ESMAP
Energy Sector Management Assistance Program

ENERGY SECTOR MANAGEMENT ASSISTANCE PROGRAM

ANNUAL REPORT 2024

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ABOUT ESMAP

The Energy Sector Management Assistance Program (ESMAP) is a partnership between the World Bank and over 20 partners that helps low- and middle-income countries reduce poverty and boost growth through sustainable energy solutions. ESMAP's analytical and advisory services are fully integrated within the World Bank's country financing and policy dialogue in the energy sector. Through the World Bank Group (WBG), ESMAP works to accelerate the energy transition required to achieve Sustainable Development Goal 7 (SDG7) to ensure access to affordable, reliable, sustainable, and modern energy for all. It helps shape WBG strategies and programs to achieve the WBG Climate Change Action Plan targets. Learn more at: https://esmap.org.

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ENERGY SECTOR MANAGEMENT
ASSISTANCE PROGRAM

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ESMAP
Energy Sector Management
Assistance Program

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SPECIAL SECTIONS

ABBREVIATIONS

ABG	Annual Block Grant
AfDB	African Development Bank
AI	artificial intelligence
AREP	Accelerating Regional Energy Projects (a multi-donor trust fund)
ASCENT	Accelerated Sustainable & Clean Energy Transformation
BESS	battery energy storage system
BREB	Bangladesh Rural Electrification Board
CCF	Clean Cooking Fund (ESMAP initiative)
CCS	Carbon Capture and Storage (ESMAP trust fund)
CCUS	carbon capture, utilization, and storage
CIF	Climate Investment Funds
CO_2	carbon dioxide
COP	United Nations Climate Change Conference
DARES	Distributed Access through Renewable Energy Scale-Up
DPV	distributed photovoltaics (solar technology)
DRE	distributed renewable energy
EAQIP	Energy Access Quality Improvement Project
EnDev	Energising Development
ESP	Energy Storage Partnership (ESMAP initiative)
ESRF	Energy Subsidy Reform Facility (ESMAP initiative)
FCV	fragility, conflict, and violence
FIEA	Financial Innovation for Energy Access (ESMAP initiative)
FY	fiscal year
GCF	Green Climate Fund
GDP	gross domestic product
GEP	Global Electrification Platform
GFMG	Global Facility on Mini Grids (ESMAP initiative)
GHG	greenhouse gas
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit
GOGLA	Global Off-Grid Lighting Association
GW / GWh	gigawatt / gigawatt hour
GWNET	Global Women's Network for the Energy Transition
H4D	Hydrogen for Development Partnership (ESMAP initiative)
HDF	Hydropower Development Facility (ESMAP initiative)
HFC	hydrofluorocarbon
IBRD	International Bank for Reconstruction and Development
iCRAFT	Innovative Carbon Resource Application for Energy Transition
IDA	International Development Association
IEA	International Energy Agency
IESP	Integrated Electrification Strategies and Planning (ESMAP initiative)
IFC	International Finance Corporation
ILHC	Improving Livelihoods and Human Capital (ESMAP initiative)
IRENA	International Renewable Energy Agency
KNES	Kenya National Electrification Strategy

LNBH	Leave No One Behind (ESMAP initiative)
LPG	liquefied petroleum gas
M300	Mission 300 (World Bank-African Development Bank initiative)
MARCOT	Energy Markets, Connectivity, and Regional Trade (ESMAP initiative)
MDTF	multi-donor trust fund
MIGA	Multilateral Investment Guarantee Agency
ML	machine learning
MTF	Multi-Tier Framework for Energy Access
MW	megawatt
MWp	megawatt peak
NEP	Nigeria Electrification Project
OECD	Organisation for Economic Co-operation and Development
PAEM	Pan-Arab Electricity Market
PPA	power purchase agreement
PV	photovoltaic (solar technology)
RBF	results-based financing
RENEW	Regional Network in Energy for Women
RETA	Regulatory Energy Transition Accelerator (ESMAP initiative)
RISE	Regulatory Indicators for Sustainable Energy
RTIFF	Regional Transmission Infrastructure Financing Facility
SAAP	Southern African Power Pool
SCED	Security-Constrained Economic Dispatch
SDG	Sustainable Development Goal (United Nations initiative)
SEforALL	Sustainable Energy for All
SIDS	small island developing state
SRMI	Sustainable Renewables Risk Mitigation Initiative (ESMAP initiative)
STEM	science, technology, engineering, and mathematics
SWAC	Seawater Air Conditioning
WAPDA	Water and Power Development Authority (a Pakistan utility in the WePOWER network)
WAPP	West African Power Pool
WB / WBG	World Bank / World Bank Group
WEF	World Economic Forum
WePOWER	South Asia Women in Power Sector Professional Network
WHO	World Health Organization
ZCPS	Zero Carbon Public Sector (ESMAP initiative)

WORLD BANK REGIONS

AFR	Africa
EAP	East Asia and Pacific
ECA	Europe and Central Asia
LAC	Latin America and the Caribbean
MNA	Middle East and North Africa
SAR	South Asia

All currency is in United States dollars (US$) unless otherwise indicated.

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FOREWORD

In spring 2024, World Bank President Ajay Banga and his counterpart at the African Development Bank, Akinwumi Adesina, made a bold commitment: the two organizations are partnering to provide 300 million more people in Sub-Saharan Africa with electricity by 2030 to study at night, power sewing machines, or cool life-saving medicines. World Bank programs will deliver electricity access to 250 million people in Sub-Saharan Africa, and African Development Bank projects will deliver power to an additional 50 million people on the continent.

Mission 300, or M300, as the flagship initiative is known, is the culmination of the World Bank's ever greater emphasis on the foundational importance of electricity access. President Banga's insistence that electricity is a human right and backbone of development found its expression in the World Bank roadmap with the Global Challenge Program on Energy Transition as one of its core pieces. ESMAP is squarely at the center of all of these initiatives.

ESMAP's mandate is to help secure universal energy access by 2030 in line with Sustainable Development Goal 7 while transitioning from polluting energy sources to low-carbon solutions, such as solar and wind power. Operating much like a think tank, we conduct research, aggregate data, and make policy recommendations—ranging from issues such as how to set up solar mini grids to financing for hydrogen projects to fossil fuel energy reform. We then apply our knowledge by advising World Bank energy projects, helping plan off-grid solar solutions in rural Nigeria, convert coal power plants in South Africa, or position windfarms off the Brazilian coast. Finally, we make donor contributions available as grants for planning and feasibility studies or help mobilize financing from third parties, including the private sector.

When launching our new business plan in spring 2024, we aligned it with the 2030 targets of SDG7 (full global energy access) and M300 (300 million more Sub-Sahara African people connected to power) by extending the plan to five years (FY2025−30), up from the customary three to four. This will allow us to support energy access and transition projects with larger and longer-term commitments through technical assistance for preparatory support, institutional strengthening, and implementation support.

ESMAP will also play a central role in the scale-up of the World Bank's energy pipeline. Our new Financial Innovation Window, for example, will support the expansion of privately led renewable energy investments in underserved markets by structuring innovative tailored risk mitigation instruments to address, for example, liquidity, foreign exchange, early market adoption, operational risks. These new instruments complement the existing ones provided by the World Bank Group and its development partners.

None of this would be possible without the support from our donors. As the World Bank's energy trust fund, ESMAP invites current and prospective partners to join the Bank's exciting M300 initiative. The battle for universal energy access will be won or lost in

Sub-Saharan Africa. While more than 90 percent of the global population now has energy access, 685 million people are still without it, and 570 million of them—or 80 percent—live in Sub-Saharan Africa. This means that about every other person on the subcontinent cannot charge a cell phone, turn on a lightbulb, or power a business. These are shocking numbers and should jolt all of us into action.

ESMAP's work going forward is rooted in the lessons we learned during the FY2021−24 business cycle, and this annual report covers its final year. During the four years, we mobilized $19 billion in external financing and helped the installation of 16.5-gigawatt renewable energy generation capacity—roughly equivalent to eight to 16 natural gas power plants. The projects we supported during this time are likely to reduce 711 million metric tons of CO_2 emissions, about the same as the annual emissions of 154 million cars. An independent, external evaluation found that ESMAP's grant-funded activities have been highly relevant to the global energy sector context (including SDG7), decarbonization, climate change adaptation, mitigation, and resilience. By the end of the first two years of the business plan, we achieved about half of our results framework targets, with the other half in progress. About a quarter of the indicators exceeded their targets.

We are proud of these results. But we also know that we need to do more and better by staging bigger interventions. Based on the successful implementation of the first phase of the **Clean Cooking Fund** (CCF), we are now launching the second phase, CCF 2.0, to scale up and expand access to clean cooking opportunities that make people less vulnerable to pollution and inefficient energy use. ESMAP's new **Electricity Access Fund** will help integrate distributed renewable energy into a least-cost electrification program. By establishing dedicated facilities and targeted subsidies, it will incentivize the private sector to serve challenging markets that cannot be reached on commercial terms or through conventional approaches.

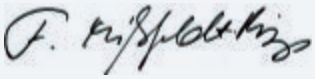
Similarly, the new Financial Innovation Window was born out of our **Sustainable Renewables Risk Mitigation Initiative** (SRMI), working to remove impediments to private development of clean energy projects. SRMI, with its nine energy and development organization partners, has witnessed repeatedly how many clean energy projects stall before financial close due to financial and operational risks developers encounter. ESMAP is therefore now moving away from working on a case-by-case basis and adopting a programmatic approach. It will see us provide tailored risk mitigation instruments for clean energy investments such as liquidity guarantees for offtaker payment risk, tariff buydown, first loss or foreign exchange instruments to projects where existing instruments are not available. The key objective is to ensure that renewable energy projects being tendered are able to rapidly reach financial closure and to bring benefits to the utilities and countries where they are deployed.

ESMAP's 10 GW Lighthouse Initiative is equally focused on lowering project risks in an attempt to remove barriers to building large renewable energy hydrogen plants in developing countries. Such projects face high financing premiums, as investors are concerned about offtake, political, and regulatory risks, among others. At COP29, in Baku in November/December 2024, 10 development finance institutions endorsed the initiative

and pledged to collaborate in bringing clean hydrogen projects of between 100 MW and 1 GW in size in emerging markets to the final investment decision stage by 2030.

The path to achieving universal energy access by 2030 and transitioning to low-carbon solutions is no doubt challenging. But the progress we have made also gives us reason for optimism. ESMAP's commitment to Mission 300 and the Sustainable Development Goals underscores our dedication to making a tangible difference in the lives of millions. Our work to date is a testament to the power of persistence, innovation, and collaboration. We ask our partners, donors, and stakeholders to continue working with us on our joint mission. Together, we can ensure that every person around the world can thrive with reliable, sustainable energy.

Chandrasekar Govindarajalu
ESMAP Practice Manager



Fanny Missfeldt-Ringius
ESMAP Practice Manager

SECTION I

ESMAP AT A GLANCE

ABOUT ESMAP

ESMAP is a partnership between the World Bank (WB) and over 20 partners formed to help low- and middle-income countries reduce poverty and boost growth through sustainable energy solutions.

ESMAP's analytical and advisory services are fully integrated within the World Bank's country financing and policy dialogue in the energy sector. Through the WB, ESMAP works to accelerate the energy transition required to achieve Sustainable Development Goal 7 (SDG7) to ensure access to affordable, reliable, sustainable, and modern energy for all. ESMAP helps shape WB strategies and programs to achieve the WBG Climate Change Action Plan targets.

HOW ESMAP WORKS

ESMAP carries out the following program activities:

- Provide grants and technical assistance to countries through the World Bank Group operational units.
- Monitor an active portfolio of about $193.9 million (as of June 30, 2024), with FY2024 average annual commitments of about $828,000.
- Deliver key global knowledge products for country engagements.
- Develop external partnerships with international organizations, research and development institutions, and industry associations.
- Collaborate across the World Bank Group Regional Energy units and sectors, such as transport, environment, urban, water, health, gender, and agriculture.
- Help mobilize $5.8 billion in external financing, including $3 billion from the private sector, $2.4 billion from public financing, and $424 million from multilateral development banks and external trust funds.

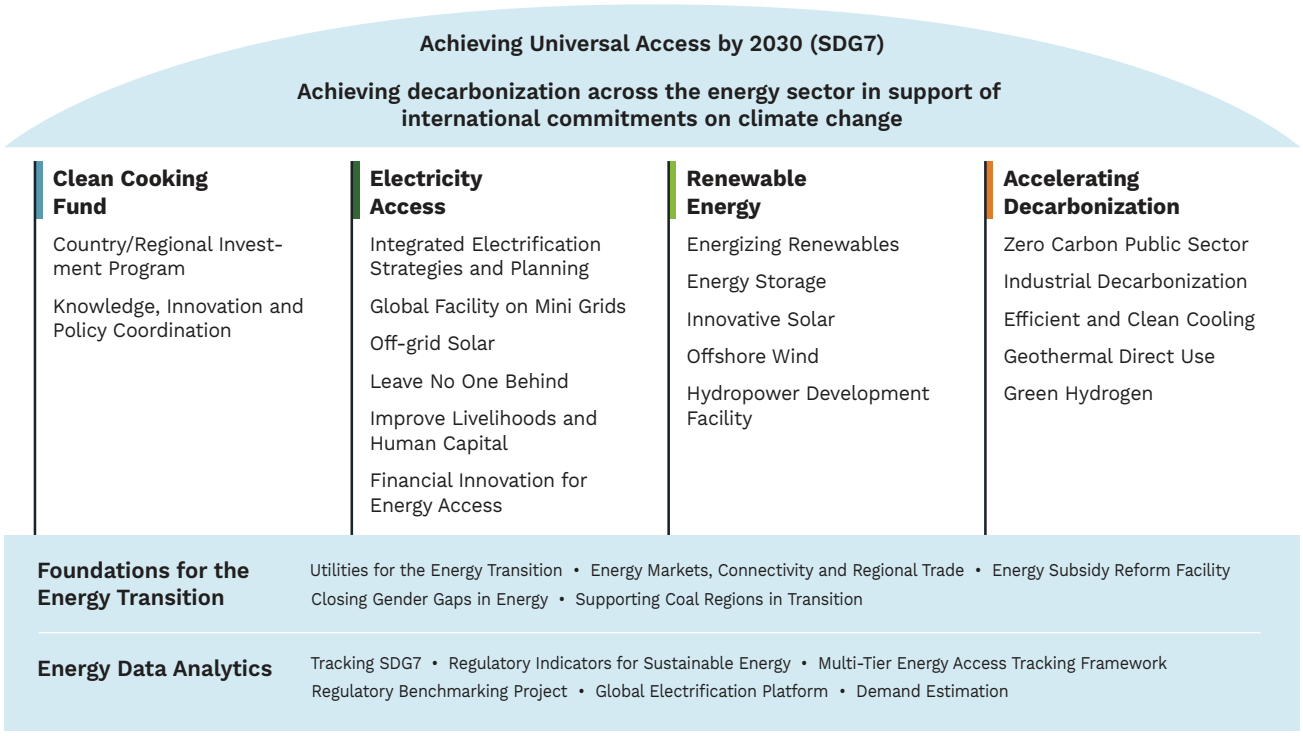
ESMAP 2021–24 BUSINESS PLAN STRUCTURE

ESMAP implemented a four-year business plan (FY2021–24) structured around 29 technical windows (or programs) organized under four thematic pillars and two cross-cutting thematic blocks—achieving universal energy access by 2030 and advancing decarbonization in support of international commitments on climate change, consistent with the World Bank Group's mission of ending extreme poverty and boosting shared prosperity on a livable planet. ESMAP's FY2021–24 business plan was conceived and approved in calendar year 2019.

To accomplish its business objectives, ESMAP works within four overarching and interlinked programs, which focus on **Clean Cooking**, **Electricity Access**, **Renewable Energy**, and **Accelerating Decarbonization**. These are underpinned by two cross-cutting programs: **Foundations for the Energy Transition** and **Energy Data Analytics**.

The overall budget target for the ESMAP Business Plan FY2021–24 was $1.3 billion, of which about $540 million would be for Bank-executed activities (primarily advisory services and analytics) and about $740 million for recipient-executed grants (primarily co-financing International Bank for Reconstruction and Development/International Development Association (IBRD/IDA) operations). The largest initiatives of the projected recipient-executed grants are (1) about $450 million for the Clean Cooking Fund; and (2) about $100 million for the COVID-19 response, to electrify health facilities through renewable energy, support an energy access relief fund, and deploy climate-friendly cold chains to deliver COVID-19 vaccines in client countries

Figure 1.1. ESMAP Theory of Change



Section I of the annual report articulates how ESMAP worked toward implementing its business plan in FY2024 (July 1, 2023 to June 30, 2024) during global challenges of great magnitude. These included the Russian invasion of Ukraine, the growing need for action to limit global warming to 1.5° Celsius, and the need to scale up efforts significantly to meet the SDG7 targets by 2030.

Section II follows the structure of the business plan, reporting on ESMAP activities within each workstream.

Section III contains a financial review, including a breakdown of lending activities by region and thematic area.

BY THE NUMBERS

Fiscal year 2024 (July 1, 2023, to June 30, 2024) marked the final year of the implementation of ESMAP's four-year business plan.

As of the end of July 2024, ESMAP's cumulative active portfolio reached $450.4 million, encompassing 511 activities implemented in about 65 countries.[1] Concrete program results are illustrated throughout the report.

In FY2024, ESMAP approved a total of $193.9 million to support global knowledge work, provide additional financing to existing activities, and finance new activities, including co-financing for World Bank projects as recipient-executed grants.[2]

Of the approved $193.9 million, $152.3 million was committed against new FY2024 grants and is funding the implementation of:

- 184 activities in 65 countries (excluding regional activities)
- 28 activities with a regional focus
- 43 activities with a global focus

Figure 1.2. Regional Profile of New ESMAP Activities Approved, FY2024

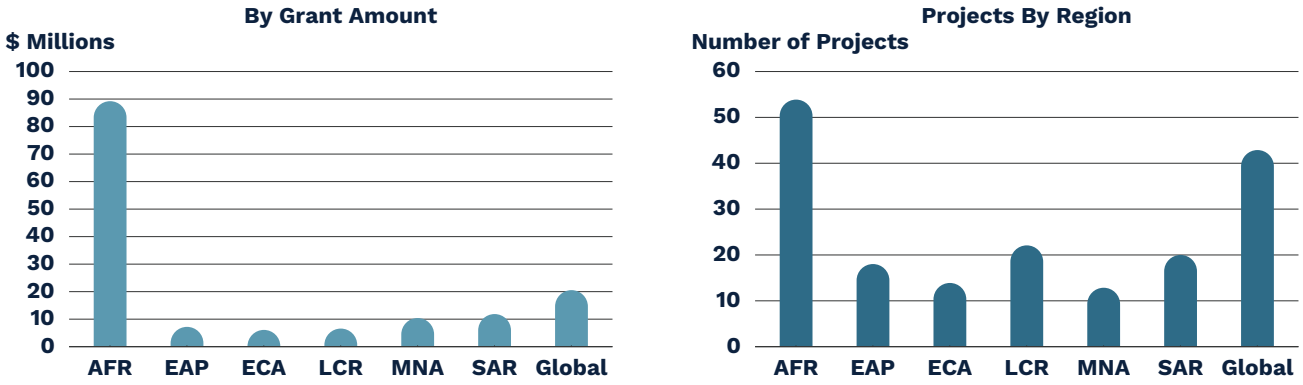
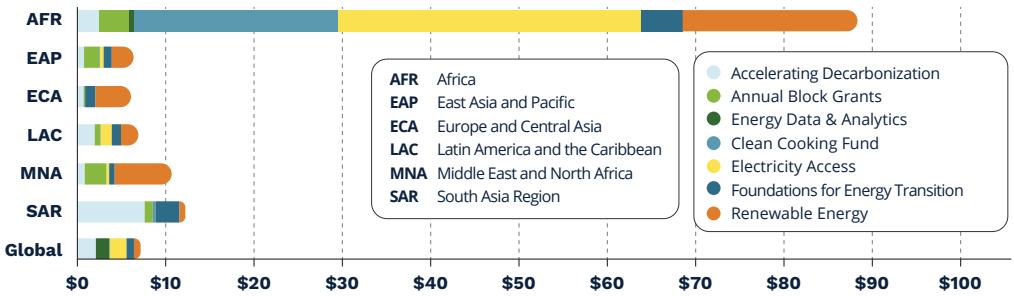


Figure 1.3. ESMAP Grant Amounts by Thematic/Cross-Cutting Areas for New Activities, FY2024 (US$ millions)



1. The active portfolio includes funding for 16 recipient-executed grants, totaling $39.2 million, which are pending approval of the lending project by the Bank's Board of Executive Directors. The active portfolio excludes allocations to cover (1) Program Management & Administration; (2) Monitoring & Evaluation; (3) Communications; and (4) Knowledge Management; totaling approximately $4.3 million.
2. Commitments represent the financial liability created against grants that become active/effective upon Bank approval.

SECTION II

OUR IMPACT IN FY2024

$11.7 BILLION
in World Bank development financing informed.

$5.6 BILLION
external financing was mobilized, including $2.7 billion from the private sector, $2.4 billion from public financing, and $424 million from MDBs and external trust funds.[3]

$8.8 BILLION
in climate finance informed.[4]

31 MILLION
people were expected to gain access to electricity, of which 23 million people will gain access to renewable energy.

59 MILLION
beneficiaries (households, communities, public facilities, utilities, industrial enterprises, etc.) are expected to be reached by ESMAP-informed World Bank development financing.

15 GW
of renewable energy is expected to be installed.

1,199 million MT of CO_2 emissions
is expected to be reduced.

67 million MWh
projected lifetime energy and fuel savings is to be achieved.

ACTUAL RESULTS FY2024[5]

15 MILLION
people have gained access to new or improved electricity services.

929,051 people
were provided with new or improved access to clean cooking solutions.

80,770 MW
of renewable energy has been constructed.

Impact indicators illustrate ESMAP's contributions to the development objectives by informing WBG lending operations. ESMAP will source the data for impact indicators from the project appraisal or other official documents of the lending operations. These indicators are cross-cutting and capture both direct and additional (indirect) contributions from multiple ESMAP initiatives (for example, energy access directly contributes to the number of people with access and may additionally contribute to metric tons of CO_2 emissions expected to be reduced). Because the additional contributions of the initiatives will be determined by the appraisal documents of the lending operations, ESMAP does not set targets for the impact indicators. Cumulative impact/expected results are available on ESMAP's Results Dashboard/Our Impact FY2021-24.

3. These amounts reflect World Bank mobilization supported by ESMAP.
4. Climate finance refers to the share of World Bank lending commitments that contributes to climate change mitigation and/or adaptation.
5. The data collected are from active and closed projects that reported actual numbers in FY2024.

Our Impact Cumulative Results, FY2021–24

$46 BILLION

in World Bank development financing informed.

$26 BILLION

in external financing was mobilized, including $10.2 billion from private sector, $11 billion from public financing, and $4.5 million from MDBs and external Trust Funds.

$28 BILLION

in climate finance informed.

31 GW

of renewable energy is expected to be installed.

1,910 million

MT of CO_2 emissions is expected to be reduced.

681 million

MWh of projected lifetime energy and fuel savings is to be achieved.

ACTUAL RESULTS—CUMULATIVE

132 MILLION

people are expected to gain access to electricity,[6] of which **107 MILLION** people will gain access to renewable energy.

163 MILLION

beneficiaries[7] (households, communities, public facilities, utilities, industrial enterprises, etc.) are expected to be reached by ESMAP-informed World Bank development financing.[8]

37 MILLION

people have gained access to new or improved electricity services.

972,884 people

were provided with new or improved access to clean cooking solutions.

82,403 MW

of renewable energy has been constructed.

