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Renewable energy and energy efficiency in developing countries: contributions to reducing global emissions

Second Report

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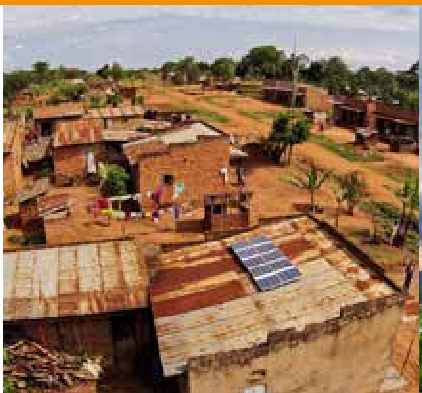

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Renewable energy and energy efficiency in developing countries: contributions to reducing global emissions

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LEAD AUTHORS

NewClimate Institute: Niklas Höhne, Markus Hagemann, Takeshi Kuramochi, Sofia Gonzales, Sebastian Sterl, Thomas Day

Yale University: Angel Hsu, Carlin Rosengarten, Amy Weinfurter, Kaiyang Xu, Chendan Yan

REN21: Hannah E. Murdock, Lorcan Lyons

REVIEWERS

Terje Kronen (Ministry of Climate and Environment), Hans Olav Ibrekk (Ministry of Foreign Affairs, Norway), Ichiro Sato (JICA), Fabian Twerdy (German Environment Agency), Zhao Xiusheng (Tsinghua University), Milena Gonzalez Vasquez (GEF), Christine Lins (REN21), Janet L. Sawin (Sunna Research), Freyr Sverrisson (Sunna Research), Kristin Seyboth (KMS Research and Consulting)

COUNTRY, INITIATIVE AND DATA CONTRIBUTORS

Multi-stakeholder partnerships: Quinn Reifmesser (REEEP), Martin Hiller (REEEP), Eva Oberender (REEEP), Michael Koeberlein (GIZ), Irma Juskenaite (CTCN), Jukka Uosukainen (CTCN), James Morris (CCAC), Tatiana Kondruchina (CCAC), Greet Maenhout (CoM), Amir Bahr (SE4All), Thibaud Voita (SE4All), Lara Younes (IRENA), Dolf Gielen (IRENA), Deger Saygin (IRENA), Elizabeth Smith (ICF), Mohamed Boussaid (4C Maroc)

Case study support:
Birama Diarra (Dèveloppement Direction Nationale de la Mètèorologie, Mali), Xiaodong Wang, The World Bank, El Mostafa Jamea, MENARES Institute, Irene Garcia, World Future Council, Nizhar Marizi, Ministry of National Development Planning/ Bappenas, Indonesia, Kakhaberu Mdivani Kakhaberi, Chief Specialist Climate Change, Mitigation. Ministry of Environment and Natural Resources Protection of Georgia, Carolina Mena, Dirección Nacional de Energía – Ministerio de Industria, Energía y Minería, Uruguay

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)

PROJECT MANAGEMENT AND COORDINATION:

Zitouni Ould-Dada (UN Environment)
Minori Lee (UN Environment)

DESIGN AND LAYOUT:

Weeks.de Webeagentur GmbH

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FOREWORD

A year ago, world leaders agreed to restrict global warming to 2°C above pre-industrial levels by the end of this century. Yet the latest Emissions Gap Report from UN Environment predicts that we are actually heading for global warming of up to 3.4°C, even with the pledges made in the Paris Agreement on Climate Change. However, it also predicts that cutting greenhouse gas emissions by another quarter could put us on track for that 2°C promise. This second report from the 1 Gigaton Coalition supports those findings by showing how investing in clean energy for developing countries can help close the emissions gap and create sustainable profitable business opportunities.

The vast majority of the national commitments made for the Paris Agreement include energy efficiency. They have major implications for tackling emissions, poverty and health, while creating jobs, better working conditions and economic growth. For example, in Mali, daily life is very difficult for women in rural communities around Mopti. But using solar-powered machinery to make and market agricultural products, at least offers a helping hand. They use more efficient cooking stoves to reduce wood collection by up to 60% and black carbon emissions by up to 90%. As well as the benefits for health and education, the resulting financial security and independence improves life for the community and leads to more women being involved in decision making.

This is just one of the many clean energy projects in developing countries that the report says will reduce emissions by over 100 million tons a year in 2020. More importantly, it gives a good indication of challenges that will arise from scaling up such efforts to tackle the much bigger emissions gap of 12 gigatons needed to reach the 2°C target. As one gigaton is roughly equivalent to the annual emissions from all road, rail and air transport in the European Union, every single gigaton is crucial.

The 1 Gigaton Coalition is supported by the Government of Norway and UN Environment. It supports efforts to reduce emissions by improving the reporting of reductions achieved through renewable energy and energy efficiency in developing countries.

Climate change is a serious threat to every nation, but the solutions could unify our efforts to improve life for millions of people on this planet. We have already seen the speed and conviction with which this can be agreed in the Kigali Amendment, which will help avoid half a degree of global warming, accelerate cleaner technology and improve energy efficiency.

This latest report from the coalition launches just as the Paris Agreement enters into force and just before the signatories gather in Marrakech for this year's climate talks. We hope its methods and findings will inspire public and private sector decision makers involved in those discussions to take bold action; not only to deliver the vital 2°C target, but to start moving towards the even safer 1.5°C limit.

H.E. Børge Brende
Minister of Foreign Affairs
Norway

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

KEY FINDINGS

- **INTERNATIONALLY SUPPORTED RENEWABLE ENERGY AND ENERGY EFFICIENCY PROJECTS** implemented in developing countries from 2005 to 2015 are projected to reduce greenhouse gas emissions by 0.4 Gt per year by 2020. If scaled up using international climate financing commitments, these efforts could achieve 1 Gt of annual reductions by 2020.
- **INTERNATIONAL SUPPORT FOR INVESTMENTS IS CRUCIAL** to create an enabling environment for renewable energy and energy efficiency in emerging markets. This support comprises less than 10% of global investments in RE and EE, yet it has an outsized impact.
- **METHODOLOGICAL HARMONISATION FOR ACCOUNTING GHG REDUCTIONS** from these projects has progressed, but more efforts are needed to ensure consistency and enhance information sharing.
- **DEVELOPING COUNTRIES' STRATEGIC SUCCESSES IN IMPLEMENTING ENERGY INITIATIVES THAT GENERATE EMISSIONS REDUCTIONS** could inspire similar efforts around the world and accelerate global emissions mitigation.
- **THE DIVERSITY AND COMPLEXITY OF ENERGY PROJECTS REQUIRES A ROBUST, REPRODUCIBLE CALCULATION METHODOLOGY.** The 1 Gigaton Coalition will continue to improve GHG estimation methodologies for renewable energy and energy efficiency projects and propose suggestions for developing a comprehensive harmonised methodology.

Wind power in Thailand

EXECUTIVE SUMMARY

Internationally supported renewable energy (RE) and energy efficiency (EE) projects in developing countries significantly reduce greenhouse gas emissions.

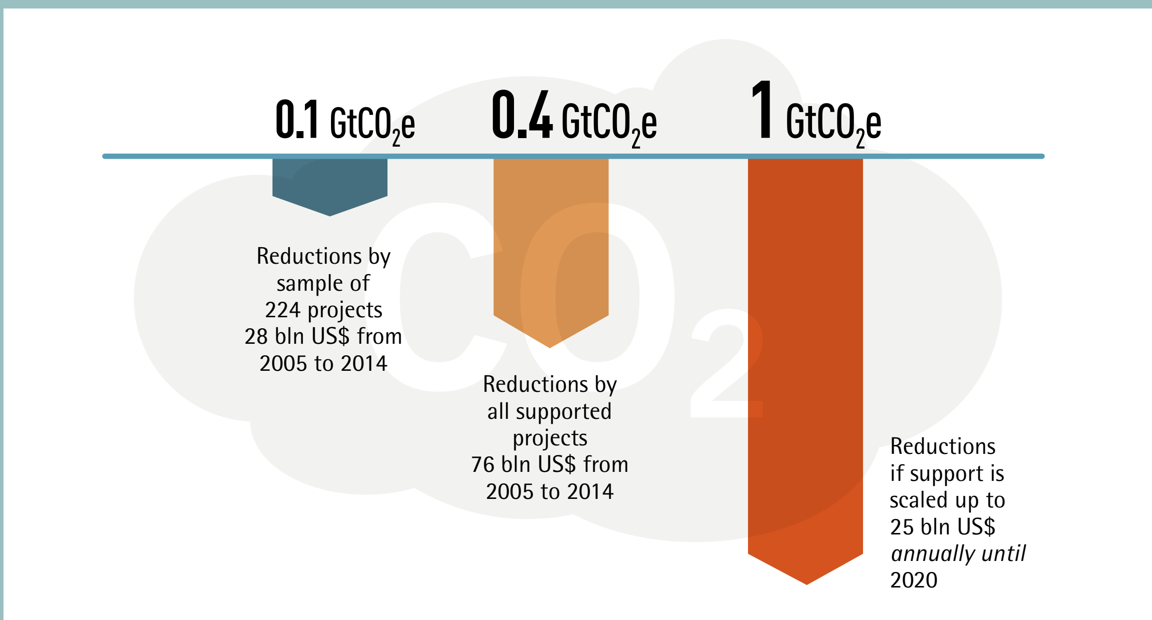
A sample of 224 internationally supported renewable energy and energy efficiency projects in developing countries implemented between 2005 and 2015 reduce greenhouse gas (GHG) emissions by approximately 0.116 gigatons of carbon dioxide (GtCO$_2$) annually in 2020. Data analysed from 224 projects – 173 on renewable energy and 51 on energy efficiency – show how these efforts have reduced emissions by displacing fossil fuel energy production with clean energy technologies and by conserving energy in industry, buildings and transportation. Renewable energy projects contribute approximately 0.049 GtCO$_2$e and energy efficiency projects contribute 0.068 GtCO$_2$e of the total emissions reductions. These projects received direct foreign support totalling US $28 billion. This analysis expands and improves upon the first 1 Gt Coalition report, which examined data from 42 projects (see Annex II for more details).

Total GHG emissions reductions from all internationally supported energy efficiency and renewable energy projects implemented in developing countries between 2005 and 2015 could be up to 0.4 GtCO$_2$e per year in 2020. This estimate is derived by scaling up the analysed sample's emissions reductions to a global level using total bilateral and multilateral support figures for renewable energy and energy efficiency (US $76 billion). These international investments are crucial to create enabling conditions for emerging renewable energy and energy efficiency markets, where there are barriers to private investment.

When public finance for climate mitigation is used to scale up the analysis's sample, GHG emissions would be reduced on the order of 1 GtCO$_2$e per year in 2020. Developed countries agreed in 2010 to mobilise US $100 billion per year by 2020 to help developing countries adapt to the impacts of climate change and reduce their emissions. For this estimate of 1 GtCO$_2$ it is assumed that a quarter of the US $100 billion is public mitigation finance and deployed in the same way as for the 224 analysed projects.

Methodological harmonisation for GHG accounting of renewable energy and energy efficiency projects has progressed, but more efforts are needed to ensure consistency and enhance information sharing. The first 1 Gigaton Coalition report highlighted the challenges inherent to GHG accounting of supported projects. This report describes steps taken towards a unified framework for GHG accounting and the major challenges that remain:

Figure ES: **Emission reduction in 2020 below baseline**



- Reporting from bilateral and multilateral funders should improve methodological information sharing so that aggregate reductions calculations are reproducible. Methods for calculating reductions from energy efficiency projects need particular attention.
- A major challenge to quantifying GHG emission impacts from renewable energy and energy efficiency projects is uncertain implementation status. Often only the implementing agency has current information about a project's status. Improved communication between funders and implementing groups would help clarify project status and enable more accurate and up-to-date estimates of GHG reductions.
- Assumptions about a project's lifetime – the period in which a project generates emissions savings – significantly influence reductions estimates. Separate funders make different assumptions about a projects' lifespan, requiring a common approach to make results comparable.
- There are no harmonised methodologies for projects with indirect effects, including capacity building, policy support, and institution development. These investments comprise a large portion of total renewable energy and energy efficiency support, making their outcomes integral to developing accurate emissions assessments.

The 1 Gigaton Coalition will continue to improve methodologies for estimating GHG emissions reductions from renewable energy and energy efficiency projects and to make suggestions for developing a harmonised method. Any such framework will need to address the challenges described above and in this report, particularly regarding impact attribution, uncertain implementation status, and time frame. New methods will require specific details and information sharing to ensure that accounting is comparable.

Developing countries' strategies for generating low-cost emissions reductions through renewable energy and energy efficiency initiatives can inform similar efforts around the world. The report's case studies describe the many social, economic, and environmental benefits of enhancing renewable energy and energy efficiency, encouraging nations at all development levels to enact robust renewable energy and energy efficiency policies. These studies highlight successful cases of renewable energy and energy efficiency policies at different levels of government and influencing a range of technologies.

- A multi-national supported initiative has helped China dramatically reduce the energy intensity of its highest energy consuming industries, resulting in total emissions reductions of as much as 0.1 $GtCO_2e$.
- Georgia's buildings use 50% more energy per area of floor space than EU nations with a similar climate, underscoring the importance of ambitious energy efficiency programmes that are already having a positive impact on its building stock.
- Indonesia has deployed decentralised renewable energy technologies with a combined capacity of nearly 5 MW, with plans to achieve 13 MW of installed renewable energy capacity by 2020.
- Mali has implemented an agrarian development initiative bringing efficient cookstoves and renewable-powered equipment to women in the country's rural communities.
- Morocco is home to the largest wind energy farm and first solar thermal plant in Africa, powering the country towards its goal of producing 6,000 MW of renewable power by 2020.
- Uruguay's energy efficiency programme in industry resulted in 82,000 MWh of energy savings in 2015 alone.

As support for renewable energy and energy efficiency projects increases and collaboration among funders becomes more common, calculating emissions reductions and attributing these reductions to different funders, initiatives, or policies becomes increasingly difficult. Methodological alternatives that avoid the use of baselines could address this problem. Future approaches could:

- Analyse sectoral emissions as a whole, taking into account all actions instead of attributing reductions to individual projects or actors. This method allows analyses to account for policy interventions – such as capacity building and policy support – that have indirect effects.
- Determine the compatibility of individual investments with requirements for limiting global temperature rise to 1.5°C and 2°C.

While efforts in developing countries represent promising contributions to global climate mitigation, meeting the Paris Agreement's long-term climate goals will require more ambitious renewable energy and energy efficiency initiatives. Only the most ambitious energy efficiency improvements will make it possible to achieve the Paris Agreement's goal to limit global temperature increases to well below 2°C and to work towards a 1.5°C limit. Renewable energy will need to comprise a majority of the world's energy mix by 2050 at the latest, as the energy sector will need to decarbonise by the middle of the century. Such a transition, if done well, will help developing countries meet sustainable development objectives.

1 INTRODUCTION

As the Paris Agreement enters into force less than a year after its adoption, countries are preparing to implement their Nationally Determined Contributions (NDCs), developing plans to reach their targets. Renewable energy (RE) and energy efficiency (EE) initiatives are central pillars of these national plans and will be integral to countries' ability to meet their commitments. The Paris Agreement's goal of limiting global temperature rise to "well below 2 degrees Celsius"[2] and endeavouring to keep average temperature rise below a more ambitious 1.5 degree limit[3] requires greater emissions cuts than countries have pledged. The 2016 United Nations Environment Programme (UN Environment) Emissions Gap Report notes that a substantial emissions gap, estimated at 12 to 14 $GtCO_2e$ in 2030, remains between the world's current emissions trajectory and the 2-degree target.[4] As the IPCC's Fifth Assessment Report[5] makes clear, the world's nations will have to invest in low carbon energy sources and dramatically increase RE and EE efforts in order to close the emissions gap.

Rapeseed flower field in Luoping, China

Energy production and consumption generates two-thirds of global greenhouse gas emissions,[6] meaning that countries must transform how they produce and consume energy to make good on commitments pledged in the Paris Agreement. One half of countries' NDCs[7] explicitly point to RE or EE as main instruments for achieving national targets. The other half will most likely employ RE and EE to meet their stated goals, but do not explicitly highlight these strategies in their NDCs. Countries that enact RE and EE programs will capitalise on the substantial co-benefits these initiatives bring, creating synergies where national objectives – such as energy security, energy access, industrial productivity, and rural poverty reduction – are met by RE and EE improvements.

The Paris Agreement has unquestionably moved the global climate agenda forward, yet the INDCs alone will not meet the Agreement's long-term goals. The 2016 UN Environment Emissions Gap Report finds that human civilization will need to achieve net-zero CO_2 emissions from energy and industry between 2060 and 2075 to limit global temperature rise to 2°C. Current national pledges leave an approximate 7 $GtCO_2e$ gap by 2025 between committed mitigation and a 2°C-compatible pathway, which could be reduced to 4 $GtCO_2e$ if countries' conditional contributions are fully implemented.[8] Worsening climate impacts create added urgency, underscoring the essential importance of raising national ambition to meet the most basic global climate goals. Recent studies on emissions pathways needed to reach a 1.5°C goal show that this target can only be reached by dramatically increasing carbon mitigation, particularly with RE and EE initiatives and especially through enhanced EE in buildings.[9]

There is tremendous potential for RE and EE initiatives in developing countries to mitigate GHG emissions and promote sustainable development, yet these programs' cumulative impacts are not entirely known. This knowledge gap has serious consequences. The lack of information makes it very difficult to perform accurate program evaluations, and successful and scalable strategies are too often overlooked. Without evidence-based reporting, countries are unable to accurately aggregate GHG mitigation estimates. Policymakers are therefore unable to use the benefits and lessons garnered from RE and EE projects to inform policy. The information gap creates a massive missed opportunity for increasing national ambition, as policymakers could use clean energy and EE projects' success stories, including co-benefits, to inform national goals and increase their mitigation targets. Publicly shared and accurate assessments of RE and EE projects are thus an essential component of an effective global movement to prevent catastrophic climate change.

The 1 Gigaton Coalition aims to support these global efforts in developing countries, where growth is accelerating and where most of the potential for energy sector initiatives lies.[10] The Coalition helps build the expertise and support the research necessary to develop improved GHG accounting methods. These tools will help make it possible to analyse RE and EE initiatives that are not captured in UN Environment's Emissions Gap Report or in other assessments of global mitigation efforts. The Coalition aids the development of open accounting metrics for GHG emission reductions resulting from RE and EE activities, to highlight these contributions.

The Coalition focuses on RE and EE actions that result from cooperation between countries and highlights GHG mitigation coming from developing countries. It also studies programs that are difficult to analyse, due to unavailable quantifiable information on project level impacts. The Coalition's first report, released in 2015, quantified emission savings from projects in developing countries supported through bilateral government and non-government initiatives. The report also identified key gaps in existing measurement and reporting frameworks that prevent consistent evaluation of RE and EE project mitigation impacts.

The 1 Gigaton Coalition's second report builds on the first report's analysis, using project-level data to estimate internationally supported RE and EE mitigation potential in developing countries. This year's analysis improves accounting methods and incorporates data on many more RE and EE projects. With a focus on mitigation in the developing world, the 1 Gigaton Coalition fills a critical gap in global understanding of how these initiatives contribute to global mitigation efforts.

This edition of the 1 Gigaton Coalition report adds these contributions to GHG emission accounting efforts: 1) An estimate of the total mitigation impacts from foreign internationally-supported RE and EE in developing countries; 2) An analysis of the role of policies and targets in developing these projects; 3) RE and EE success stories developing countries; 4) Suggestions for improving methodological harmonisation across efforts to estimate RE and EE project-level impacts; 5) GHG emission reductions achieved through supported RE and EE projects; and 6) Next steps needed to increase the information sharing of RE and EE initiatives and metrics. This report combines a high-level examination of national efforts with a bottom-up project-by-project analysis to comprehensively account for the outcomes of RE and EE projects in developing countries.

