UN environment

The 1 Gigaton Coalition

NORWEGIAN MINISTRY OF FOREIGN AFFAIRS

Renewable Energy and Energy Efficiency in Developing Countries:

Contributions to Reducing Global Emissions

Third Report | 2017

A digital copy of this report is available at 1gigatoncoalition.org

Disclaimer

The designations employed and the presentation of the material in this publication do not imply the expression of any opinion whatsoever on the part of the United Nations Environment Programme concerning the legal status of any country, territory, city or area or of its authorities, or concerning delimitation of its frontiers or boundaries. Moreover, the views expressed do not necessarily represent the decision or the stated policy of the United Nations Environment Programme, nor does citing of trade names or commercial processes constitute endorsement.

ISBN No: 978-92-807-3671-7

Job. No: DTI/2132/PA

The 1 Gigaton Coalition

Renewable Energy and Energy Efficiency in Developing Countries:

Contributions to Reducing Global Emissions

Third Report | 2017

ACKNOWLEDGEMENTS

LEAD AUTHORS

Yale University: Angel Hsu, Carlin Rosengarten, Amy Weinfurter, Yihao Xie

REN21: Evan Musolino, Hannah E. Murdock

REVIEWERS

Niklas Höhne, Markus Hagemann, and Takeshi Kuramochi (NewClimate Institute), Philip Drost (UN Environment), Nathan Borgford-Parnell and Hanxiang Cong (Institute for Governance and Sustainable Development), Zhao Xiusheng (Tsinghua University, China)

COUNTRY, INITIATIVE AND DATA CONTRIBUTORS

Case study support:

We thank and acknowledge following individuals for their valuable assistance providing consultation, feedback and information to inform the case studies.

Jaime Acuña (Univalle),Adedoyin Adeleke (Centre for Petroleum, Energy Economics and Law, University of Ibadan), Ayooluwa Adewole (Centre for Petroleum, Energy Economics and Law, University of Ibadan), Godwin Aigbokhan (Renewable Energy Association of Nigeria (REAN)), Habiba Ali (SOSAI Renewable Energies Company), Centro Regional de Producción más Limpia (CRPML), Corporación Autónoma Regional del Valle del Cauca (CVC), Tolu Fakunle (Centre for Petroleum, Energy Economics and Law, University of Ibadan), Eitan Hochster (Lumos Global), Janet Kajara (Kampala Capital City Authority (KCCA)), Shehu Ibrahim Khaleel (Renewable Energy Resources Development Initiatives (RENDANET)), Edison Masereka (Kampala Capital City Authority (KCCA)), Nolbert Muhumuza (Awuma Biomass), Tanya Müller Garcia (Secretary of Environment, Mexico City), Eleth Nakazzi (Kampala Capital City Authority (KCCA)), Ines Restrepo-Tarquino (Univalle), Patricia Ugono (Solynta), Uvie Ugono (Solynta), Paola Andrea Vásquez (GEADES-UAO), Sandra Vásquez (El Castillo)

Multistakeholder partnerships

Patrick Blake (en.lighten, U4E), Callum Grieve (Sustainable Energy for All (SEforALL)), Martin Hiller (Renewable Energy and Energy Efficiency Partnership (REEEP)), Irma Juskenaite (Climate Technology Centre and Network (CTCN)), Tatiana Kondruchina (Climate and Clean Air Coalition (CCAC)), Celia Martinez (District Energy in Cities Initiative), Wei-Shiuen Ng (International Transport Forum, OECD), Eva Kelly Oberender (Renewable Energy and Energy Efficiency Partnership (REEEP)), Ellen Paton (UK International Climate Fund (ICF)), Quinn Reifmesser (Renewable Energy and Energy Efficiency Partnership (REEEP)), Andrea Risotto (NDC Partnership), Nora Steurer (The Global Alliance for Buildings and Construction (GABC)), Jukka Uosukainen (Climate Technology Centre and Network (CTCN)), Maria van Veldhuizen (Renewable Energy and Energy Efficiency Partnership (REEEP)), Gunnar Wegner (Energizing Development and Climate Mitigation (EnDev)), Elke Westenberger (Moroccan Climate Change Competence Centre (4C Maroc)), Laura Williamson (REN21), Peter Wright (Sustainable Energy for All (SEforALL))

Data gathering

Markus Kurdziel (IKI), Sarah Leitner (IKI), Karoline Teien Blystad (Norfund), Lucie Bernatkova (EIB), Cyrille Arnould (EIB), Aglaé Touchard-Le Drain (EIB), Martina Jung (KfW), Milena Gonzalez Vasquez (GEF), David Elrie Rodgers (GEF), Ichiro Sato (JICA), Yoji Ishii (JICA)

THOMSON REUTERS

A contribution from Thomson Reuters report "Global 250 Greenhouse Gas Emitters: A New Business Logic" is included in chapter 3. Lead Authors:
David Lubin, Constellation Research and Technology; John Moorhead, BSD Consulting; Timothy Nixon, Thomson Reuters

The authors would like to thank and acknowledge the important contributions of Chris Mangieri, Dan Esty and Jay Emerson of Yale University and Constellation Research and Technology.

Important data and analytics support was provided by Frank Schilder, Thomson Reuters Research & Development, Adam Baron from Thomson Reuters Content Analytics, and Ian van der Vlugt from CDP.

PROJECT MANAGEMENT AND COORDINATION

Zitouni Ould- Dada (UN Environment),
Rashmi Jawahar Ganesh (UN Environment)

REN21

The 1 Gigaton Coalition would like to thank and acknowledge the invaluable assistance of REN21, namely: Hannah E. Murdock for research coordination, and Linh H. Nguyen for research support.

DESIGN AND LAYOUT

Weeks.de Webeagentur GmbH

TABLE OF CONTENTS

FOREWORD

H.E. Børge Brende
Minister of Foreign Affairs
Norway

Erik Solheim
UN Environment Executive Director and Under-Secretary-General of the United Nations

Even if the pledges in the Paris Agreement on Climate Change are implemented, we will still not reduce greenhouse gas emissions enough to meet the goals. The UN Environment Emissions Gap Report 2017 states that for the 2°C goal, this shortfall could be 11 to 13.5 gigatonnes of carbon dioxide equivalent. For the 1.5°C goal, it could be as much as 16 to 19 gigatonnes. We urgently need more ambitious action to close these gaps. So, this latest 1 Gigaton Coalition Report helps to focus those efforts by quantifying the progress secured through renewable energy and energy efficiency.

Electricity touches almost every aspect of our lives, yet nearly a quarter of the population still lacks access to safe, clean and affordable energy. Around the world, people continue to seek less polluting options for everyday needs like lighting, heating, water, cooking and sanitation. It should be no surprise then that renewable power capacity is growing faster than all fossil fuels combined, with a record increase of about 9% from 2015 to 2016. Particularly, when bi-products include better health, education, security and economic growth.

Take cities, which are responsible for 75% of global greenhouse gas emissions. They can also be a big part of the solution, by adopting to energy efficient buildings, electric transport, cycle schemes and waste conversion. For example, in New Delhi, India, the health of local communities is severely affected by growing mountains of waste being dumped in open spaces. The city and private sector are tackling this by investing in waste-to-energy-plants. These reduce toxic emissions and transform waste into electricity. The plant's community center offers employment and artisan training to about 200 local women. For Badru Nisha, this income has enabled her to save 70,000 rupees (US $1,100) and build a house for relatives in Bihar state. This program helps women build their skills and confidence, and provides them with some financial security and independence. This is just one of many stories inspiring local governments, mayors, businesses and civil society to join forces for significant environmental, economic and public health benefits.

This report comes at a critical moment to support the growing number of non-state actors showing leadership to deliver the Paris Agreement. We hope it will motivate donors, initiatives and countries to build on their achievements, while inspiring more public and private sector stakeholders to join this global effort.

KEY FINDINGS

- **INTERNATIONALLY SUPPORTED RENEWABLE ENERGY AND ENERGY EFFICIENCY PROJECTS** implemented in developing countries between 2005 and 2016 are projected to reduce greenhouse gas emissions by 0.6 Gigatons of carbon dioxide ($GtCO_2$) annually in 2020. When scaled up using international climate financing commitments, these efforts could deliver 1.4 $GtCO_2$ in annual reductions by 2020.

- **INTERNATIONAL SUPPORT FOR INVESTMENTS IN RENEWABLE ENERGY AND ENERGY EFFICIENCY IS VITAL FOR DECARBONIZATION,** as this support provides key resources and creates enabling environments in regions critical to the global climate future. International assistance accounts for only 10% of all global renewable energy and energy efficiency activities, yet it has extensive impact for future climate mitigation.

- **DATA AVAILABILITY AND INFORMATION SHARING REMAIN A PERENNIAL CHALLENGE,** one that is preventing countries and supporting organizations from systematically evaluating their work's impact, although renewable energy and energy efficiency projects and policies are growing in developing countries. The 1 Gigaton Coalition has developed a database of about 600 internationally supported projects implemented in developing countries between 2005 and 2016.

- **EVALUATING PROJECTS, POLICIES, AND SECTORS' COMPATIBILITY WITH GLOBAL 1.5°C AND 2°C CLIMATE GOALS IS ESSENTIAL TO LINK ACTIONS WITH LONG-TERM OBJECTIVES.** This new method would enable bilateral and multilateral development organizations to measure the long-term impacts of supported projects.

- **NON-STATE AND SUBNATIONAL ACTORS HAVE TAKEN ON A LEADING ROLE IN SCALING UP CLIMATE ACTION.** The case studies in this report show that low-carbon forms of development – particularly city-based public private partnerships – generate multiple co-benefits. These include improved environmental and human health, economic stimulus and employment creation, enhanced gender equality, and other societal gains that support the 2030 Agenda for Sustainable Development.

EXECUTIVE SUMMARY

Developing countries are achieving low-cost emissions reductions through renewable energy (RE) and energy efficiency (EE) projects and initiatives. The focus of this report is to evaluate the impact of these projects in terms of measurable greenhouse gas emissions' reductions to help close the emissions gap needed to meet the 2°C climate goal.

Greenhouse gas (GHG) emissions reductions created by a sample of 273 internationally supported RE and EE projects in developing countries implemented between 2005 and 2016 amount to approximately 0.3 gigatons of carbon dioxide ($GtCO_2$) annually by 2020. Of the analysed 273 projects, 197 are RE, 62 are EE, and 14 are both RE and EE. These efforts reduce emissions by displacing fossil fuel energy production with clean energy technologies and by conserving energy in industry, buildings, and transportation. The analysed sample's RE projects contribute approximately 0.084 $GtCO_2$, EE projects contribute 0.113 $GtCO_2$ and RE/EE projects contribute 0.059 $GtCO_2$ to the total emissions reductions. These projects received direct foreign support totaling US $32 billion. This analysis builds upon the second 1 Gt Coalition report, which examined data from 224 projects (see Annex I for more details).

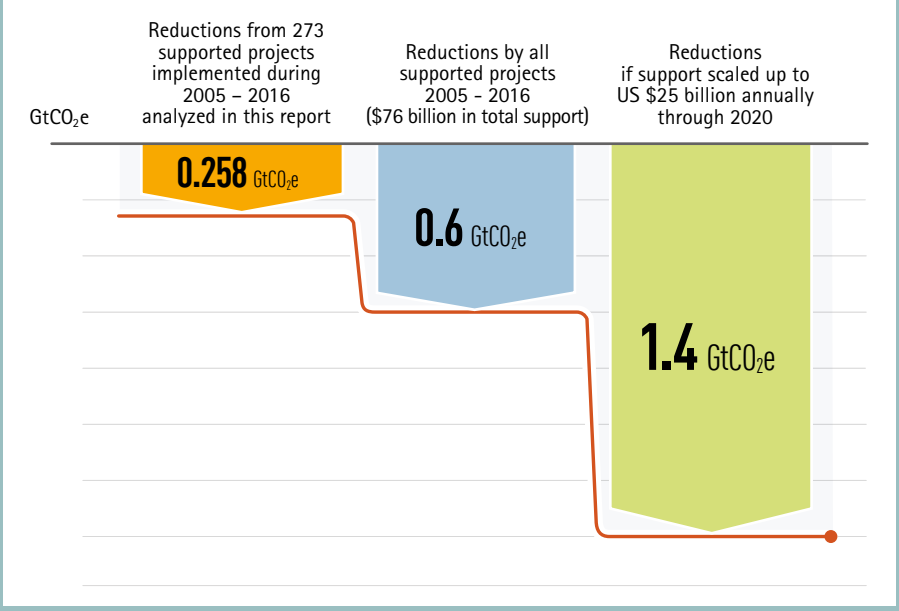
Reductions in GHG emissions resulting from all internationally supported RE and EE projects in developing countries implemented between 2005 and 2016 could be 0.6 $GtCO_2$ per year in 2020. This estimate is determined by scaling up the analysed sample's emissions reductions to a global level using the total bilateral and multilateral support for RE and EE from 2005 to 2016 (US $76 billion). These international investments create crucial enabling conditions in developing countries and emerging economies, where there are significant barriers to private RE and EE investment.

GHG emissions reductions from internationally supported RE and EE projects could be on the order of 1.4 $GtCO_2e$ per year by 2020 if committed public finance for climate mitigation is used to scale up these activities. Developed countries agreed in 2010 to mobilize US $100 billion per year by 2020 to help developing countries adapt to the impacts of climate change and reduce their emissions. To calculate the 1.4 $GtCO_2e$ estimate, it is assumed that a quarter of the US $100 billion is public mitigation finance and deployed in the same way as for the 273 analysed projects.

Assessing an initiative's emissions mitigation impact has inherent drawbacks that must be overcome in order to evaluate a project, policy, or sector in light of international climate goals. Emissions reductions estimates, even when accurate, do not explain whether the described outcomes are compatible with global climate goals. This report takes steps to overcome this challenge, by developing criteria intended to assess a sector's compatibility with global climate goals. It also shows how these compatibility conditions can be applied to RE and EE projects, outlining a conceptual framework for future analysis.

Criteria for sector-level compatibility with 1.5°C and 2°C goals were developed to evaluate emission savings from projects (Tables 3.1 – 3.15). The sectoral criteria are displayed in compatibility tables, with each table listing 1.5°C- and 2°C-compatibility conditions drawn largely from the International Energy Agency's (IEA) Energy Technology Perspectives (ETP) 2017 report and its 2°C Scenario (2DS) and Beyond 2°C Scenario (B2DS). Schematics (Figures 7 – 10) demonstrate how the sectoral compatibility criteria could be applied at the project, firm, or policy level to identify projects considered 1.5°C- or 2°C-compatible. Two actual projects, selected from this report's RE and EE database, are used as proofs of concept. Information sharing and data availability prove to be key challenges to broadening the application of this approach.

Figure ES: Emission reduction from renewable energy and energy efficiency projects by 2020



City governments are increasingly collaborating with the private sector to address common challenges related to climate change and sustainable development. The Intergovernmental Panel on Climate Change (IPCC) has indicated that achieving a 1.5°C- or 2°C-compatible future is a very challenging task, yet almost all the technologies needed to build this future are commercially available today. This report shows that many countries are acting to reduce emissions through RE and EE programmes, and that when policies are well-designed, both local and global communities benefit. The six case studies presented in this report describe the social, economic, and environmental benefits that RE and EE programmes bring to the localities where they are implemented. They highlight innovative initiatives implemented in a diverse set of cities and regions:

- **NEW DELHI'S** municipal government has partnered with Infrastructure Leasing and Financial Services Environment (IL&FS Environment) to build a waste-to-energy plant that will save approximately 8.2 million tons of greenhouse gas emissions over its 25-year lifespan, while reducing the landfill's area and air and water pollution. The project helps transition former waste-pickers to new jobs, directly hiring 70 people at the new plant, and has created a community center that provides support and job training to approximately 200 local women.

- **NANJING**, China worked with the electric vehicle industry to add 4,300 electric vehicles to its streets between 2014 and 2015. This transition has helped the city reduce emissions by 246,000 tons of carbon dioxide equivalent (CO_2e) in 2014, while saving over US $71 million in lower energy bills.

- In the industrial **VALLE DEL CAUCA** corridor of Colombia, The Women's Cleaner Production Network developed action plans to reduce industrial pollution and address climate change in small and medium-sized enterprises. The initiative has created a host of benefits, including a 110 percent increase in enterprise production efficiency and a new residential solar installation program.

- In **LAGOS**, and in many other Nigerian cities, private companies are piloting new approaches to make solar energy more accessible and affordable. A partnership between a solar start-up and local telecommunications provider has brought solar power to 50,000 homes, clinics, schools, and businesses, benefiting more than 250,000 people and creating 450 new jobs.

- Uganda's capital city, **KAMPALA**, has partnered with businesses to scale up an array of clean cooking technology initiatives, installing 64 improved eco-stoves in 15 public schools, constructing biodigesters in 10 public schools, and funding companies that train women and youth to produce low-carbon briquettes from organic waste.

- **MEXICO CITY'S** Sustainable Buildings Certification Programme, developed and implemented in partnership with the local construction and building industry, covers 8,220 square meters of floor area across 65 buildings and has reduced 116,789 tons of carbon dioxide (CO_2) emissions, saved 133 million kilowatt-hours (kWh) of electricity and 1,735,356 cubic meters of potable water, and created 68 new jobs between 2009 and 2017.

These case studies demonstrate the feasibility and benefits of a low-carbon future through the various RE and EE activities undertaken in cities in collaboration with private sector groups. Expanding this type of public-private sector engagement would harness expertise, funding, technology, and data from both arenas to help overcome barriers to action and accelerate the pace of climate action.

Governments and non-state actors will gather at COP 23 in November to discern a path forward for implementing the Paris Agreement's central provisions. Data sources needed to evaluate progress towards achieving the 1.5°C or 2°C climate goals are key points under discussion. This report provides pertinent information and evidence showing how internationally supported RE and EE projects and initiatives implemented in developing countries are contributing to narrowing the emissions gap – the difference between the status quo and the 1.5°C and 2°C goals. The report's case studies show the social and economic co-benefits associated with these emissions reductions, particularly when city governments partner with private companies to enact emissions savings programs. These initiatives have great potential to motivate countries and non-state actors to build new channels for collaboration, to raise their ambitions, and scale up their efforts. The 1 Gigaton Coalition will continue to promote RE and EE efforts, evaluate their emissions impacts, and show how they contribute to achieving both international climate objectives and Sustainable Development Goals (SDGs).

1 INTRODUCTION

Energy-related carbon dioxide (CO_2) emissions have stabilized, showing no growth in 2016 for the third year in a row, yet global energy consumption is predicted to increase 48 percent by 2040.[1] Developing countries, where rapid economic growth is the main driver of rising energy demand, will account for the vast majority of this future increase in energy consumption.[1, 2]

To meet the Paris Agreement's goal to limit global temperature to no more than 2°C, and aim to hold warming to 1.5°C, global emissions must peak around 2020 and then rapidly decline in the following three decades, approaching zero by 2050.[3] The emissions gap, however, has widened from last year's estimates. The 2017 United Nations Environment Programme (UN Environment) Emissions Gap Report finds that, by 2030, there will be a gap of 11 – 13.5 $GtCO_2e$ between countries' Paris climate pledges and the goal to limit global temperature rise to 2°C. The gap widens to 16 – 19 $GtCO_2e$ when considering the 1.5°C goal.[4]

New Delhi, India

New Delhi's waste-to-energy initiatives convert more than 50 percent of the city's daily waste into energy and fuel.

→ *Details see page 22*

Renewable energy (RE) and energy efficiency (EE) projects in developing countries are crucial means of narrowing the emissions gap and decarbonizing future energy growth. In 2016, a record 138.5 gigawatts (GW) of new capacity of RE was installed, mostly in developing countries and emerging economies, some of which have become key market players.[5] Evaluating how RE and EE projects translate to measurable emissions reductions, to closing the emissions gap, and to creating a 1.5°C or 2°C compatible future is the focus of this report.

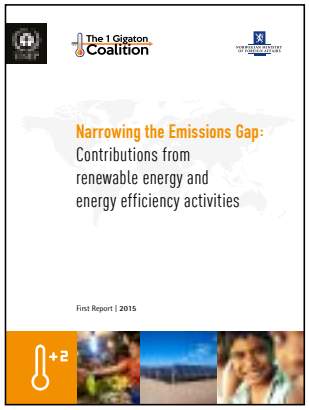
The climate imperative is clear: we must act now and with ambition to decarbonize human activities in order to meet global climate goals. The latest climate scenarios produced by the world's leading international scientific bodies show that our window to prevent dangerous global warming is rapidly narrowing as humanity's carbon budget – the total amount of carbon dioxide that can be emitted for a likely chance of limiting global temperature rise – diminishes year on year. The Intergovernmental Panel on Climate Change (IPCC) found, in its Fifth Assessment Report (2014), that the world will warm by between 3.7°C to 4.8°C by 2100 if humanity pursues a "business as usual" pathway. This level of warming, scientists agree, would be disastrous for human civilization. To give us a better than 66% chance to limit global warming below 2°C – the scientific community's agreed upon threshold for what societies could reasonably manage – the IPCC reports that atmospheric CO_2 concentrations cannot exceed 450 ppm by 2100. This limit means that the world's carbon budget through the year 2100 is less than 1,000 Gt CO_2e. Considering a 1.5°C limit, our carbon budget falls to under 600 Gt CO_2e through 2100.[6]

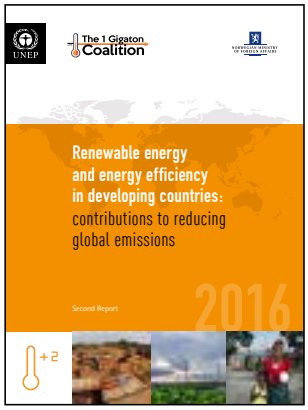
UN Environment's Emissions Gap Report 2017, which focuses on the gap between the emissions nations have pledged to reduce and the mitigation needed to meet global temperature goals, developed a "likely" (>66% chance of achieving the target) 2°C warming model under which annual global GHG emissions would need to stabilize around 52 $GtCO_2e$ through 2020 and then fall precipitously to 42 $GtCO_2e$ by 2030 and 23 $GtCO_2e$ by 2050. To have a greater than 50% chance of containing warming to 1.5°C, the 2017 Gap Report projects a greater drop in annual emissions, to 36 $GtCO_2e$ by 2030 – a significantly lower estimate than what the 2016 Emissions Gap report suggested. Under both scenarios annual global emissions appear to go negative – meaning that more carbon is absorbed than produced – by 2100. These projections are starkly divergent from baseline business as usual emissions projections as well as scenarios that account for the Nationally Determined Contributions (NDCs) that countries pledged in the Paris Agreement. By 2030, there is a 13.5 $GtCO_2e$ difference between the annual emissions in the 2017 Gap Report's unconditional NDC scenarios and its 2°C trajectory, and a 19 $GtCO_2e$ gap between the NDCs and 1.5°C trajectories.[7]

This gap points to an urgent need to increase the ambition, scope, and scale of carbon mitigation efforts worldwide. Each sector in every nation must lead the way with ambitious actions to decarbonize, and governments must enact plans and policies for sharp emissions reductions if we are to meet the 1.5°C or 2°C targets. Nearly one-half of lower middle income countries (GNI per capita between US $1,006 and $3,955) and one-fourth of low income countries (GNI per capita less than US $1,005) have made RE a primary focus of their NDCs.[8] One-third of lower middle income countries and 19 percent of low-income countries have adopted EE as a main focal instrument in their NDCs.[9] Many of these countries lack energy access for the majority of their population, suffer from the effects of poor indoor and outdoor air quality, and are striving to rapidly develop their economies to reduce poverty – needs that can be partly addressed through RE and EE efforts. Intergovernmental coordination and support are key catalysts for the requisite RE and EE initiatives, as developed nations transfer expertise, technologies, and funding to developing countries to create enabling environments for carbon-neutral growth. Yet beyond global emissions reduction goals, what specific targets should nations, sectors, and individual firms use to guide their actions? How do funding organizations, policymakers, and implementing groups know at what point their operations are compatible with the 1.5°C and 2°C targets?

The growth in RE and EE projects in developing countries in the last decade demonstrates the potential for these efforts to contribute to global climate mitigation and to narrow the emissions gap. A lack of data and harmonized accounting methodology, however, have prevented the bilateral and multilateral organizations that support these efforts from systematically evaluating their impact. The 1 Gigaton Coalition supports these organizations' efforts in developing countries, where growth in RE and EE projects have potential to transition economies to low-carbon trajectories. The Coalition works to build a robust knowledge base and support the development of harmonized GHG accounting methods. These tools will aid analysis of RE and EE initiatives that are not

directly captured in UN Environment's Emissions Gap Report or in other assessments of global mitigation efforts. Through the compilation and assessment of developing country RE and EE efforts between countries, partners, and collaborative initiatives, the 1 Gigaton Coalition promotes these efforts and strives to measure their contribution to reducing global greenhouse gas emissions reductions.





PREVIOUS 1 GIGATON COALITION REPORTS

The 1 Gigaton Coalition has released two reports to date. The 1 Gigaton Coalition 2015 report aimed to quantify RE and EE contributions to narrowing the 2020 emissions gap. The 2015 report was the first of its kind to assess and quantify RE and EE projects' global climate mitigation potential. This analysis used a comparison between the IEA World Energy Outlook (WEO) current policy scenarios and a no-policy scenario derived from the IPCC scenarios database to estimate the energy sector's total emissions reductions. The analysis found that EE and RE projects in developing countries could result in emission reductions on the order of 4 $GtCO_2$ in 2020, compared to a no-policy baseline scenario.

The 1 Gigaton Coalition 2016 report refined the approach developed in the inaugural 2015 report, expanding the database of internationally supported RE and EE projects in developing countries from 42 to 224. The larger database includes projects implemented between 2005 and 2015, receiving direct foreign support totalling US $28 billion. These projects were estimated to reduce GHG emissions by an aggregate 0.116 $GtCO_2$ annually in 2020. Avoided GHG emissions were calculated by multiplying the annual energy saved or substituted by a project (determined for RE projects by using the power generation capacity and the technology- and country-specific capacity factors and for EE projects through a project's documentation) by country-specific grid electricity CO_2 emission factors. The 2016 report estimated that all internationally supported RE and EE projects would reduce emissions by up to 0.4 $GtCO_2$ annually in 2020, and that if public finance goals for climate mitigation were met, supported projects could reduce emissions by 1 $GtCO_2$ per year in 2020.

OVERVIEW OF THE 1 GIGATON COALITION 2017 REPORT

The 1 Gigaton Coalition 2017 report builds upon the first two reports, further expanding the database of RE and EE projects from developing countries to calculate the mitigation impact of 273 internationally supported projects in developing countries. These projects, including 197 RE, 62 EE, and 14 RE and EE activities, are located in 99 countries and supported by 12 bilateral funding agencies and 16 multilateral development banks and partnerships. They are categorized for the technologies used to replace fossil fuel energy production with clean energy (i.e., solar, wind, biomass, and hydroelectricity) and reduce energy consumption in the industrial, building, and transport sectors. In total, these projects received US $32 billion in direct foreign support.

Evaluating RE and EE projects' mitigation impact is important to shed light on whether these efforts are reducing global emissions. An essential question is whether these efforts lead to long-term decarbonization or low-carbon pathways that are compatible with global goals to limit temperature rise to 1.5°C and 2°C. The 1 Gigaton Coalition 2017 report synthesizes a methodological approach to evaluate the 1.5°C- and 2°C-compatibility of RE and EE projects, intending to guide bilateral and multilateral partners and implementing countries in determining which policies, individual projects, and entire sectors are consistent with 1.5°C and 2°C scenarios. Drawing from other research initiatives and the International Energy Agency's (IEA) 2017 Energy Technologies Perspective (ETP) report, this analysis provides criteria for 1.5°C and 2°C-compatibility at the sector level and demonstrates how these criteria could be applied to RE and EE projects.

Providing real world examples of RE and EE initiatives in developing countries, this report features six in-depth case studies of ongoing programmes and policies in cities throughout the world. These case studies demonstrate the compounding benefits to human health, the economy, and environment that result from smartly planned RE and EE efforts. The cases feature collaborative initiatives in which the public sector and private companies work together to develop, implement, and scale climate action.

This report is organized as follows:

Chapter 2 provides an overview of the current landscape of RE and EE policies in developing countries. Chapter 3 presents six case studies that explore RE and EE programmes that engage the private sector to develop and implement renewable energy and energy efficiency activities. The case studies highlight the multiple benefits these initiatives garner across the various cities and regions where they are implemented. This chapter also includes a discussion by Thomson Reuters of the emerging low-carbon business paradigm. Chapter 4 describes the 1.5°C- and 2°C-compatibility methods and applications developed for this report, providing sector-level compatibility tables and project-level guidance. Chapter 5 provides an assessment of the GHG emissions mitigation from RE and EE projects in developing countries based on calculations derived from a project database built for this report. Chapter 6 concludes with the report's key implications for policymakers, RE and EE supporting partners, and climate actors.

2 DEVELOPING COUNTRIES' EFFORTS AND ACHIEVEMENTS IN ENERGY EFFICIENCY AND RENEWABLE ENERGY

This chapter describes the role of policymakers in promoting renewable energy and energy efficiency initiatives in developing countries. Data collected by REN21 – the global, multistakeholder renewable energy policy network – is used to illustrate the current status of targets and policies.

Nanjing, China

Nanjing was one of the fastest adopters of electric vehicles and has become an important hub for the industry.

→ *Details see page 26*

2.1 POLICY DEVELOPMENT

Renewable energy (RE) and energy efficiency's (EE) increasingly vital role in the rapid transformation of the energy sectors of industrialized, emerging, and developing countries continues to be stimulated in part by government actions to incentivize new technology development and deployment. Policymakers have adopted a mix of policies and targets to deploy RE and EE to expand energy access, provide more reliable energy services, and meet growing energy demand, while often simultaneously seeking to advance research and development into more advanced fuels and technologies.

Recognizing the complementary nature of RE and EE, at least 103 countries addressed EE and RE in the same government agency, including at least 79 developing and emerging countries, while an estimated 81 countries had policies or programmes combining support to both sets of technologies, including approximately 75 developing or emerging countries.

Adopted together, RE and EE can more rapidly help meet national development goals including increasing energy security, enhancing industrial competitiveness, reducing pollution and environmental degradation, expanding energy access, and driving economic growth. This can be achieved through sector-wide planning, such as China's 13th Five Year Plan adopted in 2016, which includes specific goals for both RE and EE.

Indirect policy support, including the removal of fossil fuel subsidies and the enactment of carbon pricing mechanisms such as carbon taxes, emission trading systems and crediting approaches can also benefit the RE and EE sectors. Carbon pricing policies, if designed effectively, may incentivize renewable energy development and deployment across sectors by increasing the comparative costs of higher-emission technologies. The removal of fossil fuel subsidies also may level the financial playing field for energy technologies, as fossil fuel subsidies remain significantly higher than subsidies for renewables, with estimates of the former being at least more than twice as high as those for RE. This estimate rises to ten times higher when the cost of externalities and direct payments are included.

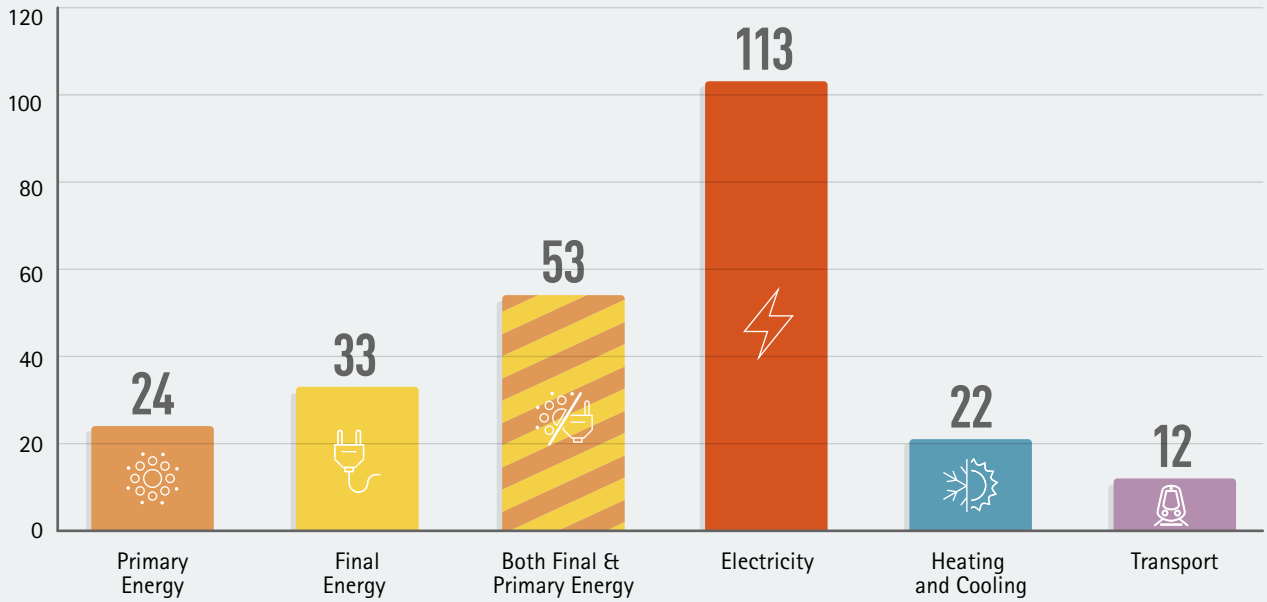
Developing countries led the way on initiating subsidy reform in 2016, with 19 countries adopting some form of reduction or removal. Similarly, by year-end 2016, Group of 20 (G20) and Asia-Pacific Economic Cooperation (APEC) initiatives had led to 50 countries committing to phasing out fossil fuel subsidies.

2.1.1 TARGETS

Targets are an important tool used by policymakers to outline development strategies and encourage investment in EE and RE technologies. Targets are set in a variety of ways, from all-encompassing economy-wide shares of capacity, generation, or efficiency, to calling for specific technology deployments or new developments in targeted sectors. Similarly, policymakers at all levels, from local, to state/provincial, regional, and national, have adopted targets to outline sector development priorities.