6. This indicator measures the increase in number of people provided with new or improved electricity service.
7. Beneficiaries can take different forms such as people, households, communities, enterprises, ministries, schools, hospitals, etc. This indicator is not necessarily energy sector specific (ESMAP finances projects in urban, water, education sectors, etc) and can encompass a variety of beneficiaries.
8. The indicator "people expected to gain access to electricity" (132 million) measures the increase in the number of people provided with new or improved electricity service. The number of beneficiaries (163 million) is not only energy sector specific, as ESMAP finances projects in urban, water, education, and other sectors that encompass a variety of beneficiaries.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NEXT

ENERGY DATA

In the past four years, technological innovation has significantly transformed the energy sector, driven by increased data availability, new artificial intelligence tools, and more collaboration among stakeholders.

Open Data Platforms

One of the most notable innovations is the launch of open data platforms such as ENERGYDATA.INFO. Developed by ESMAP and several partners, it provides access to over 180 datasets that were previously unavailable or hard to retrieve, including electricity network maps, technical and commercial performances of African utilities, and high-resolution population and settlement geospatial data. As such, it serves as a one-stop shop for open data in the energy sector, encouraging contributions from governments, and public and private organizations.

Geospatial Data and Remote Sensing

Geospatial data and remote sensing technologies have revolutionized how energy data are collected and used. The Global Solar Atlas (GSA), launched by ESMAP in 2017 and upgraded regularly, is a prime example. This web-based tool helps investors and policymakers identify potential sites globally for solar power generation. It provides high-resolution maps and geographic information system (GIS) data, enabling detailed analysis and comparison of resource potential between sites. The January 2024 upgrade of the GSA added new interactive maps, including a new map of global solar validation sites, ensuring that the site remains at the very forefront in solar modeling.

Integration of Renewable Energy Data

The integration of renewable energy data has seen significant improvements. The 2024 edition of the *Tracking SDG7* report highlights the distribution of financial flows by technology, showing increased investments in solar and wind energy. The report also notes the growing interest in energy funds, green bonds, and government-led programs supporting multiple renewable technologies, energy efficiency, and electricity access.

Capacity Building and Policy Support

Efforts to build capacity and support policy development have been crucial. The Regulatory Indicators for Sustainable Energy (RISE) report by ESMAP assesses government support for sustainable energy investments. Covering 111 countries, RISE helps identify countries that are leading in sustainable energy and areas needing improvement, guiding policy, and investment decisions to achieve global energy goals by 2030. In FY2024, 91 new indicators were added, which will significantly increase the data collected for the next RISE report, due out in 2025.

Collaborative Initiatives

Collaborative initiatives have played a vital role in advancing energy data innovation. For example, the collaboration between the World Bank and various academic and research institutions has led to the development of tools and datasets that are available free to the public, such as the Global Wind Atlas. For FY2025, a new version of the atlas is being prepared; it will include new user interface designs and cutting-edge modeling data. These collaborations have facilitated the sharing of knowledge and resources, accelerating the adoption of innovative solutions in the energy sector.

ENERGY DATA & ANALYTICS

ESMAP's **Energy Data & Analytics Hub** provides comprehensive analytical and advisory services to support sustainable energy development. The program focuses on enhancing data collection, data management, and analysis to inform energy policies and investment decisions. It leverages advanced tools and methodologies, including geospatial analysis, big data, artificial intelligence (AI) and machine learning (ML), and cybersecurity to help countries optimize their clean energy strategies.

The hub disseminates analyses of its data through four complementary flagship products and platforms:

- Tracking SDG7: The Energy Progress Report
- The Multi-Tier Framework for Energy Access (MTF)
- The Regulatory Indicators for Sustainable Energy report (RISE)
- The Energy Data Hub

FY2024 Highlights

In FY2024, the Energy Data & Analytics Hub provided support in several innovative areas:

- **Enabling environments for energy data ecosystems:** Many countries require support to strengthen their enabling environment for energy data innovation through, for instance, the deployment of energy data exchanges and the development of capacity among technical staff. The hub offered global analytics to enhance government capacity for delivering market-enabling data sharing and national AI and ML initiatives in the energy sector. The team deployed AI to map transmission grids and assess climate vulnerabilities of the grid in Bangladesh and Uganda.
- **Establishing data and infrastructure sharing frameworks for innovating energy business models:** Real-time energy data exchanges can provide governments and markets with insights that can enable the development of new time of use tariffs, demand response incentives, or inform national energy access planning. ESMAP supported building *The Responsible Data Sharing Framework,* which will facilitate secure data sharing by mini grid developers through a designated data aggregator, thereby enabling more efficient impact monitoring, energy planning, and other analytics. The framework was adopted and is now deployed through the Nigeria Distributed Access through Renewable Energy Scale-up Project (DARES) project.
- **Applying ML and AI for energy management:** As areas of advanced data processing, ML and AI can unlock more efficient deployment of renewable energy (for example, through improved hydropower scheduling), reduce outages, and improve grid climate resilience. The team provided just-in-time AI support to client countries, including Georgia, on the use of AI for advanced hydropower modeling, and Vietnam, on the use of AI for the grid. The team conducted a two-day workshop led by AI company Palantir on the Software as a Servicemodel for AI implementation and organized a session at the WB Energy and Extractives(EEX)Forum,whichwasattended by more than 100 energy specialists.
- Ensuring cybersecurity preparedness and resilience for the energy sector: The hub has provided client countries with global guidance focused on cybersecurity preparedness in the energy sector. Cyberattacks can lead to the destruction of equipment, electricity outages, data breaches of personal information, or ransom events where hostile actors overtake the energy system. For countries connected through regional energy markets, cyberattacks can lead to cascading cross-border outages, which can cause setbacks for regional integration efforts. During FY2024, the hub supported utilities in Côte d'Ivoire, Georgia, Moldova, Senegal, Tajikistan, and Ukraine with cybersecurity technical assistance across transmission, distribution, and generation.

TRACKING SDG7: THE ENERGY PROGRESS REPORTS

The first energy progress report of the World Bank/ESMAP and its fellow custodians was launched in 2013. Through 11 editions (the report was first issued biannually, later annually), the report has become the go-to data repository on tracking global access to energy. For more than a decade, the report has provided essential data on the number of people connected to electricity worldwide and has identified key challenges to achieving universal power access, including population growth, inaccessibility of remote areas, and affordability among the poorest populations.

Based on its findings, the report offers policy recommendations to accelerate progress toward achieving SDG7. These recommendations are aimed at governments, international organizations, and other stakeholders involved in the energy sector. By publishing and disseminating the report, the World Bank and its partners raise awareness of the importance of energy access and the need for concerted efforts to achieve SDG7. Over the years, this agenda has gained prominence, which has helped mobilize resources and foster international cooperation. The custodians of the report are the International Energy Agency (IEA), the International Renewable Energy Agency (IRENA), the United Nations Statistics Division (UNSD), the World Health Organization (WHO), and the World Bank/ESMAP.

SECTION II OUR IMPACT IN FY2024

FOUNDATIONS

An efficient, financially sound power sector constitutes a solid foundation for the energy transition to a low-carbon economy and the provision of clean, affordable, and reliable electricity access. ESMAP supports countries in reforming energy subsidies, promoting the entry of new service providers while enabling utilities to leverage new technology opportunities to improve the quality of service and integration of renewable energy resources. ESMAP also assists in developing competitive wholesale markets and power trading **schemes as well as plann**ing and managing the social and distributional impacts of the transition to low-carbon energies.

Transition Away From Coal

Over the past three years, the transition away from coal in developing countries has faced significant challenges due to energy security considerations, but also has experienced progress. Environmental concerns and the global push to meet the Paris Agreement goals make a drastic reduction in coal use necessary, particularly in electricity generation. The Intergovernmental Panel on Climate Change has emphasized that global coal use must fall by 80 percent from 2010 levels by 2040, with Organisation for Economic Co-operation and Development (OECD) nations ending coal use by 2030 and developing countries by 2040. However, the transition has been uneven and complex, especially in South and East Asia, which produce 70 percent of the world's coal supply.

In response, ESMAP, together with other WBG units, has stepped up its support for a "just" transition from coal to clean energy that takes into account the social costs and differentiated impacts of the transition. This includes mobilizing resources to help local governments and communities repurpose coal mines, reinvent local economies, and address other social impacts. The WBG's approach involves innovative strategies, such as moving from "mine closure" to "repurposing post-mining land and infrastructure," to attract fresh private sector investments. ESMAP has also been active in supporting the retirement and repurposing of coal power plants. In South Africa, ESMAP's preparatory work enabled a $497 million World Bank investment to deco**mmission and repurpose the Komati coal-fired power plant, with an additional $57.5 million in concessional loan and grant.**

Energy Subsidy Reform

Energy subsidies that artificially lower the cost of electricity, fossil fuels, or district heating often account for a substantial portion of government spending. The subsidies have been a focal point of policy reforms aimed at improving economic efficiency and reducing fiscal burdens.

In many developing countries, energy subsidies have historically been used to make energy more affordable for the poor, stabilize prices, and support industrial development. However, these subsidies often lead to inefficiencies and disproportionately benefit wealthier households, which consume more energy. In addition, efforts to reform energy subsidies may face political and social challenges.

Despite these challenges, reforming governments have managed to make progress. A 2024 study of successful practices shows the importance of an integrated approach for reform design and implementation, considering the drivers of subsidies, potential impacts of different reform options, the critical role of mitigation measures in addressing severe impacts, and an understanding of the political economy context to guide reform timing and phasing. The study also highlights the importance of government ownership, concerted action across key agencies, effective stakeholder engagement, and communication.

Market Connectivity and Transmission Infrastructure

Regional energy integration has seen substantial development across regions, bringing a wide range of benefits. While the focus had traditionally been on reducing power shortages and increasing

electricity access, in recent years, the emphasis has shifted toward system optimization, achieving decarbonization goals, and enhancing energy security.

Regional power pools and markets are at different stages of development. ESMAP's objective is not only to interconnect transmission infrastructure but also to ensure that the necessary "soft infrastructure"— including planning, governance, institutional development, and wholesale markets— is in place to fully harness the benefits of these interconnections.

Africa has been a particular focus of ESMAP for developing cross-border transition. ESMAP has assisted all four power pools in Sub-Saharan Africa in creating regional power markets and enhancing regional institutional capacity through a combination of lending operations, technical assistance, and advice and analytics. Regional energy integration facilitates the optimal sharing of renewable electricity resources, which are abundant but unevenly distributed across the region. This helps reduce electricity costs, meet the growing consumption demands of existing and newly electrified users, and enhance resilience to energy supply disruptions.

Smarter Utilities

Electricity utilities in developing countries face significant challenges. Many in the least developed countries are ill equipped to meet the growing demand for power and add more renewable energy to the grid. This hinders achieving global energy transition goals and providing clean, reliable, and affordable electricity to all. Financial viability remains a serious issue, especially for public sector utilities. They are struggling with tariffs that do not recover their costs and leave inadequate resources to maintain and upgrade their infrastructure.

ESMAP supports utilities in deploying digital technologies, designing and adopting new business models, leveraging the value of big data and analytics, building the capacity of sector practitioners, enhancing regulatory frameworks and policy, and enabling the emergence of new service providers in the energy sector.

UTILITIES FOR THE ENERGY TRANSITION

ESMAP's **Utilities for the Energy Transition Program** aims to enhance the performance of utilities in developing and emerging economies by promoting the effective use of smart technologies, data analytics, and innovative business approaches. The program leverages big data, AI, and digital tools to optimize grid operations, increase operational efficiency, and support informed decision making for a more sustainable energy landscape. Launched during the FY2021–24 business cycle, the program helps client countries identify and seize opportunities while addressing challenges linked to the power sector's digital transformation.

FY2024 Highlights

When countries seek to transition from traditional power generation to renewable energy sources, their utilities need to be technically sound, logistically up to modern standards, and committed to extending their distribution reach. It is increasingly recognized that modernized utilities are foundational to the energy transition and, as a result, demand for ESMAP grant support for strengthening utilities has grown. In response, the ESMAP team has substantially scaled up its support for country lending engagements and policy dialogue.

- **Commitments.** During the FY2021–24 ESMAP business cycle, the utilities program committed $9.6 million, including $3.4 million in FY2024.
- **New grants.** In FY2024, grants were approved in 11 different countries (Angola, Cabo Verde, Colombia, India, Kenya, Liberia, Mauritania, South Africa, Tajikistan, Uzbekistan, and Vietnam) plus two regional grants in Central America and the Pacific Islands.

- **Angola.** ESMAP provided a grant to help expand access to electricity and integrate regional markets. The program is building a foundation for guiding government policies on providing electricity access to all Angolans in a financially sustainable way and strengthening Angola's role in the regional market. A financial analysis of the electricity sector is underway to help the government understand how electricity access targets affect the sector's financial health. It will also establish whether the sector can fund the necessary investments to meet such goals and identify any funding gaps the government needs to close. The analysis will use an updated financial model that considers macroeconomic conditions, expected growth in demand, planned investments, capitalization needs, financing options, and sensitivity testing. This work will identify the factors weakening the sector's financial stability and causing financial shortfalls.
- **Colombia.** ESMAP provided a grant aimed at supporting the energy transition and modernization of the power sector under the Colombia Green and Resilient Program. The grant includes assistance for the Empresas Públicas de Medellin Group to enhance service quality and implement a smart grid framework. An additional grant was provided to advance smart grid development and strengthen utilities to improve power quality across the country.

TRANSFORMING BANGLADESH'S ELECTRICITY DISTRIBUTION NETWORK

Over the past decade, Bangladesh has more than quadrupled its electricity generation capacity, achieving near-universal access to electricity for its population. This milestone was largely made possible by the Bangladesh Rural Electrification Board (BREB), which has implemented one of the world's most extensive rural electrification programs, connecting over 90 million people. However, the distribution network has not kept pace with the rapid increase in generation and demand. As a result, the lack of resilience and reliability in the energy system's infrastructure is weakening Bangladesh's economic competitiveness and business environment.

To address these challenges, ESMAP's Bangladesh Electricity Distribution Network Transformation grant is providing vital support. This initiative has also informed the development of the Electricity Distribution Modernization Program, a $106 million World Bank loan disbursed in FY2024. The program is designed to enhance the delivery, reliability, and efficiency of electricity supply. Of the total loan, $15 million is allocated for a Supervisory Control and Data Acquisition pilot, $8 million for the establishment of a smart meter data center, and $15 million for the deployment of smart meters within the BREB network. Additionally, ESMAP's grant co-financed a study to lay the groundwork for future battery storage projects in Bangladesh.

The grant has supported the hiring of a specialist to help BREB assess SCADA, Smart Meters and other technologies and prepare a Performance Improvement Plan (PIP) and an Institutional Reform Plan (IRP). The grant also co-financed a technical study titled "Accelerating the role for energy storage, grid-connected solar PV, and other distributed resources to support energy transition in Bangladesh," to be published in FY2025.

By modernizing and strengthening the energy system and its supporting institutions, the ESMAP utility program aims to ensure a reliable, affordable, and sustainable electricity supply in Bangladesh. This modernization is expected to facilitate the energy transition and enable an effective response to the sector's challenges and opportunities.

ENERGY MARKETS, CONNECTIVITY, AND REGIONAL TRADE (MARCOT)

In FY2021, ESMAP launched the **Energy Markets, Connectivity, and Regional Trade** (MARCOT) initiative to provide comprehensive support for client countries and the World Bank in designing and implementing energy sector reforms, primarily focused on electricity market development. MARCOT aims to help foster competitive and transparent electricity markets, improve grid interconnectivity across borders, and scale up regional electricity trade. Well-functioning power markets not only optimize system operations but also incentivize investments in clean and flexible energy resources. Increased grid interconnectivity and electricity trade lower system costs, enhance the resilience and reliability of the electricity supply, and create larger, more stable markets that attract private sector investment. These efforts are pivotal in advancing the global commitment to achieving SDG7.

MARCOT also encompasses the Advancing Regional Energy Projects in Southern and Eastern Africa Multi-Donor Trust Fund, which was established in 2016 and is set to close in 2024. The trust fund channeled donor contributions to accelerate the preparation and development of regional energy projects and foster the enabling environment for expanding regional power trade.

FY2024 Highlights

- **Collaboration with the Regulatory Energy Transition Accelerator (RETA)**
    - MARCOT worked with RETA, a global initiative established with the International Energy Agency (IEA), the United Kingdom Office of Gas and Electricity Markets, the International Renewable Energy Agency (IRENA), and the World Bank, to facilitate knowledge sharing among over 50 energy regulators and eight regulatory networks.
- **Technical Guidance Notes**
    - Technical Guidance Notes developed under the RETA initiative include:
        - *Institutional Architecture for Regional Power System Integration,* by the IEA, with MARCOT inputs
        - *Guidelines on Transmission Pricing and Cost Allocation for Regional Power Trade* (in press)
        - A note on "Technical and Regulatory Harmonization of Grid Codes," led by ARENA, with MARCOT reviews
- **Report**
    - *Beyond Borders: Power Grid Interconnections and Regional Electricity Markets for the Sustainable Energy Transition* (in press), providing essential guidance on cross-border power grid and market integration
- **Market Design Laboratory Project**
    - Conducted a series of analyses on market design issues and their compatibility with carbon reduction policies. The findings from these studies were presented and discussed in a MARCOT-RETA June 2024 webinar, which was attended by nearly 200 participants, including regulators, energy agencies, and World Bank staff.
    - Case studies:
        - **Ukraine.** Identified market power as the primary reason for high electricity prices and established the value of battery energy storage systems.
        - **Georgia.** Highlighted key design parameters impacting market prices.
    - Focused on the implementation of Security-Constrained Economic Dispatch (SCED) in India and capacity building efforts around optimizing dispatch.
- **New Analytical Tools and Capacity Building**
    - Developed tools for market-oriented analysis of storage, including battery and pumped hydro storage, using India as a case study.
    - Assisted the Ghana energy team in including SCED in its dispatch optimization.

AFRICA AND PAN-ARAB MARKETS: MARCOT'S IMPACT

Energy Markets, Connectivity, and Regional Trade (MARCOT) has been a driving force behind advancing cross-border transmission development and regional power market integration from FY2021 to FY2024 in Africa, the Middle East and North Africa, Central Asia, and South Asia. Power integration in these areas is at different stages of maturity, and MARCOT's approach includes not only interconnecting transmission infrastructure but also developing the necessary soft infrastructure—planning, governance, and institutional frameworks—to maximize the benefits of these efforts.

MARCOT has actively supported market reforms across multiple regions. Notably, it contributed to the development of wholesale electricity markets, which are key to regional trade. It has also been involved in producing technical guidance and analysis on topics such as transmission pricing, market harmonization, and decarbonization. This has been crucial in shaping how World Bank teams develop for client countries models that can be adapted for price forecasting, market power testing, and investment analysis.

Between FY2021 and FY2024, MARCOT provided $12.8 million in grants, supporting 33 global, regional, and country-level projects. In FY2024 alone, $5.7 million was allocated to 18 projects. One of the largest grants, $2 million, was directed to encourage regional power trade among member countries of the West African Power Pool (WAPP) through the establishment of the Liquidity Enhancing Revolving Fund (LERF). This initiative exemplifies MARCOT's commitment to strengthening regional electricity trade.

Pan-Arab Markets

In the Middle East and North Africa, there is currently no regionwide institution or market in place. The World Bank and the League of Arab States launched a cooperation program in 2016 to support the implementation of building blocks—such as governance, institutions, trade enablers, and financing solutions—to establish the Pan-Arab Electricity Market (PAEM). Power trade through existing and planned interconnections under PAEM is expected to deliver massive system cost savings, estimated at $107 billion to $196 billion between 2018 and 2035.

MARCOT has been a significant player in the development of PAEM and vital regulatory frameworks to enable cross-border electricity trade. A highlight has been the development of the report *Transmission Pricing Methodologies for Use in the Pan-Arab Electricity Market*, which provides guidance on designing transmission tariffs and offers a model to facilitate wheeling transactions across the region. Transparent pricing for third-party wheeling transactions and the establishment of a regional grid code are seen as important enablers for efficient regional markets.

Southern African Power Pool (SAPP)

MARCOT's financial and technical expertise has been instrumental in bolstering the World Bank's lending operations and advisory services and analytics that form the building blocks of regional electricity trade. This includes all power pools in Africa—SAPP, helping the establishment of the Regional Transmission Infrastructure Financing Facility (RTIFF). This blended finance mechanism was designed to leverage public capital to attract private investment in transmission projects across the region. The MDTF funded analytical studies and other preparatory activities that helped design the facility's functions and institutional model, identify legal considerations, and finalize its detailed design. A milestone was achieved in January 2024 with the signing of an agreement between SAPP and the appointed fund manager to initiate the establishment and operationalization of RTIFF. The ongoing operationalization of RTIFF is expected to receive further support under the proposed Regional Energy Transmission, Trade, and Decarbonization Project, which is currently under preparation and expected to be approved in FY2025.

West African Power Pool

MARCOT has played a key role in the preparation and implementation of LERF, a guarantee mechanism aimed at ensuring payment security and improving commercial discipline in regional electricity trade. The fund, designed to reduce the risk of outstanding bills among

utilities, has been under development since 2021, with the World Bank and ESMAP providing strong support. This fund is expected to stabilize the regional power market by securing payment assurances, which in turn will enhance the reliability of the electricity supply across West Africa.

In July 2023, the synchronization of power grids across 12 WAPP member states was achieved, marking an important milestone for regional power integration. MARCOT-supported grants were instrumental in funding preparatory trials and the synchronization itself. The development of a regional Grid Code and a Market Code, which lays the commercial foundation for electricity trade, has also progressed, and the regional regulatory authority has provisionally adopted the Grid Code. Additionally, a benchmarking analysis of transmission pricing methodologies was completed by FY2024, setting the stage for revised regulations that will further enhance the Pan-Arab market's efficiency.

Eastern Africa Power Pool (EAPP)

A significant milestone was achieved with the completion of a shadow market exercise, a crucial step toward operationalizing a regional electricity market in Eastern Africa.

ENERGY SUBSIDY REFORM FACILITY (ESRF)

Energy subsidy reform is a complex, technically demanding, and politically sensitive undertaking. ESMAP's **Energy Subsidy Reform Facility** (ESRF) was established in 2013 to support governments in the design and implementation of energy subsidy reform programs.

ESRF funds analytical work and provides technical assistance to government counterparts on various aspects of energy subsidy reforms, including:

- Assessment of energy sector financial performance, quantification of energy subsidies, and fiscal transfers.
- Understanding economywide impacts of subsidies.
- Strengthening energy pricing frameworks to enable cost recovery.
- Identifying viable options for subsidy reduction and eventual removal; improving targeting and delivery of remaining subsidies.
- Developing options for enhancing social safety nets to protect poor and vulnerable households; providing advice on reducing utilities' reliance on fiscal support.
- Developing stakeholder engagement and communications strategies.

FY2024 Highlights

In FY2024, ESRF provided $2.74 million in technical assistance grants, supporting activities in 33 countries and four regional initiatives. The portfolio concentrated on sector financial sustainability, sector diagnostics, distributional impact analysis, and mitigation measures for the impact of price reforms.

Examples of ESMAP-funded technical assistance in select countries are provided below.

- **Ethiopia.** Key analyses that served as inputs to the upcoming four-year electricity tariff adjustment.
- **Ghana.** Support for the implementation of the government's Energy Sector Recovery Plan, including an electricity subsidy and tariff study that informed the government's review and contributed to the Multi-Year Tariff Order.
- **Kazakhstan.** Technical work on new tariff methodologies for electricity and heating, which served as inputs to the government's decision to adjust electricity tariffs and adoption of a new incentive-based cost-recovery tariff methodology.
- **Uzbekistan.** Extensive technical analyses that supported the government in the design of energy subsidy reforms and informed an innovative development policy crediting program, under which the country received its first payment for carbon emission reductions resulting from these reforms.
- **Zambia.** The assessment of Zambia's fuel supply chain, alongside analyses that contributed to the design of a system of monthly market-based adjustments to petroleum pump prices.

Stocktaking Study on Energy Subsidy Reform Experience

FY2024 was a banner year for knowledge delivery by ESRF with the publication of seven technical reports on specific issues related to energy subsidy reforms, culminating in a stocktaking study that gathers the conclusions of the extensive analytical work performed in the context of this in-depth and multi-global practice study.