2 DEVELOPING COUNTRIES' ENERGY EFFICIENCY AND RENEWABLE ENERGY CONTRIBUTIONS TO GLOBAL GHG EMISSIONS REDUCTION

Mopti, Mali

Renewable energy (RE) and energy efficiency (EE) programmes implemented since 2012 by national governments and businesses in developing countries will substantially lower global CO_2 emissions from energy use by 2020, compared to a high-emissions baseline. An analysis of likely emissions scenarios indicates that RE and EE activities in developing countries will abate 4.5 $GtCO_2$ emissions in 2020 compared to the baseline, with EE contributing two-thirds and RE contributing one-third to these emissions reductions.*

This chapter estimates the emissions reductions achieved by RE and EE activities in developing countries. To produce this estimate, the world's current emissions trajectory is compared to a high-emissions baseline. Estimating the emissions impact of RE and EE activities requires assumptions about a hypothetical scenario that would occur without the analysed actions. It is relatively straightforward to calculate an expected emissions trajectory taking RE and EE activities into account, and there is sufficiently robust data supplied by internationally renowned institutions to aid the process.[11] Yet it is inherently difficult to develop an accurate estimate of a baseline. This effort requires a host of assumptions to model how a baseline scenario would have developed given a range of possible influencing factors. It is essential for a rigorous analysis to clearly communicate its baseline assumptions, as well as the reasoning that guided these suppositions, in order to be more widely understood.

When modelling future scenarios, expectations held about the development of a particular trend – e.g. falling costs or a change in public opinion or policy – greatly influence the results. The IEA has provided updated estimates of future RE deployment as part of its World Energy outlook (WEO) series,[12] yet Bloomberg New Energy Finance (BNEF)[13] recently developed projections that show greater RE implementation in the coming decades, based on updated RE development data.[14] Reflecting these different forecasts by the two most prominent sources on energy trend trajectories, this report presents a range of possible RE trajectories. This analysis assumes that China and India's RE development will be stronger than IEA expectations, and data from both BNEF and IEA are used to create a range of potential emissions impacts.

This report assumes a "frozen technology" scenario for both RE and EE as a starting point for creating a baseline. Frozen technology assumes that RE and EE technologies do not develop or improve over time. According to the IPCC,[15] a frozen technology scenario can be simulated by assuming that the energy intensity per unit GDP and the emissions intensity per unit of energy output both remain constant. Employing these assumptions means that emissions growth remains coupled to economic growth. A frozen technology scenario, however, is not likely to be an accurate portrayal of the future. Further assumptions are therefore needed to adjust the scenario and derive an acceptable baseline.

Developing a baseline requires a primary assumption regarding how an economy's energy intensity will change over time. Economies generally undergo predictable structural changes, shifting from agriculture-dominated output to industry, and then yielding a greater share to the service sector. These transformations and their implications for economies' energy intensity should be taken into account when developing energy and emissions forecasts. An estimate of each sector's energy intensity should be developed along with assumptions on how an economy's sectoral shares will change over time. Using an economy-wide energy intensity figure is not sufficient to create a rigorous indicator because such a coarse measure would not account for an economy's structural shifts and would thus confound economic changes with sectoral efficiency gains. Too broad a measure would also make it difficult to discern outcomes from specific policies.[16]

Given developing countries' strong economic growth and rise in energy demand, a static emission intensity would overestimate RE's emissions savings in a baseline calculation. Growth in energy demand outpaces current RE development, which has not significantly reduced emissions intensity reductions to date. In other words, fossil fuel power plants are currently added at the same rate or at a faster pace than RE plants. An assumption must therefore be made regarding the emission intensity of a country's energy sector and how it changes over time.

Policies and technological improvements also contribute to economic energy intensity's dynamism and should be accounted for in analytical projections. As economies grow, technological advancements provide greater utility while inducing a rise in energy use that is less than the accompanied economic growth. These improvements increase economy-wide EE and are an intrinsic part of economic activity, as companies innovate to increase profit.

a This calculation uses a baseline starting in 2012. The project level analysis undertaken in Chapter 5 estimates emission reductions from projects undertaken by bilateral and multilateral funders between 2005 – 2015. The results from both analysis can therefore not be compared.

This analysis's approach accounts for these complex factors, forecasting changes in countries' economic sectors over time, and this section reports projection results that complement UN Environment's 2016 Emissions Gap Report. A distinct baseline was determined for this report based on the same historical data used for the UN Environment Emissions Gap Report's current trend scenario, which includes IEA's energy balances as well as the IEA WEO. This report separates emissions reduction estimates between RE and EE initiatives, providing a detailed analysis that expands upon the Emissions Gap Report's broad approach. This research also incorporates data from as recent as 2015 into its calculations, accounting for technological development and deployment to create the most informed model of future emissions trajectories to date.

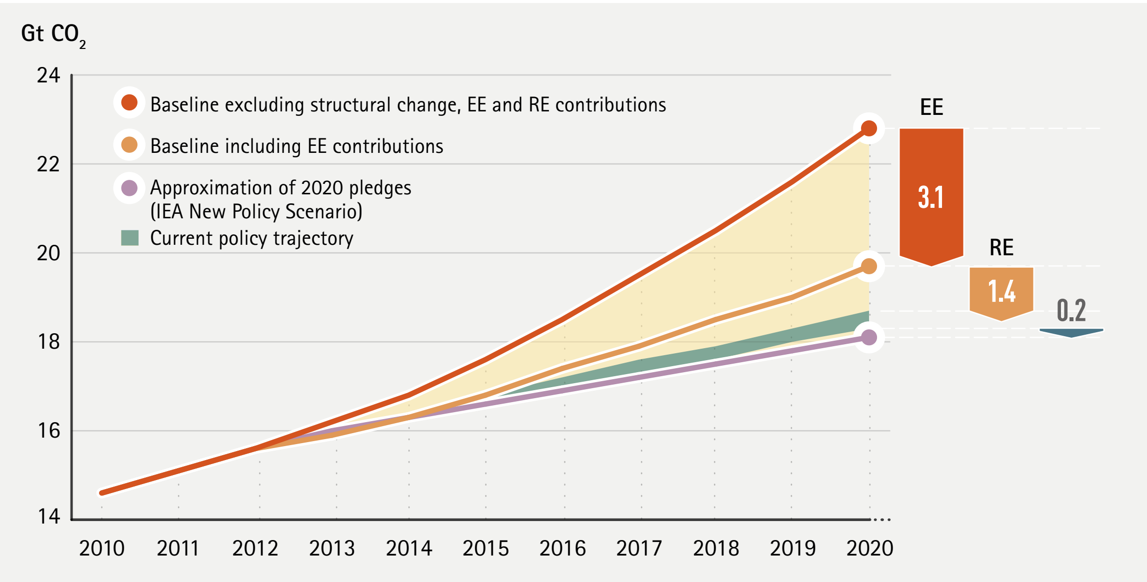
The high-emission baseline scenario developed for this report incorporates the assumption that economic structural changes are taking place in countries in accordance with IEA WEO's projections.[17] This analysis assumes that each economic sector's energy intensity drops by about 1.5% per year, reflecting autonomous gains in EE in these sectors. The high-emission baseline scenario also assumes that RE does not grow, remaining constant at today's levels.

According to this analysis RE and EE activities are projected to achieve emission reductions of approximately 4.5 $GtCO_2e$ in 2020, as shown in the difference between the high-emissions baseline and current policy low-emission trajectories (Figure 1). These figures support the inaugural 1 Gigaton Coalition Report's findings that RE and EE initiatives have achieved significant emission reductions to date and will continue to play a major role in reducing emissions in the future.

Both RE and EE will contribute towards the 4.5 $GtCO_2e$ emissions savings. Approximately two-thirds (3.1 $GtCO_2e$) of these emission reductions can be attributed to increased EE, and one-third (1.4GtCO2e) is due to RE source's increased share in the energy mix. EE achievements can be attributed to productivity increases driven by economic development and by countries gradually implementing EE policies to increase efficiency, energy security, and to meet other national goals. RE advancements result from national policies that encapsulate countries' efforts to deploy renewable power. This progress also reflects global RE market maturation, which has lowered the cost of RE technologies, making them more competitive compared to fossil fuels.

The gap between the national pledges' emissions trajectory and the current policy trend has narrowed from the 1 Gt calculated in the inaugural 1 Gigaton Coalition report to between 0.1 and 0.6 $GtCO_2$, in the year 2020. This trend reflects the fact that countries, with the support of multinational institutions, are continuing to implement RE and EE policies to help them achieve their Intended Nationally Determined Contributions (INDCs) as described in the Paris Agreement. The continued growth in RE and EE also demonstrates that global economic and political trends support RE and EE programmes and technologies. Major emitters, particularly China and India, have adjusted their emissions trajectories to bring them closer to achieving their INDC goals. Non-OECD Asia is projected to produce three-quarters of global emissions in 2030, and yet the region's adoption of RE and EE has substantially contributed to narrowing the emissions gap between the current policy trajectory and what countries have pledged to achieve to 0.1 $GtCO_2$.

Figure 1: **CO_2 emissions from energy use in developing countries under different scenarios.**



3 DEVELOPING COUNTRIES' POLICIES AND TARGETS FOR RENEWABLE ENERGY AND ENERGY EFFICIENCY

For the purposes of this chapter, "developing and emerging countries" (also called "developing and emerging economies") refers to those countries classified as low-, lower-middle-, or upper-middle-income economies by the World Bank. See World Bank website, "World Bank Country and Lending Groups", https://datahelpdesk.worldbank.org/knowledgebase/articles/906519-world-bank-country-and-lending-groups.

Developing countries have increasingly adopted renewable energy (RE) and energy efficiency (EE) targets at the national level, as these countries aim to deploy RE and EE to meet growing energy demand. 2015 saw a spike in new EE target adoption and by year's end 40 developing countries had instituted new EE targets at the national level, bringing the total of developing or emerging countries with EE targets to 67. More than 173 countries, including 117 developing or emerging economies, had established RE targets by the end of 2015 (not including targets outlined in Intended Nationally Determined Contributions (INDCs)). Thirty-eight percent of adopted EE targets are economy-wide, cross-sectoral goals (e.g. economic energy intensity targets). The rest of the EE targets apply to individual sectors, with the most represented sectors being lighting (26%) and buildings (21%).

Nearly half (57 out of 138) of countries with available data have targets for both RE and EE. At least 70 countries have policies or programmes – or both – that combine EE and RE, and at least 73 countries have a government agency that addresses both EE and RE. All but eight of the 192 United Nations (UN) member countries have submitted INDCs to the UN Framework Convention on Climate Change (UNFCCC), with 167 of these commitments and 147 mentioning RE. Seventy-nine developing and emerging countries included EE targets in their INDCs (the equivalent figure for RE targets is 82). The majority of RE targets in developing and emerging countries relate to power generation: 90 of these countries have a target specifically for the share of renewables in electricity, while 21 have similar targets for heating and cooling, and just 12 have targets for transport. The most common type of EE policy instrument is "long-term strategic plan and vision." This category accounts for one-third of 418 policies reported.

As energy consumption and economic output continue to rise, renewable energy (RE) and energy efficiency (EE) efforts in developing countries are also expanding.[18] In 2014, energy demand rose by 2.3% in developing countries,[19] whereas in OECD countries it decreased by 0.7%.[20]

In 2015, installed RE capacity and production increased throughout the world, with net investment in new RE outpacing fossil fuels for the sixth consecutive year.[21] Renewable installed capacity, excluding hydropower, increased from 665 GW in 2014 to 785 GW in 2015, with wind and solar the dominant areas of growth.[22] Reductions in the cost of renewables, particularly solar photovoltaics (PV) and wind power, have led to increases in RE across all sectors.

EE improvements continue to deliver energy savings on every continent as EE programmes merge into the policy and financial mainstream. While crude oil prices reached decade-lows in 2015 and 2016, households, businesses and governments still invested in EE projects to reduce their bills. EE policies – including national action plans, targets, standards, labels, codes, monitoring, auditing, obligation schemes and other regulations – are the main drivers of this investment, with innovation in financing also playing a role.

Distributed RE systems – i.e. non-centralised energy production and transmission – and improved EE in every sector of the economy have the potential to increase energy access and facilitate nationwide delivery of modern energy services in developing countries. These countries' governments are increasing their RE and EE ambition, reflected in new and more transformational targets, while scaling up policy support and investment to achieve their goals. This chapter describes these initiatives in more detail.

This chapter describes the outcomes and achievements of RE and EE initiatives in developing countries. Data collected by REN21 – a global, multi-stakeholder renewable energy and policy network – is used to illustrate targets and policies recently adopted around the world. Six case studies highlight RE and EE achievements in developing countries, demonstrating the strategies governments are using to increase energy savings and expand renewable energy.

3.1 POLICY DEVELOPMENT

In the past decade, governments of developing and emerging countries have expanded and strengthened their RE and EE targets and policies. This section describes the targets and policies in place as of year-end 2015.

3.1.1 TARGETS

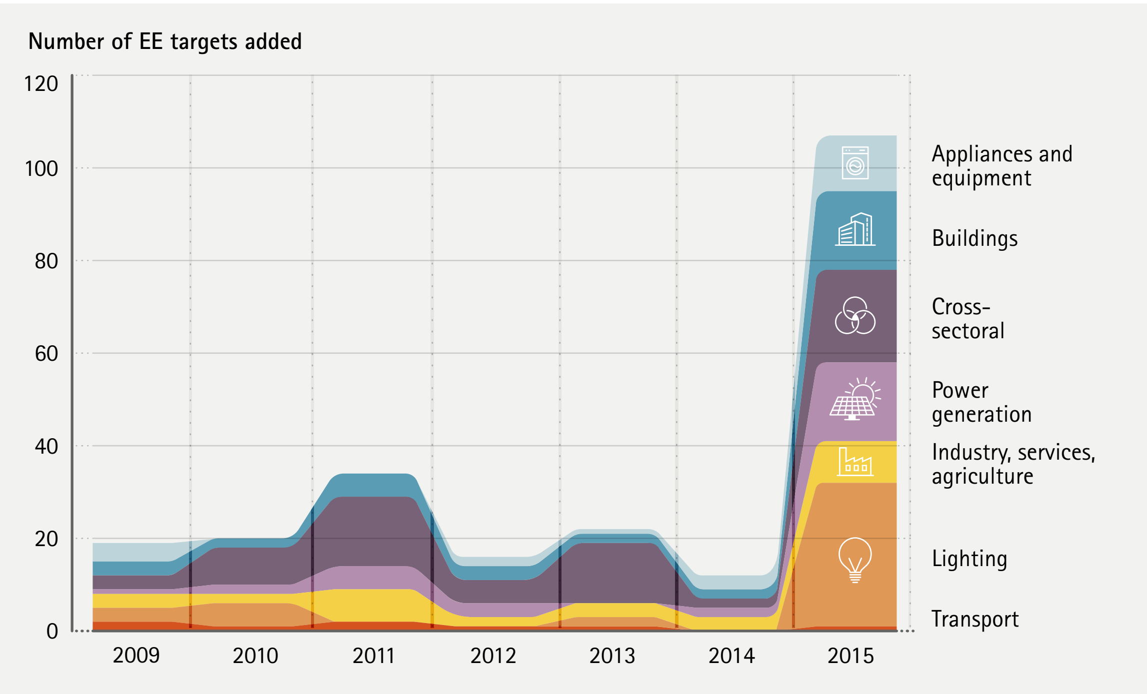
Setting targets help guide policy development and implementation, while goals benchmark a policy's progress. National targets for both RE and EE have become increasingly common and more ambitious in the last decade. In 2015, there was a significant increase in EE target adoption at the country level (Figure 2), bringing the total number of developing countries with EE targets to 67. More than 173 countries had established RE targets by the end of 2015 (not including targets outlined in Intended Nationally Determined Contributions (INDCs)),[23] and 117 of these are developing or emerging economies.

Approximately 38% of adopted EE targets are economy-wide, cross-sectoral goals. The rest of the EE targets apply to individual sectors, with the most prevalent being lighting (26%) and buildings (21%).[25] The lighting sector in particular has benefited from declining light-emitting diode (LED) prices, support from international initiatives such as en.lighten, and green procurement policies in some countries. India's UJALA (Unnat Jyoti by Affordable LEDs for all) scheme, for example, was adopted in 2015 and included in India's INDC, setting a target of replacing 770 million incandescent lamps with LED bulbs by 2019. As of March 2016, UJALA was running in 12 states in India.

Forty developing and emerging countries adopted new EE targets in 2015.[26] Many of these goals were articulated in National Energy Efficiency Action Plans (NEEAPs), particularly in NEEAPS from African countries using a template developed by the Economic Community of West African States (ECOWAS) under SE4ALL.[27] All but eight of the 192 United Nations (UN) member countries have submitted INDCs/NDCs to the UN Framework Convention on Climate Change, with 166 of these commitments mentioning EE.[28] Seventy-nine developing and emerging countries included EE targets in their INDCs (the equivalent figure for RE targets is 82).[29] Brazil, for instance, pledged a target of 10% efficiency gains in the electricity sector by 2030 in its INDC.[30]

EE targets in developing and emerging countries span various timelines, geographical and sectoral areas, and ambition levels for efficiency gains. Some EE targets are

Figure 2: **Energy efficiency targets adopted by developing countries, 2009-2015**[24]



REN21 1Gigaton Coalition Survey, 2016.

Notes: Sub-sector targets and intermediate year targets are included where available. Ex-ante policy impact assessments and targets not yet adopted (e.g. targets mentioned in INDCs but not yet adopted) are excluded where possible.'

articulated in terms of energy savings or reductions in energy consumption, others in terms of improvements in energy intensity, and still others in terms of sales or dissemination of more efficient products. Targets can be classified as cross-sectoral or sector-specific (Figure 3).

Many EE targets in developing and emerging countries are described in terms of improvements in economic energy intensity (e.g. per unit of GDP), rather than real energy savings or reductions in energy consumption – in our dataset there are 25 cross-sectoral energy intensity targets compared to 28 cross-sectoral energy savings targets. ASEAN countries, for instance, have a target to reduce energy intensity by 20% in 2020 compared to 2005. Most developing and emerging countries have experienced rapid growth in GDP and energy consumption in the past decade, with economic expansion generally outpacing growth in energy use.[32]

Cross-sectoral targets are most common for EE in developing and emerging countries, yet there was a surge in new sectoral targets adopted in 2015 (3 above). Transport is still covered, although by fewer targets than other sectors.

EE targets are found at different levels of governance, from cities and other sub-national jurisdictions to regional and national levels. In developing countries, most targets (88%) are at the national level.[33]

Developing countries have increasingly adopted both EE and RE targets. Nearly half (57 out of 138) of countries with available data have targets for both RE and EE. At least 70 countries have either policies or programmes – or both – that combine EE and RE, and at least 73 countries have a government agency that addresses both EE and RE.[34] (See Figures 7 and 8.)

The majority of RE targets in developing countries relate to power generation: 90 of these countries have a target specifically for the share of renewables in electricity, while 21 have similar targets for heating and cooling, and just 12 have targets for transport.[35] (See Figure 4.)

Policy makers in developing and emerging countries often use RE deployment targets to guide power sector development goals, which can include expanding energy access – a crucial policy goal considering that approximately 1.2 billion people live without electricity. In Africa, some countries have established renewable power targets of 70% or greater, including the Republic of the Congo, Eritrea, Gabon, and Namibia.[37] In Latin America, policy makers have likewise set some of the world's highest renewable power share targets, led by Costa Rica, which aims for 100% RE by 2030. Other leaders in the region include Uruguay (95% by 2017), Belize (85% by 2027), Guatemala (80% by 2030), and Bolivia (79% by 2030).[38] Costa Rica has already

Figure 3: **Number of developing and emerging countries with energy efficiency targets by sector and type, end-2015**[31]

Source: REN21 1Gigaton Coalition Survey, 2016.