Nearly all nations around the world have now adopted RE targets aiming for specified shares, production, or capacity of RE technologies. Targets for RE at the national or state/provincial level are now found in 124 developing and emerging countries,

Figure 1: Number of developing and emerging countries with RE targets by sector and type, end-2016



Source: REN21 Policy Database

Note: Figure does not show all target types in use. Countries are considered to have policies when at least one national or state/provincial-level policy is in place. Policies are not exclusive--that is, countries can be counted in more than one column; many countries have mroe than one type of policy in place.

with new or revised RE targets found in 53 of those countries in 2016. Economy-wide targets for primary energy and/or final energy shares have been adopted in 54 countries. By sector, renewable power has received the vast majority of attention, with targets found in 113 countries. Targets for renewable heating and cooling and transport energy have been introduced to a much lesser degree, in place in 22 and 12 developing and emerging countries, respectively, by year-end 2016.[10] (See Figure 1)

With nearly all countries around the world having some form of RE target now in place, the pace of adoption of new targets has slowed significantly in recent years. However, many countries continue to increase the ambition of their renewable energy goals, with some, including the 48 Climate Vulnerable Forum member countries, seeking to achieve 100% RE in their energy or electricity sectors.[11]

A total of 51 new EE targets were adopted in developing and emerging economies worldwide in 2016, bringing the total number of countries with EE targets in place to at least 105 by year-end 2016. Many EE targets have been put in place through National Energy Efficiency Action Plans (NEEAPs), both in developed and developing countries. Outside of the EU, NEEAPs have be particularly prevalent in Eastern Europe and African countries.[12]

Energy sector targets also played a prominent role in many National Determined Contributions (NDCs) submitted to the United Nations Framework Convention on Climate Change (UNFCCC). A total of 117 NDCs were submitted by year-end 2016, largely formalizing the commitments made in countries' Intended Nationally Determined Contributions (INDCs) submissions prior to the Paris climate conference. EE was mentioned in 107 NDCs, and 79 developing and emerging economy NDCs included EE targets, such as Brazil's target of 10% efficiency gains by 2030.[13] RE was referenced in 73 NDCs submitted by developing and emerging countries, with 44 including specific RE targets.[14]

Individual country RE and EE commitments range widely in terms of scope and ambition. In the EE sector, targets that address multiple end-use sectors are the most common. However, policymakers have increasingly set single-sector goals to transition energy supply or reduce energy use in sectors including heating and cooling, transportation, buildings, and industry. This includes targets such as India and Uganda's light-emitting diode (LED) lamp goals.

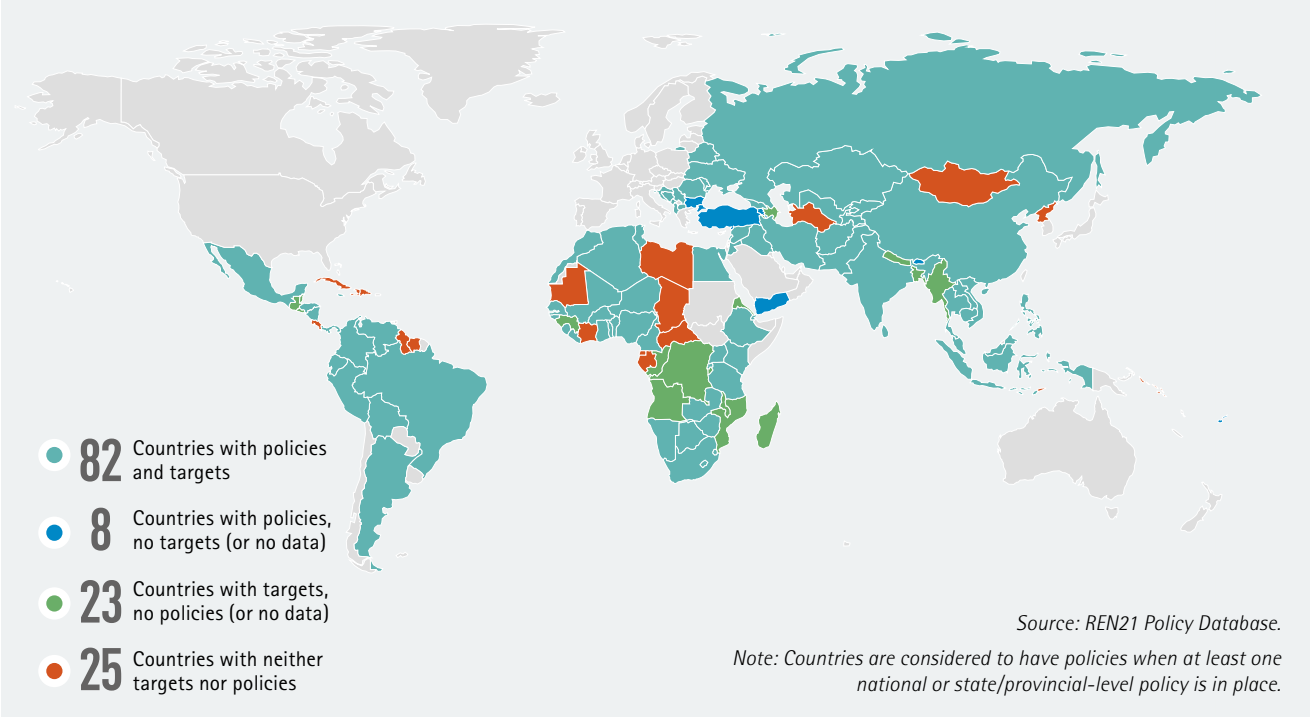
RE and EE targets have also been adopted at the regional level. In 2016, the members of the Southeast Asian Nations (ASEAN) collectively established a 20% by 2020 energy intensity reduction target in their NDCs, while the European Union set a binding 30% by 2030 energy savings target.

RE and EE targets are both often paired with specific policy mechanisms designed to help meet national goals.

2.1.2 POLICY INSTRUMENTS

In addition to targets, direct and indirect policy support mechanisms continue to be adopted by countries to promote EE (See Figure 2) and RE development and deployment (See Figure 3). Policymakers often strive to implement a unique mix of complementary regulatory policies, fiscal incentives, and/or public financing mechanisms to overcome specific barriers or meet individual energy sector development goals. These mechanisms, if well-designed and effectively implemented, can help spur the needed investment in the energy sector to meet national RE and/or EE targets.

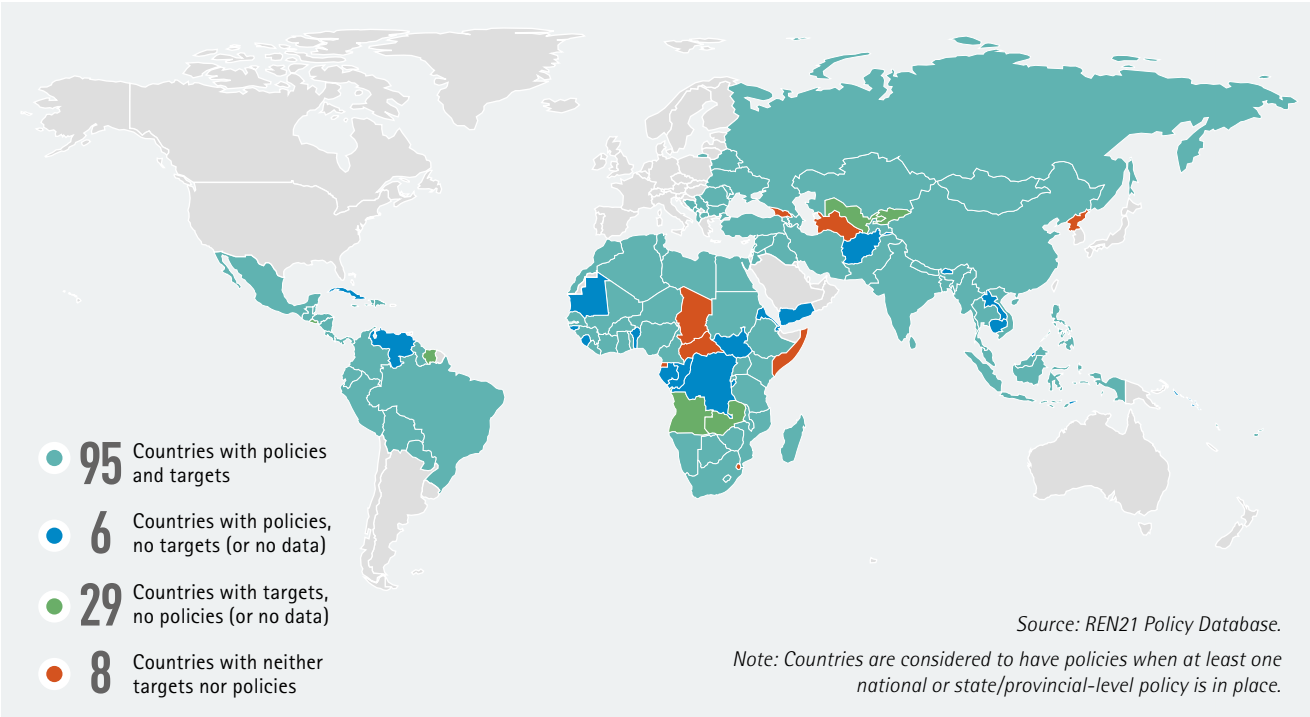
Figure 2: Developing and emerging countries with EE policies and targets, end-2016



Source: REN21 Policy Database.

Note: Countries are considered to have policies when at least one national or state/provincial-level policy is in place.

Figure 3: Developing and emerging countries with RE policies and targets, end-2016



Source: REN21 Policy Database.

Note: Countries are considered to have policies when at least one national or state/provincial-level policy is in place.

RE and EE are often adopted through differing mechanisms. EE-specific promotion policies often take the shape of standards, labels and codes, or monitoring and auditing program; while RE is often promoted through feed-in tariffs, tendering, or net metering. Policymakers have also turned to similar mechanisms such as mandates and fiscal incentives to promote both RE and EE.

RE and EE policies play an important role in the transformation of the energy sectors of industrialized, developing and emerging countries. EE policies have been adopted in at least 137 countries, including 90 developing and emerging economies.[15] EE awareness campaigns were held in at least 47 developing and emerging countries, while EE funds were in place in at least 40 such countries in 2016.[16] (See Figure 4)

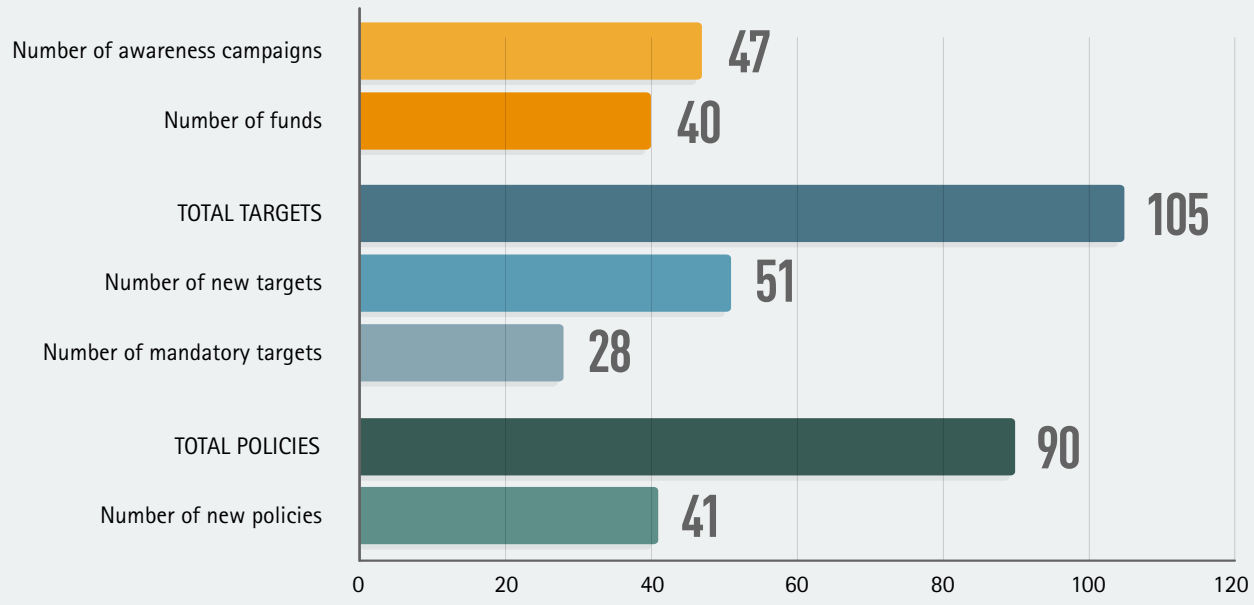
Direct RE support policies were found in at least 154 countries, including 101 developing and emerging economies as of year-end 2016.[17] The power sector continues to attract the majority of attention, with sectors such as heating and cooling and transportation receiving far less policy support. (See Figure 5)

Feed-in tariffs (FIT) remain the most common form of regulatory policy support to RE. While the pace of new FIT adoption has slowed in recent years, policymakers continue to revise existing mechanisms through a mix of expanded support to further incentivize specific RE technologies as well as reduced rates to keep pace with falling technology costs. For example, in 2016 Indonesia increased its solar FIT by more than 70% and set FIT rates for geothermal power. Similarly, Ghana announced plans to double the length of terms under its solar PV FIT to 20 years. Cuts were also made to existing mechanisms in countries such as Pakistan and the Philippines, while Egypt enacted domestic content requirements for solar PV and wind projects qualifying for FIT assistance.

In recent years many countries have revised their FIT mechanisms to focus on support to smaller-scale projects, while turning to RE auctions, or tendering, for large-scale project deployment. The use of tendering for promoting renewable power technologies has expanded rapidly in recent years with developing and emerging countries taking a leading role in the adoption of these mechanisms. Tenders were held in 34 countries in 2016, with half of them occurring in developing and emerging countries.[18] This included Chile's auction, which resulted in a world record bid for lowest price of solar PV generation at US $29.10 per MWh.

Countries in Africa were particularly active throughout the year, with Nigeria adopting a tendering system for projects larger than 30 MW to supplement its FIT policy, and both Malawi and Zambia holding their first RE tenders. In the Middle East and North Africa (MENA) region, comments included Morocco, State of Palestine, and Jordan all held tenders. In Asia, the world's two largest countries, China and India (at the national and sub-national level), as well as Turkey held RE tenders during the year. In Central America tenders were held in El Salvador, Guatemala, Honduras, Panama, and Peru. Tenders have also been held for non-power technologies, though to a far lesser degree.

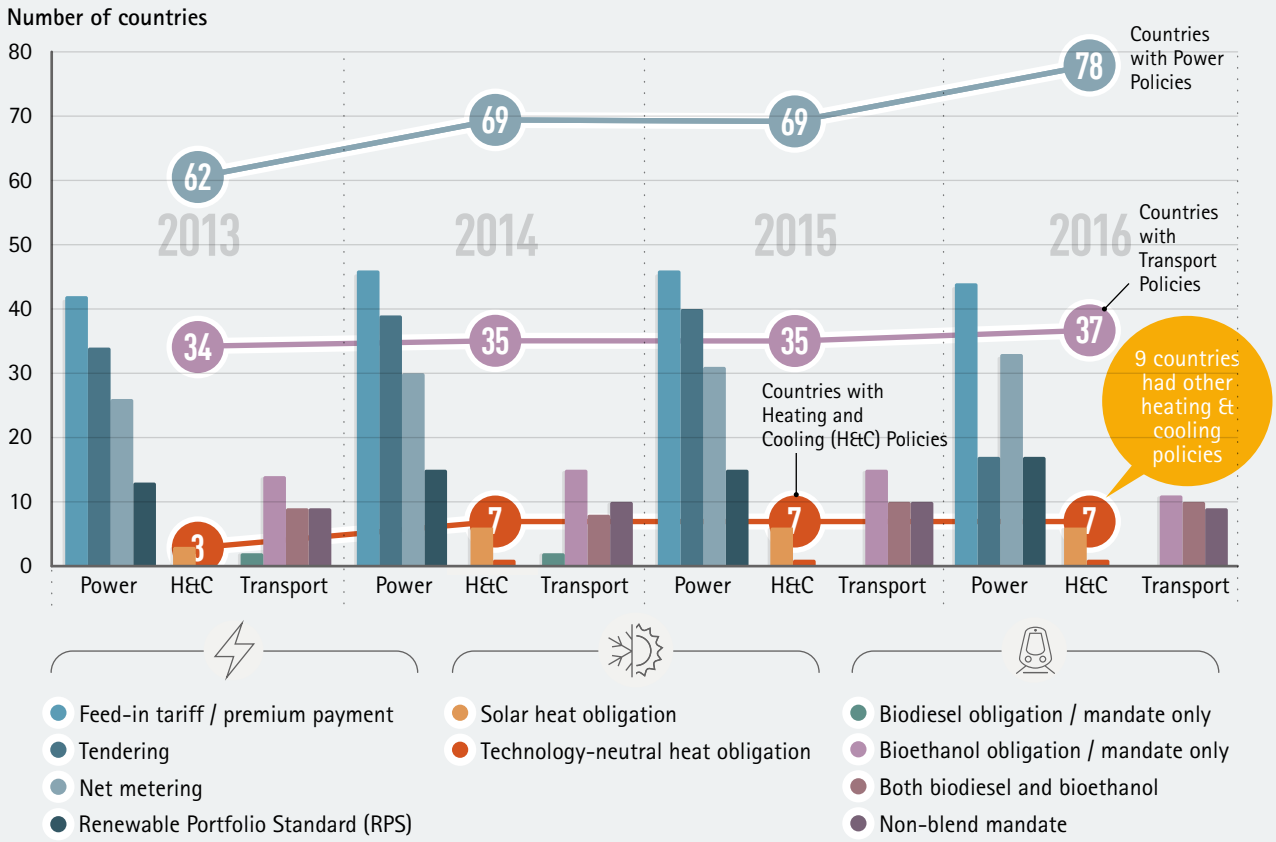
Figure 4: Number of developing and emerging countries with EE targets and policies, end-2016



Source: REN21 Policy Database.

Note: Numbers indicate countries where targets and policies have been identified but not necessarily the total number of countries with policies in place.

Figure 5: Number of RE policies and number of countries with policies by sector and type, developing and emerging countries, end-2016



Source: REN21 Policy Database

Note: Figure does not show all policy types in use. Countries are considered to have policies when at least one national or state/provincial-level policy is in place. Policies are not exclusive--that is, countries can be counted in more than one column; many countries have more than one type of policy in place.

Previously successful tendering programs in South Africa and Brazil each saw setbacks in 2016. In South Africa developers faced challenges securing power purchase agreements (PPAs) with the national utility, while reduced demand for electricity and economic challenges caused by Brazil's contracting national economy forced officials to call off previously planned auctions, marking the first time since 2009 in which the country did not hold a tender for wind power.

Policymakers have also continued to support renewable electricity deployment through enacting mandates for specified shares of renewable power, often through Renewable Portfolio Standards (RPS), or requiring payment for renewable generation through net metering policies, such as the new policies added in Suriname in 2016. In addition to regulatory policies, several countries provided public funds through grants, loans or tax incentives to drive investment in RE development or deployment. This includes India's 30% capital subsidy for solar PV rooftop systems.[19]

Governments are also adapting mechanisms that long have been used for the promotion of power generation technologies to develop an environment of enabling technologies, such as energy storage and smart grid systems, to better integrate renewable technologies in global electricity systems. For example, Suriname held a tender for solar PV systems including battery storage in 2016.[20]

RE deployment in the electricity sector through mechanisms such as those described above can also have a significant impact on the efficiency of power generation by shifting from thermal power plants, which convert only approximately one-third of primary energy to electricity, to more efficient RE installations.[21]

Renewable heating and cooling technologies are directly promoted primarily through a mix of obligations and financial support, though the pace of adoption remains well below that seen in the power and transport sectors. By year-end 2016 renewable heat obligations or mandates were in place in 21 countries, including seven emerging and developing countries (Brazil, China, India, Jordan, Kenya, Namibia, and South Africa).[22]

RE heating and cooling policies frequently focus on the use of RE technologies in the buildings sector, and are often adopted

in concert with building efficiency policies and regulations.[23] Several countries advanced EE through new or updated building codes in 2016, of which 139 are in place worldwide at the national and sub-national level, including in at least 9 developing and emerging countries.[24] This includes Indonesia's efforts to develop a Green Building Code, and members of the Economic Community of West African States (ECOWAS) implementing building codes in accordance with a regional directive.

Specific financial incentives, including grants, loans, or tax incentives, targeted at renewable heating and cooling technologies have been adopted in at least 8 developing and emerging economies. In certain cases, such as in Bulgaria, support to RE heating technologies are included in broader EE financial support programs. New developments in 2016 included Chile's extension of its solar thermal tax credit and India's new loan incentives for solar process heat developers. Renewable energy tendering has also been used to scale up deployment in the sector. Bids for South Africa's long-awaited solar water heater tender closed in early-2016.

The industrial sector also has a significant EE policy focus; however, the development of targeted mechanisms for the promotion of RE in industrial processes remains a challenge for policy makers. For EE, both Mali and Morocco now require energy audits for large industrial energy users.

Transportation-focused RE and EE policies have both been adopted to accomplish a wide range of sector goals, including increasing fuel economy or fuel switching to renewable fuels or electric vehicles. The vast majority of policy attention, particularly in developing countries, has been focused on energy use in the road transportation sector. While energy use in the maritime, rail, or aviation transportation sectors is gaining attention, concrete RE and EE policy mechanisms have been adopted in only a handful of locations.

Fuel economy standards are a primary means of increasing energy efficiency of passenger vehicles in the transport sector. At least eight countries plus the EU have now established fuel economy standards for passenger and light-commercial vehicles as well as light trucks, including Brazil, China, India, and Mexico.[25] No developing countries have yet adopted policies for heavy-duty vehicles.

RE in the transportation sector is often promoted through mandates specifying required shares or volumes of renewable fuel use. Developing countries are often at the leading edge of nations looking to promote fuel switching to renewable transport fuels. Biofuel blend mandates were in place at the national or state/provincial level in 36 countries as of year-end 2016, with developing and emerging countries accounting for 26 of that total.[26] In 2016, Mexico expanded its blend mandate to cover nationwide fuel use, while Argentina, Malaysia, India, Panama, Vietnam, and Zimbabwe all added or strengthened biofuel and/or bioethanol blend requirements.

New financial incentives also were introduced in 2016 to promote biofuel production and consumption, biorefinery development, and R&D into new technologies, including in Argentina where biodiesel tax exemptions were expanded, and Thailand which provided subsidies to support a trial program for biodiesel use in trucks and military and government vehicles.

While national policies remain an important driver of renewables and energy efficiency development, municipal policymakers are taking a leading role in the promotion of both RE and EE within their jurisdictions, often moving faster and enacting more ambitious goals than their national counterparts. As cities continue to band together to mitigate the impacts of global climate change, they have turned to RE and EE to transform their energy sectors. A number of cities around the world are now seeking to achieve 100% renewable energy or electricity, while a growing list of municipalities in developing and emerging economies such as Cape Town (South Africa), Chandigarh (India) and Oaxaca (Mexico) have established ambitious RE goals.

3 NON-STATE AND SUBNATIONAL CONTRIBUTIONS TO RENEWABLE ENERGY AND ENERGY EFFICIENCY

In cities and regions throughout the world, governments at all jurisdiction levels are collaborating with private companies, funding organizations, and civil society to implement renewable energy and energy efficiency programs. These activites reduce carbon emissions and create co-benefits including enhanced environmental quality, improved public health, economic growth and job creation, social inclusion, and gender equality. This chapter includes six case studies of successful public-private collaboration, as well as a discussion of the emerging low-carbon business paradigm.

Kampala, Uganda

Kampala aims to replace 50 percent of household charcoal use with alternative cook fuels, such as biomass or briquettes made from organic waste.

→ *Details see page 24*

Renewable energy (RE) and energy efficiency projects (EE) in developing countries often require collaboration from implementing partners, such as the private sector and subnational actors. This chapter features six case studies that demonstrate some of the strategies that cities, businesses, and other collaborators are using to support RE and EE activities across developing and emerging economies. These examples showcase the social, economic, and environmental benefits of RE and EE initiatives, demonstrating the incentives driving businesses and cities to take leadership roles in implementing them.[27, 28] It also includes an excerpt from Thomson Reuters' forthcoming 'Global 250 Report: A New Business Logic', exploring the motivations and process of companies seeking to decarbonize their business models.

Cities and the private sector will be vital to limiting global warming to well below 2°C.[29] As of 2013, over half of the global population and approximately 80 percent of global GDP resided in cities.[30] By 2050, the urban population will account for two-thirds of the global population, and 85 percent of the global GDP.[31] Since cities concentrate people and economic activity, they also shape energy use; urban areas currently make up around two-thirds of global primary energy demand and 70 percent of global energy-related carbon dioxide emissions.[32] The goals of the Paris Agreement rest on the ability to chart a sustainable urban future – through the adoption of renewable energy, increasingly efficient use of energy, and the design of resilient and low-carbon infrastructure and transport.[33]

Many cities already host innovative climate strategies, driven by governments, businesses and other actors who see opportunities to lower costs, appeal to investors, generate new forms of industry, and improve quality of life. Activities that help cities address climate change also offer opportunities to make progress towards meeting the goals of the 2030 Agenda for Sustainable Development. Low-carbon forms of development generate co-benefits, such as reduced traffic congestion and improved air quality and public health.[34, 35, 36] Between 2007 and 2015, solar and wind power in the United States produced air quality benefits of US $29.7–112.8 billion, mostly from 3,000–12,700 avoided premature mortalities.[37]

The transition to a low-carbon economy can also reduce poverty and spur job creation.[38, 39] Implementing the RE strategies articulated in the national climate action plans of the United States, European Union, China, Canada, Japan, India, Chile, and South Africa would generate roughly 1.1 million new jobs, and save about US $50 billion in reduced fossil fuel imports.[40] If these countries committed to a 100 percent RE pathway, they would generate 2.7 million new jobs, and save US $715 billion from avoided fossil fuel imports.[41] Collaboration with civil society and local stakeholders can help ensure a just transition to a low-carbon economy, that maximizes job creation, helps citizens develop new skills, and fosters community renewal.[42]

Building compact, connected cities also reduces the cost of providing services and infrastructure for urban transport, energy, water and waste.[43] In India, smart urban growth could save between US $330 billion and $1.8 trillion (₹2-12 lakh crores) per year by 2050 – up to 6 % of the country's GDP – while producing significant savings for households.[44] Altogether, the New Climate Economy estimates that global low-carbon urban actions could generate US $16.6 trillion between 2015 and 2050, while reducing annual GHG emissions by 3.7 $GtCO_2e$ by 2030.[45]

Increasingly, different kinds of actors are working together to realize this potential. One assessment found that three-quarters of the challenges facing city climate action require support and collaboration with national and regional governments or the private sector.[46] Cities and companies, in particular, have grown increasingly interdependent. Businesses aim to capture a share of the growing US $5.5 trillion global market in low-carbon and environmental technologies and products, which is often concentrated in cities.[47] Energy service companies, which base their business model on delivering EE solutions, generated US $24 billion in revenue in 2015, and employed over 600,000 people in China alone.[48] The global RE sector employed 9.8 million people in 2016, a 1.1% increase over 2015; by 2030, this number is expected to grow to 24 million.[49] Engaging in climate action also helps to mitigate the risk climate change may pose to an organization's business model and supply chain, and enables companies to meet internal and public commitments to address global warming.

The private sector can also help develop, implement, and scale climate and development solutions in urban areas that often struggle to access adequate finance. Aside from tax collection, most cities face limited options to raise or spend funds; the private sector can help access capital to initiate or expand successful projects.[50] A C40 analysis of some 80 mega-cities identified 2,300 high-impact, "shovel ready" climate actions that could mitigate 450 $MtCO_2$ – close to the annual emissions of the United Kingdom – by 2020, if US $6.8 billion in funds could be unlocked to implement them.[51]

Many of these collaborations are already underway. One survey of 627 climate change initiatives, across 100 global cities, found that private and civil society actors accounted for approximately one quarter (24 percent) of urban climate action, and 39 percent of climate action in Asian cities.[52] Private sector organizations fund and invest in climate action; act as service providers; deliver operations and maintenance support to projects such as transport or waste management; and design and build infrastructure.[53] Companies have also helped to fill gaps in infrastructure by creating new models for delivering city services, such as ride-sharing.[54] Strategies like microfinance have played important roles in further unlocking the upfront capital vital to developing and implementing urban innovations.[55] As urban areas expand, public-private partnerships that harness different forms of expertise, technology, and data can help overcome barriers to action and keep pace with cities' rapid rate of change.[56] National and regional governments can also help foster this process, by crafting policy and financial environments that help RE and EE strategies take root.

NEW DELHI

About the City

Population: (metro area)	23 million
GDP (2016):	US $ 293.6 billion
Land Area:	1,483 km² [iii]

Current situation:

→ New Delhi's 3 waste-to-energy plants enable the city to **use over 50% of its waste to produce electricity** daily.

→ The 52 MW capacity of New Delhi's 3 waste-to-energy plants constitute nearly **60% of the total 88 MW** produced by waste management practices in India.

New Delhi

About the initiative

New Delhi's Integrated Municipal Waste Processing Complex at Ghazipur, financed through a private-public partnership with IL&FS Environment, reduces emissions while transforming waste into energy. This partnership also supports local families through direct hiring and job training.

IN RELATION TO **SDGS**

Initiative Accomplishments:
The Ghazipur waste-to-energy plant will save...

... 8.2 million tons
in avoided methane emissions – equivalent to removing all cars from Delhi's roads for

100 days

...US $ 0.4 per kWh
in avoided waste treatment costs

... 200 acres
of land, valued at over Rs 2000 crores (US $308 million)

TRANSFORMING WASTE INTO ENERGY | INDIA | **NEW DELHI**

Each day, the Integrated Municipal Waste Processing Complex at Ghazipur, New Delhi, receives approximately 2,000 tons of waste, about 20% of the city's 9,500-ton waste stream.[57] Through a public-private partnership between the East Delhi Municipal Corporation and the Infrastructure Leasing and Financial Services Environment (IL&FS Environment) the landfill now includes a waste-to-energy plant which generates an annual 12 MW of power.[58] It also produces 127 tons of fuel, an alternative energy source for cement and power plants.[59] The Ghazipur plant, which began operating in November 2015, will save a projected 8.2 million tons in avoided methane emissions over its 25-year life span.[60]

The project's benefits extend beyond its climate impacts. Reusing waste will prevent 200 acres of urban land, valued at over Rs 2000 crores (US $308 million), from being consumed by the landfill.[61, 62] For IL&FS Environment, the plant enables it to engage in India's environmental goods and services sector, estimated to be worth Rs 250 billion (US $3.9 billion) and projected to grow 10 to 12% annually.[63] Across its operations, the company reuses 95% of every tonne of municipal solid waste through recycled products or energy generation.[64]

Converting waste to energy, and avoiding the expansion of the landfill, also lowers the health and safety risks of an open solid waste disposal site.[65] The plant reduces the amount of leachate the landfill generates, saving US $0.4 per kWh in annual treatment costs.[66] In managing the Ghazipur plant, IL&FS Environment relies on best-in-class technology[67] and a Continuous Emission Monitoring System, which publishes real-time emission parameters online, to meet strict air quality standards.[68]

The project also focuses on supporting the surrounding community of 373 local wastepicker families who live near and work in the landfill, salvaging and reselling waste. Providing support and retraining to local families is critical to efforts that affect access to the landfill and its materials. The Ghazipur plant employs over 70 former waste-pickers directly in the plant.[69] To foster financial inclusion, 400 families received bank accounts and Permanent Account Number cards, and kiosk banking was provided to the local community through the State Bank of India. Since July 2014, 2,075 bank accounts have been opened.[70, 71]

IL&FS Environment also worked with a nonprofit organization, Institute for Development Support (IDS), to establish Gulmeher, a community center that offers employment and training to approximately 200 local women, who previously earned a living collecting waste at the Ghazipur landfill.[72] The center, which launched in May 2013, grew out of brainstorming sessions IDS held with waste-pickers, IL&FS Environment, and other stakeholders.[73, 74] To help boost their future employability, the center provides training in a variety of jobs.[75] Women reuse materials from a nearby wholesale flower market to create products including boxes, cards, diyas, and natural holi colors.[76] In mid-2014, the center partnered with Delhi-based start-up Aakar Innovations to produce inexpensive sanitary napkins that low-income women can afford. Aakar Innovations helped train the women and buys and re-sells the products they produce.[77]

In 2014, the community organization converted into a private company, with participants also acting as shareholders of the Gulmeher Green Producer Company Limited.[78] Earnings for the participating women average approximately Rs 5,000-6,000 (US $77-90) every month.[79] For Badru Nisha, the first woman to join the center, this income has enabled her to save 70,000 Rs (US $1,100) and to build a house for relatives.[80] In India, where only 26% of women participate in the labor force, compared to almost 75% of men, this organization helps build women's skills and confidence.[81, 82]

Without intervention, New Delhi is expected to generate roughly 15,750 tons of garbage daily in 2021.[83] For cities facing a similar challenge of managing high volumes of waste with limited land, the Ghazipur plant offers a successful strategy; plans for replicating it are underway in New Delhi and other Indian cities.[84] The city's most recently constructed waste-to-management plant, Narela-Bawana, also relies on a public-private partnership model, and produces compost as well as energy.[85] As the city and its waste stream continue to grow, the private sector plays a powerful role in converting challenges into opportunities for development.

KAMPALA

About the City

Population (metro area):	3.5 million
GDP:	US $25.528 billion
Land Area:	1,895 km²

Current situation:

-22%

Reduce greenhouse-gas emissions by 22 % (compared to business-as-usual)

-50%

Replace 50% of charcoal with alternative cook fuel

Market in Kampala, Uganda

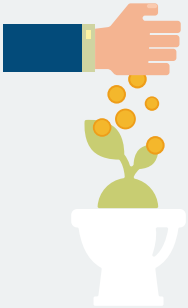
About the initiative

Kampala accelerates the development and adoption of clean cooking technology. The city partners with the private sector, civil society, and international funders to bring clean cooking technology to public schools and markets and to support low-carbon biomass businesses.

IN RELATION TO **SDGS**

64 x improved eco-stoves

installed in 15 primary schools, saving of **9,300 € (US $11,029)** in firewood costs, reducing **1,671 tons of CO_2** annually, and benefitting **15,631 children and staff members.**



1 billion

Ugandan shillings (US $276,860) raised by MTN Uganda to install bio-toilets in 10 schools.

220

eco-stoves installed in Kampala's markets.

EXPANDING ACCESS TO CLEANER COOKING | UGANDA | **KAMPALA**

Kampala has grown rapidly over the past decade, becoming home to nearly 2 million people, and generating approximately half of Uganda's GDP.[86] In 2014, the city launched a five-year Climate Change Action Strategy[87] to guide its rapid evolution and to ensure it "drives development in the most sustainable way."[88] The plan draws on a diverse array of goals – from planting half a million trees to creating traffic-free paths for pedestrians and bicyclists – to build Kampala's resilience and protect its most vulnerable populations.[89]

The early years of the Kampala's Climate Change Action Strategy have focused on creating pilot projects and building partnerships that lay the groundwork for expanded action. In particular, the city has made great strides in implementing a complementary array of clean cooking initiatives. Its Climate Change Action Strategy seeks to replace 50% of household charcoal use with alternative cook fuels, such as biomass or briquettes made from organic waste.[90] To pursue this target, Kampala provides seed capital and funding to organizations that train youth and women in making biomass briquettes; brings biogas digesters and improved cook stoves to public schools; and installs eco-stoves at city markets. These proof-of-concept demonstrations build confidence and connections with the private sector, civil society, and bilateral and multilateral funders, to help scale up these strategies.