The stocktaking study, *From Ambition to Action: Practical Insights on Energy Subsidy Reforms* presents energy subsidy reform practitioners with steps to consider while supporting subsidy reform efforts. The steps include gaining a solid understanding of the background, effects, and socioeconomic motivations for energy subsidies. Further, they involve developing several reform options, obtaining a clear understanding of the reforms' effects on stakeholders, and building mitigation measures and benefits for society and the economy into reform design. The report advises practitioners to be strategic about the timing and sequencing of reforms and communicate meaningfully and clearly with the public about them.

The technical reports that accompany the final stocktaking study include:

- *Distributional Analysis for Informing Energy Subsidy Reforms: Review of Recent Approaches.* This report, produced as part of a collaboration between the World Bank's Poverty and Equity Global Practice and ESMAP ESRF, explores how poverty and distributional analyses have been used to support energy subsidy reform efforts.
- *Approaches and Insights from Recent Research on Energy Subsidy Reform.* The report summarizes emerging approaches, along with major trends, strands of thinking, evidence, and research in the field of energy subsidy reforms, as reflected in major policy and academic journals relevant to the subject.
- *Cash Transfers in the Context of Energy Subsidy Reform: Insights from Recent Experience.* This report was developed in collaboration between the World Bank's Social Protection and Jobs Global Practice and ESMAP ESRF. It reviews recent approaches for using social assistance, especially targeted cash transfers, to help mitigate the impact of energy subsidy reforms on households, particularly on the poor and the vulnerable.
- *Macroeconomic Modelling and Energy Subsidy Reform Policy Dialogue.* Prepared as part of a collaboration between the Macroeconomics Trade and Investment Global Practice and ESMAP ESRF, the report explores approaches to the deployment of macroeconomic modeling tools, in particular, Computable General Equilibrium models, to analyze potential impacts from energy subsidy reforms in different country settings.

- *Political Economy Analysis and Communications for Energy Subsidy Reform: Approaches and Insights from Recent Technical Assistance.* Given the critical role of political economy in reform implementation and outcomes, this report takes stock of political economy analysis and communications activities in country-specific technical assistance activities funded by ESMAP ESRF in the context of real-world energy subsidy reforms.
- *Total Carbon Pricing for Energy Consumption: The Importance of Energy Taxes and Subsidies.* Governments around the world have been deploying a range of energy, climate, and fiscal policy instruments that affect the price signal for carbon emissions, even when that is not stated as an objective. This report, prepared as part of a multiyear collaboration between the World Bank's Macroeconomics Trade and Investment Global Practice and ESMAP ESRF, uses the concept of total carbon pricing to illustrate the combined carbon pricing signals sent by direct (carbon taxes and emissions trading systems) and indirect (energy subsidies and taxes) carbon pricing instruments.
- *Firm-Level Effects of Energy Price Increases: Evidence and Insights from Recent Research.* The question of how firms are affected by and respond to energy price increases has received limited attention in energy subsidy reform literature, especially compared with research and analysis on households. The report draws on academic papers and research covering more than 60 countries to help improve the understanding of firm-level effects of energy prices and firms' response mechanisms.

UZBEKISTAN: THE FIRST COUNTRY TO RECEIVE A CARBON PAYMENT FOR ENERGY SUBSIDY REFORMS

While the country's contribution to global carbon emissions is not large, Uzbekistan is one of the most energy- and emissions-intensive countries in the world. High subsidies keep electricity and gas prices low, which means that the revenue that utilities collect from energy sales is insufficient to cover the costs of production and delivery. Low prices discourage households and businesses from pursuing energy efficiency and conservation efforts, and they limit the capacity of the sector to improve service delivery.

In June 2024, Uzbekistan became the first country in the world to receive a payment for carbon emission reductions resulting from policy actions related to energy subsidy reforms. How did this happen?

The World Bank approved the first policy crediting project of its kind—the Innovative Carbon Resource Application for Energy Transition (iCRAFT)—to support Uzbekistan in reforming energy subsidies, implementing energy efficiency measures, and transitioning to cleaner energy sources. The $46.25 million iCRAFT project creates incentives for energy subsidy reforms to lower energy consumption and greenhouse gas (GHG) emissions. The project assigns value to and credit for the implementation and enforcement of policies that foster emission reductions in the energy sector.

The preparation and design of iCRAFT were informed by ESMAP funding to support the government with analytical work on energy tariffs and subsidies, development of reform options, assessment of distributional impact of those options, and preparation of a communications strategy. These analytical activities were part of a broader program of World Bank support to the government in its efforts to strengthen the financial viability and sustainability of the energy sector, supported through a series of ESMAP technical assistance grants.

One year after the 2023 approval of the project by the World Bank Board of Executive Directors, the multi-donor Transformative Carbon Asset Facility, administered by the Bank, paid Uzbekistan $7.5 million for the reduction of 500,000 tons of carbon emissions because of energy subsidy reforms carried out in 2022. The payment is the first of several anticipated payments. Uzbekistan could receive up to $20 million for verified emission reductions or carbon credits generated through its energy subsidy reforms.

Uzbekistan aims to reduce 60 million tons of CO_2 through its policy reforms, with approximately 2.5 million tons of CO_2 to be sold under iCRAFT and the remaining carbon credits to be sold on international carbon markets, using the systems and processes established by the project. The government is taking steps to create appropriate incentives to conserve energy and make the energy sector more financially sustainable. While these measures will incrementally increase energy tariffs, the reforms will be accompanied by strong social protection support for Uzbekistan's most vulnerable consumers, as well as awareness campaigns to help people understand the need for such reforms.

SUPPORTING REGIONS IN COAL TRANSITION

The energy sector is the largest source of global GHG emissions, with 80 percent of energy coming from fossil fuels like oil, coal, and natural gas. In 2021, coal was the top emitter among energy sources. Despite efforts to shift to clean energy, progress is slow due to the issue's scale and limited affordable alternatives. Coal still generates over one-third of global electricity, especially in developing countries. Transitioning from coal without compromising affordable and reliable power is a complex, long-term challenge. An added challenge for many countries is a lack of competitive alternatives and resources.

The World Bank Group stopped financing new coal projects in 2010, and ESMAP's **Supporting Energy Transition in Coal Regions Initiative** aids developing countries in successfully phasing out coal by closing mines and repurposing plants. ESMAP provides knowledge exchange, transition roadmaps, social protection packages, reskilling programs, and economic transition pathways. The program prioritizes protecting communities during the shift to cleaner energy sources.

FY2024 Highlights

In FY2024, ESMAP allocated $2.2 million in technical assistance grants to World Bank country and regional task teams for coal transition activities. This included five new initiatives and additional funding for three ongoing projects. Throughout the fiscal year, 14 grants were active, with two closing during this period. Overall, the Coal Transition Initiative supported activities in nine countries and one global study.

- **India.** In FY2024, two ESMAP grants supported India's energy transition efforts, focusing on repurposing coal power plants. Preliminary screenings of four thermal power plants found them suitable for repurposing, totaling 2 GW of capacity. Baseline planning and transmission analysis for Bokaro were completed, and a study tour to the United States took place in October 2023. An *Environmental and Social Management Framework* for repurposing plants is ongoing.

  The grant also supported initial assessments for six out of eight abandoned mining sites using the Land Utilization Rating Application, with further studies in progress. These studies will help develop a comprehensive mine closure roadmap. Preliminary feasibility studies on pump storage power in two coal mines are in progress, with findings expected to support a pilot project.

  The World Bank team prepared drafts of two coffee table books on repurposing land and assets, featuring case studies from India and other countries. The Indian Ministry of Coal has requested advisory services from the World Bank for continued support in the Just Coal Transition.

- **Indonesia.** Since FY2023, ESMAP has been supporting Indonesia's Just Transition and Coal Plant Repurposing Program. The World Bank team is working with the government on scoping and prefeasibility studies for coal plant decommissioning and repurposing.

  In FY2024, an options analysis of the early retirement of coal-fired power plants by Indonesia's state-owned electric power distribution company PT Perusahaan Listrik Negara was completed. Before finalizing the analysis, ESMAP discussed it with the government during a workshop in 2023. The findings informed the policy chapter of the Comprehensive Investment and Policy Plan under the Just Energy Transition Partnership, which the government adopted in November 2023.

- **Study on stranded assets.** During FY2024, ESMAP conducted a global study on the costs of stranded assets in the power sector due to global decarbonization. The final paper presented a framework to identify and manage risks and costs associated with stranded coal-fired power plants. The framework complements the World Bank's 2023 report on financing energy transitions and supports a just transition during coal phasedown. It includes:
  - Reducing exposure and uncertainty of stranded assets to contain transition costs.
  - Reusing assets to maintain engagement in coal phasedown discussions.
  - Reconciling conflicting interests to ensure a fair distribution of transition costs.

  The study supported dialogues with the governments of Indonesia and Vietnam on managing stranded costs and potential compensation.

ACCELERATING DECARBONIZATION

The global economy will only stand a chance of operating under a net-zero carbon emissions scenario if the world takes decisive steps toward decarbonizing the use of energy, not just in producing and using electricity, but also in energy consumption by buildings, utilities, industries, and transport.

The global economic slowdown, Russia's war on Ukraine, and the resurgence of conflict in the Middle East have pushed hydrocarbon prices up and consequently put a renewed focus on decarbonization efforts.

Country Examples

India rapidly expanded solar power over the past two years through, in part, favorable regulatory frameworks encouraging investment in renewable energy. ESMAP supported this development through technical assistance and financial support aimed at enhancing the deployment of solar energy. **Colombia** implemented a greener financial system by integrating environmental, social, and governance criteria into financial regulations and encouraging green investments through policy measures. ESMAP has provided grants and technical assistance to support studies and inform Colombia's local and national e-mobility policy and strategy. This includes the use of solar PV generation to energize docking stations for e-cargo bikes.

Going forward, carbon pricing in the power sector will be a critical tool for transitioning toward net-zero carbon development. This involves designing effective carbon pricing mechanisms to incentivize reductions in carbon emissions.

Programs

Under the **Accelerating Decarbonization** pillar, ESMAP promotes innovative strategies and technologies aimed at reducing carbon emissions from energy use in power-intensive industries, vehicles, and buildings.

As global temperatures rise, cooling services become increasingly crucial, particularly in hot climates. ESMAP's **Efficient and Clean Cooling Program** addresses the need for cooling food and medicine by promoting efficient equipment powered by renewable energy. The **Industrial Decarbonization Program** supports industries like cement, steel, and chemicals in low- and middle-income countries, encouraging technologies that reduce CO_2 emissions.

The public sector too is a polluter, responsible for up to 20 percent of countries' energy use worldwide. ESMAP's **Zero Carbon Public Sector Program** helps governments adopt policies to decarbonize public buildings, utilities, and transport.

Additionally, ESMAP advances technologies to replace fossil fuels. The **Geothermal Direct Use Program** promotes using geothermal heat directly without converting it to other forms of energy, thus reducing reliance on carbon-based energy while creating economic opportunities. The **Green Hydrogen Support Program** highlights the potential of green hydrogen—produced using renewable power—as a sustainable energy source for heavy industries, such as steel and aviation, especially in emerging economies.

CLEAN COOLING

ESMAP's **Efficient and Clean Cooling Program** is designed to address sustainable development challenges (SDG7 on energy, SDG2 on hunger, SDG3 on health, SDG13 on climate) by increasing access to cooling while minimizing adverse climate and environmental impacts. The program works to catalyze the integration of sustainable, climate-friendly, and reliable cooling solutions into World Bank policy dialogues and lending operations. Program activities support the adoption of efficient energy cooling solutions that minimize GHG and hydrofluorocarbon (HFC) emissions and bring efficient and clean cooling to

end-users in sectors such as health, agriculture (dairy, fisheries, horticulture, aquaculture), urban, and transportation to improve these populations' economic and social welfare.

Since it was established in 2019, ESMAP's Cooling Program has allocated more than $12 million in World Bank- and client-executed grants to finance technical assistance and investments in the energy sector to foster the supply of efficient cooling and in other sectors to support the use of efficient cooling services and equipment. The program has also provided support in kind through the just-in-time mobilizations of experts who work with World Bank teams on the design and preparation of projects' cooling modules.

These activities financed by the ESMAP program and experts' assistance have informed World Bank operations in 29 developing countries across Africa, Latin America, and Asia.

FY2024 Highlights

- **Cooling Facility.** ESMAP, alongside the World Bank's Energy Climate Finance team, mobilized $157 million from the Green Climate Fund (GCF) to establish a multisector Cooling Facility covering nine countries. In FY2024, two projects were approved—in **São Tomé and Principe** and **Somalia**—and technical discussions with the governments have started in **Kenya** and **Malawi**. The aim of the approved projects is to support policy, regulation, and investments in sustainable cooling for health care, especially in rural areas.
- **Small Island Developing States.** An ESMAP grant was approved for Seawater Air Conditioning (SWAC) through the Caribbean Regional Energy Initiative. SWAC harnesses cold seawater to provide cooling, significantly reducing energy consumption and CO_2 emissions. Feasibility studies were conducted in the **Dominican Republic** and **Jamaica**, and potential business models were proposed for future SWAC implementation. Interest in SWAC has also emerged from **Dominica** and the **Maldives**, with potential grant applications expected in FY2025.
- **Argentina.** An ESMAP-funded grant was provided to promote sustainable and energy-efficient social housing in **Buenos Aires**, focusing on housing projects in low-income neighborhoods. Recommendations for new housing guidelines included sustainable cooling and heating. A comprehensive report on the project's results was finalized in August 2024.
- **Africa.** ESMAP provided recipient-executed grants to support climate-friendly and efficient cooling systems in **São Tomé and Principe, Somalia,** and **South Sudan.** These projects aim to improve health care through energy-efficient cooling solutions, particularly for vaccine deployment and maternal and child health services.
- **Global.** In partnership with Sustainable Energy for All (SEforALL), ESMAP published a report on the nexus between electricity access and sustainable cooling in off-grid rural areas. The report, launched in June 2024 with a webinar attended by more than 100 participants, informed discussions on sustainable cooling at the **Global Off-Grid Forum** (GOGLA) in Nairobi in October 2024.

EFFICIENT AND CLEAN COOLING PROGRAM'S IMPACT DURING THE COVID-19 PANDEMIC

The **Efficient and Clean Cooling Program** contributed financial and technical support as part of the World Bank's COVID-19 pandemic response efforts and the rollout of vaccines. It supported the deployment of reliable and climate-friendly vaccine cold chains in collaboration with partners such as WHO, UNICEF, and GAVI, the Vaccine Alliance, enabling cold chain development across countries including Comoros, Haiti, Liberia, Niger, Nigeria, South Sudan, and Zimbabwe. The program also allocated more than $9 million in grants to over 15 countries, including fragility, conflict, and violence-affected countries, to help strengthen health systems.

The program delivered key technical support and advisory services, including workshops with government officials and implementing agencies. A tool has been developed to support planning for cold chains for health sector strengthening and is being piloted in Ethiopia, Nigeria, and Somalia. The tool will enhance these countries' understanding of the cost, energy, and climate change implications of upgrading cold chains to respond to the pandemic.

In FY2022, with a $2 million ESMAP grant, 62 solar direct drive refrigerators (climate-friendly cold chain equipment) were procured, deployed, and installed in South Sudan and were operational in field locations in the Upper Nile and Jonglei States. The investment supported services delivering to approximately 1.26 million people, a testament to the World Bank's strong commitment to fragile and conflict-affected settings and providing climate-friendly energy solutions in the health sector.

In Mongolia, a project financed by a World Bank COVID-19 Emergency Response Project received from the ESMAP team in-kind technical expertise on the design and construction of a new, reliable, energy-efficient, solar-ready, state-of-the-art central vaccine storage facility, with four times the original capacity based on the facility's technical specifications. This enabled the country to fully vaccinate more than 65 percent of the population and have reliable storage for life-saving vaccines while limiting GHG emissions and lowering operating costs.

Building on the successful World Bank COVID-19 pandemic response, particularly support for vaccine rollout, the Efficient and Clean Cooling program was broadened in FY2023 to cover assessments for climate-friendly and sustainable cooling and energy solutions in health care facilities.

INDUSTRIAL DECARBONIZATION PROGRAM

As many developing countries continue to rapidly industrialize, they are looking to decarbonize industrial activity to meet their national emissions reduction targets and improve their industrial sector's competitiveness. ESMAP's **Industrial Decarbonization Program** works to accelerate the decarbonization of industrial sectors in low- and middle-income countries by supporting the adoption of innovative technological solutions that avoid the traditional business practice of emitting CO_2 directly into the atmosphere. ESMAP provides technical assistance, market development support, capacity building, and sharing of global best practices.

The program's goal is aligned with the World Bank Group's strategic vision of scaling up financing for clean energy transitions, including projects targeting industrial decarbonization. The Industrial Decarbonization Program was one of the five thematic areas under ESMAP's Accelerating Decarbonization Program in the FY2021–24 business plan. Since its inception in 2019, ESMAP's Industrial Decarbonization Program has advised on World Bank lending projects worth more than $2 billion in lending volume for industrial decarbonization and the deployment of clean energy technologies, including green hydrogen.

FY24 Highlights

In FY2024, the Industrial Decarbonization Program approved six new grants totaling $2,298,000.

- **Colombia.** An additional $200,000 for the Industrial Decarbonization through Low Carbon Hydrogen grant. This supports the government of Colombia in designing policies for a sustainable energy transition and creating a funding facility to attract private investments in low-carbon technologies. The grant has informed the $750 million Colombia Green and Resilient Development Policy Operation 2, approved in March 2024.
- **Morocco.** $593,000 for Fostering Decarbonization of Industrial Zones. This grant supports the development of a strategy to decarbonize five industrial zones and analyzes technology adoption in the iron and steel sector, benchmarking against countries like Bangladesh, India, and Vietnam.

- **Brazil.** $415,000 for a Decarbonization Roadmap for the Industrial and Port Complex of Pecém. This includes prefeasibility studies for potential investments in decarbonizing large steel and cement industries, feeding into new $1.5 billion lending operations with Brazilian development banks.
- **East Asia and Pacific.** $300,000 for Industrial Decarbonization, aiming to catalyze investments through firm-level advisory in GHG-intensive sectors, focusing on construction materials (cement and steel) and chemicals (plastic, fertilizers).
- **South Asia.** $700,000 for Industrial Decarbonization pilot projects in **Bangladesh** and **India**, focusing on deploying innovative decarbonization technologies in heavy industries, starting with a market assessment.
- **Global.** $90,000 for Supporting the Global Scale-up of Energy Efficiency, contributing to a global study on scaling up energy efficiency in industries.

IMPACT STORY: CATALYZING SCALABLE INDUSTRIAL DECARBONIZATION TECHNOLOGIES IN INDIA

Industry decarbonization is a top priority in India, but the market is still in its early stages. With the country set to implement a carbon market in 2026, targeting heavy industries like steel, there is a pressing need for robust analytical work to drive progress.

ESMAP's **Industrial Decarbonization Program** is supporting India through the Catalyzing Scalable Industrial Decarbonization Technologies in India project, approved in FY2022. This grant aims to decarbonize India's hard-to-abate industries through several key activities.

These include developing financial models for using green ammonia, green hydrogen (H_2), and carbon capture and storage (CCS) in steelmaking; preparing India's Industrial Decarbonization Roadmap; conducting a prefeasibility study on hydrogen-based direct reduced iron (H_2-DRI)

green steel with an Indian state-owned enterprise steel company; and producing a report on the potential for electrifying heavy industrial processes.

The insights gained from these efforts have already informed the $1.5 billion India Second Low Carbon Energy Programmatic Development Policy Loan, approved in June 2024. This loan established a demand aggregation mechanism to scale up green hydrogen use in industries like fertilizers and refineries, helping bridge the cost gap between green and grey hydrogen. This initiative is anticipated to spur private sector investments in these sectors.

The project has facilitated early discussions with an Indian steel company about a potential World Bank loan, possibly blended with concessional climate funding, for investing in a green steel plant. It has also contributed to designing innovative financing mechanisms that the World Bank and the International Finance Corporation (IFC) could support to attract private sector finance for industrial decarbonization in India.

ESMAP and the Industrial Decarbonization Program will continue to support the World Bank team in India, potentially preparing World Bank Group lending operations to further catalyze private sector investment in this high-priority sector. Through these efforts, India is poised to make significant strides in reducing industrial emissions and leading the way in sustainable industrial practices.

GEOTHERMAL DIRECT USE PROGRAM

Over 60 percent of GHG emissions stems from sources other than electricity generation, including agriculture, industry, transportation, and individual or district heating and cooling. To cut these emissions, it is imperative to focus on decarbonizing these sectors, with an emphasis on expanding renewable heating solutions like geothermal energy. Direct geothermal use involves using heat energy or fluid directly from geothermal sources without converting it to another form, such as electricity.

The **Geothermal Direct Use Program**, launched by ESMAP in FY2021, aims to raise awareness about the economic and environmental benefits of direct geothermal energy use and build a supportive environment for its expansion. This program seeks to increase the adoption of geothermal resources by highlighting their role in creating economic opportunities and helping industries reduce emissions. Many countries encounter challenges such as resource risk, limited expertise, and knowledge gaps regarding geothermal energy as a viable alternative. To address these, the program facilitates capacity building and knowledge-sharing activities at both the regional and national level for sector experts, government officials, and other stakeholders.

FY2024 Highlights

- **Iceland study tour.** In FY2024, the ESMAP Geothermal Direct Use team conducted an event titled "Empowering Development Beyond Electricity Generation" alongside the Icelandic Geothermal Conference. Participants from 11 countries were invited to attend both the ESMAP event and the Icelandic Geothermal Conference. Examples were cited from the report published with SRMI, *Geothermal Energy: Unveiling the Socioeconomic Benefits*, including in El Salvador.

- **Türkiye.** Türkiye is a focal point for geothermal direct use, with two projects supported by the team expected to generate over 150 MW of thermal energy by 2025. The projects, one of which is the Agriculture Industrial Zone under construction, are crucial for enhancing the country's renewable energy capacity and supporting its decarbonization efforts. The program also provided a $400,000 grant to strengthen the capacity for renewable energy sources in the agriculture and food sectors in Türkiye. This activity supports the Türkiye Climate Smart and Competitive Agricultural Growth Projects, approved by the World Bank's board in March 2022. The ESMAP grant, approved in July 2023, supported the preparation of a feasibility report and review of tender documents. The project team has launched the tenders, and drilling is expected to commence in FY2025.
- **Georgia.** In FY2024, ESMAP approved a $700,000 grant for the Towards Sustainable Geothermal Heat in Georgia project. The objective is to reduce GHG emissions by increasing the use of indigenous geothermal energy sources to generate income. The grant finances a study to assess Georgia's geothermal resource potential and provide recommendations for optimal exploitation and resource sustainability. It will also establish the expected productivity of retired wells should they be brought back into operation and gauge the cost to restart them.

FOSTERING GREEN ENERGY TRANSITION AND CIRCULAR ECONOMY IN CENTRAL AMERICA

One of the most impactful initiatives of the **Geothermal Direct Use Program** throughout the FY2021–24 business plan cycle has been the support for geothermal sector opportunities in **Central America** and the **Dominican Republic**. Through a series of grants in FY2022 and FY2023, totaling $620,000 and focusing on **Costa Rica, El Salvador, Guatemala,** and **Honduras,** ESMAP contributed toward the green energy transition and fostered a circular economy in the region.

The primary goal of these efforts is to harness geothermal resources for direct industrial use, thereby reducing dependence on fossil fuels and supporting national decarbonization and industrial competitiveness initiatives. The project encompasses the development of legal and regulatory frameworks, conducting prefeasibility studies, assessing geothermal direct use potential (including heat pumps), and identifying geothermal opportunities.

Two prefeasibility studies on geothermal direct use potential in the El Salvadorian city Ahuachapán and municipality Conchagua made significant progress in FY2024. The studies, supported by the Icelandic Ministry for Foreign Affairs, led to additional requests to assist LaGeo, **El Salvador**'s geothermal energy company, in identifying drilling sites to evaluate both electrical and direct use potential. These ongoing studies have already provided valuable insights into the region's geothermal capabilities.

