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Green Growth in Action: Achieving Green Energy Transformation

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1. Market Assessment of Fuel Pellets and Green Charcoal for Energy Uses in Senegal, Dereje Senshaw, 2017.

2. Policy Recommendations on Energy for Productive Uses in Rural Areas of Senegal, Dereje Senshaw, 2017.

3. GGPA Synthesis Report, Jan Stelter, 2018.

4. Meeting Global Housing Needs with Low-Carbon Materials, Christina Cheong and Donovan Storey, 2019.

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11. Green Growth in Action: Achieving Green Energy Transformation, Dereje Senshaw, Muharrem Askin, Bolormaa Chimednamjil, 2020.

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ABOUT THIS REPORT

Achieving Global Green Transformation is a collection of GGGI flagship reports highlighting the economic foundations of green growth and key approaches for developing green growth policies and plans and for implementing and financing green infrastructure within several key sectors.

This publication presents the collection on Achieving Green Energy Transformation.

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Abbreviations

ASEAN	Association of Southeast Asian Nations
CO_2	Carbon dioxide
ESCO	Energy Service Company
EU	European Union
EUR	Euro
EV	Electric Vehicle
FiT	Feed-in-Tariff
G20	Group of Twenty
GCF	Global Climate Fund
GDP	Gross Domestic Product
GGGI	Global Green Growth Institute
GHG	Greenhouse Gas
GW	Gigawatt
IEA	International Energy Agency
kW	kilowatt
kWh	kilowatt-hour
LDC	Least Developed Countries
Mtoe	Metric tons oil equivalent
MW	Megawatt
MWh	Megawatt-hour
NDC	Nationally Determined Contribution
NFV	National Financing Vehicle
NGEF	National Green Energy Fund
PAYG	Pay-As-You-Go
PV	Photovoltaic
SIDS	Small Island Developing States
SME	Small and Medium Enterprise
TWh	Terawatt-hour
UN	United Nations
USD	United States Dollar

Executive Summary

Catalyzing a Global Green Transformation

This century will witness a profound global transformation— critical decisions will determine the direction of that transformation. Across the world, countries are rethinking their options for long-term prosperity given rising concerns about the global environment, the need to sustain and protect their domestic environment and natural capital, and the desire to promote strong inclusive social development. Recognizing that conventional, resource-intensive economic growth can undermine their resource base and social progress, governments are increasingly turning to green growth as their best option for long-term sustainability, social well-being, and economic prosperity.

Many countries are already taking serious action—starting a green transformation across their economies and industries, in cities and rural areas, and at the international level in adopting the Sustainable Development Goals (SDGs) and the Paris Agreement on climate change. However, much more needs to be done. Through green growth, countries are now working towards a new, green transformation that can lead to a brighter, more prosperous, and sustainable future.

Embracing Green Growth

Green growth is the optimal choice for our future. It is no longer a new concept, and an increasing number of countries have been taking steps to adopt green growth as the primary—and essential—model of national development for the long-term.

The Global Green Growth Institute (GGGI) defines green growth as a development approach that seeks to deliver economic growth that is both environmentally sustainable and socially inclusive. GGGI's definition emphasizes that economic growth is of central importance for development and reducing poverty, and that achieving environmental sustainability and social inclusion are equally important and necessary to ensure that economic development is sustainable over the long term.[1]

Green growth consists of four fundamental underlying dimensions to the concept of the green growth economy:

- **efficient and sustainable use of resources**, including energy, water, land, and materials;
- **protection of natural capital** and recognition of the limits of Earth system processes;[2]
- **green economic opportunities** for investment, trade, employment, and innovation; and
- **inclusive growth**, which ensures access to basic services and resources, health and safety, social equality, and social protection.[3]

In this technical report, GGGI explains approaches to promoting a green energy transformation, such as applying green growth policies and plans and implementing and financing scalable green energy projects and programs.

1 GGGI, *GGGI Refreshed Strategic Plan 2015-2020: Accelerating the Transition to a New Model of Growth*, (Seoul: GGGI, 2017), http://gggi.org/site/assets/uploads/2017/11/GGGI-Refreshed-Strategic-Plan-2015-2020.pdf.

2 As defined by the International Geosphere-Biosphere Programme (IGBP), "The term "Earth system" refers to Earth´s interacting physical, chemical, and biological processes. The system consists of the land, oceans, atmosphere and poles. It includes the planet's natural cycles — the carbon, water, nitrogen, phosphorus, Sulphur and other cycles — and deep Earth processes."

3 GGKP Research Committee on Measurement and Indicators, *Measuring Inclusive Green Growth at the Country Level: Taking Stock of Measurement Approaches and Indicators*, (working paper, Geneva: GGKP, 2016), https://www.greengrowthknowledge.org/resource/measuring-inclusive-green-growth-country-level

Achieving Green Energy Transformation

GGGI has identified several critical issues for the successful transition to a green growth model of development. These issues emerge from the direct experience of low- and middle-income countries around the world, pursuing green growth with the support of GGGI and its partners. Embracing sustainable energy and scaling back the use of fossil fuels—or replacing them altogether—is an urgent priority for green growth and addressing the climate emergency. This report highlights selected issues and opportunities to advance green energy.

Sustainable energy is central to a green transformation. Energy production and energy use account for around two-thirds of global greenhouse gas (GHG) emissions. They are the largest single source of emissions[4] and significant contributors to local air pollution. Energy is also central to socially inclusive development. Nearly 1 billion people still lacked access to electricity as of 2017, mostly in rural areas in developing Asia and Sub-Saharan Africa,[5] while 2.7 billion people continue to rely on cooking fuels like firewood, charcoal, coal, and kerosene.[6]

The sustainable energy disruption is in progress. Countries have an opportunity to seize the dynamic changes underway in energy markets, as renewable energy, particularly solar and wind, is becoming the cheapest form of power generation in many countries. **India** canceled all new planned coal-fired power plants in 2017 when solar energy became less expensive than coal. **Viet Nam**, which plans to build 25 additional coal-fired power plants in the post-2020 period, exceeded expectations by installing more than 4 GW of solar photovoltaic (PV) systems as of mid-2019, more than four times its target for 2020.[7]

Combined with renewable energy, improving energy efficiency reduces the overall effort required from energy supply measures and contributes significantly to spurring economic growth and reducing GHG emissions. Energy efficiency investment in the industrial sector contributes to the modernization of facilities and equipment to realize improvements in energy use and intensity. China represented 37% of USD 40 billion investment made globally in 2018 for industrial energy efficiency, driven by favorable policies encouraging investments, with Energy Companies (ESCOs) playing a substantial role in delivery. In India, strong government policy has resulted in investment in the modernization of industrial facilities rising by around 6% per year. Energy efficiency measures and investments in the building sector are rising despite a recent decline in 2018. In China, the adoption of stricter building standards in residential real estate businesses is expanding investment in energy efficiency in the building sector. Electric Vehicles (EVs) sales growth is also having an increasingly positive impact on transport efficiency. Global EV continues to rise, reaching 5.1 million in 2018, a 63% increase compared to 2017. China, the largest EV car market sold over 1.1 million electric cars in 2018[8]. In India, 630,000 electric three-wheelers were sold in 2018-2019, outselling fossil fuel models by more than 100,000. EV cars and buses sold globally in 2018 are estimated to offset 0.1 million barrels per day of transport oil demand growth. Electricity demand from EVs (including two- and three-wheelers) sold in 2018 is estimated to be around 12 Terawatt-hour (TWh) per year, only 1% of 2018 global power demand growth[9].

The deployment of decentralized sustainable energy systems offers communities new access to electricity, bringing the chance to enhance economic opportunities and social development, without having to wait for grid connections. As of 2018, off-grid solar systems have provided more than 73 million households, or 360 million people, with access to energy globally, and their reach is growing rapidly[10]. As such, off-grid appliances are also becoming an important element of the global push towards greater energy efficiency and GHG emissions reduction.

4 PBL Netherlands Environmental Assessment Agency, *Global Greenhouse Gas Emissions Per Type of Gas and Source, Including LULUCF*, December 2017, https://www.pbl.nl/en/publications/trends-in-global-co2-and-total-greenhouse-gas-emissions-2017-report.

5 International Energy Agency, *World Energy Outlook 2018*, (Amsterdam: IEA Secretariat, 2018), https://www.iea.org/reports/world-energy-outlook-2018.

6 International Energy Agency, *SDG 7: Data and Projections*, November 2019, https://www.iea.org/sdg/cooking/.

7 PV Magazine, "Vietnam: 4 GW PV Installation Finished in Past Two Months," August 7, 2019, https://www.pv-magazine.com/press-releases/vietnam-4-gw-pv-installation-finished-in-past-two-months/.

8 International Energy Agency, *World Energy Investment 2019 Investing in our future: Flagship Report*, May 2019, https://www.iea.org/reports/world-energy-investment-2019/energy-end-use-and-efficiency.

9 International Energy Agency, *World Energy Investment 2019 Investing in our future: Flagship Report*, May 2019.

10 International Finance Corporation, *Market Research on Productive Use Leveraging Solar Energy (PULSE)*, September 2019, https://www.lightingglobal.org/resource/pulse-market-opportunity/.

More robust policy, planning and regulatory frameworks are needed to increase the adoption of and investment in clean energy. GGGI offers this support to several countries, including **Cambodia**, **Ethiopia**, **Fiji**, **Guyana**, **Indonesia**, **Lao PDR**, **Mongolia**, **Nepal**, **Senegal**, **Vanuatu**, and **Viet Nam**. Renewable energy, energy efficiency and rural electrification action plans and roadmaps are necessary for setting and achieving national targets. Appropriate policies and regulations help establish the attractive environment for public and private investments needed to speed up the pace towards green growth. Enabling policies, incentives, standards and labeling can mitigate investment risk and offer much-needed certainty required for investments to flow. In several countries, the high cost of diesel-based electricity generation and correspondingly high costs for end-users underscores the value of increasing the share of renewable energy in the electricity mix.

Guyana has catalyzed private sector engagement in scaling up renewable energy with GGGI support through its Urban Solar Energy Program. The program identifies ways to remove regulatory barriers and create a pipeline of distributed roof-top solar installations to contribute 6% of the country's total installed electricity generation capacity. The initiative has successfully engaged the local business community, which is attracted by the expected long-term cost savings.

Strong political commitment remains critical for phasing out fossil fuel-based power generation. Countries must align their power development plans with their NDC targets, increase the role of renewables in the electricity mix, and reduce fossil fuels in the power sector. However, many countries rich in coal resources, such as the largest economies of Southeast Asia, are still subsidizing coal-based electricity generation and planning a significant expansion of polluting coal capacity. Governments have a pivotal role to play by ending fossil fuel subsidies, including the use of subsidized electricity rates, and investing in sustainable energy infrastructure. Transformation of energy systems requires appropriate medium-to-long-term planning for generation, distribution, and transmission infrastructure and grid integration of variable and intermittent resources. **Fiji**, for example, is investing directly in utility-scale solar, while **Mongolia** is working to restructure its regulations to increase renewable energy generation and storage capacity, improve air quality, and reduce dependence on imported electricity.

Green Energy Disruption:

Green technology disruptions and smart solutions present critical opportunities to transform economic sectors, advance social and environmental objectives, and deliver key services.

A growing number of technology disruptions are poised to accelerate the green agenda through sustainable materials use and improved delivery of energy, mobility, waste management and other services.

In the case of energy, there is already a significant market shift towards renewable energy. Global renewable power capacity has reached to around 2,378 GW in 2018, and this provides an estimated more than 26% of all electricity globally[11]. Governments should seize the opportunities these increasingly cost-competitive technologies present. They should use policy and regulatory frameworks to transfer investment away from conventional systems and towards solar PV and wind, new energy storage and smart grids.

Innovations in storage technology are achieving cost reductions, increasing grid stability and paving the way for higher penetration of variable renewable energy sources, like wind and solar. With GGGI support, **Mongolia** is building capacity in energy storage technologies and **Guyana** is introducing smart meters and systems for expanding solar PV. GGGI is also helping countries like **Mongolia**, **Fiji**, **Indonesia**, **Thailand**, and **Vanuatu** to adopt the use of energy efficient equipment and energy management tools and systems. These tools can monitor and control the energy consumption profile, analyze the feasibility of energy efficiency investments, and achieve significant energy savings in industrial, commercial, and residential sectors.

11 REN21, *Renewables 2019 Global Status Report*, 2019, https://www.ren21.net/wp-content/uploads/2019/05/gsr_2019_full_report_en.pdf.