MTN Uganda, the country's largest telecommunications company, for instance, has committed 1 billion Ugandan shillings (US $276,860), raised through two annual city marathons, to install biogas digesters in 10 public schools.[91] Their commitment will expand a program piloted at the Kansanga School, which turns human, animal, and food waste into methane gas, halving the amount of energy used to cook meals. This biogas digester produces approximately 2.6 MWh annually, lowering operating costs and reducing pollution from the firewood or charcoal it replaces.[92]

A collaboration between the Kampala Capital City Authority (KCCA) and French development agency Expertise France supports a complementary effort to bring higher efficiency cooking stoves to 15 new public schools,[93] with technical support from the Ugandan company SIMOSHI Ltd. This effort, which has distributed 64 stoves supplied by Uganda Stove Manufacturers Ltd., builds on the successful implementation of an eco-stove at another school.[94] The program has saved schools 9,300 € (US $11,029) in firewood costs, reduced 1,671 tons of CO_2 annually, and benefitted 15,631 children and staff members.[95] Earnings acquired through the Clean Development Mechanism will be reinvested in the schools to support annual maintenance, monitoring and management.[96] Eventually, the project aims to install 1,500 stoves in 450 schools, benefiting 340,000 children and reducing 31,286 tonnes of annual CO_2 emissions.[97]

Kampala also works with emerging businesses, providing seed funding to organizations that train women and youth to produce low-carbon briquettes from organic waste, food scraps and other materials. The briquettes burn cleanly, without releasing smoke or ash, and help avoid deforestation. In the words of one customer, they are also "cheap to use, time-saving and energy-saving."[98] The briquettes have gained popularity with restaurants, hotels, households and poultry farmers. Kampala's administration is developing a program to further expand the supply of low-carbon fuel and connect producers with more markets.[99]

In addition, the city has installed 220 eco-stoves in the city's marketplaces. These stoves can be linked with solar photovoltaic panels that extend stoves' cooking time and can generate electricity for other uses, such as lighting a kitchen or charging a battery.[100] This approach improves working conditions, protects the health of the women who typically cook and serve food in these spaces, and helps test and fine-tune this technology. It also builds awareness and comfort with cleaner cooking technology among smaller business owners, who often face financial barriers to the purchase of new equipment.

The shift to cleaner cooking technology can deliver vital improvements in public health. More than 90% of Ugandan households,[101] along with many restaurants, schools, and other places that serve and prepare food, cook with wood charcoal. The World Health Organization estimates exposure to cookstove smoke contributes to 13,000 premature deaths every year in Uganda.[102, 103] In Kampala, over 80% of households rely on charcoal for cooking, with dramatic impacts on air quality and public health.[104] Women and girls often face the highest levels of risk, as they can spend up to five hours daily cooking in smoky kitchens, and can face safety risks in traveling to forests to collect firewood.[105]

The use of clean cooking technology also lessens the risk of fuel shortages. The balance between biomass supply and demand remains fragile, with large deficits in materials forecasted in and beyond the 2020's.[106] Since Kampala concentrates Uganda's economic activity and, as a result, its energy demand, it is especially vulnerable to these projected shortfalls, but also particularly well-placed to test and develop solutions.[107]

The city's approach to promoting clean cooking technology reflects the need to ensure that the transition away from the charcoal market generates jobs and creates revenue.[108] Funding will also continue to be crucial to the city's ability to facilitate and accelerate the adoption of clean cooking technologies. Kampala has teamed up with the World Bank and the University of Washington to develop a climate-smart capital investment plan that aligns new projects with the city's climate action goals. It will continue to leverage partnerships with private and international partners to scale up public funding as it takes the next steps in its climate and development roadmap.[109]

NANJING

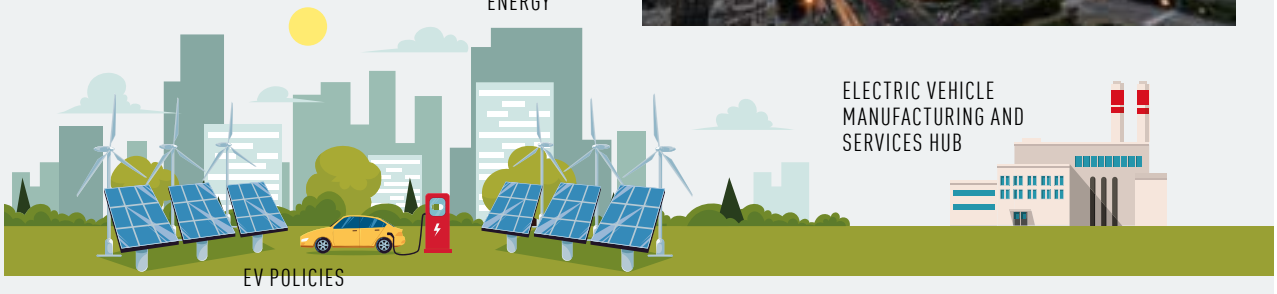
About the City

Population (metro area):	8.21 million[xlv]
GDP (2016):	US $146.4 billion[xlvi]
Land Area:	6,598 km^2[iii]

Current situation:

→ Shortlisted as one of China's National

LOW-CARBON PILOT CITIES.



About the initiative

The Nanjing Municipal Government introduced a series of policies to promote the sale, use and production of electric vehicles. It works with industry to continue transforming the city into a major electric vehicle manufacturing and services hub.

IN RELATION TO **SDGS**

Initiative Accomplishments*

*During 2014-15

+4,300

→ Added **4,300 electric vehicles (EVs)**

-246,000t

→ **reduced CO_2 emissions by 246,000 tons** and saved over **US $71 million** in lower energy bills

→ Drew more than **46** EV companies to the city, generating annual tax revenues of approximately

US$ 16 million.

PROMOTING ELECTRIC VEHICLES | CHINA | **NANJING**

The Chinese city of Nanjing deployed the fastest rollout of electric vehicles in the world, adding 4,300 electric vehicles to its streets during 2014–2015.[110] This transition to electric vehicles (EV) helped Nanjing reduce CO_2 emissions by 246,000 tons in 2014.[111] Nanjing's activities have drastically cut the city's carbon emissions and use of oil, and generated over US $71 million in savings from lower energy bills.[112]

Nanjing's adoption of renewable and electric vehicles is part of a larger economic and environmental bid to transition away from energy and carbon intensive industries like petrochemicals, steel, and building materials[113] that Nanjing's economy once relied on. These conventional industries are losing their economic competitiveness while emitting large amounts of greenhouse gases and other pollutants.[114]

The municipal government supported this shift by building compatible infrastructure for electric vehicles, introducing tax breaks and electricity price subsidies for EV consumers, and promoting the use of renewable-powered vehicles in public services. In the 2016 New Energy Automobile Promotion and Application Plan of Nanjing, the municipal government aimed to add 500 renewable energy buses, 500 service vehicles and 1,502 passenger vehicles to its transportation system in 2016.[115] By 2018, Nanjing's goal is to convert 80% of its bus fleet to be powered by renewable energy.[116] Nanjing also plans to build 3,000 charging stations, especially in residential areas, and to expand the use of electric vehicles to trucks and vans in the logistics sector.[117]

Nanjing's initiative to promote electric vehicles closely aligns with China's national climate, energy, and macroeconomic policies, and it receives support from the central and provincial levels of government. On a national level, China has set specific targets to develop a sustainable and renewable energy-driven transportation sector, as highlighted in both the State Council's Circular Economy Development Strategy and Near-Term Action Plan and the Ministry of Transport's Guiding Opinions on Accelerating Development of Green Circular Low-Carbon Transportation.[118] Electric vehicles are a key part of the solution, as they enable China to achieve GHG emission reduction targets as well as to grow and restructure its automobile industry.

At the provincial level, the Jiangsu Provincial Government has signed a Framework Agreement[119] with the Ministry of Transport to promote Jiangsu's development of low carbon transportation. The Jiangsu Provincial Government also released the Green, Circular and Low-Carbon Transportation Development Plan of Jiangsu Province (2013-2020),[120] which included a target to make 35% of public buses and 65% of taxis run on renewable energy across Jiangsu.

Through supportive policies and a favorable investment environment, Nanjing has established itself as an electric vehicle manufacturing and services hub. In 2014-15, Nanjing drew 46 companies connected to the EV sector to the city and earned tax revenues of approximately US $16 million per year.[121] In 2016, Chinese EV manufacturer Future Mobility Corporation invested US $1.7 billion to build a factory in Nanjing that has an initial production capacity of 150,000 cars per year.[122] Beijing-based EV rental company Gofun has also introduced its service to Nanjing, rolling out 200 electric cars that can be rented via smartphones.[123]

Policy coordination across different levels of government helps explain Nanjing's success. Nanjing is a National Low-Carbon Pilot City.[124] Policies and guidelines from the Central and Provincial Governments give the Municipal Government the confidence and support it needs to conduct pilot programs and test new solutions.

Private sector engagement is another important factor in scaling up EV adoption. The private sector plays a key role in Nanjing's expansion of its EV sector, by providing solutions, products, and services to meet demand. The Nanjing Municipal Government's policies have made Nanjing a pioneer both as a market and a manufacturing center for the EV industry. The Nanjing Municipal Government offers incentives for manufacturers to base their production in Nanjing, thereby promoting its economic restructuring.

The government also fosters companies' engagement in the sector's future. In August 2017, the Nanjing New Energy Automobile Operation Alliance was launched. It consists of 37 companies across the entire EV value chain – including carmakers like BYD, real estate developer China Fortune Land Development, and charging station solution provider e-charger. The alliance is supported by the Nanjing Municipal Government's EV Office and the Nanjing Economic and Technological Development Zone.[125] Platforms like this will enable Nanjing to expand its volume of EVs and develop a transportation sector that runs on clean pollution-free renewable energy.

VALLE DEL CAUCA REGION

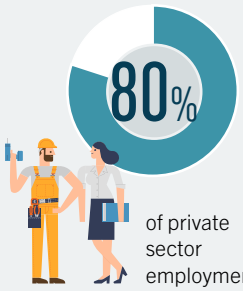
About the City

Population (metro area):	4.6 million[xciv]
GDP (2016):	US $35.3 million[lxix]
Land Area:	22,140 km^2 [iii]

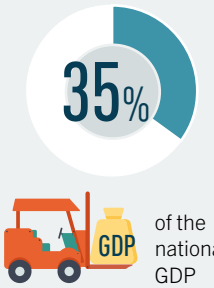
Current situation:

Across Colombia, micro, small, and medium enterprises comprise:

of all Colombian businesses



of private sector employment



of the national GDP

Cali, Valle del Cauca, Colombia

About the initiative

The Women's Cleaner Production Network trains and encourages entrepreneurs to foster clean production practices in small and medium enterprises along the Colombia's Valle del Cauca region, a major industrial corridor.

IN RELATION TO **SDGS**

Initiative Accomplishments

25

women have been trained through the initiative

Under the leadership of Network participants

→ A construction firm installed **3,304 kWh** of energy in a new housing development, saving +US $200 in the first 8 months of its projected 20-year life span

Production efficiency

+110%

→ A sugar cane mill switched to more efficient stoves and fuel, increasing production efficiency 110%

→ A construction firm achieved a:

- **31%** reduction of its construction waste;
- **69%** reuse of demolition and construction material waste;
- **50%** reduction of paper use in its organizational processes;
- **90%** and the use of rainwater for of construction activities

LEADING BY EXAMPLE IN CLEANER INDUSTRIAL PRODUCTION | COLOMBIA | **VALLE DEL CAUCA REGION**

The Women's Cleaner Production Network helps entrepreneurs transform their firms into green businesses. It gathers women from academia, utility companies, public organizations, and large and small industries to develop action plans to reduce industrial pollution and address climate change. To date, 25 women have leveraged the Network to capture efficiency savings, reduce emissions, and give their company a competitive edge.

While strategies vary across sectors, they typically deliver cost or material savings for the organization as well as benefits for the climate. At a trapiches paneleros (unprocessed sugar product) mill, old and inefficient ovens used wood and old tires as fuel, in part to compensate for the oven's open design, which failed to conserve heat. Burning these materials released sulfur dioxide, which creates respiratory risks,[126] in addition to greenhouse gases.[127] The firm's owner, a member of the Network, led the switch to an eco-oven, a system easily constructed using local materials. A fine-grained silica wall conserves heat, eliminating the need to burn tires and wood and enabling the operation to reuse sugar cane waste as fuel. The new stove also generates more heat, cuts the use of vegetable oil in the consumption process by 83%, and increases overall production efficiency by 110%.[128] The mill's production of its final products – 24-kg lumps of processed sugar cane – have jumped from 2.5 to 5.25 per hour.[129]

In another example, a firm's female construction director led a shift to the use of solar energy in residential construction projects. The firm joined forces with a national utility company, Empresa de Energia del Pacifico (Epsa), and piloted an initiative to install solar panels on the roofs of common areas, such as gardens, swimming pools and gyms. Since the panels' installation in January 2017, the PV systems have generated 3.304 kWh of energy, of which 3.303 kWh has been consumed, saving its owners over US $200 in the first 8 months of its projected 20-year life span.[130, 131] The director now hopes to expand the use of solar to individual homes, using environmentally-friendly materials to generate and store electricity.

Other women associated with the Women's Cleaner Production Network have achieved similar results in both emissions reductions and environmental protection. Increased efficiency at one large construction firm spread to ten of its suppliers; across these businesses, women led the installation of photovoltaic energy systems to provide light and pump rainwater; initiated waste recycling and water reuse programs; replaced firm motorcycles with bicycles; and cut administrative paper use by half.[132]

All of this activity occurs within the Valle del Cauca region of Colombia, a major industrial corridor that hosts roughly 450 small and medium enterprises from different industries.[133]

Across Colombia, micro, small, and medium-sized enterprises make up 99% of all Colombian businesses, and drive 80% of private sector employment, along with 35% of the national GDP.[134] They also often generate significant pollution, in part because of the challenge of accessing environmental knowledge and best practice technologies.[135] Regional cleaner production centers, universities and environmental authorities, in sync with Colombia's 2010 Sustainable Production and Consumption Policy, aim to transform polluting industries into sustainable businesses.[136]

Groups like the Women's Cleaner Production Network help facilitate collaboration between these different actors, making cleaner production efforts more resilient to financial or technical challenges. These collaborations also help identify key areas for intervention. A partnership between the Network and the Corporación Autónoma Regional del Valle del Cauca (CVC), Colombia's environmental authority, for instance, is developing clean production initiatives to support small coffee producers, which employ many women displaced by conflict.

Though many small and medium-sized enterprises are dominated by men, women have been crucial actors in the transition to cleaner technology and practices. While they work across diverse industries, participants in Women's Cleaner Production Network share a common trait: they have all already led successful cleaner production projects in various industries in Colombia prior to joining the initiative. The Network helps facilitate technology transfer, but also fosters strategic partnerships and learning alliances to help implement new tools and sustain change. Many firms, even when they successfully participate in demonstration projects, struggle to integrate these new strategies, tools or processes into their daily operations. The Women's Cleaner Production Network has been especially adept at helping its participants institutionalize these transitions, create a new business-as-usual, and lay the foundation for continued gains in clean production.[137]

The potential for replicating the Network's model in and beyond Colombian remains large. Most participants' activities draw on local technology and materials and involve simple, easily achievable steps.[138] The model of the Network itself could also be scaled up. It draws value from the diversity of institutions and industries represented, and helped build participation through concrete activities, responsibilities, and benefits for engagement in the network. Crucially, it considers technical knowledge from small firms and from large institutions to be complementary and equally valuable, enabling the group to tackle problems that would have been challenging to address from a single perspective.[139]

MEXICO CITY

About the City

Population: (metro area)	20.4 million
GDP:	US $421 billion
Land Area:	1,485 km²

Past Accomplishments:

Cut **7.7** million tonnes of CO_2e between 2008-2012 = **+10%** more than its original targets

Current Situation:

Commercial and industrial buildings' energy use generates

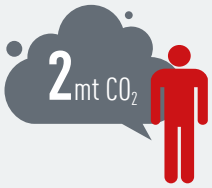
30% of Mexico City's carbon emissions

21,949 square meters of green roofs on schools, hospitals, and public buildings

Future Targets:

Reduce **10** million tonnes of CO_2e by 2020, and **31.4** million tonnes of CO_2e by 2025.

Reduce annual emissions by **80-95%** or limit to 2 metric tons of CO_2 per capita, by the year 2050



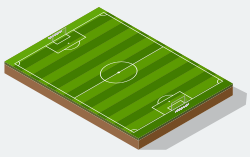
About the initiative

Mexico City's Sustainable Buildings Certification Program incentivizes sustainable commercial, industrial and residential buildings, creating benefits for building owners, tenants, and the city government.

IN RELATION TO **SDGS**

Initiative Accomplishments (between 2009-2017)

Covers **8,220** square meters of floor area across 65 buildings

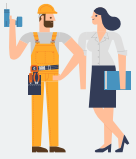


Reduced **116,789** tons of CO_2 emissions

Saved **133** million kWh of electricity

Saved **1,735,356** cubic meters of water

68 new jobs created



TAKING THE LEAD IN GREEN AND SUSTAINABLE BUILDINGS | MEXICO | **MEXICO CITY**

Mexico City has encouraged efficiency in new and existing building stock through a strategy that integrates public policy with concrete action. The Sustainable Buildings Certification Program (SBCP), "the first of its kind in Mexico,"[140] exemplifies this approch, generating buy-in and capacity for more comprehensive action while delivering tangible environmental and economic benefits. The initiative fosters the sustainable construction or improvement of commercial, industrial and residential buildings, by awarding certifications that reflect various levels of sustainability performance in energy efficiency, water, mobility, solid waste, social and environmental responsibility, and green roofs.

The SBCP launched in 2009, after approximately two years of planning and stakeholder consultation. Mexico City's Ministry of Environment gathered technical experts from the building industry, local governments, and academia to develop the program's certification process and criteria. Typically, participants audit their building's energy and water use, then use the results to develop a plan to meet or exceed existing local and national energy efficiency standards. The Ministry of the Environment certifies new or newly retrofitted buildings, rating residential structures as compliant, efficient, or excellent, and industrial buildings as compliant or excellent. Higher certification levels generate higher property tax and payroll tax reductions. Every two years, a follow-up assessment tracks performance and compliance.[141]

As of 2017, the program encompassed 8,220 square meters of floor area across 65 buildings. Between 2009 and 2017, participating buildings saved 116,789 tons of CO_2, 133 million kWh of electricity, and 1,735,356 cubic meters of potable water.[142] The SBCP's benefits also spread beyond efficiency. The program has supported renewable energy installation and expanded green roofs and gardens – its tax breaks allow participants to implement sustainability strategies that might otherwise be prohibitively expensive.

Since third-party technicians play a vital role in supporting the certification process – auditing buildings, and identifying strategies to improve performance – the city has partnered with industry to offers technicians resources, training, and the chance to earn credentials as official implementing agents of the SBPC program. The certification can help auditors win new contracts, and the process of training and hiring technicians to oversee the auditing and certification of buildings has generated 68 new jobs.[143]

Reduced property and payroll taxes, along with lower energy and water bills, help incentivize participation. The program's auditing and monitoring components enable participants to closely track their personal return on investment. Participation in the SBCP also leads to increased access to project financing and accelerated permitting procedures. These benefits help building owners overcome the high capital costs and limited financing options that can stall building improvements.[144] By lowering the demand on municipal water, energy, and waste management services, the program also enables Mexico City to stretch its resources farther.[145]

The SBCP includes multiple points of entry that accommodate different participants' needs. Its tiered certification system allows small businesses with limited access to capital to scale up efficiency improvements over time. Tenants of commercial buildings can obtain certification for the space that they rent or lease. In multi-family properties, certifications can apply to either specific building sections, common areas, or the entire building. These options help counter the challenge of "split incentives" between building tenants and owners, in which a building owner worries that savings from lower energy costs will flow to the tenant, while a tenant avoids investing in improving efficiency, since the resulting increases in property value will largely benefit the owner.[146] Continuing to tailor outreach and incentives to different audiences – and, in particular, to small and medium enterprises – will be a key next step for the city.[147]

The program also increases the transparency of the building marketplace. Domestic or international corporations seeking green office space or industrial facilities may consult a list of SBCP participants. Certified office buildings have garnered "green premiums" of around 20% in their rental yields,[148] as companies seek to meet their own sustainability commitments or harness the benefits of green buildings.

The SBCP is part of a complementary mix of reforms and incentives aimed at greening the city's building sector. Mexico City leads by example, covering 21,949 square meters of schools, hospitals, and public buildings with green roofs, and conducting audits for efficiency retrofits at 19 public buildings.[149, 150, 151] In June 2016, Mexico City's Ministry of Environment updated building codes, including guidance on materials for construction, equipment, and design, to enable more energy-efficient buildings. This dramatic shift from the previous regulations, which did not account for energy efficiency, could reduce buildings' energy use up to 20%.[152] Through platforms such as the Building Efficiency Accelerator, the city continues to engage a wide range of stakeholders to develop strategies that foster efficient buildings.[153] Voluntary initiatives, like the SBCP, help generate support for more comprehensive policies, and will play an important role in accelerating their uptake.

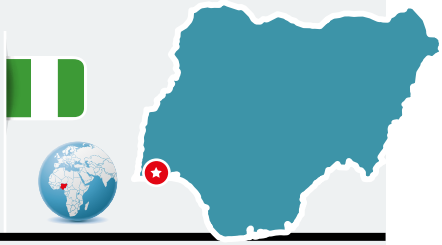
LAGOS

About the City

Population: (metro area) 16 million[cxli]

GDP: US $136 billion[cxlii]

Land Area: 999.6 km^2[cxliii]



Current situation:

Nigeria's 7,500 MW power supply lags behind the estimated **170,000 MW** demand, costing the region 2-4% of its annual GDP

→ Small and medium enterprises...

... make up **9 out of 10** Nigerian businesses and contribute over 46% of the nation's GDP

... spend some **3.5 trillion Naira** (US $9.7 billion) each year on **generator fuel**

About the initiative

Private companies are making solar energy accessible and affordable, helping to meet the vast demand for reliable energy access across Nigeria's cities.

IN RELATION TO **SDGS**

Initiative Accomplishments

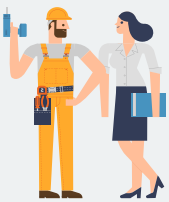
MTN Mobile Electricity...

... brings solar power to some **50,000** homes, clinics, schools, and businesses

... benefits over **250,000** people

... creates **450 jobs** in Nigeria.

... aims to reach **10 million** installations by 2022.



Solynta...

... reduces businesses fuel costs by at least **75%**.

SCALING UP THE SOLAR MARKET | NIGERIA | **LAGOS**

Solar companies are piloting innovative ways of making solar energy accessible and affordable, meeting Nigeria's enormous market and vast need for energy. The Renewable Energy Association of Nigeria estimates that 15 MW of solar PV has been installed across the country, with the potential to harness 4.0 – 6.5 kWh per square mile each day.[154] These installations reflect the diversity of energy needs across Africa's largest country. In Lagos, a solar school built through a partnership between architecture firm NLE Works, the United Nations, and the Heinrich Boll Foundation floats in the Makoko neighborhood's lagoons, providing a gathering place for 100 children.[155] Consistent Energy Limited has focused on winning business from the same city's stylists, signing up an estimated 200 barber shops for pay-as-you-go solar systems.[156]

The private sector has been instrumental in deploying and demonstrating the feasibility of distributed solar energy systems. The solar start-up Lumos Global, for instance, has partnered with Nigerian mobile provider MTN to bring solar power to over 50,000 homes, clinics, schools, and businesses, benefiting over 250,000 people, and creating 450 jobs.[157] This partnership, MTN Mobile Electricity, aims to reach 10 million installations by 2022.[158]

Working with Nigeria's largest mobile provider – MTN captures about 39% of the country's mobile market share[159] – makes solar power accessible. MTN Mobile Electricity operates through MTN's well-established marketing and distribution channels, selling eighty-watt systems, small enough to fit on the back of a motorcycle, through approximately 300 MTN locations.[160] Customers pay for solar service through SIM cards, which most citizens already use or have access to.[161] Unlike many East African countries, such as Kenya, Uganda, and Tanzania, where pay-as-you-go solar models have taken off, the infrastructure and use of mobile money in many West African countries remains nascent.[162] Finding a quick and convenient way for customers to pay for solar systems, without relying on mobile money, bank accounts, or credit cards, marks a major step towards the wider growth of the market.

From MTN's perspective, its partnership with Lumos Global helps it set itself apart from its competitors. Offering a unique service – the ability to purchase solar energy – reduces every mobile company's greatest worry: that its customers will switch to another provider. Expanding access to reliable energy also makes it easier for customers to charge and use mobile phones.[163]

The pay-as-you-go model, employed by MTN Mobile Electricity and a wide range of companies operating in Nigeria, helps customers overcome scarce access to financing, so that upfront costs do not prevent them from taking advantage of longer term savings.[164] Pay-as-you-go solar companies also act, in many ways, as financial service providers, reaching customers that

might otherwise be overlooked due to a lack of credit history. This payment models mimic the diesel and kerosene payments customers are familiar with, but deliver greater value for the money. Lumos estimates that the cost of running a diesel generator for two hours is equivalent to the cost of running their solar system for a day.[165] Solynta, which offers pay-as-you-go, along with lease-to-own and direct purchase options, has found that switching to solar reduces business fuel costs by at least 75%.[166] Solar panels can last for 20 years, extending these savings far into the future.[167]

Solar energy's lower costs could unleash additional economic development in Nigeria, where customers spened between US $10 – 13 billion on kerosene and diesel fuels each year.[168] Bottlenecks in accessing power cost the country 2-4% of its GDP each year, slowing economic growth, jobs, and investment.[169] Small and medium-sized enterprises, which make up nine out of ten Nigerian businesses, and contribute over 46% of the nation's GDP, are especially affected by a lack of access to reliable electricity, spending some 3.5 trillion Naira (US $9.7 billion) each year on generator fuel.[170] For many business owners, access to more reliable power translates into the ability to expand their services, grow their businesses, and create more jobs.[171]

By illustrating the benefits of solar power to customers, investors, and the national government, companies have helped accelerate its uptake. Education and outreach efforts have introduced solar systems to new audiences.[172] Demonstration projects have overcome reputational challenges tied to poorly constructed solar options in earlier markets.[173, 174]

Demonstrating the demand for solar energy is also unlocking urgently needed finance. Sixteen companies, supported by £2 million from the Solar Nigeria Programme, delivered small solar light and power systems to 170,000 Nigerian households during 2016 alone. By 2020, the initiative aims to reach 5 million homes.[175] In addition to partnerships with philanthropic agencies and impact investors, solar companies are increasingly attracting their own investment.[176] Lumos Global, for instance, raised a record US $90 million in 2016,[177] a hopeful signal that solar companies will continue accelerating the delivery of clean, reliable energy.

3.2 GLOBAL 250 GREENHOUSE GAS EMITTERS: A NEW BUSINESS LOGIC

the answer company THOMSON REUTERS

Non-state actors, especially the private sector, will play a critical role in addressing climate change and reducing Greenhouse Gas (GHG) emissions. Indeed, the 250 companies[178] referenced in this report, along with their value chains, account for approximately one third of global annual emissions.[179] For years, the management teams in many large organizations have recognized the future constraints that climate change could pose on their business operations and outlook. While many have deferred making a strategic shift toward a low carbon future, others have recognized a new business logic: a historic opportunity for innovation that drives sustainable growth and competitive advantage.

The good news is that some companies in the Global 250, such as Total, Ingersoll Rand, Toyota, Iberdrola, and Xcel Energy, are diversifying and decarbonizing their business models. Their plans, begun a decade or more ago, have proven business results and provide a pathway to a profitable low carbon future that

Table 1: Companies in the Global 250 include the Top 15[180] (listed below), which alone account for about 10% of global annual emissions[181], and therefore play crucial roles in our global transition to a low carbon economy[182]:

Rank (2015)	Company	GHG Emissions Metric Tons CO_2e (Scope 1+2+3)			GHG Index	Revenues Index	Decoupling Index	Employment Index
		2016	2015	2014	Baseline 2014 =100	Baseline 2014 =100	Baseline 2014 =100	Baseline 2014 =100
1	Coal India		2,014,314,687	1,869,412,290	108	105	*97	96.1
2	PJSC Gazprom		1,247,624,306	1,264,855,340	99	106	*107	104.9
3	Exxon Mobil Corporation		1,096,498,615	1,145,083,349	96	66	*69	97.6
4	Thyssenkrupp AG	950,917,000	954,185,140	954,085,140	100	95	96	96.4
5	China Petroleum & Chemical Corporation		874,153,506	901,550,000	97	71	*74	97.9
6	Rosneft OAO		835,868,134	829,849,040	101	94	*93	95.2
7	Cummins Inc.	805,343,388	813,043,062	920,001,660	88	91	104	101.5
8	PETROCHINA Company Limited		730,924,555	688,790,000	106	76	*71	97.6
9	Royal Dutch Shell	734,160,000	698,868,219	735,119,000	100	55	*56	97.9
10	Rio Tinto	668,246,000	669,751,731	652,023,000	102	71	*69	85.4
11	China Shenhua Energy		643,832,223	733,109,000	88	70	*80	103.0
12	Korea Electric Power Corp		634,243,789	666,588,494	95	103	110	207
13	Total	469,545,000	581,900,000	598,400.000	78	60	*77	101.9
14	Petróleo Brasileiro SA – Petrobras	544,200,903	547,476,491	618,399,435	88	84	*95	85.1
15	United Technologies Corporation	401,518,529	530,627,775	530,803,247	76	99	131	95.7

Notes: 1) 2014 scope 3 emissions data for Thyssenkrup AG and United Technologies Corporation vary significantly from 2015 scope 3 data; therefore, the change in scope 1+2 emissions between 2015 and 2014 is used in conjunction with Thyssenkrup AG's and United Technologies Corporation's respective 2015 scope 3 emisssions data to determine scope 3 emissions values for 2014.

*2) * indicates a Decoupling Index that is susceptible to fossil fuel commodity prices*

stretches to 2050 and beyond. Looking at the Global 250, evidence is accumulating that companies who demonstrate leadership toward a decarbonize economy gain strategic advantages.

CASE STUDY OF TOTAL GROUP[183]

Now let's take a closer look at one firm's journey to decarbonize, operating in a very challenging business sector: fossil-fuel based energy.

France's Total S.A. (Total)[184] is the fourth largest publicly held oil and gas company in the world. The firm is responsible for GHG emissions that place it 13th on our list of major emitters. Total is today widely recognized as a leader among major fossil fuel companies for its vision of a new clean energy future and its progress on adapting a large, complex business for that future.

Understanding the complex process of strategy-driven business transformation requires a framework to connect actions to outcomes over the long-term. The model presented here was adapted from previous work (Lubin & Esty, The Sustainability Imperative, HBR, 2010) to assess a firm's progress in transitioning along a "climate impact management maturity curve." Total's climate related efforts can be traced back 20 years or more, and this historical review begins with their initial recognition of the challenges that climate change poses for a major energy company and the need to address them.

Stage 1: Initial Engagement – In 2006, Total was one of the first major fossil fuel companies to publicly acknowledge the importance of climate change as a global risk. Their initial efforts focused on implementing cost-effective approaches to significantly reduce flaring gas emissions.

Stage 2: Systematic Management – By 2008, Total lead other major oil companies in systematic reporting of GHG and climate-related performance metrics, including product use, and included initial target setting for improvements in the company's operational footprint.

Stage 3: Transforming the Core – In 2009, Total launched EcoSolutions, its low carbon products and services portfolio. With a series of investments in SunPower (solar), Saft (battery design), Stem (energy optimization) and BHC Energy (operational energy efficiency) Total committed to shifting its revenue base toward sustainable energy solutions.

Approaching Stage 4: Creating Competitive Differentiation – In 2014, under the leadership of Patrick Pouyanne, Total's new Chairman and CEO, the company fully articulated its strategy to differentiate itself from other oil companies. Going forward, Total would build its future business on three strategic pillars:

1) Reducing the carbon intensity of its fossil fuel product mix;

2) Investing judiciously in carbon capture, utilization and storage technologies; and

3) Expanding its business base in "renewables," which includes production, storage and the distribution of clean energy and biofuels.

In 2015, Total exited the coal business. Total's 2016 reorganization now drives a focus on renewables and low carbon energy solutions, setting policy support and goals aligned with the IPCC's 2°C target.

If Total is to realize the full potential of its competitive advantage in the energy sector, it will need to continue to demonstrate viable decarbonization pathways consistent with the 2-degree boundary. This will require continued rapid growth of its EcoSolutions portfolio revenues and leadership among the oil companies as they address the potential challenge of so called "stranded assets."

LEADERSHIP TRANSLATES INTO REDUCED GHG IMPACTS

The data show leadership. Total has reduced emissions over the last three years well ahead of IPCC guidance, with an approximate 20% aggregate decline (or roughly 130 million metric tons) in total GHG emissions across all scopes.[185] While emissions declined, Total's carbon intensity saw a 9.2% average annual rate of decline in GHG/BOE (greenhouse gas emissions/barrel of oil equivalent), between 2013 and 2016, or a cumulative decline of 27.5% from the baseline year of 2013.[186] Both aggregate emissions and the GHG intensity of Total's footprint are falling significantly.

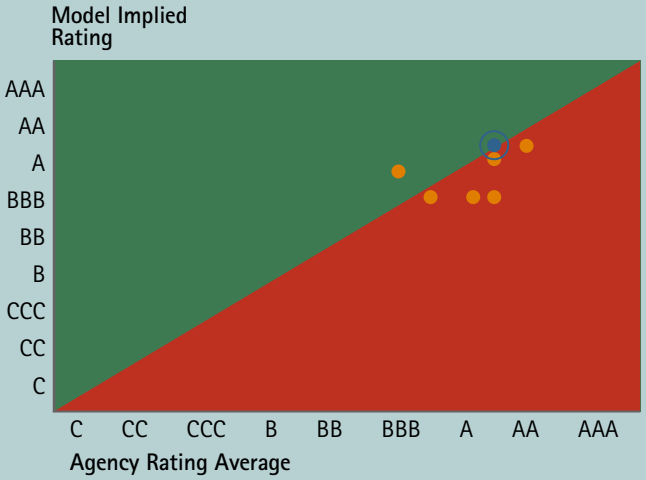
LEADERSHIP REFLECTED IN FINANCIAL OUTCOMES: REDUCED COST OF CAPITAL

Table 2 provides evidence that Total's strategy, along with their ability to execute it, is already generating value for the firm. Thomson Reuters's Eikon platform displays Total's peer-leading credit rating, represented by the blue dot in the peer-scatterplot below. This is a significant advantage in the capital-intensive energy sector. As Total continues to extend its climate impact leadership with more renewable and low carbon solutions, the increasing value of its transformed green product portfolio is likely to significantly outpace the potential declining value of its traditional high carbon products.