Complementing these efforts, the German development agency, Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ), conducted market-potential studies for direct use applications in the same locations. This collaboration between the World Bank and GIZ has been important for understanding the broader market dynamics and potential for geothermal energy in Central America. The joint studies have highlighted the feasibility and benefits of using geothermal resources for various industrial applications, including agricultural activities such as food drying. By providing technical assistance, fostering collaborations, and supporting innovative projects, these initiatives not only contribute to reducing GHG emissions but also promote economic resilience and industrial competitiveness.

In addition to these initiatives, the World Bank is preparing a new geothermal project for El Salvador, focusing on drilling activities for power generation. A small component of this project will also include using geothermal resources directly for socioeconomic engagement with local communities. This holistic approach ensures that the benefits of geothermal energy extend beyond mere power generation, fostering community development and economic growth.

Another notable achievement was the completion of a study investigating the market opportunities for geothermal heat pumps in Central America, with a special focus on El Salvador. The report demonstrated the potential of geothermal heat pumps, particularly for cooling institutions or industries with high cooling needs. Presented to relevant stakeholders in El Salvador, the findings have sparked interest and discussions on how to integrate these technologies into the country's energy landscape.

ESMAP's efforts in Central America exemplify the transformative potential of geothermal energy.

GREEN HYDROGEN SUPPORT PROGRAM

Green hydrogen, a gas produced from the electrolysis of water using electricity from wind, solar, or hydropower, can be a low-carbon energy carrier, especially for heavy industries such as steel and fertilizer production, shipping, and aviation. Replacing the use of fossil fuel with green hydrogen helps decarbonize such industries and reduce GHG emissions.

ESMAP's **Green Hydrogen Support Program's** mission is to raise awareness of green hydrogen's potential to decarbonize energy-consuming heavy industries and create economic opportunities in developing countries.

It assists governments of more than 20 countries in identifying opportunities and overcoming challenges in deploying green hydrogen. The program provides grants and technical assistance to help governments scale up green hydrogen projects. It collaborates with development partners in integrating technology, infrastructure, and energy systems, enabling policy frameworks and regulations, investments, financing, and procurement. Moreover, it examines the socioeconomic and sustainability impact of introducing green hydrogen solutions.

ESMAP also initiated and runs the **Hydrogen for Development Partnership (H4D)** as a global platform to accelerate clean hydrogen deployment by fostering the kind of international cooperation that is needed to offer tailored solutions for low- and middle-income countries, including knowledge sharing and capacity building. At end-FY2024, H4D had grown from 12 partners in November 2022 to 45.

FY2024 Highlights

Given that hydrogen markets are in their infancy in developing countries, ESMAP focused in FY2024 on helping countries put national hydrogen strategies in place and take first steps in implementing them, wherever possible. Examples include:

- ***Scaling Hydrogen Financing for Development***. This report, launched at COP28, in Dubai in November/December 2023, was prepared in cooperation with the Hydrogen Council, OECD, and the Global Infrastructure Facility. It outlines the opportunities, challenges, and solutions for financing clean hydrogen projects in emerging markets and developing countries.
- **India.** ESMAP helped put the country firmly on a path toward using green hydrogen to decarbonize its industrial and transport sectors. The team developed a green hydrogen roadmap, including technical deep dives and skill studies, and supported the Indian Ministry of New and Renewable Energy in drafting its green hydrogen hub policy. The efforts informed India's national green hydrogen roadmap and resulted in the World Bank's largest development policy operation of $3 billion to strengthen the policy and regulatory ecosystem across three pillars of green hydrogen, renewable energy, and access to low-cost financing.
- **Brazil.** ESMAP provided funding to support Brazil's Energy and Mines Ministry in implementing the country's national hydrogen strategy. Key areas include mapping the hydrogen value chain, identifying hubs, analyzing hydrogen production, and conducting prefeasibility studies for shared infrastructure, especially at the Port of Pecém in the state of Ceará.
- **Panama.** In Panama, ESMAP has supported the development of a strategic master plan for green hydrogen bunkering, with a focus on hydrogen legislation and capacity building. The July 2023 grant supports decarbonizing the energy, transport, and industrial sectors.
- **Mauritania.** An ESMAP grant is supporting Mauritania in identifying infrastructure needs for the deployment of renewable hydrogen projects while maximizing socioeconomic benefits and minimizing environmental, climate, and social impacts. During FY2024, ESMAP drafted the Mauritania hydrogen infrastructure study and socialized it among government and private sector stakeholders.

- **Namibia.** During FY2024, ESMAP supported Namibia in executing its green hydrogen strategy by preparing an implementation plan with a focus on creating an enabling framework, including adequate regulations to produce synthetic fuels. ESMAP delivered a hydrogen market sounding study and provided advice on fund structuring.

10 GW HYDROGEN LIGHTHOUSE INITIATIVE

To help accelerate the deployment of clean hydrogen, the World Bank, through ESMAP, is leading an action plan that includes the launch of a 10 GW Hydrogen Lighthouse Initiative. This initiative, launched at COP28, in November/December 2023 in Dubai, was developed by the World Bank in collaboration with partner financing institutions. It is designed to expand clean hydrogen production capacity in emerging markets and developing countries. The aim is to demonstrate the viability of clean hydrogen production by overcoming barriers to adoption, such as high costs and financial risks, and create scalable models that can be replicated across markets.

The 10 GW Hydrogen Lighthouse Initiative focuses on bringing to fruition clean hydrogen projects ranging in size from 100 MW to 1 GW. Collectively, they would increase global hydrogen electrolysis capacity tenfold. These projects would provide proof of concept that clean hydrogen can play a vital role in reducing emissions in sectors like steel production and long-haul transportation—industries that are difficult to decarbonize.

One of the most significant barriers to clean hydrogen's growth is its high production and financing costs, particularly in developing countries. ESMAP's role includes designing financing mechanisms to reduce these costs and de-risk projects. By addressing uncertainties around future buyers, pricing, and regulatory conditions, ESMAP aims to attract investment and encourage the development of clean hydrogen infrastructure. ESMAP is particularly focused on lowering financial risks, working with its partners to make clean hydrogen projects more commercially viable and thus paving the way for broader adoption. In FY2024 the World Bank approved 1.6 billion in funding for renewable hydrogen loans, in addition to the $1.65 billion approved in FY2023, bringing the total loan amount for hydrogen activities to $3.25 billion. Investments up to $3 billion are currently in preparation.

In partnership with other stakeholders, ESMAP is also developing a digital hub to support knowledge sharing, training, and technical assistance. The platform will serve as a resource for countries and stakeholders looking to implement clean hydrogen projects. It will also help connect governments, investors, and technical experts, promoting collaboration and enabling stakeholders to benefit from shared knowledge and expertise.

This work is closely tied to broader efforts by international partners to establish global standards and a transparent pricing system for clean hydrogen. The efforts aim to reduce transaction risks and create a more stable market. By working alongside organizations such as the OECD and the Hydrogen Council, ESMAP is helping lay the groundwork for a coordinated global approach to clean hydrogen development.

In addition to its environmental benefits, clean hydrogen offers socioeconomic advantages for developing countries. By becoming early adopters of this technology, these nations are helping achieve SDG7. In addition, hydrogen helps strengthen countries' energy security, create jobs, and foster economic growth. ESMAP's initiative aims to assist governments in tapping into these opportunities by providing the financial and technical support needed to build clean hydrogen capacity.

ZERO CARBON PUBLIC SECTOR PROGRAM

Up to 20 percent of an average country's energy consumption can be traced to public institutions and facilities, such as buildings, utilities, and public transport. By adopting innovative approaches, the public sector can lead the charge to a net-zero carbon future and contribute to market transformation through planning, policy, and procurement. Improved policy and regulation can substantially impact decarbonization in buildings, transport, and public services. While existing public buildings often have the potential to save 30 to 50 percent of their energy use, new public facilities can be constructed to meet even higher energy efficiency standards, which can also be replicated in the private sector.

ESMAP's **Zero Carbon Public Sector** (ZCPS) initiative aims to accelerate the uptake of energy-efficient and low-carbon solutions for public institutions in developing countries The initiative provides technical assistance to governments to help them decarbonize public buildings, public transport, street lighting, and utility services, such as district heating and cooling, water, sewage, and waste management.

Decarbonizing the Public Sector through Energy Efficiency and E-Mobility

In FY2024, the ZCPS program provided grants to 16 new projects, bringing the total number of supported projects to an aggregated amount of $9.02 million grants in all regions of the World Bank.

The activities focused on the decarbonization of buildings, transport, and utilities. By end-FY2024, ZCPS supported 39 active projects, two of which are already Board-approved WBG operations and another two are expected to be approved in FY2025.

FY2024 Highlights

- **Dominican Republic**
  - Supported the development of regulatory and policy frameworks for energy efficiency.
  - Provided recommendations for implementing the Energy Efficiency Law and National Energy Efficiency Award.
  - Conducted energy audits in 12 public buildings, for energy efficiency measures and rooftop solar installations.
- **Latin America and the Caribbean Region**
  - Completed studies on energy sector sustainability in **Argentina** and renewable energy challenges in **Paraguay.**
- **Malawi**
  - Developed an integrated national strategy for e-mobility, including an infrastructure assessment and a policy framework.
  - Supported the transition to electric vehicles, reducing CO_2 emissions and improving transportation efficiency.
- **Middle East and North Africa Region**
  - Unlocking electric mobility potential, including strategies for sustainable electric mobility and gender benefits.
  - Influenced the design and rollout of battery electric buses in **Egypt** as part of the Greater Cairo Air Pollution Management and Climate Change Project.
- **Tamil Nadu, India**
  - Aimed to reduce energy consumption and costs in affordable housing through energy efficiency and green building certification.
  - Supported technical assistance and capacity building for mainstreaming energy efficiency and climate resilience in housing regulations.
- **Tanzania**
  - Scaling up reliable, efficient, and renewable energy resources.
  - Focused on energy efficiency and demand-side management, including technical assistance for the Tanzania Energy Efficiency Action Plan.

UNLOCKING ELECTRIC MOBILITY POTENTIAL IN THE MNA REGION: A TRANSFORMATIVE JOURNEY

In a groundbreaking initiative supported by ESMAP, the World Bank embarked on a mission to unlock the electric mobility development potential in the Middle East and North Africa (MNA) region. This initiative, part of the project Disruptive Energy Transition and Opportunities for Job Creation and Electric Mobility in MNA, aimed to develop strategies and solutions to scale up the implementation of a sustainable electric mobility agenda.

The study focuses on several key aspects, including the assessment of sustainable mobile cooling and the exploration of gender benefits associated with electric mobility. By identifying the most effective interventions and recommending actionable steps, the initiative made possible

a number of country-specific loan operations, particularly targeting the electrification of bus corridors to promote sustainable mobility.

The findings of this comprehensive study were published in November 2023. These insights were instrumental in enhancing the design and rollout plan for battery electric buses as part of the Greater Cairo Air Pollution Management and Climate Change Project in **Egypt**. This project, which was approved in FY2021 with an IBRD loan of $200 million, aimed to greatly improve air quality and address climate change challenges in Greater Cairo.

The electrification of transport emerged as one of the most promising and readily deployable solutions to accelerate decarbonization and energy transition. The e-buses, part of the Greater Cairo project, will help the city make the transition toward a greener, more livable environment. Public transport played a crucial role: after energy, transport was Egypt's second-largest producer of GHG emissions. Modern and reliable e-buses encouraged commuters to shift from cars to buses, substantially reducing transport emissions.

In Cairo, air pollution was one of the city's biggest environmental health issues. Every year, as many as 2 million people sought medical treatment for respiratory problems related to poor air quality. The levels of fine particulate matter, which pose great human health risk, were several times higher than levels recommended by the World Health Organization (WHO). These health issues carried hefty economic costs, equivalent to about 1.4 percent of Egypt's gross domestic product (GDP) each year. The project underscored the importance of sustainable transportation solutions in mitigating health risks and climate change, enhancing energy efficiency, and developing economic opportunities, including job creation.

SECTION II OUR IMPACT IN FY2024

CLEAN COOKING

About a third of the global population—about 2.1 billion people—cook using open fires or inefficient stoves fueled by kerosene, wood, animal dung, crop waste, or coal. This generates harmful household air pollution, leading to millions of deaths each year, including over 230,000 deaths of children younger than 5 (WHO 2020; *Tracking SDG7*). But the practice of using fossil fuels for cooking, particularly acute in Sub-Saharan Africa and South Asia, does not only impact people's health. It also affects the environment, exacerbates climate change, and deepens gender inequality.

Health Impacts

The use of traditional biomass fuels for cooking leads to household air pollution, which is a major health hazard. It is estimated that household air pollution from cooking with solid fuels causes about 3.2 million premature deaths annually, primarily from respiratory and cardiovascular diseases. Women and children are disproportionately affected, as they spend more time near cooking areas.

Environmental and Climate Impacts

The environmental impact of traditional cooking methods is substantial. The burning of biomass fuels contributes to deforestation, forest degradation, and increased GHG emissions. The production and use of charcoal are significant drivers of cutting down trees in many developing countries. Moreover, the inefficient burning of these fuels releases black carbon, a potent climate pollutant.

Gender Inequality

The burden of collecting biomass fuels often falls on women and children, leading to significant time poverty and limiting opportunities for education and economic activities. This gendered division of labor exacerbates inequality and hinders women's empowerment.

Economic Costs

The economic cost of inaction is staggering. The World Bank estimates that the lack of access to clean cooking costs the global economy $2.4 trillion annually. This includes health costs, lost productivity, and environmental degradation. Without accelerated action, *Tracking SDG7: The Progress Report 2024* estimates, 1.8 billion people will not have access to clean cooking technologies by 2030.

Progress and Challenges

There has been some progress in increasing access to clean cooking appliances using green and renewable energy sources such as solar power, biogas, and ethanol or highly efficient cookstoves using liquefied petroleum gas (LPG). However, that progress has been uneven. The number of people without access to clean cooking has continued to rise in Sub-Saharan Africa due to population growth and economic challenges. The COVID-19 pandemic further exacerbated the situation by reducing incomes and increasing the prices of LPG and other clean cooking fuels (ESMAP 2022).

Policy and Investment Needs

Achieving universal access to clean cooking by 2030, a target of SDG7, requires significant policy interventions and investments. Governments need to prioritize clean cooking in their energy planning and provide financial incentives to encourage the adoption of clean cooking technologies. This includes conditional cash transfers, results-based grants, and subsidies for clean cooking equipment (World Bank 2021).

ESMAP's Work

At the 2019 UN Climate Action Summit, ESMAP launched its $500 million **Clean Cooking Fund**—the first such fund to increase investments in the clean cooking sector. The fund aims to scale up public and private investments by co-financing with multilateral development banks, catalyzing technology and business innovation, and linking

incentives to verified results. In FY2024, ESMAP launched CCF 2.0, which will replicate and expand technical support for the timely design and implementation of projects, develop new replicable instruments for hard-to-reach populations with no or low income, and coordinate resources to bridge the gap between the clean cooking knowledge ecosystem and demand in the field.

CLEAN COOKING

ESMAP's **Clean Cooking Fund** (CCF) aims to galvanize political commitment, scale up public and private investment, and catalyze innovation in clean cooking where people use cleaner, non-air polluting fuels and energy-efficient modern stoves. The fund addresses deeply entrenched gender norms, consumer preferences, and behavioral aspects related to cooking practices. The CCF provides:

- Upstream support by integrating clean cooking into World Bank strategy documents, such as Energy Compacts, Country Climate and Development Reports, and Systematic Country Diagnostics that guide Country Partnership Frameworks.
- Midstream support by providing data, tools, technical advice, and operational design.
- Downstream support by co-financing World Bank lending operations.

During FY2021–24, the CCF provided grants for 42 activities, with a focus on improving the enabling environment for clean cooking solutions, identifying and preparing lending projects with sizable clean cooking investments, and supporting the implementation of CCF-cofinanced investment projects. The CCF has also established a global pipeline with projects being prepared in Sub-Saharan Africa, South Asia, and Latin America and the Caribbean.

FY2024 Highlights

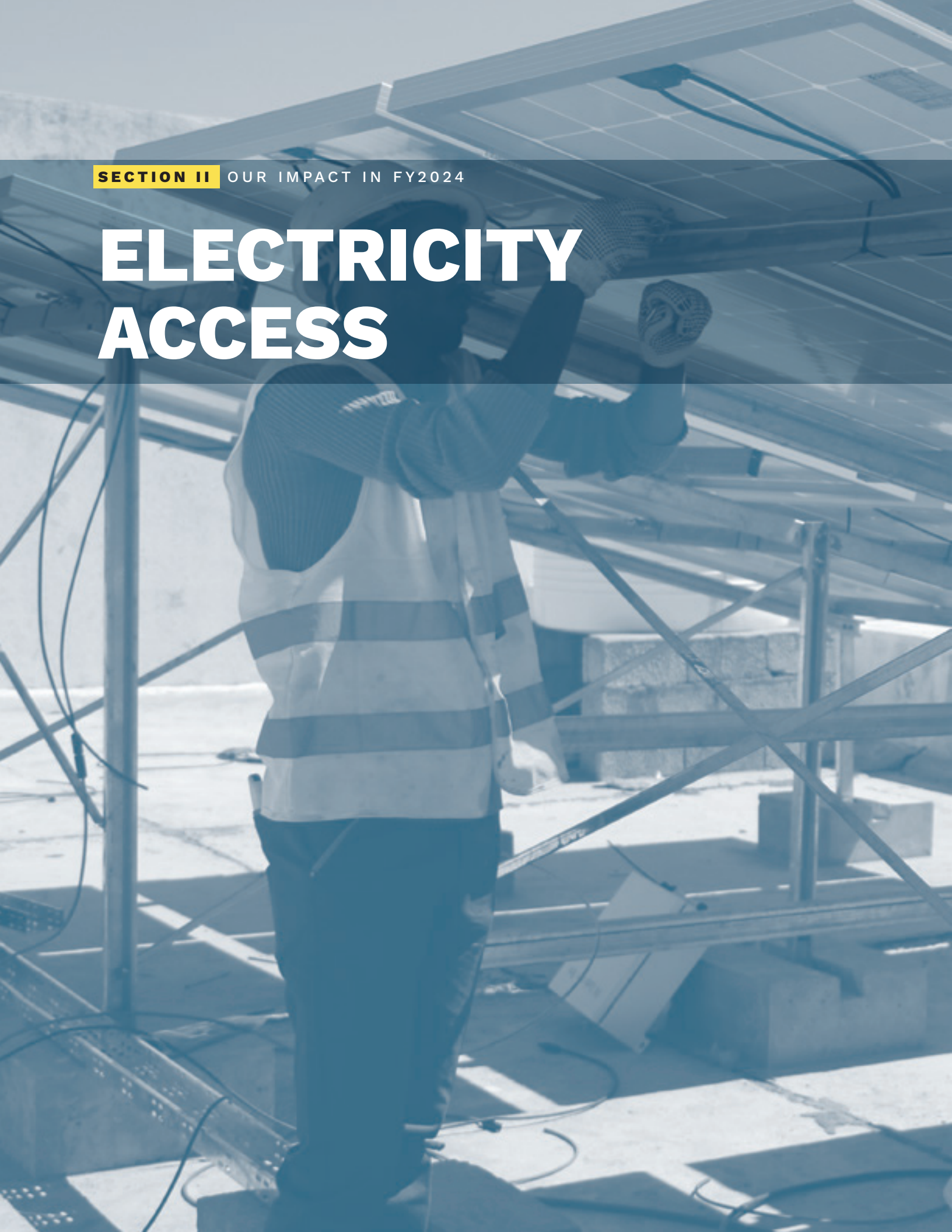
- **Rwanda.** ESMAP provided $10 million in cofinancing for clean cooking activities, contributing to an overall $20 million clean cooking operation with IDA cofinancing under the Rwanda Energy Access Quality Improvement Project (EAQIP). The project also received $3.15 million from ESMAP to support clean cooking in schools. EAQIP has made significant progress, as the Development Bank of Rwanda has signed grant subsidiary agreements with 20 clean cooking companies, resulting in the installation of about 310,000 clean cooking solutions and benefiting over 1.2 million people. The bank has disbursed about $4.1 million as results-based grants to clean cooking companies. Awareness-raising campaigns have produced two documentary films, radio talk shows, flyers, and other communications materials.
- **Ghana.** The CCF provided a $2.5 million grant, which leveraged $5 million in IDA cofinancing to support the institutional cooking program in schools under the Ghana Productive Safety Nets Project 2. With ESMAP CCF's support, the project will equip 1,500 schools in low-income communities with facilities for hygienic and fuel-efficient cooking. This will provide safer and more environmentally friendly cooking environments for about 4,350 caterers, almost all of whom are women, and 450,000 children in these schools.
- **Clean Cooking in schools.** The program published a report on *The State of Cooking Energy Access in Schools*, which shows that in developing countries, most school meals are prepared using rudimentary, polluting biomass stove-and-fuel combinations, with unknown costs to the health of students and personnel, school finances, and the local environment. The report's key recommended actions include stepping up governments' role, leveraging lessons from the household cooking sector, and harnessing the institutional advantages of schools.
- **Knowledge Café.** ESMAP's Clean Cooking team organized at the World Bank Spring Meetings in 2024 a Knowledge Café on "Clean Cooking at the Heart of Access," featuring panelists from Malawi, the Netherlands, Sierra Leone, the Clean Cooking Alliance, and the University of Loughborough.

CLEAN COOKING: AN INTEGRAL PART OF ASCENT

Accelerating access to clean cooking is an integral part of sustainable, reliable, and clean energy service. Maximizing synergies with electricity access and providing dedicated support to overcome barriers to clean cooking are key principles of integrating the clean cooking agenda into Accelerating Sustainable and Clean Energy Access Transformation (ASCENT) (see Special Section on Electricity Access). Through a $10 million grant, the CCF is cofinancing the clean cooking activities under ASCENT to support a regional results-based financing (RBF) facility to accelerate clean cooking expansion into markets that are unserved or underserved by national RBF programs. ASCENT aims to mobilize $200 million in development financing to unlock at least $400 million in private investment and help 20 million people access clean cooking.

The RBF payments will partially offset the initial costs and risks associated with companies expanding their operations and setting up sales and service infrastructure in new regions. The payments will also help bridge the affordability gap, incentivizing the private sector to serve more underserved areas while keeping end-user prices affordable.

ELECTRICITY ACCESS



At the current pace of energy access expansion, an estimated 660 million people will still be without access to electricity by 2030. Moreover, 1.7 billion people will be without access to clean cooking solutions, with disproportionate impacts on women and girls, particularly in Africa. Communities lacking electricity access are harder to reach, as they typically live in more remote areas, have lower disposable incomes, and are frequently affected by fragility, conflict, and violence (FCV). There is an urgent need for accelerated and targeted interventions, leveraging innovative technologies, increased private sector participation, and stronger partnerships to ensure that the most vulnerable populations are not left behind in the global push for universal energy access.

The Role of Decentralized Renewable Energy Solutions

In the push for universal electricity access, decentralized renewable energy solutions are playing an ever-greater role. Results from least-cost modeling suggest that of 439 million new connections between 2022 and 2030, 44 percent will come from standalone solar PV and a further 24 million (3 percent) from mini grids. They provide a more cost-effective solution compared with providing power from a central point through grid expansion, as they can be quickly deployed to meet lower levels of demand.

ESMAP Energy Access Program

In FY2024, the ESMAP **Energy Access Program** informed several World Bank lending operations, promoted knowledge development and dissemination, entered new partnerships, and supported global advocacy for energy access. Specifically, the program supported a total of 30 activities comprising a grant amount of $40.9 million, while the **Clean Cooking Fund** supported a total of 13 activities with a grant amount of $23.5 million. Sub-Saharan Africa received the majority of the total financing, including recipient-executed grants.

