actions such as climate waivers, climate clubs, carbon pricing, and border adjustment measures must be carefully considered.

---

## 10.1 Next Steps

As the World Bank moves to realize the vision described in this report, additional work will be done to dive deeper into what is needed to implement each of the priorities identified. This report is the first step. More work will also be done to develop a similar long-term approach to adaptation, and as the IPCC publishes its Sixth Assessment Report, starting in 2021, the ensuing debates may further shape the World Bank’s approach to long-term decarbonization.

As countries plan for resources to be allocated and devoted to economic recovery from the global COVID-19 pandemic, the long-term implications of their decisions must not be overlooked. Large volumes of resources through domestic or development finance will be channeled to stimulate economies and ideally enable them to bounce back from the commercial, social and health impacts of the pandemic. These investments should be directed to ensure that the recovery builds on progress on climate action to date, and further catalyzes the transformative change needed for long-term decarbonization.

The urgent need to act directly on climate change is even more pressing. By looking ahead at the future they want, countries can ensure that the choices they make today—and the scale and pace of their actions—are enough to put them on a path to resilience, decarbonization and sustainable development.

---

# References

- Ashton, E. 2008. "The Impact of Shrimp Farming on Mangrove Ecosystems." *CAB Reviews: Perspectives in Agriculture, Veterinary Science, Nutrition and Natural Resources* 3 (003). <https://doi.org/10.1079/pavsnr20083003>.
- BAPPENAS. 2019. "A Paradigm Shift towards Low Carbon Development: A Green Economy in Indonesia." Jakarta, Indonesia: National Development Planning Agency, Indonesia.
- Blanco, Gabriel, Reyer Gerlach, Sangwon Suh, John Barrett, Heleen C. de Coninck, Cristobal Felix Diaz Morejon, Ritu Mathur, et al. 2014. "Drivers, Trends and Mitigation." In *Climate Change 2014: Mitigation of Climate Change. Contribution of Working Group III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change*, edited by O. Edenhofer, R. Pichs-Madruga, Y. Sokona, E. Farahani, S. Kadner, K. Seyboth, A. Adler, et al. Cambridge, UK, and New York: Cambridge University Press. <https://www.ipcc.ch/report/ar5/wg3/>.
- Boretti, Alberto, and Lorenzo Rosa. 2019. "Reassessing the Projections of the World Water Development Report." *Npj Clean Water* 2 (1): 1–6. <https://doi.org/10.1038/s41545-019-0039-9>.
- Carney, Mark. 2015. "Breaking the Tragedy of the Horizon: Climate Change and Financial Stability." Lloyd's of London, September 29. <http://www.bankofengland.co.uk/speech/2015/breaking-the-tragedy-of-the-horizon-climate-change-and-financial-stability>.
- Carney, Mark. 2018. "A Transition in Thinking and Action." Presented at the International Climate Risk Conference for Supervisors, The Netherlands Bank, Amsterdam, April 6. <https://www.bis.org/review/r180420b.htm>.
- CDP. 2019. "Group of 88 Investors Target over 700 Companies for Not Reporting Environmental Information - CDP." June 17, 2019. <https://www.cdp.net/en/articles/media/group-of-88-investors-target-over-700-companies-for-not-reporting-environmental-information>.
- Chattopadhyay, Debabrata, and Rhonda L. Jordan. 2015. "Integrating Climate Model Data into Power System Planning." 95787. Washington, DC: The World Bank. <http://documents.worldbank.org/curated/en/611541468339042302/Integrating-climate-model-data-into-power-system-planning>.
- Chattopadhyay, Debabrata, and Tom Remy. 2020. "Promoting Better Economics, Renewables and CO<sub>2</sub> Reduction through Trade: A Case Study for the Eastern Africa Power Pool." Washington, DC: The World Bank.
- CIF. 2019. "FIP Operational and Results Report." FIP/SC.23/3. Nairobi: Climate Investment Funds. <https://www.climateinvestmentfunds.org/documents/fip-operational-and-results-report-2>.
- Climate Watch. 2019. "Global Historical Emissions." World Resources Institute, Washington, DC. 2019. <https://www.climatewatchdata.org/countries/compare>.
- Coady, David, Ian Parry, Nghia-Piotr Le, and Baoping Shang. 2019. "Global Fossil Fuel Subsidies Remain Large: An Update Based on Country-Level Estimates." IMF Working Paper No. 19/89. Washington, DC: International Monetary Fund. <https://doi.org/10.5089/2F9781484393178.001>.
- Coalition for Urban Transitions. 2019. "Climate Emergency, Urban Opportunity: How National Governments Can Secure Economic Prosperity and Avert Climate Catastrophe by Transforming Cities." Washington, DC, and London. <https://urbantransitions.global/en/publication/climate-emergency-urban-opportunity/>.
- Coalition of Finance Ministers for Climate Action. 2019. "Helsinki Principles." Helsinki. <http://pubdocs.worldbank.org/en/600041555089009395/FM-Coalition-Principles-final-v3.pdf>.
- Cozzi, Laura, and Apostolos Petropoulos. 2019. "Growing Preference for SUVs Challenges Emissions Reductions in Passenger Car Market." International Energy Agency – Commentary. October 15, 2019. <https://www.iea.org/commentaries/growing-preference-for-suvs-challenges-emissions-reductions-in-passenger-car-market>.
- Dos Anjos Ribeiro Cordeiro, Maria Joao, Christopher R. Bennett, Sean David Michaels, Frederico Ferreira Fonseca Pedrosa, Marc S. Forni, and Julie Rozenberg. 2017. "Climate and Disaster Resilient Transport in Small Island Developing States: A Call for Action." Report No. 120998. Washington, DC: The World Bank. <http://documents.worldbank.org/curated/en/879491510323939763/Climate-and-disaster-resilient-transport-in-small-island-developing-states-a-call-for-action>.
- Dutton, Alastair Simon Piers, Charlene Coyuki Sullivan, Elizabeth Oakes Minchew, Oliver Knight, and Sean Whittaker. 2019. "Going Global: Expanding Offshore Wind to Emerging Markets." 143162. Washington, DC: The World Bank. <http://documents.worldbank.org/curated/en/716891572457609829/Going-Global-Expanding-Offshore-Wind-To-Emerging-Markets>.
- Eckstein, David, Vera Künzel, Laura Schäfer, and Maik Winges. 2019. "Global Climate Risk Index 2020." Briefing Paper. Bonn: Germanwatch. <http://germanwatch.org/en/17307>.
- Elahi, Raihan, Dana Rysankova, Zubair K. M. Sadeque, and Ruchi Soni. 2014. "Scaling up Access to Electricity : The Case of Bangladesh." Report No. 88702. The World Bank. <http://documents.worldbank.org/curated/en/699721468003918010/Scaling-up-access-to-electricity-the-case-of-Bangladesh>.
- ETC. 2018. "Mission Possible: Reaching Net-Zero Carbon Emissions from Harder-to-Abate Sectors by Mid-Century." Energy Transition Commission. <http://www.energy-transitions.org/mission-possible>.
- Evans, Simon. 2020. "Analysis: Coronavirus Set to Cause Largest Ever Annual Fall in CO<sub>2</sub> Emissions." *Carbon Brief* (blog). April 9, 2020. <https://www.carbonbrief.org/analysis-coronavirus-set-to-cause-largest-ever-annual-fall-in-co2-emissions>.