Notes: Sub-sector targets, intermediate year targets, ex-ante policy impact assessments and targets not yet adopted (e.g. targets mentioned in INDCs but not yet adopted) are excluded where possible. "Other" includes non-specified and greenhouse gas emissions targets.

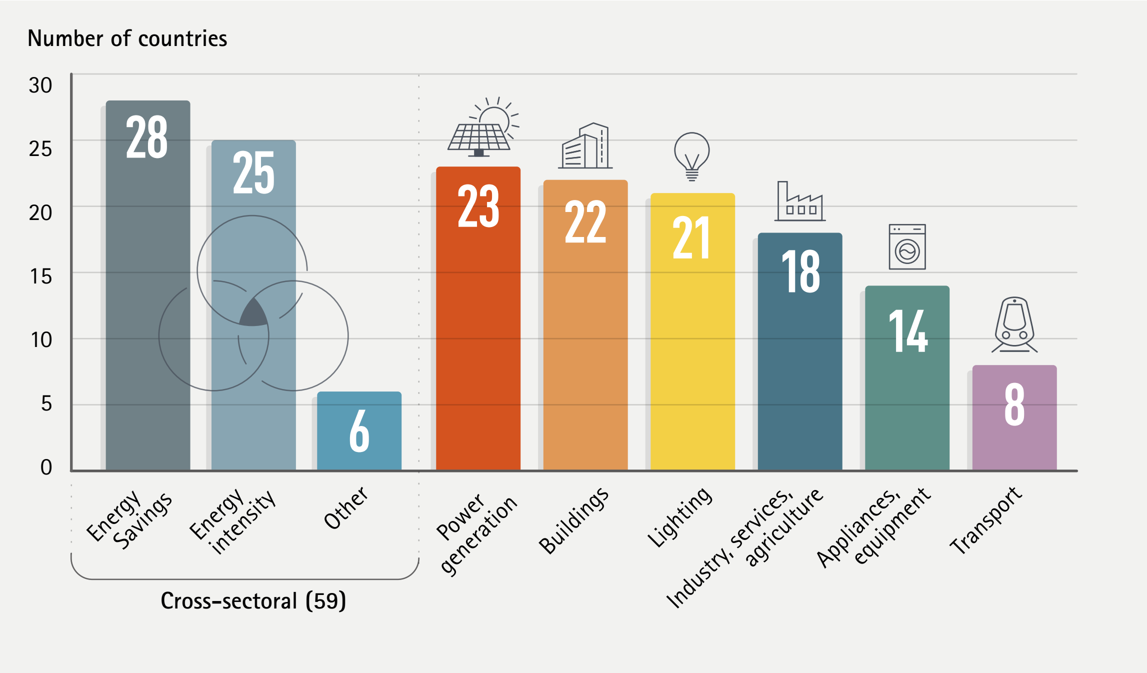
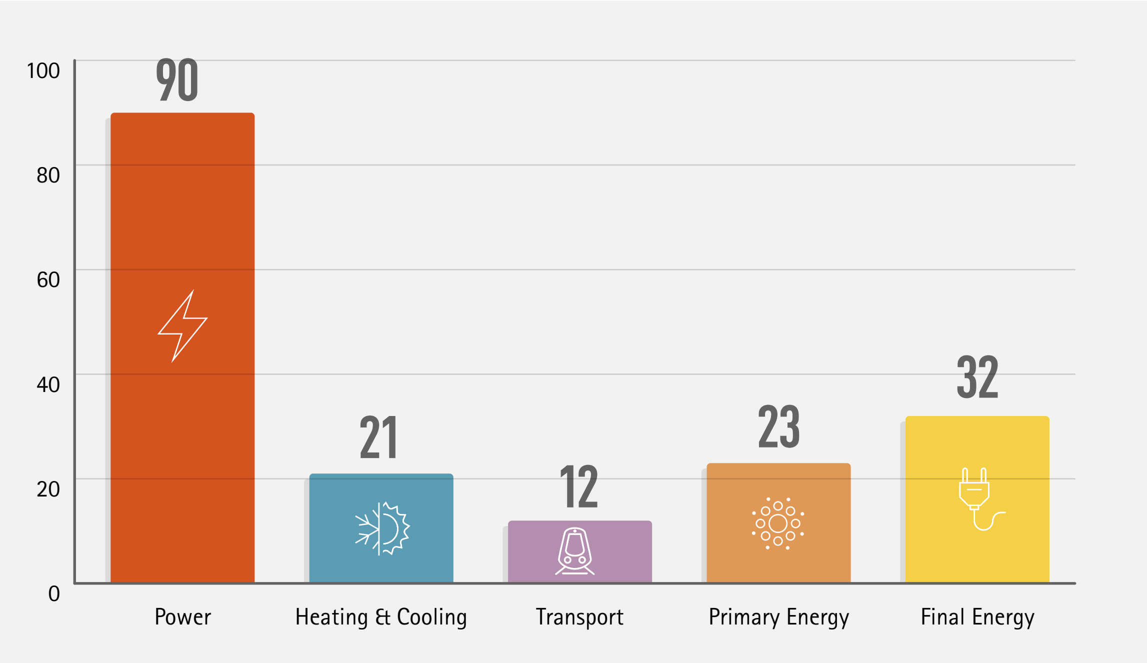


Figure 4: **Number of developing and emerging economies with RE targets by sector and type, end-2015**[b, 36]



Source: REN21 Policy Database, 2016.

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 more than one type of policy in place.

achieved its ambitious RE goal by drawing 100% of its power from renewable sources for two periods of more than two consecutive months in two years, and powering the country for a total of 299 days without fossil fuels in 2015.[39]

Some countries outlined goals in their INDCs to expand the deployment and manufacturing of renewable heating technologies, as part of efforts to decarbonise their heating and cooling sectors. Malawi, for example, introduced a target to manufacture 2,000 solar water heaters, though with no target date specified, and to increase the deployment of solar water heaters from the 2,000 in place in 2015 to 20,000 by 2030.[40] Jordan included a target in its INDC to provide short-term support for the deployment of solar water heaters.[41] These technologies could replace traditional biomass sources[c], (see Mali case study).

A small number of new renewable transport targets were introduced in 2015, mostly as part of INDC submissions. In Africa, Liberia set a vehicle fuels target for blending up to 5% palm oil biodiesel by 2030, and Malawi aims to increase the proportion of vehicles running on ethanol to 20% by 2020.[42] Meanwhile Lao PDR established a target for biofuels to meet 10% of its transport fuel demand by 2025.[43]

The state of implementation to meet these RE and EE targets remains unclear. Many developing and emerging countries do not regularly report on progress towards national goals. And many targets also do not give details on how or when goals are to be achieved.

3.1.2 POLICY INSTRUMENTS

Policy support has contributed to growth in RE and improvements in EE globally. Governments in developing countries use various policy instruments to support RE and EE.

The most common type of EE policy instrument reported is "long-term strategic plan and vision" (Figure 5). These national strategies are intended to guide energy savings programmes over a specified period of time; they sometimes feature specific goals and typically span all major sectors of the economy. This category accounts for one-third of 418 policies reported.[44] Eastern

b *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 more than one type of policy in place.*

c *The world's largest single renewable energy source, for 10% of global primary energy supply, its use can lead to high pollution levels, forest degradation and deforestation.*

European countries, for example, are at various stages of adopting NEEAPs, while China has had a national energy conservation law in place since 2008 and has since strengthened its policy framework for achieving energy savings in successive Five Year Plans (see Georgia and China case studies).

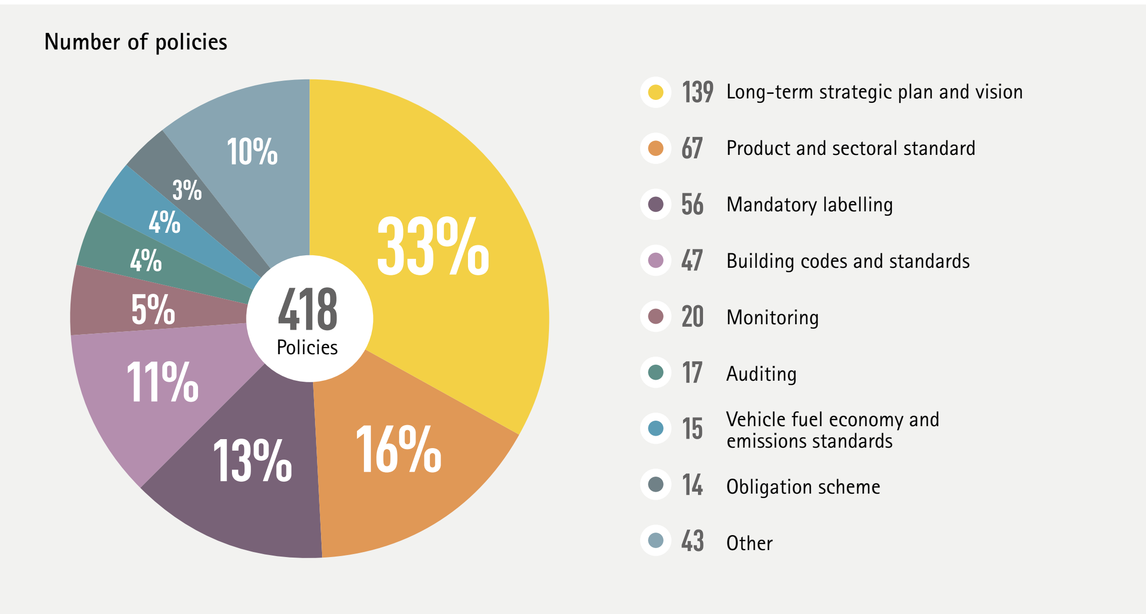
Countries often turn to standards and labelling programmes aimed at market transformation towards more efficient appliances and other products. By 2015, at least 81 countries had implemented these kinds of programmes.[45] There are almost as many reported labelling policies as there are standards, as governments recognise that both are needed in order to "pull" as well as "push" markets towards greater energy efficiency.[46] Standards and labelling programmes, however, pose distinct challenges in implementation. Uganda, for instance, developed Minimum Energy Performance Standards (MEPS) in 2011 for five appliances – refrigerators, air conditioners, motors, lighting appliances, and freezers – but the country has had difficulties implementing this programme, as it has few personnel to enforce the standards, financing challenges, and a lack of testing equipment.[47] Wealthier countries are better able to overcome these challenges. Singapore, for example, successfully extended MEPS to clothes dryers in 2014 and lamps in 2015.[48]

Countries report fewer building codes than standards or labels for products. Building energy codes set minimum EE standards to guide the construction or retrofit of structures. Given the building sector's large energy consumption, comprising more than 30% of world energy demand,[49] and potential for significant improvements, countries should prioritise the development of such codes. It is often useful to distinguish among different categories of building. Tunisia, for example, introduced mandatory building codes for offices and large buildings in 2008, followed by EE specifications for residential buildings in 2009, and voluntary minimum energy performance specifications for hospitals and hotels.[50] West African countries, including The Gambia, are currently (2015-2016) implementing building codes in accordance with the directive on energy efficiency of buildings of the Economic Community of West African States.[51]

Monitoring energy use helps governments and businesses establish a basis for energy management, both in buildings and other sectors. Recognising this fact, Singapore has, since 2013, required more than 165 energy-intensive industrial companies operating within its borders to implement energy management programmes.[52] Energy audits are an important starting point for sound management. These procedures analyse energy flows within an existing building, process or system to identify ways to reduce energy use without negatively affecting output. Several countries, including Morocco since 2011, require energy audits for large energy users.[53] Others, such as Mali, have implemented energy auditing in industrial sectors since 2015, as part of NEEAPs. Some governments have focused on increasing efficiency in transport, often through vehicle

Figure 5: **Energy efficiency policy types in 106 developing countries, end-2015**

Source: REN21 1Gigaton Coalition Survey, 2016.



fuel economy standards. The Philippines implemented such a standard in 2014.[54]

Energy efficiency obligation schemes require energy consumers, suppliers or generators to meet a minimum and usually increasing level of EE, with the aim to decrease energy consumption. These mandates often involve energy efficiency portfolio standards and building energy codes. Obligation schemes are relatively rare in developing countries, but China has had Demand-Side Management Implementation Measures in place for electric utilities since 2010. This mandate requires utilities to develop end-use energy efficiency and load management systems, achieve annual electricity savings of at least 0.3% and reduce peak demand by 0.3%, while encouraging strategic planning to ensure optimal efficiency investments. Once this level of energy efficiency is achieved (the mandate was due to run until at least 2015), the measure is expected to be revised to require companies to take up all available cost-effective end-use energy efficiency resources.[55]

EE policies are often tailored to a specific end-use sector. Each sector differs in terms of the actors involved, the barriers to investment in EE, and other key factors. Table 1 shows the main sectors for each policy type, other sectors that can be covered by the policy type, as well as a few sectors for which a particular policy type may not be suitable.

Ninety-six developing countries had some kind of support policy for renewables as of year-end 2015, the majority of which are focused on the power sector. There are renewable policies specifically for the power sector in 69 of these countries, while 7 have heating and cooling policies and 35 have transport policies (Figure 6).[57] These figures have not increased very much in recent years. Regulatory policies remain the most prevalent instrument dealing with RE, yet other instruments, such as fiscal incentives and public financing, are also commonly utilised.

Feed-in tariff (FIT) policies remain the most widely adopted form of renewable power support, currently in place in 46 developing countries.[58] Prominent recent developments include Algeria implementing a FIT in 2014 for solar PV and wind projects of at least 1 MW; Ghana placing a temporary cap on its FIT to limit utility-scale solar PV until the country can assess the impact of initial projects that are yet to be constructed and connected; Ecuador eliminating FIT support for all technologies; and Costa Rica proposing new FIT rates for solar PV systems.[59]

Tendering – also referred to as competitive bidding or

Table 1: **Eeveloping countries with energy efficiency policies by sector and type, end-2015**[56]

	Cross-sectoral	Power generation	Buildings	Lighting	Industry, services, agriculture	Appliances and equipment	Transport
Long-term strategic plan and vision	42	26	15	13	16	12	15
Efficiency targets	29	17	9	6	8	5	8
Product and sectoral standards	3	2	4	20	6	28	4
Mandatory labelling	4	-	4	18	3	25	2
Building codes and standards	1	1	37	3	2	3	-
Monitoring	5	4	2	1	6	2	-
Auditing	1	1	6	1	7	1	-
Vehicle fuel economy and emissions standards	1	-	-	-	-	-	10
Obligation schemes	2	2	2	2	3	2	1
Other	11	6	5	11	5	4	1

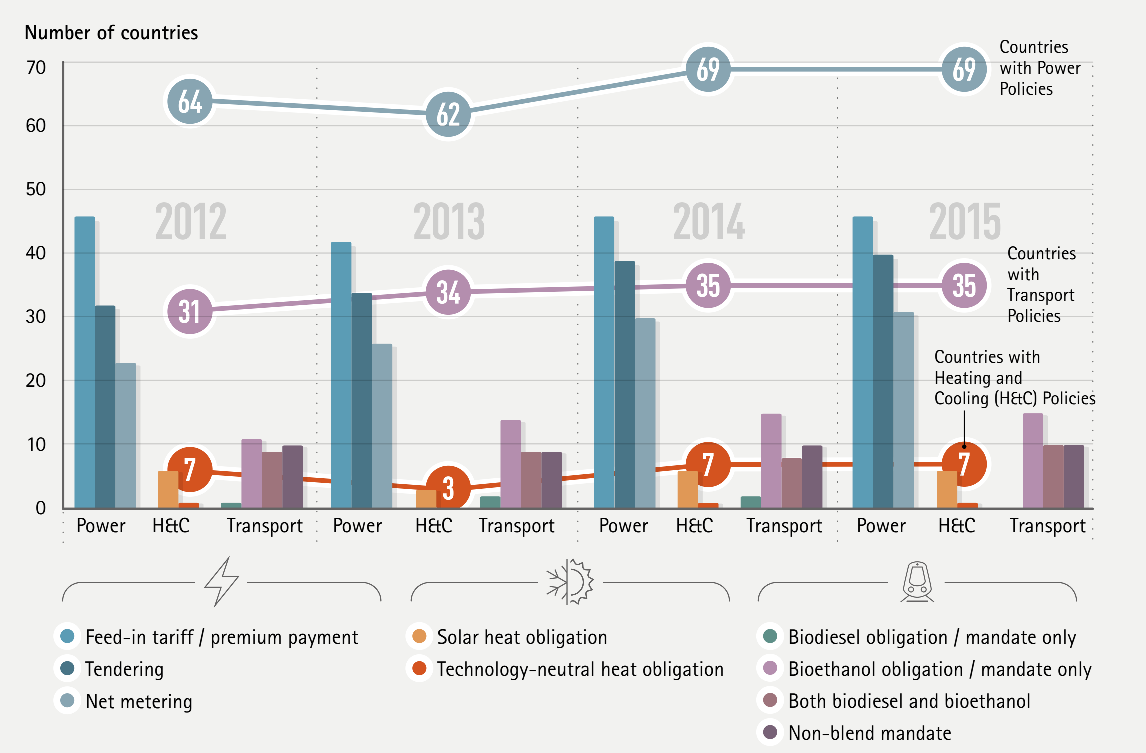
Cells shaded gray designate an absence of policies.

Source: REN21 1Gigaton Coalition Survey, 2016.

Figure 6: **Number of renewable energy policies and number of countries with policies by sector and type, developing countries, end 2015**[60]

Source: REN21 Policy Database, 2016.

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.



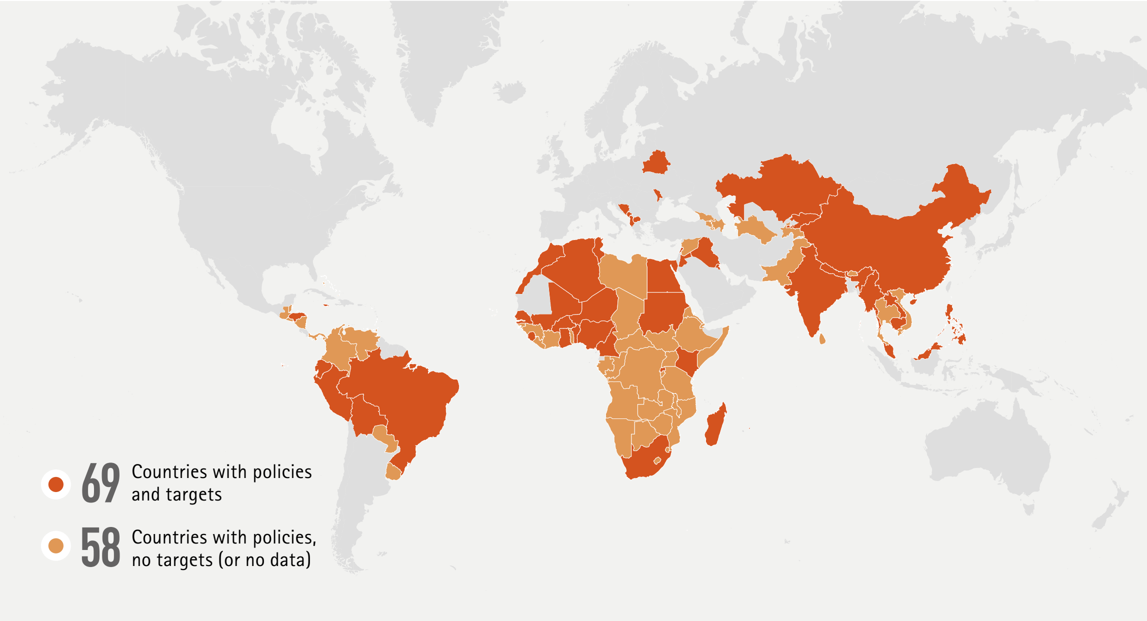
auctioning – has gained momentum in recent years for RE power, and many developing countries attracted bids in 2015 that set records for both low prices and high volumes. Latin America was an early adopter of RE tenders and remained one of the most active regions in 2015. Tendering activity increased in the Middle East-North Africa (MENA) region in 2015, with both Iraq and Jordan holding their first tenders, Morocco awarding 850 MW of new wind projects, and Turkey holding multiple auctions that resulted in bids totalling nearly 15 times the capacity offered. The BRICS countries also continued using tenders in 2015.[61]

Many countries have used public finance mechanisms as part of a suite of policy instruments to stimulate RE investment and increase deployment. In 2015, El Salvador, India, Jordan, Mongolia, and Pakistan all added new policies or extended existing policies in this domain.[62]

The adoption of policies supporting the development and deployment of RE technologies in the heating and cooling sector remains well below that of the power and transport sectors, and the focus is overwhelmingly on heating rather than cooling. Governments in some developing and emerging nations have, however, recognised renewables' potentially significant role in transforming the heating and cooling energy mix. Policy makers in these countries have established regulatory and financial mechanisms to support RE technologies such as solar water heaters and modern biomass heat. Nations typically adopt one of two types of mandates: solar obligations or technology-neutral renewable heat obligations. Solar obligations have been adopted in China, Jordan, Kenya, and Namibia at the national level, and in Brazil and India at the state/provincial level; technology-neutral renewable heat obligations were in place in South Africa by year-end 2015.[63] These countries have also established financial incentives and public financing to support the deployment of renewable heat technologies.