Table 2: Credit ratings among Total and its leading competitors, showing Total's competitive advantage on this metric.

PEER COMPARISON								EDIT PEERS
RIC	Company Name	Model Score	Probability of Default	Model Implied Rating	Agency	Component Scores		
					S&P/ Moody's	Structural Model	SmartRatios Model	Text Mining Model
TOTF.PA	Total SA	75	0.05%	A+	A+/-	71	47	51
RDSb.L	Royal Dutch Shell PLC	63	0.06%	A	A+/-	60	39	27
ENI.MI	Eni SpA	37	0.11%	BBB	BBB+/Baa1	39	12	29
BPL	BP PLC	33	0.12%	BBB	A-/A1	39	7	43
REP.MC	Repsol SA	49	0.09%	A-	BBB-/Baa2	53	18	30
STL.OL	Statoil ASA	37	0.11%	BBB	A+/-	36	16	16
GALP.LS	Galp Energia SGPS SA	80	0.04%	A+	-/-	51	79	75
CVX.N	Chevron Corp	72	0.05%	A+	AA-/Aa2	87	37	50
Peer Avg.		56	0.08%	BBB+	A-/A3	55	32	40

Source: Starmine, Thomson Reuters Eikon



This section has been contributed by "David Lubin, Constellation Research and Technology; John Moorhead, BSD Consulting; Timothy Nixon, Thomson Reuters.

The full "Global 250 Report, A New Business Logic", provides answers to the following questions as a changing climate disrupts markets and ecosystems:

1) Who are the 250 public companies and value chains which are responsible for the largest emissions of greenhouse gases?

2) Among this critical group, how are emissions trending by company over the past 3 years?

3) Is there evidence that decarbonization creates a drag on financial performance, or a premium?

4) Given the long-term transformation challenge confronting these large emitters, how can we assess a company's progress and define leadership?

5) How are policy and investor leadership evolving in a post-carbon economy?

The report will be available at: https://blogs.thomsonreuters.com/sustainability.

The case studies featured in this chapter highlight the diverse benefits that renewable energy and energy efficiency activities generate. These projects have catalyzed economic growth across all levels of development, creating opportunities for small construction firms and multinational companies. In improving air quality, reducing pollution, expanding energy access, and creating jobs, RE and EE efforts move the world closer to the 2030 Agenda's Sustainable Development Goals. Continued action across both developed and developing countries will also be vital to meeting the Paris Agreement's targets, and protecting these development gains. Partnerships among cities, regions, companies, civil society, and national governments can help leverage these actors' respective strengths, to further accelerate the development of RE and EE solutions.

4 1.5°C- AND 2°C-COMPATIBILITY: A NEW APPROACH TO CLIMATE ACCOUNTING

This chapter outlines a new approach that can be used to determine the compatibility of policies, individual projects, and entire sectors with scientific scenarios that limit global temperature rise to 1.5°C and 2°C. It provides sector-level compatibility tables and project-level guidance, and demonstrates how these criteria could be applied to individual RE and EE projects. Applying these compatability conditions to internationally supported RE and EE projects can help identify and develop specific policy recommendations to create the local and national conditions necessary for 1.5°C and 2°C-compatible pathways.

Mexico City, Mexico

Mexico City is greening its building sector through a combination of policy incentives and reforms.

→ *Details see page 30*

The final chapter of the 1 Gigaton Coalition 2016 report, "Chapter 6: A Path Forward: New Concepts for Estimating GHG Impacts," suggested an alternative approach to assessing climate outcomes at the project and sector levels. In addition to the problematic exercise of developing a counterfactual baseline (i.e., a business-as-usual scenario reflecting what would have happened in the absence of specific policy intervention or technology adoption), national governments' Paris pledges or nationally-determined contributions (NDCs) often overlap with other actions within countries, making it difficult to attribute specific emissions reductions to partner-supported activities.

For renewable energy (RE) projects, evaluating whether a technology or policy is compatible with science-based 1.5°C and 2°C scenarios can be straightforward. A wind farm, for instance, that offsets equivalent fossil-fuel based emissions from grid electricity would be 2°C-compatible. Energy efficiency (EE) projects are less straightforward: a certified zero energy house under the passive house standard is, for example, more in line with 2°C development than an energy efficient house that just exceeds current building standards. Secondary effects, however, will also need to be taken into consideration. If a bioenergy project leads to adverse land use effects and increased emissions through deforestation then this project may not be in line with a 2°C pathway. These significant secondary effects may not be captured using the GHG emissions reductions accounting method employed in the first two 1 Gigaton Coalition reports.

This chapter outlines a new approach that can be used to determine the compatibility of policies, individual projects, and entire sectors with scientific scenarios that limit global temperature rise to 1.5°C and 2°C. Drawing from other research initiatives and the International Energy Agency's (IEA) 2017 Energy Technologies Perspective (ETP) report, this chapter presents criteria for 1.5°C and 2°C-compatibility at the sector level. It also demonstrates how these criteria could be applied to RE and EE projects, drawing examples from the RE and EE database compiled for this report. Creating 1.5°C- and 2°Ccompatibility conditions and applying these standards to internationally supported RE and EE projects opens the door for researchers to make key inferences and conclusions, including:

- Evaluation of local and national conditions necessary for 1.5°C and 2°C-compatible pathways.
- Determination of additional efforts needed to make projects 1.5°C and 2°C compatible.
- Development of specific policy recommendations to address project- and sectorlevel issues that create 1.5°C and 2°C-incompatibilities.
- Sector level aggregation of emissions outcomes and resulting policy implications.

4.1 DEVELOPING 1.5°C AND 2°C-COMPATIBILITY CONDITIONS

A growing community of scientists, researchers, and policymakers have begun to develop metrics to assess sectors, companies, projects, and policies for their compatibility with global climate targets. The Climate Action Tracker (CAT), a scientific analysis produced by three independent research organizations – NewClimate Institute, Ecofys, and Climate Analytics – last year produced a list of ten short-term global targets that sectors need meet in order to limit warming to 1.5°C. These goals include building no new coal-fired power plants and reducing emissions from coal by 30% by 2025; ending the production of fossil fuel cars by 2035; constructing only fossil-free or near-zero energy buildings and quintupling renovation rates of existing structures by 2020; and achieving 100% renewable energy penetration in electricity production by 2050.[187]

Earlier this year CAT joined forces with a consortium of other research groups convened by former UNFCCC chair Christiana Figueres to produce an analysis of five of the heaviest emitting sectors. The resulting report, called "2020: The Climate Turning Point" and published under the collaborative's name "Mission2020", isolates short-term, sectoral targets that are necessary to meet the long-term 2°C climate goal. Giving context to CAT's list of ten sectoral targets, the Mission2020 report shows that these targets are achievable under current conditions and that meeting them would produce desirable economic and human health outcomes.[188]

Sector-level targets are key tools for governments and policymakers to plan, assess, and implement climate actions in reference to 1.5°C or 2°C goals. Applying global, sectoral objectives at the project level, however, requires another layer of analysis that incorporates a host of local considerations. Factors

pertaining to a locality's policies, economy, development level, energy mix, and deployed technologies need to be examined in order to develop appropriate and rigorous goals that are compatible with 1.5°C or 2°C pathways.

Science Based Targets (SBT) is a leading international initiative that strives to assess the complex conditions that determine 2°C compatibility at the firm or project level, helping private companies set their own science-based climate targets. A collaboration of the Climate Disclosure Project (CDP), United Nations Global Compact, World Resources Institute (WRI), and World Wildlife Fund (WWF), and with technical support from Ecofys, SBT aims to institutionalize climate target setting among firms in every sector. SBT considers GHG emission reduction targets to be "science-based" if they align with a level of decarbonization that the international scientific community has deemed necessary to keep global temperature rise below 2°C. Using at least one of SBT's seven methods for setting emission targets, 293 companies have applied to have their climate benchmarks verified, of which SBT has approved 61 firms' science-based targets.

The NewClimate Institute has also pioneered 2°C-compatibility methods and in November 2015 published a report, "Developing 2°C-Compatible Investment Criteria", in which the authors outline a methodology for investors to evaluate whether their investments are compatible with a science-based 2°C scenario.[189] Distilling complex science and policy issues into easy-to-understand "positive" and "negative" lists, NewClimate shows how investors could apply a compatibility approach to the projects they finance. Employing positive and negative lists that use quantitative and qualitative conditions to determine a project or sector's climate compatibility offers some relative advantages to a counterfactual baseline approach.

A positive and negative list approach incorporates minimum and dynamic quantitative benchmarks, giving clear markers of 2°C-compatibility and how these thresholds change over time. This process can also include decision trees and scoring methodologies that help lay-persons use the compatibility method. Central to creating positive and negative lists are the conditions that must be met to classify a project to either side. Developing these conditions requires the distillation of complex information into a malleable and understandable format. This balance of complexity and practicability is perhaps the compatibility approach's greatest strength.[190]

To develop meaningful compatibility conditions and positive and negative lists requires robust and current science. The IEA's Energy Technology Perspectives 2017 (ETP) provides the scientific backbone for this report's compatibility criteria as it also does for SBT's analytical tools.[191] ETP features three scenarios through the year 2060: a Reference Technology Scenario (RTS), representing energy and climate commitments made by countries, including Nationally Determined Contributions (NDCs) pledged under the Paris Agreement; a 2°C Scenario (2DS) and a Beyond 2°C Scenario (B2DS), which feature rapid decarbonisation measures, creating pathways that align with long-term climate goals. RTS illustrates explicit international ambitions, which do not produce emissions reductions compatible with stated global climate objectives. RTS would nonetheless represent a large emissions cut from a historical "business as usual" scenario. 2DS and B2DS are centered around 2°C and 1.75°C pathways, respectively, and depict scenarios in which clean energy technologies are pushed to practical limits. These scenarios align with some of the most ambitious aspirations outlined in the Paris Agreement.

This report synthesizes current research on climate compatibility and incorporates targets from ETP's 2DS and B2DS to create sector-level 1.5°C- and 2°C-compatibility criteria and conditions. Demonstrating how one could apply these conditions to RE and EE initiatives, graphical and flow-chart schematics are provided

for guidance, and an example project is drawn from a database of bilateral- and multilateral-supported projects that was compiled for this report. The challenges inherent to this approach are discussed, as well as how one might overcome these issues and the policy implications of results.

In May of 2017, the 1 Gigaton Coalition convened a meeting of climate policy experts in Bonn, Germany, initiating a dialogue to inform the development of 1.5°C- and 2°C compatibility criteria. Dialogue participants evaluated questions prepared by this report's authors and discussed research challenges. This section strives to address all of the most pertinent issues that came to the fore through the Bonn dialogue. Many of the challenges inherent to 1.5°C- and 2°C-compatibility are addressed in Tables 3.1 – 3.15 below, and potential methods for tackling those beyond the scope of this analysis are discussed.

Sector-level 1.5°C- and 2°C-compatibility tables were developed. The tables are categorized by sector, including by RE technology type and various sectors that are grouped under EE, a broad categorization encompassing transportation, buildings, and industry. Sectors are divided into sub-sectors where data availability allowed. There are clear science-based targets, for instance, for rail, shipping, and aviation, allowing the creation of compatibility criteria for these transportation sub-sectors. The tables do not represent every societal sector – agriculture, for example, is missing, as is hydropower. The compatibility analysis is therefore limited to this project's research scope as well as to the availability of scientific information. The tables are tools for assessing 1.5°C- and 2°C compatibility and they are also proofs of concept that can and should be expanded upon to the limits of current scientific knowledge.

The compatibility conditions in each table were largely drawn from the IEA's ETP 2017 and its 2DS and B2DS models. ETP's sectoral targets were cross-referenced with other scientific sources, and were in some cases altered according to the researcher's judgement. It should be noted that ETP's 2DS and B2DS models correspond to a 50 percent chance of limiting temperature increases to 2°C and 1.75°C, respectively, by the year 2100. This level of uncertainty carries over to the compatibility tables and should inform the perspective of those undertaking any science-based compatibility approach. In this analysis, the 1.5°C sectoral targets do not correspond precisely to 1.5°C of warming. The 1.5°C conditions are rather aspirational targets that align with a level of warming at least 0.25°C below 2°C. It would imply a false level of certainty to assert that the emissions targets and warming trajectories in this analysis precisely align with 1.5°C or 2°C of warming. There are also drawbacks inherent to using one report, ETP, as the backbone of the analysis. The compatibility conditions are, however, based on the most current and robust science available, and it is believed they provide the best estimate for 2°C and below 2°C pathways.

4.2 COMPATIBILITY TABLES

Key factors to consider when reading the sectoral Compatibility Tables (Tables 3.1 – 3.15):

- All compatibility conditions must be met for a sector to be positive listed (i.e. compatible).
- Yet the suites of conditions in this analysis do not mean to be comprehensive: there may be other conditions or a suite of conditions that must be met under alternative 1.5°C and 2°C scenarios.
- 1.5°C compatibility conditions are inclusive of 2°C conditions unless otherwise noted.
- 1.5°C and 2°C compatibility conditions are combined for some sectors depending on data availability – this analysis does not distinguish between 1.5°C and 2°C compatibility in these cases.
- Enabling policies are considered to be required for positive listing, except in instances in which effective proxy policies are in place.
- Conditions are considered met when sectors, firms, or policies demonstrate alignment with long-term, global targets. See Figures 7 – 10 for illustrations of this alignment.

Table 3.1. Renewable energy-powered electricity production aggregate sector-level 1.5°C- and 2°C-compatibility conditions.

Renewable Power: Aggregate	Compatibility Conditions	Enabling Policies
2°C	RE accounts for 72% of global energy mix by 2060. Electricity accounts for ~35% final energy demand by 2060. $61 trillion cumulative investment to decarbonize power sector – 2/3 of this investment in non-OECD countries. $34 trillion of investment goes to renewable power generation technologies (tripling of annual average). Early retirement of coal-fired power plants. Annual investment in transmission doubles by 2025 compared to 2014. >2,000 GW transmission capacity deployed by 2060. Large-scale R&D and deployment of electricity storage technologies. R&D and deployment of carbon negative technologies including BECCS, which achieves 2% share of electricity generation by 2060. Deployment of comprehensive demand-side management systems. Variable renewable energy integration with natural gas baseload systems. Triple investment in interconnected high-voltage transmission from 2015 levels by 2025. Power sector achieves near-full decarbonization by 2050.	Carbon pricing. Renewable power investment incentives. Transparent disclosure of climate vulnerability to investors and stakeholders. Policies promoting systemic integration. Retirement of coal-fired power facilities. Shift of investment priorities from coal-fired power to renewables, natural gas, and CCS technologies.
1.5°C	Accounts for 75% of energy mix by 2060. 1,000 PWh cumulative RE electricity generation through 2060. Electricity accounts for >40% final energy demand by 2060. Power sector achieves full decarbonization by 2050 and is carbon negative thereafter. CCS systems account for >10% of total electricity production by 2050 (including BECCS). BioEnergy with CCS achieves 4% share of electricity generation by 2060. Nuclear has 15% share of electricity generation by 2060.	

Table 3.2. Renewable energy-powered electricity production disaggregated sector-level 1.5°C- and 2°C-compatibility conditions.

Renewable Power: Sectors	Compatibility Conditions	Enabling Policies
SOLAR	**Photovoltaics (PV)** ▪ Achieves 17% of energy mix by 2060. ▪ >1,000 TWh of annual power produced by 2025. ▪ 4,400 GW capacity by 2050; 6,700 GW capacity by 2060. ▪ 4x increase in annual capacity additions by 2040. ▪ Investment costs for GW capacity decrease by two-thirds by 2060 compared to 2015. ▪ $11 trillion cumulative investment through 2060.	Carbon pricing. Renewable power investment incentives. Transparent disclosure of climate vulnerability to investors and stakeholders. Policies promoting systemic integration. Retirement of coal-fired power facilities. Shift of investment priorities to from coal-fired power to renewables, natural gas, and CCS technologies.
	Solar Thermal ▪ Achieves 10% energy mix by 2060. ▪ 160 TWh of annual power produced by 2025. ▪ Increased deployment for industrial applications. ▪ $6 trillion cumulative investment through 2060.	
WIND	▪ 20% of energy mix by 2060. ▪ Onshore: 2,400 TWh annual power produced by 2025. ▪ Offshore: 225 TWh annual power produced by 2025. ▪ 10,500 TWh produced by 2060. ▪ 3,400 GW capacity by 2050. ▪ 4,200 GW capacity by 2060. ▪ Investment costs per GW capacity decrease by ~18% compared to 2015. ▪ $11 trillion cumulative investment through 2060.	
BIOENERGY	▪ 24% of energy mix by 2060. ▪ Energy output doubles to around 145 EJ by 2060. ▪ Increased integration of advanced biomass with industrial processes. ▪ 100% sustainably sourced by 2060. ▪ Net negative carbon source by 2060.	
GEOTHERMAL	▪ 220 TWh annual power produced by 2025. ▪ Increased integration with industrial processes.	

Table 3.3. Industry aggregate sector-level 1.5°C- and 2°C-compatibility conditions.

Industry: Aggregate	Compatibility Conditions	Enabling Policies
2°C	Global direct emissions from industry are halved by 2060. Immediate adoption of ISO-certified energy management system (EMS). Industrial energy consumption growth limited to 0.3% annually (~90% decrease from 2000 - 2014 average). ~30% improvement in industrial energy intensity by 2060. Demonstrated BAT implementation. Portion of fossil fuel sources declines by >4% annually through 2030. Shift toward higher proportion of renewables-powered electrification (on- and off-site) as end-use energy source. Improved material yields across supply chain; improved inter-industry material efficiencies.	Energy and material efficiency standards. Policies that improve scrap collection and recycling rates. Incentives for BAT adoption. Remove fossil fuel subsidies. Catalyzing investment for R&D and commercialization of new technologies. Improve data reporting and collection. Carbon pricing. Large scale shifts in investment. Develop advanced life-cycle assessments for industrial inputs and products.
1.5°C	Global direct emissions from industry are reduced by 80% by 2060. Industrial energy consumption growth limited to 0.2% annually (>90% decrease from 2000 – 2014 average). >30% improvement in industrial energy intensity by 2060. Demonstration of zero- and negative- carbon technologies. Proportion of fossil fuel sources declines by >7% annually through 2030. Electrification in industrial operations increases ~27% by 2060 and electrical power use is 98% decarbonized by 2060 compared with present levels.	

Table 3.4. Industry: cement disaggregated sector-level 1.5°C- and 2°C-compatibility conditions.

Industry: Cement	Compatibility Conditions	Enabling Policies
2°C	Direct carbon intensity decreases by ~10% by 2030. 10% carbon captured by 2030 towards 30% captured by 2060. Diminished use of coal as source of energy for cement production, so coal is <50% of energy mix by 2060. Increase use of cement clinker substitution materials.	Energy and material efficiency standards. Policies that improve scrap collection and recycling rates. Incentives for BAT adoption. Remove fossil fuel subsidies. Catalyzing investment for R&D and commercialization of new technologies. Improve data reporting and collection. Carbon pricing. Large scale shifts in investment. Develop advanced life-cycle assessments for industrial inputs and products.
1.5°C	Direct carbon intensity decreases by >20% by 2030. 25% carbon captured by 2030 towards >75% captured by 2060. Diminished use of coal as source of energy for cement production, so coal is one-third of energy mix by 2060. 10% reduction in clinker ratio by 2060.	

Table 3.5. Industry: iron and steel disaggregated sector-level 1.5°C- and 2°C-compatibility conditions.

Industry: Iron and Steel	Compatibility Conditions	Enabling Policies
2°C	30% reduction in CO_2 intensity of crude steel production by 2030 compared with 2014. Aggregate energy intensity of crude steel production reduced by 25% by 2030 compared with 2014 levels. >10% carbon captured by 2025 towards 40% captured by 2060. 50% of energy used for crude steel production is from electricity, natural gas, and sources other than coal by 2060. Improved metal scrap reuse and recycling; towards 100% end-use scrap recycling.	Energy and material efficiency standards. Policies that improve scrap collection and recycling rates. Incentives for BAT adoption. Remove fossil fuel subsidies. Catalyzing investment for R&D and commercialization of new technologies. Improve data reporting and collection. Carbon pricing. Large scale shifts in investment. Develop advanced life-cycle assessments for industrial inputs and products.
1.5°C	>90% reduction in annual emissions by 2060. 50% reduction in CO_2 intensity of crude steel production by 2030 compared with 2014. Aggregate energy intensity of crude steel production reduced by one-third by 2030 compared with 2014 levels. >20% carbon captured by 2025 towards 80% captured by 2060. >50% of energy used for crude steel production is from electricity, natural gas, and sources other than coal by 2060.	

Table 3.6. Industry: chemicals and petrochemicals disaggregated sector-level 1.5°C- and 2°C-compatibility conditions.

Industry: Chemicals and Petrochemicals	**Compatibility Conditions**	**Enabling Policies**
2°C	Annual emissions < 1 $GtCO_2$ in 2060. Depending on chemical produced, emissions intensity decrease by between ~15% and 40% by 2030. Reduced aggregate energy intensity; amount reduced depends on energy expenditure on CCS. >15% carbon captured by 2025 towards 30% captured by 2060. Waste plastic recycling increases to >40% by 2060.	Energy and material efficiency standards. Policies that improve scrap collection and recycling rates. Incentives for BAT adoption. Remove fossil fuel subsidies. Catalyzing investment for R&D and commercialization of new technologies. Improve data reporting and collection. Carbon pricing. Large scale shifts in investment. Develop advanced life-cycle assessments for industrial inputs and products.
1.5°C	Annual emissions decrease by 70% from 2015 levels by 2060 (reaching ~320 Mt CO_2). Depending on chemical produced, emissions intensity decrease by between ~25% and 60% by 2030. >25% carbon captured by 2025 towards 90% captured by 2060.	

Table 3.7. Industry: pulp and paper disaggregated sector-level 1.5°C- and 2°C-compatibility conditions.

Industry: Pulp and Paper	**Compatibility Conditions**	**Enabling Policies**
2°C	CO_2 intensity is cut by ~40% by 2030 and reduced by ~75% by 2060 compared to 2014 levels. 28% reduction in energy intensity by 2060 compared to 2014 levels. Deployment of Best Available Technologies (BAT) as well as low-carbon and CCS technologies. Substitute heat, biomass, and electricity for fossil fuel energy supply. 66% end-use paper product recycling by 2060.	Energy and material efficiency standards. Policies that improve scrap collection and recycling rates. Incentives for BAT adoption. Remove fossil fuel subsidies. Catalyzing investment for R&D and commercialization of new technologies. Improve data reporting and collection. Carbon pricing. Large scale shifts in investment. Develop advanced life-cycle assessments for industrial inputs and products.
1.5°C	CO_2 intensity is cut in half by 2030 and reduced by >90% by 2060 compared to 2014 levels. 30% reduction in energy intensity by 2060 compared to 2014 levels. 66% end-use paper product recycling by 2060.	

Table 3.8. Buildings aggregate sector-level 1.5°C- and 2°C-compatibility conditions.

Industry: Buildings	Compatibility Conditions	Enabling Policies
2°C	Specific building energy use between 10 - 150 kWh/m² or under 4 MWh/person. 1.5% annual improvement in building envelope performance. Limit global energy demand to 130 EJ. Shift to electrification to supply ~70% of final energy consumption in buildings globally by 2060. Renewables (on- and off-site) supply >85% of final energy consumption by 2060. Shift to BAT electric heat pumps in temperate climates. Aim to achieve 350% efficiency improvement in cooling equipment and 120% efficiency improvement for heating equipment, with further improvements through 2060. Immediate scaling up to 3% renovation rate (global average). Retrofits improve energy intensity by at least 30% with plan to move to "near-zero" energy use.	Mix of policy and financial incentives and requirements for energy efficient construction, deep renovations, and BAT uptake. Strong Mandatory Energy Performance (MEP) targets for all buildings and financial penalties for substandard performance. Upfront financial incentives (e.g. rebates, tax breaks, guaranteed loans). Comprehensive support for BATs. Special emphasis given to heating and cooling demand efficiency in cold and hot climates, respectively. In countries with large portion of 2060 building stock to be new construction, MEPs, integrated efficiency policies, and incentives for near-zero energy building construction (nZEBs) are given weight. In countries with large portion of 2060 building stock already built, renovation policies are given weight. Integrated urban planning that encompasses construction that increasing building lifetime and reducing secondary and tertiary emissions. Policies designed to develop a robust market for high-efficiency building construction, renovations, and BAT uptake.
1.5°C	Specific building energy use under 3.5 MWh/person. Decrease energy demand by around 0.2% annually through 2060 to around 114 EJ. Shift to electrification to supply ~70% of final energy consumption in buildings globally and near total elimination of fossil power. Renewables supply >95% of final energy consumption. Immediate scaling up to 5% renovation rate (global average). Retrofits improve energy intensity by at least 50% with plan to move to "near-zero" energy use.	

Table 3.9. Transportation aggregate sector-level 1.5°C- and 2°C-compatibility conditions.

Transportation: Aggregate	Compatibility Conditions	Enabling Policies
2°C	54% GHG reductions by 2060 compared to 2015 (75% in OECD countries; 29% in non-OECD countries). Move toward electrification, biofuels, and full decarbonization by 2060. Efficiency improvements (systemic, technological, material, and fuel) that reduce life-cycle energy intensity by more than half. Intermodal shifts (e.g. replace aviation with high speed rail).	Regulatory GHG targets at national and international level. Fuel, technological, and material efficiency standards. Mandates and financial incentives/support for BAT adoption. Elimination of fossil fuel subsidies. Carbon pricing and fuel taxes. Regulations and financial incentives supporting transition to zero-emission vehicles and electrification of transport modes. Alternative fuel development and technological R&D. Demand management. Intermodal and systemic planning. R&D support for zero- and negative-emission technologies and infrastructure. Systemic data collection and organization on policy effectiveness.
1.5°C	83% GHG reductions by 2060 compared to 2015 (95% in OECD countries; 72% in non-OECD countries).	

Table 3.10. Transportation: Bus disaggregated sector-level 1.5°C- and 2°C-compatibility conditions.

Transportation: Bus	Compatibility Conditions	Enabling Policies
2°C	Large-scale adoption of electric engines and other zero-emission technologies. Implementation of negative cost efficiency measures, including technological upgrades. Intermodal shifts from light-duty vehicles (LDV) to buses. Passenger kilometers more than double through 2060.	Regulatory GHG targets at national and international level. Fuel, technological, and material efficiency standards. Mandates and financial incentives/support for BAT adoption. Elimination of fossil fuel subsidies. Carbon pricing and fuel taxes. Alternative fuel development and technological R&D. Regulations and financial incentives supporting transition to zero-emission vehicles and electrification of transport modes. Demand management. Intermodal and systemic planning. R&D support for zero- and negative-emission technologies and infrastructure. Systemic data collection and organization on policy effectiveness.
1.5°C	80% energy efficiency improvement by 2060 (urban). 47% energy efficiency improvement by 2060 (intercity). Passenger kilometers nearly triple through 2060.	

Table 3.11. Transportation: Rail disaggregated sector-level 1.5°C- and 2°C-compatibility conditions.

Transportation: Rail	Compatibility Conditions	Enabling Policies
2°C	Full electrification by 2060. Passenger kilometers more than triple through 2060. Intermodal shifts from aviation and LDV to high-speed rail and light rail. Rail's share of transport activities increases from 10% to 15%.	Regulatory GHG targets at national and international level. Fuel, technological, and material efficiency standards. Mandates and financial incentives/support for BAT adoption. Elimination of fossil fuel subsidies. Carbon pricing and fuel taxes. Regulations and financial incentives supporting transition to zero-emission vehicles and electrification of transport modes. Demand management. Intermodal and systemic planning. R&D support for zero- and negative-emission technologies and infrastructure. Systemic data collection and organization on policy effectiveness.
1.5°C	100% light rail electrification by 2045. Passenger kilometers increase sixfold through 2060. Rail's share of transport activities about doubles from ~10% to ~20%.	

Table 3.12. Transportation: Aviation disaggregated sector-level 1.5°C- and 2°C-compatibility conditions.

Transportation: Aviation	Compatibility Conditions	Enabling Policies
2°C / 1.5°C	50% reduction from 2005 levels by 2050. 70% reduction in direct emissions by 2060, without offsets. Shift to ~70% advanced biofuels by 2060. 2.5% annual reduction in specific energy use per passenger kilometer. Intermodal shifts away from aviation toward high speed rail.	Regulatory GHG targets at national and international level. Fuel, technological, and material efficiency standards. Mandates and financial incentives/support for BAT adoption. Elimination of fossil fuel subsidies. Carbon pricing and fuel taxes. Regulations and financial incentives supporting transition to zero-emission vehicles and electrification of transport modes. Alternative fuel development and technological R&D. Demand management. Intermodal and systemic planning. R&D support for zero- and negative-emission technologies and infrastructure. Systemic data collection and organization on policy effectiveness.

Table 3.13. Transportation: Shipping disaggregated sector-level 1.5°C- and 2°C-compatibility conditions.

Transportation: Shipping	Compatibility Conditions	Enabling Policies
2°C	Steady emissions through 2030. 25% emissions reduction through 2060. 2.8% annual reduction in specific energy use per tonne kilometer through 2060. 62% improvement over 2010 levels in energy per efficiency by 2060 (except only 53% for container ships). Continuous ship capacity growth through 2060: container ships 0.9%; bulk carriers 0.4%; general cargo 0.6% (annual rates).	Regulatory GHG targets at national and international level. Fuel, technological, and material efficiency standards. Mandates and financial incentives/support for BAT adoption. Elimination of fossil fuel subsidies. Carbon pricing and fuel taxes. Regulations and financial incentives supporting transition to zero-emission vehicles and electrification of transport modes. Alternative fuel development and technological R&D. Broad retrofit program. Demand management. Intermodal and systemic planning. R&D support for zero- and negative-emission technologies and infrastructure. Systemic data collection and organization on policy effectiveness.
1.5°C	Emissions reductions beginning in 2020; 50% reductions through 2060. Shift to 50% advanced biofuels by 2060.	

Table 3.14. Transportation: Trucking disaggregated sector-level 1.5°C- and 2°C-compatibility conditions.

Transportation: Trucking	Compatibility Conditions	Enabling Policies
2°C	78% reduction in road freight emissions by 2060, compared to 2015. Ultra-low and zero-carbon engines achieve majority share in global trucking fleet by 2050. Large-scale logistics and vehicle utilization improvements.	Regulatory GHG targets at national and international level. Fuel, technological, and material efficiency standards. Mandates and financial incentives/support for BAT adoption. Elimination of fossil fuel subsidies. Carbon pricing and fuel taxes. Regulations and financial incentives supporting transition to zero-emission vehicles and electrification of transport modes. Demand management. Intermodal and systemic planning. R&D support for zero- and negative-emission technologies and infrastructure. Systemic data collection and organization on policy effectiveness.
1.5°C	>78% reduction in road freight emissions by 2060, compared to 2015. >20% energy supplied by low-carbon fuels by 2060 with complimentary zero-emission technologies.	

Table 3.15. Transportation: Light-duty vehicles disaggregated sector-level 1.5°C- and 2°C-compatibility conditions.

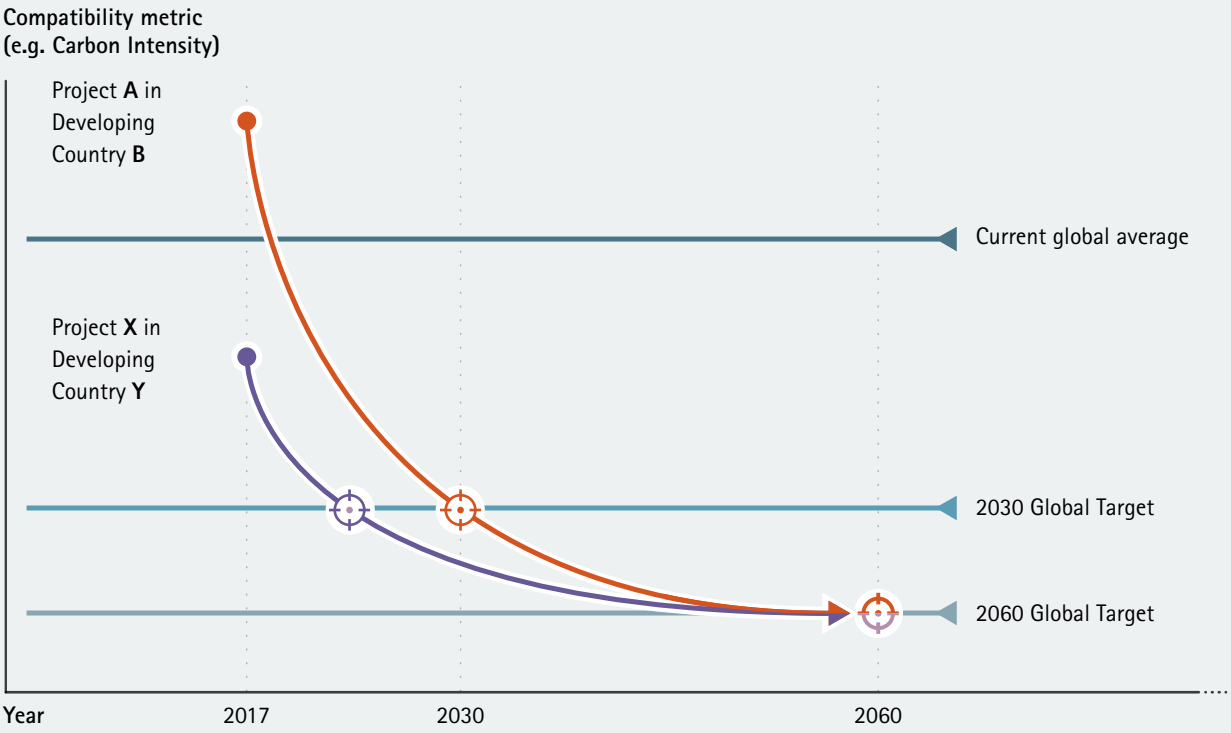
Transportation: Light-Duty Vehicles	Compatibility Conditions	Enabling Policies
2°C	30% fuel efficiency improvement in all new cars in OECD countries by 2020. 50% fuel efficiency improvement in all new cars globally by 2030. 50% fuel efficiency improvement in all cars globally by 2050.	Regulatory GHG targets at national and international level. Fuel, technological, and material efficiency standards. Mandates and financial incentives/support for BAT adoption. Elimination of fossil fuel subsidies. Carbon pricing and fuel taxes. Regulations and financial incentives supporting transition to zero-emission vehicles and electrification of transport modes. Policies that increase cost of ownership of petroleum LDVs and decrease cost of ownership of zero-emission LDVs. Demand management. Intermodal and systemic planning. R&D support for zero- and negative-emission technologies and infrastructure. Systemic data collection and organization on policy effectiveness.
1.5°C	>50% of LDVs are non-combustion engine vehicles by 2050. 90% of all cars are plug-in hybrids. All new vehicles by 2030 will have fuel efficiency equal to 4 litres per 100 km (in accordance with the Worldwide harmonized Light vehicles Test Procedure (WLTP)). 40% of all new vehicles of all kinds are "ultra-low" or "zero emission" by 2030. 13% of new LDVs are PEVs in OECD and China by 2020; 32% by 2030. >70% of all energy use by LDVs is electric by 2060. Electric driving share for plug-in hybrid electric vehicles (PHEVs) increase to 50% by 2020 and 80% by 2030.	