- FAO. 2009. "How to Feed the World in 2050." Background paper for High-level Expert Forum in Rome, Italy, 12-13 October 2009. Food and Agriculture Organization of the UN. [http://www.fao.org/fileadmin/templates/wfs/docs/expert\\_paper/How\\_to\\_Feed\\_the\\_World\\_in\\_2050.pdf](http://www.fao.org/fileadmin/templates/wfs/docs/expert_paper/How_to_Feed_the_World_in_2050.pdf).
- FAO. 2016. *The Agriculture Sectors in the Intended Nationally Determined Contributions: Analysis*. Environment and Natural Resources Management, Working Paper No. 62. Rome: Food and Agriculture Organization of the United Nations. <http://www.fao.org/3/a-i5687e.pdf>.
- FAO. 2017. *World Fertilizer Trends and Outlook to 2020: Summary Report*. Rome, Italy: Food and Agriculture Organization of the United Nations. <http://www.fao.org/publications/card/en/c/cfa19fbc-0008-466b-8cc6-0db6c6686f78/>.
- FAO. 2019. "The State of Food Security and Nutrition in the World 2019." Rome: Food and Agriculture Organization of the United Nations. <https://doi.org/10.18356/63e608ce-en>.
- FAO. 2020. *The State of World Fisheries and Aquaculture 2020*. Rome: Food and Agriculture Organization of the United Nations. <https://doi.org/10.4060/ca9229en>.
- FAO. n.d. "Global Livestock Environmental Assessment Model (GLEAM)." Food and Agriculture Organization of the United Nations, Rome. Accessed June 13, 2020. <http://www.fao.org/gleam/results/en/>.
- FAO, and UNEP. 2020. *The State of the World's Forests 2020: Forests, biodiversity and people*. 2020. Rome: Food and Agriculture Organization of the United Nations and United Nations Environment Programme. <https://doi.org/10.4060/ca8642en> Also Available in: Chinese Spanish Arabic French Russian.
- FAO, and World Bank Group. 2018. "Water Management in Fragile Systems: Building Resilience to Shocks and Protracted Crises in the Middle East and North Africa." Text/HTML. Rome and Washington, DC: Food and Agriculture Organization of the United Nations and World Bank Group. <http://hdl.handle.net/10986/30307>.
- Fay, Marianne, Stephane Hallegatte, Adrien Vogt-Schilb, Julie Rozenberg, Ulf Narloch, and Tom Kerr. 2015. *Decarbonizing Development: Three Steps to a Zero-Carbon Future*. Washington, DC: The World Bank. <https://doi.org/10.1596/978-1-4648-0479-3>.
- FCPF. 2018. "Forest Carbon Partnership Facility 2018 Annual Report." Washington, DC: The World Bank. <https://www.forestcarbonpartnership.org/system/files/documents/FCPF+Annual+Report+2018+FINAL+VERSION-compressed+under+20+MB.pdf>.
- Fransen, Taryn, Ichiro Sato, Kelly Levin, David Waskow, David Rich, Sadya Ndoko, and Julie Teng. 2019. "Enhancing NDCs: A Guide to Strengthening National Climate Plans by 2020." Washington, DC: World Resources Institute and United Nations Development Programme. <https://www.ndcs.undp.org/content/ndc-support-programme/en/home/impact-and-learning/library/ndc-enhancement-guide0.html>.
- GeSI, and Accenture Strategy. 2015. "#SMARTer2030: ICT Solutions for 21st Century Challenges." Brussels: Global e-Sustainability Initiative. <http://smarter2030.gesi.org>.
- Gilbert, Natasha. 2012. "One-Third of Our Greenhouse Gas Emissions Come from Agriculture." *Nature*, October. <https://doi.org/10.1038/nature.2012.11708>.
- Global Commission on Adaptation. 2019. "Adapt Now: A Global Call for Leadership on Climate Resilience." Rotterdam and Washington, DC: Global Center on Adaptation and World Resources Institute. <https://gca.org/global-commission-on-adaptation/report>.
- Global Commission on the Economy and Climate. 2018. "Unlocking the Inclusive Growth Story of the 21st Century: Accelerating Climate Action in Urgent Times." Washington, DC: New Climate Economy. <https://newclimateeconomy.report/2018/>.
- Global Infrastructure Hub, and Oxford Economics. 2017. "Global Infrastructure Outlook." Sydney and Oxford. <https://outlook.gihub.org/>.
- Government of Costa Rica. 2019a. "Decarbonization Plan: Commitment of the Bicentennial Government – Descarbonicemos Costa Rica: Compromiso País 2018–2050." San José: Ministry of Environment and Energy (MINAE). <https://www.2050pathways.org/wp-content/uploads/2019/02/Decarbonization-Plan-Costa-Rica.pdf>.
- Government of Costa Rica. 2019b. "Presidente Alvarado Abre Foro de La Vulnerabilidad Climática En La COP25." Ministry of Foreign Relations Press Release. December 2, 2019. <https://www.rree.go.cr/?sec=servicios&cat=prensa&cont=593&id=5254>.
- Griscom, Bronson W., Justin Adams, Peter W. Ellis, Richard A. Houghton, Guy Lomax, Daniela A. Miteva, William H. Schlesinger, et al. 2017. "Natural Climate Solutions." *Proceedings of the National Academy of Sciences* 114 (44): 11645–50. <https://doi.org/10.1073/pnas.1710465114>.
- Hallegatte, Stephane, Mook Bangalore, Laura Bonzanigo, Marianne Fay, Tamaro Kane, Ulf Narloch, Julie Rozenberg, David Treguer, and Adrien Vogt-Schilb. 2016. "Shock Waves: Managing the Impacts of Climate Change on Poverty." *Climate Change and Development*. Washington, DC: The World Bank. [https://doi.org/10.1596/978-1-4648-0673-5\\_fm](https://doi.org/10.1596/978-1-4648-0673-5_fm).
- Hallegatte, Stephane, Jun Rentschler, and Julie Rozenberg. 2019. *Lifelines: The Resilient Infrastructure Opportunity*. Sustainable Infrastructure Series. Washington, DC: The World Bank. <https://doi.org/10.1596/978-1-4648-1430-3>.
- Haque, Md Najmul. 2018. "Dietary Manipulation: A Sustainable Way to Mitigate Methane Emissions from Ruminants." *Journal of Animal Science and Technology* 60 (1): 15. <https://doi.org/10.1186/s40781-018-0175-7>.
- Harper, Anna B., Tom Powell, Peter M. Cox, Joanna House, Chris Huntingford, Timothy M. Lenton, Stephen Sitch, et al. 2018. "Land-Use Emissions Play a Critical Role in Land-Based Mitigation for Paris Climate Targets." *Nature Communications* 9 (1): 2938. <https://doi.org/10.1038/s41467-018-05340-z>.
- Herrero, Mario, Benjamin Henderson, Petr Havlik, Philip K. Thornton, Richard T. Conant, Pete Smith, Stefan Wirsenius, et al. 2016. "Greenhouse Gas Mitigation Potentials in the Livestock Sector." *Nature Climate Change* 6 (5): 452–461. <https://doi.org/10.1038/nclimate2925>.
- Hoegh-Guldberg, Ove. 2015. "Reviving the Oceans Economy: The Case for Action—2015." Gland, Switzerland: WWF International. <https://www.worldwildlife.org/publications/reviving-the-oceans-economy-the-case-for-action-2015>.

