REN21 Renewable Energy Policy Network for the 21st Century

ECOWAS RENEWABLE ENERGY AND ENERGY EFFICIENCY

STATUS REPORT

2014

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PARTNER ORGANISATIONS

ECREEE is a specialised agency of ECOWAS which is based in Praia, Cabo Verde, and operates through a network of National Focal Institutions (NFIs) among all ECOWAS countries. The centre has a public mandate to promote sustainable development in West Africa by creating an enabling environment for regional renewable energy and energy efficiency markets. ECREEE contributes to the achievement of the targets of the UN Sustainable Energy for All Initiative and the ECOWAS Renewable Energy and Energy Efficiency Policy.

The Centre addresses the various existing market barriers for renewable energy and energy efficiency technologies and services and implements activities in the areas of policy development, capacity development, knowledge management and awareness-raising and business and investment promotion.

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

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

UNIDO is the specialized agency of the United Nations that promotes industrial development for poverty reduction, inclusive globalization and environmental sustainability.

The mandate of the United Nations Industrial Development Organization (UNIDO) is to promote and accelerate inclusive and sustainable industrial development in developing countries and economies in transition.

The Organization is recognized as a specialized and efficient provider of key services meeting the interlinked challenges of reducing poverty through productive activities, integrating developing countries in global trade through trade capacity-building, fostering environmental sustainability in industry, and improving access to clean energy.

Funding provided by:

FOREWORD

Fellow citizens, partners and readers!

It is a great honour and pleasure for me to present the first edition of the ECOWAS Renewable Energy and Energy Efficiency Status Report which provides a regional perspective of the renewable energy and energy efficiency market and industry development in West Africa in recent years.

Despite the vast energy resources of its 15 Member States, the energy market remains largely underdeveloped. Expanding access to modern, reliable, and affordable energy services has therefore become a key regional priority.

As part of efforts to increase access to modern energy services in the region, the ECOWAS authority established the ECOWAS Centre for Renewable Energy and Energy Efficiency (ECREEE) in 2010. Since its establishment, ECREEE has sought to actualise its vision and mandate of developing viable sustainable energy markets in the ECOWAS region.

In 2012, ECREEE in collaboration with its partners developed two regional policies: the ECOWAS Renewable Energy Policy (EREP) and ECOWAS Energy Efficiency Policy (EEEP). In July 2013, the Authority of ECOWAS Heads of State and Government adopted these two landmark policies. Both policies outline Renewable Energy and Energy Efficiency targets to be achieved by ECOWAS countries by 2030. The goals of the policies correspond precisely to the poles of the UN Secretary General's initiative on Sustainable Energy for All and have led to new developments in the renewable energy and energy efficiency sectors throughout the region.

In order to meet the ambitious targets set out above, ECREEE is currently assisting 15 ECOWAS countries to develop their Renewable Energy and Energy Actions Plans as well as the United Nations SE4ALL Action Agenda policy best practices, cross-border collaborations and domestic, regional and foreign investments in the region all need to be scaled-up. To achieve this it is critical that the full range of renewable energy activities in the region is understood and that this information is available to stakeholders in the region as well as to local and global investors, developers and project promoters.

The accelerated deployment of renewable energy and energy efficiency practices in the region cannot be achieved without good, up-to-date information. The ECOWAS Renewable Energy and Energy Efficiency Status Report contributes to this process by providing a comprehensive overview of the status of renewable energy markets, industry, policy and regulatory frameworks investments activities in the ECOWAS region. It draws on information at both regional and national levels to present the most up-to-date status on sustainable energy development in the 15 ECOWAS countries.

The report examines the evolving investment climate in the region, as it concerns renewable energy and energy efficiency. Understanding the region's emerging renewable energy industry, market development and growth is critical

> **UNDERSTANDING THE REGION'S EMERGING RENEWABLE ENERGY INDUSTRY, MARKET DEVELOPMENT AND GROWTH IS CRITICAL TO REALISING THE REGION'S POTENTIAL AND SCALING UP INVESTMENT OPPORTUNITIES.**

to realising the region's potential and scaling up investment opportunities.

Dear readers, it is my hope that this first edition of the ECOWAS Renewable Energy and Energy Efficiency Status Report will pave the way for further discussions, not only at the regional level but also at a global level. The report showcases the ECOWAS region as one of the most active regions in Africa for the promotion of renewables and energy efficiency, and thus a region ripe for increased investment. The region's collective efforts in this area will, in turn, lead to improvement in energy security, energy access and reduction of environmental externalities of the region's energy system and allow the ECOWAS countries to leapfrog towards a sustainable energy future by 2030.

As the Executive Director of the ECOWAS Centre for Renewable Energy and Energy Efficiency (ECREEE), I would like to thank the Government of Cape Verde, our strategic partners—the Governments of Austria (ADA), Spain (AECID) and the United Nations Industrial Development Organization (UNIDO), the European Union (EU), Germany, USAID, GEF and other development partners—for their strong and continuous support. I would also like to thank the REN21 Secretariat for their collaboration and management of the process as well as to the team of reviewers who have contributed immensely to the successful development of this report.