01 Achieving Green Energy Transformation

Embracing sustainable energy and scaling back the use of fossil fuels or replacing them altogether—is an urgent priority for green growth and addressing the climate emergency.

The world has never depended so much on energy resources or required so much energy as it does now, and demand continues to grow year on year. Energy is a fundamental resource that drives the global economy and provides a wide range of essential services that support social welfare and human development. It is a key driver of economic and social development and is necessary to achieve SDG 7, of increasing access to modern energy services. It also contributes to achieving SDGs 1, 2, 3, 4, 5, 6, 8, 9, 11, 12, 13, 15, 16 and 17. Yet energy is a significant contributor to environmental challenges. Fossil fuels have been the most abundant energy source since the start of the Industrial Revolution and are the primary source of GHG emissions responsible for the growing climate emergency. Energy poses a unique challenge in the green transformation given the scale of challenge required and the extent to which many countries are locked into polluting and GHG-emitting energy systems. Fully decarbonizing power systems is critical for achieving Paris Agreement commitments while simultaneously strengthening energy security and addressing pollution-related health impacts. Although the renewable energy transformation has begun, much more must be done to realize the full potential of greener, more sustainable energy. Low- and middle-income countries are working closely with organizations like GGGI to achieve a green energy transformation.

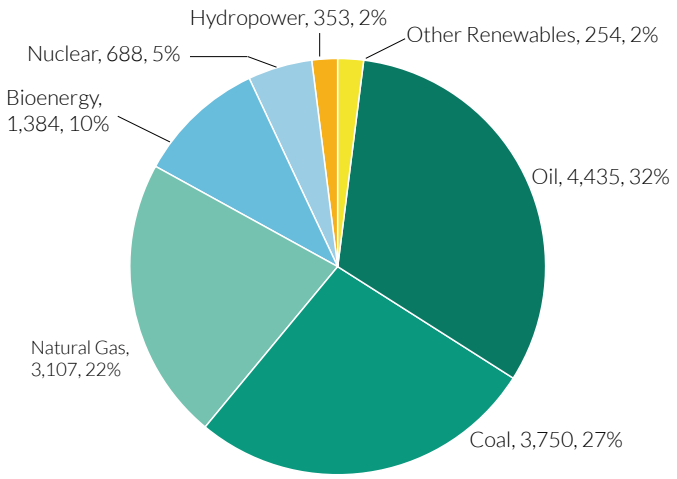
02
The Energy Challenges

Increasing Energy Demand, Emissions, and the Challenge of Phasing Out Fossil Fuels

Global energy consumption tracks closely with world economic growth, and modernization has made energy use increasingly efficient, achieving even more per unit of energy. Currently, energy consumption is growing at the fastest rate in a decade,[12] and globally most energy is produced using fossil fuels. In 2017, global primary energy demand consisted of about 80% fossil fuels (32% petroleum, 27% coal, 22% natural gas), 5% nuclear, 2.5% hydropower and 12% bioenergy and other renewables, as shown in figure 1.

The world's energy systems must undergo a rapid transformation to avert the climate emergency. Fossil fuel consumption accounts for around two-thirds of global GHG emissions. Global energy-related CO_2 emissions reached a historic high of 33.1 Gt CO_2 in 2018,[13] and these emissions have been steadily increasing, creating an even greater gap to achieving Paris Agreement objectives.[14] The Intergovernmental Panel on Climate Change (IPCC) has warned that the world will not be able to stop atmospheric warming of 2.0°C without fully decarbonizing economies by mid-century, and this includes energy systems. The energy sector is also a significant contributor to local air pollution.

Figure 1. Total global primary energy demand (2017, Mtoe, %)



Source: International Energy Agency, *World Energy Outlook 2019*.

12 International Energy Agency, "Global energy demand rose by 2.3% in 2018, its fastest pace in the last decade," March 26, 2019, https://www.iea.org/news/global-energy-demand-rose-by-23-in-2018-its-fastest-pace-in-the-last-decade.

13 International Energy Agency, *Global Energy and CO_2 Status Report 2019*, 2019, https://www.iea.org/geco.

14 International Renewable Energy Agency, *Global Energy Transformation: A roadmap to 2050*, 2019 ed. April 2019, https://www.irena.org/publications/2019/Apr/Global-energy-transformation-A-roadmap-to-2050-2019Edition.

Coal, the largest source of electricity generation,[15] has historically contributed to about 30% of the total temperature increase since pre-industrial times. Although progress is being made in some countries to reduce dependence on coal, it remains a significant energy source in Asia, comprising an estimated 75% of total global demand as of 2018, and demand is growing.[16] While about one-third of new energy generation in **India** is in renewables, most of it is in new coal power, and coal use is growing in **Indonesia**, **Vietnam**, the **Philippines**, and **Malaysia**. Coal-fired power plants in Asia are also relatively young and their lifetime is typically 40 years, meaning that coal-dependent countries could be locked into coal-based power generation technology.[17]

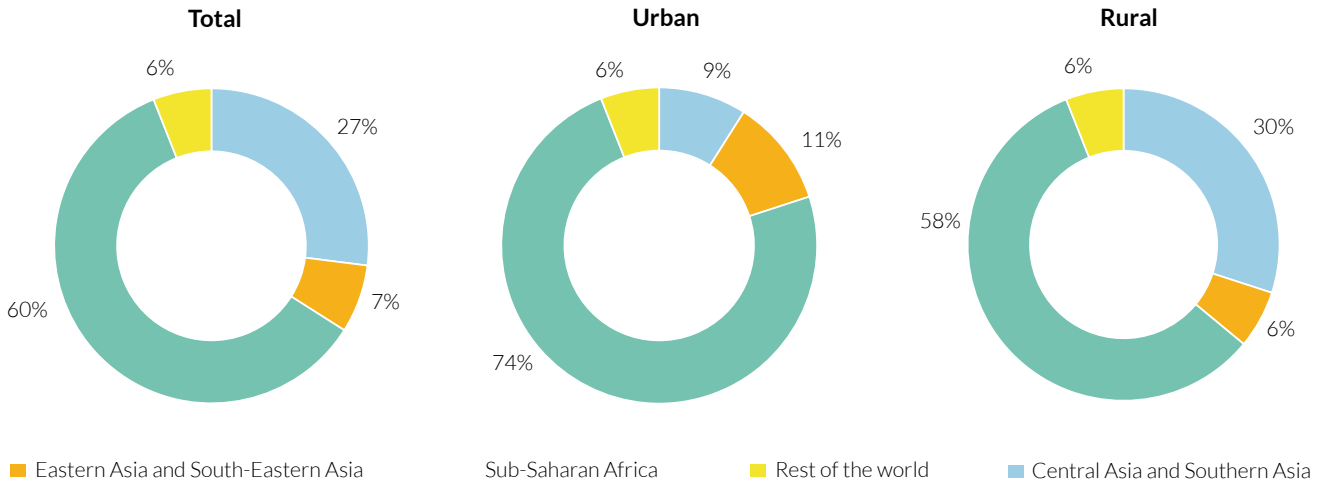
Continued subsidies and tax breaks, estimated at $400 billion remain one of the most significant obstacles to reducing fossil fuel use globally. The subsidies and tax breaks are on oil, coal, natural gas and fossil fuel-based electricity which have historically risen with rises in fuel prices. Oil is the most heavily subsidized fuel, receiving about 40% of the total[18]. Many countries subsidize fossil fuel use in contradiction to their sustainable development objectives, and some have justified subsidies as "pro-poor" despite little evidence to support this.

Access to Energy and the Just Transition

An "energy divide" between rich and poor and between rural and urban populations presents challenges for ensuring equitable access to and benefits from energy. An estimated 84% of those that lack electricity live in rural areas.[19] Energy access remains a global problem. In 2017, nearly 1 billion people still lacked access to electricity, primarily in developing Asia and in Sub-Saharan Africa, while 2.6 billion people lack access to clean cooking facilities.[20] Based on the World Bank's recent report on tracking SDG7, 650 million people will remain without access to electricity by 2030, of which Sub-Saharan Africa counties represent 90% of the deficit[21]. Figure 2 shows the breakdown of the access deficit by region in 2016.

The energy divide also exists between genders. Women and girls disproportionately hold the responsibility for labor intensive and time-consuming tasks such as biomass collection or manual food processing. This responsibility impedes opportunities to access education and employment and to participate effectively in social and political activities outside the household.

Figure 2. Share of local access deficit based on population without access to electricity, urban -rural, by region, 2016



Source: World Bank, *Tracking SDG7*, 2018.

15 International Energy Agency, *Tracking Power*, May 2019, https://www.iea.org/reports/tracking-power-2019/coal-fired-power.

16 International Energy Agency, *World Energy Outlook 2019*, (Amsterdam: IEA Secretariat, 2019), https://www.iea.org/reports/world-energy-outlook-2019.

17 International Energy Agency, *Global Energy and CO_2 Status Report 2019*, 2019.

18 International Energy Agency, *World Energy Outlook 2019*, 2019.

19 International Energy Agency, *World Energy Outlook 2011, Energy for All: Financing Access for the Poor*, 2011.

20 International Energy Agency, *SDG 7: Data and Projections*, November 2019, https://www.iea.org/reports/sdg7-data-and-projections.

21 World Bank, *Tracking SDG7*, 2019, https://www.worldbank.org/en/topic/energy/publication/tracking-sdg7-the-energy-progress-report-2019.

Challenges the Green Energy Transformation

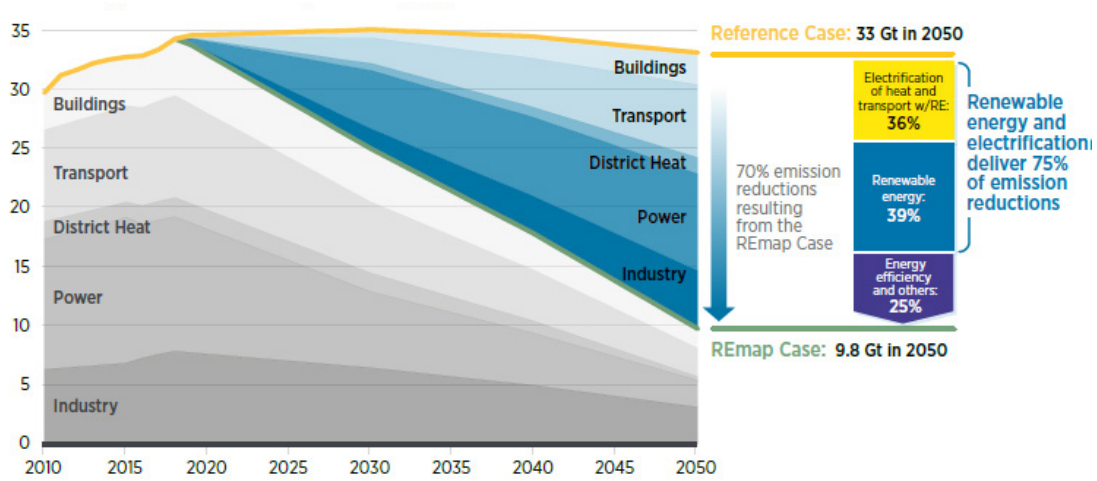
Despite the dominance of fossil fuels, a sustainable energy transformation has already begun. More electricity generation capacity from renewables is now added each year than fossil fuel capacity, mainly because several leading renewables are already or will soon be less expensive than fossil fuels and because of the plunging cost of energy storage.[22] As of 2017, renewable electricity provided 26.5% of global electricity generation,[23] expected to increase to 30% of total electricity demand by 2023. The decreasing cost of batteries is also helping to accelerate the adoption of electric vehicles, with several governments and major car companies proposing to end the use of the combustion engine within coming decades.[24]

Energy efficiency is the most cost-effective option for GHG emissions mitigation and climate change adaptation. Energy efficiency is already a critical part of energy transformation, cutting costs and reducing emissions in transportation, industries, buildings, homes, and agriculture. Cities are also playing a leading role in the renewable energy transformation. Canberra, **Australia**, for example, expects to source 100% of its energy from renewables by 2020 and become a zero-emission city by 2030. Copenhagen, **Denmark**, anticipates becoming a zero-emission city by 2025.[25]

As shown in figure 3, it is possible to reduce CO_2 emissions from energy by as much as 77% from 2020 to 2050. Measures include the adoption of renewable energy, energy efficiency, and electrification of heat and transport—affecting power generation, industries, buildings, transportation, and district heating.