- Hoegh-Guldberg, Ove, Ken Caldeira, Thierry Chopin, Steve Gaines, Peter Haugan, Mark Herner, Jennifer Howard, et al. 2019. "The Ocean as a Solution for Climate Change: 5 Opportunities for Action." Washington, DC: World Resources Institute. <https://www.oceanpanel.org/>, <https://www.oceanpanel.org/climate>.
- Hoegh-Guldberg, Ove, Linwood Pendleton, and Anne Kaup. 2019. "People and the Changing Nature of Coral Reefs." *Regional Studies in Marine Science* 30 (July): 100699. <https://doi.org/10.1016/j.rsma.2019.100699>.
- ICAO. n.d. "Carbon Offsetting and Reduction Scheme for International Aviation (CORSA)." International Civil Aviation Organization. Accessed June 13, 2020. <https://www.icao.int/environmental-protection/CORSA/Pages/default.aspx>.
- IDB, and DDPLAC. 2019. "Getting to Net-Zero Emissions: Lessons from Latin America and the Caribbean." Washington, DC: Inter-American Development Bank and Deep Decarbonization Pathways for Latin America and the Caribbean consortium. <https://doi.org/10.18235/0002024>.
- IEA. 2017. "Energy Technology Perspectives 2017: Catalysing Energy Technology Transformations." Paris: International Energy Agency. [https://doi.org/10.1787/energy\\_tech-2017-en](https://doi.org/10.1787/energy_tech-2017-en).
- IEA. 2019a. "CO<sub>2</sub> Emissions from Fuel Combustion 2019." Paris: International Energy Agency. <https://www.iea.org/reports/co2-emissions-from-fuel-combustion-2019>.
- IEA. 2019b. "World Energy Outlook 2019." Paris: International Energy Agency. <https://www.iea.org/reports/world-energy-outlook-2019>.
- IEA. 2020a. "The Oil and Gas Industry in Energy Transitions." World Energy Outlook Special Report. Paris: International Energy Agency. <https://www.iea.org/reports/the-oil-and-gas-industry-in-energy-transitions>.
- IEA. 2020b. "Global Energy Review 2020." Paris: International Energy Agency. <https://www.iea.org/topics/covid-19>.
- IEA. 2020c. "World Energy Investment 2020." Paris: International Energy Agency. <https://www.iea.org/reports/world-energy-investment-2020>.
- IEA. n.d. "Data and Statistics." International Energy Agency. Accessed June 15, 2020. <https://www.iea.org/data-and-statistics>.
- IFC. 2016. "Climate Investment Opportunities in Emerging Markets: An IFC Analysis." Washington, DC: International Finance Corporation. [https://www.ifc.org/wps/wcm/connect/NEWS\\_EXT\\_CONTENT/IFC\\_External\\_Corporate\\_Site/News+and+Events/News/New+IFC+Report+Points+to+%2423+Trillion+of+Climate+Smart+Investment+Opportunities+in+Emerging+Markets+by+2030](https://www.ifc.org/wps/wcm/connect/NEWS_EXT_CONTENT/IFC_External_Corporate_Site/News+and+Events/News/New+IFC+Report+Points+to+%2423+Trillion+of+Climate+Smart+Investment+Opportunities+in+Emerging+Markets+by+2030).
- IHA. 2019. "Hydropower Sector Climate Resilience Guide." London: International Hydropower Association. <https://www.hydropower.org/climate-resilience-guide>.
- ILO. 2018. "Greening with Jobs – World Employment and Social Outlook 2018." Geneva: International Labour Organization. <https://www.ilo.org/global/research/global-reports/weso/greening-with-jobs/lang-en/index.htm>.
- IMO. 2018. "UN Body Adopts Climate Change Strategy for Shipping." International Maritime Organization. April 13, 2018. <http://www.imo.org/en/MediaCentre/PressBriefings/Pages/06GHGinitialstrategy.aspx>.