Priorities

One of the priorities of the Electricity Access Program during the FY2021−24 business plan was to address the growing electrification challenge posed by FCV situations, with particular attention to the needs of displaced people and their host communities. Because 75 percent of the people without access to electricity reside in FCV areas, most of ESMAP's new engagements have been in such countries, which require complex, tailored interventions.

Moving Forward

In FY2024, Sub-Saharan Africa continued to be the largest regional recipient of ESMAP's support. The region has a particularly immense need: to tackle its 83 percent of the global access deficit. ESMAP's support aligns with the World Bank's renewed commitment to accelerating energy access in Sub-Saharan Africa through the Bank's recent partnership with the African Development Bank to connect 300 million people in Africa with electricity access by 2030 under the Mission 300 (M300) agenda. Leveraging IDA financing to engage the private sector and mobilizing capital can help close the gap in electricity service provision. Also, many projects are focused on expanding energy access to vulnerable and underserved populations through innovative business models. Finally, there is a push to implement data-driven and technological solutions in electrification policies and programs.

INTEGRATED ELECTRIFICATION STRATEGIES AND PLANNING

ESMAP's **Integrated Electrification Strategies and Planning** (IESP) program was established to enhance the capacity of countries struggling with electricity access to develop and execute national electrification strategies and cost-effective electrification plans. IESP offers technical assistance and operational support to governments in geospatial electrification planning, which includes national least-cost plans, the creation of geospatial-based mini grid investment portfolios, and analytics for electrifying public institutions such as schools and clinics. The program also manages the Global Electrification Platform (GEP), which provides least-cost electrification plans for 58 countries with different scenarios. GEP is the first open source, online, interactive platform that offers a high-level investment outlook aimed at achieving universal electricity access by 2030.

Global Electrification Platform 3.0: Integrating Climate and Access

In FY2024, the **Global Electrification Platform** reached a significant milestone with the completion of version 3.0. This version uniquely incorporated the impact of carbon pricing on the least-cost pathways to universal electricity access. The platform, vetted by climate change and energy experts, represents the first unified approach to integrating electricity access planning with climate considerations in a way that specifies the exact location of each object of interest. GEP 3.0 was instrumental in providing data and analysis for the *Tracking SDG7: Energy Progress Report 2024,* highlighting least-cost options for electricity access and supporting climate advocacy efforts.

Responsible Data Sharing Framework for Distributed Renewable Energy

IESP, in collaboration with ESMAP's **Energy Data and Analytics program**, finalized a new Responsible Data Sharing Framework and corresponding Data Sharing Agreement. The framework sets standards for the secure and responsible handling of data from mini grid operators, solar home system distributors, and solar-powered productive-use equipment. The initial implementation took place in the context of Nigeria Distributed Access through Renewable Energy Scale-up (DARES), with plans to expand to other markets. The initiative ensured that data across distributed renewable energy programs was shared and used responsibly, promoting transparency and security.

Geospatial Platform for Mini Grid Development

The ESMAP team created a specialized geospatial platform for mini grid development, covering 58 countries. Initially used for mini grid site identification and assessment, the platform's applications expanded to include grant calibration for off-grid solar and catchment area analyses for sectors such as health, education, financial inclusion, and transport. The public launch of this platform is planned for December 2024, offering a valuable tool for various stakeholders in the energy sector.

GLOBAL FACILITY ON MINI GRIDS

ESMAP's **Global Facility on Mini Grids** (GFMG) works to increase the deployment of mini grids as part of World Bank operations and client country electrification programs. The GFMG has helped expand mini grids from a niche solution to a mainstream solution, with an emphasis on robust national and international markets and policies driving the sector's growth to provide large numbers of people with access to high-quality, affordable electricity. With the GFMG's direct, hands-on support, the World Bank portfolio of projects with mini grid components has grown exponentially over the past 7 years and currently includes 28 ongoing projects in 26 countries, totaling nearly $1.9 billion and leveraging another $1 billion in partner and private sector co-financing. The GFMG is collaborating with IFC, the Multilateral Investment Guarantee Agency (MIGA), and IDA operations teams to accelerate private sector investment in mini grids, also as part of Mission 300.

HAITI: POWERING UP COMMUNITIES IN FRAGILE AND CONFLICT-AFFECTED AREAS

Haiti, known for its unreliable grid infrastructure, is making strides toward sustainable electrification. ESMAP's off-grid work in Haiti has been transformative in expanding access to clean and modern energy services, particularly in areas not served by the national electricity grid. The Renewable Energy for All project, a key initiative supported by ESMAP, focuses on deploying a variety of off-grid electrification options to reach underserved households, communities, and enterprises.

The project includes several components aimed at different aspects of off-grid energy solutions, including renewable energy mini grids, productive and community uses, standalone off-grid solar products, and mesh grids. These efforts have significantly increased energy access, benefiting over 130,000 people to date.

Renewable Energy for All also provided off-grid solar power to five hospitals and two regional testing laboratories. In a country with fragile government and security challenges, these installations have ensured continuous delivery of essential health services, underscoring the value of clean energy in fragile state contexts.

FY2024 Highlights

- **Framework contract with the Africa Mini Grid Developers Association (AMDA).** ESMAP has established a framework contract with the AMDA to support several initiatives, including data gathering, market research, organizing joint events, advocating for the mini grid sector, and building capacity among local and international mini grid companies.
- **Collaboration with the CrossBoundary Innovation Lab.** In **Ethiopia**, ESMAP is piloting a project in partnership with the CrossBoundary Innovation Lab, showcasing productive and income-generating appliances in communities that have recently been connected to mini grids.
- **Development of the Odyssey digital platform.** ESMAP has partnered with the Odyssey software platform to enhance the program's digital tools for distributed renewable energy financing programs. The Odyssey platform, which has already been used for managing results-based financing programs, e-tendering windows, and grant management, plays a crucial role in advancing mini grid and off-grid projects in multiple countries in the World Bank's portfolio, including Burkina Faso, Democratic Republic of Congo, Lesotho, Madagascar, and Nigeria.
- **Report on Nigeria and India Mini Grids.** The Mini Grid team produced the report *Mini Grid Solutions for Underserved Customers: New Insights from Nigeria and India*, which explores undergrid mini grids. These are mostly solar hybrid-powered mini grids built and operated by private companies in areas already connected with the main electricity grid but facing poor technical and commercial service. The report examines how undergrid mini grids can create win-win-win outcomes for retail customers, distribution enterprises, and mini grid developers. The report showcases detailed case studies from India and Nigeria, shedding light on the challenges and opportunities of interconnected and non-interconnected undergrid mini grids.

OFF-GRID SOLAR/LIGHTING GLOBAL

ESMAP's **Off-Grid Solar Energy Access Program**, previously known as Lighting Global, is the World Bank's initiative to rapidly increase access to off-grid solar energy for the hundreds of millions of people worldwide living without electricity. For more than 15 years, ESMAP has been advising World Bank Energy Access teams, working with governments, the private sector, development partners, and end-users, continually innovating to overcome market barriers and enable affordable access to off-grid solar electrification to those who would otherwise be left behind. ESMAP's efforts have already impacted more than 300 million people and have helped create markets, enabling environments, and built capacity, kickstarting a market that continues to grow and deliver on the potential of the off-grid sector.

In recent years, ESMAP's support to off-grid solar electrification has expanded to technologies that go far beyond lighting, including standalone solar systems to power the needs of households, farms, businesses, schools, health centers, and more. The three primary beneficiaries are households, businesses, and public institutions.

FY2024 Highlights

- **Verasol Quality Assurance.** ESMAP-funded VeraSol sets quality standards, promotes high-quality off-grid solar products, and fosters the adoption of harmonized policies. In FY2024, VeraSol worked with the International Electrotechnical Commission and sector stakeholders to revise test methods and standards for solar energy kits, as well as off-grid and weak-grid refrigerators. It provided technical assistance to 11 national governments—Benin, Burundi, Cameroon, Democratic Republic of Congo, Ethiopia, Liberia, Madagascar, Nigeria, Papua New Guinea, Sierra Leone, and Uganda—and two regional bodies, the Economic Community of West African States and

the Common Market for Eastern and Southern Africa, to adopt and implement international standards for off-grid solar products. VeraSol is expanding quality assurance for appliances by developing a framework to evaluate the quality of off-grid cooling products, including refrigerators and walk-in cold rooms, and has provided cooling technical assistance to World Bank programs in Nigeria and Kenya. VeraSol extended technical assistance to the government of Uganda to develop bidding documents for selecting energy service companies to electrify health facilities and schools under long-term energy service contracts. This is an innovative business model to allow private sector participation in the electrification of public institutions. In 2023 alone, approximately 8 million units of VeraSol-certified off-grid solar products were sold globally, serving more than 99 million people.

VERASOL SUPPORT IN PAPUA NEW GUINEA

Since 2014, VeraSol has supported Papua New Guinea (PNG) and its development partners in establishing a national quality assurance framework for solar energy kits. Key contributions include developing tender documents, conducting technical evaluations, and creating a national roadmap for quality standards adoption. VeraSol led stakeholder workshops, provided technical assistance for adopting the IEC standard in 2022, and delivered an action plan for implementation. Additional efforts include issuing procurement guidance through USAID and ongoing collaboration with PNG institutions and partners to implement and maintain the quality assurance framework.

- **E-Waste Management Toolkit.** ESMAP finalized the *Off-Grid Solar E-Waste Management Toolkit* in FY2024. The objective of the toolkit is to provide World Bank project teams and counterpart governments with the information and tools needed to develop appropriate environmental instruments and policies/regulations relevant to e-waste management for off-grid solar projects. The toolkit covers a range of standalone off-grid solar solutions, including household solar lights and home systems, income-generating uses, and electrification of public facilities.
- ***Designing Responsible End-User Subsidies for Energy Access: A toolkit featuring case studies for the design of subsidies in off-grid solar and clean cooking*.** ESMAP collaborated with GOGLA, the Clean Cooking Alliance, and EnDev to develop this toolkit in FY2024. It provides insights into the design and implementation of end-user subsidy programs for off-grid solar and clean cooking solutions, which can improve access, especially in Sub-Saharan Africa, where affordability is a key barrier. The document is centered on a design framework that has been developed based on learnings from end-user subsidy programs to date and uses examples and case studies where relevant.
- ***The Off-Grid Solar Policy Toolkit: Supporting Inter-Ministerial Collaboration to Advance Energy Access, Digital Transformation, and Financial Inclusion*.** Together with the Public-Private Infrastructure Advisory Facility, the Digital Development Partnership, and Strategic Impact Advisors, ESMAP developed this toolkit to assist governments in creating an enabling environment for off-grid solar and pay-as-you-go sector growth by establishing policy reforms determined through a structured process of interministerial policy dialogue. It identifies 12 key policy issues and considers the advantages and disadvantages of different policy approaches to each issue. The toolkit then outlines a step-by-step process that governments can use to facilitate policy dialogue, providing guidance and tools at each step. This process envisions a scenario where government ministries and agencies work together to advance policy reforms that accelerate progress in energy access, digital inclusion, and financial inclusion.

THE LONG-TERM SERVICE-BASED MODEL IS HELPING (EM)POWER COMMUNITIES

In 2020, nearly 280,000 women around the world died from childbirth, 95 percent of them in low-income countries—where a 15-year-old girl has a 1 in 49 lifetime risk of dying from a maternal cause. Contributing to these statistics is the reality that nearly 1 billion people in low- and lower-middle-income countries are served by health facilities lacking reliable electricity, meaning critical interventions including labor and delivery are often performed in the dark.

Electricity is critical to delivering essential community services like health care and education safely and effectively. In remote and rural areas, off-grid solar systems can be deployed with relative ease and at a low cost and can provide clean electrification around the clock. But without regular maintenance of these systems, communities can quickly be left right back in the dark.

ESMAP's off-grid solar energy access team has thus been working with partners to procure long-term service contracts for the installation of off-grid solar systems in public institutions. Under these arrangements, solar companies will maintain the off-grid solar systems in exchange for regular payments for reliable electricity service. This model incentivizes companies to install, operate, and maintain high-functioning solar systems that communities can rely on.

ESMAP'S CONTRIBUTIONS TO OFF-GRID SOLAR ELECTRIFICATION SINCE 2009

Since kicking off its first off-grid solar pilot program in Kenya in 2009, ESMAP has been at the forefront of expanding access to off-grid solar services to people living without access to electricity. Through its activities (including previously in partnership with IFC under the Lighting Africa and Lighting Global programs), ESMAP has helped enable off-grid energy access to tens of millions of people, reduced GHG emissions, and informed World Bank lending and government policies.

OVERALL IMPACT

Over 300 million

people benefited from products meeting Lighting Global / VeraSol Quality Standards between 2009 and 2022. [2]

63.1 million

products meeting Lighting Global / VeraSol Quality Standards were sold between 2009 and 2022.

78.3 million

metric tons of CO_2e have been avoided due to the use of products meeting Lighting Global/ VeraSol Quality Standards. This is the emissions equivalent of taking over 20 coal-fired power plants offline for a year. [EPA calculator]. [3]

POLICY & WORLD BANK OPERATIONS

28

Countries have adopted IEC Quality Standards based on those developed by ESMAP, for off-grid solar energy kits: China, the Democratic Republic of Congo (DRC), Ethiopia, Kenya, Madagascar, Malawi, Pakistan, Papua New Guinea, Rwanda, Tanzania, Uganda, Zambia, Zimbabwe, and ECOWAS' 15 member states — Benin, Burkina Faso, Cape Verde, Côte d'Ivoire, Gambia, Guinea, Guinea-Bissau, Liberia, Mali, Niger, Nigeria, Senegal, Sierra Leone, and Togo).

2/3+

of Sub-Saharan African countries had World Bank projects with an off-grid solar component, approved between 2015 and 2022.

$2.6 billion+

has been approved by the World Bank since July 2015 to accelerate the adoption of off-grid solar, including technical assistance.

QUALITY ASSURANCE

The International Electrotechnical Commission (IEC) adopted Lighting Global's test methods as a reference point for quality assurance for off-grid solar products up to 350W under Tech Spec 62257-9-5, the only internationally recognized standards for these products.

The United Nations Framework on Climate Change (UNFCC) required that solar lighting products must be tested to IEC Tech Spec 62257-9-5 in order to qualify for carbon financing (CDM).

VeraSol, an evolution of Lighting Global Quality Assurance, was launched in 2020. The program is operated by CLASP in partnership with the Schatz Energy Research Center.

IMPROVING LIVELIHOODS AND HUMAN CAPITAL

ESMAP's **Improving Livelihoods and Human Capital** (ILHC) program was launched during the COVID-19 crisis to support the World Bank's pandemic response and post-pandemic recovery. It promotes the income-generating use (often referred to as "productive use") of electricity and the electrification of public institutions. The program aims to restore livelihoods, create jobs, and generate income to enhance the development impacts of energy access programs. It also supports local initiatives and grassroots entrepreneurship by leveraging renewable energy for productive uses.

ESMAP is enhancing energy access for farmers, businesses, and public institutions by systematizing cross-sectoral work through collaboration across areas such as agriculture, water, health, education, and digital services. This global effort aims to inspire similar national-level cooperation, strengthening countries' energy access initiatives. An example is a project mapping electricity access for public institutions to build global knowledge.

ESMAP also focuses on sustainable energy solutions for public institutions through solar power. To address the issue of failing off-grid solar systems due to poor maintenance, ESMAP is collaborating with IFC and MIGA to design a new business model using the Energy as a Service approach to engage private energy service companies to electrify public institutions. ESMAP is also supporting MIGA in developing a new risk mitigation instrument. In addition, ESMAP is coordinating with the World Bank Health and Education teams to ensure Bank support is extended to education and health ministries to make adequate budgetary provisions for timely payment to the electricity service providers.

LEAVE NO ONE BEHIND

At the end of 2023, over 120 million people were forcibly displaced worldwide, mostly in low-income countries with limited resources and inadequate energy infrastructure. This situation makes achieving SDG7 targets significantly more difficult and leaves displaced people and their host communities vulnerable.

ESMAP's Leave No One Behind (LNBH) program addresses these challenges by developing sustainable energy strategies for these people and communities. The program aims to integrate displaced people, improve their quality of life and economic prospects, and achieve universal electricity access by 2030. LNBH conducts electricity needs assessments and develops solutions with national utilities and off-grid companies. It focuses on energy for personal needs, camp infrastructure, and productive activities, reducing risks like gender-based violence. LNBH activities also aim to close data gaps, design appropriate projects, improve implementation capacity, and ensure the success and scalability of operations.

FY2024 Highlights

- **Electrification needs of Indigenous People in Panama.** LNBH supports Panama's government in assessing electrification needs for indigenous communities, aligning with the National Strategy for Universal Access to Electricity and the Indigenous People's Development Plan. The focus includes gender inclusion, training indigenous women in PV system installation and maintenance.
- **Electricity access for displaced communities in Mauritania.** LNBH identified host communities and conducted a feasibility study for a hybrid solar and diesel power plant to serve the Mberra refugee camp, home to 130,000 refugees, and the neighboring community of Bassiknou, with 15,000 people. The project,

in collaboration with the United Nations Refugee Agency, will be part of the Mauritania Universal Access Roadmap in FY2026 and support a new lending operation in FY2025. Fundraising is in progress for phase 2 expansion.

- **Energy access roadmap for host communities and displaced people in Bangladesh.** LNBH helped develop a roadmap to guide energy sector activities in Rohingya refugee camps and host communities, shaping major investment projects like the Emergency Multisector Rohingya Crisis Response Project, which will deploy 100 solar nano grids. It also will support future projects like the Host and Rohingya Enhancement of Lives Through a Multi-Sectoral Approach.
- **Energy access assessment for host communities and displaced people in the Lake Chad and Sahel regions.** LNBH funded an assessment of electricity access in the Lake Chad Basin, influencing energy access strategies and the Chad Energy Access Scale-Up Project. A field assessment in the Sahel highlighted severe energy access issues, emphasizing the need for improved energy solutions for refugees, host communities, and particularly for women and children.

FINANCIAL INNOVATION FOR ENERGY ACCESS

Innovative financing is required to improve access to electricity for society's most vulnerable and disadvantaged people. Existing market incentives without adequately targeted interventions are insufficient for the private sector to extend solutions to hard-to-reach populations. The right incentives and implementation tools are needed to help deliver electricity services and address affordability constraints for end-users. ESMAP's **Financial Innovation for Energy Access** program supports the development and testing of financing instruments and implementation models to drive energy access acceleration, inclusion, and impact across all electricity systems and solutions.

FY2024 Highlights

- **End-User Subsidy Toolkit and Subsidy Lab.** In FY2024, the program launched two significant resources to enhance subsidy programs for decentralized renewable technologies: the End-User Subsidy Toolkit and the End-User Subsidy Lab.

  The End-User Subsidy Toolkit provides a comprehensive guide on designing responsible end-user subsidies for energy access, particularly in off-grid solar and clean cooking. It features case studies and best practices to aid governments and development agencies in creating effective subsidy programs.

  The End-User Subsidy Lab serves as a platform for knowledge sharing among partners like EnDev, GOGLA, and the Clean Cooking Alliance to promote well-designed, market-friendly subsidies.

  ESMAP has collaborated with EnDev to design subsidy pilot projects in Malawi, Uganda, Liberia, and Niger, with the first three projects now in implementation, and is ensuring these pilots inform World Bank lending operations. Through the Subsidy Lab, ESMAP has also provided high-level support for designing end-user subsidies as part of World Bank energy access projects in Madagascar, Malawi, Nigeria, and Uganda.

- **Digital Financial Innovation for Power Utilities.** The program completed a new internal technical note on Digital Financial Innovation for Power Utilities. The note explains how digital payment methods, like mobile money and electronic transfers, can benefit utilities. These technologies help lower operating costs, reduce electricity losses, and improve payment collection. For customers, digital payments offer a safer, more convenient way to pay for electricity and can help align payments with income, ultimately supporting financial inclusion and improved access to energy.


M-PESA
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ESMAP AT THE HEART OF MISSION 300

On April 17, 2024, the World Bank Group and the African Development Bank committed to providing at least 300 million people in Africa with electricity access by 2030. The World Bank alone pledged to electrify 250 million people. The project is known as Mission 300 (M300).

ESMAP and Mission 300

The World Bank's ability to make this commitment is the result of years of preparatory work and previous operations focused on energy access in Africa, many of which benefited from significant ESMAP contributions. For years, ESMAP has been working closely with World Bank energy teams in Africa to build government capacity, collect and disseminate expert knowledge on renewable energy, prepare least-cost energy access plans, support changes in legislation, build the lending pipeline, and implement projects. During ESMAP's FY2021–24 Business Plan alone, ESMAP's electricity access programs supported 182 World Bank energy access activities, comprising a grant volume of $97.2 million.

In January 2025, as part of Mission 300, 15 countries will announce their Electrification Compacts, which will provide details on how they plan to accelerate connections. ESMAP is helping them develop national electrification strategies and least-cost electrification plans, which will be the basis for the Electrification Compacts.

Mission 300 is welcoming other partner organizations to help reach its ambitious goal. ESMAP donors have answered the call, as have new partners, such as the Rockefeller Foundation and the Global Energy Alliance for People and Planet. While partner support is taking different shapes, ESMAP is the conduit for external financing contributions. Funding provided through ESMAP goes directly to technical assistance and training for African governments, preparatory studies for projects, and project financing.

ESMAP as the World Bank's Spearhead for Access to Clean Energy

While the World Bank has a long history of financing electricity grid projects in client countries, ESMAP took a leadership position in providing access to clean energy and guided the institution toward clean energy solutions in access projects.

ESMAP financing and cross-support enabled milestone access projects such as the Nigeria Electrification Project (NEP) and the Kenya National Electrification Strategy (KNES). NEP, launched in 2018, focused on providing electricity to unserved and underserved communities through renewable energy solutions, including standalone solar systems and mini grids. As of November 2024, the project had provided electricity to close to 5.9 million people through 173 mini grids and almost 1.2 million standalone solar systems. Moreover, solar hybrid power solutions were installed at 100 COVID-19 isolation and treatment centers. The project demonstrated significant private sector interest, with 81 mini grid developers and 52 standalone solar distributors qualified under the program, contributing to the development of renewable energy infrastructure in Nigeria.

ESMAP played a crucial role in the NEP by providing technical assistance and rapid response advisory services. ESMAP supported the preparation of the project, reviewed the rural electrification strategy, guided mini grid regulations, and conducted geospatial mini grid portfolio analysis.

The Kenyan government launched KNES in 2018 with World Bank support to accelerate universal access to electricity in the country through a mix of grid and off-grid solutions. KNES significantly increased electricity access in Kenya, leading to a 75 percent electrification ratio by 2021, up from 20 percent in 2013. ESMAP played a pivotal role in the strategy's development and execution, delivering technical assistance and advisory services, including geospatial analyses for mini grid portfolio planning, reviewing rural electrification implementation strategies, and facilitating stakeholder workshops.

ASCENT and DARES

These milestone projects provided the foundation for game-changer programs at the center of Mission 300: the Accelerating Sustainable and Clean Energy Access Transformation (ASCENT) program and the Distributed Access through Renewable Energy Scale-Up Platform (DARES).

ASCENT, with $5 billion in IDA financing, aims to provide energy access to 100 million people across up to 20 countries in Sub-Saharan Africa to provide universal energy access and promote clean energy.