Mahama Kappiah
Executive Director
ECOWAS Centre for Renewable Energy and Energy Efficiency (ECREEE)

> **REN21 IS COMMITTED TO TRACKING THE DEVELOPMENT OF RENEWABLES WORLDWIDE. IN ADDITION TO ITS ANNUAL FLAGSHIP PUBLICATION - THE RENEWABLES GLOBAL STATUS REPORT - REN21 WORKS WITH REGIONAL PARTNERS TO SHED FURTHER LIGHT ON RENEWABLES DEVELOPMENT IN DIFFERENT WORLD REGIONS.**

Over the past decade, the share of people who lack access to modern energy services has fallen by nearly 10 percentage points — down from almost 25% — even as the global population has expanded significantly. Renewables have played a role in this improvement. These advances however are not evenly spread geographically. Large areas of Africa remain without access to modern energy services and it is the only region in the world where the share of population electrified is less than growth in total population. Renewables are uniquely positioned to provide needed energy services in a sustainable manner, more rapidly and generally at lower cost than their alternatives. Their potential for the African continent is significant.

Ten years ago, markets for modern renewable energy technologies were mainly concentrated in Europe and the United States. In the course of the past decade, renewables deployment has spread globally. Today, renewable energy technologies are viewed not only as tools for improving energy security and mitigating and adapting to climate change, but are also recognised increasingly as investments that provide both direct and indirect economic advantages by reducing dependence on imported fuels; improving local air quality and safety; advancing energy access and security; propelling economic development; as well as creating jobs.

Declining costs have also played a significant role in the expansion of renewable energy deployment in recent years. Several renewable energy technologies are today cost-competitive with conventional generation technologies, even before environmental and other externalities are taken into consideration.

REN21 is committed to tracking the development of renewables worldwide. In addition to its annual flagship publication — the Renewables Global Status Report — REN21 works with regional partners to shed further light on renewables development in different world regions. The ECOWAS Renewable Energy and Energy Efficiency Status Report, complements earlier regional status reports on China, India and the MENA region.

We would like to thank ECREEE and all partners involved for the excellent collaboration throughout the production of this report. Particular thanks go to colleagues at the Worldwatch Institute for their dedicated work throughout the process. We hope that you find this report informative.

Christine Lins
Executive Secretary
Renewable Energy Policy Network for the 21st Century (REN21)

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Through research and outreach that inspire action, the Worldwatch Institute works to accelerate the transition to a sustainable world that meets human needs. Worldwatch is a global leader in climate and renewable energy policy analysis, with a 40-year track record as one of the most influential environmental think tanks in the world.

The Institute works with governments around the world to develop Sustainable Energy Roadmaps that facilitate the integration of local and renewable energy sources to their full potential. Worldwatch authors the highly acclaimed State of the World and Vital Signs series of reports capturing the latest global climate and energy trends, and has written numerous publications on international renewable energy development.

Bloomberg New Energy Finance has contributed data from the forthcoming Global Climatescope (www.global-climatescope.org), an assessment, index and practical tool for investors, policy-makers and other decision-makers to access data on and compare the attractiveness of countries around the world for clean energy and other low carbon investment. Climatescope is supported by the UK Department for International Development (DFID), the Multilateral Investment Fund (MIF) of the Inter-American Development Bank Group and the US Agency for International Development (USAID). The first Global Climatescope, builds on the editions in 2012 and 2013 covering the Latin American and Caribbean nations and will include activity in Africa and Asia to comprise a total of 78 countries and key states around the world. It will be published later in 2014.

The Africa EU Energy Partnership (AEEP) provides a long-term framework for structured dialogue and co-operation between Africa and the EU on energy issues of mutual strategic importance. Its efforts focus on meeting a series of concrete, realistic and visible targets set by African and European Ministers to be achieved by 2020, the results of which have been elaborated in a Status Report released in early 2014. The report has laid the foundation for the creation of a Monitoring Tool that tracks progress towards achieving the AEEP 2020 Political Targets in future. Data compiled by the AEEP for this work has been used in the preparation of the ECOWAS Renewable Energy and Energy Efficiency Status Report.

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EXECUTIVE SUMMARY

In recent years, the Economic Community of West African States (ECOWAS), comprising 15 Member States,[i] has emerged as one of the most active and dynamic regional economic communities on the African continent. Expanding access to modern, reliable, and affordable energy services is a key priority, prompting inter-state cooperation in crucial areas including capacity building, policy development and implementation, and investment. Recognising the critical role that sustainable energy plays in catalysing social, economic, and industrial development across the region, ECOWAS Member States formally inaugurated the ECOWAS Centre for Renewable Energy and Energy Efficiency (ECREEE) in 2010 to "contribute to the sustainable economic, social and environmental development of West Africa by improving access to modern, reliable and affordable energy services, energy security and reduction of energy related externalities."

Drawing on data from the ECOWAS Observatory for Renewable Energy and Energy Efficiency (ECOWREX) and a network of contributors and researchers across the region, the *ECOWAS Renewable Energy and Energy Efficiency Status Report* supports ECREEE's efforts to increase the deployment of renewable energy and energy efficiency in West Africa by providing a comprehensive regional review of renewable energy and energy efficiency developments, evolving policy landscapes, market trends and related activities, investments in renewable energy and off-grid energy solutions, and the crucial nexus between energy access and gender.