Based on existing or planned policies, an estimated USD 95 trillion will be invested in the energy sector by 2050. Decarbonizing all energy will require increasing that by 16% to a total of USD 110 trillion, or 2% of annual global GDP. Reducing fossil fuel subsidies while boosting renewable energy investments would still save about USD 10 trillion compared with business-as-usual investments to the year 2050.[26] Because of the avoided costs of climate change, projections show the total impact of these investments resulting in an increase in global GDP every year to 2050. The GDP increases rise to as high as 2.5% per year starting in the year 2035, with overall cumulative gains in global GDP of USD 99 trillion and slight improvements in overall employment.

Figure 3. Possible CO_2 emission reductions through renewables, energy efficiency, and electrification to 2050 (annual energy-related CO_2 emissions, 2010-2050, Gt/yr)



Source: IRENA, *Global Energy Transformation: A Roadmap to 2050*, 2019.

22 New Climate Economy, *Unlocking the Inclusive Growth Story of the 21st Century: Accelerating Climate Action in Urgent Times*, (Washington, DC: New Climate Economy, 2018), https://newclimateeconomy.report/2018/wp-content/uploads/sites/6/2019/04/NCE_2018Report_Full_FINAL.pdf.

23 International Energy Agency, *Global Energy and CO_2 Status Report 2019*, 2019.

24 Joern Buss, "Automakers Need A Global Timetable For Phasing Out Internal-Combustion Engines," *Forbes*, March 27, 2018, https://www.forbes.com/sites/oliverwyman/2018/03/27/automakers-need-a-global-timetable-for-phasing-out-internal-combustion-engines/#69badd1323c3; Jack Ewing, "Volvo, Betting on Electric, Moves to Phase Out Conventional Engines," *The New York Times*, July 5, 2017. https://www.nytimes.com/2017/07/05/business/energy-environment/volvo-hybrid-electric-car.html.

25 "Canberra – 100% Renewable Powered Capitol City by 2020"; "City of Copenhagen", Go 100% Renewables, Renewables 100 Policy Institute, http://www.go100percent.org.

26 IRENA, *Global Energy Transformation: A Roadmap to 2050*, 2019.

To achieve the Paris Agreement goals, all countries must achieve net-zero emissions within 30 years. The world must bring about a near complete transformation of power generation, transportation, industries, and buildings. Ideally, this means setting a target of replacing fossil fuel use with 100% renewable energy, combined with full electrification of transportation, heating, and cooling systems, and scaling up energy efficiency to its fullest potential. According to IRENA, renewables and energy efficiency, along with significant electrification, can yield more than 90% of the necessary reductions in energy-related emissions by 2050.[27]

The current pace of transformation is far from sufficient. The International Energy Agency (IEA) estimates that by 2040, even with aggressive renewable energy adoption policies in place globally, the share of primary energy demand for bioenergy, hydropower, and other renewable energy will only reach 31% of the total. Demand for coal, oil, and natural gas is expected to remain at 60%.[28] Aggressive adoption of renewable energy, energy efficiency and electrification for energy access is technologically and economically viable[29]. However, challenges remain in establishing the necessary enabling policies and incentives, financing, increased capacity, data collection and management systems, and leadership in government and the private sector. Section 4.2 addresses these topics in more detail.

27 IRENA, *Global Energy Transformation: A Roadmap to 2050*, 2019.

28 International Energy Agency, *World Energy Outlook 2019*, 2019.

29 IRENA, *Global Energy Transformation: A Roadmap to 2050*, 2019.

03

Effective Strategies and Approaches for Green Energy Development

There is no one-size-fits-all approach to green energy development. In recent decades, many low- and middle-income countries have made political commitments, dedicated public funds, and initiated measures to make the green energy transition, but barriers remain. There is potential to broadly introduce sustainable energy systems on a commercial basis in many low and middle-income countries if a sufficient scale can be reached to make projects attractive for the private sector. However, limited knowledge and experience in the local market, combined with policy obstacles, has prevented a rapid transition. Given the importance of energy as a driver of social and economic development, the slow uptake of greener energy systems can hold back a country's progress towards green growth. A rapid, effective transition will require stepping up the use of integrated national energy plans and international partnerships and addressing weak, inconsistent policies and planning frameworks that create barriers to investment, financing challenges, and limited human and institutional capacity.

Box 1. GGGI's approach to Green Energy

GGGI supports its Member and partner countries to transform the energy sector and provide affordable, clean, and reliable energy sources, in pursuit of NDC targets, SDG 7, and green, sustainable, and inclusive economic growth. GGGI helps with developing green energy strategies and plans and increasing country capacity to attract finance for green energy investment projects that result in:

(1) expanded access to affordable and sustainable energy services, particularly through decentralized systems;
(2) improved sustainable and renewable energy mix; and
(3) enhancement and integration of energy efficiency.

GGGI support includes incentivizing green energy projects, facilitating national dialogue, conducting pre-feasibility studies, developing pipelines of bankable green energy projects, facilitating financial closure, and developing business and finance models. Through its Global Climate Fund (GCF) Readiness program, GGGI facilitates access to climate finance for both green energy project development and provides readiness support. Countries supported with GCF Readiness include **Vanuatu**, **Papua New Guinea**, **Thailand**, **Senegal**, **India**, and **Mongolia**.

International Action

Countries have prioritized the adoption of green, sustainable energy through a range of international agreements, initiatives, and intergovernmental organizations and partnerships. Leveraging these initiatives will be vital for taking the green energy agenda forward in low and middle-income countries around the world.

Under the 2030 Agenda, **SDG 7** explicitly calls for universal access to sustainable, affordable, reliable modern energy by 2030. SDG 12 promotes responsible consumption and production by removing market distortions caused by fossil fuel subsidies through taxation restructuring, and subsidy phase-out while minimizing impacts on affected individuals. Under the Paris Agreement, virtually all NDCs include energy-related actions, and about three-quarters include specific renewable energy-specific targets.[30]

Actors across the public, private and non-governmental sectors are collaborating to bring about a green energy transition. The **International Renewable Energy Agency (IRENA)**, an intergovernmental organization representing more than 180 countries is doing significant work on international cooperation and renewable energy knowledge development and sharing.[31] **Sustainable Energy for All (SEforALL)** is dedicated to drive further, faster action toward achievement of SDG7 and the Paris Agreement.[32] Many platforms are also facilitating international knowledge sharing and delivering technical support, such as the Renewable Energy Network for the 21st Century (REN21)[33], the Renewable Energy and Energy Efficiency Partnership (REEEP),[34] and the Clean Energy Solutions Center.[35]

Separately, some 90 countries, including eight GGGI Members—**Costa Rica**, **Denmark**, **Ethiopia**, **Fiji**, **Mexico**, **Senegal**, the **United Kingdom**, and **Vanuatu**—have joined the **Powering Past Coal Alliance (PPCA)**, which aims to accelerate the phase-out of coal power generation.[36] Twelve GGGI Members are also part of the **Least Developed Countries Renewable Energy and Energy Efficiency Initiative for Sustainable Development (LDC REEEI)**. LDC REEEI is an LDC-led initiative to deliver, in all LDCs, 100% access to affordable renewable energy by 2030, maximum utilization of energy efficiency by 2040, and 100% electricity generation from renewable sources by 2050.

During the 2019 UN Climate Summit, the Danish government, in collaboration with Denmark's biggest pension funds, announced an investment plan of USD 50 billion by 2030 to support the green transition[37]. Notably, the Danish pension industry has already invested EUR 16 billion in the green energy sector[38]. The World Bank Group has set up an investment plan of USD 200 billion from 2021 to 2025 to support the implementation of 35 gigawatts (GW) of renewable energy projects and related enabling infrastructure[39]. Moreover, more than 1,000 institutions, including cities, banks, insurance companies, pension funds, and faith groups with professionally managed investment funds, amounting to nearly USD 8 trillion have committed to divesting from fossil fuels. The private sector is also stepping up. For example, the Climate Group's RE100 brings together the world's most influential businesses to commit to 100% renewable energy by affecting corporate energy sourcing decisions.[40]

Greening Policy and Planning Frameworks

Energy planning and policy frameworks are the foundation of pursuing the green energy transition and achieving SDG and NDC objectives. To succeed, countries must remove regulatory and administrative barriers, such as complicated licensing or permitting procedures,[41] and effectively implement policy and regulatory frameworks to reduce financial risks and avoid wasted resources. These steps are critical in regions like Africa, where 70% of all countries lack the enabling legal and regulatory environment for promoting and deploying renewable energy. Many countries still have outdated policies that directly forbid businesses to connect rooftop solar to the grid or cap these installations at such a small capacity that it is financially unattractive.[42]

Designing a policy and planning framework begins with **identifying the most appropriate and effective renewable energy**, **energy efficiency**, and **clean transportation technologies** based on relative costs, resource availability, and potential for scale-up. A wide range of energy modeling tools can support this process, such as cost-benefit and scenario analyses that can ascertain potential benefits and effects on GDP, energy capacity, and GHG emissions. It is similarly essential to develop evidence-based strategies and proposals to demonstrate a solid return on investments. Funders such as the GCF, multilateral development banks, bilateral donors, private equity, and commercial financial institutions require that proposals show strong evidence of an expected financial return on investment, while also contributing to the SDGs, reducing GHG emissions, or enhancing resilience.

30 International Renewable Energy Agency, *Renewable Energy in National Climate Action: Updates to IRENA's 2017 analysis of the renewable energy components of NDCs*, 2018, https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2018/Dec/IRENA_COP24_NDC_update_2018.pdf.

31 "About IRENA," International Renewable Energy Agency, https://www.irena.org/aboutirena.

32 "About Us," Sustainable Energy for All, https://www.seforall.org/about-us.

33 "What We Do," REN21, https://www.ren21.net/about-us/what-we-do/.

34 "About REEEP," REEEP, https://www.reeep.org/about-reeep.

35 Clean Energy Solutions Center (website), https://cleanenergysolutions.org.

36 "Members," Power Past Coal Alliance, https://poweringpastcoal.org/about/members.

37 Rachel Fixsen, "UN Climate Summit: Danish pensions to lead green transition with 47bn pledge," *IPE magazine*, September 24, 2019, https://www.ipe.com/un-climate-summit-danish-pensions-to-lead-green-transition-with-47bn-pledge/10033458.article.

38 Rachel Fixsen, 2019.

39 REN21, *Renewables 2019 Global Status Report*, 2019.

40 GGGI, *G20 Background paper: Green growth to achieve the Paris Agreement*, (Seoul: GGGI, 2019), https://gggi.org/site/assets/uploads/2019/02/GGGI_G20-Background-Paper_FINAL-v2.pdf.

41 International Renewable Energy Agency, *Renewable Energy Policies in the Time of Transition*, April 2018, https://www.irena.org/publications/2018/Apr/Renewable-energy-policies-in-a-time-of-transition.

42 RE100, *Business Leadership in the Transition to Renewable Electricity*, 2018, http://media.virbcdn.com/files/ef/f8e97377fa5493be-RE100LeadershipPaper.pdf.

In **Indonesia**, for example, GGGI has supported extended cost-benefit analysis (eCBA) to locate renewable energy potential in Central and Eastern Kalimantan provinces. The eCBAs provide monetary values of likely costs and benefits associated with on- and off-grid solar PV, micro-hydro, biomass, and biogas. A key step in conducting these analyses is to address inadequate data needed to analyze opportunities and track progress.[43]

There are advantages to adopting **mutually reinforcing policies** that take into account the inter-relationships between economic, transport, and land-use sectors, and social and environmental considerations. Such integrated approaches can effectively address market failures and barriers, create an enabling policy framework for large-scale private sector investment and identify ideal development pathways. Depending on national conditions, countries with low energy access may find advantages in introducing low-carbon renewable energy. In contrast, countries with established energy and industrial structures may emphasize energy efficiency.

Together with the World Bank and with GCF support, GGGI supported **Vanuatu** to revise its National Energy Road Map (NERM) to 2030. The revision identified policy interventions for increasing energy access and affordability, energy security, sustainability, and green growth, focusing on tourism, fisheries, and water sectors. These efforts led to the establishment of **Vanuatu**'s National Green Energy Fund (NGEF) to support financing to achieve 100% electrification using renewables. **Mongolia**, with support from GGGI and the Stockholm Environment Institute, has adopted strategies to introduce green energy systems that reduce GHG emissions, improve air quality, and facilitate other socio-economic benefits, and to launch the National Green Credit Fund (NGCF).