4.3 PROJECT-LEVEL COMPATIBILITY

Assessing project level compatibility with 1.5°C- and 2°C goals is a significantly more challenging task than establishing sector level targets. To determine an individual project, firm, or policy's compatibility with global climate goals requires greater subjectivity than do appraisals of sectors, as one must consider local heterogeneity – a mix of factors that high-level targets do not specifically address. Actions are undertaken at the local level, and a compatibility analysis strives to link these actions, with all their particularities, to global phenomena. Development level is perhaps the most challenging local factor to account for.

Every project or policy takes shape in a particular development context, with financial, economic, technological, and knowledge barriers that can vary greatly from country to country and case to case. Development trajectories also differ greatly depending on locality, and these trajectories are crucially important to determining 1.5°C- and 2°C-compatibility pathways. Reconciling climate goals with national and international development priorities is a critical component of 1.5°C- and 2°C-compatibility analyses, and this process remains a difficult hurdle for many countries to overcome.

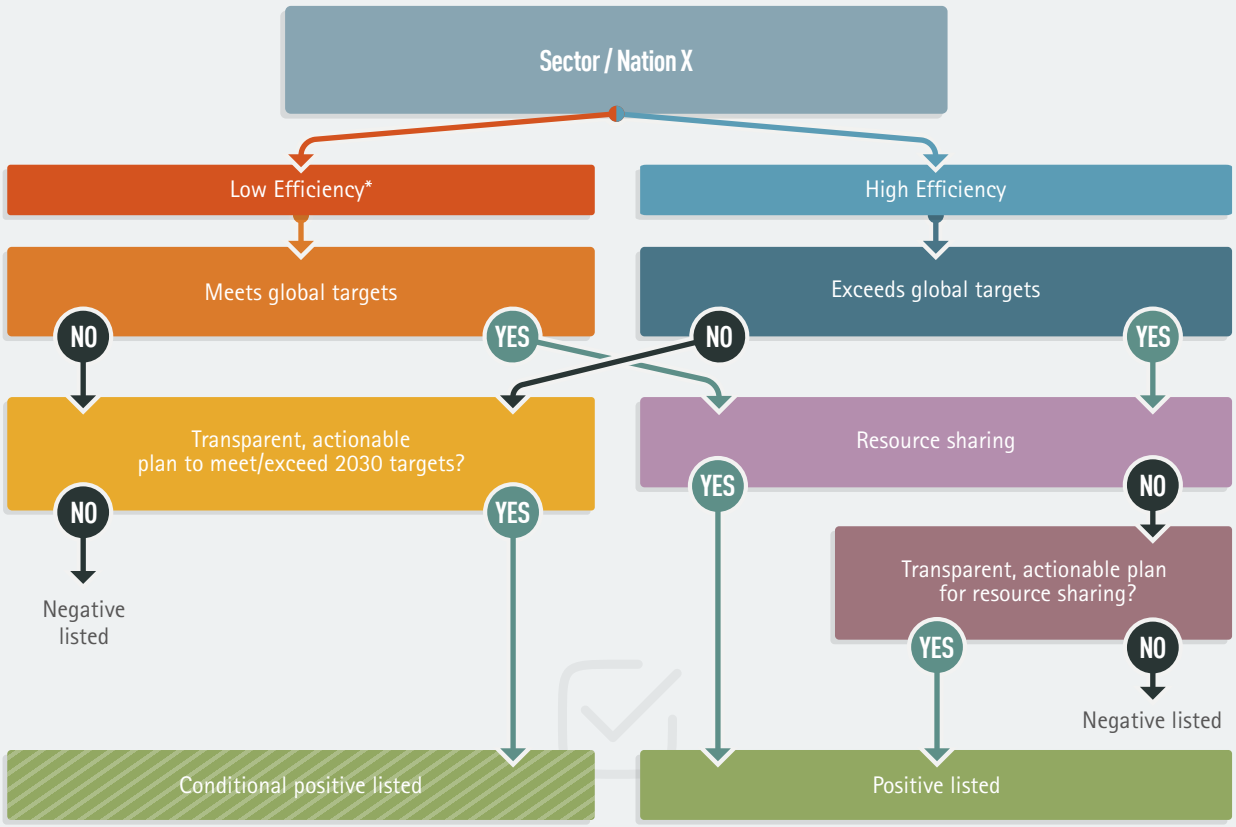
Figure 6: Graphical schematic showing how projects of the same type in separate development contexts could achieve 1.5°C- or 2°C-compatibility.



Source: Authors, 1 Gigaton Coalition Report 2017

Figures 7 - 10 present a suite of schematics that illustrate how a project, firm, policy, sector, or nation could demonstrate 1.5°C- and 2°C-compatibility and become positive listed. In this analysis, complete access to information – on project inputs and operations, for instance – is prerequisite for any policy, project, or entity to be positive listed. In the schematics, nations, sectors, and projects employing best available technologies (BATs) and producing output at or near maximum efficiency are considered "high efficiency" and are held to stricter conditions than "low efficiency" activities. Nations and sectors with adequate resources – including all OECD countries and sectors therein – would be required to have in place a plan for resource sharing with less developed countries, sectors, and project implementers in order to achieve positive listing. Precise resource sharing levels would have to be determined on a case by case basis, requiring climate policy experts and scientists to facilitate international cooperation. These schematics underscore the importance of both quantitative and qualitative criteria when determining 1.5°C- and 2°C compatibility. Rather than supplanting human judgment, this exercise shows the need for subjective decisionmaking, as most project and sectoral compatibility hinges on transparent and actionable planning as well as complex, cross-sector interactions that are not captured in this report's tables and schematics.

Figure 7: Decision tree schematic that could inform whether a sector or nation is positive listed for 1.5°C- or 2°C-compatibility

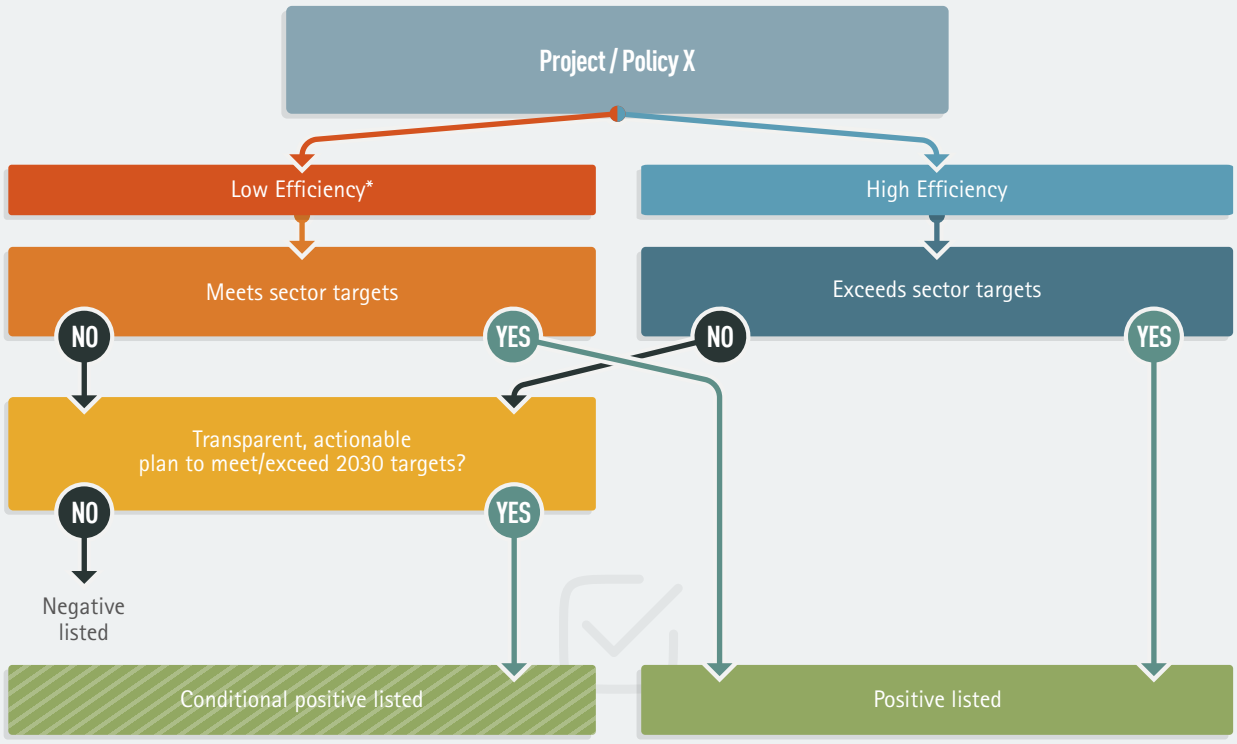


*Characterized by low income and rapid development trajectory, limited use of BATs

Note that sectors in high efficiency, developed national contexts would have to exceed global targets to be positive listed, thereby balancing out less efficient sectors in developing countries.

All nations or sectors that currently meet or exceed global targets would have to demonstrate a transparent, actionable plan to share resources with those not currently meeting global targets in order to be positive-listed.

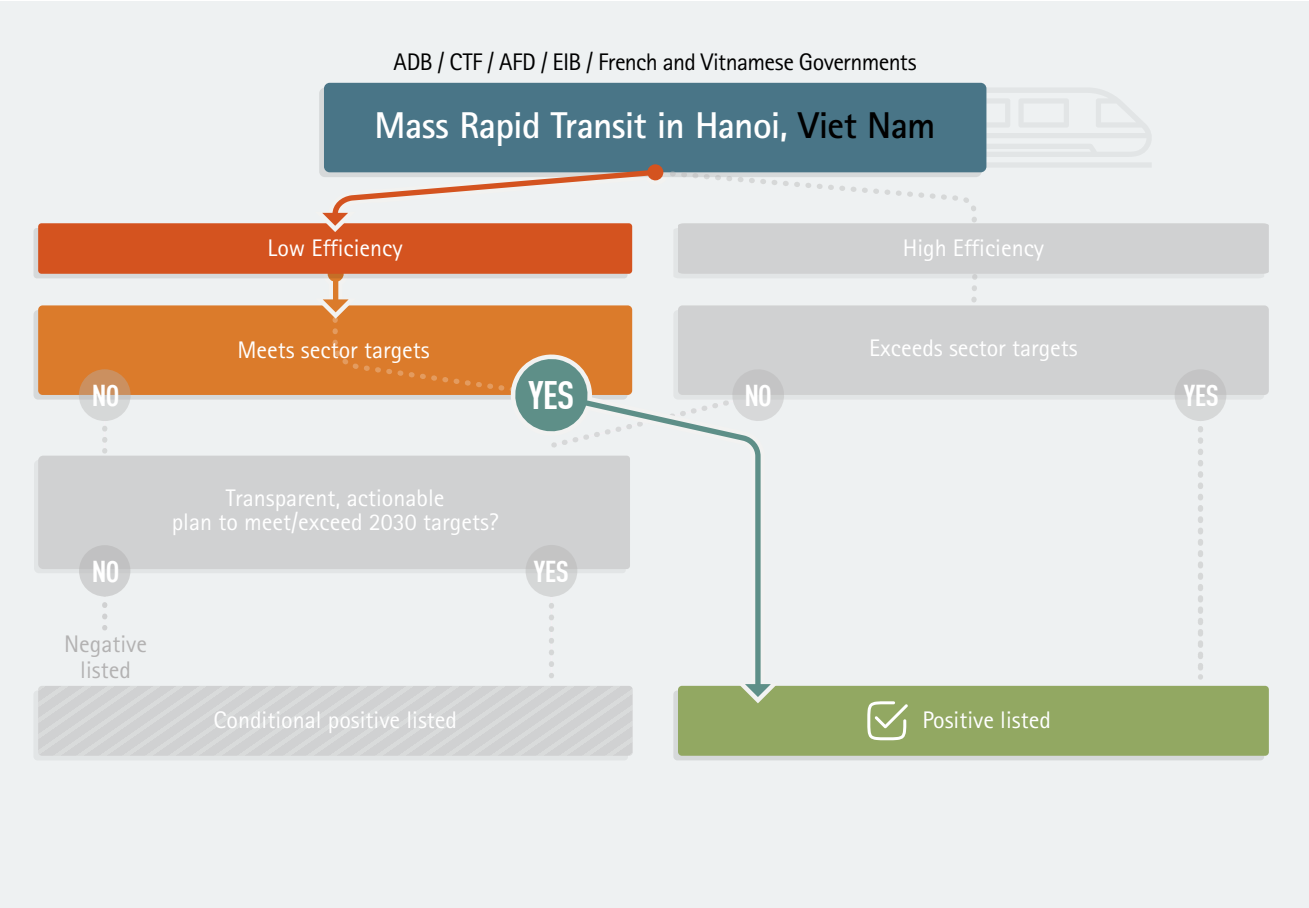
Figure 8: Decision tree schematic that could inform whether a project or policy is positive listed for 1.5°C- or 2°C-compatibility



*Characterized by low income and rapid development trajectory, limited use of BATs

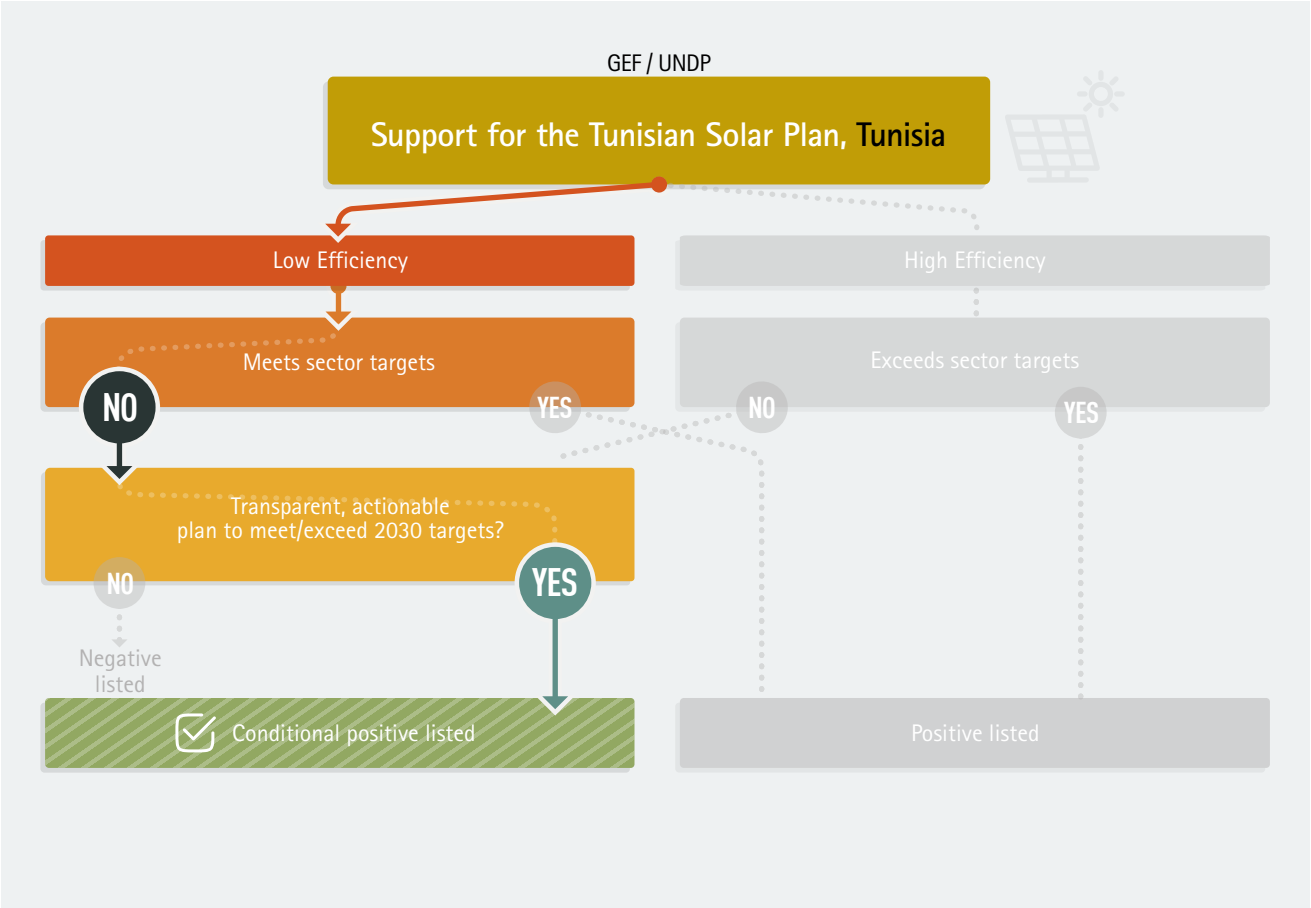
Note that projects in high efficiency, developed national contexts would have to exceed global targets to be positive listed, thereby balancing out low efficiency projects in developing countries.

Figure 9: A recently-approved Mass Rapid Transit (MRT) project based in Hanoi, was chosen for a demonstration of the decision tree schematic.



With more than $1.5 billion in approved funding, this project is jointly supported by the World Bank's Clean Technology Fund (CTF), administered via the Asian Development Bank (ADB); a CTF loan; the Agence Française de Développement (AFD); the European Investment Bank (EIB); the French government's Direction Générale du Trésor; and the Vietnamese government's counterpart funds. The project is classified as "low efficiency" due to its developing nation context, and its location's general lack of public transit. With plans to meet daily demand of 157,000 passengers by 2018 and 458,000 passengers by 2038, ADB estimates that the project will mitigate an average of 33,150 tCO_2e annually through 2038. These demonstrable goals are considered to meet the sector-level 1.5°C- and 2°C-compatibility conditions for rail (see Table 1.10), particularly the passenger kilometers (pkm) metrics (threefold pkm increase for 2°C-compatibility and sixfold pkm increase for 1.5°C-compatibility). With no MRT currently running in Hanoi, this project is a massive improvement on the status quo, especially considering Vietnam's status as a low-income nation.[192]

Figure 10: Approved in 2013, a project supporting the development of the Tunisian Solar Plan was chosen for a demonstration of the decision tree schematic.



With more than $3.5 million in grants from the Global Environment Facility (GEF) and UNDP and more than $63 million in public and private co-financing, the Plan includes one 10 MW solar PV plant and one 24 MW wind farm as demonstration projects and has a target of achieving 30% RE penetration by 2030. This meets most of the 1.5°C- and 2°C-compatibility conditions for RE, Solar PV, and Wind power (see Tables 1.1 and 1.2). Yet this 2030 energy mix goal falls short of the global 2060 targets. The Tunisian Solar Plan fits well within the sector's enabling policies goal, and considering Tunisia's status as a low-income nation, this project is conditionally positive listed as 1.5°C- and 2°C-compatible. This initiative, however, is a prime example of a policy ripe for positive influence and aid from funders and outside governments. Considering Tunisia's rich solar and wind resources, the country's national plan should be expected to incorporate a greater mix of RE in the long term.[193]

5 DATABASE ASSESSMENT

Building from a custom 600-project database compiled for the second 1 Gigaton Coalition report, this report has expanded the analysis to assess 273 of these projects, including 197 renewable energy (RE), 62 energy efficiency (EE), and 14 classified as having both RE and EE components. With implementation dates ranging from 2005 through 2016, the projects are found in 99 countries. Of the 273 projects, 100 are supported by 12 bilateral institutions and firms in 10 different countries, and another 173 projects are supported by 16 multilateral development banks and partnerships. Project-level data were collected from these organizations, including information on assistance levels, energy capacity, energy savings, supported technologies, and impact evaluation methodologies. The resulting database was not intended to include all of the developing world's RE and EE efforts, but instead exhibits a representative cross-section of bilateral- and multilateral supported projects.

Valle De Cauca, Colombia

Across Colombia's Valle del Cauca region, entrepreneurs are transforming their firms into green businesses.

→ *Details see page 28*

The projects encompass every sector taken into evaluation for 1.5°C- and 2°C compatibility, including wind and solar power generation; geothermal, small hydro, and biomass; energy efficiency in buildings; rapid public transit systems; electric vehicle deployment; electricity transmission; industrial efficiency; and other sub-sectors. The sample of internationally supported RE and EE projects in developing countries will reduce emissions by approximately 258 million tons carbon dioxide ($MtCO_2$) annually in 2020. Total emissions reductions from internationally supported RE and EE projects from 2005 through 2015 could be up to 600 $MtCO_2e$ per year in 2020 if the sample's emissions reductions are scaled up to a global level using total bilateral and multilateral support figures for RE and EE (US $76 billion).

After a historic year in 2015, when global investments in renewable energy (RE) projects reached a record high of $286 billion, new investment in renewables (excluding large hydro) fell to $242 billion in 2016. In developed economies, new investments decreased by 14% to $125 billion, while in developing economies, they went down by 30% to $116.6 billion.[194] The decrease in investment is explained by two main factors. First, solar photovoltaics, onshore wind and offshore wind saw more than 10% decreases in average dollar capital expenditure per capacity. These technologies have become more cost-competitive. Second, financing slowed in China, Japan and some emerging markets. Across different renewable technologies, solar capacity additions rose from 56 GW to a historic-high 75 GW, while wind capacity additions slowed down to 54 GW compared to 63 GW in 2015. Overall, the total amount of new capacity installed increased from 127.5 GW in 2015 to a record 138.5 GW in 2016. For two years in a row, renewable power comprised more than half of the world's added electric generation capacity. Investment in energy efficiency also rose 9% to $231 billion in 2016.[195]

Bilateral and multilateral development aid organizations have for decades played a key role in energy projects in developing countries.[196] From 2004 to 2014, development institutions in OECD countries financed more than US $247 billion for RE and EE projects in developing nations. Bilateral development finance institutions, such as Norway's Norfund, and bilateral government agencies, such as Japan International Cooperation Agency (JICA), are the vehicles for state-sponsored foreign investments. Multilateral development banks (MDBs), including the Asian Development Bank (ADB) and European Investment Bank (EIB), have joined forces to finance RE and EE projects throughout the developing world, investing more than US$100 billion from 2004 - 2014, according to OECD estimates.[197] These groups also build policy and administrative capacity among governments and businesses in recipient countries. According to OECD estimates, they invested US $4.7 billion in energy policy and administrative management in 2014, more than any other recipient sector besides electricity transmission and distribution.[198]

5.1 AGGREGATED IMPACT

This section seeks to build on the 1 Gigaton Coalition 2016 Report and update the evaluation of emissions impact of bilateral- and multilateral-supported RE and EE projects in developing countries implemented from 2005 – 2016.[199] Project-level data were collected from organizations, including information on assistance levels, energy capacity, energy savings, supported technologies, and impact evaluation methodologies. The resulting database was not intended to include all RE and EE efforts in developing countries, but instead exhibited a representative cross-section of bilateral- and multilateral-supported projects.

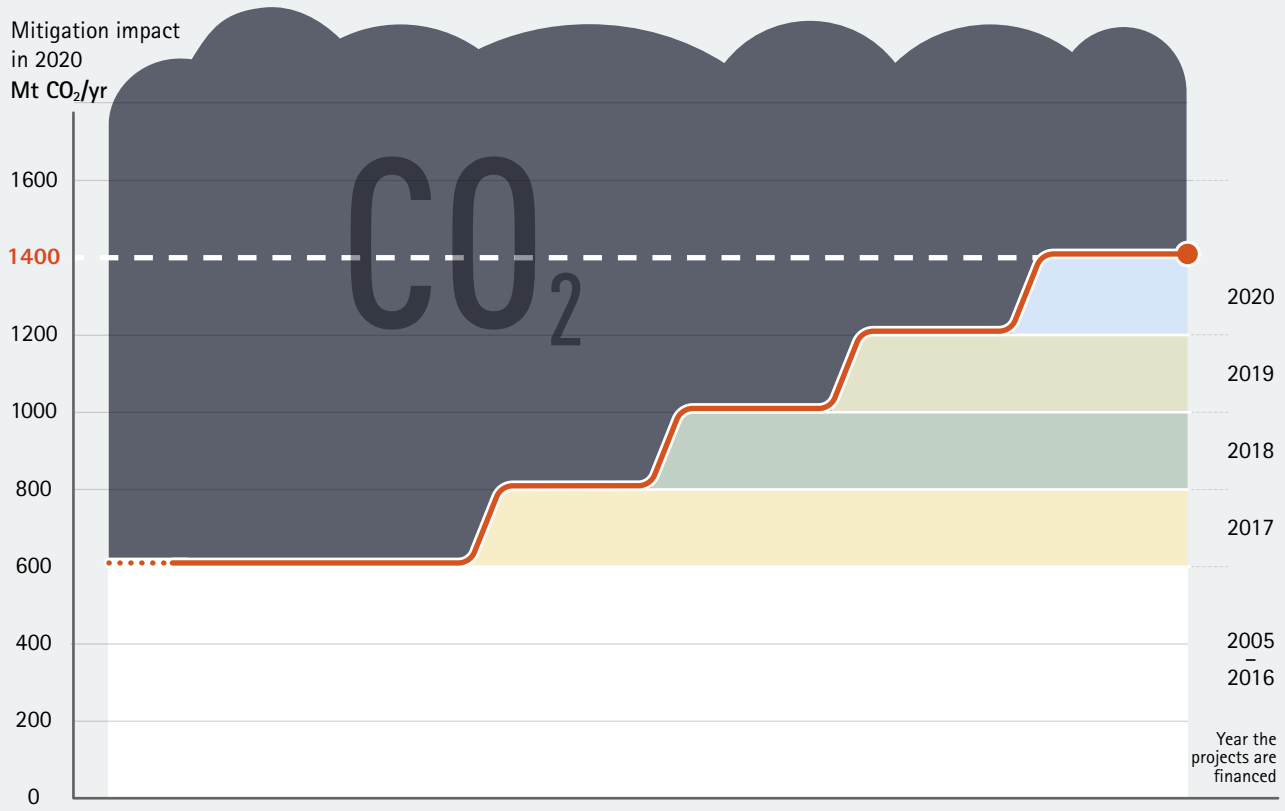
Despite the harmonized framework for calculating GHG emissions savings from RE and EE projects that International Financial Institutions (IFIs) agreed upon in 2015, current aggregate GHG impact data are incomplete to accurately assess these efforts' total effects.[200] The new framework's influence has extended beyond Multilateral Development Banks (MDBs) and has been incorporated by as many bilateral groups. Yet the framework is still not detailed enough to provide sufficient methodological information to meet the criteria for this analysis. Organizations generally describe how their aggregate estimates attribute reductions from projects with multiple supporters and, despite the harmonised framework, calculation assumptions may vary widely from project to project. Project-level research is therefore needed to overcome these issues.

Communications with aid organization representatives and extensive desk research yielded sufficient information on 197 RE, 62 EE projects and 14 RE/EE projects for calculating GHG emissions impact estimates. The project-by-project emissions reductions estimates were made using a common calculation method that accounts for Scope 1 emissions (see Annex).

The supported projects on energy efficiency and renewable energy have significant impact on greenhouse gas emissions:

- **The analyzed sample of internationally supported RE and EE projects in developing countries will reduce emissions by approximately 0.258 gigatons carbon dioxide ($GtCO_2$)**

Figure 12: Emission reductions in 2020 from scaled up public mitigation finance for RE and EE projects.



Source: Authors, 1 Gigaton Coalition Report 2017

annually in 2020. The 273 analysed projects generate these emissions savings by displacing fossil fuel energy production with clean energy technologies or by conserving energy in industry, buildings and transportation. RE projects contribute around 0.085 $GtCO_2$, EE projects contribute 0.113 $GtCO_2e$, and RE/EE projects contribute about 0.059 $GtCO_2$ to the analysis's total emissions reductions. These projects received direct foreign assistance totalling US $32 billion.

- **Total emissions reductions from internationally supported RE and EE projects since 2005 could be up to 0.600 $GtCO_2$ per year in 2020**. This estimate is derived by scaling up the analysed sample's emissions reductions to a global level using total multilateral and bilateral support figures for RE and EE ($76 billion between 2005 and 2016).[201] International support flows to markets that are in the early stages of development, where barriers to private investment have to be lifted for RE and EE finance to mature. This foreign investment, which includes critical support for capacity building, is essential for spurring RE and EE development, despite the fact that foreign support accounts for less than 10% of total RE and EE investments in developing countries.

- **If public finance for mitigation is scaled up through 2020, emissions would be reduced by more than 1 $GtCO_2$ per year** (Figure 12). Countries agreed to mobilize US $100 billion in total climate finance (mitigation and adaptation, public and private). For this estimate we assume that a quarter of the US $100 billion is public mitigation finance.

5.2 SELECTED BILATERAL INITIATIVES

Outreach to bilateral organizations and desk research yielded detailed data on 100 projects from 12 bilateral groups in nine countries: China, Finland, France, Germany, Japan, The Netherlands, Norway, United Kingdom, and the United States. The eight OECD countries invested more than US $9 billion in RE power generation in developing nations from 2006 – 2015.[202] Data on China's foreign energy investments is difficult to obtain, yet it is known that China has in the past 15 years begun to invest in RE abroad. China has supported at least 124 solar and wind initiatives in 33 countries since 2003. Fifty-four of these investments – those for which financial data is available – sum to nearly US $40 billion.[203]

The bilateral groups featured in this analysis include state-owned investment funds like Norway's Norfund; government-owned development banks like the China Development Bank; and some are private companies operating on behalf of government ministries, like GIZ in Germany. The full list of bilateral organizations included in this analysis is shown in Table 4. Bilateral development groups generally mobilize public funds from national budgets to finance initiatives abroad. Some groups raise capital from private markets and others use both public and private financing in their operations. Development institutions finance projects via grants and/or loans distributed to governments of recipient nations, which in turn distribute funding to ministries, local agencies, and firms in charge of project implementation. Promoting development abroad is central to the mission of all the groups considered in this report, and the analysis focuses only on funding for RE and EE projects, which may comprise a relatively small portion of a bilateral organization's total portfolio.

Table 4. Selected Bilateral Organizations[204]

Bilateral Organization	Country	Year/Established	OECD-reported National Assistance for RE and EE Development (millions current US $)[205, 206]		
			2015	2005–2015 (cumulative)	
Agence Française de Développement (AFD)	France	1998	401	2,533	
China Development Bank and China Exim Bank	China	1994		1,000[208]	
Department for International Development (DFID)/International Climate Fund (ICF)	UK	1997/2011	59	359	
Danida	Denmark	1971	2	151	
FinnFund	Finland	1980	20	226	
FMO	The Netherlands	1970	38	521	
Deutsche Gesellschaft für Internationale Zusammenarbeit GmbH (GIZ)[212]	Germany	2011	954	9,899	
KfW/DEG	Germany	1948/1962			
Japan International Cooperation Agency (JICA)	Japan	1974	204	4,807	
NorFund	Norway	1997	27	883	
Overseas Private Investment Corporation (OPIC)	USA	1971	244	763	
All OECD countries			1,949	21,142	

Note: Cells shaded grey indicates no data available.

Bilateral Development Organization's RE and EE Achievements	Bilateral Organization's Estimated GHG Emissions Mitigation Impact	RE and EE Investments in this Analysis (millions current US $)	# RE and EE Projects in this Analysis
AFD's supported projects installed 1,759 MW of RE	Projects financed from 2013 – 2015 abate 11.4 Mt CO_2 annually[207]	1,850	30
		549	4
DFID and ICF supported projects with 230 MW of RE capacity already installed and 3,610 MW of RE capacity expected over the projects' lifetime.	Supported RE projects have achieved 6.6 Mt CO_2 abatement[209]	207	4
Danida has allocated more than 1,604 million DKK to projects on natural resources, energy and climate changes in developing countries between 2016 and 2020.		108	5
US $168 million invested in "Energy and Environmental development" from 2011 – 2015[210]		40	2
Established its climate investment fund, Climate Investor One (CIO), in 2014, which will develop approximately 20 RE initiatives and build 10 more RE projects, with cumulative 1,500 MW capacity. These efforts will create 2,150,000 MWh of additional clean electricity production and bring electricity access to approximately 6 million people	CIO aims to achieve an annual avoidance of 1.5 $MtCO_2$ emissions through the 10 RE projects it builds.[210]	189	3
Since 2005, GIZ's EE programs have achieved energy savings equal to the annual energy consumption of more than one million German households. GIZ has also distributed energy-saving cookstoves to more than 10 million people. GIZ currently has 39 active RE projects in developing countries with more than $480 million invested in this sector.[213]		7	2
DEG's supported RE initiatives have an estimated annual production of 8,000,000 MWh, equivalent to the annual consumption of approximately 9 million people.	KfW's supported 2015 EE projects produce an estimated 1.5 MtCO2e/year and its supported 2015 RE projects generate an estimated 2.5 MtCO2e/year, though it should be noted that these projects include large hydropower and biomass plants.[214]	1,007	9
Committed in 2014 to support RE projects with total capacity of 2,900 MW	JICA supported RE projects are expected to reduce emissions by 2.8 MtCO2/year (does not include supported EE projects).[215]	4,726	30
Supported RE projects in Africa, Asia, and Americas have a total installed capacity of 4,800 MW, with 600 MW more currently under construction. These RE projects produced 18,500,000 MWh in 2015 alone.	Norfund's supported RE projects reduced emissions by an estimated 7.4 $MtCO_2$ in 2015.[209]	39	11
In 2015, committed nearly $1.1 billion to RE in developing countries marking the fifth year in a row that its investments in RE have topped $1 billion[217]		666	5

RE AND EE PROJECT DATA COLLECTION CRITERIA

To be included in the analysis, projects had to meet the following criteria. These boundaries allowed for the calculation of each project's GHG emissions mitigation and the identification of reporting overlaps.