REGIONAL OVERVIEW

With an expanding population of just over 334.6 million in mid-2014, ECOWAS Member States represent approximately one-third of sub-Saharan Africa's total population. They comprise a diverse set of demographic, socio-economic, and social contexts. Population size ranges from Cabo Verde (539,000) to Nigeria (177,156,000), while gross domestic product (GDP) per capita ranges from USD 800 in Niger to USD 4,400 in Cabo Verde. Overall, most ECOWAS Member States continue to face major development challenges, with 13 Member States classified as having "Low Human Development" by the United Nations. These factors, along with demographic trends including urbanisation and accelerating economic development, contribute to and are influenced by the region's severe energy challenges.

Given the positive correlation between energy access and human and economic development, expanding access to modern energy services, including electricity and modern cooking fuels, is an enormous and urgent priority for the ECOWAS region. As of 2014, the region remains heavily dependent on traditional biomass resources like wood and charcoal, particularly in rural areas. In 2011, sub-Saharan Africa accounted for almost half (47.6%) of all people without access to electricity and is the only region in the world where the rate of progress in expanding access to electricity and non-solid fuels fell behind population growth between 1990 and 2010. Within ECOWAS, national electricity access rates vary widely, from Niger—which had an electrification rate of just 9% in 2011—to Cabo Verde, which has achieved nearly universal access. However, national rates mask wide disparities between access in urban versus rural areas, which remain underserved by grid networks supplying major cities. Within ECOWAS, the estimated share of rural populations with access to electricity ranges from just 1% in Guinea and Sierra Leone to 70% in Cabo Verde. Access to modern cooking fuels is also severely limited. In sub-Saharan Africa as a whole, the average share of national populations relying on solid fuels for cooking is just over 79%; within ECOWAS, this figure rises to 85.7%.

Energy security in the ECOWAS region is threatened by various factors including poor system reliability, limited infrastructure, fuel import dependence, and heavy reliance on fossil fuels, hydropower, and traditional biomass resources. In the electricity sector, the growing gap between generation capacity and demand is exacerbated by high commercial and technical losses—estimated at 21.5% in West Africa in 2010. Dependence on either fossil fuels or hydropower can pose additional challenges, leaving countries vulnerable to volatile global fuel prices, variations in annual and

i. Benin, Burkina Faso, Cabo Verde, Côte d'Ivoire, The Gambia, Ghana, Guinea, Guinea-Bissau, Liberia, Mali, Niger, Nigeria, Senegal, Sierra Leone, and Togo.

seasonal output from hydropower plants, and supply disruption. Despite fossil fuel extraction being an important economic factor in specific ECOWAS countries—including Ghana and Nigeria—all but two Member States are net importers of refined petroleum products. Reliance on traditional biomass has resulted in significant deforestation in several Member States.

The region's energy sector has also had significant impacts on human health and the environment. Reliance on traditional biomass and solid fuels for cooking and heating has led to more than 257.8 million people being affected by household air pollution from indoor smoke, small particle pollution, carbon monoxide, and nitrogen oxides. Other injuries—particularly burns—pose significant threats. Collecting these resources also exposes women—mostly in rural areas—to the risk of injury, rape, or harassment, and limits the time available for education, commercial activities, or leisure. In Member States that extract fossil fuels, negative environmental impacts on air, soil, and water have been widely reported. Projected climate change impacts in the region are significant, and will likely affect energy supply. For example, more variable rainfall could make dependence on hydropower increasingly costly and unreliable, highlighting the need to diversify energy supply and consider climate resilience in energy planning.

In the coming years, rising energy demand fuelled by population growth, rapid urbanisation, and economic development will place additional strain on the region's energy system. By harnessing the region's tremendous renewable energy potential across a diverse set of resources, including modern biomass, hydropower, solar, and wind, ECOWAS Member States have already begun to address these challenges.

RENEWABLE ENERGY MARKET AND INDUSTRY OVERVIEW

Cooking accounts for a large share of regional energy use. An average 85.7% of each Member State's population currently uses solid fuels (predominantly wood and charcoal) for cooking, with national figures ranging from 98% in Guinea-Bissau, Liberia, Mali, and Sierra Leone, to 31% in Cabo Verde. Efficient cook stoves, gas, and electricity represent opportunities to expand access to clean cooking fuels. Although data on clean cook stove penetration in the region is limited, it is estimated that significant shares of the populations in Sierra Leone (10%), Senegal (16%), and the Gambia (20%) are using improved biomass cook stoves. Cabo Verde and Senegal exhibit particularly widespread use of liquefied petroleum gas (LPG) which, although not renewable, has significant environmental and health benefits over wood and charcoal. Very few ECOWAS inhabitants rely on electricity for cooking, which remains expensive and unavailable in many parts of the region.

Renewable energy technologies play an increasingly important role in power generation. Although hydropower has been used throughout the region for many decades, deployment of non-hydro renewables—including wind, solar, and biomass—is accelerating. Within ECOWAS, electricity has traditionally been provided through conventional grid systems. As of mid-2014, an estimated 4.8 gigwatts (GW) of grid-connected renewable installed capacity (39 megawatts (MW) exists in the region, accounting for approximately 28% of the region's total installed capacity. Increasingly, however, regional electricity grids face considerable challenges including high expansion costs, aging infrastructure, and vulnerability to the impacts of climate change. Moving forward, renewable mini-grids and stand-alone systems have been identified as important tools to achieve the region's energy goals.