Rapid declines in the cost of renewable energy technology and innovative business and financing instruments are helping to motivate countries to update **green energy targets**. Establishing and increasing these targets provides a clear signal to the private sector, power utilities, and investors. As of 2016, 150 countries had adopted renewable power generation targets, 47 countries had targets in heating and cooling, and 41 countries had targets related to clean transport.[44] By the end of 2016, 130 low- and middle-income countries had established targets or policies for renewable energy at the national or subnational level, many aiming for 100% renewable energy adoption in the medium or long term.[45]

Given the rapidly dropping costs of renewable energy technologies, targets are becoming more ambitious. Fifteen GGGI Member countries have committed to 100% renewable energy in the medium to long term—four with a target of 2030 or earlier and 11 by 2050.[46] For example, in 2018, **Costa Rica** committed to becoming the world's first carbon-neutral economy by 2021 and established a goal to reach a 100% renewable energy mix. The country can power itself for months at a time, drawing solely on renewable energy. In 2017 it exclusively relied on clean energy sources for electricity generation for a record 300 days.[47] The Government of **Guyana**, aims to transition to 100% renewable energy in the public sector by 2025 although current energy production is primarily fossil fuel-based, in part to address the country's high electricity tariffs.[48]

Regulatory incentives and disincentives create significant barriers and opportunities for promoting green energy, such as fossil fuel subsidies, auctions, feed-in-tariffs, and carbon pricing in many countries. As efforts mount to address the climate emergency, one of the top priorities for countries is to eliminate **fossil fuel subsidies**, which cost more than $400 billion globally and reward fossil fuel use while keeping sustainable energy options at a disadvantage.[49] While governments recognize the need to scale back these subsidies, they are often concerned with the social impacts of allowing fuel prices to go up, like the social unrest in France in 2018. **Indonesia** addressed these concerns when the government began reducing fossil fuel subsidies from USD 19.3 billion in 2014 to USD 4.3 billion in 2016[50] by launching social assistance programs. Programs included temporary cash transfers to the poorest 25% of households, and infrastructure development projects.[51]

Various **financial and fiscal incentives** can accelerate the deployment of renewable energy.[52] **Feed-in-tariffs (FiTs)**, which involve paying for renewable energy generation at a fixed price under a certain period of years, have been the most popular and successful policy measure worldwide. Auctions are also gaining popularity due to their reduced risk. FITs have supported the deployment of renewable energy, increasing its share in the overall energy mix. From the early 2000s, FiT instruments have sustained both large and small renewable energy investments. Countries such as **Germany**, **Malaysia**, **Japan**, and **Thailand** introduced FiTs and experienced an increase in renewable energy power. Japan introduced a generous FiT for renewable energy in 2012 as part of a strategy to quickly reduce its dependency on nuclear energy.

43 RE100, *Business Leadership in the Transition to Renewable Electricity*, 2018, http://media.virbcdn.com/files/ef/f8e97377fa5493be-RE100LeadershipPaper.pdf.

44 GGGI, *G20 Background paper*, 2019.

45 GGGI, *G20 Background paper*, 2019.

46 Costa Rica, Fiji, Papua New Guinea, and Vanuatu have 100% renewable energy targets to 2030. Cambodia, Denmark, Ethiopia, Kiribati, Mongolia, Morocco, the Philippines, Rwanda, Senegal, and Viet Nam have set targets for 100% by 2050.

47 Umair Irfan, "Costa Rica has an ambitious new climate policy — but no, it's not banning fossil fuels," *Vox*, July 17, 2018, https://www.vox.com/energy-and-environment/2018/7/17/17568190/costa-rica-renewable-energy-fossil-fuels-transportation.

48 GGGI, *G20 Background paper*, 2019.

49 International Energy Agency, *World Energy Outlook 2019*, 2019.

50 Global Strategies Initiative and IISD, *The Case for Renewable Energy in Indonesia: The Cost of Energy, Subsidies, Externalities and Non-Cost Factors*, 2019, forthcoming.

51 World Bank, *Indonesian Economic Quarterly: Resilience Through Reforms*, June 2016, https://www.worldbank.org/en/country/indonesia/publication/indonesia-economic-quarterly-june-2016-resilience-through-reforms.

52 Friedemann Polzin et al., "How do policies moblize private finance for renewable energy? An investor perspective," *Applied Energy 236*, (February 2019): 1249–1268, https://doi.org/10.1016/j.apenergy.2018.11.098.

Germany subsidized its FiT scheme following the Fukushima disaster, and resulting plans to phase out nuclear energy.[53] Through a project supported by GGGI, **Viet Nam** raised the FiT to the same level as solar, enabling the sugar industry to install 737 MW to generate 4,300 GWh of electricity, enough to service 630,000 households a year while reducing emissions by 2.7 $MtCO_2$ and creating over 2,000 green jobs.[54]

Auction instruments are also becoming popular as they provide regulatory certainty to investors and support real price discovery. Auctions provide transparency on costs, with only the most aggressive cost-cutters among the developers submitting bids likely to be rewarded with tariffs. In 2017, total renewable energy capacity auctioned globally reached 50.6GW, up from 33.6GW in 2016- representing somewhere between USD 30 to 50 billion worth investment.[55] Over the past decade, "reverse" auctions, usually blended with other instruments, have also become a common mechanism to promote the deployment of renewable energy in the power sector in both developed and developing countries. The auction mechanism enables the project developers to submit proposals to the respective government authorities. Then the government ranks and selects the proposals according to selection criteria, i.e. technical, financial. For example, **Mexico** adopted a competitive auction combined with a clean energy certificate scheme and renewable energy generation targets up to the year 2050. As of 2018, Mexico's approach resulted in the world's lowest prices for both wind and solar energy—below USD 20.80 per MWh.[56] Similarly, in **India**, where renewable energy capacity is expected to more than double between 2018 and 2022, the government adopted a reverse e-auction, which resulted in a significantly lower solar feed-in-tariff.[57] Other financial support and incentives such as grants, concessional loans, green technology subsidies and tax exemptions, and certification schemes are also widely available.

Renewable energy portfolio standards (RPS) have also promoted the uptake of renewable energy in some countries through tradable clean certificates.[58] For instance, **China** has increased renewable energy generation by introducing a renewable energy quota system—equivalent to a green certificate—which requires electricity producers, grid companies, and retailers to obtain a renewable energy certificate.[59]

53 REN21, *Renewables 2018 Global Status Report*, 2018, https://www.ren21.net/wp-content/uploads/2019/05/GSR2018_Full-Report_English.pdf.

54 GGGI, *G20 Background paper*, 2019.

55 United Nations Environment Programme, *Global Trends in Renewable Energy Investment 2018*, April 2018, https://www.greengrowthknowledge.org/resource/global-trends-renewable-energy-investment-report-2018.

56 United Nations Environment Programme, *Global Trends in Renewable Energy Investment 2018*, 2018.

57 Rob Smith, "Three Countries Are Leading the Renewable Energy Revolution," *World Economic Forum*, February 26, 2018, https://www.weforum.org/agenda/2018/02/countries-behind-global-renewable-energy-growth/.

58 United Nations Environment Programme, *Global Trends in Renewable Energy Investment 2018*, 2018.

59 Allianz Climate Solutions GmbH, Germanwatch e.V., and NewClimate Institute for Climate Policy and Global Sustainability GmbH, "China and India lead the global renewable energy transition," *UNFCCC*, April 20, 2017, https://unfccc.int/news/china--and-india-lead-global-renewable-energy-transition.

Mobilizing Finance and Promoting New Business Models

Substantial financial gaps for sustainable energy ambitions persist despite the extensive financing available globally. Among the challenges in closing these gaps are the need for dedicated institutions, improved licensing and permitting, financing vehicles and instruments, innovative business models, and the identification of "bankable" projects.[60]

Given the challenges of many smaller developing countries to access international climate financing, **National Financing Vehicles (NFVs)** are providing an important alternative in helping countries to access climate finance, particularly for small and medium enterprises. GGGI and its partners support the development of NFVs to simplify access to climate financing. They do so by channeling bilateral and multilateral aid, private funding, capital markets, and national budgets into a government-led pooling mechanism that offers grants to local entities with lower transaction costs. NFVs can be set up in a Ministry of Finance, such as the Climate Resilient Green Economy facility in **Ethiopia**, as a parastatal entity, such as the **Rwanda** Green Fund (FONERWA) or the **Vanuatu** Green Energy Fund, or as a fund managed by a national development bank or private bank, such as the **Mongolia** Green Credit Fund.

Establishing public-private partnerships can complement these efforts. For example, the **Moroccan** Solar Energy Association (MSEN) has been instrumental in attracting both local and foreign investment in renewable energy technologies, making **Morocco a leader** in adopting public-private partnership approaches to de-risking and guarantee-based financing. In **India**, the North Delhi Municipal Corporation (NDMC) has collaborated with Ramky Group, a sustainability company, to build a 24 MW waste-to-energy plant that will consume 2,000 tons of garbage per day. The City of Kampala, **Uganda**, has partnered with several companies to promote and expand clean cooking technology initiatives. A solar start-up in Lagos, **Nigeria**, partnered with local telecommunications providers to launch new business initiatives aimed at making solar energy more accessible and affordable.[61]

An essential element in attracting investment is **designing effective financial and risk mitigation instruments**, including the development of de-risking and guarantee instruments, as supported by GGGI. To utilize **blended finance**, combining concessional finance with public and private investment, governments adopted legal and regulatory frameworks to facilitate public-private-partnerships (PPP) and investments, and build up stakeholders' institutional and operational capacity to design, implement, and manage various financial instruments.

60 International Renewable Energy Agency, *Renewable Energy Policies in the Time of Transition*, 2018.

61 GGGI, *G20 Background paper*, 2019, 22.

As the clean energy market evolves, an increasing number of **innovative business models** and financial instruments are emerging and maturing that appeal to private companies and commercial banks. Any sound financial proposal needs to have a business model that focuses on long-term management and funding, not only to make proposals attractive to international funders but also to clarify domestic financial requirements and processes. Business models can also take a different form, for example concerning **supply chains**. Effectively managed supply chains are crucial to meeting rapidly growing demand for sustainable **bioenergy**. There is tremendous potential to produce bioenergy sustainably and cost-effectively on existing farmland and grassland without affecting food production.[62]

Seeking private financing has also become more challenging for small-scale and decentralized applications, such as for off-grid renewables. The practice of **aggregating multiple small projects** into one has helped expand investment in this area. **Indonesia**'s Nusa Tenggara Timur (NTT) province aims to develop 15MW of solar energy capacity with battery storage across eight small islands. GGGI's pre-feasibility study presented an aggregated project that persuaded private investors to go for plan investment in the project without concessional financing.

Capacity Building and Governance

Although there is potential to broadly introduce renewable energy, energy efficiency, and clean transport options on a commercial basis in many developing countries, limited knowledge and experience in the local market prevents a rapid transition. Weak **institutional capacity**, a **shortage of career professionals**, and **political hurdles** remain significant barriers.[63] Strengthening capacity, awareness, and governance is thus central to the green energy transformation.

Capacity building support by GGGI, IRENA, and other partners helps to increase institutional and human capacity, knowledge, and awareness for countries like **Uganda**, **Mozambique**, **Burkina Faso**, **Cote d'Ivoire**, **The Gambia**, **Guinea**, **Senegal**, **Fiji**, **Vanuatu**, **Papua New Guinea**, and the **Solomon Islands**. Such efforts have focused on sustainable community energy planning, rural energy access, green energy financing and procedures, and target-setting for NDCs and other policies.

There is often resistance and reluctance to engage in the renewable energy transition, regardless of national policies. It is thus critical to work closely with utilities to gain their trust and demonstrate the viability of renewable energy projects as part of their energy mix.[64] **Stakeholder consultation** is often critical in identifying the priority areas in capacity development, tailored to country needs for green energy development. **Strengthening institutional capacity**, for example for power sector regulators, can play a central role in developing and integrating renewable energy into national energy systems. **Training and education programs** can ensure adequate numbers of skilled professionals and technicians where skilled labor is often scarce locally, and hiring foreign expertise can significantly increase costs, for example, in solar and wind energy construction installation, operation, and maintenance or energy efficiency retrofits.

Raising awareness and providing information to local financial institutions helps to lower barriers to finance and access to green energy technologies. Governments can play a leading role in raising awareness through media campaigns, events, workshops, educational tours, and demonstration projects.