Scope of Data

- Project location: the report only considers projects in developing and emerging economies; China was given special consideration as both a recipient and distributor of foreign investments.
- Project focus: the report only evaluates projects with an explicit RE or EE focus.
- Support: the report only examines projects at least partly supported by bilateral or multilateral development groups.
- Timeframe: the report only analyzes projects that were implemented from 2005 through 2016. Data was collected for projects that have not yet been implemented, but these projects were excluded from the analysis.

Types of Data

- Technology type: analysis could only be performed where the technology type (for RE) or technical improvement (for EE) was given (e.g. solar or power system upgrade).
- Energy information: To be analyzed, projects had to include quantified power or capacity data. This report builds on the previous 1 Gigaton Coalition reports' scope, including many more RE and EE projects in its analysis. RE projects employ one of only a handful of technologies with the primary goal of producing electrical power, which is commonly expressed in generating capacity (MW) or power (MWh), making reporting and collecting data on these initiatives straightforward. EE, on the other hand, is a broad classification that can refer to a multitude of different activities, including initiatives that involve multiple economic sectors. EE programs often involve buildings and appliances, and they are also employed in industrial systems, the power sector, transportation, and waste. Any program that seeks to enhance efficiency in energy production or consumption can be considered an EE project. Such an extensive classification requires a flexible methodological framework with sector-specific considerations for each project type in order to establish baselines and determine initiative outcomes (see Section 4). These complex considerations mean that EE project impacts are generally more challenging to quantify than RE project results. With various types of EE programs there are varying metrics for describing project results. This analysis only includes EE efforts that report energy savings resulting from project implementation, a metric most often expressed in terajoules (TJ) or megawatt-hours (MWh)

5.3 SELECTED MULTILATERAL INSTITUTIONS

Building on the data collected for the 2016 1 Gigaton Report, the analysis this year includes 173 projects supported by 16 multilateral groups. The multilateral institutions featured include multilateral development banks (MDBs) like the Asian Development Bank (ADB), European Investment Bank (EIB), and Inter-American Development Bank (IDB). These institutions are often intertwined, as, for instance, the International Bank for Reconstruction and Development (IBRD) and International Finance Corporation (IFC) are both part of the extensive World Bank Group. Some are affiliated with bilateral institutions, such as Proparco in France, which is a private sector subsidiary of the bilateral Agence Française de Développement (AFD). As the name suggests, multilateral development groups draw public and private funding from multiple countries to finance development initiatives throughout the world. These organizations often fund projects in collaboration with each other, employing multi-layered finance agreements that include grants, loans, and leveraged local funding.

Organizational frameworks and funds that pool resources and coordinate project support among MDBs have become increasingly influential in recent years. The Global Environment Facility (GEF) is perhaps the most prominent of these collaborative efforts. A partnership of 18 multinational agencies representing 183 countries, GEF's investments support and attract co-financing to a significant portion of the developing world's RE and EE projects.[218] The Climate Investment Funds (CIF), created by the World Bank in 2008, is another catalyst of MDB support. CIF now consists of four programs, two of which focus on developing and expanding RE in middle- and low-income countries.[219] These collaborations help mobilize funds and they also act as data hubs, collecting information on the projects that their partners implement.

MDBs' collaborative approach to project finance makes double-counting individual efforts – i.e., counting individual projects more than once – more likely when creating an initiative database. One project may have multiple groups supporting it, all of whom report the initiative and its outcomes as their own. This overlap means that if an analyst were to combine different sets of MDB-reported aggregated data, there would be projects counted multiple times. This problem of multiple attribution and double counting can debase the credibility of an otherwise sound analysis (see Section 4). With detailed project-level data on RE and EE projects, this analysis is able to avoid the hazard of double-counting MDBsupported programs. Any overlaps between projects in the database were discerned and appropriately addressed so that each project was only counted once. Note that in Table 5, overlaps among projects from "Supporting organization reported" sources are not disaggregated, so these data may exhibit double counting, demonstrating the difficulties of aggregating data at this level.

Table 5: Selected Multilateral Development Organizations[220]

Multilateral Firm, Fund, Institution or Partnership		Number of Member Countries and Structure	Year/ Established	OECD-reported Development Assistance ($ millions current USD)[205, 206]		
				2015	2005–2015 (combined)	
acumen FUND	**Acumen**	Non-profit venture fund	2001			
ADB	**Asian Development Bank (ADB)**	67 member countries; MDB	1966	350	4,227	
	African Development Bank (AfDB)	80 members; MDB	1964	58	1,824	
AIIB	**Asian Infrastructure Investment Bank (AIIB)**	56 countries; MDB	2014; officially launched in 2016			
	European Development Fund (EDF)	EU's main instrument for providing development aid to African, Caribbean and Pacific (ACP) countries and to overseas countries and territories (OCTs)	1959			
European Investment Bank	**European Investment Bank (EIB)**	28 European member states; European Union's nonprofit long-term lending institution	1958			
GREEN CLIMATE FUND	**Green Climate Fund (GCF)**	Established by 194 countries party to the UN Framework Convention on Climate Change in 2010. Governed by a 24-member board, whose participants are equally drawn from developed and developing countries, and which receives guidance from the Conference of the Parties to the Convention (COP).	2010			
gef	**Global Environment Facility (GEF)**	GEF's governing structure is organized around an Assembly, the Council, the Secretariat, 18 Agencies representing 183 countries, a Scientific and Technical Advisory Panel (STAP) and the Evaluation Office. GEF serves as a financial mechanism for several environmental conventions.	1992	84	296	
HYDROCHINA	**HydroChina Investment Corp**	Public company in China.	2009			

Note: Cells shaded grey indicates no data available.

Supporting Organization's Reported RE and EE Investments and Impacts	Supporting Organization's Estimated GHG Emissions Mitigation Impact	RE and EE Investments in Analysis ($ millions current USD)	# RE and EE Projects in Analysis
Acumen invested $12.8 million in breakthrough innovations and impacted 23.3 million lives.		1.25	2
Invested $2.47 billion in clean energy in 2015 (RE and EE); including 1,481 GWh/year renewable electricity generation; 4,479 GWh/year electricity saved; 37,994 TJ/year direct fuel saved; and 618 MW newly added renewable energy generation capacity	Achieved abatement of 21.9 MtCO2e/year[221]	4,390	30
		43	1
Invested $165 million in one EE project	Achieved abatement of 16,400 tCO_2 per year[222]	165	1
		273	5
As a result of $21 billion of climate lending in 2014, 3,000 GWh of energy was saved and 12,000 GWh of energy was generated from renewable sources.	Climate lending in 2014 led to avoidance of 3 $MtCO_2$ emissions.[225, 226]	214	3
$10.3 billion of support was announced by 43 state governments, towards a goal of mobilizing $100 billion by 2020.	Anticipated avoidance of 24.8 $MtCO_2e$ through 17 projects.[227, 228]	337	2
Since 1991, GEF has invested more than $4.2 billion in 1,010 projects to mitigate climate change in 167 countries. GEF's investments leveraged more than $38.3 billion from a variety of other sources, including GEF Agencies, national and local governments, multilateral and bilateral agencies, the private sector and civil society organizations.	2.7 billion tonnes of greenhouse gas (GHG) emissions have been removed through the GEF's investment and co-financing activities around climate change mitigation, from 1991 – 2014.[229]	3,098	76
		115	1

continue next page

Table 5: Selected Multilateral Development Organizations[220] (continued)

Multilateral Firm, Fund, Institution or Partnership		Number of Member Countries and Structure	Year/ Established	OECD-reported Development Assistance ($ millions current USD)[205, 206]	
				2015	2005–2015 (combined)
IFC	**International Finance Corporation (IFC)**	184 member countries	1946	422	2,394
IDB	**Inter-American Development Bank (IDB)**	48; MDB	1959	588	3,959
New Development Bank	**The BRICS New Development Bank**	5; MDB	July 2014 (Treaty signed)/July 2015 (Treaty in force)		
Proparco	**Proparco**	Public-Private European Development Finance Institution based in France	1977		
WORLD BANK	**World Bank**	189 member countries; The World Bank Group is comprised of five multilateral finance organizations including IBRD and IFC as well as The International Development Association (IDA), The Multilateral Investment Guarantee Agency (MIGA), The International Centre for Settlement of Investment Disputes (ICSID).	1944	1,092	8,801
CLIMATE INVESTMENT FUNDS	**Climate Investment Funds (CIF)**	72 developing and middle income countries; comprised of four programs including CTF and SREP as well as the Forest Investment Program (FIP) and Pilot Program Climate Resilience (PPCR); all implemented and supported by MDBs.	2008	579	2,132
CTF	**Clean Technology Fund (CTF)**	72 developing and middle income countries; projects implemented by MDBs	2008		

Note: Cells shaded grey indicates no data available.

Supporting Organization's Reported RE and EE Investments and Impacts	Supporting Organization's Estimated GHG Emissions Mitigation Impact	RE and EE Investments in Analysis ($ millions current USD)	# RE and EE Projects in Analysis
		95	2
		134	4
Invested $911 million in RE projects in 2016 equaling 1,920 MW in capacity.	These investments are expected to avoid 3.236 $MtCO_2e$/yr.	911	5
Proparco's supported RE projects 2013 – 2015 have a combined capacity of 1.75 MW; 695 MW in 2015 alone.	Proparco's 2015 investments have reduced emissions by an estimated 0.876 $MtCO_2e$.[231]	344	10
In 2015, the World Bank catalysed $28.7 billion in private investments and expanded renewable power generation by 2,461 MW.	588 $MtCO_2e$ reduced with the support of special climate instruments in 2015; 1,270,000 in MWh in projected lifetime energy savings based on projects implemented in 2015.[230]	504	11
Funding pool of $8.3 billion ($58 billion in expected co-financing). CIF investments of $1.8 billion (as of 2015) are expected to contribute to 1 GW of CSP and 3.6 GW of geothermal power.[223]		10,891 (including cofinance)	23
Fund of $5.6 billion with approved RE capacity of 18,865 MW; These projects expected to generate 70,099 GWh/yr.	CTF investments are expected to deliver emissions reductions of 1,500 $MtCO_2e$ over all projects' lifetime; 20 $MtCO_2e$ have already been achieved.[224]	13,332 (including co-finance)	12

International Financial Institutions (IFIs) are banks that have been chartered by more than one country. All of the MDBs featured in this report are also IFIs. These institutions adopted the "International Financial Institution Framework for a Harmonised Approach to Greenhouse Gas Accounting" in November 2015, in an important step toward developing a global methodological standard for GHG accounting.[232] As the IFI framework gains widespread adoption, there are opportunities to add specifications that would improve and further unify the methodologies. The framework in its current form could provide more detailed instructions to ensure that results are reproducible. This way, a third-party analysis would be able to combine GHG emissions impact estimates of different projects from multiple sources. Nevertheless, in many instances, supporting MDBs present project-level emissions mitigation estimates, citing the recently harmonised framework, yet without providing the precise assumptions inherent to their calculations. The IFI framework is a very promising development, and widespread sharing of methodological approaches is a powerful tool for catalyzing harmonization efforts.

Accounting for Scope 2 and 3 emissions remains a difficult task and a near-term goal for groups financing RE and EE projects. With an annual investment of US$11 billion, internationally supported RE and EE initiatives in developing countries are less than 10% of total investment. Yet this class of funding can have outsized effects, as foreign investment leverages other financing, builds capacity in local institutions, and helps mainstream RE and EE project finance.[233] According to OECD estimates, aid groups invested US$4.7 billion in energy policy and administrative management in 2014, more than any other recipient sector besides electrical transmission and distribution. There is, however, no harmonized method for estimating emissions impacts from such activities. Analysts from several bilateral and multilateral institutions interviewed expressed their desires to accurately measure the outcomes of capacity building efforts as well as policy and administrative aid. As funding for these initiatives grow, developing rigorous and harmonized ways to do this evaluation is key to fully capturing the results of foreign investments in RE and EE projects.

5.3.1 MULTISTAKEHOLDER PARTNERSHIPS

In addition to bilateral and multilateral initiatives, multi-stakeholder partnerships of both public and private actors also extend financial and capacity-building support to developing countries, spurring innovation and new policies. This section features some examples of initiatives that are operating in developing countries as models for demonstrable mitigation impact.

CLIMATE AND CLEAN AIR COALITION (CCAC)

www.ccacoalition.org

Established in 2012, the Climate and Clean Air Coalition (CCAC) is a voluntary partnership uniting governments, intergovernmental and nongovernmental organizations, representatives of civil society and the private sector committed to improving air quality and slowing the rate of near-term warming in the next few decades by taking concrete and substantial action to reduce short-lived climate pollutants (SLCPs), primarily methane, black carbon, and some hydrofluorocarbons (HFCs). Complementary to mitigating CO_2 emissions, fast action to reduce short-lived climate pollutants has the potential to slow expected warming by 2050 as much as 0.5 Celsius degrees, significantly contributing to the goal of limiting warming to less than 2°C.

Reducing SLCPs can also advance priorities that are complementary with the 1 Gigaton Coalition's work, such as building country capacity and enhancing energy efficiency. For example, replacing current high Global Warming Potential (GWP) HFCs with available low- or no-GWP alternatives can also improve the efficiency of the appliances and equipment that use them, potentially reducing global electricity consumption by between 0.2 and 0.7% by 2050, resulting in a cumulative reduction of about 5.5 Gt CO_2e.[234] Another example of this alignment is the SNAP Initiative of the CCAC, which supports twelve countries to develop a national strategy to reduce short-lived climate pollutants and identify the most cost-effective pathways to large-scale implementation of SLCP measures. This initiative has resulted in a number of countries, including Mexico, Cote d'Ivoire, Chile, and Canada submitting NDCs that integrate SLCP mitigation.

CLIMATE TECHNOLOGY CENTRE AND NETWORK (CTCN)

ctc-n.org

The Climate Technology Centre and Network (CTCN) delivers tailored capacity building and technical assistance at the request of developing countries, across a broad range of mitigation and adaptation technology and policy sectors. As the implementation arm of the UNFCCC Technology Mechanism, the CTCN is a key institution to support nations in realizing their commitments under the Paris Agreement.

As countries around the world seek to scale up their energy-efficient, low-carbon and climate-resilient development, the CTCN plays the role of technology matchmaker, mobilizing a global network of technology expertise from finance, NGO, private and research sectors to provide customized technology and policy support. Over 200 technology transfers are currently underway in 70 countries.

The Centre is the implementing arm of the UNFCCC Technology Mechanism. It is hosted and managed by UN Environment and the United Nations Industrial Development Organization (UNIDO), and supported by more than 340 network institutions around the world. Nationally-selected focal points (National Designated Entities) in each country coordinate requests and implementation at the national level.

EN.LIGHTEN

http://united4efficiency.org/

The en.lighten initiative is a public-private partnership between the UN Environment and companies such as OSRAM, Philips Lighting and MEGAMAN, with support from the Global Environment Facility (GEF). The initiative's main aim is to support countries in their transition to energy efficient lighting options. en.lighten has taken a regional approach to standards implementation. Through this method, countries are able to share the costs for innovation and testing centres, as well as recycling and waste schemes to manage disposal of the new products (e.g. lights containing mercury). To date, the en.lighten initiative accounts for over 60 partner countries with a number of ongoing regional and national activities and projects. Over the next several years, the en.lighten initiative – as the lighting chapter of United for Efficiency – will focus its support for countries to leapfrog to LED lighting and assisting countries and cities to implement efficient street lighting policies and programmes.

DISTRICT ENERGY IN CITIES INITIATIVE (DES)

districtenergyinitiative.org/

The District Energy in Cities Initiative is a multi-stakeholder partnership coordinated by UN Environment, with financial support from DANIDA, the Global Environment Facility, and the Government of Italy. As one of six accelerators of the Sustainable Energy of All (SEforAll) Energy Efficiency Accelerator Platform, launched at the Climate Summit in September 2014, the Initiative is supporting market transformation efforts to shift the heating and cooling sector to energy efficient and renewable energy solutions.

The Initiative aims to double the rate of energy efficiency improvements for heating and cooling in buildings by 2030, helping countries meet their climate and sustainable development targets. The Initiative helps local and national governments build local know-how and implement enabling policies that will accelerate investment in modern – low-carbon and climate resilient – district energy systems. UN Environment is currently providing technical support to cities in eight countries, including Bosnia and Herzegovina, Chile, China, India, Malaysia, Morocco, Russia and Serbia.

Since its establishment, the Secretariat has been leading and coordinating the development of, as well as facilitating global access to, the best relevant technical information necessary to address regulatory, economic, environmental and social barriers to enable successful and sustainable district energy programmes.

The Initiative works with a wide range of committed partners and donors. Partnerships are a key enabler for combatting climate change and fostering sustainable development, and are firmly embedded in the way the initiative works at global, regional and national level. By joining forces with other players, the initiative leverages additional resources, expertise and technical know-how to help countries and cities in their effort to move towards modern district energy systems.

GLOBAL ALLIANCE FOR BUILDINGS AND CONSTRUCTION (GABC)

http://www.globalabc.org/

The Global Alliance for Buildings and Construction (GABC) promotes and works towards a zero-emission, efficient and resilient buildings and construction sector. It is a voluntary, international, multi-stakeholder partnership serving as global collaborative umbrella organization for other platforms, initiatives and actors to create synergies, and increase climate action scale and impact for decarbonising the buildings and construction sector in line with the Paris Agreement goals.

The GABC's common objectives are:

(a) Communication: Raising awareness and engagement making visible the magnitude of the opportunities and impact in the buildings and construction sector.

(b) Collaboration: Enabling public policy and market transformation action to achieve existing climate commitments, through implementing partnerships, sharing technical expertise, and improving access to financing.

(c) Solutions: Offering and supporting programmes and locally adapted solutions to achieve climate commitments and further ambitious 'well-below 2°C path' actions.

The GABC has five Work Areas for addressing key barriers to a low-carbon, energy-efficient, and resilient buildings and construction sector: Education & Awareness; Public Policy; Market Transformation; Finance; and Measurement, Data and Accountability.

Specifically, the GABC focuses on:

- Working towards a common vision and goals by developing a GABC global roadmap and issuing an annual GABC Global Status Report.
- Catalysing action, particularly supporting and accelerating NDC implementation.
- Facilitating access to and scaling-up technical assistance by coordinating members' needs with other members' capabilities and capacities.

GLOBAL COVENANT OF MAYORS FOR CLIMATE AND ENERGY

http://www.globalcovenantofmayors.org/

The Global Covenant of Mayors for Climate & Energy is an international alliance of cities and local governments with a shared long-term vision of promoting and supporting voluntary action to combat climate change and move to a low emission, resilient society. The Covenant focuses on:

- **Local Governments as Key Contributors:** The Global Covenant of Mayors works to organize and mobilize cities and local governments to be active contributors to a global climate solution.
- **City Networks as Critical Partners:** Local, regional and global city networks are core partners, serving as the primary support for participating cities and local governments.
- **A Robust Solution Agenda:** Focusing on those sectors where cities have the greatest impact, the Global Covenant of Mayors supports ambitious, locally relevant solutions, captured through strategic action plans that are registered, implemented and monitored and publicly available.
- **Reducing Greenhouse Gas Emissions and Fostering Local Climate Resilience:** The Global Covenant of Mayors emphasizes the importance of climate change mitigation and adaptation, as well as increased access to clean and affordable energy.

Created through a coalition between the Compact of Mayors and EU Covenant of Mayors, the Global Covenant of Mayors is the broadest global alliance committed to local climate leadership, building on the commitments of over 7,477 cities, representing 684,880,509 people and 9.31% of the global population.

INTERNATIONAL TRANSPORT FORUM AT THE ORGANISATION FOR ECONOMIC DEVELOPMENT AND COOPERATION (OECD)

https://www.itf-oecd.org/

The International Transport Forum (ITF) at the Organisation for Economic Development and Cooperation (OECD) is an intergovernmental organization with 59 member countries. The ITF acts as a think tank for transport policy and organises the Annual Summit of transport ministers. It serves as a platform for discussion and pre-negotiation of policy issues across all transport modes, and it analyses trends, shares knowledge and promotes exchange among transport decision-makers and civil society. The ITF also has a formal mechanism, through its Corporate Partnership Board (CPB), to engage with the private sector. Created in 2013 to enrich global policy discussions with a private sector perspective, it brings together companies with a clear international perspective in their activities that play an active role in transport and associated sectors. CPB partners represent companies from across all transport modes and closely related areas, such as energy, finance, or technology.

Together with its member countries and corporate partners, the ITF has developed a wide range of projects, including transport and climate change. In May 2016, the ITF Decarbonising Transport project was launched to help decision makers establish pathways to carbon-neutral mobility. This project brings together a partnership that extends far beyond the member countries of ITF. There are currently more than 50 Decarbonising Transport project partners from intergovernmental organisations, non-governmental organisations, national governments, city networks, foundations, universities, research institutes, multilateral development banks, professional and sectoral associations, and the private sector.

ENERGISING DEVELOPMENT (ENDEV)

www.endev.info

EnDev is an international partnership with the mission to promote sustainable access to modern energy services in developing countries as a means to inclusive social, economic and low carbon development. EnDev is funded by six donor countries: Norway, the Netherlands, Germany, United Kingdom, Switzerland and Sweden. EnDev was initiated in 2005 and is currently implemented in 26 countries in Africa, Asia and Latin America, with a focus on least developed countries. EnDev promotes sustainable access to climate-smart energy services that meet the needs of the poor: long lasting, affordable, and appreciated by users, while also fulfilling certain minimum quality criteria. The most widely promoted technologies are improved cookstoves for clean cooking, solar technologies for lighting and electricity supply as well as mini-grids.

EnDev has a robust monitoring system, which provides donors, partners and management with verified data and reliable assessments. By now, EnDev has facilitated sustainable access for more than 17.3 million people, more than 38,600 small and medium enterprises and 19,400 social institutions. In 2016, through the measures of the programme, CO_2 emission reductions totalled 1.8 million tons per year. Since beginning in 2005, EnDev has contributed to avoiding more than 8.5 million tons of CO_2. This figure is a conservative estimate: it includes various deductions for sustainability, additionality, free riding and replacement or repeat customers. The majority of the EnDev's avoided emissions are generated in the cookstove sector.

INTERNATIONAL RENEWABLE ENERGY AGENCY (IRENA)

www.irena.org

The International Renewable Energy Agency (IRENA) is an intergovernmental organization that supports countries in their transition to a sustainable energy future through accelerated deployment of renewable energy.

IRENA's Roadmap for a Sustainable Energy Future, REmap 2030, demonstrated that doubling the share of renewable energy in the global energy mix by 2030 is both economically viable and technically feasible. Through its Renewable Readiness Assessments, IRENA helps countries assess local conditions and prioritize actions to achieve renewable energy potentials. The Agency's regional initiatives, such as the African Clean Energy Corridor, promote the penetration of renewable electricity in national systems and renewable energy cross-border trade. IRENA is organizing dialogues with a broad range of stakeholders to advance specific regional concerns, including efforts to strengthen renewable energy objectives in countries' NDCs.

IRENA makes its data, knowledge products, and tools a public good so that many can benefit from the Agency's unique mandate and reach. These tools include, among others: a Global Atlas that consolidates renewable resource potential worldwide; a Project Navigator that guides the preparation of high quality project proposals; and a Sustainable Marketplace that facilitates access to finance to scale up investments.

THE PRIVATE FINANCING ADVISORY NETWORK (PFAN)

www.pfan.net

The Private Financing Advisory Network is one of few actors in the climate finance space addressing the barriers to success for small and medium enterprises (SME) in developing countries and emerging economies – a shortage of bankable projects on the demand side and difficulties assessing risks and a conservative lending culture on the supply side.

PFAN's goals are to reduce CO_2 emissions, promote low-carbon, sustainable economic development, and help facilitate the transition to a low-carbon economy by increasing financing opportunities for promising clean energy projects. PFAN accomplishes this by coaching and mentoring high-potential climate and clean energy businesses; by developing a network of investors and financial institutions with an interest in and extensive knowledge of clean energy markets; and by presenting to these investors projects that have been screened for commercial viability, sustainability and environmental and social benefits.

To date, PFAN has raised over US $1.2 billion in investment for the projects in its pipeline, which have led to installing and operating over 700 MW of clean energy capacity.

PFAN is a multilateral public-private partnership, founded by the Climate Technology Initiative (CTI) and the United Nations Framework Convention on Climate Change (UNFCCC). It has recently been relaunched under a new hosting arrangement with the United Nations Industrial Development Organization (UNIDO) and the Renewable Energy and Energy Efficiency Partnership (REEEP). Under this arrangement, PFAN's operations are set to scale by a factor of two to five by 2020.

RENEWABLE ENERGY POLICY NETWORK FOR THE 21ST CENTURY (REN21)

www.ren21.net/

REN21 is the global renewable energy policy multi-stakeholder network that connects a wide range of key actors. REN21's goal is to facilitate knowledge exchange, policy development and joint action towards a rapid global transition to renewable energy.

REN21 brings together governments, non-governmental organizations, research and academic institutions, international organizations and industry to learn from one another and build on successes that advance renewable energy. To assist policy decision making, REN21 provides high quality information, catalyses discussion and debate and supports the development of thematic networks.

REN21 facilitates the collection of comprehensive and timely information on renewable energy. This information reflects diverse viewpoints from both private and public-sector actors, serving to dispel myths about renewables energy and to catalyse policy change. It does this through six product lines: the Renewables Global Status Report (GSR), which is the most frequently referenced report on renewable energy market, industry and policy trends; Regional Reports on renewable energy developments of particular regions; Renewables Interactive Map, a research tool for tracking the development of renewable energy worldwide; the Global Future Reports (GFR), which illustrate the credible possibilities for the future of renewables; the Renewables Academy, which offers a venue to brainstorm on future-orientated policy solutions; and International Renewable Energy Conferences (IRECs), a high-level political conference series.

NDC PARTNERSHIP

http://www.ndcpartnership.org/

The NDC Partnership is a global coalition of countries and international institutions working together to mobilize support and achieve ambitious climate goals, while enhancing sustainable development. Launched at COP22 in Marrakesh, the NDC Partnership aims to enhance cooperation so that countries have access to the technical knowledge and financial support they need to achieve large-scale climate and sustainable development targets as quickly and effectively as possible, and increase global ambition over time.

In-Country Engagement
The Partnership engages directly with ministries and other stakeholders to assess needs and identify opportunities for collective action across sectors, regions, and international partners. Through the Partnership, members provide targeted and coordinated assistance so that nations can effectively develop and implement robust climate and development plans. Leveraging the skills and resources of multiple partners towards a common objective, and delivering with speed, is a unique value proposition that the Partnership brings.

Increasing Knowledge Sharing
The Partnership raises awareness of and enhances access to climate support initiatives, best practices, analytical tools, and resources. Information to address specific implementation needs is made available through online portals, as well as communities and networks that generate opportunities for knowledge sharing.

Governance
The NDC Partnership is guided by a Steering Committee comprised of developed and developing nations and international institutions, and is facilitated by a Support Unit hosted by the World Resources Institute in Washington and Bonn. The Partnership is co-chaired by the Governments of Germany and Morocco.

RENEWABLE ENERGY AND ENERGY EFFICIENCY PARTNERSHIP (REEEP)

www.reeep.org

REEEP invests in clean energy markets to help developing countries expand modern energy services, improve lives and keep lowering CO_2 emissions. Leveraging a strategic portfolio of high-impact investments, REEEP generates, adapts and shares knowledge to build sustainable markets for clean energy and energy efficiency solutions, advance energy access, and combat climate change in order to facilitate economic growth where it matters most.

REEEP invests in small and medium-sized enterprises (SMEs) in low and middle-income countries and develops tailor-made financing mechanisms to make clean energy technology accessible and affordable to all.

Market transformation is complex and multidimensional. REEEP monitors, evaluates and learns from its portfolio to better understand the systems we work in, identify opportunities and barriers to success and lower risk for market actors. The knowledge we gain is shared with government and private sector stakeholders, influencing policy and investment decisions.

Current major projects and activities by REEEP include: managing the Sweden-funded Beyond the Grid Fund for Zambia, which is set to bring clean energy access to 1 million Zambians by 2021; Powering Agrifood Value Chains, a portfolio of eight promising clean energy businesses in the agrifood space; market-based clean energy and energy efficiency solutions for urban water infrastructure in Southern Africa; and the hosting and execution of activities of the Private Financing Advisory Network PFAN (see p. 72).

Founded at the 2002 World Summit on Sustainable Development in Johannesburg, REEEP works in close collaboration with a range of public and private sector partners at the early stages of clean energy market development.

MOROCCAN CLIMATE CHANGE COMPETENCE CENTRE (4C MAROC)

www.4c.ma/

The Moroccan Climate Change Competence Centre (4C Maroc) is a national capacity building platform for multiple stakeholders concerned with climate change, including government entities at all levels, private companies, research institutions, and civil society organizations. 4C Maroc acts as a hub for regional climate change information.

4C Maroc works to strengthen national actors' capacities in coping with climate change by collecting and developing information, knowledge, and skills pertaining to climate change vulnerability, adaptation, mitigation, and funding in Morocco. It also develops tools to improve and aid decision-making regarding climate change. 4C Maroc is particularly focused on creating a link between policymakers and scientists, aiming to ensure that universities and research centres get necessary funding to work on topics most relevant to improving public well-being. This effort's goal is to enable the public sector to make the best decisions on matters relating to climate change.

SUSTAINABLE ENERGY FOR ALL (SEforALL)

www.seforall.org

Sustainable Energy for All (SEforALL) was launched in 2013 as an initiative of the United Nations with a focus on moving the importance of sustainable energy for all center stage. Following the adoption of the SDGs, SEforALL has now transitioned into an international non-profit organization with a relationship agreement with the UN that serves as a platform supporting a global movement to support action.

SEforALL empowers leaders to broker partnerships and unlock finance to achieve universal access to sustainable energy as a contribution to a cleaner, just and prosperous world for all. SEforALL marshals evidence, benchmarks progress, tells stories of success and connects stakeholders. In order to take action at the scale and speed necessary, SEforALL's work focuses on where we can make the greatest progress in the least amount of time.

UK INTERNATIONAL CLIMATE FUND

https://www.gov.uk/government/publications/international-climate-fund/international-climate-fund

In 2010, the UK established the International Climate Fund (ICF) as a cross government programme, managed by BEIS, DFID and DEFRA. The Fund has delivered £3.87 billion in Official Development Assistance between 2011 and 2016. It now has a mature portfolio of over 200 programmes with global reach, working through private sector, multilateral, and bilateral channels, and has committed to spending at least £5.8 billion over the next five years. The ICF aims to spend half of its finances on climate mitigation and half on adaptation.

Up to US $90 trillion will be invested in infrastructure globally over the next 15 years in energy, cities, and transport. Much of this will be in developing countries where the ICF will try to influence finance flows to lower carbon investments by making visible, distinctive and catalytic investments that can be scaled up and replicated by others.

Since 2011, the ICF has directly supported 34 million people, helping them cope with the effects of climate change, and improved energy access for 12 million people. ICF investments have also helped prevent 9.2 million tonnes of CO_2 emissions –and generated US $2.86 billion of public investment and US $650 million of private investment.

UNITED FOR EFFICIENCY (U4E)

united4efficiency.org

The UN Environment-GEF United for Efficiency (U4E) supports developing countries and emerging economies to leapfrog their markets to energy-efficient lighting, appliances and equipment, with the overall objective to reduce global electricity consumption and mitigate climate change. High impact appliances and equipment such as lighting, residential refrigerators, air conditioners, electric motors and distribution transformers will account for close to 60 percent of global electricity consumption by 2030. The rapid deployment of high-energy efficient products is a crucial piece of the pathway to keep global climate change under 2°C. A global transition to energy efficient lighting, appliances and equipment will save more than 2,500 TWh of electricity use each year reducing CO_2 emissions by 1.25 billion tons per annum in 2030. Further, these consumers will save US $350 billion per year in reduced electricity bills.

Founding partners to U4E include the United Nations Development Programme (UNDP), the International Copper Association (ICA), the environmental and energy efficiency NGO CLASP, and the Natural Resources Defense Council (NRDC). Similar to en.lighten, U4E also partners with private sector manufacturers, including ABB, Electrolux, Arçelik, BSH Hausgeräte GmbH, MABE, and Whirlpool Corporation.

6 CONCLUSION

Meeting the Paris Agreement's climate goals will require an immediate and worldwide shift toward decarbonizing human activities. According to the IPCC, global emissions will have to peak in the next few years and then rapidly decline over the following three decades, approaching zero by 2050, if the world is to have a likely chance of limiting warming in line with the 1.5°C or 2°C goals established in the Paris Agreement. The annual emissions gap, however, is growing, and will equal 11 – 19 $GtCO_2e$ by 2030 unless efforts to reduce emissions dramatically ramp up. Timing is crucial, as the global carbon budget shrinks each year and the window of opportunity for achieving our shared climate goals narrows. Emissions benchmarks that correspond with 1.5°C or 2°C scenarios are moving targets, and if the world misses them in the short term, climate trajectories would worsen and long-term goals would become more difficult to meet.

Lagos, Nigeria

Private companies are making solar energy accessible and affordable, helping to meet the vast demand for reliable energy access across Nigeria.

→ *Details see page 32*

Renewable energy (RE) and energy efficiency (EE) initiatives are the most prominent and effective means for cutting carbon emissions while promoting sustainable economic growth. As with their timing and scale, the location of these efforts is crucial to achieving global climate goals. Developing countries are projected to drive almost all of the world's energy demand growth this century as well as the vast majority of new buildings, new modes of transportation, and new industrial activity.[236] These countries must balance domestic development needs with global climate goals, and they cannot be expected to do so without support from the rest of the world. Developing countries are installing RE facilities at a record pace, accounting for more than half of the nearly 140 GW of RE that came online in 2016. These nations are also developing and implementing more RE and EE policies than ever before, as documented in Chapter 2 of this report.

In cities and regions throughout the world, governments at all jurisdictional levels are partnering with private companies to implement RE and EE programmes, achieving carbon emissions reductions as well as co-benefits for their localities, including enhanced environmental quality, human health, economic outcomes, social inclusion, and gender equality. Section 3.1 of this report details six cases from various cities and regions, where public-private RE and EE initiatives are proving successful. These efforts are prime examples of the global movement to decouple carbon emissions from development. It is challenging, however, for many policymakers, project supporters, and implementers to determine individual RE and EE projects and policies' contributions to closing the emissions gap. Judging these efforts' compatibility with global 1.5°C and 2°C scenarios is also an unchartered territory for many actors.