Hydropower is the region's most well established and widely used renewable energy technology and remains the only renewable technology deployed on a commercial scale in many Member States. With only 19% of the region's estimated 25 GW of hydropower potential exploited to date, significant opportunities for expansion remain. While the region has historically targeted large, rather than small or medium-sized hydropower projects, interest in small hydropower development has increased, with numerous projects now under way across the region.[ii]

As of 2014, two ECOWAS member states have over 1 GW of hydropower capacity. Nigeria is the regional leader with just under 2 GW installed, followed by Ghana with a total of 1.6 GW. Additional hydropower capacity is installed in Côte d'Ivoire (604 MW), Mali (300 MW), Guinea (126.8 MW), Togo (65.6 MW), Sierra Leone (56 MW), Burkina Faso (29 MW), Liberia (4.6 MW), and Benin (2 MW).

As of early-2014, a total of 27 MW of wind power had been installed in ECOWAS. Most of the region's wind capacity is located in Cabo Verde, where the 25.5 MW Cabeolica wind farm became sub-Saharan Africa's first commercial-scale, public-private partnership (PPP) wind project when it was inaugurated in 2011. Additional grid-connected wind power has been developed in the Gambia, and several new projects are scheduled to come online in Senegal and Togo.

Member States have demonstrated a growing interest in grid-connected and large-scale solar photovoltaic (PV) projects. Cabo Verde is the regional leader in solar PV, with two solar farms totalling 6.4 MW. Ghana's 1.9 MW solar PV installation, slated for expansion to 2.5 MW, is the largest grid-connected solar project outside of Cabo Verde and several additional PV plants are scheduled to come online in Ghana by the end of 2015. To date, however, the region's use of solar PV remains concentrated in distributed and off-grid functions. Although estimates of total installed solar PV capacity are unreliable, as few Member States collect data on self-generation or off-grid projects, assorted estimates for Guinea-Bissau (3 MW), Ghana (3.2 MW), Niger (4 MW), Nigeria (20 MW), and Senegal (21 MW), indicate widespread use of the technology throughout the region.

ii. Although definitions of small-scale hydropower differ by Member State, the ECOWAS definition is between 1 and 30 MW.

Several projects in the region use modern biomass to supply electricity to the grid, including a 3 MW Waste-to-Power plant in Côte d'Ivoire. Primarily, biomass power production is used for self-generation in industrial plants. Wind and solar have long supplied power for tasks including water pumping, although data regarding region-wide implementation and use remain limited.

In the face of insufficient and unreliable central grid systems, mini-grids and off-grid technologies present cost-effective ways to generate electricity in remote communities. Solar technologies—including solar PV, solar lanterns, and solar water heaters—are well-suited for distributed generation and rural electrification efforts and are being used throughout the ECOWAS region to power community centres, health clinics, and individual homes, as well as street lights, and for water heating, cooling, and drying. Renewable and hybrid mini-grids are increasingly being explored and implemented as solutions for rural electrification. The Malian Agency for the Development of Household Energy and Rural Electrification has been particularly active in developing mini-grids, including 21 hybrid PV-diesel projects totalling 2.1 MW.

ENERGY EFFICIENCY

Energy efficiency improvements are among the most cost-effective solutions for offsetting the rising energy costs, unpredictable and uncertain energy supply, and growing demand for energy services faced by ECOWAS Member States. Currently, the region's continued reliance on aging and inefficient equipment (often acquired second-hand) combined with the inefficient use of traditional biomass results in low efficiency ratings. Collectively, the 15 ECOWAS Member States have an average energy intensity of 14.5 mega joules (MJ) per USD, well above the continental average of 11 MJ/USD. The ECOWAS Heads of State have prioritised energy efficiency as an essential tool to meet the region's energy supply challenge, a commitment formalised with the 2013 adoption of the *ECOWAS Energy Efficiency Policy* (EEEP). The EEEP prioritises cooking, lighting, buildings, and electricity distribution as high-impact opportunities for improving efficiency, and outlines targets and priority measures to reduce energy use and increase productivity through the development of National Energy Efficiency Action Plans (NEEAP) in each Member State.

Technical and non-technical losses in the region's grid networks represent a major barrier to further energy sector development. National rates of electricity loss vary by Member State, ranging from 15% to 50%, while estimated average losses across the region fall between 21.5% and 25%. Despite the current lack of formalised initiatives to increase efficiency in the region's electricity systems, ECREEE has identified two successful programmes—in Ghana and Nigeria—that have sought to reduce losses by improving and maintaining existing equipment, as well as removing illegal connections and optimising billing to increase cost recovery. For future infrastructure planning across the region, decentralised renewables have the potential to mitigate losses by reducing the need for extensive transmission infrastructure.

Lighting, which accounts for 15% of global electricity consumption, has been identified as a "High Impact Opportunity" by the Sustainable Energy for All (SE4ALL) initiative. Lighting is also a priority area for efficiency improvements in ECOWAS, where it is estimated, for example, that in Nigeria up to 60% of peak load goes to lighting services. Introducing efficiency measures is one of the most cost-effective ways to reduce electricity consumption during peak periods. ECREEE is spearheading a region-wide focus on efficient lighting through the Regional Energy Efficient Lighting Strategy. The complete phase-out of incandescent lamps by 2020 is expected to result in annual energy savings of some 2.4 terawatt-hours, equal to 6.8% of the region's annual consumption—which would meet the annual electricity needs of an estimated 2.4 million households and save the region more than USD 200 million per year.