In the transport sector, policy makers have adopted regulatory measures and fiscal incentives to support renewable fuels and electric vehicles (EVs), with biofuel blend mandates as the most commonly used form of regulatory support. Developing and emerging nations have adopted mandates for both biodiesel and bioethanol (10 countries), bioethanol-only (15 countries), and non-blend requirements (10 countries).[64] In 2015, Brazil, Malaysia, and Indonesia increased their blend mandates; Ecuador introduced a new mandate; and Thailand's mandate came into force.[65] Additional RE measures in the transport sector expanded to include auction-based mechanisms, market deregulation, new financial incentives, and public investment schemes.[66] Governments and businesses in several developing and emerging countries have also expressed interest in EVs, but policy makers have yet to adopt measures that directly link these vehicles to renewables.

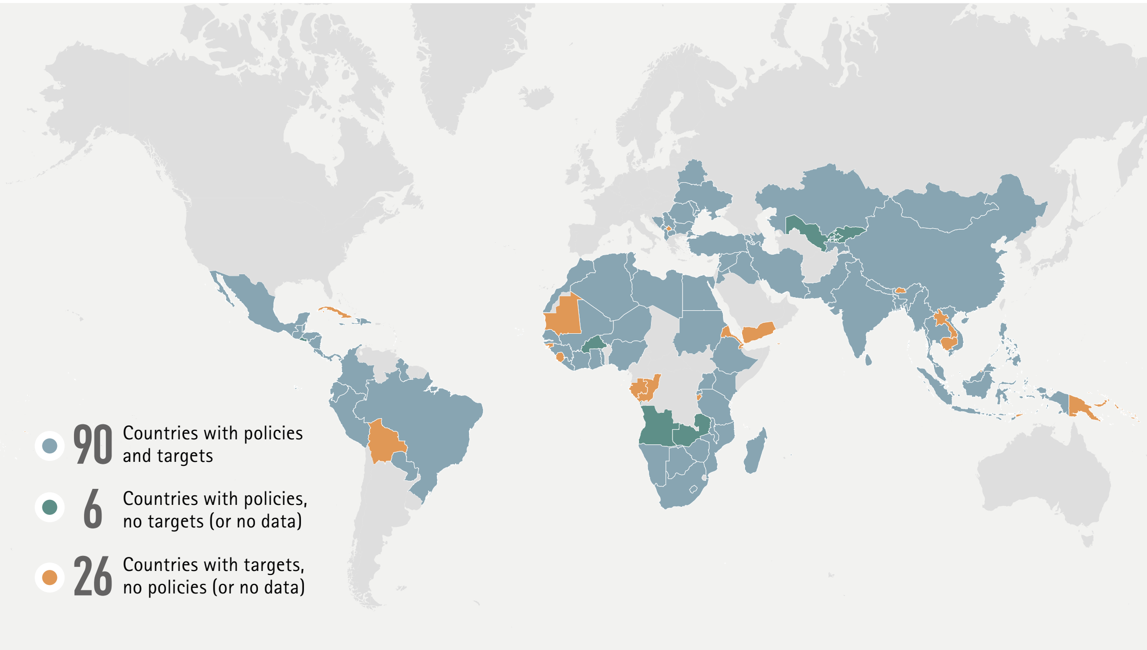
Figure 7: **Developing countries with EE policies and targets end-2015**



Source: REN21 1Gigaton Coalition Survey, 2016.

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

Figure 8: **Developing countries with RE policies and targets (MAP)**



Source: REN21 Policy Database, 2016.

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

3.2 SUCCESS STORIES

Six case studies demonstrate national strategies for supporting and expanding renewable energy (RE) and energy efficiency (EE), at different scales and through a wide range of technologies. These examples also highlight the many social, economic, and environmental benefits of renewable energy and energy efficiency initiatives.

CHINA

Capital	**Beijing**
Area	9,390,000 km^2
Population	1.371 billion
Density	146/km^2
GDP per capita	7,920.00 US$

+6.9%

China's economy annually

18.4%

Renewable Energy Consumption (% of total final consumption), 2012

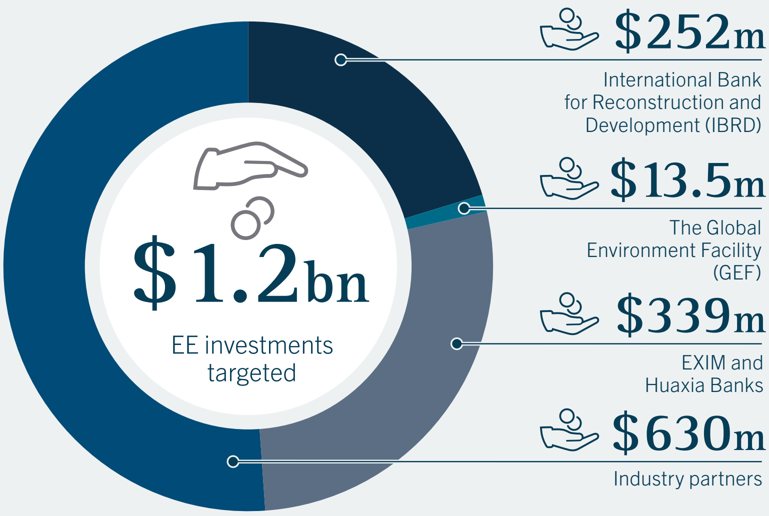
CHEEF I

10.3m

tons in CO_2 emissions reductions (estimate)

The project's first phase, **CHEEF I**, has disbursed **$252 million** (out of an expected $300 million) in loans from the International Bank for Reconstruction and Development (IBRD) to China's EXIM and Huaxia Banks to date. The Global Environment Facility (GEF) has also granted **$13.5 million** for technical assistance to the participating banks and the government. These disbursements have leveraged **$969 million** in cofinancing - **$339 million** from EXIM and Huaxia Banks and **$630 million** from industry partners - amounting to more than **$1.2 billion** in EE investments targeted for medium and large industrial firms.[lxxi]

EE investments



Energy Efficiency

Energy Intensity Level of Primary Energy (MJ $2011 PPP GDP)

2010	8.6
2011	8.5
2012	8.3

CHEEF II

The project's second phase, **CHEEF II**, was approved in June 2010, clearing the path for a $100 million IBRD loan to Minsheng Bank, intended to finance EE projects for selected industrial enterprises. More than 70% of the loan had been disbursed by January 2016, and the remaining $30 million is expected to be in place by the end of 2017.

To date, these loans have leveraged more than $1.5 billion in additional EE investments and renewable commercial lending.[lxxii]

Building on this financing foundation, World Bank approved **CHEEF III** in late 2011, green-lighting an additional $100 million loan from IBRD to China's EXIM bank to pilot energy service company (ESCO) lending and target market segments that previous financing had missed, particularly investments in the building sector.[lxxiii]

Low carbon science and technology museum, Tangshan City, China

FINANCING ENERGY EFFICIENCY | **CHINA**

China has experienced spectacular growth in recent decades. Its real GDP grew 30-fold from 1990 to 2015 and, as its economy has industrialised, energy consumption has risen rapidly, with per capita energy use more than doubling from 2002 to 2013.[67] Much of the growth in energy demand has come from industrial sectors, which, by 2011, consumed approximately 70% of the nation's energy.[68] A decade ago these industries, including steel, fertiliser, cement, and coal-fired power production, were significantly inefficient compared to international best practices.[69]

Recognising the importance of improving the nation's energy efficiency (EE), China's National Development and Reform Commission (NDRC) launched the Medium and Long Term Energy Conservation Plan in 2004, the nation's first program of its kind, which laid out a framework for energy conservation programs through 2020. The national government built on its EE commitments, pledging in its 11th Five-Year Plan for Economic and Social Development to reduce China's economy-wide energy intensity by 20% from 2006 to 2010. In 2006, NDRC issued the "1000 Large Industrial Enterprises Energy Conservation Action Plan," a cornerstone of the government's national efficiency ambitions, which targeted the country's 1,008 largest industrial energy users who account for nearly one third of China's total energy consumption.[70] The government remained committed to improving nationwide EE, pledging a 16% reduction in the economy's energy intensity in the 12th Five-Year Plan, from 2011 to 2015, and an additional 15% in the 13th Five-Year Plan, from 2016 – 2020.[71]

In 2008, China partnered with the World Bank and Global Environment Facility (GEF) to overcome structural barriers to EE financing, launching The China Energy Efficiency Financing (CHEEF) Project, a three-phase financing program designed to fund medium and large industrial EE projects in China.

Having completed phases I and II, the CHEEF program has met most of its project objectives, and in some areas it has exceeded expectations. The World Bank estimates that the more than US $1.2 billion in EE investments that CHEEF's EXIM and Huaxia financing has induced will generate energy savings equal to 2.47 million tons of coal equivalent and 5.93 million tons of CO2 emission reductions.[75] Meanwhile CHEEF's support of Minsheng's EE investments and the Chinese bank's parallel funding in renewable energy (RE) are expected to produce energy savings equivalent to 38.6 million tons of coal.[76] CHEEF project leaders estimate that the program will end up leveraging US $2.5 billion in EE and RE investments, achieving 10.3 million tons in CO2 emissions reductions.[77] These gains have helped China reduce its industrial and national energy intensity every year since the program's inception.[78]

CHEEF has accomplished perhaps its most critical and lasting achievements in capacity building. The project has played a central role in China's efforts to improve EE nationwide and reduce its economy's energy intensity, as CHEEF funds and technical support have helped bring EE investment into the mainstream. Since receiving CHEEF financing and support, China's EXIM Bank has gone from having no EE investments to developing EE lending as a major inhouse business. Huaxia Bank is in the process of setting up a Green Finance Center under its roof while developing results measurement and verification protocols, efforts that are establishing the bank as an industry leader in EE finance.[79]

Along with energy and financial savings, capacity building, and greenhouse gas emissions abatement, the CHEEF program has produced valuable lessons for developing an EE investment sector. With a leverage ratio of 1:4 – meaning that every dollar of original investment resulted in four dollars of co-financing – CHEEF financing has demonstrated that EE financing has the ability to encourage further investments. Recipient banks often repaid loans into the financed project, doubling the program's leveraging effect. The program has also shown that financial institutions can quickly progress from having limited understanding of EE lending to become national leaders in EE finance. The CHEEF program's dedication to institutional capacity building proved crucial for realizing the project's successes. Project leaders provided technical assistance to banks, developing EE lending expertise that will outlast loans and other kinds of support.[80]

The CHEEF program's success derives in part from its grounding in national policy imperatives. The Chinese government's desire to conserve energy and reduce carbon emissions spurred a demand for multi-lateral assistance that CHEEF filled. The program's successes, in turn, energised national EE ambitions, bringing additional attention, expertise, and funding into the burgeoning EE financing sector. CHEEF's cofinanced investments have so far focused mainly on a few heavy industries, iron and steel, cement, and chemicals, and EE technologies – predominantly waste heat recovery. National policies will have to continue to boost efficiency targets to create the demand for the CHEEF program to develop into its third phase, one designed to pilot financing innovations and broaden the project's sectoral scope.[81] Above all, CHEEF has shown how strong national policy and multi-lateral financing can work in harmony to produce strong results in industrial EE.

GEORGIA

Capital	**Tbilisi**
Area	69,700 km²
Population	3.67 million
Density	64/km²
GDP per capita	3,796 US$

Energy efficiency in the nation of Georgia's existing building stock is very low, as is common in the region. The thermal resistance rating of many of the buildings in Tbilisi, Georgia's capital, is three to four times lower than recommended for the local climate zone.[82] Deterioration of buildings that are decades older than their designed lifespans has further reduced the energy performance of these structures. Georgia uses approximately 50% more energy per unit of floor space than EU countries with a similar climate,[83] leading to carbon dioxide emissions of about 2.4 $MtCO_2$ from the country's building sector in 2013.[84]

Causasus

Energy use
per unit of floor space

+50%

compared with EU countries with similar climate

Energy Intensity Level of Primary Energy (MJ $2011 PPP GDP) 2012

5.2

2010

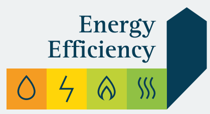
SEAP programme

SEAPs seek to reduce building sector emissions in their 10 cities by an average of 18% by 2020, translating to a total emission reduction of approximately 250 $ktCO_2e$.

250 $ktCO_2e$

TenGeorgian cities, covering nearly 20% of the country's population, submitted Sustainable Energy Action Plans (SEAPs) under the Covenant of Mayors programme as of 2016.

Basic weatherisation renovations, such as the replacement of old window frames…



… could improve energy efficiency for spatial heating by 25% to 30% in most buildings –

… with payback periods as low as 2-3 years.

Georgia is finalising the country's first Energy Efficiency Law, alongside the first National Energy Efficiency Action Plan (NEEAP).

SUSTAINABLE ENERGY ACTION PLANS (SEAPs) FOR ENERGY EFFICIENCY IN BUILDINGS | **GEORGIA**

Energy consumption and emissions in Georgia would be even greater if it weren't for the nation's high level of fuel poverty. Most residential building occupants in Georgia heat only one room of their home, due to high energy costs and energy leakage. The nation's average urban household spent approximately US $45 per month on utility bills in 2015, equal to approximately 25% of the average net monthly income for non-professional trades.[85]

Studies on buildings in Tbilisi show that basic weatherisation renovations, such as the replacement of old window frames, could improve energy efficiency for spatial heating by 25% to 30% in most buildings, with payback periods as low as 2-3 years.[86] Deeper retrofits that address building insulation and install new central heating systems could improve structural energy performance by more than 50%, with payback periods of approximately 6-7 years.[87, 88, 89]

Despite great economic and conservation potential for cost-effective energy efficiency improvements, key barriers have prevented implementation. These challenges include a lack of awareness, lack of common ownership of buildings or effective owners' associations to mobilise investments, and fuel poverty that suppresses energy demand, making cost savings often difficult to achieve in practice. The problems inherent to Georgia's existing buildings are typical of many countries in the region, particularly former Soviet Union states where a history of low energy prices and low-cost construction practices has left a similar legacy on the built environment.

Georgia's government now prioritises action on building energy efficiency and is making efforts to achieve the vast mitigation potential on many fronts. Ten Georgian cities, covering nearly 20% of the country's population, have submitted Sustainable Energy Action Plans (SEAPs) under the Covenant of Mayors programme. SEAPs are subnational strategies, usually at the city level, that propose a voluntary emission reduction target through 2020. The cities' SEAPs include measures to improve buildings' energy efficiency, such as the installation of central heating systems, general refurbishments, and structural insulation in municipal and residential buildings. The SEAPs' proposed programs seek to reduce building sector emissions by an average of 18% by 2020, compared to a baseline scenario, translating to a total emission reduction for the ten cities of approximately 250 ktCO_2e.[d]

The recently published progress monitoring report for Tblisi, the first Georgian city to publish a SEAP in 2011, indicates that mobilising finance will be a major challenge SEAPs' successful implementation.[90] Municipal budgets alone have been used

to finance SEAP measures, with private finance's accessibility remaining lower than anticipated. Financial instruments that leverage funding from the private sector and other stakeholders with vested interests are needed to realise SEAPs' targets. The Government of Georgia is currently designing a nationally appropriate mitigation action (NAMA) for building energy efficiency retrofits, which is expected to identify innovative financial mechanisms for converting the successes of demonstration projects to widespread and replicable action.

SEAPs' development and implementation will be reinforced in the coming years by new national policies. Georgia is currently finalising the country's first Energy Efficiency Law, alongside the first National Energy Efficiency Action Plan (NEEAP), which will launch of the Energy Efficiency Fund, new energy efficiency information systems, and more demonstration projects.[91] Georgia is also in the process of developing the country's first energy efficiency building codes,[92] as required by the EU Association Agreement, adopted in 2014. The recent development of the policy and strategy framework for energy efficiency in Georgia is, in this regard, similar to that of its regional neighbours, such as Armenia, Azerbaijan, Moldova and Ukraine, which have all made important first steps towards developing energy efficiency law, strategy and legislation in recent years.[93]

d Authors' calculation based on analysis of SEAPs available from the Covenant of Mayors website: http://www.covenantofmayors.eu

INDONESIA

Capital	**Jakarta**
Area	1,910,930 km²
Population	257.6 million
Density	142/km²
GDP per capita	3,346.5 US$

Access to electricity
… in Indonesia

81% total

… in Sumba Island

2010 **25%** → 2014 **37%**

Increase in Electricity access 2010 – 2014

Rapid GDP growth

x8 GDP from 1998 – 2011 →

- Rising GHG emissions
- Worsening air Pollution
- Loss of natural Capital
- Environmental challenges

In Indonesia's East Nusa Tenggara province, one island has pledged to generate 100% of its energy through renewable sources by 2025.
Since 2010, the Iconic Sumba Island program has harnessed an increasing share of the 37 MW of potential energy available from the island's solar, water, wind, biogas, and biomass sources.