- IPCC. 2014a. "Summary for Policymakers." In *Climate Change 2014: Mitigation of Climate Change. Contribution of Working Group III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change*, edited by O. Edenhofer, R. Pichs-Madruga, Y. Sokona, E. Farahani, S. Kadner, K. Seyboth, A. Adler, et al. Cambridge, UK, and New York: Cambridge University Press. <http://www.mitigation2014.org>.
- IPCC. 2014b. "Technical Summary." In *Climate Change 2014: Impacts, Adaptation, and Vulnerability. Part A: Global and Sectoral Aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change*, edited by Field, C.B., V.R. Barros, D.J. Dokken, K.J. Mach, M.D. Mastrandrea, T.E. Bilir, M. Chatterjee, K.L. Ebi, Y.O. Estrada, R.C. Genova, B. Girma, E.S. Kissel, A.N. Levy, S. MacCracken, P.R. Mastrandrea, and L.L. White, 1–32. Cambridge, UK, and New York: Cambridge University Press. <https://www.ipcc.ch/report/ar5/wg2/>.
- IPCC. 2018. "Summary for Policymakers." In *Global Warming of 1.5°C. An IPCC Special Report on the Impacts of Global Warming of 1.5°C above Pre-Industrial Levels and Related Global Greenhouse Gas Emission Pathways, in the Context of Strengthening the Global Response to the Threat of Climate Change, Sustainable Development, and Efforts to Eradicate Poverty*, edited by V. Masson-Delmotte, P. Zhai, H.-O. Pörtner, D. Roberts, J. Skea, P.R. Shukla, A. Pirani, et al. Geneva: Intergovernmental Panel on Climate Change. <https://www.ipcc.ch/sr15/>.
- IPCC. 2019a. *Climate Change and Land: An IPCC Special Report on Climate Change, Desertification, Land Degradation, Sustainable Land Management, Food Security, and Greenhouse Gas Fluxes in Terrestrial Ecosystems – Summary for Policymakers*. Edited by Priyadarshi R. Shukla, Jim Skea, Eduardo Calvo Buendia, Valérie Masson-Delmotte, Hans-Otto Pörtner, Debra C. Roberts, Panmao Zhai, et al. Intergovernmental Panel on Climate Change.
- IPCC. 2019b. "Summary for Policymakers." In *IPCC Special Report on the Ocean and Cryosphere in a Changing Climate*, edited by Hans-Otto Pörtner, Debra C. Roberts, Valérie Masson-Delmotte, Panmao Zhai, Melinda Tignor, E. Poloczanska, K. Mintenbeck, et al. Intergovernmental Panel on Climate Change. <https://www.ipcc.ch/srocc/>.
- IRENA. 2018. "Global Energy Transformation: A Roadmap to 2050." Abu Dhabi: International Renewable Energy Agency. <https://www.irena.org/publications/2019/Apr/Global-energy-transformation-A-roadmap-to-2050-2019Edition>.
- ITF. 2019. *ITF Transport Outlook 2019*. Paris: International Transport Forum. [https://doi.org/10.1787/transp\\_outlook-en-2019-en](https://doi.org/10.1787/transp_outlook-en-2019-en).
- Janssens-Maenhout, Greet, Monica Crippa, Diego Guizzardi, Marilena Muntean, Edwin Schaaf, Frank Dentener, Peter Bergamaschi, et al. 2019. "EDGAR v4.3.2 Global Atlas of the Three Major Greenhouse Gas Emissions for the Period 1970–2012." *Earth System Science Data* 11 (3): 959–1002. <https://doi.org/10.5194/essd-11-959-2019>.
- Krantz, Randall, Kasper Søgaard, and Tristan Smith. 2020. "The Scale of Investment Needed to Decarbonize International Shipping." Getting to Zero Coalition Insight Series. Global Maritime Forum, Friends of Ocean Action, and World Economic Forum. [https://www.globalmaritimeforum.org/content/2020/01/Getting-to-Zero-Coalition\\_Insight-brief\\_Scale-of-investment.pdf](https://www.globalmaritimeforum.org/content/2020/01/Getting-to-Zero-Coalition_Insight-brief_Scale-of-investment.pdf).