Evaluating internationally supported RE and EE initiatives' measurable emissions reductions and creating a 1.5°C or 2°C-compatibility framework for RE and EE sectors and projects is the focus of this report. The results show that, when scaled up with proposed funding figures, supported RE and EE projects in developing countries could produce 1.4 $GtCO_2e$ in annual reductions by 2020. The compatibility framework presents a practical alternative to using counterfactual baseline scenarios to estimate an RE or EE project or sector's impacts, allowing funders, policymakers, project implementers, and other laypeople to quickly determine if a programme, project, or policy is 1.5°C or 2°C compatible, and to isolate crucial determining factors of project and sector-level compatibility. The compatibility analysis illustrates the need for integrated, system-focused policy promoting decarbonization in every sector. This means policies that link electricity generation and transmission with end-use management; regulations and standards that address upstream and downstream emissions throughout supply chains; and a large-scale shift of incentives away from fossil fuels and inefficient energy use towards RE sources and system-wide efficiencies.

Decarbonization is occurring throughout the world, as cities and other subnational jurisdictions have aligned their actions with national governments and partnered with private firms to implement innovative RE and EE programmes. Public-private partnerships, particularly collaborations at the subnational level, are assuming an increasingly prominent role in international climate efforts, and these collaborations will be a main focus at COP23. Yet these actions are not happening at the speed or scale necessary to achieve the 1.5°C or 2°C goals. Developed countries need to transfer resources, including policy and technical expertise, best available technologies, and financing, to developing countries in order to create the enabling environments necessary for RE and EE expansion at a scale commensurate with what international climate goals demand. Nations, project implementers, and supporting organizations must determine which policies and programmes do in fact meet the ambitious climate goals set out in the Paris Agreement while also achieving the Sustainable Development Goals (SDGs). This report provides some of the key elements that could be used to assess projects, policies, and initiatives according to their promotion of global climate and sustainable development objectives.

Information is a key resource that is little discussed. This report's 1.5°C or 2°C compatibility exercise finds that data transparency and information sharing are essential components of compatibility at the national, sector, and project levels. International efforts to improve data availability need to ramp up immediately. Bilateral and multilateral development organizations are among the groups best suited to catalyze these global changes. This report finds that these international organizations leverage large emissions reductions for relatively small RE and EE investments. These groups are shown to foster enabling environments helping to create homegrown low carbon trajectories in developing countries. International development authorities now should expand their support to advance transparency and resource transfers at an ever greater scale and speed.

ANNEX I: DETAILED DESCRIPTION OF MITIGATION IMPACT CALCULATIONS

This study performed a three-step calculation to determine the GHG mitigation impact from bilateral and multilateral-supported renewable energy (RE) and energy efficiency (EE) finance in 2020.

In the first step, the annual emission reduction for a project number i in 2020 were calculated as follows:

$$CO_2R2020_i = ES_i \times EF_i \quad (1)$$

where:
- CO_2R2020_i = Direct CO_2 emission reduction in 2020 by project number i (t/yr)
- ES_i = Annual energy saved or substituted by project number i (MWh/yr);
- EF_i = country-specific grid electricity CO_2 emission factor for project number i (t/MWh)

Whenever the project capacity size was reported, ESi was calculated as follows:

$$ES_i = PC_i \times 8760\ (\text{hours/yr}) \times CF_i \quad (2)$$

where:
- PC_i: Capacity of project i (MW)
- CF_i: Capacity factor of project i (dimensionless)

Following this step, the analysed projects' aggregate mitigation impact was scaled up to estimate the total mitigation delivered by bilateral- and multilateral-supported RE and EE projects in developing countries between 2005 and 2016. The scale-up was done by using the following equation:

$$CO_2R2020_{tot,2005\text{-}2016} = \Sigma_j \left(\Sigma\, CO_2R2020_{j,Dataset} \times \frac{FIN_{j,tot,2005\text{-}2016}}{\Sigma FIN_{j,Dataset}}\right) \quad (3)$$

where:
- $CO2R2020_{tot,2005\text{-}2016}$ = total mitigation in 2020 by bilateral- and multilateral-supported RE and EE projects in developing countries committed between 2005 and 2016 ($MtCO_2$/yr)
- $CO2R2020_{j,Dataset}$ = CO_2 emissions reduction in 2020 estimated for a project under technology category j in the dataset developed in this analysis (MtCO2/yr)
- $FIN_{j,tot,2005\text{-}2016}$ = total finance committed by bilateral and multilateral institutions on technology category j between 2005 and 2016 (million current USD)
- $FIN_{j,Dataset}$ = Finance committed by a project under technology category j in the dataset developed in this analysis (million current USD)

In the final step, the analysed projects' aggregate mitigation figure was used to estimate the expected mitigation from bilateral and multilateral support that will be committed through 2020 in line with the US $100 billion global climate finance goal.[237]

$$CO_2R2020_{tot,2005\text{-}2020} = \Sigma_j \left(\Sigma\, CO_2R2020_{j,Dataset} \times \frac{FIN_{j,tot,2005\text{-}2016} + FIN_{j,tot,2015\text{-}2020}}{\Sigma FIN_{j,Dataset}}\right) \quad (4)$$

where:
- $CO_2R_{tot,2005\text{-}2020}$ = total mitigation in 2020 by bilateral- and multilateral-supported RE and EE projects in 2020 in developing countries committed between 2005 and 2020 (MtCO2/yr)
- $FIN_{j,tot,2015\text{-}2020}$ = total finance expected to be committed by bilateral and multilateral institutions on technology category j between 2015 and 2020 (million current USD)

Further details about these steps are given in the following sections. CO_2 emissions generated through the construction of RE facilities are excluded, as these are generally less than emissions from fossil fuel power plant construction.

1.1 TECHNOLOGY CATEGORIZATION (J)

Technologies were categorised into the following (Table 1: Categorization of renewable energy technologies): solar photovoltaic (PV), solar thermal, wind (including onshore and offshore), hydro (including large, medium and small), biomass/waste and geothermal. The presented categorization makes it possible to develop country- technology-specific capacity factors in a consistent manner using datasets from different sources.

Projects were categorized through a word search from project descriptions. For projects reporting the implementation of more than one technology, the category "multiple renewable technologies" was used.

Table 1: Categorisation of renewable energy technologies

Category used in this study	IRENA category	OECD DAC category
Solar photovoltaic	Solar Photovoltaic	Solar energy
Solar thermal	Concentrated Solar Power	
Geothermal energy	Geothermal Energy	Geothermal energy
Hydropower (excluding large and medium, over 50 MW capacities)	Large Hydropower	Hydro-electric power plants
	Medium Hydropower	
	Small Hydropower	
Wind	Offshore Wind	Wind energy
	Onshore Wind	
Bioenergy/waste	Biogas	Biofuel-fired power plants
	Liquid Biofuels	
	Solid Biomass	
Multiple renewable technologies		Energy generation, renewable sources – multiple technologies
(Not considered)	Marine	Marine energy
	Pumped storage and mixed plants	

1.2 TOTAL ANNUAL ENERGY SAVED OR SUBSTITUTED (ES)

Total annual power generation by RE projects are in most cases calculated by using the power generation capacity and the technology- and country-specific capacity factors. Total annual power generation values reported by supporting institutions were used only when capacity values were not available. Whereas the first method included the use of the capacity factor, the grid electricity CO_2 emission factor and the reported project capacity, the second included only the grid electricity CO_2 emission factor and the reported project power.

For EE projects, the amount of energy saved annually reported in the project documentation was used for the calculations.

1.3 CAPACITY FACTORS (CF)

For efficient fossil fuel-fired power plant projects, uniform capacity factor of 80% was assumed. For other EE projects, capacity factor values were not used for calculations because the energy consumption reduction values were taken directly from the project documentation. For RE projects, average capacity factors were calculated for the period 2010-2014 for individual RE technologies per country, except for Concentrated Solar Power (CSP), using the installed capacity and power generation datasets from the IRENA database[238]. For CSP, a projected value for 2020 (33%) was used, drawn from the IEA Energy Technology Perspectives 2016 report.[239] In the absence of country-specific capacity factor data, the average of all countries with values was used as a proxy. For any project with multiple renewable technologies, the capacity factor was defined as the mean of the capacity factor values of RE technologies involved in that particular project.

Table 2: Country-specific average capacity factors by renewable technology.

Country	Solar	Wind	Hydro	Bioenergy/ waste	Geothermal
Range for the countries in which projects were implemented	5-20%	10-36%	10-84%	N/A	42-84%
Simple average across all countries in the IRENA database*	15%	22%	42%	40%	63%

**Average values are used as proxies.*

Source: Calculations based on IRENA (2016).

1.4 GRID ELECTRICITY CO_2 EMISSION FACTORS (EF)

Grid electricity CO_2 emission factors (tCO_2/MWh) were obtained from the Clean Development Mechanism (CDM) grid emission factors database (version 13 January 2017) published by the Institute for Global Environmental Strategies (IGES)[240]. Among three different emission factors, the combined margin emission factors were used for both RE and EE projects. Because the database only covers countries with CDM projects, regional average values were used for other countries. The countries that are not covered by the IGES database (by region) are:

- **Asia:** Cook Islands, Kiribati, Maldives, Marshall Islands, Myanmar, Nepal, Palau, Reunion, Samoa, Solomon Islands, Timor Leste, Tonga and Vanuatu.
- **Latin America:** Antigua and Barbuda, Barbados, Dominica, Guadeloupe, Haiti, St. Lucia, St. Vincent and Grenadines and Suriname.
- **Africa:** Algeria, Benin, Botswana, Burundi, Cabo Verde, Cameroon, Chad, Congo, Congo DR, Djibouti, Equatorial Guinea, Ethiopia, Gambia, Guinea, Guinea-Bissau, Liberia, Lesotho, Malawi, Mauritania, Mozambique, Niger, Seychelles, Togo and Zimbabwe.
- **Middle East:** Iraq and Yemen.
- **Others:** Afghanistan, Belarus, Kazakhstan, Kyrgyzstan, Moldova, Tajikistan, Turkey.

For biomass-fired power plants, an attempt was made to make simplified yet robust estimates on GHG emissions resulting from bioenergy production, but it was not possible due to the lack of data that can be applied to the specific set-up of each bioenergy project analysed in this study.

1.5 CALCULATED MITIGATION IMPACTS FOR THE PROJECT DATASET ASSESSED IN THIS REPORT

Table 3. presents total CO_2 emission reductions expected in 2020 from 273 RE and EE projects per area and technology analysed in this study.

Table 3: CO_2 emission reductions expected in 2020 from 224 RE and EE projects analysed in this study.

Area/technology	Number of projects	Annual emissions reduction ($MtCO_2$/yr)	Finance committed (million current USD)
RE	**197**	**84.9**	**20,142**
Solar Thermal	11	2.2	1,948
Geothermal	17	14.9	6,066
Hydro	29	2.5	1,567
Solar PV	39	36.7	2,719
Wind	44	15.4	4,281
Biomass/waste	19	0.2	324
Multiple RE	38	13.1	3,237
RE/EE	**14**	**59.2**	**926**
EE	**62**	**113.8**	**10,831**

1.6 SCALED UP MITIGATION IMPACTS USING DEVELOPMENT FINANCE COMMITMENTS

To quantify the total mitigation impact in year 2020 delivered by bilateral- and multilateral-supported RE projects implemented from 2005 - 2015, the aggregated mitigation impact for 2020 calculated for the 273 projects was scaled up using the total finance committed (in million current US dollars) in approximately the same period. Data on financial commitments to renewable technology projects were obtained from the OECD Development Assistance Committee (DAC) database[241] for the years 2005 to 2015 (Table 4: Total amount of development finance committed to RE projects by all supporting partners between 2005 and 2015 (million current US dollars). Note: data for 2016 is not yet available at the time of writing.

The OECD DAC database does not provide finance figures for energy efficiency projects. Therefore, an assumption was made on the ratio between of finance for RE and EE projects; the ratio for 2014 estimated by Climate Policy Initiative (CPI) in 2015.[242, 243] was also assumed for the period 2005–2020.

Mitigation impacts were scaled up for each RE category. Shown in Table 4., the data comprised all renewable technologies and a category was added for projects with multiple RE technologies. For the scaling up calculations, finance data categorized as "multiple RE technologies" was proportionally distributed to individual renewable energy categories, while finance and carbon mitigation data categorized as "RE/EE" was divided equally among the two categories. The results were summed to achieve a total renewable funding per technology. Solar PV and solar thermal projects are scaled up collectively as "solar energy" projects. The results are shown in Table 5.

It should be noted that the estimated CO_2 emissions reductions from bioenergy projects, which are uncertain due to the lack of information on land-use related emissions, accounted for less than 1% of total emissions reductions from all RE projects. Therefore, the exclusion of indirect emissions related to biomass production is unlikely to affect our overall results.

Table 4: Total amount of development finance committed to RE projects by all supporting partners between 2005 and 2015 (million current US dollars).

Sector	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	Total
Energy generation, renewable sources – multiple technologies	347	274	363	734	1,172	1,799	2,561	1,763	2,030	2,447	1,742	**15,233**
Hydro-electric power plants	480	720	1,181	442	208	716	586	997	1,387	1,285	806	**8,808**
Solar energy	64	53	25	155	328	243	103	621	971	1661	718	**4,942**
Wind energy	126	93	147	322	219	990	78	140	92	488	82	**2,776**
Marine energy		0.4		0.0	0.1	0.1		0.0	0.5	0.1	0.1	**1**
Geothermal energy	225	10	8	3	43	673	397	48	290	606	372	**2,676**
Biofuel-fired power plants	15	20	35	105	132	53	26	43	117	83	71	**701**
Total	**1,258**	**1,171**	**1,760**	**1,761**	**2,102**	**4,474**	**3,751**	**3,612**	**4,886**	**6,571**	**3,791**	**35,137**

Note: data for 2016 is not yet available at the time of writing.

Table 5: Estimated total mitigation impact in 2020 from RE and EE projects financed by bilateral and multilateral institutions between 2005 and 2015.

OECD category	Total finance 2005-2015 (billion current USD)	Expected total emissions reduction in 2020 resulting from finance 2005 – 2016 (MtCO2e/yr)
RE and RE/EE total	**49.4**	**322**
Biofuel-fired power plants	1.67	6.05*
Solar energy	11.6	102.5
Geothermal energy	5.49	16.6
Hydro-electric power plants	24.6	171.1
Wind energy	6.07	26.5
EE total	**26.2**	**332**

** Includes energy projects from waste.*

Several assumptions were made to estimate the expected total mitigation impact from finance commitments made between 2005 and 2020. First, it was assumed that the global finance target of US $100 billion in 2020 will be achieved. Second, half of this US $100 billion was assumed to address mitigation, and half of that figure was assumed to be public finance. This means that the public finance for RE and EE projects would comprise 25% of the US $100 billion. Third, the US $25 billion was assumed to be distributed to RE and EE at the same 2014 ratio as reported by CPI.

REFERENCES

1 U.S. Energy Information Administration (EIA). (2016). International Energy Outlook 2016. Washington, D.C. Available: https://www.eia.gov/outlooks/ieo.

2 International Energy Agency (IEA). (2016). World Energy Outlook. Paris, France. Available: www.worldenergyoutlook.org.

3 Mission2020. 2020: The Climate Turning Point. Available: http://www.mission2020.global/2020%20The%20Climate%20Turning%20Point.pdf

4 UN Environment Programme (UNEP). (2017). The 2017 Emissions Gap Report. Available: http://www.unep.org/emissionsgap/.

5 Frankfurt School-UNEP Centre/Bloomberg New Energy Finance. (2017). Global Trends in Renewable Energy Investment 2017, http://www.fs-unep-centre.org (Frankfurt am Main). Available: http://fs-unep-centre.org/sites/default/files/publications/globaltrendsinrenewableenergyinvestment2017.pdf; REN-21. (2017). 2017 Global Status Report. Available: http://www.ren21.net/wp-content/uploads/2017/06/17-8399_GSR_2017_Full_Report_0621_Opt.pdf.

6 IPCC, 2014: Climate Change 2014: Synthesis Report. Contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Core Writing Team, R.K. Pachauri and L.A. Meyer (eds.)]. IPCC, Geneva, Switzerland, 151 pp.

7 UNEP (2016). The Emissions Gap Report 2016. United Nations Environment Programme (UNEP), Nairobi

8 Pauw, W.P, Cassanmagnano, D., Mbeva, K., Hein, J., Guarin, A., Brandi, C., Dzebo, A., Canales, N., Adams, K.M., Atteridge, A., Bock, T., Helms, J., Zalewski, A., Frommé. E., Lindener, A., Muhammad, D. (2016). NDC Explorer. German Development Institute / Deutsches Institut für Entwicklungspolitik (DIE), African Centre for Technology Studies (ACTS), Stockholm Environment Institute (SEI). DOI: 10.23661/ndc_explorer_2017_2.0.

9 Ibid.

10 REN21 Renewable Energy Policy Database.

11 Renewable Energy Policy Network for the 21st Century (REN21). (2017). Renewables 2017 Global Status Report. Retrieved from: www.ren21.net/gsr.

12 Renewable Energy Policy Network for the 21st Century (REN21). (2017). Renewables 2017 Global Status Report. Retrieved from: www.ren21.net/gsr.

13 NDCs submitted as of late March 2017.

14 Renewable Energy Policy Network for the 21st Century (REN21). (2017). Renewables 2017 Global Status Report. Retrieved from: www.ren21.net/gsr.; UNFCCC. NDC Registry (Interim). http://www4.unfccc.int/ndcregistry/Pages/Home.aspx

15 REN21 Renewable Energy Policy Database.

16 REN21 (2017). 1Gigaton Coalition Survey.

17 REN21 Renewable Energy Policy Database.

18 REN21 Renewable Energy Policy Database.

19 "The Government of India launches an ambitious rooftop solar subsidy scheme", Bridge to India, 4 January 2016, http://www.bridgetoindia.com/blog/the-government-of-india-launches-an-ambitious-rooftop-solarsubsidyscheme/.

20 Roger Sallent, Inter-American Development Bank (IDB), personal communication with REN21, 2 December 2016.

21 Thermal power plants include gas, coal, oil, biomass and multi-fuel (e.g., gas/oil, coal/biomass). PBL Netherlands Environmental Assessment Agency and European Commission (EC) Joint Research Centre. (2016). Trends in Global CO_2 Emissions: 2016 Report (The Hague). Available from: http://www.pbl.nl/en/publications/trends-in-global-co2-emissions-2016-report

22 REN21 Renewable Energy Policy Database.

23 IEA (2016). Medium-Term Renewable Energy Market Report 2016. Paris: IEA. Available: https://www.iea.org/newsroom/news/2016/october/medium-term-renewable-energy-market-report-2016.html

24 IEA. IEA Building Energy Efficiency Policies Database. Available: www.iea.org/beep (accessed 22 November 2016).

25 Eight countries plus EU as of 2014, per International Council on Clean Transportation. (2014). Global Passenger Vehicle Standards. Available: www.theicct.org/info-tools/global-passenger-vehicle-standards.

26 REN21 Renewable Energy Policy Database.

27 Council of European Municipalities and Regions (CEMR) European section of United Cities and Local Governments. (12 May 2015). 1000 Mayors worldwide lead the fight against climate change. Available: http://www.ccre.org/en/actualites/view/3177.

28 Organization of Economic Development (OECD), *Cities and climate change*, (Paris, 2010).

29 Höhne, N., Drost, P., et al., "Chapter Four: Bridging the gap - the role of non-state action", The Emissions Gap Report 2016 (Paris, United Nations Environment Programme (UNEP), 2016).

30 International Energy Agency (IEA), *Energy Technology Perspectives 2016: Towards Sustainable Urban Energy Systems*, (Paris, 2016). Available from: https://www.iea.org/publications/freepublications/publication/EnergyTechnologyPerspectives2016_ExecutiveSummary_EnglishVersion.pdf

31 Ibid.

32 Ibid.

33 Ibid.

34 N. Dubash, D. Raghunandan, Girish Sant, and Ashok Sreenivas, "Indian climate change policy: exploring a cobenefits based approach", *Economics Politics Weekly vol 22*, No. 22 (2013).

35 A. Gouldson, N. Kerr, F. McAnulla, S. Hall, S. Colenbrander, A. Sudmant, J. Roy, S. Sarkar, D. Chakravarty, and D. Ganguly, "The economics of low carbon cities", *Kolkata: Centre for Low Carbon Futures* (Leeds, 2014).

36 S. Akbar, G. Kleiman, S. Menon, L. Segafredo, *Climate-smart development: adding up the benefits of actions that help build prosperity, end poverty and combat climate change* (The ClimateWorks Foundation and the World Bank, 2014). Available from http://documents.worldbank.org/curated/en/794281468155721244/Main-report

37 D. Millstein, R. Wiser, M. Bolinger, and G. Barbose, "The climate and air-quality benefits of wind and solar power in the United States", *Nature Energy vol 6* (2014), p.17134.

38 Jan Beermann, Appukuttan Damodaran, Kirsten Jörgensen, and Miranda A. Schreurs. "Climate action in Indian cities: an emerging new research area", *Journal of Integrative Environmental Sciences 13*, no. 1 (2016): p. 55-66.

39 S. Akbar, G. Kleiman, S. Menon, L. Segafredo, L. *Climate-smart development: adding up the benefits of actions that help build prosperity, end poverty and combat climate change.* (The ClimateWorks Foundation and the World Bank, 2014). Available from http://documents.worldbank.org/curated/en/794281468155721244/Main-report

40 Thomas Day, Niklas Höhne, and Sofia Gonzales, *Assessing the missed benefits of countries' national contributions Quantifying potential co-benefits.* (Bonn, NewClimate Institute, 2015). Available from: https://newclimateinstitute.files.wordpress.com/2015/10/cobenefits-of-indcs-october-2015.pdf.

41 Ibid.

42 New Climate Economy (NCE). *Seizing the Global Opportunity: Partnerships for Better Growth and a Better Climate* (2015). Available from: http://newclimateeconomy.report/2015/wp-content/uploads/sites/3/2014/08/NCE-2015_Seizing-the-Global-Opportunity_web.pdf.

43 Ibid.

44 A. Dasgupta, "India can save up to 1.8 trillion per year with smart ubran growth," World Resources Institute (WRI), 2 Decmeber 2016. Available from: http://thecityfix.com/blog/india-can-save-up-to-1-8-trillion-per-year-with-smart-urban-growth-ani-dasgupta/.

45 New Climate Economy (NCE). *Seizing the Global Opportunity: Partnerships for Better Growth and a Better Climate* (2015). Available from: http://newclimateeconomy.report/2015/wp-content/uploads/sites/3/2014/08/NCE-2015_Seizing-the-Global-Opportunity_web.pdf.

46 C40 Cities Climate Leadership Group and Arup, *Potential for Climate Action: Cities are Just Getting Started*, (2015). Available from: https://issuu.com/c40cities/docs/c40_citypotential_2015

47 New Climate Economy (NCE). *Seizing the Global Opportunity: Partnerships for Better Growth and a Better Climate* (2015). Available from: http://newclimateeconomy.report/2015/wp-content/uploads/sites/3/2014/08/NCE-2015_Seizing-the-Global-Opportunity_web.pdf.

48 International Energy Agency (IEA),*Energy Efficiency Market Report 2016*, (Paris, 2016). Available from: https://www.iea.org/eemr16/files/medium-term-energy-efficiency-2016_WEB.PDF

49 International Renewable Energy Agency (IRENA), *Renewable Energy Jobs: Annual Review* (Abu Dhabi, 2017). Available from: https://www.irena.org/DocumentDownloads/Publications/IRENA_RE_Jobs_Annual_Review_2017.pdf.

50 C40 Cities Climate Leadership Group, Unlocking Climate Action in Megacities, (New York, 2015) Available from: http://www.c40.org/researches/unlocking-climate-action-in-megacities.

51 Ibid.

52 V. Castán Broto and H. Bulkeley, H., "A survey of urban climate change experiments in 100 cities", *Global Environmental Change* vol. 23 No. 1(2013): p. 92–102.

53 New Climate Economy (NCE). *Seizing the Global Opportunity: Partnerships for Better Growth and a Better Climate* (2015). Available from: http://newclimateeconomy.report/2015/wp-content/uploads/sites/3/2014/08/NCE-2015_Seizing-the-Global-Opportunity_web.pdf.

54 A. Masseen and B. Lefevre, "4 Keys to Unlock Innovative Urban Services for All", (16 February 2016). Available from: http://thecityfix.com/blog/4-keys-unlock-innovative-urban-service-for-all-anne-maassen-benoit-lefevre/

55 Ibid.

56 Global Cities Business Alliance, "How cities and business can work together for growth", (2016). Available from: https://www.businessincities.com/publication/how-cities-and-business-can-work-together-for-growth/

57 Narela waste plant opened, to generate 24 MW power. (11 March 2017). The Times of India. Available: http://timesofindia.indiatimes.com/city/delhi/narela-waste-plant-opened-to-generate-24mwpower/articleshow/57583891.cms.

58 C40 Cities Climate Leadership Group. (15 November 2016). Cities100: Delhi – Turning Waste into Energy and Better Livelihoods. Available from: http://www.c40.org/case_studies/cities100-delhi-turning-waste-into-energy-and-better-livelihoods.

59 Ibid.

60 C40 Cities Climate Leadership Group. (15 February 2016). C40 Good Practice Guides: Delhi - Energy recovery. Available: http://www.c40.org/case_studies/c40-good-practice-guides-delhi-energy-recovery

61 Infrastructure Leasing & Financial Services Limited (IL & FS). Waste to Energy Plant, Ghazipur. Available from: https://www.ilfsindia.com/our-work/environment/waste-to-energy-plant-ghazipur/ (accessed August 2017).

62 C40 Cities Climate Leadership Group. (15 November 2016). Cities 100: Delhi - Turning Waste into Energy and Better Livelihoods. Available: http://www.c40.org/case_studies/cities100-delhi-turning-waste-into-energy-and-better-livelihoods.

63 Infrastructure Leasing & Financial Services Limited (IL & FS). Our Work: Environment. Available: https://www.ilfsindia.com/our-work/environment/ (accessed August 2017).

64 Ibid.

65 C40 Cities Climate Leadership Group. (15 February 2016). C40 Good Practice Guides: Delhi - Energy recovery. Available: http://www.c40.org/case_studies/c40-good-practice-guides-delhi-energy-recovery

66 C40 Cities Climate Leadership Group. (15 November 2016). Cities 100: Delhi - Turning Waste into Energy and Better Livelihoods. Available: http://www.c40.org/case_studies/cities100-delhi-turning-waste-into-energy-and-better-livelihoods.

67 C40 Cities Climate Leadership Group. (15 February 2016). C40 Good Practice Guides: Delhi - Energy recovery. Available: http://www.c40.org/case_studies/c40-good-practice-guides-delhi-energy-recovery

68 Infrastructure Leasing & Financial Services Limited (IL & FS). Waste to Energy Plant, Ghazipur. Available: https://www.ilfsindia.com/our-work/environment/waste-to-energy-plant-ghazipur/ (accessed August 2017).

69 C40 Cities Climate Leadership Group. (15 February 2016). C40 Good Practice Guides: Delhi - Energy recovery. Available: http://www.c40.org/case_studies/c40-good-practice-guides-delhi-energy-recovery

70 Ghazipur landfill solution soon, trial run of waste-to-energy plant to begin. (28 February 2015). Deccan Herald. Available: http://www.deccanherald.com/content/462504/ghazipur-landfill-solution-soon-trial.html

71 Infrastructure Leasing & Financial Services Limited (IL & FS). Integrated Solid Waste Management. Available from: http://ilfsenv.com/Brochures/Integrated-Solid-Waste-Management.pdf (accessed August 2017).

72 C40 Cities Climate Leadership Group. (15 November 2016). Cities 100: Delhi - Turning Waste into Energy and Better Livelihoods. Available: http://www.c40.org/case_studies/cities100-delhi-turning-waste-into-energy-and-better-livelihoods.

73 Pande, A. (1 June 2015). As New Delhi Plant Gears Up to Turn Rubbish into Energy, Community Organizer is Turning Ragpickers into Artisans. *Global Press Journal*. Available: https://globalpressjournal.com/asia/india/as-new-delhi-plant-gears-up-to-turn-rubbish-into-energy-community-organizer-is-turning-ragpickers-into-artisans/.

74 C40 Cities Climate Leadership Group. (15 February 2016). C40 Good Practice Guides: Delhi - Energy recovery. Available: http://www.c40.org/case_studies/c40-good-practice-guides-delhi-energy-recovery

75 Pande, A. (1 June 2015). As New Delhi Plant Gears Up to Turn Rubbish into Energy, Community Organizer is Turning Ragpickers into Artisans. *Global Press Journal*. Available: https://globalpressjournal.com/asia/india/as-new-delhi-plant-gears-up-to-turn-rubbish-into-energy-community-organizer-is-turning-ragpickers-into-artisans/.

76 Ibid.

77 Cut from a different cloth. (14 September 2014). *The Economist*. Available: https://www.economist.com/news/business/21586328-building-business-around-solving-chronic-female-health-care-problem-cut-different.

78 Tiwari, P. (July 2016). How Ghazipur wastepickers became flower artists, shareholders *Kenfolios*. Available from: https://www.kenfolios.com/gulmeher/

79 Cut from a different cloth. (14 September 2014). *The Economist*. Available: https://www.economist.com/news/business/21586328-building-business-around-solving-chronic-female-health-care-problem-cut-different.

80 Pande, A. (1 June 2015). As New Delhi Plant Gears Up to Turn Rubbish into Energy, Community Organizer is Turning Ragpickers into Artisans. *Global Press Journal*. Available: https://globalpressjournal.com/asia/india/as-new-delhi-plant-gears-up-to-turn-rubbish-into-energy-community-organizer-is-turning-ragpickers-into-artisans/.

81 Ibid.

82 Chaudhary, R. and Verick, S. (2014). Female labour force participation in India and beyond. International Labor Organization. Available from: http://www.ilo.org/newdelhi/whatwedo/publications/WCMS_324621/lang--en/index.htm

83 C40 Cities Climate Leadership Group. (15 November 2016). Cities 100: Delhi - Turning Waste into Energy and Better Livelihoods. Available: http://www.c40.org/case_studies/cities100-delhi-turning-waste-into-energy-and-better-livelihoods.

84 C40 Cities Climate Leadership Group. (15 February 2016). C40 Good Practice Guides: Delhi - Energy recovery. Available: http://www.c40.org/case_studies/c40-good-practice-guides-delhi-energy-recovery.

85 India's largest waste-to-energy plant to be launched at Narela-Bawana in March. (18 February 2017). *The Economic Times*. Available: http://energy.economictimes.indiatimes.com/news/power/indias-largest-waste-to-energy-plant-to-be-launched-at-narela-bawana-in-march/57217386.

86 C40 Cities Climate Leadership Group. Good Practice Guide: Creditworthiness. Available: http://www.c40.org/networks/creditworthiness (accessed August 2017)

87 Kampala Capital City Authority. Kampala Climate Change Action. Available: https://www.kcca.go.ug/Climate%20Change (accessed July 2017).

88 Kampala Capital City Authority. Kampala City Climate Action Plan Video. Available: https://youtu.be/atdi3DRZRAc.

89 Kampala Capital City Authority. (2015). Kampala Climate Change Action: Energy and Climate Profile. Available: https://www.kcca.go.ug/uDocs/Energy%20and%20Climate%20Profile.pdf.

90 Kampala Capital City Authority.(2016). Kampala Climate Change Action Strategy. Available: http://www.kcca.go.ug/uDocs/Kampala%20Climate%20Change%20Action.pdf.

91 Interview with Kampala Capital City Authority staff members, 3 August 2017.

92 Kampala Capital City Authority.(2016). Kampala Climate Change Action Strategy. Available: http://www.kcca.go.ug/uDocs/Kampala%20Climate%20Change%20Action.pdf.

93 Kampala Capital City Authority. Kampala Climate Change Action. Available from: https://www.kcca.go.ug/Climate%20Change (accessed July 2017).

94 Interview with Kampala Capital City Authority staff members, 3 August 2017.

95 Kampala Capital City Authority, Expertise France, and SIMOSHI (2017). Institutional Improved Cook Stoves in 15 KCCA Schools pilot Project supported by Expertise France.

96 Ibid.

97 SIMOSHI Ltd. Projects. Available: http://www.simoshi.org/projects/ (accessed September 2017).

98 Fallon, A. (10 June 2016). Kampala aims to lead African cities in fight against climate change. Citiscope. Available: http://citiscope.org/story/2016/kampala-aims-lead-african-cities-fight-against-climate-change.

99 Ibid.

100 Kampala Capital City Authority. Kampala Climate Change Action: Energy and Climate Profile. Available: https://www.kcca.go.ug/uDocs/Energy%20and%20Climate%20Profile.pdf.

101 Fallon, A. (10 June 2016). Kampala aims to lead African cities in fight against climate change. *Citiscope*. Available: http://citiscope.org/story/2016/kampala-aims-lead-african-cities-fight-against-climate-change.

102 Global Alliance for Clean Cookstoves. (6 April 2016). Alliance Launches 'Fumbalive' Cookstoves Campaign in Uganda. Available: http://cleancookstoves.org/about/news/04-06-2016-alliance-launches-fumbalive-cookstovescampaign-in-uganda.html.

103 Kampala Capital City Authority. Kampala Climate Change Action: Energy and Climate Profile. Available: https://www.kcca.go.ug/uDocs/Energy%20and%20Climate%20Profile.pdf.

104 Kampala Capital City Authority. Kampala Climate Change Action: Energy and Climate Profile. Available: https://www.kcca.go.ug/uDocs/Energy%20and%20Climate%20Profile.pdf.

105 Awamu biomass energy. Available: http://awamu.ug/ (accessed July 2017).

106 Climate and Development Knowledge Network (CDKN). Economic assessment of the impacts of climate change in Uganda – National Level Assessment. Accessed via: Kampala Capital City Authority. Kampala Climate Change Action: Energy and Climate Profile. Available: https://www.kcca.go.ug/uDocs/Energy%20and%20Climate%20Profile.pdf.

107 Kampala Capital City Authority. Kampala Climate Change Action: Energy and Climate Profile. Available: https://www.kcca.go.ug/uDocs/Energy%20and%20Climate%20Profile.pdf.

108 Ibid.

109 C40 Cities Climate Leadership Group. Good Practice Guide: Creditworthiness. Available: http://www.c40.org/networks/creditworthiness (accessed August 2017)

110 C40 Cities Climate Leadership Group. Case Study Cities100: Nanjing – World's Fastest Electric Vehicle Rollout. Available: http://www.c40.org/case_studies/cities100-nanjing-world-s-fastest-electric-vehicle-rollout (accessed August 2017).