62 IRENA, *Global Energy Transformation: A Roadmap to 2050*, 2019.

63 Mustafa Zakir Hussain, *Financing renewable energy options for developing financing instruments using public funds*, (Washington DC : World Bank, 2013), http://documents.worldbank.org/curated/en/196071468331818432/Financing-renewable-energy-options-for-developing-financing-instruments-using-public-funds.

64 GGGI, *G20 Background paper*, 2019.

04

Expanding Access to Affordable and Sustainable Energy Services

The world is steadily moving towards universal access to electricity. In 2016, the number of people without access dropped to below 1 billion and access in rural areas increased to 76%.[65] The main drivers behind increased access are strong political will and commitment, coupled with financing, local entrepreneurship, and technological innovations. Increasing both on-grid and off-grid access to electricity is essential for promoting economic productivity and social development. It needs a strong enabling environment and expanded, and in some cases innovative, energy service delivery models to allow private sector-driven off-grid electrification.

Achieving universal access through only grid extension is expensive and non-viable. According to the IEA, renewables-based **off-grid electricity**, mainly from standalone systems and mini-grids, has the potential to deliver electricity to around 75% of the unserved (and underserved) population in the world. Significant challenges to off-grid electricity include poor policy design, unfavorable and inconsistent policies, unclear power purchase agreements (PPA), feed-in-tariffs and lack of transparency, and uncertain targets for on and off-grid areas. Bureaucratic permitting and licensing procedures hinder the confidence of investors and developers. Many developing and emerging countries have adopted policy support measures aimed to address these challenges for deploying distributed or decentralized off-grid renewable energy systems.[66]

Two important issues in expanding access to affordable, sustainable energy services are efforts to mainstream rural electrification into national energy strategies, plans, and policies; and promoting mini-grids and standalone systems to complement grid extension efforts.

4.1 Mainstreaming Rural Electrification

Incorporating rural electrification plans into national energy plans and strategies can provide the basis for the expansion of sustainable and affordable electricity. Demarcated areas for long-term on-grid and off-grid energy, for example, can help to inform private sector investors and developers. For example, **Rwanda**'s national electrification plan has a clear policy that demarcates areas for off-grid expansion and grid extension for de-risking uncertainty for private investments. As part of the national Climate Resilient Green Economy (CRGE) Strategy, **Ethiopia** launched its national electrification program (NEP) in 2017, which aims to electrify the unserved population, 35% through off-grid solutions and 65% through on-grid extensions. **Tanzania** and **Nigeria** have developed comprehensive supportive policies to expand access to energy from renewable sources. **Senegal** has successfully developed rural electrification strategies and plans to promote off-grid sustainable energy access through privately operated mini-grids based on renewable energy sources such as mini-grids from solar and micro-hydro mini-grids.

65 World Bank, *Tracking SDG7: The Energy Progress Report 2018*, May 2018, https://openknowledge.worldbank.org/handle/10986/29812.

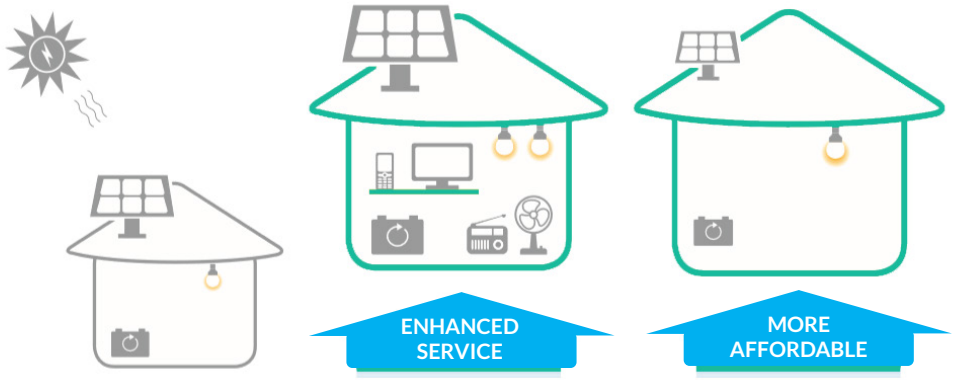
66 International Renewable Energy Agency, *Renewable Energy Policies in the Time of Transition*, 2018.

Mainstreaming rural electrification plans through national energy strategies, laws, and regulations that establish clear policy targets and demarcated on- and off-grid areas provides a crucial foundation for private developers and investors to expand access to electricity in rural areas. In Southeast Asia, for instance, **Cambodia**'s rural electrification rates rapidly increased after the introduction of a 2001 electricity law that led to regulations for mini-grids and grid integration. **Indonesia** is developing community-based rural electrification to provide electricity for about 10 million people living on various islands. To complement this initiative, Perusahaan Listrik Negara (PLN),[67] Indonesia's primary electric power producer, signed Power Purchase Agreements (PPAs) with several Independent Power Producers (IPPs), including renewable energy-based power plants. Capacities of such powerplants are kept to a maximum installed capacity of 10 MW, based on regulatory requirements introduced in 2017. In 2016, the State of Uttar Pradesh in **India** introduced dedicated rural electrification policies and regulations for IPPs to provide electricity access to the 27% of the remaining unserved population.[68]

Private companies operating off-grid energy supply are playing a pivotal role in expanding energy access and the renewable energy transition. Companies such as M-KOPA, for instance, play a significant role in off-grid energy access in the **East African** region through the use of innovative pay-as-you-go (PAYG) mobile payment instruments. In 2016, the total annual investment in PAYG companies reached a record of USD 223 million.[69]

Although technology costs are decreasing, off-grid energy systems can be difficult to afford for lower-income consumers, and a barrier to adopting these technologies in local markets. As illustrated in figure 4, appropriate, super-efficient off-grid appliances can deliver the same or better performance as inefficient alternatives. Efficient appliances can also radically reduce the size and cost of the energy systems needed to support households and communities since there is a reduced need for solar panels and batteries. The up-front cost of a typical off-grid energy system could be reduced by as much as 50% when using super-efficient appliances and appropriately sized solar PV and batteries while delivering the same or greater energy services.[70] In this way, energy efficiency has made—and will continue to make—modern energy services available to vast new segments of the lower-income consumer market.

Figure 4. Off-grid appliance Super-Efficiency & Clean Energy Access



An **energy system** with a **40 Wp solar panel** and **70 Ah battery** will power:
- a 25W Incandescent light bulb (250-400 lumens) for 5 hours/day

The **same system** paired **with super-efficient off-grid appliances** provides greatly enhanced energy service:
- 2 LED lighting fixtures (=900 lumens) for 5 hours/day
- a 13 W TV for 3.5 hours/day
- a 6 W fan for 4 hours/day
- a 1 W mobile phone charger for 4 hours/day
- a 1 W radio for 5 hours/day

Appliance super-efficiency also enables much **smaller**, **more affordable energy systems** to provide equivalent, and even superior, service.
- For example, a 10 Wp solar panel and 2 - 5 Ah battery can power a LED lighting fixture (200-300 lumens) up to 8 hours/day

Source: World Bank, *EA+EE: Enhancing the World Bank's Energy Access Investments Through Energy Efficiency*, 2015.

67 Perusahaan Listrik Negara, Indonesia's primary electric power producer.

68 International Renewable Energy Agency, *Policies and Regulations for Renewable Energy Mini-Grids*, September 2016, https://www.irena.org/publications/2016/Sep/Policies-and-regulations-for-private-sector-renewable-energy-mini-grids.

69 International Renewable Energy Agency, *Renewable Energy Policies in the Time of Transition*, 2018.

70 World Bank, *EA+EE: Enhancing the World Bank's Energy Access Investments through Energy Efficiency*, January 2015, http://documents.worldbank.org/curated/en/875391468186565552/pdf /98193-WP-P151483-Box391505B-PUBLIC-World-Bank-EA-EE-Enhancing-WBs-Energy-Access-Investments-Through-Energy-Efficiency-FINAL-25-June-2015.pdf.

4.2 Complementing Grid Extension: The Role of Mini-Grids and Standalone Systems

Special enabling conditions are needed to help accelerate access to electricity through mini-grids and standalone systems. For example, tariff-setting regulations with clear and transparent methodologies based on cost-recovery are essential for the sustainable operation of mini-grids. They can contribute to scaling up renewable energy based mini-grids. In some countries, such as **Tanzania**, **Nigeria**, **Rwanda**, **Indonesia**, and **Cambodia**, end consumers planning to use small-scale capacity below 100 kW can directly negotiate tariffs with the developers.

Introducing simple licensing and permitting procedures is another step to increase the deployment of renewable energy mini-grids. In practice, a one-stop-shop service is recommended to facilitate and encourage developers and investors in off-grid areas. Clearer licensing and legal provisions in some countries, such as **Rwanda**, **Tanzania**, and **Nigeria**, have already effectively promoted new micro-hydro and solar mini-grids. Licensing and permits are not mandatory for projects less than 100 kW, only the notification of regulatory entities. In **Cambodia**, more than 310 installed hybrid diesel and renewable energy mini-grids have helped accelerate rural electrification for more than 1 million households.

Governments should develop a template of a standardized Power Purchase Agreement (PPA), which improves the bankability of renewable energy projects and accelerates their deployment. Standardized PPA templates facilitate quicker negotiations and provide increased clarity for investors. While many countries currently have standardized PPAs for utility-scale power projects, similar efforts are underway for mini-/micro-grid distributed system renewable energy projects[71].

The government also needs to provide a clear legal framework for "grid arrival," i.e., clarifying what will happen to mini-grids when the main grid arrives.[72] Some possibilities include partially selling the mini-grid assets to a utility or becoming a distributor.

Providing clear legal frameworks are also necessary to effectively manage "grid arrival" to help attract private sector investment, i.e., "what will happen to my mini-grid when the main grid arrives?"[73] Some countries have effectively adopted options for de-risking investment. For example, in **Cambodia**, one practice is to sell part of the mini-grid assets to a utility and become a small power producer, selling electricity at a fixed FiT rate. Another option is to make the mini-grid a distributor of electricity purchased from a utility. In such circumstances, when the main grid is connected to a mini-grid, the mini-grid's generation and distribution license can be converted into a distribution license. The operator can then start reselling electricity purchased from the main utility at wholesale prices. Government-introduced licensing requirements, regulations, and standards have helped main grid arrival to integrate mini-grids in Cambodia, creating 1 million new household connections.

Additional measures to help reduce the high up-front investment costs for renewable energy mini-grids include direct lending to mini-grid developers through intermediate public de-risking and guarantee instruments financed by bilateral organizations. In some countries like **Rwanda** and **India**, support also includes capacity building for financial institutions to increase awareness on reducing barriers to finance. **Cambodia** subsidizes mini-grids through grants and interest-free loans and incentivizes high tariff prices based on performance. **Indonesia** offers exemption from VAT and customs duties for renewable energy technologies, and preferential corporate tax rate and tax holiday for renewable energy investment and local renewable energy manufacturing industries. The **Indian** State of Uttar Pradesh offers a 30% subsidy based on pre-determined requirements and post-commission performance by mini-grids, which leverages the distributed nature of renewable energy to provide electricity in areas not served by the main grid.[74]

71 WBCSD, *Microgrids for Commercial and Industrial companies delivering increased power reliability, lower energy costs and lower emissions*, 2017, https://docs.wbcsd.org/2017/11/WBCSD_microgrid_INTERACTIVE.pdf.

72 Bernard W. Tenenbaum, Chris Greacen, and Dipti Mulrajsinh Vaghela, *Mini Grids and the Arrival of the Main Grid: Lessons from Cambodia, Sri Lanka, and Indonesia*, Energy Sector Management Assistance Program (ESMAP) Technical Report; no. 013/18, (Washington, D.C. : World Bank Group, 2018), http://documents.worldbank.org/curated/en/258101549324138093/Mini-Grids-and-the-Arrival-of-the-Main-Grid--Lessons-from-Cambodia-Sri-Lanka-and-Indonesia.

73 Bernard W. Tenenbaum, Chris Greacen, and Dipti Mulrajsinh Vaghela, *Mini Grids and the Arrival of the Main Grid*, 2018.

74 International Renewable Energy Agency, *Policies and Regulations for Renewable Energy Mini-Grids*, 2016.

Box 2. Expanding access to sustainable and affordable energy

Several countries offer compelling examples of effective measures to expand access to sustainable and affordable energy. **India**'s USD 120 million Access to Clean Energy (ACE) Fund is an innovative fund designed to promote off-grid energy investment. The Ministry of Mineral and New Renewable Energy (MNRE), Indian Renewable Energy Development Agency (IREDA), and the National Bank of Agriculture and Rural Development (NABARD), a GCF accredited entity, planned, designed, and structured this fund with GGGI support, which is currently under technical appraisal by the GCF.