- Lange, Glenn-Marie, Quentin Wodon, and Kevin Carey. 2018. *The Changing Wealth of Nations 2018: Building a Sustainable Future*. Washington, DC: The World Bank. [https://doi.org/10.1596/978-1-4648-1046-6\\_es](https://doi.org/10.1596/978-1-4648-1046-6_es).
- Markkanen, Sanna, and Annela Anger-Kraavi. 2019. "Social Impacts of Climate Change Mitigation Policies and Their Implications for Inequality." *Climate Policy* 19 (7): 827–844. <https://doi.org/10.1080/14693062.2019.1596873>.
- McKinsey Global Institute. 2017. "Beyond the Supercycle: How Technology Is Reshaping Supply and Demand for Natural Resources." McKinsey & Company. <https://www.mckinsey.com/business-functions/sustainability/our-insights/how-technology-is-reshaping-supply-and-demand-for-natural-resources>.
- McKinsey Global Institute. 2020. "Climate Risk and Response: Physical Hazards and Socioeconomic Impacts." McKinsey & Company. <https://www.mckinsey.com/business-functions/sustainability/our-insights/climate-risk-and-response-physical-hazards-and-socioeconomic-impacts>.
- MDBs. 2015. "From Billions to Trillions: MDB Contributions to Financing for Development." 98023. Washington, DC: African Development Bank, Asian Development Bank, European Bank for Reconstruction and Development, European Investment Bank, Inter-American Development Bank Group, Islamic Development Bank, and World Bank Group. <http://documents.worldbank.org/curated/en/602761467999349576/From-billions-to-trillions-MDB-contributions-to-financing-for-development>.
- MDBs. 2019. "Joint Report on Multilateral Development Banks' Climate Finance." Text/HTML. London: African Development Bank, Asian Development Bank, European Bank for Reconstruction and Development, European Investment Bank, Inter-American Development Bank Group, Islamic Development Bank, and World Bank Group. <http://www.ebrd.com/2018-joint-report-on-mdb-climate-finance>.
- Morgan Stanley. 2019. "Decarbonization: The Race to Zero Emissions." New York. <https://www.morganstanley.com/ideas/investing-in-decarbonization>.
- Mountford, Helen. 2011. "Water: The Environmental Outlook to 2050." Presented at the OECD Global Forum on Environment: Making Water Reform Happen, Paris, 25-26 October. <https://www.oecd.org/env/resources/49006778.pdf>.
- Nelson, Gerald C., Mark W. Rosegrant, Jawoo Koo, Richard Robertson, Timothy Sulser, Tingju Zhu, Claudia Ringler, et al. 2010. "The Costs of Agricultural Adaptation to Climate Change." 56662. Washington, DC: The World Bank. <http://documents.worldbank.org/curated/en/973551468165538882/The-costs-of-agricultural-adaptation-to-climate-change>.
- Nikel, David. 2019. "Norway Wealth Fund to Dump Fossil Fuel Stocks Worth Billions in Environmental Move." *Forbes*, June 12, 2019. <https://www.forbes.com/sites/davidnikel/2019/06/12/norway-wealth-fund-to-dump-fossil-fuel-stocks-worth-billions-in-environmental-move/#6a34b38248a3>.
- OECD. 2012. *OECD Environmental Outlook to 2050: The Consequences of Inaction*. Paris: Organisation for Economic Co-operation and Development. <https://doi.org/10.1787/9789264122246-en>.
- OECD. 2018. *OECD Companion to the Inventory of Support Measures for Fossil Fuels 2018*. Paris: Organisation for Economic Co-operation and Development. <https://doi.org/10.1787/9789264286061-en>.
- OECD, World Bank, and UNEP. 2018. "Financing Climate Futures." Paris: Organisation for Economic Co-operation and Development, World Bank, and United Nations Environment Programme. <https://doi.org/10.1787/9789264308114-en>.
- Oh, Jung Eun, Xavier Espinet Alegre, Raghav Pant, Elco Eduard Koks, Tom Russel, Roald Schoenmakers, and Jim W. Hall. 2019. "Addressing Climate Change in Transport: Volume 2: Pathway to Resilient Transport." Vietnam Transport Knowledge Series. Washington, DC: The World Bank. <http://documents.worldbank.org/curated/en/438551568123119419/Volume-2-Pathway-to-Resilient-Transport>.
- PBL. 2009. "Global CO<sub>2</sub> Emissions: Annual Increase Halved in 2008." Text. PBL Netherlands Environmental Assessment Agency, Press Release. June 26, 2009. [https://www.pbl.nl/en/press-messages/sub%3E-emissions\\_-annual-increase-halved-in-2008](https://www.pbl.nl/en/press-messages/sub%3E-emissions_-annual-increase-halved-in-2008).
- Powell, Emily J., Megan C. Tyrrell, Andrew Milliken, John M. Tirpak, and Michelle D. Staudinger. 2019. "A Review of Coastal Management Approaches to Support the Integration of Ecological and Human Community Planning for Climate Change." *Journal of Coastal Conservation* 23 (1): 1–18. <https://doi.org/10.1007/s11852-018-0632-y>.
- Ray, Patrick A., and Casey M. Brown. 2015. *Confronting Climate Uncertainty in Water Resources Planning and Project Design: The Decision Tree Framework*. Washington, DC: The World Bank. <http://hdl.handle.net/10986/22544>.
- Rigaud, Kanta Kumari, Alex de Sherbinin, Bryan Jones, Jonas Bergmann, Viviane Clement, Kayly Ober, Jacob Schewe, et al. 2018. "Groundswell: Preparing for Internal Climate Migration." Washington, DC: The World Bank. <https://doi.org/10.1596/29461>.
- Robins, Nick, and James Rydge. 2019. "Why a Just Transition Is Crucial for Effective Climate Action." Inevitable Policy Response Series. London: Vivid Economics Limited. <https://www.unpri.org/inevitable-policy-response/why-a-just-transition-is-crucial-for-effective-climate-action/4785.article>.
- Rodriguez, Diego J., Anna Delgado, Pat DeLaquil, and Antonia Sohns. 2013. "Thirsty Energy." Water Papers. Washington, DC: The World Bank. <http://documents.worldbank.org/curated/en/835051468168842442/Thirsty-energy>.
- Rosemberg, Anabella. 2017. "Strengthening Just Transition Policies in International Climate Governance." Policy Analysis Brief. Muscatine, IA: The Stanley Foundation. <https://stanleycenter.org/publications/pab/RosembergPABStrengtheningJustTransition417.pdf>.
- Royal Dutch Shell. 2018. "Shell Energy Transition Report." The Hague. <http://www.shell.com/energytransitionreport>.
- Ruijven, Bas J. van, Enrica De Cian, and Ian Sue Wing. 2019. "Amplification of Future Energy Demand Growth Due to Climate Change." *Nature Communications* 10 (1). <https://doi.org/10.1038/s41467-019-10399-3>.
- Scialabba, Nadia. 2015. "Food Wastage Footprint & Climate Change." Summary Report. Rome: Food and Agriculture Organization of the United Nations. <http://www.fao.org/documents/card/en/c/7338e109-45e8-42da-92f3-ceb8d92002b0/>.