100% Renewable Energy on Sumba Island

37MW Potential for RE

Installation so far:

- **12** **micro-hydro power** installations
- **100** **wind power** systems
- **14,868** **solar power** systems
- **1,173** **biogas** home installations

The National Energy Conservation Master Plan:

RE share of total energy mix

2016	2019	2025
5%	16%	23%

PILOTING 100% RENEWABLE ENERGY ON SUMBA ISLAND | **INDONESIA**

Indonesia has sustained strong economic growth over the last 15 years, with real GDP expanding eightfold from 1998 to 2011.[94] Natural resource exploitation and industrialization have fuelled this rapid growth, and Indonesia now faces the challenge of reconciling economic development with environmental challenges in the form of "rising GHG emissions, worsening air pollution, and the loss of the significant natural capital and ecosystem services provided by its forests and their underlying biodiversity."[95] Indonesia's extensive coastline and reliance on agriculture and natural resources leaves it especially vulnerable to climate change.[96] The Asian Development Bank estimates global warming could shrink the country's GDP by 2.5% to 7% by 2100.[97]

Renewable energy can help combat these challenges, and in 2015 Indonesia's government announced a national goal to expand the share of renewables in its total energy mix from current levels of about 5% to 16% in 2019,[98] and 23% in 2025.[99] In East Nusa Tenggara province, Sumba Island has pledged to generate 100% of its energy through renewable sources by 2025. Since 2010, the Iconic Sumba Island pprogram has supplied an increasing share of the 37 MW of potential solar, water, wind, biogas and biomass energy sources available. This initiative will help supply the 13 MW the island hopes to generate from all energy sources by 2020.[100, 101]

In addition to offering a model for the rest of Indonesia, this program aims to expand energy access and expand economic opportunity for the island's 656,259 residents.[102] The people of Sumba Island, some of the poorest in the province, live in scattered, remote areas, making grid connections a challenge. Before the Iconic Sumba Island project began in 2010, only 25% of the population had access to electricity, and most households relied on kerosene or diesel fuel for cooking and lighting.[103] As Danny Suhandi, the Head of the Energy and Mineral Resources Office in East Nusa Tenggara, explains, "In Java [a more densely populated Indonesian region], one electricity pole can serve 50 homes. In Sumba, it takes 50 electricity poles to connect to one house."[104]

Focusing on decentralised, small-scale renewable power installations has helped the Iconic Sumba Island program surmount the logistical challenges and high costs of installing power lines, which run an estimated US $22,000 per kilometre.[105] Since 2011, the program has implemented 14,868 solar power units, 1,173 biogas installations, 100 wind power systems, and 12 micro-hydro power plants. Together, these initiatives add up to a renewable energy capacity of 4.87 MW, providing 9.8% of the population with access to electricity, and avoiding 13,804.37 tCO_2 annually.[e] The initiative helped expand the total percentage of the population with access to electricity to 37.4% in 2014.[106]

In addition to lowering power line installation costs, the program has reduced residents' reliance on expensive fossil fuels. Expanding Sumba Island's decentralized approach to renewable development could meet basic energy needs in the isolated and rural off-grid areas spread across Indonesia's 6,000 inhabited islands.[107]

By increasing access to electricity, the Iconic Sumba Island program has enabled new economic ventures. Solar water pumps and biogas fertilisers make it possible to expand local agricultural operations into former off-seasons, while lamplight allows children to study and artisans to work after the sun sets.[108, 109] An increased ability to charge mobile phones has strengthened rural health networks and enabled quicker responses to patients in need, resulting in strong improvements in maternal and infant health.[110]

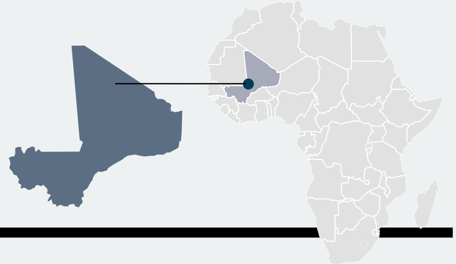
The Iconic Sumba Island program's achievements rest, in part, on a thorough understanding of renewable energy's environmental and social benefits. A detailed survey of the island's renewable energy potential and of households' willingness to pay for off-grid electricity and energy networks guided the creation of a least-cost electrification plan.[111] The program also combines the perspectives of multiple stakeholders, including the Directorate General of New & Renewable Energy and Energy Conservation within the Ministry of Energy and Mineral Resources; the provincial government of Nusa Tenggara Timur and the Regencies of Sumba; Perusahaan Listrik Negara (PLN), the Indonesian national utility; other government ministries and non-governmental organisations, such as Hivos and IBEKA; and international donors, including the Norwegian Embassy and the Asian Development Bank.[112] By incorporating publicly available data and information from key stakeholders, such the PLN and the local regencies, the initiative has enabled other stakeholders to include its findings into their planning efforts.[113]

Sumba Island's success and lessons learned can inform Indonesia's path toward its national renewable energy goals. Expanding the availability of reliable energy data will be critical to investing in and implementing comprehensive projects.[114] To maintain Sumba Island's rapid pace of renewable energy installation, investor decisions must speed up, and national policy around key renewable energy sectors, such as wind, will need to be strengthened and streamlined.[115] The PLN, local communities, and government agencies also face political, logistical and funding questions around the management of off-grid energy systems. National and sub-national governments could increase certainty and confidence around renewable energy projects by clarifying the ownership around the project development and oversight process.[116] Their coordination will help enable Indonesia to harness Sumba Islands' "living example"[117] of the transformative potential of renewable energy.

e *Authors' calculation based on installed capacity listed on the Sumba Iconic Island website: http://sumbaiconicisland.org/. 4.87 MW * 365 * 24 *0.7578017 (kg CO_2/kWh) * 0.427 (capacity factor) = 13804.37 tCO_2 annually.*

MALI

Capital	**Bamako**
Area	1,240,190 km²
Population	17.6 million
Density	14.4/km²
GDP per capita	744.30 US$



+7%
Mali's economy annually

+10%
energy demand annually

Mali's energy demand is growing 10% annually. Diversifying and expanding the reach of the country's energy resources is vital to ensure the nation's continued, equitable growth. Mali's economy has expanded by around 7% annually from 2013-2015. Sustaining this level of growth requires a diverse national energy profile, an energy mix that can bolster the country's poverty alleviation efforts and foster sustainable development.

Africa's Sahel Region

Access to electricity

26% total → **55%** hydroelectric power

Household Energy

80% biomass in household → **81%** Mali's greenhouse gas emissions

Women in Mali

77% live in rural areas

49% of the active farming population

drive **70%** of Mali's food production

"Support for Economic Independence of Women in Rural Mali Facing Food Insecurity and Climate Change"

...provided training and solar- and gas-powered equipment to women in 13 pilot units, allowing them to produce and market local products.

...equipped 5,000 households in 13 townships with improved cook stoves to free up women's time for participation in the project.

EMPOWERING WOMEN THROUGH RENEWABLE ENERGY | **MALI**

Mali's economy has expanded by around 7% annually from 2013-2015,[118] while its energy demand grows by approximately 10% each year.[119] Diversifying and expanding the country's energy resources is vital to ensuring continued, equitable growth. Mali has increased electricity access in the past decade, bringing electricity to 53% of the urban population as of 2013.[120] More than three-fifths of Mali's people live in rural areas, however, where only 9% of the population has access to electricity.[121] The energy sector relies heavily on hydroelectric power generation, which comprised 55% of grid-connected primary energy in 2010, and on biomass, which met 80% of household energy needs and generated 81% of Mali's greenhouse gas emissions in the same year.[122]

Powering homes with renewable energy reduces the adverse health impacts and environmental consequences of burning biomass and other solid fuels indoors. Renewable power sources avoid water scarcity problems that hydropower plants face in times of drought. New renewable energy projects also generate social gains and economic opportunities, particularly for women, youth, and members of poor communities.[123] In the past two decades, Mali's government has used distributed renewable energy systems – power, cooking, heating and cooling systems that can operate independent of a grid[124] – to expand energy access. These systems often include solar lighting and thermal systems used to heat critical facilities, such as health clinics, pump water to irrigate crops, and dry and store food.[125] The government has also promoted efficient biomass use through improved cook stoves, agro-industrial appliances, and other innovative equipment.[126]

Mali's Growth and Poverty Reduction Strategy (CSCRP 2012 – 2017) leverages renewable energy to expand energy access and promote economic development and gender equality.[127] Rural populations are especially vulnerable environmental and demographic pressures, such as climate change, declining soil productivity, and population growth, due to their increased reliance on natural resources.[128] Forty-two percent of Mali's GDP and 19% of its workforce depend on agriculture, making this sector vital to the country's economic and social stability.[129] Over 77% of Mali's women live in rural areas,[130] representing 49% of the country's active farming population.[131] They drive 70% of the country's food production, despite a frequent lack of access to credit or ownership of resources, such as land and equipment.[132]

A new initiative, "Support for the Economic Independence of Women in Rural Mali Facing Food Insecurity and Climate Change," recognises the pivotal role women play in food production, consumption, and management.[133] It supports the economic achievements of women while helping agrarian communities adapt to the pressures of climate change, providing women in 13 pilot communities with equipment and training to produce and market agricultural products. Solar and gas-powered machinery, such as mills, freezers, and dryers, help the women extract, dry, and grind fruit like mangoes, tamarind, and ginger to make juice, jam, syrup and biscuits. Gas lamps light buildings across the Koulikoro, Ségou and Mopti regions, as well as the area surrounding the capital city of Bamakom, where participants convert grains like millet and fonio into flour and prepare local dishes.[134] The initiative has also distributed improved cook stoves to approximately 5,000 households in the 13 participating townships.[135] These efficient stoves consume less fuel, reducing women's fuel collection burden and allowing more time for other productive work, in addition to easing pressure on local forest resources. Current cookstove models can lower fuel use an estimated 30 – 60% and reduce emissions of black carbon, a short-lived climate pollutant, by 50 – 90%.[136]

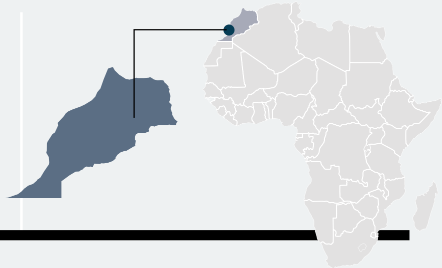
Women's economic empowerment has far-reaching benefits for their families and communities. Their new income has alleviated the debt and financial pressures typically experienced during agricultural off-seasons.[137] Diversifying family and community assets builds community resilience, helping to buffer the impacts of climate change on agriculture.[138] Participants also note an increased solidarity among project members and a growing engagement of women in rural decision-making bodies.[139] Newly formed community groups help build civic strength, laying the foundation for climate adaptation through shared purchases of farm appliances and equipment, applications for group loans, and capacity building among members.[140]

Launched in 2013 by UN Women and the Food and Agriculture Organisation, the initiative is supported by the Kingdom of Sweden and implemented in coordination with the Malian Agency for the Development of Household Energy and Rural Electrification (AMADER). Local organisations including ACTION MOPTI, the Association for the Promotion of Women and Children, and the Partnership for Action to Reduce Poverty in Mali, as well as local women's groups and cooperatives, help install the equipment and implement the program.[141]

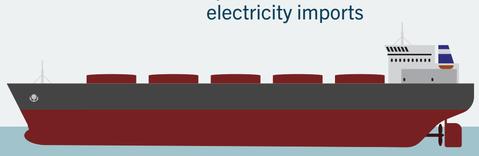
The next phase of the initiative will build business management capacity, teaching rural women accounting, marketing, and advertising skills. UN Women also plans to expand the project to other regions in Mali as part of a broader initiative to support resilience in rural areas across Africa's Sahel region.[142] As the program scales up, it could help overcome communities' limited link to external financing and the broader lack of a financial framework to promote renewable energy.[143] Its success speaks to the overlapping challenges facing energy access, resilience, and gender equity, and the tremendous value gained from integrating gender into climate solutions.

MOROCCO

Capital	**Rabat**
Area	446,550 km^2
Population	34.37 million
Density	77/km^2
GDP per capita	2,871.50 US$



3 billion USD
spent on fuel and electricity imports



Morocco's energy demand has grown rapidly, rising by an average of 5.7% from 2002 to 2011 – a surge that has paralleled the nation's economic expansion, advancing industrialization, greater prosperity and a growing population.[144] To keep up with demand, the North African country imports over 95% of its energy demand.[145] Petroleum now accounts for 24% of its total imports and 50% of its current trade deficit.[146] Morocco's government spends approximately US$3 billion annually on fuel and electricity imports, diverting funds away from other domestic needs and leaving the country vulnerable to volatile commodities markets.[147]

95% fuel supply is imported

24% of its total imports

50% of its current trade deficit

Access to electricity

99%

Renewable Energy today

32% → **42%**

Target 2020

Hydropower
Wind power
Solar PV and CSP

The Tarfaya Wind Project

has a capacity of 303.1 MW, and is expected to mitigate 900,000 tons of CO_2e and generate 1,119,000 MWh each year of its 20-year lifespan.

CO_2
900,000 tons avoided

The Noor-Quarzazate Plant

- once finished - will bring the complex's installed capacity to an estimated 580 MW, enough to bring power to 1.1 million people, by 2018. The plant will lower carbon emissions by 0.76 Mt per year, mitigating 17.5 Mt of carbon emissions in its 25-year life span.

CO_2
17.5 Megatons avoided

LARGE-SCALE WIND AND SOLAR ACHIEVEMENTS | **MOROCCO**

What Morocco lacks in fossil fuel reserves, it makes up for in vast wind and solar energy resources. The country's average annual solar irradiation level is up to 30% better than Europe's strongest sites,[148] and its 3,500 kilometres of coastline have some of the strongest winds in the world.[149] Morocco's wind potential is estimated at 25,000 MW, enough to power more than 6 million of its homes.[150] As of 2014, renewable energy constituted 32% of the country's total installed capacity, with hydropower contributing 22%, wind power 10%, and solar PV and CSP 2%,[151] and made up 11.6% of the total 33,532,000 MWh consumed.[152] By 2020, Morocco aims to increase renewable power's share to 42%, or 6000 MW, split evenly between wind, solar photovoltaic (PV) and concentrated solar power (CSP), and hydropower, with each technology producing 2,000 MW, or 14% of the country's total power capacity.

Morocco's government has developed a three-pronged strategy for reaching its renewable energy targets. The government established laws and regulations that facilitate the development of renewable energy, gradually reforming fossil fuel subsidies and establishing a framework for public-private partnerships in the renewable energy sector.[153] It formed new institutions to manage and promote renewable energy projects.[154] The government also addressed the financial aspects of renewable energy development, investing $13 billion in wind, solar and hydroelectric power generation capacity.[155]

Morocco's regulatory, institutional, and financial framework has helped deliver pioneering achievements in both wind and solar energy. The Tarfaya Wind Project, with a capacity of 303.1 MW, is Africa's largest wind farm and a shining example of the country's recent renewable energy policy success. The project is expected to mitigate 0.9 Mt of CO_2e[156] and generate 1,119,000 MWh each year of its 20-year lifespan.[157] The Noor-Ouarzazate Power Complex, another prominent example of Morocco's renewable leadership, will be Africa's first stand-alone concentrated solar power (CSP) plant and one of the world's largest of its kind.[158, 159] The first phase of the Noor-Ouarzazate Plant, Noor 1, came online in 2015 with a generating capacity of 160 MW.[160] The project's second and third phases will bring the complex's installed capacity to an estimated 580 MW, enough to bring power to 1.1 million people, by 2018.[161, 162] The plant will reduce the country's dependence on oil by roughly 2.5 million tons and is expected to lower carbon emissions by 0.76 Mt per year, mitigating 17.5 Mt of carbon emissions in its 25-year life span.[163]

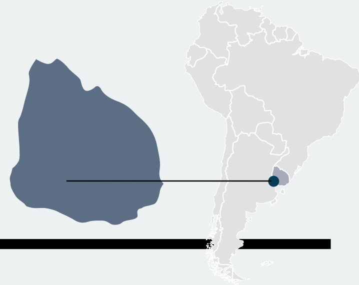
Comparing Morocco's wind and solar initiatives reveals the flexibility and breadth of the country's renewable energy plan. The Tarfaya wind project reflects wind power's growing momentum in Morocco. In 2016, the country set a new low for the price of wind energy, securing average bids of $30/MWh, well below average bids of $80/MWh for coal.[164] The Moroccan Integrated Wind Energy Programme will support the construction of five major wind farms, with a total capacity of 850 MW,[165] generating an estimated US $3.5 billion in investment, reducing fuel consumption by 1.5 million tons of oil equivalent, and mitigating roughly 5.6 million tonnes of CO_2 emissions.[166] A total of 16 wind farms, including nine currently under development or construction, are scheduled to be operating in Morocco by 2020, amounting to 1,878 MW of installed wind energy capacity.[167]

In contrast to Morocco's wind developments, the Noor-Ouarzazate Plant seeks to jumpstart the deployment of an up-and-coming technology at a commercial scale. Despite CSP's great promise, high installation costs relative to other energy sources often discourage utilities from investing in this renewable technology.[168] Morocco's government has developed an innovative financing system to enable the nation to overcome the high costs and emerge as one of the first movers in developing this power source.

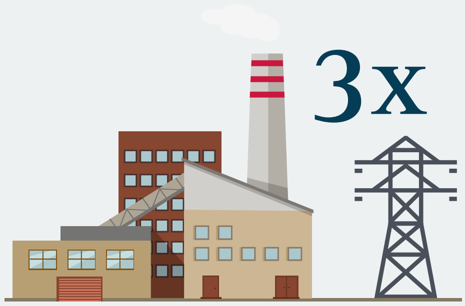
The Noor-Ouarzazate Power Complex was one of the first projects to be financed through the new system, which facilitates an optimal distribution of risks through a blend of public, private and international funding with the oversight of the Moroccan Agency for Solar Energy (MASEN).[169] In the first phase of the project, low-cost debt provided by international financial institutions reduced project costs by approximately 20% compared with financing available from commercial banks.[170] Operating the plant as a public-private partnership will ease the pressure on Morocco's public finances, lowering the annual subsidy required of the government from an estimated US $98 million to US $31 million during the project's first phase.[171] In successfully completing the Tarfaya Wind Project and Noor-Ouarzazate Power Complex, Morocco's government shows the importance of creating an enabling environment to finance and implement renewable energy projects.

URUGUAY

Capital	**Montevideo**
Area	176,220 km^2
Population	3.43 million
Density	20/km^2
GDP per capita	15,573.90 US$

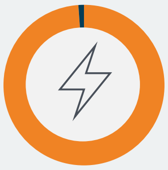


Uruguay has experienced sustained economic growth in the past decade, exhibiting an average annual growth rate of 5.2% from 2006 to 2014. This expansion has led to a sharp increase in energy demand, particularly in industry. Energy demand from industry tripled from 2004 to 2012, and, by 2015, the industry sector accounted for 42% of the country's total energy consumption.[172] This trend is expected to continue at a rate of 2.4% per year.[173] Uruguay's government has responded with the National Energy Directorate, which includes policies to ensure that growth in energy demand is met with efficiency measures for energy consumption and production. These measures are designed to prevent energy waste and to increase national industries' competitiveness.[174]



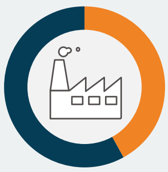
Latin America

Access to electricity



99%

Industry

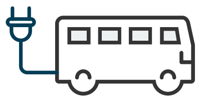


accounted for 42% of the total energy consumption

The Plan features a host of programs and actions including

Energy efficiency labeling for compact fluorescent lamps

2015 national energy efficiency prize



Electric bus pilot project in Montevideo

New edition of the Benefit for Efficient Industries through Electricity Bill

Summary of the results of the Benefit for efficient industries

edition 2014 and 2015 [177]

	2014	2015
Number of applications received	32	87
Number of industries that received the benefit	31	70
Sectoral electricity consumptions coverage	15%	21%
Electricity savings (MWh/year)	30 218	57 824
Emissions reductions (tCO_2/year)	4 593	8 789
Amount awarded (million USD)	1.7	2.5

EFFICIENT INDUSTRIES FIND BENEFITS IN THE ELECTRICITY BILL | **URUGUAY**

With the National Plan for Energy Efficiency (2015 – 2024), Uruguay's Ministry of Industry, Energy and Mining (MIEM) aims to reduce fossil fuel dependency through improved energy efficiency, establishing an institutional framework for removing existing barriers to energy efficiency in all sectors. An integral part of the plan is the 'Benefit for Efficient Industries through Electricity Bill' program, which targets industry, the sector with the highest energy demand in the country, rewarding companies for implementing energy efficiency actions and training staff on energy efficiency practices.

The programme's first iteration launched in 2014, and a second edition began in June 2015. Under this scheme, the government reduces the monthly electricity charges of participating companies by 15% for up to 6 months, proportional to their achieved savings in electricity consumption.[175] A Certifying Agent verifies the annual energy savings reported or expected for each industry.

The government plans to adapt and replicate this initiative in other sectors. The programme's second edition (2015) has already introduced a new capacity building component that targets not only big but also small- and medium-size companies. This new element provides technical assistance through a subsidy that covers advisory and consultancy services that help companies identify the best energy efficiency measures for their firms.[176] Between the two first editions of the initiative, the number of applications received increased almost threefold. During the same time, the government's expenditures to support participating industries increased by nearly 50%, to a total of just over US $4 million (see Table 2).

Together, both phases of the initiative reduced electricity demand by between 8.0% and 8.7% per industry, which, in total, generated electricity savings of 88,000 MWh. This translates into emissions reductions of about 13 $MtCO_2$. Twelve percent of these savings were generated by newly implemented measures, reflecting the initiative's ability to promote the adoption of additional strategies. Applicants for the program's second phase accounted for more than one-fifth of the industrial sector's consumption.