Guyana, with GGGI support, has been working to catalyze private sector participation in scaling up renewable energy. This includes: promoting solar PV to displace captive diesel generation in the commercial and manufacturing sectors; raising awareness regarding solar technologies and business models; updating policy and technical regulations supporting feed-in-tariffs to increase the penetration of embedded solar PV feed-in tariffs and other incentives; identifying least-cost renewable energy investment options; and supporting new procurement approaches and standard power purchase agreements.

GGGI has supported the **Fijian** Government and is working with **Fiji**'s Ministry of Economy, the **Fiji** Electricity Authority (FEA), the Department of Energy (DOE), and the Korean International Cooperation Agency (KOICA) to develop a 1.55 MW solar PV project on the island of Taveuni. The project aims to provide energy for green tourism development, to increase energy security, and cut GHG emissions.[75].

75 GGGI, *G20 Background paper*, 2019.

05 Expanding Sustainable and Renewable Generation

5.1 Challenges and Barriers

Increasing the share of renewable energy in the energy mix offers various benefits: meeting energy demand, reducing dependence on fossil fuel imports, increasing energy security, meeting GHG emissions reduction goals, and other socio-economic benefits. However, several barriers prevent renewable energy from broader deployment, as described in Section 4.1. In many developing countries, renewable energy developers still lack access to finance and the capacity to develop bankable projects that can attract investment. Many investors also have a limited understanding of renewable energy technologies, business models, and risks and returns in financing renewable energy.

Despite impressive global trends in renewable energy expansion, **the deployment rate of renewables is still low in low- and middle-income countries** where various technical, financial, policy, and institutional challenges can hinder investment. Most **developing countries lack** a clear strategy and tend to have weak policy environments, regulatory frameworks, and institutions to promote renewable energy, effectively shunning private investment. Examples of these include complex approval and licensing processes, lack of technical standards for renewable energy systems, lack of technical standards for power generation and distribution, outdated grid codes (technical parameters of the grid), and unclear roles and responsibilities of government institutions. Other significant challenges include a lack of technical capacity in renewable energy in both the public and private sectors, together with limited financing options and fiscal incentives.

There is **potential to broadly introduce renewable energy on a commercial basis in many in small developing countries** if a sufficient scale can be reached to make projects attractive for the private sector. Other obstacles to accelerated renewable energy deployment are **access to land**, either private or community-owned, and distrust and poor local understanding of renewable energy technology and potential. The trust issue is closely linked to weak stakeholder involvement and limited knowledge of the benefits and impacts of new technologies.[76] Since solar PV was expensive and unreliable when it was first introduced in Africa, solar PV providers continue to have to build trust with their customers and add incentives like service guarantees.[77] In larger developing countries and emerging economies, government agencies and energy utilities are more experienced in developing fossil fuel-based energy projects but have often made significant recent investments that are at risk of becoming stranded assets. Consequently, there is resistance and reluctance to engage in the renewable energy transition, even if the national government has renewable energy targets in its NDCs. It is therefore critical to work closely with the utilities to gain their trust and to use demonstration projects to prove the viability of renewable energy projects.[78]

76 Oliver Johnson et al., *SEI Discussion Brief: Energy Pathways for Achieving Kenya's Nationally Determined Contribution to Global Efforts to Mitigate Climate Change*, 2017.

77 Bill McKibben, "The race to solar-power Africa," *The New Yorker*, June 26, 2017, https://www.newyorker.com/magazine/2017/06/26/the-race-to-solar-power-africa.

78 GGGI, G20 Background paper, 2019.

5.2 Drivers behind Expanded Renewable Energy Share: Targets and Incentives

Despite prevailing challenges to renewable energy deployment, countries across global regions have made progress in expanding renewable energy in the overall energy mix by employing renewable energy targets and other policy and regulatory frameworks that effectively attract private developers and investors.

With **ambitious renewable energy targets** and the transition away from conventional fuels, countries can achieve a significant increase in the share of renewable energy in the national overall energy mix. As of 2017, 150 countries had established economic-wide or sector-specific renewable energy targets[79]. Given their heavy reliance on the import of fossil fuels and their vulnerability to global fossil fuel market prices, SIDS countries such as **Fiji**, **Samoa**, **Vanuatu**, **Tuvalu**, and the **Cook Islands** have set 100% renewable energy-based electricity targets. **China**, which pledged to achieve 40% renewable energy supply by 2030 in its NDC, managed to reach 38.5% in 2018. However, it still faces the technical challenge of delivering renewable-generated electricity to load centers due to transmission congestion and lack of transmission lines. **Germany**'s renewable energy mix, reaching 41%, surpassed that of coal in 2018. In several regions, cumulative regional targets also promote the adoption of renewable energy, such as EU targets for 10% renewable energy share by 2020 and ASEAN member countries' aspirational target of 23% renewable energy by 2025.[80]

Economic incentives, including grants, capital subsidies, and refunds for equipment and services help to reduce project cost, attract investment, and improve affordability for end-users.

Tax incentives can also play a key role, such as production sales tax and customs duty tax exemption, tax rebates and tax holidays/breaks, and accelerated depreciation. For example, **India**'s accelerated depreciation (at 80% during the first year) and reduced charges for renewable energy power transmission and distribution have supported wind energy deployment across the country. The **United States** offers production tax exemptions to promote distributed renewable energy which spur the uptake of clean energy. **Fiji** provides a 10-year tax holiday for biofuels and custom-free import of related equipment. Soft credits and grants from public investment also support small-scale renewable energy. For instance, **Bangladesh** provides financing of up to 80% of capital required for small solar projects, in the form of grants and soft loans in order to address access to financing challenges. **Thailand** successfully uses an Energy Service Company (ESCO) Revolving Fund that provides venture capital for investments to support private sector investment in small-scale renewable energy projects.[81]

Over the years, a committed government's public investment, private banks, and international climate finance have supported an increase in the deployment and share of renewable energy in the overall energy mix.

Government commitment to provide public investment has been critical in increasing the deployment of renewable energy. Investment in new renewable energy projects (excluding large hydropower[82]) reached USD 216.1 billion in 2017, an increase of just 0.2% or USD 500 million compared to the previous year. Globally, wind and solar are still the leading sources of renewable energy and accounted for USD 208.6 billion, or 97% of the total in 2017, with biomass and waste, geothermal, small hydro, and tidal energy making up the remaining 3%. In 2017, **China** invested USD 103.3 billion, representing 48% of the global total. The **United States**, **India**, **Germany**, the **United Kingdom**, **Australia**, **Japan**, **Mexico**, **Brazil**, and **Sweden** were also among the top investing countries.[83] International climate finance from MDBs, corporations, and other financing mechanisms such as green energy bonds are further contributing to enhanced investment.

Renewable energy is gaining momentum, and the share of renewable energy mix continues to increase. Investment gaps need to be addressed together with technical knowledge and capacity transfer. Cost-effective renewable energy and maximum benefits can only be attained when countries successfully integrate variable renewable energy sources into the grid. Integration requires upgrading and expanding the grid systems, effective grid planning, effectively planning for and managing demand and consumption, and improved storage systems. **India**, for example, improved its variable renewable energy integration by developing renewable energy zones and planning generation and transmission lines to enhance the quality of power supply from renewable energy-rich areas to support areas with high demand.

Strengthening regional trade cooperation through grid pools is another option for expanding renewables. **Ethiopia**'s power trading scheme with **Sudan**, **Djibouti**, and **Kenya** is a notable example of how a renewable energy-rich country can trade power and support the broader development objectives of SDGs and NDCs.[84]

79 REN21, *Renewables 2018 Global Status Report*, 2018.

80 World Bank Group, *Global Tracking Framework Report 2017*, 2017, https://www.worldbank.org/en/topic/energy/publication/global-tracking-framework-2017.

81 GGGI, *Impact of Greening the Industrial Sector in Cambodia*, 2018.

82 Defined as greater than 50MW.

83 United Nations Environment Programme, *Global Trends in Renewable Energy Invesment 2018*, 2018.

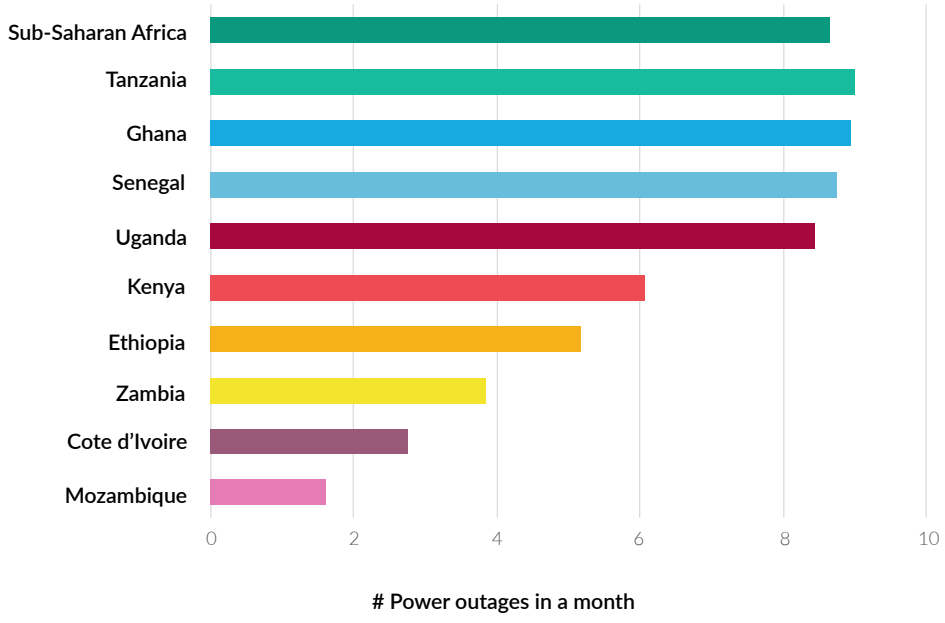
84 "Power Sale," Ethiopian Electric and Power Corporation (EEPCo), accessed February 5, 2020, https://www.eep.com.et/en/power-sale/.

5.3 Expanding Renewables in Africa

Sub-Saharan Africa has significantly lower household electricity access, electricity generation capacity, and electricity consumption per capita compared with other parts of the world.[85] The region has exceptionally fragile utilities that lack financial and technical capacity. The grid network systems are fragile, resulting in frequent power outages, as shown in figure 5. Systems experience high transmission and distribution losses without regular grid infrastructure upgrades. Energy services are also often inadequate in terms of capacity constraints, quality, and reliability. Poor-quality energy services are a significant constraint to GDP growth, and the need for diesel back-up generation is both expensive and polluting, causing severe environmental and social impacts. Adding to these challenges are the fragile financial positions of off-takers, currency mismatches between energy providers and consumers, and inadequate transparency in the procurement processes of independent power producers. Unrealistic expectations by private sector partners often reinforce these challenges. Of all utilities in the region, only two in the **Seychelles** and **Uganda** can cover their operational and capital expenditures.[86]

Mini-grids and standalone renewable systems, such as solar home systems, can help overcome the persistent challenges associated with utility-based grid systems in Africa. They can supply power to isolated communities at a lower cost than extending the central grid. To increase the scale of investment and deployment needed, countries are now focusing on developing a fully sustainable value chain for these mini-grid and standalone renewable energy systems—from manufacture to distribution, retail, and end-user consumption. Another important step has been to improve access to affordable consumer financing, and thus remove the need for high up-front cash payments by consumers. Suppliers must also offer financial support to develop a viable chain. Support could include providing early-stage venture capital, creating a new loan product, building technical capacity for investment appraisal and monitoring to get access to project finance, and reducing need for hard asset collaterals. Technology and financing innovations over recent years, such as mobile payment and PAYG services, have enabled off-grid energy delivery to increase dramatically, particularly in places like **Kenya**, **Rwanda**, **Uganda**, and **Tanzania**. As of November 2016, up to 800,000 solar home systems are available on a PAYG basis and close to 40,000 new systems are being installed monthly.[87] Opportunities abound throughout the region to replicate and scale up these achievements.[88]

Figure 5. Number of power outages per month reported by firms in selected sub-Saharan African countries, averaged between 2006 and 2017



Source: World Bank Database, (ID: IC.ELC.OUTG)

85 World Bank, Sustainable Energy for All (SE4All) Database, last updated June 30, 2018, https://datacatalog.worldbank.org/dataset/sustainable-energy-all.