- Searchinger, Tim, Richard Waite, Craig Hanson, Janet Ranganathan, Patrice Dumas, and Emily Matthews. 2018. *Creating a Sustainable Food Future: A Menu of Solutions to Feed Nearly 10 Billion People by 2050*. World Resources Report. Washington, DC: World Resources Institute. <https://wrr-food.wri.org/>.
- Seto, Karen C., Shobhakar Dhakal, A. Bigio, H. Blanco, G.C. Delgado, David Dewar, Luxin Huang, et al. 2014. "Human Settlements, Infrastructure, and Spatial Planning." In *Climate Change 2014: Mitigation of Climate Change. Contribution of Working Group III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change*, edited by O. Edenhofer, R. Pichs-Madruga, Y. Sokona, E. Farahani, S. Kadner, K. Seyboth, A. Adler, et al. Cambridge, UK, and New York: Cambridge University Press. <http://www.mitigation2014.org>.
- Smith, Pete, Mercedes Bustamante, Helal Ahammad, Harry Clark, Hongmin Dong, Elnour A. Elsiddig, Helmut Haberl, et al. 2014. "Agriculture, Forestry and Other Land Use (AFOLU)." In *Climate Change 2014: Mitigation of Climate Change. Contribution of Working Group III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change*, edited by O. Edenhofer, R. Pichs-Madruga, Y. Sokona, E. Farahani, S. Kadner, K. Seyboth, A. Adler, et al. Cambridge, UK, and New York: Cambridge University Press. <http://www.mitigation2014.org>.
- Sova, Chase Anthony, Godefroy Grosjean, Tobias Baedeker, Tam Ninh Nguyen, Martin Wallner, Andreea Nowak, Caitlin Corner-Dolloff, Evan Girvetz, Peter Laderach, and Miguel Lizarazo. 2018. *Bringing the Concept of Climate-Smart Agriculture to Life*. Washington, DC: The World Bank. <https://doi.org/10.1596/31064>.
- Stanley, Michael C., John E. Strongman, Rachel Bernice Perks, Helen Ba Thanh Nguyen, Wendy Cunningham, Achim Daniel Schmillen, and Michael Stephen McCormick. 2018. "Managing Coal Mine Closure: Achieving a Just Transition for All." 130659. Washington, DC: The World Bank. <http://documents.worldbank.org/curated/en/484541544643269894/Managing-Coal-Mine-Closure-Achieving-a-Just-Transition-for-All>.
- Sustainable Mobility for All. 2019. "Global Roadmap of Action Toward Sustainable Mobility." Washington, DC. <https://sum4all.org/resources/publications>.
- Suzuki, Emi. 2019. "World's Population Will Reach Nearly 10 Billion by 2050." The World Bank. July 8, 2019. <https://datatopics.worldbank.org/world-development-indicators/stories/world-population-will-continue-to-grow.html>.
- The Shift Project. 2019. "Lean ICT: Towards Digital Sobriety." Paris. <https://theshiftproject.org/en/article/lean-ict-our-new-report/>.
- Tuukka, Castrén, Marko Katila, Karoliina Lindroos, and Jyrki Salmi. 2014. "Private Financing for Sustainable Forest Management and Forest Products in Developing Countries: Trends and Drivers." Washington, DC: Program on Forests. <https://www.profor.info/knowledge/private-financing-sustainable-forest-management-and-forest-products-developing-countries-%E2%80%9393>.
- UN. 2018. "World Urbanization Prospects 2018." New York: United Nations Department of Economic and Social Affairs, Population Division. <http://esa.un.org/unpd/wup/>.
- UNCTAD. 2014. "World Investment Report 2014: Investing in the SDGs: An Action Plan." Geneva: United Nations Conference on Trade and Development. <http://unctad.org/en/pages/publicationwebflyer.aspx?publicationid=937>.
- UNEP. 2018. "The Adaptation Gap Report 2018." Nairobi: United Nations Environment Programme. <https://www.unenvironment.org/resources/adaptation-gap-report>.
- UNEP. 2019. "Emissions Gap Report 2019." Nairobi: United Nations Environment Programme. <https://www.unenvironment.org/resources/emissions-gap-report-2019>.
- UNEP. 2020. "Locust Swarms and Climate Change." Interview with Richard Munang, United Nations Environment Programme Expert on Climate and Africa. February 6, 2020. <http://www.unenvironment.org/news-and-stories/story/locust-swarms-and-climate-change>.
- UNFCCC. 2015. "Paris Agreement." FCCC/CP/2015/10/Add.1. Paris: United Nations Framework Convention on Climate Change. [http://unfccc.int/paris\\_agreement/items/9485.php](http://unfccc.int/paris_agreement/items/9485.php).
- UN-Water. 2020. "UN World Water Development Report 2020: Water and Climate Change." Paris: United Nations Educational, Scientific and Cultural Organization. <https://www.unwater.org/publications/world-water-development-report-2020/>.
- Waha, Katharina, Linda Krummenauer, Sophie Adams, Valentin Aich, Florent Baarsch, Dim Coumou, Marianela Fader, et al. 2017. "Climate Change Impacts in the Middle East and Northern Africa (MENA) Region and Their Implications for Vulnerable Population Groups." *Regional Environmental Change*, April. <https://doi.org/10.1007/s10113-017-1144-2>.
- Whitley, Shelagh, Joe Thwaites, Helena Wright, and Caroline Ott. 2018. "Making Finance Consistent with Climate Goals." London: Overseas Development Institute, World Resources Institute, Rocky Mountain Institute, and E3G. <https://www.odi.org/publications/11253-making-finance-consistent-climate-goals-insights-operationalising-article-21c-unfccc-paris-agreement>.
- Wong, Louisa. 2014. "ICTs for Forestry and Green Growth | Biodiversity." *RESET* (blog). January 5, 2014. <https://en.reset.org/blog/icts-forestry-and-green-growth-05012014>.
- World Bank. 2011. "World Bank Supports Morocco's Bold Solar Power Plans." Press Release. November 17, 2011. <https://www.worldbank.org/en/news/press-release/2011/11/17/world-bank-supports-moroccos-bold-solar-power-plans>.
- World Bank. 2014. "Turn Down the Heat: Confronting the New Climate Normal." Washington, DC: Prepared for the World Bank by the Potsdam Institute for Climate Impact Research and Climate Analytics. <http://hdl.handle.net/10986/20595>.
- World Bank. 2016a. "Forest Action Plan FY16–20." 106467. Washington, DC. <http://documents.worldbank.org/curated/en/240231467291388831/Forest-action-plan-FY16-20>.
- World Bank. 2016b. "World Bank Group Global Crisis Response Platform." 108146. Washington, DC: The World Bank. <http://documents.worldbank.org/curated/en/334721474058771487/World-Bank-Group-global-crisis-response-platform>.
- World Bank. 2016c. "World Bank Group Country Engagement: An Early-Stage Assessment of the Systematic Country Diagnostic and Country