The transition to energy-efficient, clean cook stoves and cleaner cooking fuels is another critical component of the ECOWAS Renewable Energy Policy. The use of advanced cook stoves can mitigate many of the negative health, environmental, and social impacts associated with the use of traditional biomass. In recent years, projects in the ECOWAS region have demonstrated many of the benefits of using energy-efficient stoves. These include cost, time, and fuel savings; easier and faster cooking; decreased smoke and negative health impacts from indoor air pollution; and the reduced occurrence and risk of fires and burns. In the Gambia, for example, households using new, efficient cook stoves reported a one-hour reduction in cooking time, and a one-third reduction in average monthly cooking fuel expenditures. Several national level training and dissemination programmes have been developed in ECOWAS Member States including the Gambia, Ghana, Mali, and Nigeria. The Global Alliance for Clean Cookstoves is also active in the region, with Ghana and Nigeria ranking amongst its eight prioritised focus countries.

Buildings, the final priority area of the EEEP, account for 30–40% of total final energy demand around the world. With a rapidly growing population, urban expansion, and projected economic growth, buildings' contribution to energy demand across Africa is expected to rise. Energy efficiency improvements in buildings typically fall into two major categories: improvements in building construction and improvements in building energy use through advanced equipment. Benin has emerged as a leader in building sector energy efficiency—identifying potential for a 35% reduction in energy use from public buildings—and is joined by Côte d'Ivoire and Senegal as the only three ECOWAS Member States to have established domestic programmes for building efficiency. At the regional level, both ECOWAS and the West African Economic and Monetary Union (UEMOA) have enacted programmes dedicated to increasing building efficiency in West Africa through trainings, financing, and the development of standardised model building codes.

> **ENERGY EFFICIENCY IMPROVEMENTS ARE AMONG THE MOST COST-EFFECTIVE SOLUTIONS FOR OFFSETTING THE RISING ENERGY COSTS, UNPREDICTABLE AND UNCERTAIN ENERGY SUPPLY, AND GROWING DEMAND FOR ENERGY SERVICES FACED BY ECOWAS MEMBER STATES.**

POLICY

The enactment of the ECOWAS Renewable Energy Policy (EREP) and the ECOWAS Energy Efficiency Policy (EEEP) highlights the strong commitment that ECOWAS Member States have made to develop their sustainable energy sectors. Through these policies, Member States have committed to a host of ambitious regional energy development goals. At the national level, Member States have already begun incorporating sustainable energy development into their policymaking process and are strengthening their commitments by developing National Renewable Energy Action Plans (NREAPs). As of early-2014, 13 Member States had adopted some form of renewable energy support policy, 13 Member States had a renewable energy target in place, and all 15 Member States had at least one policy or one target at the national level, promoting renewable energy technology developments.

Throughout ECOWAS, renewable energy targets have been an important tool for charting an ambitious path forward for the sustainable energy sector at the national and regional levels. Targets have taken many forms and focussed on many different aspects of energy development, including expanding energy and electricity access, increasing renewable power, and improving energy efficiency.

Renewable energy support policies also take many forms and address different barriers to renewable energy development. Pricing instruments—such as feed-in policies or fiscal incentives—as well as quantity instruments—including renewable portfolio standards (RPS)—can provide a strong incentive to project developers. As is the case worldwide, the majority of renewable energy support policies in ECOWAS continue to focus on the electricity sector. Feed-in policies remain the most commonly used policy support mechanism, currently implemented in 71 countries and 27 states/provinces worldwide. In 2011, Ghana became the first ECOWAS Member State to establish a feed-in tariff (FIT) for renewable energy. As of early-2014, FITs had been adopted in two Member States—Ghana and Nigeria—and are currently being developed in the Gambia and Senegal. In 2011, Cabo Verde became the first and only, as of early-2014, ECOWAS Member State to adopt a net metering policy. The policy was inaugurated with the connection of a 9.9 kilowatt (kW) solar PV system installed on ECREEE headquarters. Provisions for the Gambia's proposed FIT and net metering policies are included in its proposed Renewable Energy Act 2012, which has yet to be adopted. To date, quantity instruments have played a lesser role in the region's renewable energy policy mix. Ghana mandates its Public Utilities Regulatory Commission to develop quotas for the purchase of renewable power by electricity distribution companies and bulk consumers, while Senegal mandates that its national electric company deploy renewables in its concession areas.

Throughout ECOWAS, financial instruments are the predominant means of supporting the renewable energy sector and are in place in 13 Member States. Tax incentives take a number of forms, including investment or production tax credits, as well as reduction or elimination of taxes such as import duties, sales, and value-added tax (VAT). Import duties on renewable energy components have been reduced or removed in Burkina Faso, Ghana, Mali, and Nigeria, while value-added tax reductions for renewable energy projects have been established in Burkina Faso, Ghana, and Mali. In addition, Benin, Cabo Verde, Côte d'Ivoire, the Gambia, Guinea, Guinea-Bissau, Niger, Senegal, and Togo all offer some form of tax incentive for renewable energy. In Ghana, Mali, Nigeria, and Senegal additional financial support has come from public financing mechanisms such as public investment, project grants or low interest loans. Tendering or auctions for renewable energy projects have also attracted policymakers' attention in recent years because of their potential to identify the most cost-effective project development plans. Both Burkina

Faso and Cabo Verde have utilised renewable energy auctions for project allocation.