86 World Bank, *Making Power Affordable for Africa and Viable for Its Utilities*, 2016, https://openknowledge.worldbank.org/bitstream/handle/10986/25091/108555.pdf?sequence=10.

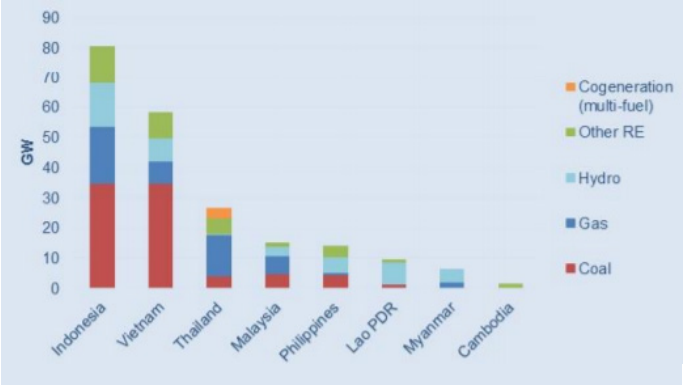
87 GSMA, *Mobile for development utilities*, 2017, https://www.gsma.com/mobilefordevelopment/wp-content/uploads/2017/01/Lessons-from-the-use-of-mobile-in-utility-pay-as-you-go-models.pdf.

88 United Nations Environment Programme, *Global Trends in Renewable Energy Invesment 2018*, 2018.

5.4 Expanding Renewables in Asia

Developing countries in Asia account for a significant proportion of the world's growing energy demand, and this is expected to increase over the coming decades. Investing in sustainable, low-carbon sources of energy generation is a priority to meet this growing demand. According to the IEA, achieving the Paris Agreement objectives means all coal-fired power plant generation must cease by the year 2040, merely two decades away. Despite this, **Indonesia**, **Vietnam**, and the **Philippines**—the three largest economies in Southeast Asia—are currently planning a significant expansion of coal capacity in the coming years, as shown in figure 6.[89]

Figure 6. Power sector capacity additions by generation type (2016-2025)



Source: Oxford Institute for Energy Studies, 2016.

Countries should rapidly replace fossil fuels with renewable energy in line with NDC targets. Actions to promote and prioritize renewable energy alternatives, such as solar PV and waste-to-energy, require efforts to strengthen country capacity in technical, policy, and financial solutions. Innovative business models and transparent procurement processes can reduce the cost of installed renewable energy capacity, ensure the sustainability and inclusivity of new projects, promote competitive auction and establish proper risk mitigation mechanisms, and assess technology options. Box 3 highlights some of the approaches that GGGI has supported through its country programs in Asia.

Box 3. Scaling up Renewable Energy in Southeast Asia

Viet Nam's economy is one of the fastest-growing in Southeast Asia, driving ever-higher demand for electricity—much of which now comes from coal. However, biomass energy has recently emerged as a competitor to coal. The Government of Viet Nam has set guidelines for developing provincial biomass energy master plans as a means of exploring the potential for biomass. The experience in Soc Trang Province, where GGGI supported the preparation of the local plan, suggests that as much as 68 MW of its new energy needs could be met by using sugarcane waste through five potential biomass energy projects valued at USD 43 million. Taking full advantage of the energy potential of Viet Nam's sugar industry could generate 737 MW of electricity, reduce the country's carbon emissions by 2.7 million tons per year, and create more than 2,100 new green jobs, according to a report by GGGI and the GIZ. Further effort will be needed to strengthen Viet Nam's feed-in-tariff, which is currently too low to support electricity production in the sugar industry (5.8 cents per kilowatt-hour for biomass compared with 13 cents in Thailand).

GGGI supported the **Indonesian** Province of Kalimantan to design three financially feasible green projects, including one solar PV project and two palm oil mill effluent (POME). The Provincial Government of Nusa Tenggara Timur identified eight demonstration hybrid solar projects, also with GGGI support, that would collectively generate 15 MW and displace diesel consumption by 236 million liters, saving the province up to USD 125 million and avoiding 549,300 in CO_2 emissions over 20 years.[90]

Communities and individuals are also playing an increasing role in green energy development in Asia, such as in solar and micro-hydropower. **Nepal** and **Indonesia**'s governments, for example, have initiated community-based micro-hydropower that can help to provide clean energy to households without access.[91]

89 Oxford Institute for Energy Studies, *The role of coal in Southeast Asia's power sector and implications for global and regional coal trade*, December 2016, https://www.oxfordenergy.org/wpcms/wp-content/uploads/2016/12/The-role-of-coal-in-Southeast-Asias-power-sector-CL-4.pdf.

90 "Nusa Tenggara Timur (NTT) Hybrid Solar PV Project," Projects, GGGI, accessed 2019, http://gggi.org/project/ntt-and-mandaliaka-projects.

91 International Renewable Energy Agency, *Renewable Energy Policies in the Time of Transition*, 2018.

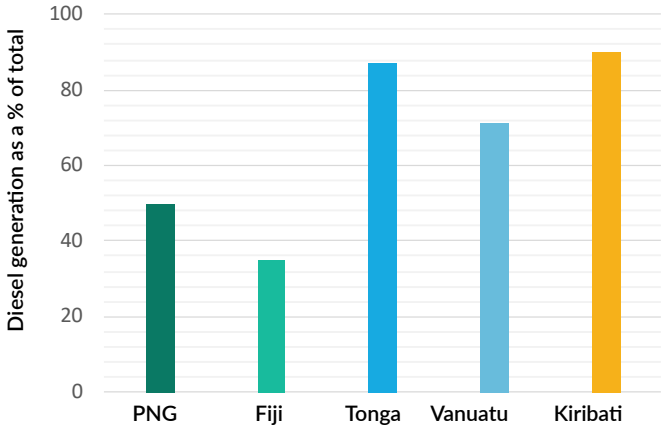
5.5 Expanding Renewables in SIDS

SIDS are highly dependent on fuel imports and are thus vulnerable to oil price fluctuations, facing elevated risks to their energy security. High dependence on diesel, as depicted in figure 7, is the Pacific region's most significant challenge for sustainable economic development, given the high cost of diesel-based grid electricity generation. As renewable technology costs continue fall, both on-grid and off-grid solar energy and energy storage options are becoming commercially viable substitutes for expensive diesel fuel and will ultimately help countries mitigate their GHG emissions.

Despite the challenges they face, SIDS nations possess high potential for scaling up renewable energy and strengthening local economies through improvements in energy efficiency. The renewable energy targets of SIDS are among the most ambitious in the world. **Fiji**, **Vanuatu**, and **Papua New Guinea** have set targets in their NDCs to reach 100% renewable energy by 2030, while **Guyana** committed to increasing its share of renewable energy to 100% by 2025.[92] Off-grid renewable electrification offers a viable alternative to providing basic electricity services in areas where grid extension is expensive or physically difficult.

Since the greatest demand is for small-scale, decentralized solar power, off-grid systems are becoming more financially viable through aggregation into larger development projects that can reduce transaction costs. Growing experience in project aggregation in SIDS around the world is making it possible to replicate projects across countries with similar physical geographies and energy needs.

Figure 7. Reliance on diesel for power generation in Pacific SIDS



Source: Pacific Energy Conference 2016, New Zealand Foreign Affairs and Trade.

Efforts to scale up renewables in SIDS require significant technical support, innovative financing, and business models considering the low penetration percentage of renewable energy. Countries like **Fiji**, **Vanuatu**, and **Guyana** have begun to implement both decentralized and utility-scale renewable energy projects to increase renewable energy generation capacity and to engage public and private stakeholders to increase confidence and accelerate investment. Box 4 provides case studies of initiatives supported by GGGI.

92 INDCs as communicated by parties," UNFCCC, https://www4.unfccc.int/sites/submissions/indc/Submission%20Pages/submissions.aspx; "Small Island Developing States," Sustainable Development Goals Knowledge Platform, https://sustainabledevelopment.un.org/topics/sids/list. Guyana is classified as a SIDS country despite being mostly located on the mainland of South America..

Box 4. SIDS Case Studies in Scaling Up Renewable Energy: Vanuatu and Guyana

Vanuatu faces significant energy security concerns, with 71% of its electricity generation from imported fossil fuels. An estimated 30% of households and public institutions in Vanuatu are connected to the electricity grid. Still, this network covers only parts of four of the country's 65 inhabited islands, and almost 90% of people living in rural areas are not grid-connected, creating significant constraints to social and economic development. The government has identified renewable energy is the best way to address these concerns. With GGGI support, it recently updated its National Energy Road Map (NERM) to deliver 100% electricity access using only renewable energy sources and reduce overall energy use by 14% through increased efficiency.

To address Vanuatu's challenges in financing major development and infrastructure projects, GGGI also helped create a National Green Energy Fund (NGEF). The fund is now in operation, and aims to boost household energy access, including in rural communities, while also providing a pathway to local businesses to invest in clean, climate-resilient energy. Going forward, the NGEF is expected to play a central role in expanding energy access and energy efficiency in the water, agriculture, fisheries, and tourism sectors.

Further efforts have aimed to address the challenges of Vanuatu's most important sector, tourism, which comprises 60% of GDP. An innovative pilot project devised by the government with GGGI support involved installing solar-powered freezers free of charge to tourist bungalow operators in rural areas. The freezers were financed by the German government and implemented by a local supplier supported through a Vanuatu government grant. These small investments yielded immediate benefits—increased local income, new local jobs, and better-run tourism businesses. Training has also helped women to grow in their leading roles in running the bungalows.

Guyana is also scaling up the use of solar power to reduce the country's reliance on expensive imports of diesel and bunker fuel, which contribute about 85% of Guyana's electrical power generation. Situated on the northeastern coast of South America, just north of the equator, Guyana experiences an average of 12 hours of daylight all year round. The country and its population of only 785,000 regularly enjoy sunny conditions, making Guyana ideal for solar energy. But while solar power is cheaper to generate and considerably better for the environment than burning diesel, the up-front costs of buying and installing solar panels is beyond the reach of most Guyanese businesses and property owners.

Efforts in Guyana focus on supporting the government in removing market and regulatory barriers and engaging the private sector in new renewable energy projects. GGGI initiated the Urban Sector Solar Energy Program (USSEP) to expand the role of businesses in scaling up renewable energy, provide hands-on policy and technical support to the government, and remove market and regulatory barriers. These efforts have led to a USD 15-19 million pipeline of 14-megawatt peak (MWp) distributed roof-top solar installations, representing about 6% of total electricity generation capacity. These systems will displace captive diesel generation using a lease-to-own business model for commercial and industrial consumers, and ultimately provide cheaper and cleaner energy while helping Guyana achieve its 100% renewable energy target.

06 Enhancing and Integrating Energy Efficiency

6.1 Challenges and Barriers

Energy consumption can be just as important as energy generation in global energy transformation. It plays a major role in decreasing energy intensity and building stronger and more competitive economies while reducing the need for fossil-based energy generation and related GHG emissions.

Energy efficiency is widely viewed as one of the most effective ways to achieve multiple economic, social and environmental benefits and is at the core of achieving sustainable energy for all. Concerns over energy security, the social and economic impacts of high energy prices, and growing awareness of climate change have led many countries to put greater emphasis on developing policies and measures that promote energy efficiency. A fundamental driver behind energy efficiency investment is its capacity to lower energy demand and deliver energy cost savings. In recent years, the notion that energy efficiency helps to achieve a much broader range of outcomes that contribute to improving welfare and wealth has attracted more attention. These benefits include various macroeconomic benefits, such as improved productivity and job creation, increased access to and affordability of energy services, reduced air pollution, and improved health.[93] ESCOs are crucial in delivering energy efficiency projects that are financed based on energy savings. Given the need to rapidly and significantly increase financing for energy efficiency, interest in ESCO business models is growing[94].

Energy efficiency investments are increasing, but not at the scale necessary to achieve SDG target 7.3 or the Paris Agreement objectives. Significant challenges exist in scaling up energy efficiency, particularly in low- and middle-income countries, including limited understanding of energy efficiency as an energy resource, energy price distortions, lack of standardized measurement and verification protocol and financial barriers, including up-front costs and limited understanding of energy efficiency among financiers.