According to the World Energy Outlook 2015[178], the industry sector in Latin America accounts for more than 30% of the region's total final energy consumption. In some countries, such as Chile and Mexico, the share of energy demand from industry is greater than 40% of total energy consumption. Many other Latin American countries have experienced recent growth in industry similar to Uruguay's and could gain large benefits from enacting energy efficiency initiatives. Latin American countries have historically cooperated on such issues, and successful programmes such as Uruguay's benefit for efficient industries through electricity bill point to the great potential for replicating these policies throughout the region.

4 QUANTIFICATION OF EMISSIONS REDUCTIONS: A METHODOLOGICAL OVERVIEW

A number of key methodological challenges arise when carrying out an extended assessment of the impact of renewable energy and energy efficiency projects on greenhouse gas (GHG) emissions reductions. Many factors contribute to mitigation impacts, but different institutions assess these effects in disparate ways. The methods may vary according to emissions scope (e.g., direct versus indirect), mitigation approach (e.g., primary versus secondary intervention), and timeframe (e.g., project lifetime or ex-post evaluation) (Figure 9 and Table 3).

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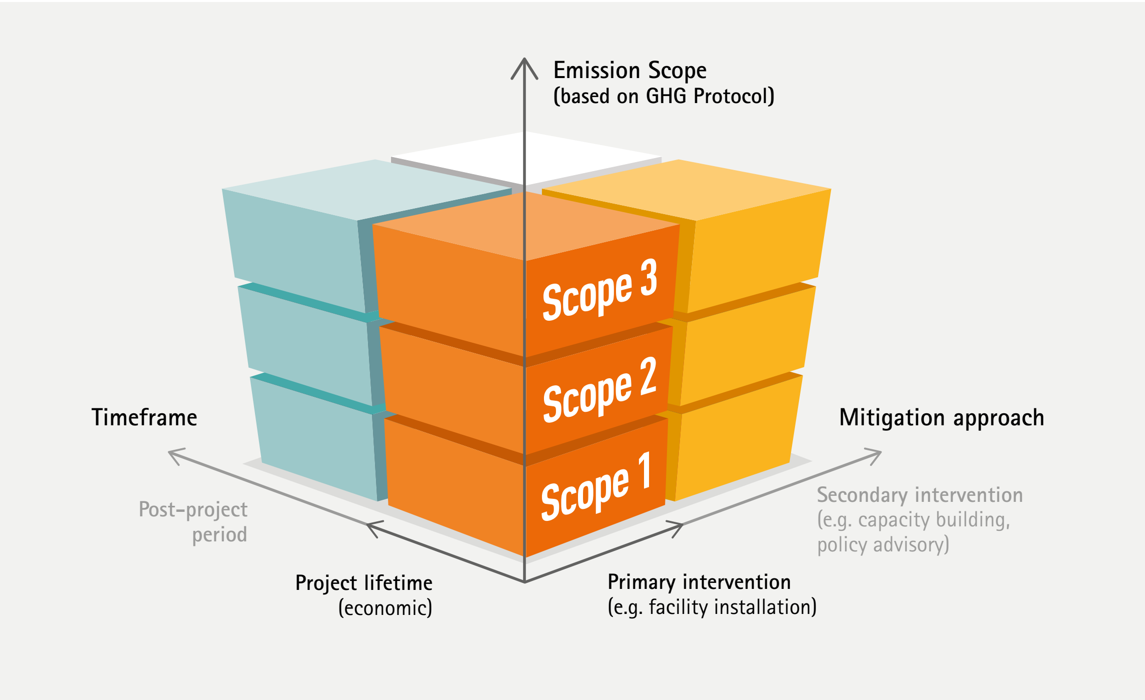
Initiatives to harmonise accounting approaches among financial institutions, however, are making progress towards greater consistency in measurement and reporting mitigation impacts of financed projects. In November 2015, the International Financial Institutions (IFI), a consortium of bilateral and multilateral agencies and banks, published guidelines for a harmonised approach to GHG emissions accounting in renewable energy (RE) and energy efficiency (EE) projects[179]. These guidelines provide useful knowledge for the analysis of internationally-supported RE and EE projects' GHG emissions impact in Section 5.

Figure 9: **GHG mitigation accounting concepts and boundaries**



Source: Narrowing the Emissions Gap: Contributions from renewable energy and energy efficiency activities (2015), Figure 10.

This section discusses four key issues related to project-level GHG mitigation accounting: primary and secondary interventions, emission accounting scope, baseline setting, and mitigation accounting timeframe. This section does not draw definitive conclusions on any of the key issues identified, but describes in detail the considerations that need to be made for each issue when setting up the analytical approach for a particular assignment. The outcomes of this section serve as the basis for the calculation methods applied in Section 5. The following sections also incorporate expert feedback, gathered during a 1 Gigaton Coalition workshop on GHG accounting methodology held in Bonn, Germany in May 2016.[9]

Table 3: **Overview of GHG mitigation accounting methods developed by bilateral aid agencies and multilateral development institutions.**

Institution		JICA (2011)	"International Financial Institutions" (International Financial Institutions, 2012)				GEF approach-based		
			AFD (2011)	IFC (2011a, 2011b)	EIB (2014)	EBRD (2010)	GEF (2015)	GIZ (GTZ, 2008)	CTF (CIF, 2009)
Emission accounting Scope	1	Y	Y				Y		
	2	Y	Y				Y		
	3	N	Y	Optional	Optional	N	N		
Project intervention types	Primary	Y	Y				Y		
	Secondary	N	N				Y	N	N
Mitigation accounting timeframe	Mitigation account-ing period (years)	N.D.	Dams: 50 Transport infra-structure: 30 Others: 20	Limited to financing term (10 years for equity and other products with indefinite timelines)	N.D.	N.D.	Investment lifetime (sector and technology specific, no more than 20 years after the projects ended)	EE: 20 Others: 10	Investment lifetime (for RE, 10 for off-grid PV and bagasse 10, and 20 for others)
	Post-project life reduction	N	N				Y	Y	N
Attribution of mitigation impact for co-financed projects		N.D.	N.D.	N	Pro rata to the amount of finan-cing	N.D.	N.D.		N

4.1 PRIMARY AND SECONDARY INTERVENTIONS

Classifying an activity as either a "primary" (e.g., explicit) or "secondary" (e.g., implied) intervention is an essential decision for any GHG accounting process (see the "mitigation approach" axis in Figure 9). Primary intervention projects directly affect energy production or consumption, GHG emission, mitigation, or carbon sinks. The installation of a wind farm is a common example of a primary intervention project. The IFI document on harmonised approach to GHG accounting covers primary intervention projects, yet there is no harmonised methodology for measuring emissions impacts from secondary interventions[180].

Secondary intervention projects induce emission reductions with catalytic and barrier removal effects. Project examples include capacity building, training, policy support and financial mechanism development[181]. Although the contributions of these secondary intervention projects to GHG mitigation are not always considered, captured or measured, they are essential for the global temperature increase to stay "well below 2°C" compared to pre-industrial levels.[182]

One can take the following approaches:

- **Assess only primary intervention projects:** only projects with direct mitigation impact, e.g., the installation of a renewable energy producing facility or energy efficiency installation.
- **Assess both primary and secondary intervention projects:** e.g. also those that potentially induce (large-scale) emission reductions with catalytic and barrier removal effects, e.g. policy support or capacity building.

Because the mitigation impacts of some secondary intervention projects (e.g., policy support for introducing vehicle fuel efficiency standards) can lead to large GHG reductions, it is still important to take them into consideration wherever possible. Quantifying their impact, however, is significantly more difficult than for primary intervention projects and the issue of double counting GHG reductions with other secondary intervention projects needs to be considered.

Moreover, quantified mitigation impacts from primary and secondary intervention projects are not comparable and they should not be mixed. When quantifying the expected mitigation impact from a set of projects, it is important to treat the two types of projects separately, e.g. as direct avoided GHG emissions (primary interventions) and potentially avoided GHG emissions (secondary interventions).

4.2 ACCOUNTING SCOPE

Emissions accounting scopes vary both within and across institutions for GHG accounting at the project level (see Table 3). Many institutions account for direct emissions (Scope 1 emissions) and emissions related to electricity use (Scope 2 emissions), and several also include other indirect (Scope 3) emissions, such as the emissions associated with the production of purchased materials and fuels.[183] One can take the following approaches:

- **Include only direct and electricity use-related (Scope 1 and 2) emissions:** for instance, when assessing a renewable energy project, account for only the GHG emissions associated with the project's construction and the completed installation's energy output.
- **Also include other indirect (Scope 3) emissions:** include emissions from a project's supply chain and use of products (e.g., both upstream and downstream sources, or the embodied carbon).

The calculation of emission reductions from primary intervention projects (e.g., an efficient steel plant) typically encompasses direct emissions (e.g., from heating) and electricity use-related emissions. For a full assessment, also other indirect emissions can be calculated (e.g., emissions during the mining process), which usually rely more heavily on assumptions and expert judgment.[184]

Accounting for other indirect emissions is particularly important for projects related to infrastructure development (e.g., urban transport systems, which could reduce steel and fuel consumption due to reduced demand for private passenger vehicles), as well as for bioenergy projects, where land-use emissions can be significant. Accurately estimating other indirect emissions, however, is challenging for a number of reasons. First, the comparability of reported data for other indirect emissions is especially difficult to verify, as the accounting boundaries and methods used are not always clear. Second, quantifying other indirect emissions independently in a rigorous manner involves carrying out an extensive life cycle assessment, which is a major task in itself.

Taking into account the degree of accuracy and methodological challenges associated with quantifying other indirect emissions, it is realistic to only consider direct and electricity use-related emissions. Exceptions include bioenergy projects, where indirect emissions from land use can be significant. Nevertheless, other indirect emissions should be acknowledged for their potentially large impacts and should carefully be examined ex ante upon project planning and implementation.

4.3 SETTING BASELINE EMISSIONS

Baseline-setting is one of the most important steps for quantifying the impact of any emission reduction activity. For a project-level mitigation impact assessment, calculating emission reductions requires a baseline describing what would have happened without intervention (e.g., a counterfactual scenario). This baseline is a critical determinant of the final calculated reductions, and, at the same time, it is difficult to verify because a baseline always describes a counterfactual situation (e.g., "what would have happened without the project").

There are two project-level baseline setting methods that are generally used:[185]

- **A project-specific baseline,** which involves developing a baseline scenario (or scenarios) based on the most likely pathway without the project.
- **A performance standard,** which uses uniform factors for particular types of projects under specific circumstances.

The project-specific procedure establishes a baseline scenario via a structured analysis of a particular project's activity and the alternatives to the intervention's deployment. The baseline scenario could account for the implementation of similar interventions in a project's absence or the baseline could assume a "do-nothing" alternative. If a nation, for instance, does not construct a particular renewable energy facility, would it instead build a fossil fuel plant, or a nuclear plant? Where would these resources be funnelled? The project-specific procedure requires a set of assumptions, which is subject to analysts' judgements.

The Clean Development Mechanism (CDM) addresses these questions for renewable energy projects by using "Combined Margin" emission factors, which are comprised of two different grid emission factors: "Operating Margin" and "Build Margin." In the operating margin, the emission factor "refers to the group of existing power plants whose current electricity generation would be affected" by the proposed project activity and the existing dispatch hierarchy that would likely be replaced by the project is taken into account. The build margin "refers to the group of prospective power plants whose construction and future operation would be affected" by the proposed project activity.[186] For energy efficiency projects, even more case-specific assumptions are required because additional factors, such as changes in production due to the new facility, and how the increased or reduced production would affect emissions elsewhere, need to be taken into account.[187] If the set of assumptions made by the analysts lead to large uncertainty of the results, it is also an option to prepare multiple baseline scenarios.

The performance standard procedure requires less data on the specific project in question, employing instead a standard product measure that a given intervention produces. Considering RE projects, which produces electricity, developing a performance standard is relatively straightforward. Project-specific grid electricity emission factors, for example, can be used to create a technology- or country-specific standardised average emission factor that can be applied to a range of future projects. Performance standard baselines are more practical when estimating the total mitigation impact from project databases because project-level CO_2 emissions reductions are not always reported.

4.4 ACCOUNTING TIMEFRAME

Another important issue regarding mitigation impact quantification is defining an accounting timeframe. This process entails setting a year up to which a project's emissions reductions are considered "additional" to a baseline scenario. Different institutions employ vastly disparate accounting timeframes for estimating GHG emissions reductions from renewable energy and energy efficiency projects (Table 32).

As in all accounting, uncertainty in GHG emission reduction estimates increases as projections extend into the future. After a period of time, either GHG reductions from a given project are assumed to go to zero or a new baseline scenario is established. The chosen length of time will vary according to project-specific considerations.

Setting an accounting period largely determines what type of policy scenario serves as a baseline and to what extent the projects are additional to that baseline scenario. Taking a RE project as an example, if we assume a policy scenario in which there is no additional RE deployment, then the accounting period for emissions reductions would be the RE facility's entire lifetime. On the other hand, if we assume a baseline situation where RE deployment is increasing without any support measures, then the accounting period for emissions reduction could theoretically be zero because the projects will be implemented anyway without delay, even in the absence of development finance.

The IFI harmonised approach documents do not include detail on the accounting period.[188] Among bilateral and international development banks and agencies, it is rare that project-level GHG assessments extend beyond a 20-year time horizon. For CDM projects there are two different accounting periods: (i) 7-year crediting period, renewable twice; or (ii) a single 10-year crediting period.[189]

One can take the following approaches:

- **Analyse emissions using a single timeframe,** in accordance with baseline scenario data and assumptions.
  - Full project lifetime depending on project type.
  - Fixed periods as used for CDM projects.
- **Report results using multiple timeframes** (e.g. 10-year, 20-year, and 50-year), assigning a level of uncertainty to each.

Although timeframes are best chosen in line with the ultimate objective of the exercise, multiple timeframes could be aligned with specific processes (e.g., the Paris Agreement and UNFCCC processes or other global initiatives' assessment periods). The use of multiple timeframes would also be more appropriate than just analysing with a single timeframe because situations and technologies evolve over time, which changes baseline assumptions rapidly.

4.5 SUMMARY

The IFI's development of harmonised approaches to GHG accounting in RE and EE projects is a major step forward for quantifying the mitigation impacts at project level. In order to evaluate additional emissions reductions delivered by projects compared to certain policy scenarios, reasonable assumptions have to be made on the project accounting period, but there is no harmonised approach to this issue.

While employing an approach using baselines (e.g., "versus baseline") has methodological shortcomings, the usefulness of these calculated emission reductions is limited when considering global climate change mitigation goals in the Paris Agreement. For example, some types of large-scale infrastructure projects could possibly lock-in a significant amount of GHG emissions for the coming decades, prohibiting a 2 °C/1.5 °C-compatible emission pathway, even if these projects are less emissions-intensive than the assumed baseline.

An alternative approach to circumvent the various challenges of the "versus baseline" assessments is to compare RE and EE projects with a menu of technologies and projects that are compatible with the "well below 2 °C" pathway.[190] This approach does not require the determination of a baseline, but has its own limitations, such as the need for expert judgment in attributing projects to specific emissions pathways (see Section 6).

5 ANALYSIS OF EMISSION REDUCTIONS FROM SUPPORTED RENEWABLE ENERGY AND ENERGY EFFICIENCY PROJECTS

The analysis examines a total of 224 projects, 112 of which are supported by 12 bilateral institutions and firms in 9 different countries, and another 112 projects supported by 15 multilateral development banks and partnerships. Project-level data were collected from these organisations, 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 renewable energy (RE) and energy efficiency (EE) efforts, but instead exhibits a representative cross-section of bilateral- and multilateral-supported projects. Communications with organisation representatives and extensive desk research yielded sufficient information on 173 RE and 51 EE projects for calculating GHG emissions impact estimates. The analysed sample of internationally supported RE and EE projects in developing countries will reduce GHG emissions by approximately 0.116 gigatons carbon dioxide ($GtCO_2$) annually in 2020. Total greenhouse gas (GHG) emission reductions from internationally supported RE and EE projects from 2005 through 2015 could be up to 400 $MtCO_2e$ per year in 2020.

Global investments in renewable energy (RE) projects reached a record US $286 billion in 2015, a 5% increase from the year prior and US $7 billion more than the previous record set in 2011. Investment totals in renewable power (US $266 billion) more than doubled the amount for new coal and gas plants (US $130 billion). Meanwhile, 118 GW of renewable capacity came online in 2015, surpassing the record of 94 GW set in 2014, and making 2015 the first year that renewable power comprised more than half of the world's added electric generation capacity.[191] Communications with multilateral development organisations and further research produced data on 113 projects supported by 15 multilateral groups.

With an annual investment of US $11 billion, foreign internationally-supported RE and energy efficiency (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.

2015 also marked the first year that renewable investment in developing countries, where the world's populations, economies, and energy demand are growing rapidly, exceeded that in developed countries. Developing countries, including Brazil, China, and India, pledged US $156 billion in 2015 for RE. Global investment in energy efficiency (EE) also reached record levels in 2015. At US $221 billion, expenditures on EE projects increased 6% from the year before.[192]

Most new RE and EE investments are now occurring in developing countries, yet developed countries have helped spur the surge in these initiatives. Bilateral and multilateral development aid organisations have grown in number, size, and financial influence in recent decades, and these groups have increasingly focused their support on energy projects. From 2004 – 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 these 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.[193] More than sending capital, these groups build policy and administrative capacity among governments and businesses in recipient countries. According to OECD estimates, these organisations invested US $4.7 billion in energy policy and administrative management in 2014, more than any other recipient sector besides electrical transmission and distribution.[194]

What are the outcomes of these investments? How much do supported RE and EE projects reduce GHG emissions? Can bilateral and multilateral development energy initiatives help close the global emissions gap?[195]

5.1 AGGREGATED IMPACT

This section seeks to answer the above questions by evaluating the emissions impact of bilateral- and multilateral-supported RE and EE projects in developing countries implemented during 2005 – 2015.[f] The analysis examines a total of 224 projects, 112 of which are supported by 13 bilateral institutions and firms in 10 different countries, and another 112 projects supported by 15 multilateral development banks and partnerships. Project-level data were collected from organisations, 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.

This analysis uses a sample of recent internationally supported RE and EE projects in developing countries to estimate the total GHG emissions mitigation reduction from these kinds of initiatives. Despite the harmonised 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 not sufficiently available to give an accurate picture of these efforts' total effects.[196] The new framework's influence has extended beyond the Multilateral Development Banks (MDBs) that created it, as many bilateral groups have also incorporated the harmonised approach into their accounting methodologies. This framework does not currently provide methodological details that meet the criteria for this analysis. Organisations 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 (see Section 4 for more information). Project-level research is therefore needed to overcome these issues.