While the EREP established regional targets for renewable heating and transportation, only a handful of Member States have enacted national policies or targets directed at these sectors. Sierra Leone is the only ECOWAS Member State with an established target for the use of solar thermal technology, while both Ghana and Senegal have enacted mandates for the use of renewable heat. Ghana has also adopted a 50% import tax reduction for solar water heaters. In the transportation sector, Mali and Ghana have both established mandates for the use of biofuels, while Nigeria has established a 10% ethanol blend and 20% biodiesel target under its national biofuel policy.

Energy efficiency is increasingly becoming a central focus of policymakers in the region. However, the uptake of energy efficiency policies has been slow compared to the renewable energy sector, with energy efficiency policies having been enacted in only four Member States. Regionally, the EEEP has established targets for energy efficiency improvements across its priority sectors: lighting, electricity distribution, cooking, standards and labelling, building codes, and financing. Within individual Member States, mandates, incentives, and financing measures to promote efficiency are beginning to be adopted. Standards—often called Minimum Energy Performance Standards (MEPS)—and labelling for energy-efficient products are primary regulatory measures used to promote energy efficiency in the region. To date, MEPS have been utilised primarily for lighting, as well as for electrical appliances like air conditioners and refrigerators. As of early-2014, Ghana and Nigeria were the only ECOWAS Member States with MEPS in place, having established standards for CFLs and air conditioners and self-ballasted lamps and compact fluorescent lamps (CFLs) respectively. Additional standards are being developed in Burkina Faso, Côte d'Ivoire, Nigeria and Senegal. At the international level, Ghana and Nigeria are engaged with the Global Alliance for Clean Cookstoves, the International Organization for Standardization, and a network of 20 countries to develop international standards for cook stoves and clean cooking solutions. Mandates and/or quotas for the use of energy-efficient lighting are now in place in both Ghana and Senegal. Ghana has banned the importation and sale of used cooling equipment, while Senegal has developed a biomass quota system to reduce dependence on forest resources for cooking fuels. As with renewable energy technologies, a host of tax incentives and public financing measures for energy efficiency have been employed in the region, although to a lesser degree.

INVESTMENTS

Globally, an estimated USD 214 billion was invested in renewable energy technologies in 2013. This figure rises to USD 249.4 billion if large hydropower is included. After increasing by 228% from 2011 to 2012, renewable energy investment in the Middle East and Africa declined in 2013, attracting USD 9 billion (down from USD 11 billion in 2012). Overall, the Middle East and Africa accounted for 4.2% of the global investment total. Despite the lack of consolidated, reliable data on investments in the renewable energy sector for the ECOWAS region, analysis by Bloomberg New Energy Finance of six leading ECOWAS Member States—Côte d'Ivoire, Ghana, Liberia, Nigeria, Senegal, and Sierra Leone—shows a historically variable investment climate for renewables. In 2013, these six countries attracted USD 29.7 million, down significantly from the peak of USD 370 million in 2011.

Both public and private financing have played an important role in the sector's development to date. While data on private finance flows in the region is not widely available, an analysis of regional projects such as the Cabeolica Wind Farm shows that private financing has played a key role in project development. Further incentivising private finance has been one of the key priorities within the developing regional energy policy framework.

Public financing from national, regional, and international institutions has also been instrumental in the funding of renewable energy development in the ECOWAS region. Domestic governments, international development partners, and multilateral development banks have all allocated funds to the region's energy sector. Millions of dollars of support have been lined up through specialised regional and Africa-wide funds and programmes such as the ECOWAS-led Renewable Energy Investment Initiative (EREI) and Renewable Energy Facility (EREF), the Sustainable Energy Fund for Africa (SEFA), the African Renewable Energy Fund (AREF), and the Power Africa Initiative. International financing through mechanisms established under the United Nations Framework Convention on Climate Change (UNFCCC) process—such as the Global Environment Facility (GEF), Climate Investment Funds (CIF), Clean Development Mechanism (CDM), and Nationally Appropriate Mitigation Actions (NAMAs)—have all supported renewable energy development in the region and offer an opportunity to continue scaling up future investments.

01

REGIONAL INTRODUCTION

01 | REGIONAL INTRODUCTION

OBJECTIVE OF THE REPORT

In recent years, the Economic Community of West African States (ECOWAS), comprising 15 Member States, [iii] has emerged as one of the most active and dynamic regional economic communities on the African continent. ECOWAS works across a variety of fronts to "promote economic integration in all fields of economic activity", including industry, transportation, telecommunications, energy, and natural resources.[1] Expanding access to modern, reliable, and affordable energy services is a key ECOWAS priority, prompting inter-state cooperation in crucial areas including capacity building, policy development and implementation, and investment.

Over the past decades, the region has taken enormous steps toward defining its energy goals and establishing strategies to achieve them. Recognising the critical role that sustainable energy plays in catalysing social, economic, and industrial development across the region, ECOWAS Member States formally inaugurated the ECOWAS Centre for Renewable Energy and Energy Efficiency (ECREEE) in 2010, granting it a public mandate to promote renewable energy and energy efficiency in the region.[2] ECREEE's overall objective is to "contribute to the sustainable economic, social and environmental development of West Africa by improving access to modern, reliable and affordable energy services, energy security and reduction of energy related externalities."[3] To achieve these goals, the ECREEE Secretariat works with a network of National Focal Institutions (NFIs) in each Member State, as well as with key organisational partners, to support activities designed to overcome sectoral barriers and facilitate regional markets in renewable energy and energy efficiency.