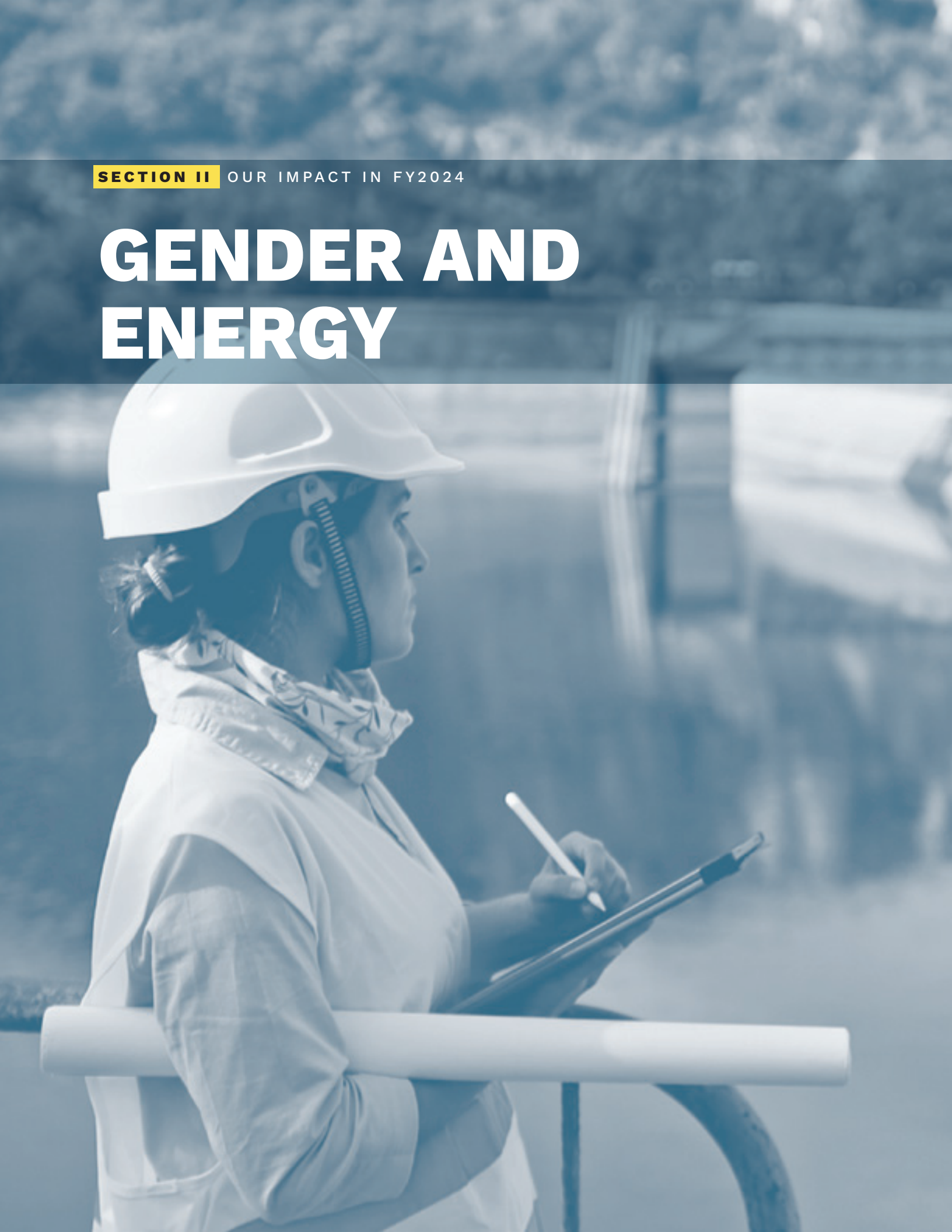
Through the DARES platform, the World Bank, MIGA, IFC, and other development agencies aim to promote private investment in distributed renewable energy (DRE) systems to electrify targeted areas quickly and efficiently. The first DARES project, the $750 million Nigeria DARES, was approved by the World Bank in December 2023 and became effective in November 2024.

ESMAP is again playing a significant role in these programs by supporting their preparation and design and now implementation. Through its Electrifying Africa program, ESMAP financed a series of project preparation missions, analytical and feasibility studies, stakeholder engagement, and expert support.

ESMAP's Key Role

ESMAP's achievements in accelerating access to clean energy have been twofold. First, it has informed, and often initiated, far-reaching parts of the World Bank's $8.4 billion (FY2018–23) access to clean energy loan investments. Second, through its preparatory work, ESMAP has enabled the World Bank to approve large, innovative, and tailored operations in FCV-affected areas, as well as climate-friendly investments, with gender-transformative and gender mainstreaming approaches. As a result, today's energy access projects are more ambitious and tend to be regional, comprehensive, and structured as longer engagements, as is the case with multiyear programmatic approaches.

GENDER AND ENERGY



Women are doubly disadvantaged in the energy sector, as they are underrepresented compared with men and their lack of access to energy compounds inequities. These include economic disparities where women tend to have fewer assets compared with men, limiting their ability to access credit, or are more likely engaged in unpaid domestic work due to gender norms.

Women in the Energy Workplace

Women hold only a third of jobs in renewable energy and even fewer in the oil and gas sector, according to an ESMAP report. Gender norms and systemic barriers curtail their opportunities for employment and leadership roles. The imbalance starts at the educational level, with women comprising only 35 percent of science, technology, engineering, and math (STEM) students in higher education worldwide (*Tracking SDG7: The Energy Progress Report 2021*), and this leads to women's underrepresentation in the energy sector.

Women's Access to Modern Energy

To make matters worse, women and girls are also disproportionately impacted by a lack of access to electricity and clean cooking fuel, leading to health risks from inefficient and polluting energy sources such as wood or dung for cooking fires. Women perform the household chores, which are more time-consuming without modern energy. This limits their time for education, economic activities, and social engagement. Gathering fuel can also expose women to harassment and assault.

Promising Solutions

More access to clean electricity and clean cookstoves can catalyze gender equality and economic growth. These modern, time-saving devices enable women to participate more fully in economic activities and decision making. Further, electrification can enhance women's wellbeing and safety, as cooking with modern energy decreases the risk of respiratory infections and other health issues.

For women working in the energy sector, creating inclusive workplace policies can help ensure women can achieve decision making positions. Providing access to credit, training, and market opportunities can increase female entrepreneurship in the energy sector.

Results-based financing (is one way to incentivize women's participation in energy projects. This includes setting improvement indicators, such as increased access to energy services for women, as conditions for project loan disbursements. ESMAP also helps build capacity among corporate and government officials to address gender-specific challenges, for example, allocating funds for gender gap analyses during project preparation and reviews. The World Bank/ESMAP Lighting India program has been successful in this area.

CLOSING THE GENDER GAP

ESMAP's **Gender and Energy Program** is dedicated to addressing gender inequalities in the energy sector. This program enhances women's roles as consumers, employees, and entrepreneurs by increasing female workforce participation, productivity, and access to modern energy services. ESMAP operates six regional gender programs across various World Bank regions, collaborating closely with other initiatives to generate and disseminate knowledge on gender and energy. In FY2024, 92 percent of Energy and Extractives Global Practice operations were gender tagged. The mechanism tracked the implementation of the World Bank Group Gender Strategy, identifying operations that seek to close gender gaps in human endowments, more and better jobs, ownership and control of assets, and women's voice and agency.

FY2024 Highlights

The Canada Clean Energy and Forest Climate Facility enhances female employment and leadership in renewable energy within small island developing states.

- **Cabo Verde.** The Centre for Renewable Energy and Industrial Maintenance enrolled 30 young people (43 percent women) in solar PV operations and maintenance training, surpassing the initial target of 30 percent female participation.
- **St. Lucia.** The Renewable Energy Sector Development Project awarded 17 scholarships in engineering to women, with 20 percent employed in technical roles within a year.
- **South Asia.** The Pacific Women's Energy Employment and Empowerment Program collected gender-related employment data from seven government agencies and 14 utilities across the Pacific, creating a baseline for gender diversity initiatives. A survey on gender norms was conducted with 61 employees, with findings set to inform the Pacific Women's Energy Employment and Empowerment Program baseline report.
- **Maldives.** The South Asia Gender and Energy Facility partnered with utility company FENEKA, reaching 215 women through STEM education, scholarships, and mentorship initiatives. Supported by WePOWER and Canada, FENAKA promotes gender-responsive policies and practices in the energy sector.
- **Small Island Developing States.** The Geospatial Assessment of Women Employment and Business Opportunities in the Energy Sector developed the Gender Enabling Environments Spatial Tool for assessing women's employment and business opportunities in renewable energy, with pilot tests in Comoros, Dominican Republic, and Papua New Guinea.

Regional initiatives. Over the past four years, ESMAP has made significant strides in addressing gender disparities through its Global Gender and Energy Program, with regional initiatives in Africa, Europe and Central Asia, East Asia and Pacific, Latin America and the Caribbean, the Middle East and North Africa, and South Asia.

- **Democratic Republic of Congo.** In 2022, ESMAP supported the Electricity & Water Access and Governance Project. The project was designed to target female-headed households to increase female participation in the water and electricity sectors.
- **Africa.** ESMAP throughout the Africa Gender and Energy Program supported the development of activities to reduce gender gaps. The activities focused on developing technical knowledge through training for the water and electricity utilities to attract, retain, and promote women in technical jobs.
- **Global.** The sector also introduced youth-focused, innovative initiatives to lending and technical assistance operations supported by ESMAP, including two global mentorship programs for young professional women in energy storage (the Women in Energy Storage Mentorship Program with the Energy Storage Partnership (ESP) and the Global Women's Network for the Energy Transition (GWNET). In addition, the project will work with La Maison de la Femme to ensure gender-based violence is addressed. Finally, efforts will be made to ensure that women beneficiaries are included in decision making and are also satisfied with the provided services.

WePOWER | CLOSING THE ENERGY GENDER GAP

In South Asia and parts of Europe and Central Asia, as in many other regions, female students with technical degrees struggle to find employment in the energy sector. Although they are equipped with the same diploma as their male counterparts, companies still hesitate to hire them. In response, ESMAP established the South Asia Women in Power Sector Professional Network (WePOWER) in 2019 in collaboration with the World Bank South Asia Gender Regional Program. This dynamic network supports women's roles in energy projects and institutions while encouraging broader acceptance of women in STEM fields.

Between 2019 and 2023, WePOWER partners positively impacted more than 136,644 women in South Asia, reaching students, interns, engineers, and mothers returning to work. The network of over 50 energy utilities, including new partners from India, Nepal, Pakistan, and Sri Lanka, has provided internships for more than 650 women students and graduates. Through collaborations with regional institutions, WePOWER also launched working groups on systems training, grassroots women in energy, human resource management, and support for returning parents.

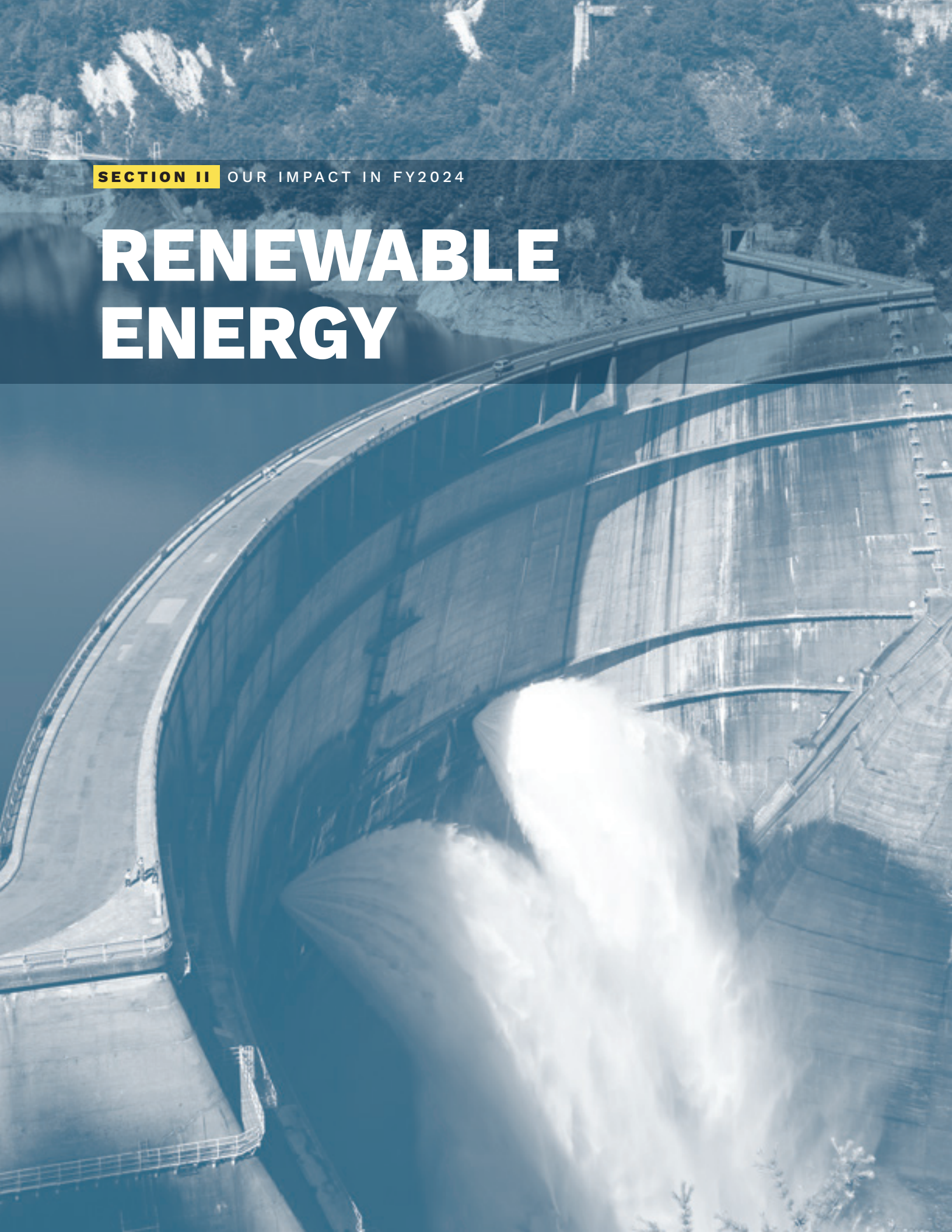
Tayyaba Malik is the WePOWER focal point at the Water and Power Development Authority (WAPDA) in Pakistan. The Deputy Director of Human Resources, Malik said she was proud to be able to directly contribute to women's empowerment.

> “The impact we have made with WePOWER has further strengthened my commitment to gender equity and inclusion. Since WAPDA joined the WePOWER in 2019 as one of the first partners, we’ve made significant progress in supporting women professionals and creating a more inclusive workplace. This is essential for retaining and advancing female employees for successful careers and maximizing the potential of our workforce.”

Malik explains the personal impact of WePOWER: “My family and I have directly benefited from WAPDA’s adherence to the wedlock policy. My husband was able to transfer to my duty station at the Daimer Bhasha Dam site in Gilgit, which is over 8 hours travel by road from WAPDA HQ in Lahore. I have also been able to avail from WAPDA’s commitment to ensuring that all projects include toilets, lodging, and safe transportation facilities for women in the field.”

Since WePOWER’s launch, ESMAP has expanded its network by establishing the Regional Energy Network for Women in the Middle East and North Africa (RENEW MNA) in 2022 and the Women’s Network in Energy Africa (WEN Africa) in 2024. ESMAP has also helped expand RENEW MNA with national chapters in Egypt and Morocco.

RENEWABLE ENERGY



Stimulated by policy support, technological advancements, and market competitiveness, global growth in renewable energy has been phenomenal in recent years. In fact, renewable energy is likely to surpass coal as the largest global source of electricity generation in 2026. In 2023, renewable energy sources provided nearly 30 percent of global electricity generation, with solar and wind the fastest-growing sectors. Solar PV and wind energy are anticipated to lead other sources in capacity additions, propelled by decreasing equipment costs, their modular build, and technical improvements. And for the share of renewable energy in electricity generation to increase to 65 percent by 2030, hydropower must grow by 30 percent over 2020 (IRENA).

Accelerating Renewables in Developing Countries

However, global progress is largely driven by Brazil, China, and India. Across large swathes of emerging markets and developing countries, much more needs to be done to bring renewable energy projects to maturity. One of the biggest challenges is that Sub-Saharan Africa utilities are often cash strapped and not creditworthy, dissuading private developers from the type of long-term investments that solar, hydropower, geothermal, and wind power installations require (see Special Section on Renewable Energy).

Private Sector Mobilization

Mobilizing the private sector at scale and pace will require the accelerated development of pipelines of bankable clean energy projects. ESMAP advises on devising sound investment policies, supports the upgrade and expansion of grid infrastructure to accommodate greater shares of renewables, and helps reduce bureaucracy and delays so that projects can move forward. The program also works to ensure access to climate finance by strengthening governance and risk mitigation instruments.

Importance of Storage

Developing robust energy storage facilities is also key to widespread adoption of solar and wind to guarantee continuity in electricity generation and reliable power systems, even when the sun does not shine and the wind does not blow. These include hydropower, pumped storage hydropower, and battery storage and, where feasible, mechanical and thermal storage. ESMAP's Energy Storage Program and the Hydropower Development Facility support developing countries in deploying such solutions by providing access to concessional finance and technical assistance.

The rapid growth of renewable energy, led by solar and wind, is set to make it the largest source of electricity by 2025. However, substantive efforts are needed in low- and middle-income countries, especially in Sub-Saharan Africa, to overcome financial and infrastructure challenges. ESMAP's work in investment policy, preparation of renewable energy projects, and energy storage is essential to mobilizing private sector investment and ensuring a sustainable energy future globally.

SUSTAINABLE RENEWABLES RISK MITIGATION INITIATIVE

The shift to sustainable energy sources presents a tremendous opportunity for emerging markets. However, the adoption of renewable energy in these regions remains slow. A key obstacle is the scarcity of bankable projects that can attract private sector investments. To address this, ESMAP introduced the **Sustainable Renewables Risk Mitigation Initiative** (SRMI) in 2018. SRMI is a partnership of nine entities that aim to help countries design and implement sustainable, resilient renewable energy programs that appeal to private investors while delivering socioeconomic benefits.

Next to ESMAP, the SRMI partnership includes Agence Française de Développement (AFD),

International Renewable Energy Agency (IRENA), International Solar Alliance (ISA), Sustainable Energy for All (SEforALL), Asian Development Bank (ADB), European Bank for Reconstruction and Development (EBRD), African Development Bank (AfDB), and the Get.Transform program from the German development agency (GIZ).

SRMI helps countries integrate variable renewable energy sources into their electricity grids, enhancing the planning process, ensuring projects are financially viable, and securing essential public funding, particularly concessional and climate financing. This requires a multifaceted strategy that combines greater mobilization of private capital and financial innovation.

In FY2024, ESMAP-SRMI wrote a position paper—"How to Unlock Pipelines of Bankable Renewable Energy Projects in Emerging Markets and Developing Countries"—presenting the main bottlenecks to be tackled to unlock pipelines of such projects. (For more on SRMI's work, see the Special Section on Renewable Energy.)

FY2021–24 Highlights

Funding

- During the FY2021–24 business cycle, SRMI allocated $45.3 million to more than 90 grants, and $18.7 million was allocated to 35 activities during FY2024 alone. In addition, under the SRMI-1 and SRMI-2 Green Climate Fund (GCF) Facilities, $52.5 million in technical assistance funding and under the Climate Investment Fund (CIF), $10 million in technical assistance funding were leveraged. These allocations total $107.8 million in SRMI technical assistance funding under this business plan.
- The funding was used to finance generation and transmission plans, renewable energy strategies, socioeconomic analyses, transaction advisories for renewable energy tenders, feasibility studies, and environmental and social instruments and to develop innovative risk mitigation instruments (in the case of São Tomé).

Results

- SRMI helped governments change their generation plans, adding 66 GW of renewable energy capacity (compared with older/previous plans) across 43 countries during the FY2021–24 business cycle.
- Renewable energy totaling 11.5 GW was enabled by World Bank investments representing $6.81 billion in World Bank financing mobilized, along with $11.65 billion in private capital and $1.27 billion in climate finance leveraged.
- These efforts were developed with a strong focus on gender equality, socioeconomic benefits, and skills development, ensuring inclusive and sustainable energy transitions. For example, in Central African Republic, a broad socioeconomic assessment has been completed focusing on gender and social inclusion issues around women's employment in STEM and more broadly in the energy sector. In Guinea-Bissau, the Solar Energy Scale-up and Access Project proposes a set of targeted interventions focused on strengthening gender equality in the electricity sector and reducing the gender gaps identified.

TRANSFORMING BOTSWANA'S ENERGY FUTURE WITH RENEWABLE ENERGY

Botswana is making substantial progress toward a sustainable energy future by implementing a comprehensive renewable energy program. The program is based on a roadmap for the government to maximize the climate and energy security benefits of such a program while reducing electricity costs.

SRMI supported the drafting of this roadmap, which was complemented by a study on how best to integrate variable renewable energy (solar and wind) into the country's energy mix. Under its new program, the country is now targeting a 30 percent share of renewables by 2030. A key component of this will be, per the SRMI study, to upgrade the grid significantly by 2050, including putting battery energy storage and data systems in place. Such upgrades are not only crucial to ensure a seamless integration of variable renewable energy, but also because private sector investors are reluctant to invest in renewable energy generation if the prospects for long-term offtaking and distribution are uncertain.

This is the purpose of a new World Bank loan, cofinanced with SRMI-GCF concessional fundings approved in FY2025 (July 2024). The $122 million project, to be implemented by the Botswana Power Corporation, will finance critical grid investments. ESMAP had made the project possible with a $3.5 million grant that provided technical assistance for developing wind and solar projects—including financing the transaction advisory support to select private investors.

Socioeconomic and gender-related dimensions are also a focus and include developing a gender strategy, supporting women's employment policies, and creating a framework to maximize the socioeconomic benefits of renewable energy projects.

ENERGY STORAGE PROGRAM AND PARTNERSHIP

ESMAP's **Energy Storage Program** supports developing countries in deploying sustainable energy storage by providing access to concessional finance and technical assistance. Since 2019, the program has mobilized approximately $961 million in concessional climate funding and $2.2 billion in IDA and IBRD funding for energy storage projects. These funds are channeled to countries through development partners such as the Climate Investment Funds (CIF), Green Climate Fund (GCF), and Canada-World Bank Clean Energy and Forests Climate Finance Facility.

In 2019, ESMAP convened the **Energy Storage Partnership** (ESP), whose members reached 58 as of November 2024 and range from research institutions and industry bodies to multilateral development banks, development groups, and power utilities. ESP helps introduce technological and regulatory solutions to countries and develop business models that leverage the full range of services that storage provides.

FY2024 Highlights

- **Increasing battery storage capacity.** Six investments informed by the Energy Storage Program obtained World Bank Board approval. The program's technical engagement in various countries has continued to dynamically evolve as energy storage becomes more critical as an enabler for the integration of variable renewable energy into the grid. Cumulatively, the ESP has contributed to 6 GWh of committed battery storage capacity in Board-approved projects in 33 countries and to an additional 1.5 GWh of identified capacity in the future pipeline. Commitments totaling 477.74 MWh were specifically for FY2024, covering Guinea-Bissau, Kenya, Namibia, Nigeria, São Tomé and Principe, and Türkiye.
- **Energy storage for mini grids.** Of those 6 GWh, the configurations of energy storage vary—between grid-scale energy storage, whether standalone or coupled with renewables, and energy storage capacities integrated into mini grids. Over 2.5 GWh has been or will be commissioned through various projects, including in Central African Republic (25 MWh), China (1,570 MWh), India (120 MWh), and South Africa (833 MWh). Additionally, there are ongoing procurement activities in different countries, including Maldives (50 MWh), Tanzania (40MWh), and West Africa (91 MWh).
- Through its **Working Group 6 on "Enabling policies and procurement frameworks,"** ESP published a report on *Unlocking the Energy Transition: Guidelines for Planning Solar-Plus-Storage Projects*. The report distills insights and best practices from various projects that synergize solar energy generation with energy storage systems. It outlines a strategic four-phase framework, designed to guide the planning and implementation of such integrated projects. This framework serves as a valuable roadmap for stakeholders involved in the transition to sustainable energy solutions. This important report, encapsulating the collective global experience of the World Bank and other key renewable energy stakeholders, was soft launched with a QR code at the ESP Partners Meeting in Pretoria in November 2023, allowing partners to access the executive summary on the World Bank's website. The report was officially launched at COP28, in November/December 2023 in Dubai. The World Economic Forum (WEF) published a blog by the report's authors titled *How Battery Energy Storage Can Power Us to Net Zero*, among the most highly shared content on the WEF site in 2023.