- Partnership Framework Process and Implementation.” Corporate and process evaluation by the Independent Evaluation Group. Washington, DC: World Bank Group. <http://documents.worldbank.org/curated/en/261671492447399270/World-Bank-Group-country-engagement-an-early-stage-assessment-of-the-systematic-country-diagnostic-and-country-partnership-framework-process-and-implementation>.
- World Bank. 2017a. “Modeling the Water-Energy Nexus : How Do Water Constraints Affect Energy Planning in South Africa?” Thirsty Energy. Washington, DC: The World Bank. <http://documents.worldbank.org/curated/en/706861489168821945/Modeling-the-water-energy-nexus-how-do-water-constraints-affect-energy-planning-in-South-Africa>.
- World Bank. 2017b. “Mobile Metropolises: Urban Transport Matters – an IEG Evaluation of the World Bank Group’s Support for Urban Transport.” Report No. 120110. Washington, DC. <http://documents.worldbank.org/curated/en/309551506621356068/Mobile-metropolises-urban-transport-matters-an-IEG-evaluation-of-the-World-Bank-Group-s-support-for-urban-transport>.
- World Bank. 2018a. “Piecing Together the Poverty Puzzle: Poverty and Shared Prosperity 2018.” Text/HTML. Washington, DC. <https://www.worldbank.org/en/publication/poverty-and-shared-prosperity>.
- World Bank. 2018b. “Year in Review: 2018 in 14 Charts.” December 21, 2018. <https://www.worldbank.org/en/news/feature/2018/12/21/year-in-review-2018-in-14-charts>.
- World Bank. 2019a. “2025 Targets to Step Up Climate Action.” Text/HTML. Washington, DC: The World Bank. <https://www.worldbank.org/en/news/press-release/2019/01/15/world-bank-group-announces-50-billion-over-five-years-for-climate-adaptation-and-resilience>.
- World Bank. 2019b. “The World Bank Group Action Plan on Climate Change Adaptation and Resilience.” Text/HTML. Washington, DC: The World Bank. <https://www.worldbank.org/en/news/press-release/2019/01/15/world-bank-group-announces-50-billion-over-five-years-for-climate-adaptation-and-resilience>.
- World Bank. 2019c. “World Bank Group Entities Issue Financial Statements for FY19.” Press Release. August 9, 2019. <https://www.worldbank.org/en/news/press-release/2019/08/09/world-bank-group-entities-issue-financial-statements-for-fy19>.
- World Bank. n.d. “Electricity Production from Hydroelectric Sources (% of Total).” World DataBank. Accessed June 14, 2020. <https://data.worldbank.org/indicator/EG.ELC.HYRO.ZS>.
- World Bank, IFC, and MIGA. 2008. “Development and Climate Change: A Strategic Framework for the World Bank Group – Technical Report.” Washington, DC: World Bank, International Finance Corporation, and Multilateral Investment Guarantee Agency. <http://hdl.handle.net/10986/28201>.
- World Bank, IFC, and MIGA. 2016. “World Bank Group Climate Change Action Plan 2016–2020.” Washington, DC: World Bank, International Finance Corporation, and Multilateral Investment Guarantee Agency. <http://hdl.handle.net/10986/24451>.
- World Bank, and UN DESA. 2017. “The Potential of the Blue Economy: Increasing Long-Term Benefits of the Sustainable Use of Marine Resources for Small Island Developing States and Coastal Least Developed Countries.” Working Paper. Washington, DC: World Bank and UN Department of Economic and Social Affairs. <http://hdl.handle.net/10986/26843>.