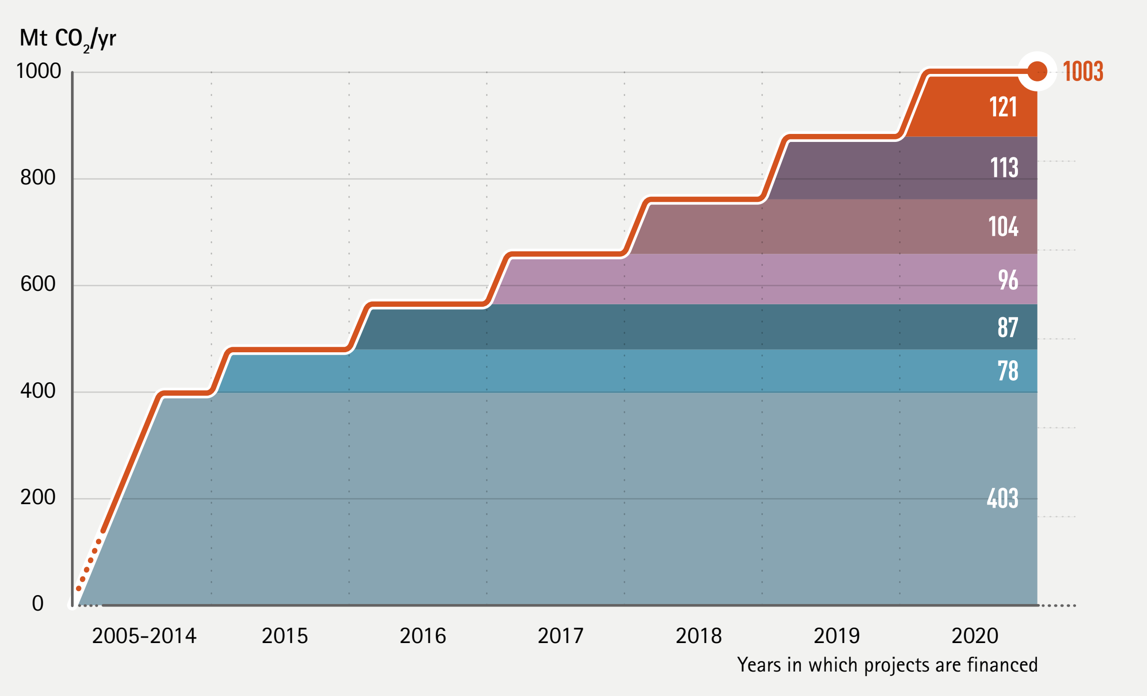
Communications with aid organisation representatives and extensive desk research yielded sufficient information on 173 RE and 51 EE projects for calculating GHG emissions impact estimates. The project-by-project emission reductions were made by using a common calculation method (see Annex).

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

- **The analysed sample of internationally supported RE and EE projects in developing countries will reduces GHG emissions by approximately 0.116 gigatons carbon dioxide ($GtCO_2$) annually in 2020.** The 224 analysed projects include 51 EE initiatives, 166 RE initiatives, and 7 projects classified as both RE and EE. These initiatives 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 0.047 $GtCO_2e$, EE projects contribute 0.069 $GtCO_2e$, and RE/EE projects contribute about 0.001 $GtCO_2e$ to the analysis's total emissions reductions. These projects received direct foreign assistance totalling US $28 billion.
- **Total greenhouse gas (GHG) emission reductions from internationally supported RE and EE projects since 2005 could be up to 0.4 $GtCO_2e$ 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.[197] 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, GHG emissions would be reduced on the order of 1 $GtCO_2e$ per year** (Figure 10). Countries agreed to mobilise 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.

f For this analysis, "implemented" projects are those that have been completed by the end of 2015 and are achieving emissions reductions.

Figure 10: **Emission reductions in 2020 below baseline from scaled up public mitigation finance for energy efficiency and renewable energy projects**



5.2 SELECTED BILATERAL INITIATIVES

Outreach to bilateral organisations and desk research yielded detailed data on 112 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 – 2014.[198] 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.[199]

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 organisations included in this analysis is shown in **Table 4**. Bilateral development groups generally mobilise 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 organisation's total portfolio.

Table 4: **Selected Bilateral Organisations**[g]

Bilateral Organisation	Country	Year /Established	OECD-reported National Assistance for RE and EE Development (millions current US $)[h, 200]		
			2014	2005–2014 (cumulative)	
Agence Française de Développement (AFD)	France	1998	437	1,977	
China Development Bank and China Exim Bank	China	1994		1,000[202]	
Department for International Development (DFID) / International Climate Fund (ICF)	UK	1997 / 2011	69	300	
FinnFund	Finland	1980	43	175	
FMO	The Netherlands	1970	37.6 (2015)	521	
Deutsche Gesellschaft für Internationale Zusammenarbeit GmbH (GIZ)[i]	Germany	2011	1,451	8,751	
Japan International Cooperation Agency (JICA)	Japan	1974	782	7,467	
KfW / DEG	Germany	1948 / 1962	1,451	8,751	
NorFund	Norway	1997	87	810	
Overseas Private Investment Corporation (OPIC)	USA	1971	9	217	
All OECD countries			2,859	20,247	

g Cells shaded grey indicates no data available.

h Official Development Assistance + Other Official Flows

i 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 organisation for these projects while IKI is the supporting institution.

Bilateral Development Organisation's RE and EE achievements	Bilateral Organisation'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 that installed 1,759 MW of RE	Projects financed from 2013 – 2015 abate 11.4 Mt CO_2 annually[201]	1,699	17
		970	3
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[203]	67	2
$168 million US invested in "Energy and Environmental development" from 2011 – 2015[204]		20	1
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.[205]	15	1
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.[206]		3	1
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 $MtCO_2$/year (does not include supported EE projects).[207]	6,152	34
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 $MtCO_2e$/year and its supported 2015 RE projects generate an estimated 2.5 $MtCO_2e$/year, though it should be noted that these projects include large hydropower and biomass plants.[208]	686	9
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.[210]		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 countries; 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 analyses projects that were implemented from 2005 through 2015. 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 analysed, projects had to include quantified power capacity or energy savings data.

This report expands on the inaugural 1 Gigaton Coalition report's 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, with the unit megawatts (MW), 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 considerations, which can be complex, 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

Communications with multilateral development organisations and further research produced data on 113 projects supported by 15 multilateral groups. The multilateral institutions featured in this analysis 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 organisations often fund projects in collaboration with each other, employing multi-layered finance agreements that include grants, loans, and leveraged local funding.

Organisational 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.[211] 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.[212] These collaborations help mobilise 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 MDB-supported programmes. 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 organisation 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 Organisations**[k]

Multilateral Firm, Fund, Institution or Partnership	Number of member countries and structure	Year / Established	OECD-reported Development Assistance ($ millions current USD) [l, 213]	
			2014	2005–2014 (combined)
Asian Development Bank (ADB)	67 member countries; MDB	1966	1,547	2,854
Asian Infrastructure Investment Bank (AIIB)	57 countries; MDB	2014; officially launched in 2016		
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	412	1553
Clean Technology Fund (CTF)	72 developing and middle income countries; projects implemented by MDBs	2008		
Scaling up Renewable Energy Program (SREP)	72 developing and middle income countries; projects implemented by MDBs	2008		
European Bank for Reconstruction and Development (EBRD)	65 countries, as well as the European Union and the European Investment Bank	1991		
European Investment Bank (EIB)	28 European member states; European Union's nonprofit long-term lending institution	1958		
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		
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	39.75	212.29
HydroChina Investment Corp	Public company in China.	2009		

k Cells shaded grey indicate no data available.

l Official Development Assistance + Other Official Flows

Supporting organisation reported RE and EE Investments and Impacts	Supporting organisation estimated GHG emissions mitigation impact	RE and EE Investments in Analysis ($ millions current USD)	# RE and EE Projects in Analysis
Invested $2.47 billion in clean energy in 2015 (RE and EE); including 1,481 GWh/year renewable electricity generation; and 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 $MtCO_2e$/year[214]	4,161	30
Invested $165 million in one EE project	Achieved abatement of 16,400 tCO_2 per year[215]	165	1
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.[216]		14,054 (including co-finance)	29
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.[217]	13,332 (including co-finance)	12
SREP has $780 million with approved RE capacity of 739.5 MW; These projects are expected to generate 2,592 GWh/yr	737.6 MW in renewable energy capacity has been approved[218]	354 (including co-finance)	6
Pool of $422 million (donor funds provided in 2014)	An estimated 7.3 million tonnes of CO_2 emissions were avoided in 2014.[219, 220]	144	3
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.[221, 222]	221	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.[223, 224]	328	1
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 organisations.	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.[225]	2,112	74
		115	1

continue next page

Table 5: **Selected Multilateral Development Organisations**[k] (continued)

Multilateral Firm, Fund, Institution or Partnership	Number of member countries and structure	Year / Established	OECD-reported Development Assistance ($ millions current USD) [l, 213]	
			2014	2005–2014 (combined)
World Bank	189 member countries; The World Bank Group is comprised of five multilateral finance organisations 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		
International Bank for Reconstruction and Development (IBRD)	189 member countries	1946	1,536	6,330
International Finance Corporation (IFC)	184 member countries	1946	1,508	1,971
Inter-American Development Bank (IDB)	48; MDB	1959	4.883	112.935 75
Islamic Development Bank (IsDB)	65; IFI	1975	208	2040.21 272
The BRICS New Development Bank	5; MDB	July 2014 (Treaty signed)/ July 2015 (Treaty in force)		
Proparco	Public-Private European Development Finance Institution based in France	1977		

k Cells shaded grey indicate no data available.

l Official Development Assistance + Other Official Flows

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.[229] 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. To date, however, 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 catalysing harmonisation efforts.

Supporting organisation reported RE and EE Investments and Impacts	Supporting organisation estimated GHG emissions mitigation impact	RE and EE Investments in Analysis ($ millions current USD)	# RE and EE Projects in Analysis
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.[226]		17
		59M	4
		7.63	4
		5.5	1
In 2014, IsDB committed $1.9 billion in 16 energy projects in 10 nations, all in Asia and Africa.[227]		10	1
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	181	2
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 $MtCO_2e$.[228]	$ 409	12

Accounting for Scope 2 and 3 emissions (see Section 4) remains a difficult task and a near-term goal for groups financing RE and EE projects. With an annual investment of US $11 billion, foreign 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, a phenomenon demonstrated by the China Energy Efficiency Financing project (CHEEF). 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 harmonised 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 harmonised ways to do this evaluation is key to fully capturing the results of foreign investments in RE and EE projects.

5.3.1 MULTI-STAKEHOLDER PARTNERSHIPS

Initiatives representing multi-stakeholder partnerships of both public and private actors are extending financial and capacity-building support to developing countries, spurring innovation and new policies. The following section features some examples of initiatives that are operating in developing countries as models for demonstrable mitigation impact.

COVENANT OF MAYORS

www.covenantofmayors.eu

Created as part of the European Union Climate and Energy package, the Covenant of Mayors (CoM) is a coalition of subnational (local and regional) authorities that voluntarily commit to reduce GHG emissions by more than 20% by 2020 or more than 40% by 2030. CoM membership has grown steadily. CoM is establishing a global network as it prepares to merge with the Compact of Mayors initiative in North America and to create regional coordinating offices in Latin America, China, India and Japan.

CoM signatories' CO_2 emissions reduction commitment is an average 27% target by 2020. The 315 cities that submitted monitoring data before September 2016 demonstrate a 23% reduction in greenhouse gas emissions in the region under their mandate, covering 25.5 million citizens. The corresponding per capita CO_2 reduction is even stronger, a 26% savings, as these cities have grown in population. Other cities are expected to submit similar monitoring reports, allowing CoM to follow their progress in lowering per capita emissions from a baseline of 5.4 tonnes of CO_2e to the 2020 goal of less than 4.0 tonnes CO_2e.

CLIMATE TECHNOLOGY CENTRE AND NETWORK (CTCN)

ctc-n.org

Developing countries are accessing innovative technologies for free, through a unique mechanism operated by the United Nations in Denmark. The CTCN provides technical assistance in response to developing country requests submitted via nationally-selected focal points called National Designated Entities (NDEs). Upon receipt of such requests, the CTC quickly mobilises its global network of climate technology experts to design and deliver a customized solution tailored to local needs.

Over 150 technology transfers are underway in 60 countries for sectors ranging from agriculture and energy to industry and transportation. CTCN plays the role of technology matchmaker between countries, technology companies and organisations and finance institutions. Partnerships provide expertise and innovation in technology development, deployment, capacity building, and finance. By outsourcing this expertise, the CTCN is able to support countries on a much larger range of sectors and technologies and ensure that the most relevant and up to date solutions can be offered.

EN.LIGHTEN INITIATIVE

www.enlighten-initiative.org

The en.lighten initiative is a public-private partnership between the UN Environment and companies OSRAM and Philips Lighting, 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 programs.

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 15.8 million people, more than 37,000 small and medium enterprises and 18,100 social institutions. In 2015, through the measures of the programme, CO_2 emission reductions totalled 1.7 million tons per year. Since beginning in 2005, EnDev has contributed to avoiding more than 7 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.

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 CO2 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 two degrees 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. A prime example of this alignment is the SNAP Initiative, which supports eight countries to develop a national strategy for SLCPs to identify and implement 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 and Chile, submitting INDCs that integrate SLCP mitigation.

RENEWABLE ENERGY AND ENERGY EFFICIENCY PARTNERSHIP (REEEP)

www.reeep.org

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 policy development. REEEP creates, adapts and shares knowledge to build sustainable markets for renewable energy and energy efficient solutions, advance energy access, improve lives and economic opportunities, and reduce climate and environmental damage.

This insight influences policy, encourages public and private investment, and informs our portfolio strategy to build scale within and replication across markets.

REEEP works with partners among its international network to share methodologies and synthesized lessons from the supply and demand sides of the market based on sector and country specific investments.

UK INTERNATIONAL CLIMATE FUND

GOV.UK

www.gov.uk

In 2010, the UK established the International Climate Fund (ICF) as a cross government program, managed by BEIS, DFID and DEFRA. The Fund has delivered $5.90 billion USD 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 US $8.85 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 the infrastructure and energy sectors over the next 15 years, and the ICF aims to shape country investments, financial flows, and the wider policy context to avoid countries being locked into long-term high carbon growth. Since 2011, the ICF has directly supported 21 million people, helping them cope with the effects of climate change, and improved energy access for 6.6 million people. ICF investments have also helped prevent 4.9 million tonnes of CO_2 emissions – roughly equivalent to emissions from 1 million vehicles driven for one year – and generated US $2.13 billion of public investment and US $473 million of private investment.

INTERNATIONAL RENEWABLE ENERGY AGENCY

IRENA
International Renewable Energy Agency

www.irena.org

The International Renewable Energy Agency (IRENA) is an intergovernmental organisation 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 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.

SUSTAINABLE ENERGY FOR ALL

SUSTAINABLE
ENERGY FOR ALL

www.se4all.org

UN Secretary-General Ban Ki-moon launched the Sustainable Energy for All (SE4ALL) in September 2011 to catalyse an equitable and sustainable transformation in the world's energy systems. SE4ALL's three objectives are: to ensure universal access to modern energy services; double the global rate of improvement in energy efficiency; and double the share of renewable energy in the global energy mix by 2030. SE4ALL 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. SE4ALL connects stakeholders, marshals evidence, benchmarks progress, amplifies the voices of their partners, and tells stories of success.

MOROCCAN CLIMATE CHANGE COMPETENCE CENTRE

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 organisations. 4C Maroc acts as a hub for regional climate change information and freely disseminates its data.

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 wellbeing. This effort's goal is to enable the public sector to make the best decisions on matters relating to climate change. A team of Moroccan climate change experts are compiling a database of regional climate information that will be available on 4C Maroc's website in time for COP-22.

UNITED FOR EFFICIENCY (U4E)

united4efficiency.org

The UNEP-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 degrees Celsius. 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.

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. 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. 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.

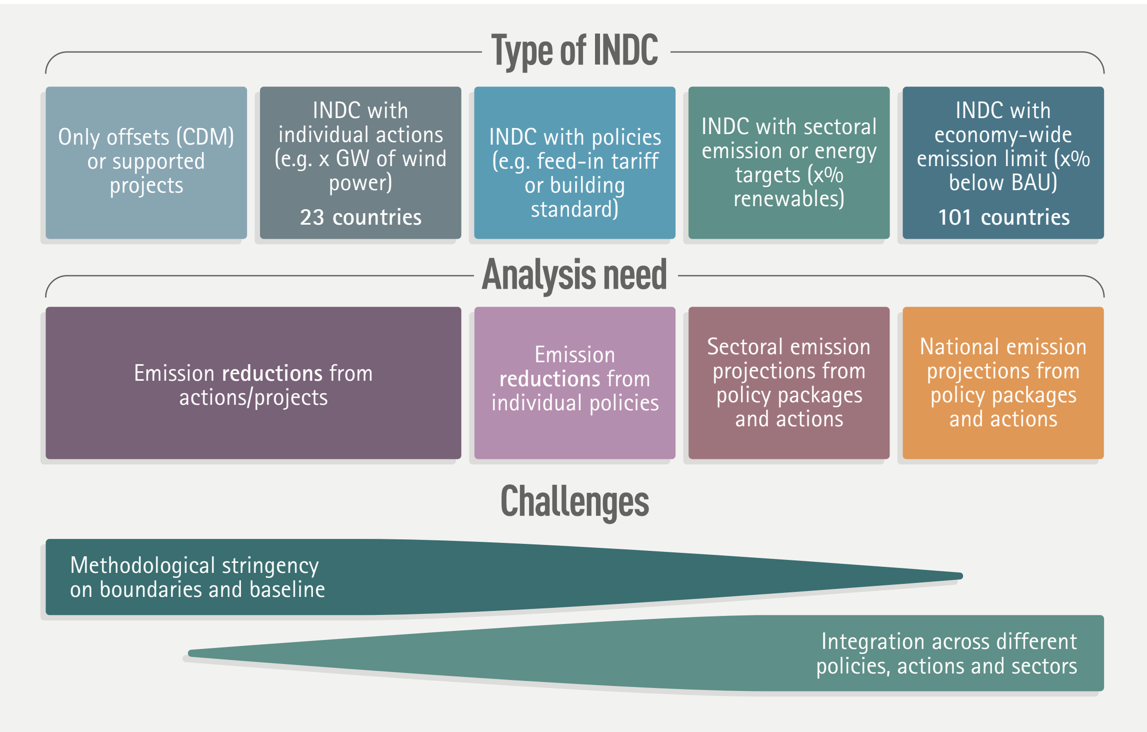
6 A PATH FORWARD: NEW CONCEPTS FOR ESTIMATING GHG IMPACTS

As support for renewable energy (RE) and energy efficiency (EE) projects increases and collaboration among funders becomes the common mode of implementation, calculating and attributing emissions reductions from distinct measures and policies becomes more and more difficult. Future impact analyses could use alternative approaches from those focused on calculating GHG reductions below a baseline. One alternative approach would examine an entire sector's future emissions, aggregating actions without attributing outcomes to individual projects or actors. This method would allow the inclusion of interventions that have indirect effects, such as capacity building and policy development. An alternative method is to determine the compatibility of individual investments with the requirements for limiting global temperature rise to 1.5°C or 2°C.

Activities to reduce greenhouse gas emissions by national, regional, and municipal governments, as well as businesses, civic groups, and individual citizens have substantially increased in recent years. These actions need to expand even further in number and ambition in order to achieve the goals laid out in the Paris Agreement: to limit global temperature rise to well below 2°C and to work towards a 1.5°C target. To reach these goals net GHG emissions need to reach zero by mid-century.[230]

As GHG mitigation activities increase in number, scale, and scope, relevant research questions evolve and expand (see Figure 11). Countries with only a few climate change initiatives (left hand side of Figure 11) may only have a few supported projects with significant impacts. The challenges for measuring these limited impacts are in setting project boundaries and establishing a baseline (see Section 4).

Figure 11: **Increasing complexity of emission reduction activities and analysis requirements and challenges**



Countries usually develop and implement national policies to guide climate actions and catalyse GHG mitigation activities (see Section 3 for examples). As these policies take effect, they influence many projects at once, producing significant emissions reductions. It is difficult, if not impossible, to determine if emissions reductions from a project can be attributed to a certain policy or supporting financial institution. If outcomes from individual policies and various projects are evaluated in isolation, however, the results are piecemeal and likely incomplete. These difficulties as well as the problem of double-counting (see Section 5) make emissions reduction aggregation fraught with challenges.

To create a framework for increasing climate actions, countries may implement policy packages, set targets, and establish national GHG emission limits. These broad policy tools add to the complexity and challenges of attributing emissions reductions to a particular action or actor. It can therefore be more meaningful to analyse sectoral or national emissions that occur as a result of a country's overall climate governance. The difficulties of this approach rest in deciding how to integrate different policies and actors rather than establishing a project's boundaries or defining a baseline. In fact, the remaining emissions that result from all activities are most relevant to this sort of analysis, rather than achieved emissions reductions.