111 Ibid.

112 Ibid.

113 Nanjing Think-tank Alliance. (2015). Develop Low Carbon Industries to Promote Building Nanjing as a Low-Carbon Ecological City. Available: http://www.njzx.gov.cn/zxzz_2016/jy_2016/201610/P020161014417408026102.pdf

114 Ibid.

115 Nanjing Municipal People's Government. (2016). 2016 New Energy Automobile Promotion and Application Plan of Nanjing. Available: http://www.nanjing.gov.cn/xxgk/szf/201607/t20160712_4023115.html

116 Up to 80% of Public Buses in Nanjing Could Be Renewable-Powered This Year. (15 April 2017). *Yangtse Evening Post*. Available: http://pic.yangtse.com/epaper/yaowen/2017-04-15/1236337.html

117 Ibid.

118 People's Republic of China Central Government. (2013). Notice of the Ministry of Transport on Issuing Accelerating Development of Green Circular Low-Carbon Transportation. Available from: http://www.gov.cn/gongbao/content/2013/content_2466586.htm.

119 Ministry of Transport and Jiangsu Province Sign Framework Agreement on Developing Green, Circular and Low-Carbon Transportation. (10 June 2013). *Idea Carbon*. Available: http://www.ideacarbon.org/archives/15745

120 Jiangsu Provincial Government Information Hub. Notice of the General Office of Jiangsu Provincial People's Government on Issuing Green, Circular and Low-Carbon Transportation Development Plan of Jiangsu Province (2013-2020). Available: http://www.js.gov.cn/jsgov/tj/bgt/201408/t20140804452293.html.

121 C40 Cities Climate Leadership Group. Case Study Cities100: Nanjing - World's Fastest Electric Vehicle Rollout. Available: http://www.c40.org/case_studies/cities100-nanjing-world-s-fastest-electric-vehicle-rollout (accessed August 2017).

122 China EV Startup Future Mobility to Build $1.7 Billion Factory. (19 January 2017). *Bloomberg News*. Available: https://www.bloomberg.com/news/articles/2017-01-19/china-ev-startup-future-mobility-to-build-1-7-billion-factory

123 Gofun launches in Nanjing, Ease of Parking for Renewable-Powered Cars. (28 March 2017). *Electrical Vehicle Resources*. Available: http://www.evpartner.com/news/64/detail-26143.html.

124 Nanjing and Changzhou Approved as National Low-Carbon Pilot Cities. (18 February 2017). *Xinhua Yangtze River Delta News*. Available: http://csj.xinhuanet.com/2017-02/18/c_136066174.htm

125 Jia, Y. and Yuan, J. (2017). Nanjing's complete industry chain EV operating alliance: How to survive in the face of reduced policy subsidies. *The Paper*. Available from: http://www.thepaper.cn/newsDetail_forward_1776716.

126 United States Environmental Protection Agency. What are the harmful effects of SO_2? Available: https://www.epa.gov/so2-pollution/sulfur-dioxide-basics#effects (accessed September 2017).

127 Vásquez, P., Restrepo-Tarquino, I., Acuña, J., and Vásquez, S. (2017). Women Fostering Energy Efficiency Through Cleaner Production. GEADES-UAO, Univalle and El Castillo.

128 Ibid.

129 Ibid.

130 Ibid.

131 Markham, D. (19 October 2015). How long will solar panels last? CleanTechnica. Available: https://cleantechnica.com/2015/10/19/how-long-will-solar-panels-last/

132 United Nations Framework Convention on Climate Change (UNFCCC). Momentum for Change: Fostering Cleaner Production. Available: http://unfccc.int/secretariat/momentum_for_change/items/9258.php (accessed July 2017).

133 Ibid.

134 Vásquez, P., Restrepo-Tarquino, I., Acuña, J., and Vásquez, S. (2017). Women Fostering Energy Efficiency Through Cleaner Production. GEADES-UAO, Univalle and El Castillo.

135 Vásquez, P., and Restrepo, I. (2016). Women learning alliances for greening manufacturing industries in developing countries. From the 2016 International Conference on Sustainable Development (ICSD), September 21 and 22, 2016: Columbia University, New York, New York. Available: http://ic-sd.org/2017/02/03/proceedings-from-icsd-2016/

136 Vásquez, P., Restrepo-Tarquino, I., Acuña, J., and Vásquez, S. (2017). Women Fostering Energy Efficiency Through Cleaner Production. GEADES-UAO, Univalle and El Castillo.

137 Vásquez, P., and Restrepo, I. (2016). Women learning alliances for greening manufacturing industries in developing countries. From the 2016 International Conference on Sustainable Development (ICSD), September 21 and 22, 2016: Columbia University, New York, New York. Available: http://ic-sd.org/2017/02/03/proceedings-from-icsd-2016/

138 United Nations Framework Convention on Climate Change (UNFCCC). Momentum for Change: Fostering Cleaner Production. Available: http://unfccc.int/secretariat/momentum_for_change/items/9258.php (accessed July 2017).

139 Vásquez, P. and Restrepo, I. (2016). Women learning alliances for greening manufacturing industries in developing countries. From the 2016 International Conference on Sustainable Development (ICSD), September 21 and 22, 2016: Columbia University, New York, New York. Available: http://ic-sd.org/2017/02/03/proceedings-from-icsd-2016/

140 City of Mexico. (2012). Programa de Certificación de Edificaciones Sustentables. Ministry of the Environment. Available: http://martha.org.mx/una-politica-con-causa/wp-content/uploads/2013/09/15-Certificacion-Ed ificaciones-Sustentables.pdf.

141 Trencher, G., Takagi, T., Nishida, Y., Downy, F. (2017). Urban Efficiency II. Seven Innovative City Programmes for Existing Building Energy Efficiency. Tokyo Metropolitan Government Bureau of Environment and C40 Cities Climate Leadership.

142 Tanya Müller García, Secretary of the Environment, Mexico City, email correspondence 14 September 2017.

143 Ibid.

144 Ibid.

145 Interview with Tanya Müller García, Secretary of the Environment, Mexico City, 29 August 2017.

146 Trencher, G., Takagi, T., Nishida, Y., Downy, F. (2017). Urban Efficiency II. Seven Innovative City Programmes for Existing Building Energy Efficiency. Tokyo Metropolitan Government Bureau of Environment, C40 Cities Climate Leadership.

147 Interview with Tanya Müller García, Secretary of the Environment, Mexico City, 29 August 2017.

148 Trencher, G., Takagi, T., Nishida, Y., Downy, F. (2017). Urban Efficiency II. Seven Innovative City Programmes for Existing Building Energy Efficiency. Tokyo Metropolitan Government Bureau of Environment, C40 Cities Climate Leadership.

149 Cuidad de México, Secretaría de Medio Ambiente. Transition and energy efficiency, priority themes for the CDMX, are presented in New York. Available: http://www.sedema.cdmx.gob.mx/comunicacion/nota/transicion-y-eficiencia-energetica-temas-prioritarios-para-la-cdmx-son-presentados-en-nueva-york.

150 Mexico City. (2016). Mexico City's Climate Action Program 2014-2020: Progress Report 2016. Available: http://www.data.sedema.cdmx.gob.mx/cambioclimaticocdmx/images/biblioteca_cc/PACCM-ingles.pdf.

151 Jones, S. (24 April 2014). Can Mexico City's roof gardens help the metropolis shrug off its smog? *The Guardian*. Available: https://www.theguardian.com/global-development/2014/apr/24/mexico-city-roof-gardens-pollution-smog.

152 World Resources Institute. (2016). Mexico City Prioritizes Building Efficiency with New Regulations. http://www.wrirosscities.org/news/mexico-city-prioritizes-building-efficiency-new-regulations.

153 New partnership targets energy consumption in buildings to reduce emissions in Mexico City. (1 April 2015). World Resources Institute. Available: http://www.wrirosscities.org/news/new-partnership-targets-energy-consumption-buildings-reduce-emissions-mexico-city.

154 Bagu, T. et al. (2016). Market Study: Captive Power in Nigeria (A Comprehensive Guide to Project Development). Africa-EU Energy Partnership & Africa-EU Renewable Energy Cooperation Program. Available: http://rean.com.ng/img/market_study_captive_power_nigeria_0.pdf.

155 Kazeem, Y. (21 December 2015). A floating school in Lagos has helped bring solar power to one of the city's oldest slums. Quartz Media. Available: https://qz.com/578843/a-floating-school-in-lagos-has-helped-bring-solar-power-to-one-of-the-citys-oldest-slums/

156 Nigeria's Solar Stylists. (3 March 2017). *DW News*. Available: http://www.dw.com/en/nigerias-solar-stylists/a-38210081.

157 Eitan Hochster, Director of Business Development, Lumos Global, email 17 September 2017.

158 Shalev, A. (9 February 2017). Solar Power Taking Hold in Nigeria, One Mobile Phone at a Time. *Inside Climate News*. Available: https://insideclimatenews.org/news/07022017/solar-energy-nigeria-africa-renewable-energy-climate-change-lumos.

159 Ibid.

160 Interview with Eitan Hochster, Director of Busines Development, Lumos Global, 30 August 2017.

161 Rotshuizen, S. (28 July 2017). From the Practitioner Hub: Interview with Ron Margalit from solar home system provider Lumos. Inclusive Business Accelerator. Available: https://iba.ventures/2017/07/28/from-the-practitionerhub-interview-with-ron-margalit-from-solar-home-system-provider-lumos/.

162 Kazeem, Y. (8 October 2015). Nigerian mobile money leader Paga is doubling down on building a payments giant. Quartz. Available from: https://qz.com/520115/nigerian-mobile-money-leader-paga-is-doubling-down-on-building-a-payments-giant/.

163 Interview with Eitan Hochster, Director of Busines Development, Lumos Global. 30 August 2017.

164 Brent, W. (4 August 2016). In conversation with Leigh Vial. Power for All. Available: http://www.solar-ng.com/2016/08/04/vial-nigerias-solar-revolution-has-begun/

165 Ibid.

166 Agomuo, Z. (24 October 2014). Consumers get succour from renewable energy as power supply challenges persist. Business Day. Available: https://www.businessdayonline.com/consumers-get-succour-from-renewal-energy-as-power-supply-challenges-persist/.

167 Interview with Eitan Hochster, Director of Busines Development, Lumos Global. 30 August 2017.

168 Shalev, A. (9 February 2017). Solar Power Taking Hold in Nigeria, One Mobile Phone at a Time. *Inside Climate News*. Available: https://insideclimatenews.org/news/07022017/solar-energy-nigeria-africa-renewable-energy-climate-change-lumos.

169 Africa Progress Panel. (2015). *Power People Planet Africa Progress Report*. (Geneva: Africa Progress Panel). Accessed via International Renewable Energy Agency (IRENA). (2016). Solar PV in Africa: Costs and Markets. Available: http://www.irena.org/menu/index.aspx?mnu=Subcat&PriMenuID=36&CatID=141&SubcatID=2744

170 Are Off-Grids the Answer to Nigeria's Energy Crisis? Heinrich Boll Stiftung. Available from: https://ng.boell.org/true-cost-electricity (accessed July 2017).

171 Interview with Eitan Hochster, Director of Busines Development, Lumos Global. 30 August 2017.

172 Interview with Uvie Ugono, Founder and CEO, Solynta, 31 August 2017.

173 Rotshuizen, S. (28 July 2017). From the Practitioner Hub: Interview with Ron Margalit from solar home system provider Lumos. *Inclusive Business Accelerator*. Available: https://iba.ventures/2017/07/28/from-the-practitioner-hub-interview-with-ron-margalit-from-solar-home-system-provider-lumos/.

174 Interview with Uvie Ugono, Founder and CEO, Solynta, 31 August 2017.

175 Solar Nigeria Programme, "Solar Nigeria adds 170,000 solar homes in just 1 year" (16 February 2017). Available from: http://www.solar-ng.com/2017/02/16/solar-nigeria-adds-170000-solar-homes-in-just-1-year/.

176 Shalev, A. (9 February 2017). Solar Power Taking Hold in Nigeria, One Mobile Phone at a Time. *Inside Climate News*. Available: https://insideclimatenews.org/news/07022017/solar-energy-nigeria-africa-renewable-energy-climate-change-lumos.

177 Rotshuizen, S. (28 July 2017). From the Practitioner Hub: Interview with Ron Margalit from solar home system provider Lumos. Inclusive Business Accelerator. Available: https://iba.ventures/2017/07/28/from-the-practitioner-hub-interview-with-ron-margalit-from-solar-home-system-provider-lumos/.

178 Thomson Reuters and CDP have collaborated on this report to bring together the latest data from companies that do report emissions and the latest estimates for those which do not or incompletely report emissions. The finance sector was excluded, as there are insufficient estimates on its Scope 3 emissions.

179 This is measured against total anthropogenic emissions, including land use of approximately 52 Gigatons CO_2e. This number includes direct, indirect and value chain emissions (scopes 1, 2 and 3) adjusted for a double counting of 60%.

180 Top 15 in terms of total annual aggregate emissions. In the table, a GHG Index above 100 indicates an increasing emissions trend; a **Revenues Index** above 100 indicates an increasing revenue trend; **a Decoupling Index** above 100 indicates that revenues are increasing faster than emissions; and an **Employment Index** above 100 indicates an increasing employment trend.

181 This is measured against total anthropogenic emissions, including land use of approximately 52 Gigatons CO_2e. This number includes direct, indirect and value chain emissions (scopes 1, 2 and 3) adjusted for double counting of 60%

182 Values which are "N/A" for 2016 are not available yet because they are not provided by the companies in a manner which allows for peer comparison, and therefore require further analysis; all values will be available by end of 2017 and/or in the full Global 250 Report.

183 Note this is an abridged version of case study as it appears in the full Global 250 report.

184 Of the examples of emerging leadership in this report, Total Group represents an underlying thesis that even the most carbon intensive firms have the opportunity for transformative business model change

185 According to Total completed CDP Climate Change information request submissions

186 http://www.annualreports.com/HostedData/AnnualReportArchive/t/NYSE_TOT_2015.pdf

187 Kuramochi et al. (2016) "The ten most important short-term steps to limit warming to 1.5C". Climate Action Tracker. Available: http://climateactiontracker.org/assets/publications/publications/CAT_10Steps_Summary.pdf

188 Mission2020. 2020: The Climate Turning Point. Available: http://www.mission2020.global/2020%20The%20Climate%20Turning%20Point.pdf

189 N. Hoehne, et al. (2015). Developing 2C Compatible Investing Criteria. NewClimate Institute, Germanwatch and 2° Investing Initiative. Available: https://www.newclimateinstitute.files.wordpress.com/2015/11/2criteria-final.pdf

190 Ibid.

191 International Energy Agency. (2017). Energy Technology Perspectives. Available: www.iea.org/publications/freepublications/publication/EnergyTechnologyPerspectives2017ExecutiveSummaryEnglishversion.pdf

192 Asian Development Bank. (2016). The Asian Development Bank and the Climate Investment Funds Country Fact Sheets. Second Edition. ADB Climate Change and Disaster Risk Management Division. Retrieved from: www.adb.org/sites/default/files/publication/167401/adb-cif-country-fact-sheets-2nd-ed.pdf

193 GEF. (2013). GEF Secretariat Review for Full/Medium-Sized Projects. GEF ID: 5340. Retrieved from: www.thegef.org/sites/default/files/project_documents/5340-2013-04-25-152137-GEFReviewSheetGEF52

194 United Nations Environment Programme (UNEP) & Bloomberg New Energy Finance. (2017). Retrieved from: http://fs-unep-centre.org/sites/default/files/publications/globaltrendsinrenewableenergyinvestment2017.pdf

195 International Energy Agency, 2017. Global energy investment fell for a second year in 2016 as oil and gas spending continues to drop. Available: https://www.iea.org/newsroom/news/2017/july/global-energy-investment-fell-for-a-second-year-in-2016-as-oil-and-gas-spending-c.html

196 Frankfurt School-UNEP Centre/Bloomberg New Energy Finance. (2017). Global Trends in Renewable Energy Investment 2017, http://www.fs-unep-centre.org (Frankfurt am Main). Available: http://fs-unep-centre.org/sites/default/files/publications/globaltrendsinrenewableenergyinvestment2017.pdf

197 Organisation for Economic Co-operation and Development (OECD). (2016). Creditor Reporting System. Retrieved from: https://stats.oecd.org/Index.aspx?DataSetCode=CRS1#

198 Organisation for Economic Co-operation and Development (OECD). (2016). Creditor Reporting System. Retrieved from: https://stats.oecd.org/Index.aspx?DataSetCode=CRS1#

199 For this analysis, "implemented" projects are those that have been approved by the end of 2016 and will achieve emissions by 2020.

200 World Bank. (2015). International Financial Institution Framework for a Harmonised Approach to Greenhouse Gas Accounting. Available: http://www.worldbank.org/content/dam/Worldbank/document/IFI_Framework_for_Harmonized_Approach%20to_Greenhouse_Gas_Accounting.pdf

201 Organisation for Economic Co-operation and Development (OECD). (2016). Creditor Reporting System. Retrieved from: https://stats.oecd. org/Index.aspx?DataSetCode=CRS1

202 World Bank. (2015). International Financial Institution Framework for a Harmonised Approach to Greenhouse Gas Accounting. Available: http://www.worldbank.org/content/dam/Worldbank/document/IFI_Framework_for_Harmonized_Approach%20to_Greenhouse_Gas_Accounting.pdf

203 J. Bai. (2013). China's Overseas Investments in the Wind and Solar Industries: Trends and Drivers. Working Paper. Washington, DC: World Resources Institute. Retrieved from: http://www.wri.org/publication/china-overseasinvestments-in-wind-and-solar-trends-and-drivers.

204 Cells shaded grey indicates no data available.

205 Official Development Assistance + Other Official Flows

206 Organization for Economic Cooperation and Development. Creditor Reportign System. Retrieved from: https://stats.oecd.org/Index.aspx?DataSetCode=CRS1#.

207 Agence Française de Développment. (2016). 2015: Our Work Around the World. Retreived from: http://www.afd.fr/webdav/site/afd/shared/PUBLICATIONS/Colonne-droite/Rapport-annuel-AFD-VA.pdf

208 Soular, R. (2016). China becomes world's biggest development lender. The Third Pole. Retrieved from: https://www.thethirdpole.net/2016/06/01/china-becomes-worlds-biggest-development-lender/

209 UK International Climate Finance. (2016). 2016 UK Climate Finance Results. Retrieved from: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/553402/2016-UK-Climate-Finance-Results2.pdf

210 FinnFund. (2016). Annual Report 2015. Retrieved from: http://annualreport.finnfund.fi/2015/filebank/753-Annual_Report_2015.pdf

211 FMO. (2016). 2015 Annual Report. Retrieved from: http://annualreport.fmo.nl/I/library/download/urn:uuid:921394c0-bb5b-45d9-99e9-18d09fd21961/fmo_annualreport2015_online.pdf?format=save_to_disk&text=.pdf

212 The International Climate Initiative (IKI), the German government's climate funding instrument, supplies the funds for many GIZ RE and EE projects. GIZ is the implementing organization for these projects while IKI is the supporting institution.

213 Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH. Projects. Retrieved from: https://www.giz.de/projektdaten/index.action?request_locale=en_EN

214 KfW Development Bank. (24 February 2016). Presentation on KfW Development Bank 2015: Environment and Climate Commitments & CO_2 – Monitoring. Retrieved from: https://urldefense.proofpoint.com/v2/url?u=https-3A__www.kfw-2Dentwicklungsbank.de_PDF_Entwicklungsfinanzierung_Umwelt-2Dund-2DKlima_Zahlen-2DDaten-2DStudien_KfW-2DKlimafinanzierung-2Din-2DZahlen_Umwelt-2DKlimaneuzusagen-2D2015-5FEN.pdf&d=CwIFAw&c=-109dg2m7zWuuDZ0MUcV7Sdqw&r=KjRxMDLnH5mYpLVbZF3u_UtYA0frxBmccQMurQoKFFk&m=z0-IQV0b8MFI57AINkF_zVMGgXCzaqh3KPZ-K_-AgW8&s=W9Ezfc2ZuAIrScF_-IjhjQYyn0PGffRYH23Qo_dQTgA&e=215 Retrieved from: https://www.jica.go.jp/english/publications/reports/annual/2015/c8h0vm00009q82bmatt/c8h0vm00009q82o5.pdf

215 Retrieved from: https://www.jica.go.jp/english/publications/reports/annual/2015/c8h0vm00009q82bm-att/2015_36.pdf

216 Norfund. (2016). 2015 Report on Operations; Norwegian Investment Fund for Developing Countries. Retrieved from: https://issuu.com/merkurgrafisk/docs/norfund_virksomhetsrapport_2016_bla?e=13799334/35569369

217 Overseas Private Investment Corporation. OPIC Annual Report 2015. Retrieved from: https://www.opic.gov/sites/default/files/files/2015annualreport.pdf

218 Global Environment Facility. (2016). About us. Retrieved from: https://www.thegef.org/about-us

219 Climate Investment Funds. (2016). What we do. Retrieved from: http://www-cif.climateinvestmentfunds.org/about

220 Cells shaded grey indicate no data available.

221 Asian Development Bank. (2016). 2015 Clean Energy Investment Project Summaries. Retrieved from: https://www.adb.org/sites/default/files/publication/184537/clean-energy-investment-2015.pdf

222 Asian Infrastructure Investment Bank. (2016). The People's Republic of Bangladesh Distribution System Upgrade and Expansion Project. Retrieved from: https://www.aiib.org/en/projects/approved/2016/_download/bangladesh/summary/bangladesh_distribution_system_upgrade_and_expansion.pdf

223 Climate Investment Funds. (2016). *Empowering a Greener Future: Annual Report 2015*. Retrieved from: http://www-cif.climateinvestmentfunds.org/sites/default/files/annual-report-2015/cif-annual-report-ebook.pdf

224 Climate Investment Funds. (2016). *Empowering a Greener Future: Annual Report 2015*. Retrieved from: http://www-cif.climateinvestmentfunds.org/sites/default/files/annual-report-2015/cif-annual-report-ebook.pdf

225 European Investment Bank. (2016). *2015 Activity Report*. Retrieved from: http://www.eib.org/attachments/general/reports/ar2015en.pdf

226 European Investment Bank. (2015). *2014 Sustainability Report*. Retrieved from: http://www.eib.org/attachments/general/reports/sustainability_report_2014_en.pdf.

227 Green Climate Fund. (2016). Resources Mobilized .Retrieved from: http://www.greenclimate.fund/partners/contributors/resources-mobilized

228 Global Environment Facility. *Behind the Number 2015; A Closer Look at GEF Achievements*. Retrieved from: https://www.thegef.org/sites/default/files/publications/GEF_numbers2015_CRA_bl2_web_1.pdf

229 Global Environment Facility. About Us. Retrieved from: https://www.thegef.org/about-us

230 World Bank Group. (2016). Corporate Scorecards. Retrieved from: http://pubdocs.worldbank.org/en/963841460405876463/WBG-WBScorecard.pdf#zoom=100

231 Proparco. (2016). *Key Figures 2015*. Retrieved from: http://www.proparco.fr/webdav/site/proparco/shared/ELEMENTS_COMMUNS/PDF/Chiffres%20Clefs/Proparco_Key_Figures_2015_UK_Web.pdf

232 World Bank. (2015). International Financial Institution Framework for a Harmonised Approach to Greenhouse Gas Accounting. Available: http://www.worldbank.org/content/dam/Worldbank/document/IFI_Framework_for_Harmonized_Approach%20to_Greenhouse_Gas_Accounting.pdf

233 Frankfurt School-UNEP Centre/BNEF. (2016). *Global Trends in Renewable Energy Investment 2016*. Retrieved from: http://fs-unep-centre.org/sites/default/files/publications/globaltrendsinrenewableenergyinvestment2016lowres_0.pdf

234 Höglund-Isaksson, L., Purohit, P., Amann, M., Bertok, I., Rafaj, P., Schöpp, W., Borken-Kleefeld, J., 2017. Cost estimates of the Kigali Amendment to phase-down hydrofluorocarbons. Environmental Science & Policy 75, 138–147. doi:http://dx.doi.org/10.1016/j.envsci.2017.05.006

235 UN Environment Programme (UNEP). (2017). *The 2017 Emissions Gap Report*. Available: http://www.unep.org/emissionsgap/.

236 International Energy Agency. (2017). Energy Technology Perspectives. Available: www.iea.org/publications/freepublications/publication/EnergyTechnologyPerspectives2017ExecutiveSummaryEnglishversion.pdf

237 Westphal, M. I., Canfin, P. A. S. C. A. L., Ballesteros, A. T. H. E. N. A., & Morgan, J. E. N. N. I. F. E. R. (2015). Getting to $100 Billion: Climate Finance Scenarios and Projections to 2020. *World Resources Institute Working Paper*. Available at: https://www.wri.org/sites/default/files/getting-to-100-billion-final.pdf.

238 IRENA, 2016. Data & Statistics. International Renewable Energy Agency: Abu Dhabi, United Arab Emirates. Available at: http://resourceirena.irena.org/gateway/dashboard/?topic=4&subTopic=15 [Accessed September 20, 2016].

239 IEA, 2016. *Energy Technology Perspectives 2016*. Towards Sustainable Urban Energy Systems, International Energy Agency: Paris, France.

240 IGES, 2016. List of grid emission factors. Update August 2016, Hayama, Japan: Institute for Global Environmental Stratgegies (IGES). Available at: http://pub.iges.or.jp/modules/envirolib/view.php?docid=2136 [Accessed September 30, 2016].

241 OECD, 2016. OECD.Stat: Query Wizard for International Development Statistics. Available at: http://stats.oecd.org/qwids/ [Accessed September 30, 2016].

242 Buchner, B.K., Trabacchi Chiara, Federico, M., Abramskiehn, D. & Wang, D., 2015. Global Landscape of Climate Finance 2015, Climate Policy Initiative.

243 USD 49 billion was identified for renewable energy projects and USD 26 billion for energy efficiency projects.

GLOSSARY

The entries in this glossary are adapted from definitions provided by authoritative sources, such as the Intergovernmental Panel on Climate Change and UN Environment.

Additionality: a criterion that stipulates that emissions savings achieved by a project must not have happened anyway had the project not taken place.

Baseline Scenario: the scenario that would have resulted had additional mitigation efforts and policies not taken place.

Bilateral Development Organization: a bilateral development organization mobilizes public funds from national budgets to finance development initiatives abroad. Some groups also raise capital from private markets and some use both public and private financing in their operations. Development institutions generally finance projects via grants and/or loans distributed to governments of recipient nations, which in turn distribute funding to ministries, local agencies, and firms in charge of project implementation.

Bottom-up analysis: a method of analysis that looks at the aggregated emissions impact from individual renewable energy and energy efficiency projects.

Business as usual: the scenario that would have resulted had additional mitigation efforts and policies not taken place (with respect to an agreed set).

Developing Countries: this report uses the same definition of developing countries as used by organizations such as the IEA or IRENA.[243]

Double counting: the situation where the same emission reductions are counted towards meeting two parties' pledges (for example, if a country financially supports an initiative in a developing country, and both countries count the emissions towards their own national reductions).

Emission pathway: the trajectory of annual global greenhouse gas emissions over time.

International Financial Institutions (IFIs): banks that have been chartered by more than one country.

Multilateral Development Banks (MDBs): financial institutions that draw public and private funding from multiple countries to finance development initiatives in developing countries. These organizations often fund projects in collaboration with each other, employing multi-layered finance agreements that include grants, loans, and leveraged local funding.

Scenario: a hypothetical description of the future based on specific propositions, such as the uptake of renewable energy technologies or the implementation of energy efficiency standards.

Top-down analysis: a method of analysis that uses aggregated data, often supplied by organizations that support renewable energy and energy efficiency projects in developing countries, to determine global impact of a certain policy, measure, group, etc.

ACRONYMS

£	British Pound
€	Euro
2DS	2°C Scenario
B2DS	Beyond 2°C Scenario
AFD	Agence Française de Développement
ADB	Asian Development Bank
APEC	Asia Pacific Economic Cooperation
BAU	Business as usual
BAT	Best available technology
BECCS	Bioenergy with carbon capture and storage
BEIS	UK Department for Business, Energy & Industrial Strategy
AFD	Agence Française de Développement
ADB	Asian Development Bank
CAT	Climate Action Tracker
CCS	Carbon capture and storage
CDP	Carbon Disclosure Project
CF	Capacity factor
CIF	Climate Investment Fund
CO_2	Carbon dioxide
CO_2e	Carbon dioxide equivalent
DEFRA	Department for Environment, Food & Rural Affairs of the United Kingdom of Great Britain and Northern Ireland
DFID UK	Department for International Development of the United Kingdom of Great Britain and Northern Ireland
EC	European Commission
ECOWAS	Economic Community of West African States
EE	Energy efficiency
EIA	Energy Information Administration of the United States of America
EIB	European Investment Bank
EJ	Exajoule
ES	Energy saved or substituted
ETP	Energy Technology Perspectives
EV	Electric vehicle
FIT	Feed-in tariff
JICA	Japan International Cooperation Agency
GDP	Gross domestic product
GEEREF	Global Energy Efficiency and Renewable Energy Fund
GEF	Global Environment Facility
GHG	Greenhouse gas
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit
GNI	Gross national income
Gt	Gigaton
GW	Gigawatt
kg	kilogram
kWh	Kilowatt hours
LED	Light Emitting Diode
LCA	Life-Cycle Analysis
LDV	Light-duty vehicle
IDS	Institute for Development Support
IEA	International Energy Agency
IFI	International Financial Institution Framework for a Harmonised Approach to Greenhouse Gas Accounting
IKI	International Climate Initiative
IPCC	Intergovernmental Panel on Climate Change
IRENA	International Renewable Energy Agency
ISO	International Organization for Standardization
MDB	Multilateral development banks
MWh	Megawatt-hour
NDCs	Nationally Determined Contributions
NDEs	National designated entities
NEEAPs	National Energy Efficiency Action Plans
ODA	Official development assistance
OECD	Organisation for Economic Cooperation and Development
PPA	Power purchase agreement
PV	Photovoltaic
PWh	Petawatt-hour
R&D	Research and development
RE	Renewable energy
REN21	Renewable Energy Policy Network for the 21st Century
REEEP	Renewable Energy and Energy Efficiency Partnership
RPS	Renewable Portfolio Standards
Rs	Indian Rupee
RTS	Reference Technology Scenario
SBCP	Sustainable Buildings Certification Program
SBT	Science-Based Targets
SDGs	Sustainable Development Goals
SE4ALL	Sustainable Energy For All
TWh	Terawatt hour
UNFCCC	United Nations Framework Convention on Climate Change
US $	United States Dollars
WEO	World Energy Outlook
WRI	World Resources Institute
WWF	World Wildlife Fund

IMPRESSUM/PICTURE RIGHTS

Titelpage: People using lights powered by Off-Grid: Electric's solar service, mPower. © Power Africa; Geothermally active ground/ shutterstock, SvedOliver; H'mong ethnic minority children/Laocai, Vietnam; Wind Farm/shutterstock, Mongkol Udomkaew

page 9: Matemwe village, Zanzibar, Sam Eaton/PRI

page 10: Udaipur, India

page 13: Nanjing, China

page 14: World Bank Photo Collections Fotos

page 19: Kuala Lumpur, Malaysia; Hanoi, Vietnam

page 20: Women prepare matoke dish, Kampala © IFPRI/Milo Mitchell

page 22: Jama Masjid, Old Delhi, India

page 23: New Delhi, India; New Delhi, India; Amravati, India

page 24: Kampala, Uganda

page 26: Nanjing Jianye District, China; Nanjing, China; car charger/Flickr, © Håkan Dahlström, CC BY 2.0

page 27: Wikimedia Commons, DKMcLaren, CC BY-SA 4.0

page 28: Cali, Valle Del Cauca, Colombia; Creative Commons licensed by user CoCreatr on Flickr, CoCreatr.typepad.com

page 30: Alameda (central park), Mexico/CityFlickr, Ingrid Truemper, CC BY-NC 2.0; gardens integrated into building/ UnSplash, Oliver Wendel

page 32: Lagos, Nigeria/Flickr, Seun Ismail, CC BY-NC 2.0, Figmentmedia.co.uk; Jessica Seldon, Department for International Development (DFID), CC BY 2.0; Bariadi, Tanzania/Flickr, Russell Watkins, Department for International Development (DFID), CC BY 2.0; Flickr, Russell Watkins/Department for International Development, CC BY 2.0; Uribia, Colombia

page 33: Bariadi, Tanzania, Flickr, Russell Watkins, Department for International Development, CC BY 2.0

page 35: Luxembourg/shutterstock, Vytautas Kielaitis

page 37: Monumento a la Revolucion, Mexico City, Mexico

page 38: India; shutterstock, singh_lens

page 39: Flickr, David Mellis, CC BY 2.0; Mwanza, Tanzania/Flickr, Russell Watkins, Department for International Development (DFID)

page 40: Lambarene, Gabon, Africa; Tay Son street/Hanoi, Vietnam

page 50: Nanjing Yangtze River Bridge/Flickr, Jack No1, CC BY 3.0

page 51: Bariadi, Tanzania/Flickr, Russell Watkins/Department for International Development (DFID), CC BY 2.0

page 54: Hanoi, Vietnam; Hanoi Metro, Hanoi, Vietnam/ wikimedia commons, Autumnruv; CC BY-SA 4.0

page 55: gobi desert, central asia

page 56: Plaza de Caicedo, Cali, Colombia

page 58: Kokemnoure, Burkina Faso

page 59: shutterstock, LIUSHENGFILM

page 62: barefoot-banner.jpg

page 63: Kampala, Uganda

page 69: shutterstock, Srdjan Randjelovic

page 70: Casablanca, Morocco

page 71: Mexico City, Mexico; Rwanda camp for internally displaced people (IDP), Tawila, North Darfur/Flickr, Albert Gonzalez Farran UNAMID, CC BY-NC-ND 2.0

page 74: Morocco, shutterstock

page 75: People using lights powered by Off-Grid: Electric's solar service, mPower. © Power Africa

page 87: Siem Reap, Cambodia

page 89: Isla Contoy, Mexico

UN environment
United Nations
Environment Programme

UN Environment
P.O. Box 30552 Nairobi, Kenya
Tel. ++254-(0)20-762 1234
Fax. ++254-(0)20-762 3927
uneppub@unep.org

Email: 1gigaton@unep.org
www.1gigatoncoalition.org

ISBN: 978-92-807-3671-7
Job Nr. DTI/2132/PA