The *ECOWAS Renewable Energy and Energy Efficiency Status Report* supports ECREEE's efforts to strengthen data collection and knowledge sharing by providing a comprehensive regional review of renewable energy and energy efficiency developments, market trends and related activities, evolving policy landscapes, investments in renewable energy, and the crucial nexus between energy access and gender. It draws on data from the ECOWAS Observatory for Renewable Energy and Energy Efficiency (ECOWREX), as well as a broad network of contributors and researchers across the region.

Data Collection for the ECOWAS Renewable Energy and Energy Efficiency Status Report

The *ECOWAS Renewable Energy and Energy Efficiency Status Report* presents up-to-date, reliable data and information on the sustainable energy sectors of the 15 ECOWAS Member States. Information compiled in the report is based on contributions from ECREEE, ECREEE National Focal Institutions (NFIs), REN21's extensive international network, and a number of leading organisations and experts active throughout the ECOWAS region. Despite noteworthy advancements in data collection and valued collaboration with regional partners, significant data gaps remain. While effort was made to provide the most comprehensive overview of the region's current sustainable energy sector, the scope and scale of the material presented here reflects these information gaps. The exclusion of any programmes, themes, sectors, or technologies reflects a lack of information, not a judgment on their importance to the region. The report serves as a both a benchmark for assessing the current status of renewable energy and energy efficiency as well as for expanding future data gathering initiatives in ECOWAS.

iii. Benin, Burkina Faso, Cabo Verde, Côte d'Ivoire, The Gambia, Ghana, Guinea, Guinea-Bissau, Liberia, Mali, Niger, Nigeria, Senegal, Sierra Leone, and Togo.

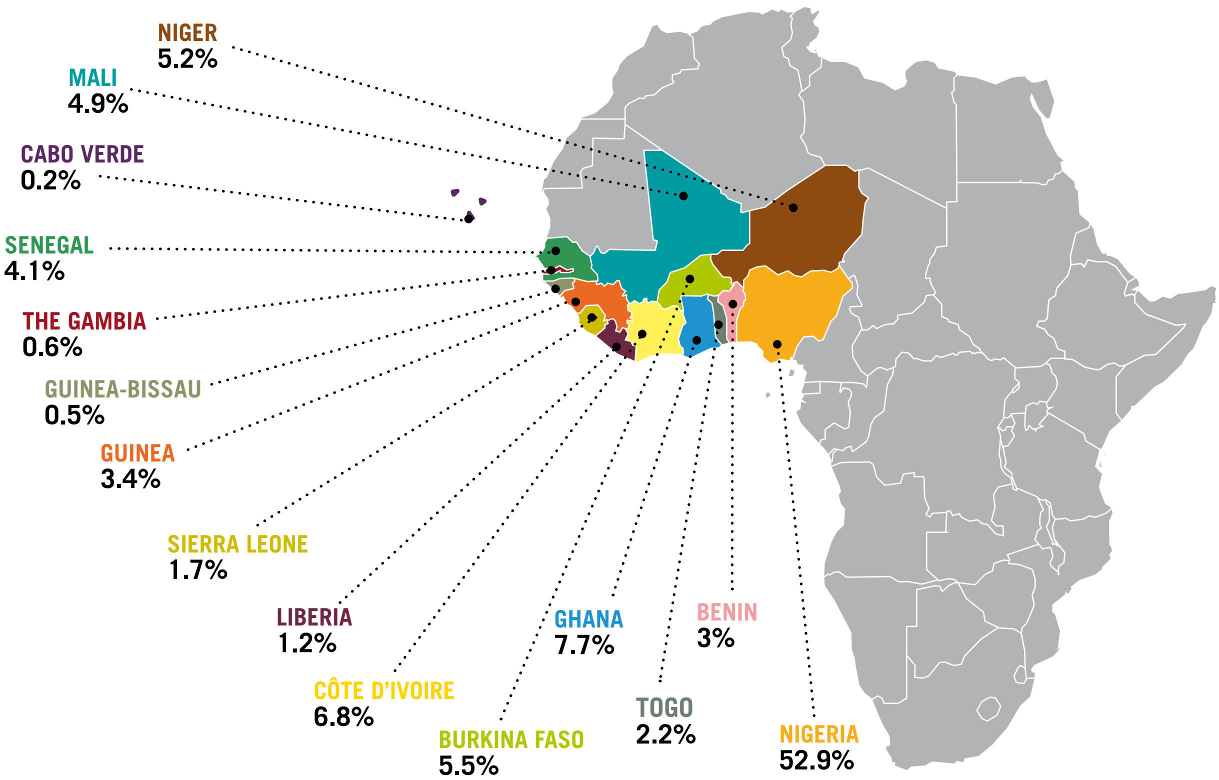
REGIONAL OVERVIEW

The 15 ECOWAS Member States cover a diversity of demographic, socio-economic, and social contexts, each of which impacts energy demand and supply throughout the region.[4] (See Table 1.) With a regional population of just over 334.6 million, ECOWAS accounts for approximately one-third of sub-Saharan Africa's total population.[5] (See Figure 1.) Three Member States (Côte d'Ivoire, Ghana, and Nigeria) account for more than two-thirds (67.5%) of the region's population.[6] By 2050, Nigeria is projected to become the third most populous country in the world—behind only India and China—while Niger already has the world's highest Total Fertility Rate[iv] at 7.6.[7] With an average regional population growth rate of 2.5% and regional economic growth generally projected to accelerate, rising demand for energy and other resources will continue to pose a major challenge in the decades ahead, contributing to the urgent need to improve energy efficiency and deploy renewable energy solutions.[8]