WOMEN IN ENERGY STORAGE

Women are still severely underrepresented in the energy sector. As consumers, in value chains, as workers and decision makers, in leadership and senior management roles, and especially on executive boards, the paucity of women is striking.

Gender equality is considered smart economics in developing countries. However, there is an urgent need for technical knowledge to capitalize on opportunities that could improve gender balance and mitigate risks related to ignoring inequality. Capacity-building support and training are required to implement and sustain action plans for gender equality.

To empower women as agents of change and promote best practices for gender diversity and inclusion in the energy storage sector, ESMAP's **Energy Storage Partnership** (ESP) has collaborated with the Global Women's Network for the Energy Transition (GWNET) to create a mentoring program specifically for women in energy storage.

Launched in 2020, the Women in Energy Storage (WES) Mentorship Program focuses on career development and improving knowledge about thermal energy storage and battery storage for grids, batteries for renewable energy hybrids, and mini grids. The goal is to accelerate the career trajectories of women in junior- or middle-management positions in the energy storage field, support their pathway to leadership positions, and foster a global network of mentorship, knowledge sharing, and empowerment.

The program was supported by a group of strong mentors—each a senior professional committed to making a difference and having a positive impact on a younger woman's career in the energy sector.

The first cohort in 2021, received over 240 applications from more than 50 countries. It included 25 mid-career women from 17 countries, working in utilities, government, small businesses, the private sector, consulting, and academia. Yewande Omolara, the Renewable Energy Technical Sales Manager (West-Africa) for Jinko Solar Co., was a member of the first cohort.

"My mentor was like a coach, friend, and sister," Omolara explained. "She went the extra mile for me. I mostly worked on solar projects before the mentoring program, I wasn't working much on the battery storage ones. However, my mentor's inputs guided me in transitioning into a technical sales manager, and now I deal more with not only solar PV modules, but energy storage solutions [with multiple-megawatt capacities], where I am able to implement and train other people around these topics on the African market (lithium-ion batteries, hydrogen, etc.)."

For Abhilasha Bhuju, a Renewable Energy Consultant at Quasar Energy Consultants, "the program was helpful to network with women participants from across the globe. The webinars conducted by the hosts showed us common problems that women come across in this energy-based workplace," Bhuju said. "It gave me the confidence to face my problems and have the courage to pursue a better career in this renewable energy sector."

Innovative Solar

ESMAP's **Innovative Solar** program aims to enlarge the scope of solar deployment beyond typical large-scale, ground-mounted solar PV projects. It supports the deployment of distributed solar, such as rooftop solar; floating solar, where solar panels are mounted on structures that float on water; and the hybridization of solar power, for example, by combining hydropower and solar power plants.

During the FY2021–24 business plan, ESMAP's Innovative Solar Initiative supported 40 country grants that have informed 22 World Bank operations in 28 countries, constituting approximately $4.48 billion in World Bank lending, plus $1.57 billion in private finance. The program contributed to more than 2.6 GW of distributed and floating PV capacity installation commitments.

FY2024 Highlights

- **Cameroon.** The Innovative Solar program provided technical assistance in Cameroon to explore developing floating PV or ground-mounted PV to combine them with the Lom Pangar and Memve'ele hydropower plants. The prefeasibility studies focused on technical design, site assessment, contractual and institutional assessment, financial and economic analysis, and risk analysis.
- **Tanzania.** ESMAP supported two major utilities—TANESCO (mainland) and ZECO (Zanzibar)—to conduct an options study for grid-connected distributed/rooftop solar PV and associated regulatory frameworks, tariffs, and design. The study assesses the potential for distributed photovoltaics (DPVs) across different customer segments, such as residential,

industrial, and commercial enterprises, including tourism operators.

- **From Sun to Roof to Grid.** The program also finished delivering its series of reports titled *From Sun to Roof to Grid*. The first report in the series, *Distributed PV in Energy Sector Strategies* (ESMAP 2021), introduces nine distinct use cases, or applications, of DPV to address challenges in different low- and middle-income country contexts. It is aimed at energy ministries and other decision makers. The second report of the series covers technical challenges and solutions for grid-friendly DPV from a power system perspective, *Power Systems and Distributed PV* (ESMAP 2023). The third and final report, *The Economics and Policy of Distributed PV* (ESMAP 2024), guides policymakers, regulators, and utilities through a framework for designing a program or policy package with DPV components.

OFFSHORE WIND

The **Offshore Wind Development Program** is a partnership between ESMAP and IFC. The program advocates for the inclusion of offshore wind in World Bank client countries' energy sector policies and strategies and supports countries in building a pipeline of bankable projects. The objective is to accelerate the uptake of offshore wind in emerging markets by learning from the experiences of established markets. Since its inception in 2019, the program has supported 26 countries ranging from large, fast-growing economies, like India and Vietnam, to small island developing states, such as Fiji and St. Lucia.

As offshore wind is a new field for most clients, countries typically require a broad range of technical assistance to establish industry frameworks before offshore wind development can begin. Given the magnitude of this task in each country, progress is slowly accelerating as governments establish targets and regulatory frameworks. Against this background, the FY2024 focus was on progressing country roadmaps by helping governments set offshore wind development targets and following this preparatory work with specific technical assistance.

FY2024 Highlights

- **Two global studies were conducted that undergird the project with evidence-based research and lessons learned.** *The Role of Concessional Climate Finance in Accelerating the Deployment of Offshore Wind in Emerging Markets* concludes that concessional climate financing is essential to unlocking offshore wind in emerging markets and estimates that $15 billion in concessional climate financing could catalyze offshore wind deployment across 10 emerging markets. *Integrated Environmental & Social Sensitivity Mapping. Guidance for Early Offshore Wind Spatial Planning* discusses how wind turbines can be installed so as not to endanger marine life or harm human development.
- **FY2024 saw progress toward the program's two main outcome indicators:** (1) government policy/strategy informed for 20 GW of offshore wind energy by end-FY2024; projects in India, Türkiye, and Viet Nam contributed about 13 GW; and (2) activities supported by development policy loans in Colombia and India contributed 2 GW toward the 20 GW target.
- **ESMAP provided for roadmaps for offshore wind.** Since 2019, 10 country teams have received grants from ESMAP, with half of them, totaling $697,000, provided during FY2024 (Brazil, Dominican Republic, South Africa, Türkiye, and Viet Nam). Each of these supports the development of strategic country roadmaps for offshore wind and informs follow-up technical assistance, which ESMAP grants are likely to fund in the future as well. The expectation is that these projects will eventually lead to World Bank lending for infrastructure and de-risking initiatives to support the respective countries' initial offshore wind projects.

OFFSHORE WIND ROADMAP FOR COLOMBIA

In Colombia, an extensive ESMAP-supported technical assistance engagement has led to two key outcomes over the past two years: (1) the country has included offshore wind targets in its energy plans; and (2) the World Bank has provided financial support to Colombia that is linked to offshore wind implementation.

The engagement commenced in 2022 when the Colombian mining and energy ministry voiced interest in developing an Offshore Wind Roadmap for Colombia. With substantial support from the World Bank, the ministry released an offshore wind resolution in August that year, outlining the approach for leasing seabed areas for Colombia's first offshore wind projects. The World Bank also supported the administration logistically through a series of industry engagement workshops in September 2022. In June 2023, following the ministry's request, ESMAP provided a $600,000 technical assistance grant to help prepare the roadmap's implementation, using preferential funds from the United Kingdom Department for Energy Security and Net Zero.

The ESMAP team delivered a series of intragovernment technical workshops and capacity building discussions among key stakeholders. During FY2023, ESMAP advised on the design of a competitive seabed leasing process. At COP28, in Dubai in November/December 2023, Colombia launched the bidding for its first tender, and since then, the World Bank has supported the government in liaising with the private sector and refining the bidding documents.

As part of the second deliverable for this grant, ESMAP/IFC identified the lack of specific tariffs/revenues for offshore wind as a key barrier to investment. In FY2024, they produced a regulatory analysis examining the potential options for offshore wind offtake and support mechanisms, along with recommendations for removing this barrier. Simultaneously, the World Bank scoped work for environmental sensitivity mapping to inform marine spatial planning activities and will procure consultants for this work in FY2025. The consultants will undertake a study on the port requirements to manage logistics for offshore wind construction and operation.

Offshore wind is now part of Colombia's national energy plan (PEN 2052), with up to 18 GW capacity expected by 2052. Although a short-term target has not been set, the country's first competition may lease about 3 GW of offshore wind projects, and their operation is projected to start around 2030. Offshore wind has also been a component of two World Bank development policy loans totaling $1.75 billion and including a series of ESMAP-provided technical assistance programs.

HYDROPOWER DEVELOPMENT FACILITY

Hydropower is essential for climate mitigation, adaptation, and supporting energy systems to incorporate variable renewable sources. As the currently largest renewable energy source, hydropower will continue to be critical in achieving universal electricity access. While solar and wind are also low-carbon energy options, their intermittent availability presents challenges. Hydropower balances this intermittency in energy systems and provides stable, reliable access to electricity, enhancing overall system resilience and reliability.

The ESMAP **Hydropower Development Facility** (HDF) assists developing countries by building project pipelines, creating implementation strategies, and identifying and mitigating hydropower development risks. The program supports both the modernization of existing hydropower facilities and the construction of new ones while also analyzing ways for the optimal use of hydropower to further integrate variable renewable energy.

FY2024 HIGHLIGHTS

- **Europe and Central Asia Region.** The technical assistance for Kambarata 1 Hydropower Plant Project in the **Kyrgyz Republic**, supported by an ESMAP grant of $2 million and additional funding of $2.6 million from the CAWEP, focuses on the project's technical feasibility, enhancing environmental and social sustainability and strengthening financial and commercial frameworks. Approved by the World Bank Board in October 2023 with $14 million in IDA grants, the technical assistance project has led to the Kyrgyz government's deciding on a three-government public financing structure for its implementation. The ESMAP grant has facilitated knowledge sharing among stakeholders and the establishment of a Donor Coordination Committee. Additionally, the grant is preparing the Kambarata 1 project for expected board approval in FY2025, with a capacity of 1,900 MW and annual generation of 5,640 GWh. The hydropower plant will be crucial for Kyrgyz's energy security and regional decarbonization,

addressing winter energy shortages and supporting the integration of renewable energy sources. The project requires over $4 billion in financing, combining concession and commercial financing.

- **Latin America and the Caribbean Region.** In FY2024, ESMAP's HDF provided a grant of $100,000 toward fostering the clean energy transition and energy efficiency rollout in **Ecuador.** One of the activities is to assess hydropower storage options to enhance flexibility in the power system, and, notably, the technical and economic viability of storage options. The assessments have identified the existing hydropower reservoirs and storage capacity and the location of the hydropower plants to better understand their seasonality and constraints. It is envisioned that this upstream engagement will inform a potential lending operation in the future.
- **Publications**
    - *Power with Full Force | Getting to Gender Equality in the Hydropower Sector*
    - *Power of Flexibility | Facilitating the Energy Transition with Hybrid Hydropower Solutions*
    - *Hydropower | Unveiling the Socioeconomic Benefits*

TRANSFORMING THE ENERGY LANDSCAPE OF CENTRAL ASIA

Situated in the heart of Central Asia, the Rogun Hydropower Project represents a bold vision for transforming the energy landscape of Tajikistan and its neighboring countries.

ESMAP's Strategic Role

In FY2024, ESMAP's **Hydropower Development Facility** provided a $300,000 grant to help ready the project for financing from the World Bank and other institutions. The grant builds on a prior $400,000 grant in FY2022, which focused on due diligence and preparatory activities.

Through this support, ESMAP is helping Tajikistan leverage the Rogun Hydropower Project to address climate challenges at scale. The project aims to decarbonize Central Asia's power systems by adding 3,780 MW of renewable energy capacity and incorporating 6,000 GWh of energy storage. These initiatives align with the country's transition to a more sustainable energy future.

The grants have targeted key areas, including:

- **Technical Upgrades and Quality improvements:** ensuring that dam safety and operations comply with the World Bank's Environmental and Social Framework.
- **Economic and financial updates:** revising assessments to reflect current conditions and ensuring financial sustainability.
- **Environmental and social impact:** helping to finalize impact assessments to meet international standards.
- **Benefit-sharing mechanisms:** designing programs to strengthen social safety nets and distribute project benefits equitably across the population.

Financing and Economic Impact

The World Bank is expected to approve the project in FY2025, with $650 million in funding, including $350 million from IDA for the first phase. This package is expected to catalyze an additional $2.97 billion in grants and concessional financing from 10 development partners. The total estimated cost of the project is $6 billion.

Beyond electricity generation, the Rogun Hydropower Project is poised to deliver substantial economic and social benefits. It will secure a reliable power supply to meet Tajikistan's winter energy demands and significantly improve flood management for rivers traversing populated areas.

This transformative initiative underscores Tajikistan's leadership in harnessing renewable energy to foster regional development, address climate challenges, and ensure energy security for future generations.

ACCELERATING RENEWABLE ENERGY THROUGH PARTNERSHIPS

> *And what do we do when the sun doesn't shine and the wind doesn't blow?*

This has been the recurring concern of colleagues at energy ministries and electricity utilities around the world despite the discussion that solar and wind generators can provide the cheapest kilowatt-hour (kWh). It is a fundamental question that has been impeding the expansion of clean energy. As a result, too many countries, especially the world's poorest, are still locked in a vicious cycle of power sector deficits that prevent investments, and heavy subsidies that lead to fiscal stress and further indebtedness.

Combining Storage to Renewable Energy

The solution lies in energy storage systems, often hydropower, pumped storage hydropower, and batteries, which store energy from natural river flow or electricity produced from renewable energy like solar panels and wind turbines. They dispatch it as needed, ensuring an uninterrupted supply and building energy security for a reliable and resilient power system. Such a system shift can allow governments to benefit from affordable hydropower, geothermal, solar, and wind energy while reducing reliance on costly, imported fossil fuels.

It is now widely recognized that energy storage is crucial for achieving Mission 300 and net-zero goals.

Accelerating Storage Through Partnership

In 2019, to accelerate the deployment of energy storage in developing countries, the World Bank brought together a diverse group of stakeholders to innovate together. At the Clean Energy Ministerial in Canada, ESMAP convened a unique global partnership on energy storage—the Energy Storage Partnership (ESP)—to foster international cooperation on adapting and creating energy storage solutions for developing countries. Starting with 29 members, drawn from national laboratories, research institutions, development agencies, industry, and philanthropies, ESP now has 58 partners.

The Energy Storage Partnership's Achievements

Since its inception five years ago, ESP has grown, thanks to the collective efforts and shared vision of its partners. They have worked to promote technical cooperation and training, crucial for accelerating the spread of energy storage systems, while facilitating knowledge sharing and exchange between partners and client countries.

ESP and the Energy Storage Program are symbiotic. Since its establishment, the program has mobilized over $961 million for battery storage projects through the CIF, Canada Climate Finance Facility, and other climate funds on top of over $2.2 billion in IDA and IBRD funding. The program has contributed to 6 gigawatt hours (GWh) of committed battery storage capacity

in active projects across 33 countries, including Botswana, Burkina Faso, Kenya, Namibia, and Türkiye, with an additional 1.5 GWh identified for future projects in the pipeline. The program has also supported energy storage in Central African Republic (25 MWh), China (1,570 MWh), India (120MWh), Maldives (50 MWh), and South Africa (833 MWh), among other countries. For reference, one GWh of battery capacity can store the electricity produced by 1.9 million solar PV panels or 294 wind turbines.

ESMAP interventions have introduced battery storage in countries at the forefront of technological advancement, such as China and India, as well as countries that lack cutting-edge technologies, such as Guinea-Bissau and São Tomé and Principe.

In Ukraine, the Bank support aims to enhance the flexibility of the Ukrainian power grid through storage investments. A total of 197 MW of battery energy storage system (BESS) and 35.9 MWp of solar will be installed at selected hydropower plants to provide grid ancillary services and improve system flexibility for variable renewable energy integration. In Burkina Faso, World Bank support aims to enable the integration of renewable energy plants into the grid with BESS assets, mitigating its shortfall in energy supply. The first phase of the 150 MWp + 120 MWh solar-plus-storage tender is underway.

ESP and Gender

ESP is committed to closing gender gaps in the energy sector. Through the Women in Energy Storage mentoring program, in partnership with the Global Women's Network for Energy Transition (GWNET), ESP advances women's professionalization and leadership. Now in its third cohort, the program has 45 alumni in important decision making and leadership roles in their home countries and regions.

New Technologies

ESP is a key forum for exchange on new battery storage technologies adapted to developing countries climates. Leading practitioners, technical experts, and investors are regular speakers at ESP events. Recently, discussions have been held on long-duration storage technologies, essential for storing energy with minimal losses over extended periods. These technologies include compressed air, flow batteries, hydropower, and pumped storage hydropower.

Marking Five Years of the Power of Partnerships

ESP marked its fifth anniversary at the Stakeholder Forum and 11th Partners' Meeting, November 4–7, 2024, in Marrakesh, organized with ESP partner Masen. Masen is a pioneer and world leader in large-scale concentrated solar power, notably through Morocco's Noor plants. The meetings cemented the Masen-World Bank partnership, which now includes capacity building and knowledge sharing, benefiting other ESP partners and Bank clients, especially in Sub-Saharan Africa. New joint programs like the BESS Testbed and South-South Knowledge Exchanges, as well as the latest policies and regulations, investment needs, capacity building, and implementation, were discussed.

RENEWABLE ENERGY IS POWERING AHEAD GLOBALLY, BUT NOT ENOUGH IN MOST DEVELOPING COUNTRIES

The headlines couldn't be more positive for renewable energy. "Massive expansion of renewable power opens the door to achieving the global tripling goal set at COP28," predicted the IEA at the beginning of 2024. The United Nations names five reasons for clean energy as the pathway to a livable planet for generations to come. Among them: renewable energy is now the cheapest power option in most parts of the world. Solar electricity costs fell by 85 percent between 2010 and 2020; wind energy costs halved, according to IRENA. Often, renewable energy is cheaper than fossil fuel-based power.

However, the picture is distorted by fantastic progress in Brazil, India, and particularly China. Excluding China, developing countries will need to increase renewable energy threefold by 2030 and almost tenfold in Sub-Saharan Africa to align with the climate objectives of the Paris Agreement.

Indeed, the costs of electricity from solar PV and onshore wind have significantly decreased in recent years, making them competitive with, and often less expensive than, fossil fuel-based electricity generation. However, low production costs alone do not drive adoption, particularly in emerging markets and developing countries. Building solar power plants and wind farms is capital intensive, and private developers are only willing to incur significant upfront costs if offtakers, most often public utilities, are committed to buying the renewable power and extending the grid 20+ years into the future. Similarly, hydropower and geothermal power generation require significant public financing due to high upfront investment costs given their scale and complex technical, environmental, and social challenges.

In Sub-Saharan Africa, utilities are often cash strapped and not creditworthy, increasing the buyer, or offtaker, risk. Operational risks such as these, plus project development risks including grid risks, land ownership risks, or environmental and social risks, can scare investors away. In project finance parlance, projects become un-bankable even if private investors are otherwise willing to seek opportunities in challenging markets.

This is where ESMAP, in concert with other World Bank units, helps reduce investor risks, often by distributing them across several stakeholders. The 150-megawatt peak (MWp) regional solar power park project in the Gambia is one example. As one of several utility-scale solar PV power plant projects across the West African Power Pool, it is of regional importance and helps reduce electricity costs domestically, where costs are among the highest in Sub-Saharan Africa. ESMAP has financed a variable renewable integration analysis to mitigate grid and curtailment risks, as well as transaction advisory, to help the government launch the solar park's first 50 MWp phase and tackle the procurement risk. Next, the World Bank team is exploring with IFC and MIGA how best to address the project's financing and risk coverage.

West Africa's solar power parks are also an example of the importance of regional integration of power markets for developers because a regional approach allows them to recoup investments by selling clean energy across borders and procure power from a neighboring country. ESMAP's **MARCOT Program** focuses on the development of grid interconnectivity across borders and regional markets such as African power pools. The ESMAP **Hydropower Development Facility** supports sustainable development of hydropower in the region to help build a reliable interconnected power system.

Power is also among the sectors that generate myriad data points during operation and hence is rife for digital transformation. ESMAP's **Utilities for the Energy Transition Program** helps harness big data, artificial intelligence, and digital technologies to optimize grid operations and improve operational efficiency, in the long run removing another risk that keeps private capital away from developing countries. In India, the program supports the automation of electricity distribution networks to facilitate the integration of renewable energy and improved power supply, specifically, the integration of distribution automation mechanisms in the West Bengal State Electricity Distribution Company. ESMAP helped map the business processes and identify gaps to ensure that automation is institutionalized in the day-to-day operations. The goal is to create a smart electricity center that integrates various automation technologies on one platform.

The next two years will be critical to proving the business case for renewable energy in emerging markets and developing countries, as many now have initial projects in place. ESMAP's strategy is to help develop a few private sector-led renewable energy projects where offtakers pay for the power on time and grid infrastructure is upgraded and expanded. Doing so would demonstrate the viability of the business case for renewable energy and help developing countries attract more private sector developers.

CHALLENGES FOR RENEWABLE ENERGY IN EMERGING MARKETS AND DEVELOPING COUNTRIES

1. **Regulatory and policy uncertainty.** Uncertainty around governments' energy policies and regulations deters investment.
2. **Utility creditworthiness.** Low creditworthiness of utilities is often exacerbated by high generation costs and significant technical and commercial losses. Utilities are unable to offer attractive power purchase agreements (PPAs).
3. **Inadequate grid infrastructure and grid management practices.** Weak or outdated grid infrastructure delays or even halts projects. Especially the variability of renewable energy (solar and wind power is available only intermittently) makes public sector investments in the grid necessary.
4. **Lack of competitive and transparent procurement.** Inconsistent or noncompetitive procurement processes increase costs and the risk of corruption, discouraging investment.
5. **Foreign exchange risks and domestic lending constraints.** Financing renewable projects often involves foreign investment in hard currency, as there is limited access to affordable, long-term local currency financing. This introduces convertibility and exchange rate risks in countries with unstable local currencies.
6. **Hydropower's social and environmental challenges.** While hydropower is a significant source of renewable energy capable of balancing out variable renewable energy in the power system, its impact on people and the environment needs to be carefully managed.

ESMAP SUPPORT FOR RENEWABLE ENERGY PROJECTS IN EMERGING MARKETS AND DEVELOPING COUNTRIES

1. **Technical assistance during early planning.** Reducing perceived risks preventing investors from financing renewable energy projects. This includes supporting generation and transmission planning, variable renewable energy integration, regulatory and strategic support, and socioeconomic analyses.
2. **Technical assistance during execution.** Increasing renewable energy projects' attractiveness for investors by helping governments tender projects in a way that reduces procurement costs and uncertainties. This includes transaction advisory support, feasibility studies, and resource assessments.
3. **Public investment and risk mitigation.** Funding for critical public investments in infrastructure, such as grid reinforcements, battery storage, and renewable energy parks. Also, leveraging innovative risk mitigation instruments to address residual risks, including guarantees for grid-connected projects and other insurance mechanisms. These measures lower unattractive risks, such as political instability and foreign exchange risks, for private investors.
4. **Promoting competitive procurement.** Minimizing risks related to corruption and noncompetitive practices by encouraging countries to adopt competitive and transparent procurement processes. Transparent tenders result in lower tariffs and a more stable investment environment, essential for generating a pipeline of renewable energy projects that investors consider bankable.
5. **Reducing offtaker and foreign exchange risks.** Promoting the use of credit enhancement mechanisms and power sector reforms to improve utilities' creditworthiness and reduce offtaker risks. Additionally, advocating for PPAs in hard currency, reducing foreign exchange risks and making projects more viable for investors. (For 1–5, see ESMAP's Sustainable Renewables Risk Mitigation Initiative.)
6. **Supporting regional integration of power markets.** Support for well-functioning power markets and grid interconnectivity across borders.
7. **Driving digital transformation.** Improving utilities' performance through the effective use of smart technology, data analytics, and innovative business models.
8. **Promoting energy storage.** Providing access to concessional finance and technical assistance to deploy energy storage solutions.
9. **Developing hydropower.** Through the uninterrupted availability of hydropower and its energy storage, helping make renewable power systems more reliable. ESMAP's Hydropower Development Facility devises implementation strategies and mitigates risks for the sustainable development of hydropower.
10. **Unveiling the socioeconomic benefits.** Highlighting opportunities and benefits that can be enhanced at national and local levels throughout various solar, wind, geothermal, and hydropower projects' development and operation.