The methods to evaluate the impact of international financial institutions (IFIs) may need to evolve with this increasing complexity of emission reduction activities. We offer several possible approaches here.

FOCUS ON AGGREGATED REDUCTIONS AND NOT ATTRIBUTE REDUCTIONS TO INDIVIDUAL ACTORS

A possible approach would be to calculate overall reductions from an entire sector resulting from the activities of many actors and not to attribute reductions to any individual actor. This way the actors have collectively achieved the reductions and can all claim them. This method would change the focus of analysis away from individual emission reductions to examining policies and measures and individual projects that affect outcomes for an entire sector.

Such an approach would cover projects that have indirect effects, such as capacity building or policy support. The effect of such projects on GHG emissions is very difficult to evaluate in isolation.

A sectoral approach would also capture IFI activities that potentially increase emissions – e.g., support for fossil fuel power plants or infrastructure projects. These projects are not covered in the standard calculations of GHG reductions below a baseline.

The sectoral emissions calculation can then be analysed to determine what measures are needed to move the sector to 1.5°C and 2°C trajectories.

CRITERIA FOR 1.5°C/2°C COMPATIBILITY OF PROJECTS

An important component of any future emissions accounting analysis would be to evaluate if individual projects are compatible with the 1.5°C and 2°C limits[231]. Determining a project's absolute emission reductions does not necessarily speak to whether the project is aligned with the internationally recognised 1.5°C and 2°C limits for global temperature rise.

For RE projects this determination is usually straightforward: a wind farm with almost zero emissions is compatible with a future that needs to reach net zero emissions in the long run. It becomes more complicated if, for instance, a biomass project leads to increased emissions through deforestation. This sort of project may be better than a coal plant that it is replacing, but still not in line with a 2°C pathway, which may require zero deforestation.

Assessing compatibility with the 1.5°C and 2°C limits is difficult for EE projects. A zero energy use house certified under the passive house standard is, for instance, closer to 2°C compatibility than a house that meets building standards and is more efficient than the current housing stock, but still has significant energy use. In fact, given the long lifetime of buildings and the generally low rates of renovation, the latter example might cause an energy-use lock-in that is clearly not in line with the 2°C pathway.

Analysing infrastructure projects like roads and airports to determine their 1.5°C/2°C compatibility is even more challenging. These kinds of projects are very important to assess because they comprise a major share of support from IFIs and can also lock-in high-emission pathways for decades.

Certain types of projects, such as unabated coal fired power plants, are clearly incompatible with a 1.5°C/2°C trajectory. Employing a 1.5°C/2°C criteria would identify such projects, which are not covered in the standard calculations of GHG reductions below a baseline.

Developing and applying project-level criteria that allow analysts to judge whether a project is 2°C compatible could overcome these challenges. Previous studies have shown that such criteria can be identified for projects in different sectors.[232]

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 2014. The scale-up was done by using the following equation:

$$CO_2R2020_{tot,2005-2014} = \Sigma_j \left(\Sigma\, CO_2R2020_{j,Dataset} \times \frac{FIN_{j,tot,2005-2014}}{\Sigma FIN_{j,Dataset}}\right) \quad (3)$$

where:
- $CO2R2020_{tot,2005-2014}$ = total mitigation in 2020 by bilateral- and multilateral-supported RE and EE projects in developing countries committed between 2005 and 2014 ($MtCO_2$/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)
- $FIN_{j,tot,2005-2014}$ = total finance committed by bilateral and multilateral institutions on technology category j between 2005 and 2014 (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.

$$CO_2R2020_{tot,2005-2014} = \Sigma_j \left(\Sigma\, CO_2R2020_{j,Dataset} \times \frac{FIN_{j,tot,2005-2014} + FIN_{j,tot,2015-2020}}{\Sigma FIN_{j,Dataset}}\right) \quad (4)$$

where:
- $CO_2R_{tot,2005-2020}$ = 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)
- $FIN_{j,tot,2015-2020}$ = 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.

Table 6: **Categorisation of renewable energy technologies**

Category used in this study (j)	IRENA category	OECD DAC category
Solar photovoltaic	Solar Photovoltaic	Solar energy
Concentrated solar power	Concentrated Solar Power	
Geothermal energy	Geothermal Energy	Geothermal energy
Hydropower	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	

A.1 TECHNOLOGY CATEGORISATION (J)

Technologies were categorized into the following (Table 6): solar photovoltaic (PV), concentrated solar power (CSP), wind (including onshore and offshore), hydro (including large, medium and small), bioenergy/waste and geothermal. The presented categorisation enables to develop country- technology-specific capacity factors in a consistent manner using datasets from different sources. Projects were categorized was made through a word search from project descriptions. For projects reporting the implementation of more than one technology, the category "multiple renewable technologies" was used.

A.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 CO2 emission factor and the reported project capacity, the second included only the grid electricity CO2 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.

Table 7: **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%

Source: Authors' own calculations based on IRENA (2016).

** Average values are used as proxies.*

A.3 CAPACITY FACTORS (CF)

For efficient fossil fuel-fired power plant projects, we assumed a uniform capacity factor of 80%. 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 CSP, using the installed capacity and power generation datasets from the IRENA database[234]. For CSP, a projected value for 2020 (33%) was used, drawn from the IEA Energy Technology Perspectives 2016 report[235]. In the absence of country-specific capacity factor data, the average of all countries with values was used as a proxy. The capacity factor for projects with multiple renewable technologies was defined as the median of the average values for solar photovoltaic, wind, hydro, bioenergy/waste and geothermal technologies.

A.4 GRID ELECTRICITY CO_2 EMISSION FACTORS (EF)

Grid electricity CO2 emission factors (tCO2/MWh) were obtained from the latest Clean Development Mechanism (CDM) grid emission factors database (version 30 August, 2016) published by the Institute for Global Environmental Strategies (IGES)[236]. Among three different emission factors, the combined margin emission factors (see section 4.3 for details) 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.

Table 8: **CO_2 emission reductions expected in 2020 from 225 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	**166**	**47.5**	**2028**
CSP	1	0.3	435
Geothermal	18	15.5	6330
Hydro	36	10.8	2448
Solar	51	7.4	6648
Wind	31	10.8	3333
Biomass/waste	17	7.4	376
Multiple RE	13	0.2	658
RE/EE	**7**	**1.2**	**544**
EE	**51**	**67.7**	**7063**

A.5 CALCULATED MITIGATION IMPACTS FOR THE PROJECT DATASET ASSESSED IN THIS REPORT

Table 8 presents total CO_2 emission reductions expected in 2020 from 224 RE and EE projects per area and technology analysed in this study.

A.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 173 projects (including seven projects with both RE and EE components) 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[237] for the years 2005 to 2014 (Table 9).

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 CPI (2015)[238, 239], was also assumed for the period 2005–2020.

Mitigation impacts were scaled up for each RE category. Shown in Table 9, the data comprised all renewable technologies and a category was added for projects with multiple RE technologies. For the scaling up calculations, finance data categorised as 'multiple RE technologies' was proportionally distributed to individual renewable energy categories. The results were summed to achieve a total renewable funding per technology. Solar PV

Table 9: **Total amount of development finance committed to RE projects by all supporting partners between 2005 and 2014 (million current US dollars).**

Sector	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	Total
Energy generation, renewable sources – multiple technologies	347	274	363	734	1172	1799	2561	1763	2030	2447	13491
Hydro-electric power plants	480	720	1181	442	208	716	586	997	1387	1285	8002
Solar energy	64	53	25	155	328	243	103	621	971	1661	4224
Wind energy	126	93	147	322	219	990	78	140	92	488	2694
Marine energy	..	0.4	..	0.0	0.1	0.1	..	0.0	0.5	0.1	1
Geothermal energy	225	10	8	3	43	673	397	48	290	606	2304
Biofuel-fired power plants	15	20	35	105	132	53	26	43	117	83	630
Total	1258	1171	1760	1761	2102	4474	3751	3612	4886	6571	31345

Table 10: **Estimated total mitigation impact in 2020 from RE and EE projects financed by bilateral and multilateral institutions between 2005 and 2014.**

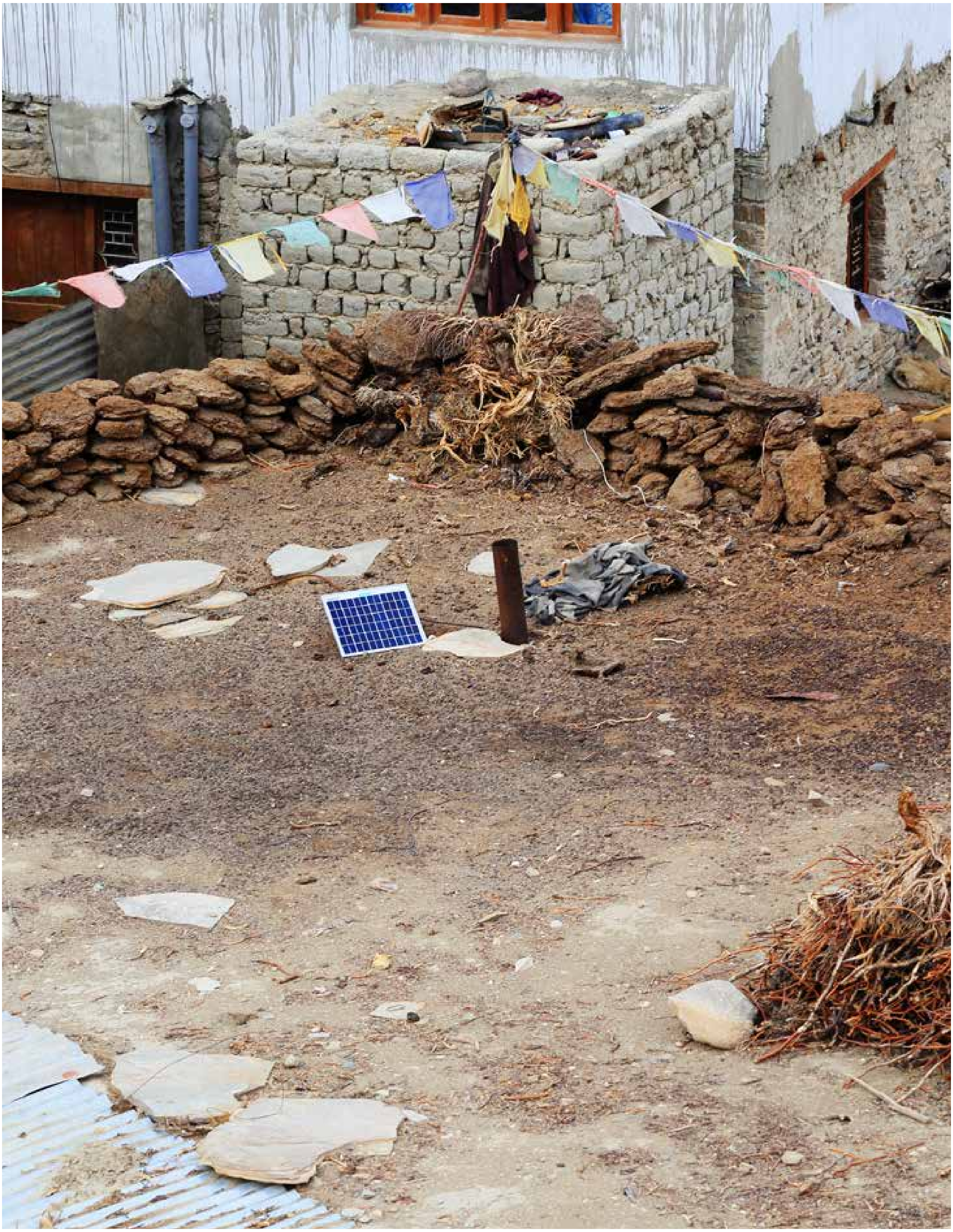
OECD category	IRENA category	OECD DAC category
RE and RE/EE total	**49.4**	**152**
Biofuel-fired power plants	1.67	10.7*
Solar energy	11.6	12.7
Geothermal energy	5.49	13.7
Hydro-electric power plants	24.6	105.0
Wind energy	6.07	20.1
EE total	**26.2**	**251**

* *Includes energy projects from waste.*

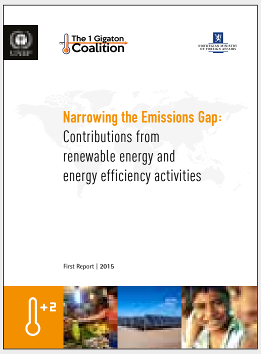
and CSP projects are scaled up collectively as "solar energy" projects. The results are shown in Table 10.

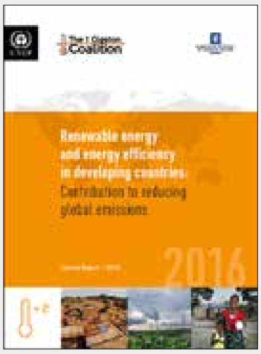
It should be noted that the estimated CO_2 emissions reductions from bioenergy projects, which are uncertain due to the lack of information on land-use related emissions, accounted for less than 1% of total emissions reductions from all RE projects. Therefore, the exclusion of indirect emissions related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

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.



ANNEX II: **DISTINCTIONS BETWEEN THE FIRST AND SECOND 1 GT COALITION REPORTS**





This second report of the 1 Gigaton Coalition expands on the first report, released in 2015, in several key respects:

1. Scope – The second report features an analysis of 224 RE and EE projects, more than five times the number (42) analysed in the first report. Fifty-one of these 224 projects are categorised as EE, whereas the first report's analysis included two such projects. This report features projects from more multilateral and bilateral groups than the first report, including projects in and financed by China. The second report also expands on the first report's temporal scope, incorporating data from projects implemented from 2005 through the end of 2015. The first report's upper limit was 2012, meaning this year's analysis includes more and more recent RE and EE projects than last year's. See Section 5.2's Box "RE and EE Project Data Collection Criteria" for more about this report's selection criteria.

2. Methodology – The methodology used in this analysis to calculate emissions reductions from the 224 featured RE and EE projects and for scaling up these reductions to the global level differ from those used in last year's analysis. These differences in approach have resulted in disparate results. The results from the two reports cannot be directly compared due to the different methods used to achieve them, yet their relative meanings should be briefly discussed.

   This report's scaled-up results provide an estimate of the emissions reductions achieved by bilateral- and multilateral-supported RE and EE projects in developing countries. These results were calculated using OECD data describing support for individual RE technology types. A separate scale up figure was estimated for each technology type. Last year's analysis reported a larger scaled-up estimate compared to this analysis because the analysed projects were scaled up using finance figures for all climate initiatives in developing countries, including project financed entirely by private investors. Last year's analysis used a global factor across all technologies to scale up from the 42 projects analysed, thus providing a less detailed analysis than this year's report. This year's scaled-up analysis provides a targeted appraisal for organizations supporting RE and EE projects in developing countries, showing the potential for these particular investments. In calculating emissions reductions from the RE and EE projects featured in this report, separate calculations were performed for projects of each technology type and then aggregated to achieve the total reductions figure. These methods differ from last year's approach, providing a more accurate assessment of the total emissions reductions from the analysis's sample of RE and EE projects. See Annex I for further details regarding the methods and assumptions that went into these calculations.

   This report also includes a general discussion of methodological considerations and approaches for performing GHG emissions accounting (Chapter 4). Providing context for and insight into the analysis's methods, these sections expand upon the first report's methodology discussion.

3. Updates – This analysis's emissions reductions calculations incorporate updated capacity factors for RE technologies and updated national grid emissions factors. These additions help make this analysis the most up-to-date of its kind.

SOURCES

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GLOSSARY

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

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

BILATERAL DEVELOPMENT ORGANISATION: a bilateral development organisation mobilises 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 aggregates emissions impacts from individual renewable energy and energy efficiency projects.

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

DEVELOPING COUNTRIES: This report uses the same definition of developing countries as used by organisations such as the IEA or IRENA[1].

DOUBLE COUNTING: the act of counting emission reductions from a single action more than once, often resulting in the mistaken attribution towards meeting more than one actor's pledges (e.g. 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 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 organisations 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 organisations that support renewable energy and energy efficiency projects in developing countries, to determine global impact of a certain policy, measure, group, etc.

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ACRONYMS

AFD	Agence Française de Développement
ADB	Asian Development Bank
AIIB	Asian Infrastructure Investment Bank
AMADER	Malian Agency for the Development of Household Energy and Rural Electrification
ASEAN	Association of Southeast Asian Nations
BAU	Business as usual
BNEF	Bloomberg New Energy Finance
BRICS	Brazil, Russia, India, China and South Africa
CDM	Clean Development Mechanism
CEFPF	Clean Energy Financing Partnership Facility
CIF	Climate Investment Fund
CO_2	Carbon dioxide
CO_2e	Carbon dioxide equivalent
CCAC	Climate and Clean Air Coalition
CFL	Compact fluorescent lamps
CHEEF	China Energy Efficiency Financing Project
CoM	Covenant of Mayors
CREIA	Chinese Renewable Energy Industries Association
CSP	Concentrated Solar Power
CTCN	Climate Technology Centre and Network
CTF	Clean Technology Fund
DEG	Deutsche Investitions- und Entwicklungsgesellschaft (subsidiary of KfW)
DFID	United Kingdom's Department for International Development
EBRD	European Bank for Reconstruction and Development
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
EnDev	Energising Development
EV	Electric Vehicles
ESCO	Energy service company
FiT	Feed-in tariff
FMO	Dutch Development Bank
JBIC	Japan Bank for International Cooperation
JICA	Japan International Cooperation Agency
GCF	Green Climate Fund
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 (German Corporation for International Cooperation)
Gt	Gigaton
GW	Gigawatt
IBRD	International Bank for Reconstruction and Development
ICF	UK International Climate Finance
IDB	Inter-American Development Bank
IEA	International Energy Agency
IFC	International Finance Corporation
IFI	International Financial Institutions
IKI	International Climate Initiative
INDC	Intended Nationally Determined Contribution
IPCC	Intergovernmental Panel on Climate Change
IRENA	International Renewable Energy Agency
IsDB	Islamic Development Bank
JICA	Japan International Cooperation Agency
KfW	Kreditanstalt für Wiederaufbau (Development Bank, Germany)
kWh	Kilowatt hours
LED	Light Emitting Diode
MDB	Multilateral development banks
MEPS	Minimum Energy Performance Standards
MIEM	Uruguay Ministry of Industry, Energy and Mining
Mt	Megaton (one million tons)
MW	Megawatts
MWh	Megawatt hour
NEEAPs	National Energy Efficiency Action Plans
NDC	Nationally Determined Contribution
NDEs	National designated entities
NDRC	China's National Development and Reform Commission
NREL	National Renewable Energy Laboratory of the United States of America
ODA	Official development assistance
OECD	Organisation for Economic Cooperation and Development
OECD-DAC	Organisation for Economic Cooperation and Development – Development Assistance Committee
OPIC	Overseas Private Investment Corporation
PFAN	Private Finance Advisory Network
PLN	Perusahaan Listrik Negara (Indonesian national utility)
PPA	Power purchase agreement
PV	Photovoltaic
RE	Renewable energy
REN21	Renewable Energy Policy Network for the 21st Century
REEEP	Renewable Energy and Energy Efficiency Partnership
SE4ALL	Sustainable Energy For All
SEAP	Sustainable Energy Action Plan
SREP	Scaling Up Renewable Energy Program
t	Ton
U4E	United for Efficiency
UJALA	Unnat Jyoti by Affordable LEDs for all
UN	United Nations
UNFCCC	United Nations Framework Convention on Climate Change
US $	United States Dollars
WEO	World Energy Outlook (publication by the International Energy Agency)
4C Maroc	Moroccan Climate Change Competence Centre

www.unep.org

United Nations Environment Programme
P.O. Box 30552 Nairobi, Kenya
Tel: ++254-(0)20-762 1234
Fax: ++254-(0)20-762 3927
E-mail: uneppub@unep.org

UNEP

Email: 1gigaton@unep.org

www.1gigatoncoalition.org

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