# A

## Appendix A Outlook 2050: Approach and Methodology

The Outlook 2050 Initiative followed a comprehensive engagement plan that was based on extensive consultations across the World Bank focusing on cross-sectoral and sectoral discussions. A total of 14 consultations and focus groups were held. The initiative started with a cross-sectoral consultation followed by sectoral foresight consultations and closed with another cross-sectoral consultation. An overview of the consultation framework is presented below. Detailed background materials were developed for each consultation, and the discussion was facilitated using the foresight approach.

### Cross-Sectoral Consultation

**The first cross-sectoral consultation was organized with sector experts across World Bank teams** (Sustainable Development and Infrastructure global practices). The objective of the consultation was to identify cross-sectoral engagement priorities for post-2020 Bank climate action, and to design an outline for subsequent sectoral consultations.

**Background materials were developed for discussions among the sector experts.** The team prepared consultation materials that were sent to the participants in advance. Background notes were prepared on the key emission drivers and critical cross-sectoral issues facing each sector – Agriculture, Environment, Energy, Transport, Urban, Water, and Digital Development. Additionally, the team developed a questionnaire to solicit feedback from the sector experts on how to shape the sectoral consultations.

**Cross-sectoral climate actions were identified.** After an extensive discussion with all the sector experts, the group reached a consensus on the key priorities for cross sectoral climate action. Based on these discussions, the 2050 team developed and circulated among the sector teams draft proposals for cross-sectoral climate actions where Bank engagement can be scaled up. These were incorporated into the World Bank Group 2025 Climate Action and Targets.

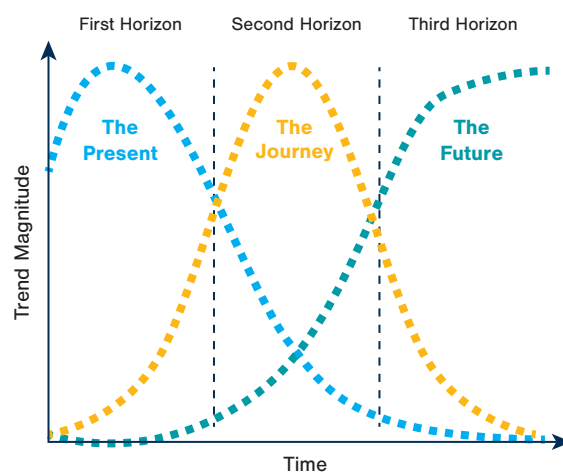
### Sectoral 'Foresight' Consultations

**As a next step, the 2050 team facilitated sectoral deep dives with 11 sectors** (across Sustainable Development, Infrastructure, Equitable Growth, Finance and Institutions practice groups) using the 'foresight approach'. The team also held a consultation with the Strategic Country Diagnostics (SCD) advisory group for discussion on systematic integration of long-term climate priorities into the World Banks' country engagement strategy through SCDs and therefore into Country Partnership Frameworks (CPFs). These long-term visioning workshops examined: (i) the challenges the World Bank currently faces in scaling up climate action with countries, (ii) the future desired by World Bank experts in terms of integration of their specialist sector into long-term climate action, and (iii) the near and medium-term strategies available to Bank teams through the current engagement model to support countries in meeting decarbonization objectives.

**Consultations were based on the 'foresight' approach** using a Three Horizons approach. Three Horizons is an aspirational approach to Foresight that invites workshop participants to

envision the most desirable future state they can imagine for the sector. In doing so, participants take time to think about and articulate the change they want to see in the world, and what they would do to get there. During the course of the workshop, participants offered ideas on each of three ‘Horizons’: the present, the journey, and the future. Starting with the present, participants then discussed a desired future state, building pathways, that build on or disrupt current approaches to climate action and development to deliver a more ambitious vision for the sector.

All the sector deep dives began by examining current progress and key challenges acting as barriers to widespread integration of climate change objectives in the sectoral operations and strategies. Next, participants provided a vision for the future if the Paris Agreement is fully integrated into the sector. Specifically, participants were asked to reflect upon how the World Bank supports its client countries in preparing for major technology and other economic and social transformations that will directly or indirectly contribute to a decarbonized and resilient future. The workshops concluded with participants developing and prioritizing specific new sectoral actions for World Bank engagement in the near- and intermediate-term to help client countries promote the long-term climate goals of decarbonization and resilience by the second half of the century.



**Background materials were developed in advance:** The 2050 team prepared detailed consultation materials to facilitate the sectoral discussions:

- » **Sector ‘Present’ notes:** This provided an overview of the current state of climate action in World Bank engagement in a specific sector. The notes addressed how the World Bank is currently addressing climate change based on a portfolio review of each sector over the last three years. The sector notes also provided a gap analysis on the missed opportunities for climate action. This enabled the participants to form an understanding of key challenges to be addressed when engaging countries in new areas for decarbonization and climate resilient development.
- » **Sector ‘Future’ notes:** These notes summarized sectoral trends and future development based on a range of external scenarios. The trends offered insight into some of the discrete factors that are shaping the world, and how the future in the year 2050 will be influenced by all of them. The future notes also discussed how the decisions that organizations and governments make (as they seek to manage these trends) can coalesce in different ways, creating a range of possible futures. Two key scenarios were developed that attempted to understand the future of the sectors: (i) a ‘business as usual’ approach and (ii) a decarbonization approach.

Sector consultation summary notes and challenge mapping exercises were prepared. Based on these discussions, sector specific consultation summary notes were developed for each sector team that highlighted the key priority actions to deepen long-term climate change mitigation action. The summary notes also included a mapping of different types of challenges (technology, policy and financing) that are seen as barriers to the implementation of these long-

term actions. Based on the challenges identified, priority actions were strengthened to include specific measures to overcome these hurdles.

## Final Cross-Sectoral Consultation

Following all the sectoral consultations, another cross-sectoral consultation was held. The objective was to discuss and finalize key cross-sectoral priorities that emerged from the previous cross-sectoral consultation and sector deep dives. With new context from the sector deep dives, the sector experts finalized recommendations and long-term cross-sectoral priorities for the World Bank's climate action.

Summary notes were provided in advance. The 2050 team provided short notes for all the sector teams on the specific cross-sectoral issues identified during the sectoral consultations. The finalized cross-sector priorities have been distilled into the 2050 Strategic Directions note.

Figure 12: Outlook 2050: World Bank Engagement Process