ASSOCIATED TRUST FUNDS

CARBON CAPTURE AND STORAGE

Between 2009 and 2024, the World Bank Group supported the development of carbon capture and storage (CCS) enabling environments through the **Carbon Capture and Storage Trust Fund** (WB CCS TF). The CCS TF focused during FY2024 on wrapping up activities it supported in Egypt, Nigeria, South Africa, and Timor-Leste and closed two months after the end of the fiscal year.

FY2024 Highlights

- **Nigeria.** Between 2022 and 2024, the WB CCS TF engaged with the Nigerian government to support the country's development of a business environment that enabled carbon capture utilization and storage (CCUS) and identify potential industrial demonstration projects with a focus on industrial CO_2 sources. Given the characteristics of Nigeria's industry, cement and fertilizer production are the most likely candidates for an industrial CCUS pilot project, given that these two sectors make up the bulk of Nigeria's industrial emissions. Pilot concepts were defined for CO_2 capture at both a cement plant and a fertilizer plant.
- **South Africa.** In 2018, the World Bank and the South African government signed a grant agreement committing to a recipient-executed $23 million program to support the development of a pilot CO_2 storage project. The pilot focused on the identification of a suitable CO_2 storage site to inject CO_2. A site was identified in the Govan Mbeki Municipality to inject CO_2 into basalt rocks. The project completed the environmental impact assessment in 2023 and completed drilling of the pilot injection well in early 2024. However, the pilot project was unable to inject CO_2 before the termination of WB CCS Trust Fund support.
- **Egypt.** Between 2021 and 2023, the WB CCS TF supported engagement with the Egyptian government on the development of industrial CCUS hubs in the country. The technical assistance centered on identifying potential construction sites for CCUS hubs, quantifying the CCUS potential to enable the decarbonization of Egypt's major industrial sectors and determining the degree the location of industrial clusters matched likely storage resources. Phase one of the work found that the country has significant depleted gas reservoirs that could be used for storage. Egypt's involvement in the Carbon Management Challenge demonstrates the country's continued interest in CCUS and carbon management.
- **Timor-Leste.** During 2022–24, the CCS TF supported IFC-implemented work in Timor-Leste. One of the objectives of the program was to assess how the country's depleted oil and gas fields could be converted into CO_2 storage sites.

Lessons Learned

Throughout its 15 years, the CCS TF has learned lessons and gathered good practices:

- In low- and middle-income countries, CCUS or carbon management pilot development can take many years due to project complexities and the need to secure funding and implementation support. Inflation can adversely affect project finances and cause further delays in project development.
- Continuity in government strategies and priorities is essential, as changes in government can affect the degree of interest in working on specific decarbonization technologies and/or energy projects.
- Capacity development remains a continuing need. While awareness of CCS/CCUS technologies is growing, in-country expertise is often limited. Encouraging and facilitating the engagement of public and private sector stakeholders as part of the international CCUS community can result in dialogue and developments that extend beyond the lifetime of a specific project.

SMALL ISLAND DEVELOPING STATES (SIDS) DOCK

Small island developing states (SIDS) are highly vulnerable to climate change and rely heavily on imported fuel for energy, leading to high electricity costs and susceptibility to supply interruptions and oil price shocks. Despite having abundant solar, wind, ocean, geothermal, and biomass resources, SIDS face challenges like inadequate infrastructure, lack of capacity, and insufficient capital to develop these resources.

To address these issues, ESMAP established the **SIDS DOCK Support Program** in 2011 with a budget of $22.1 million, funded by Denmark and Japan. The program aims to create an enabling environment for renewable energy and energy efficiency policy reforms and to implement renewable energy and energy efficiency initiatives for potential scale-up through climate finance and other funding sources.

ESMAP provides grants to SIDS DOCK members to support analytical and advisory activities and investments in renewable energy and energy efficiency initiatives.

Results Highlights

Since its launch, the SIDS DOCK Support Program has supported four global and 23 country/regional activities across 15 countries and three regions. Beneficiary countries include Belize, Cabo Verde, Comoros, Dominica, Maldives, Mauritius, Organisation of Eastern Caribbean States (OECS) countries, Pacific Islands, São Tomé and Principe, Seychelles, Solomon Islands, St. Lucia, Tuvalu, and Vanuatu.

The program has mobilized and informed investments totaling $309 million, including $167 million from IDA and $142 million from other cofinancing sources. These investments have benefited countries such as the Comoros, Dominica, Maldives, Marshall Islands, Micronesia, São Tomé and Principe, Solomon Islands, and Tuvalu.

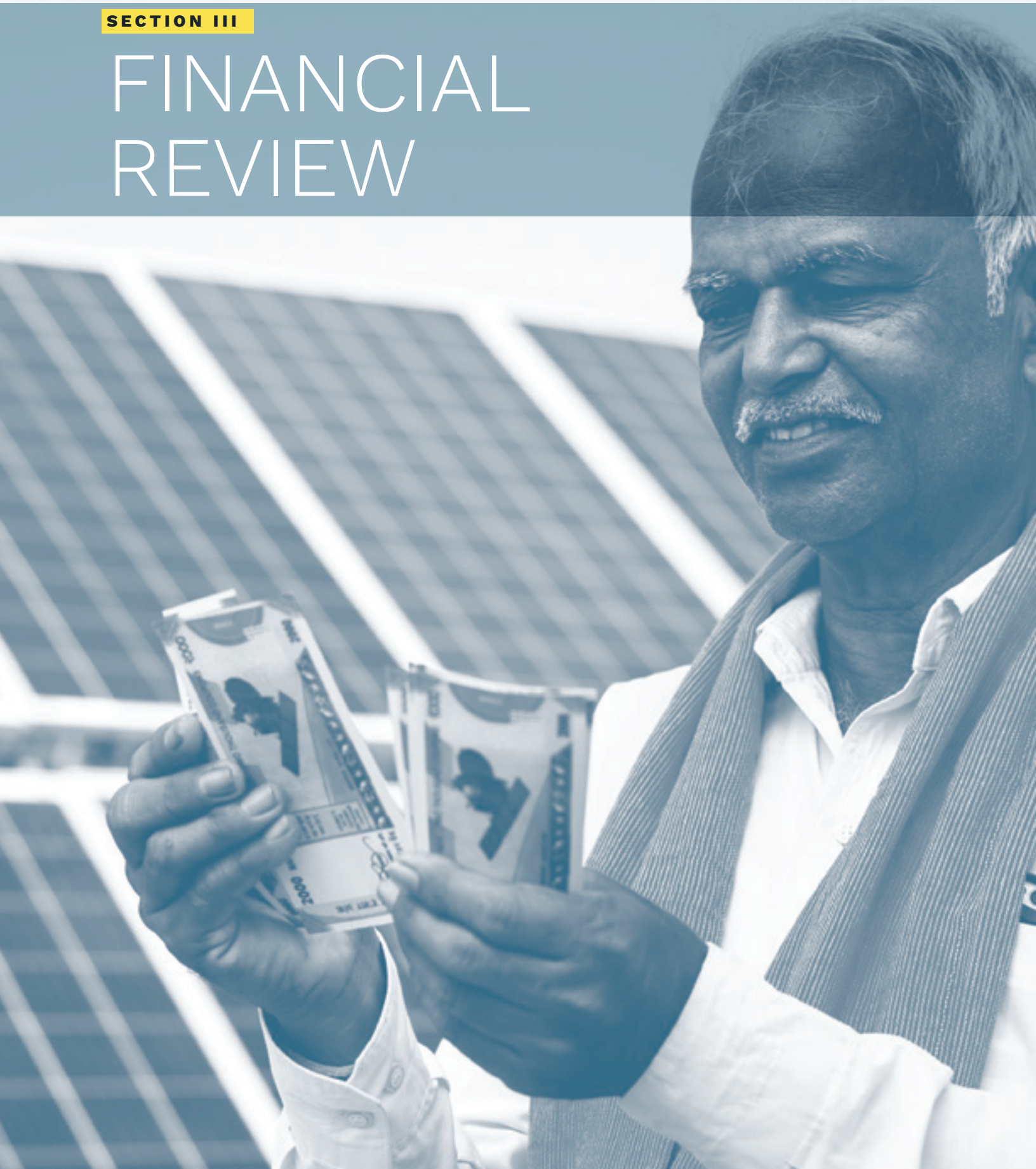
To date, the program has supported the development of 98.1 MW of new renewable energy capacity (including 37 MW geothermal and 2.2 MW hydropower) and 75 MWh of new BESS capacity through ESMAP grant activities.

Currently, the SIDS DOCK program supports five activities: four cofinancing projects and one World Bank-executed trust fund advisory services and analytics activity in the Maldives. The program is on track to fully disburse funds by the end of 2025.

On the research side, ESMAP's Sustainable Risk Mitigation Initiative gathered data during engagements with renewable energy developers operating in small island countries to better understand the unique social, economic, environmental, and geographical challenges small island states face in transitioning to low-carbon fuels. The resulting report, *Empowering Small Island Developing States: Scaling Up Renewable Energy for Resilient Economic Growth*, proposes tailored solutions to these challenges to accelerate the clean energy transition, thereby fostering economic growth and resilient development.

SECTION III

FINANCIAL REVIEW



This chapter summarizes the FY2024 financial information of the ESMAP Umbrella Trust Fund Program umbrella "anchor" and its associated trustee accounts.[9]

CONTRIBUTIONS

In FY2024, ESMAP received $80.6 million from five donors. Table 3.1 presents actual receipts in FY2024 from individual donors to ESMAP and cumulative receipts during the FY2021–24 business plan period. Table 3.2 indicates cumulative pledges and receipts of associated trust funds to ESMAP.

Table 3.1. Donor Contributions to ESMAP, FY2021–24 (US$ thousands)

Country	ESMAP FY2024 Contribution Paid-In & Receivables	ESMAP FY2021–24 Cumulative Pledges	Cumulative Receipts	Cum. Receipts over Cum. Pledges
Austria		2,423	2,423	100%
Canada		18,076	8,146	45%
ClimateWorks Foundation		100	100	100%
Denmark		35,669	35,669	100%
France		1,209	1,209	100%
Germany				
- BMU		11,219	11,219	100%
- BMZ		3,541	1,940	55%
Global Energy Alliance for People and Planet (GEAPP) LLC		50,000	30,000	60%
Iceland	2,000	3,778	1,778	47%
Italian Ministry of Environment and Energy Security		11,317	11,317	100%
Japan		15,000	15,000	100%
Netherlands	40,000	80,500	50,500	63%
Norway - NORAD		56,651	48,592	86%
Sweden - Sida	3,664	60,029	49,760	83%
Switzerland - SECO		17,270	17,270	100%
UK				
- DESNZ	29,112	48,402	23,164	48%
- FCDO	5,802	38,901	17,753	46%
World Bank	200	1,000	1,000	100%
Grand Total	80,778	455,085	326,840	

Note: The UK Department for Energy Security and Net Zero (DESNZ) provides its contribution in promissory notes. Receipts denote the encashed amount.

9. As set out in the Administration Agreement with ESMAP donors, the current financial information relating to multi-donor and associated trust funds under ESMAP management can be accessed via the Bank's Trust Funds Development Partner Center. The Bank's Financial Statements, as well as the Single Audit Report on Trust Funds, can be accessed on the Bank's public website on Financial Results. Consistent with the Bank's Trust Fund Reform, the ESMAP has an Umbrella "Anchor" MDTF TF073553 and the older TF072490, considered an associated TF to the Anchor. Other associated TFs to the ESMAP Umbrella are: (1) TF071728: Support for Small Island Developing States (SIDS DOCK); (2) TF071379: Carbon Capture and Storage (CCS); (3) TF072636: Advancing Regional Energy Projects (AREP) in Africa; (4) TF073420: Support to Regional Off-Grid Electrification Project (ROGEP); (5) TF073825: Support to Electricity Sector Modernization and Sustainability Project in Kyrgyz Republic (KEMS); and (6) TF073761 Support to Energy Access and Quality Improvement Project (EAQIP). Totals provided in this financial section may not add up due to rounding.

Table 3.2. Donor Contributions to Associated Trust Funds to ESMAP (US$ thousands)

Donor Country	Associated Trust Fund	Cumulative Pledges	Cumulative Receipts	Cum. Received over Cum. Pledges	Sum of Unpaid Contribution USD
Sweden	Advancing Regional Energy Projects (AREP) in Africa	17,446	17,446	100%	-
Norway	Carbon Capture and Storage (CCUS)	18,313	18,313	100%	-
United Kingdom		40,759	40,759	100%	-
Global Carbon Capture and Storage Institute, Ltd.		2,173	2,173	100%	-
Denmark	Support for Small Island Developing States (SIDS DOCK)	7,093	7,093	100%	-
Japan		15,000	15,000	100%	-
Netherlands	Support to Regional Off-Grid Electrification Project (ROGEP)	44,000	16,000	36%	28,000
Swiss State Secretariat for Economic Affairs (SECO)	Support to Electricity Sector Modernization and Sustainability Project (KEMS) in Kyrgyz Republic Single Donor Trust Fund	13,160	8,779	67%	4,381
Denmark	Support to Energy Access and Quality Improvement Project (EAQIP) in Rwanda	3,796	3,796	100%	-

DISBURSEMENTS

ESMAP disbursed about $74.3 million in FY2024, a 4 percent decrease compared to the amount disbursed in FY2023.[10] The total disbursements for the associated trust funds AREP, CCS, EAQIP, KEMS, ROGEP, and SIDS DOCK amounted to about $5.8 million.[11] By the end of 2024, the total cumulative disbursement of the ESMAP Umbrella reached $206.3 million, increasing by 11 percent compared to FY2023. The following figures and tables present the FY2024 breakdown of disbursements by region.

10. Total ESMAP disbursement refers to the amount disbursed under the ESMAP Umbrella MDTF TF073553 and the parallel account TF072490. (TF072490 is also referred to as an associated TF to the Umbrella and was formerly the main MDTF for contributions under the FY2017-20 Business Plan, i.e., before the establishment of the Umbrella Approach under World Bank's TF Reform.)
11. AREP: Advancing Regional Energy Projects in Southern and Eastern Africa Multi-Donor Trust Fund (TF072636); CCS: Carbon Capture and Storage Trust Fund (TF071379); EAQIP: Support to Energy Access and Quality Improvement Project in Rwanda Single-Donor Trust Fund (TF073761); KEMS: Support to Electricity Sector Modernization and Sustainability Project in Kyrgyz Republic Single-Donor Trust Fund (TF073825); ROGEP: Support to Regional Off-Grid Electrification Project Trust Fund (TF073420); SIDS DOCK: Support for Small Island Developing States DOCK Support Program Multi-Donor Trust Fund (TF071728).

Figure 3.1. ESMAP Disbursements and Percentages, by Region, FY2024 (US$ millions)

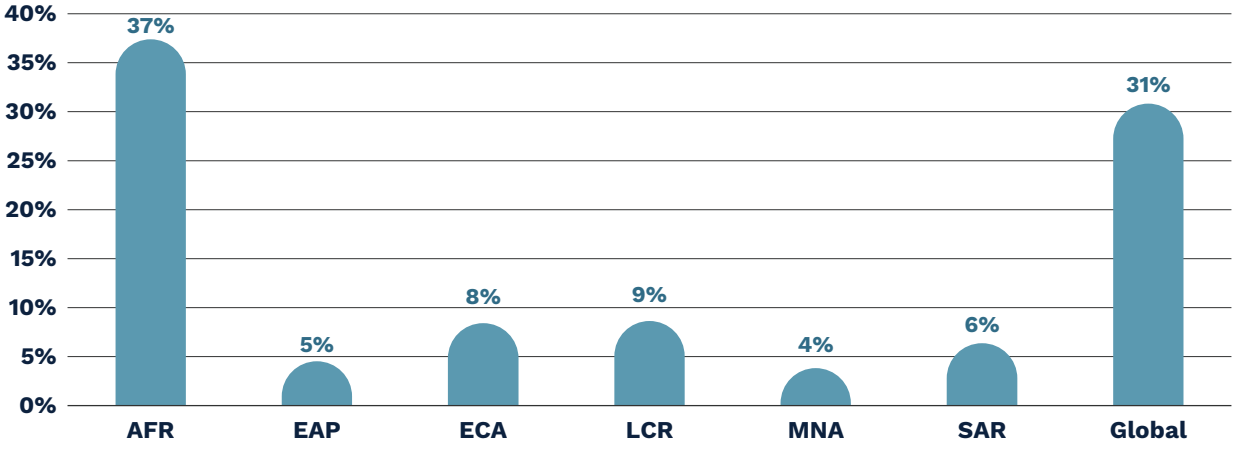


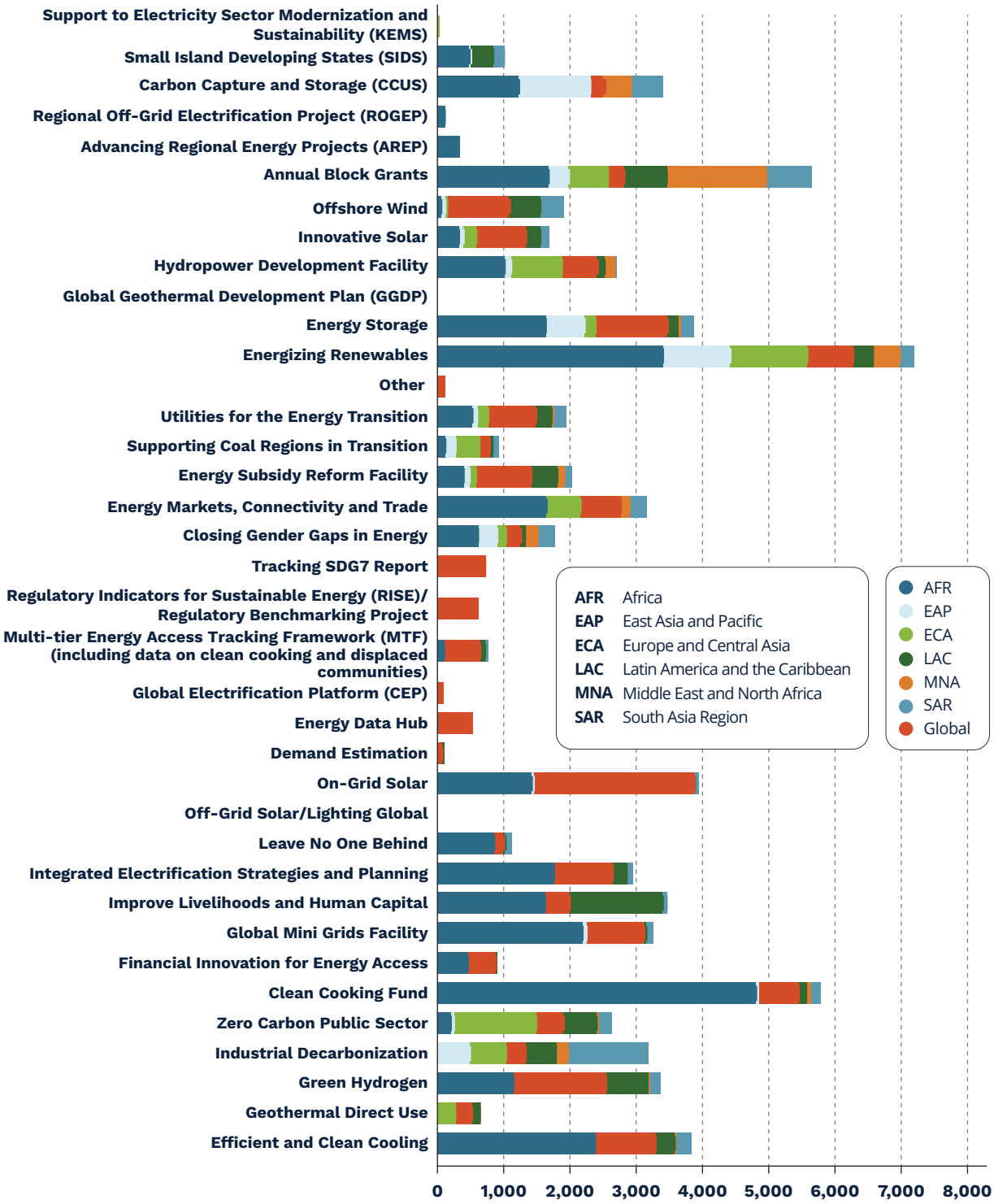
Table 3.3. ESMAP Disbursements, by Region and Program Management, FY2023 (US$ thousands)

Region		US$ Thousands
AFR		27,781
EAP		3,364
ECA		6,253
LCR		6,422
MNA		2,848
SAR		4,726
Global Programs		18,556
	Subtotal	**69,951**
Administrative Unit		
Program Management		4,349
	Grand Total	**74,300**

Table 3.4. ESMAP and Associated Trust Funds Disbursements, by Region, FY2023 (US$ thousands)

Region	ESMAP	AREP	CCS	KEMS	ROGEP	SIDS	Total
AFR	27,781	341	1,248		125	1499	30,995
EAP	3,364		1,076			28	4,468
ECA	6,253			34			6,287
LCR	6,422					334	6,757
MNA	2,848		392				3,240
SAR	4,726		351			158	5,235
Global Programs	22,906		223				23,128
Total	**74,300**	**341**	**3,290**	**34**	**125**	**2019**	**80,110**

Figure 3.2. ESMAP & Associated Trust Funds Disbursements, by Program Area, FY2024 (US$ thousands)



Note: ESMAP provides Annual Block Grants to World Bank regional energy units for flexible, just-in-time assistance to clients for sector fundamentals which can be combined with other ESMAP grants for strategic targets and dedicated technical support, agreeing on multi-year country programs with energy units, taking a whole-of-sector approach to achieving the overarching objectives of energy transition and energy access.

AR 2024 IMAGE LIST

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Woman watering crops using a solar powered irrigation system

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Photovoltaic Solar Energy Power Plant in the Dominican Republic

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Minigrid in Akura community, Nasarawa State, Nigeria

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Indian villager assembles a solar lamp in a class held as part of the Barefoot Solar Project

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Transporting produce in refrigerated trucks

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Electric buses in Kenya reduce emissions

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ENERGY DATA

Asian female engineer is repairing the charging station

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BOX: TRACKING SDG7

Safety inspector meets with a technician to review the plans for the upcoming changes that are needed for the solar panel rotation

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Crowd of anonymous people walking on busy street

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Amir Temur Square in central Tashkent, Uzbekistan

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Factory workers in India

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Electric buses at charging station

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CLEAN COOKING

https://www.esmap.org/State_of_Cooking_in_Schools

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BOX COOKING

Woman using an improved cookstove

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Technician installing solar panel

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A doctor examining a young pregnant woman as part of a medical health care camp in a village

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Maintenance female engineer working in hydroelectric power station

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Indian villagers assemble solar lamps in a class held to bring solar powered lighting to rural India

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Kurobe Dam, which is flooded for sightseeing

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Gaborone the capital city & commercial hub of Botswana

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Two women engineers, walking side by side through a job site

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An electrician at an offshore wind farm at dawn at work on the beach

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BOX HYDRO: Tajikistan

Dam spillway in Tajikistan

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ASSOCIATED TRUST FUNDS

FROM BUSINESS PLAN FY2025-30

https://www.esmap.org/ESMAP-business-plan-FY2025-2030

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Aerial view of solar panel on island

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FINANCIAL REVIEW

Happy farmer counting money or currency notes in front of solar panel at farmland

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Bringing electricity to underserved communities in Kenya

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Energy storage power station

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Solar park in Morocco

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