Going forward, integrated policy approaches and increased capacity are essential to enable smart grid technologies, tariff adjustments, technical regulations and building codes, and structured finance and investments. In addition to supporting efforts in these areas, GGGI works with public and private stakeholders to identify barriers and reduce the risk perception of energy efficiency investments by introducing country tailored policy and market instruments. For example, in Mongolia, GGGI is helping the government in strengthening the capacity of government and private sectors on energy efficiency, market assessment for designated entities/large energy users, and a pilot energy audit for selected public buildings. The energy efficiency of Mongolia's building and energy sectors will be increased through incentive mechanisms, improved energy demand management, and implementation of ESCO projects. GGGI Mongolia is also working on designing a standard offer program to introduce an incentive mechanism for the implementation of building retrofitting projects. Another GGGI project in Mongolia will help to raise finance for scaling up the use of renewables by replacing coal-operated heat only boilers.

Section 6.2 – 6.4 describes the different focuses in effectively promoting energy efficiency by region.

93 International Energy Agency, *Capturing the Multiple Benefits of Energy Efficiency*, November 2015, https://www.iea.org/reports/capturing-the-multiple-benefits-of-energy-efficiency; International Energy Agency, Energy Efficiency 2018, https://www.iea.org/reports/energy-efficiency-2018; European Commission, Impact Assessment Guidelines, January 2009, http://ec.europa.eu/smart-regulation/impact/commission_guidelines/docs/iag_2009_en.pdf.

94 "Energy Service Companies (ESCOs)," International Energy Agency, December 2018, https://www.iea.org/reports/energy-service-companies-escos-2.

6.2 Promoting Energy Efficiency in Africa

Africa has insufficient electrification rates to achieve the SDG for universal access by 2030, especially in Sub-Saharan Africa. At this rate, 650 million people will have no electricity access in 2030.[95] Simultaneously, electricity demand in Africa is predicted to more than triple by 2040, driven by economic growth, urbanization, industrialization, and a legacy of unmet energy demand,[96] while climate change will reduce the productivity of hydropower plants in Southern and East Africa.

In the face of these challenges, countries in the region have been prioritizing investment in new power plant capacity. While renewable energy is the preferable option, energy efficiency can significantly offset the need for expanded capacity. Cost-effective efficiency measures include eliminating inefficient end-use appliances and other devices through market-based approaches or replacement programs.

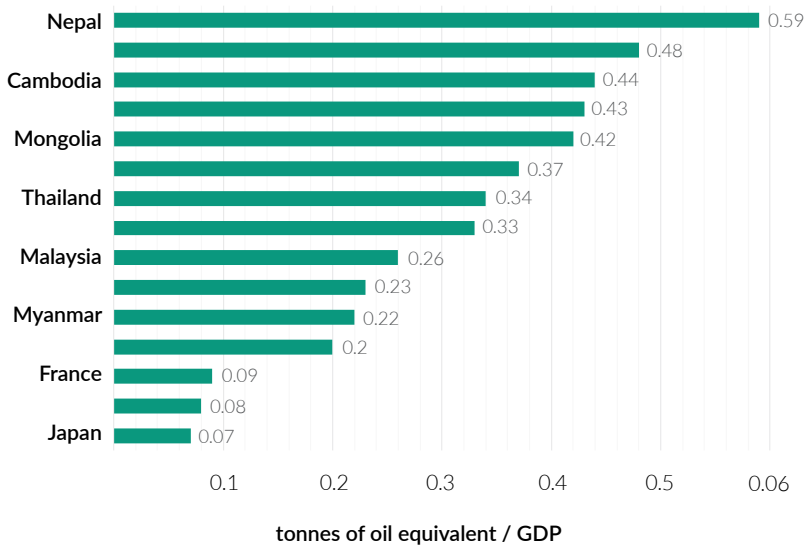
GGGI's assessment finds that new, cost-effective efficiency measures can provide numerous benefits, including stretching existing energy supplies; lowering generation costs; improving the financial performance of utilities or sectors; reducing peak demand; mitigating the need for load shedding; reducing the need for fuel imports; and granting more people access to energy services. Eliminating inefficient end-use lighting, appliances and other devices through market-based approaches (e.g., product rebates, subsidies, market development, and consumer education programs) or replacement programs can greatly reduce peak demand. This will lower generation costs and free up capacity in the grid so that more consumers can benefit from energy services.

6.3 Promoting Energy Efficiency in Asia

Due to the anticipated high growth in energy demand in Asia, improving energy supply will be insufficient to meet Asia's growing energy demand, and energy security, economic, and environmental objectives, especially improving the air quality, and addressing energy security.[97] To do so, many governments require support in the form of capacity building and technical assistance to develop appropriate regulations and effective enforcement mechanisms.

Figure 8 presents the energy intensity levels in various Asian countries compared to a sample of developed economies. **Vietnam**, **Cambodia**, and **Thailand** have among the highest energy intensities in the world due to high industrialization and inefficient energy resource use. Most of the significant outdoor and indoor air pollution challenges in the Asia region can be directly attributed to unregulated, poorly regulated, or inefficient combustion of fossil fuels and the use of inefficient cooking and lighting systems. These countries therefore have among the highest potential for future energy savings and investment opportunities, particularly in the industrial sector.

Figure 8. Energy intensity of selected countries (toe consumption per unit GDP)



Source: International Energy Agency, Southeast Asia Energy Outlook 2017, 2017.

95 World Bank, *Tracking SDG7*, 2019.

96 International Energy Agency, *Africa Energy Outlook*, 2014.

97 United States Energy Information Administration, *International Energy Outlook 2016: Chapter 7 Industrial sector consumption*, 2016, www.eia.gov/outlooks/ieo/pdf/industrial.pdf.

GGGI has been supporting countries in pursuing energy efficiency investments, some of which are highlighted in Figure 9. In **Cambodia**, a GGGI study on the economics and social benefits of promoting energy efficiency to green the industrial sector is now informing the development of green growth priorities in Cambodia's 2019-2023 National Strategic Development Plan (NSDP).[98]

Figure 9. Countries in Asia with energy efficiency targets, 2016

EE target previously existing, no new target in 2015/2016

No EE target previously existing, new target in 2015/2016

EE target previously existing, new target in 2015/2016

Source: REN21, *Renewables 2016 Global Status Report*.

In **Mongolia**, GGGI designed and developed the National Energy Efficiency Action Plan (NEEAP), adopted in September 2017. GGGI also supported the Energy Regulatory Commission (ERC) in developing a pipeline of 15 bankable energy efficiency projects for the Mongolian Green Credit Fund (MGCF) to invest in, valued at around USD 60 million with an average payback period of 3 years. GGGI determined that the total market potential for the 198 designated entities could exceed USD 500 million. In addition, GGGI provided technical assistance and support to Arig Bank's "innovation challenge" to finance up to MNT 100 million (approximately USD 37,000) in grants for the best technical solutions for displacing fossil fuel use and reducing air pollution in peri-urban areas of Ulaanbaatar City. Solutions included using electric heating technologies, alternative fuels and renewable energy-based heating technologies.

In 2018, **Thailand**'s Provincial Electricity Authority (PEA), a state-owned electricity utility, secured USD 20 million in investments to improve the energy efficiency of the country's SMEs. The benefits could amount to USD 380 million in total and demonstrate serious action to address climate change. Thai SMEs face challenges because of their small scale of operation. The Thai government has been very supportive of engaging GGGI to develop a robust and innovative business model that helps SMEs to access finance. Under the program, GGGI assessed 220 Thai SMEs for potential energy efficiency investments and has been developing a business model to mobilize energy investments and reduce GHG emissions to support Thailand's NDC.

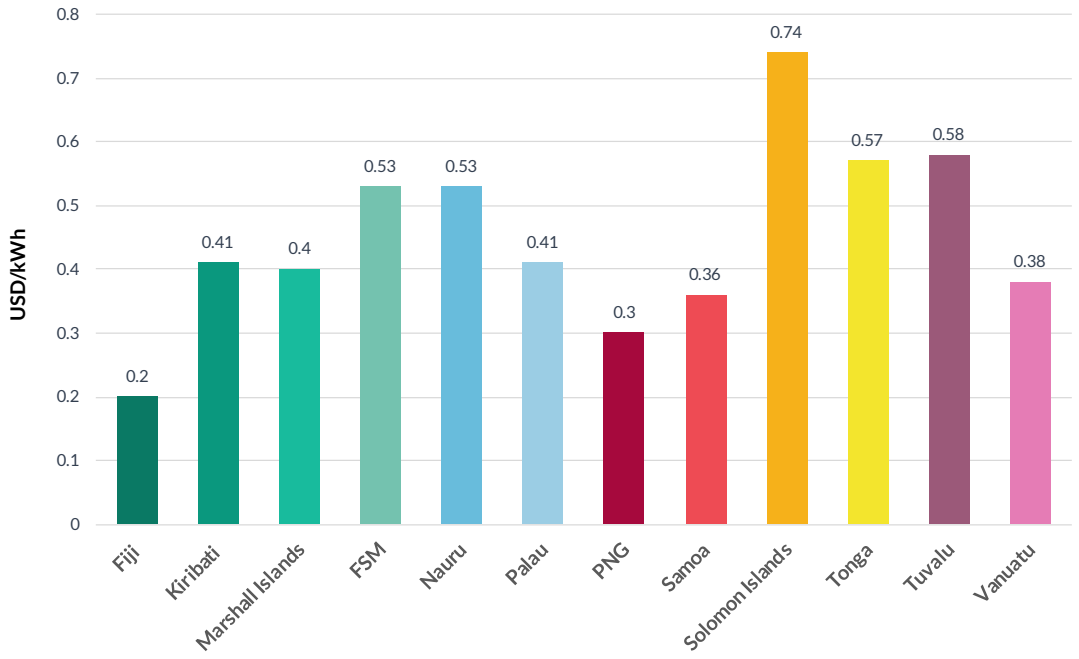
6.4 Promoting Energy Efficiency in Small Island Developing States

Among the energy challenges facing SIDS are frequent power outages, geographic constraints, small distributed populations, and limited generation capacity. These factors lead to high electricity tariffs as shown in figure 10, or costly subsidies, transmission and distribution losses, and low overall electrification rates. Many SIDS countries are recognizing the potential of energy efficiency and taking measures to promote it. Most SIDS countries currently lack the enabling policy and regulatory environment for energy efficiency and the institutional and technical capacity to reduce unnecessary energy consumption by end-users. Those making purchasing decisions have limited information about the energy performance of appliances and other technologies, and an inadequate understanding of the many benefits of investing in energy efficiency.

Countries must promote energy efficiency by developing databases, scenario analyses, policies and regulations, and strengthening capacity and awareness. Specific measures include enforcing minimum energy performance standards (MEPS), developing performance codes and standards, reducing import duties and taxes on energy-efficient products, and developing energy action plans. The affordability of off-grid energy systems is especially important to lower-income consumers. Super-efficient off-grid appliances can deliver equal or improved performance and radically decrease the cost and size of the energy system. In this way, energy efficiency will continue to make modern energy services available to vast new segments of the lower-income consumer market.

98 GGGI, *Impact of Greening the Industrial Sector in Cambodia*, 2018.

Figure 8. Average electricity tariff for commercial customers in SIDS (USD/kWh)



Source: IFC, 2018

SIDS countries have opportunities to promote energy efficiency in other key sectors. With the transport sector being one of the most polluting sectors in SIDS dependent on fossil fuels, the uptake of EVs can provide local emission reductions and contribute to enhanced energy security. SIDS can conduct relevant studies on the applicability of EVs, piloted and tested. For large scale adoption, policies can be put to incentivize the use of EVS and greater uptake of more efficient forms of transport either through EVs or public transport.

With rapid price reductions in solar and battery technologies in the power sector, the use of micro-grids or distributed energy sources can also disrupt SIDS countries' traditional electricity supply and distribution systems, making improved energy efficiency more viable. Incentivizing energy efficiency through legislation is useful in removing import duties or taxes on advanced energy efficient equipment and facilities, batteries, amongst others.[99]

99 UN-OHRLLS, *Policy Brief 13, Achieving SDG 7 In Small Island Developing States-Mid-Term Review of The Samoa Pathway*, 2019, http://unohrlls.org/custom-content/uploads/2019/08/pb13_SIDS.pdf.

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Ethiopian Electric and Power Corporation (EEPCo). https://www.eep.com.et/en/power-sale/.

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ABOUT THE GLOBAL GREEN GROWTH INSTITUTE

The Global Green Growth Institute was founded to support and promote a model of economic growth known as "green growth", which targets key aspects of economic performance such as poverty reduction, job creation, social inclusion and environmental sustainability.

Headquartered in Seoul, Republic of Korea, GGGI also has representation in a number of partner countries.

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