The average annual rate of urbanisation (2010–2015) in ECOWAS Member States is just under 4%, marking a continuing trend of people moving to cities in search of economic opportunity.[9] As of 2011, 43% of ECOWAS's population lived in urban areas, although this figure varies widely on a national level from 17.8% in Niger to 62.6% in Cabo Verde.[10] In Burkina Faso, urbanisation is particularly rapid (6% per year), and Lagos, Nigeria already ranks among the world's megacities. [v,11]

The size and scope of ECOWAS economies vary widely. Nigeria, with a gross domestic product (GDP) of USD 478.5 billion, has by far the region's largest economy, while Guinea-Bissau has a GDP of only USD 2.01 billion.[12] GDP perw capita ranges from USD 800 in Niger to USD 4,400 in Cabo Verde.[13] Most ECOWAS countries rank among the poorest in the world, with 13 Member States classified as having "Low Human Development" by the United Nations.[14]

FIGURE 1 | National Share of ECOWAS Total Population



Source: see Table 1 of this section.

iv. Total Fertility Rate refers to the average number of children born to a woman during her lifetime.
v. Defined as a metropolitan area with a total population in excess of 10 million people. (See Figure 1.)

TABLE 1 | Regional Overview Statistics

	Population (July 2014 est.)	Population Density (July 2014 est.)	Population Growth Rate (2014 est.)	Urban Population (2011)	Annual Rate of Urbanisation (2010–15 est.)	GDP (2013 est.)	GDP per Capita (2013 est.)	Human Development Index 2014	
	thousand people	people/km²	%	%	%	USD billlion PPP[a]	USD/PPP	ranking[b]	
Benin	10,161	91.9	2.81	44.9	4.12	16.65	1,600	165	Low
Burkina Faso	18,365	67.1	3.05	26.5	6.02	26.51	1,500	181	Low
Cabo Verde	539	133.6	1.39	62.6	2.12	2.22	4,400	123	Med.
Côte d'Ivoire	22,849	71.9	1.96	51.3	3.56	43.67	1,800	171	Low
The Gambia	1,926	192.6	2.23	57.3	3.63	3.68	2,000	172	Low
Ghana	25,758	113.2	2.19	51.9	3.5	90.41	3,500	138	Med.
Guinea	11,474	46.7	2.63	35.4	3.86	12.56	1,100	179	Low
Guinea-Bissau	1,693	60.2	1.93	43.9	3.59	2.01	1,200	177	Low
Liberia	4,092	42.5	2.52	48.2	3.43	2.90	700	175	Low
Mali	16,456	13.5	3.00	34.9	4.77	18.90	1,100	176	Low
Niger	17,466	13.8	3.28	17.8	4.91	13.98	800	187	Low
Nigeria	177,156	194.5	2.47	49.6	3.75	478.50	2,800	152	Low
Senegal	13,636	70.8	2.48	42.5	3.32	27.72	2,100	163	Low
Sierra Leone	5,744	80.2	2.33	39.2	3.04	9.16	1,400	183	Low
Togo	7,351	135.2	2.71	38	3.3	7.35	1,100	166	Low
ECOWAS	Total	Member State Average	Member State Average	Member Stat Average	Member State Average	Member State Average	Member State Average		
	334,666	88.5	2.47	42.9	3.79	50.4	1,807		

[a] Purchasing power parity
[b] The Human Development Index ranks 186 countries in terms of their human development, with 1 being the highest score and 186 being the lowest.
Source: see endnote 4 for this section.

As the region progresses in its efforts to streamline sustainable energy policy and scale up investment, the demographic trends featured in Table 1 will contribute to shaping energy demand profiles and determining effective strategies. For example, the breakdown of final energy consumption by sector varies significantly according to economic size and composition.[15] (See Table 2.) In low-income economies, the household sector tends to account for the vast majority of energy consumption; in Niger, for example, households consume approximately 90% of all final energy.[16] This energy goes towards fulfilling a variety of basic needs. In the Gambia, as in much of the region, the primary uses of domestic energy in 2013 included heating water; cooking (brewing tea, roasting meat, warming food); drying fish, fruit, and vegetables; and ironing clothes.[17] In other Member States, consumption is distributed more evenly across economic sectors. Ghana's household sector consumed 38.8% of final energy in 2012, while transport accounted for an additional 38.9% and industry nearly 20%.[18] These factors help determine which sectors should be targeted for energy efficiency improvements, as well as where renewable energy deployment could have the biggest impact.

REGIONAL ENERGY CHALENGES

In the lead-up to developing the *ECOWAS Renewable Energy Policy*, ECREEE identified several major interrelated energy challenges facing the region including energy access, energy security, impacts on human health and the environment, and climate change.[19] Each of these plays a major role in shaping the regional energy situation, and policy frameworks and investment must take them into account. Factors including policy and regulatory mechanisms (Chapter 4), technical capacity, and access to commercial and concessional finance (Chapter 5) affect countries' abilities to address these challenges.

Energy Access

Expanding access to modern energy services, including clean cooking fuels and electricity, is an enormous and urgent priority for the ECOWAS region. The United Nations' Sustainable Energy for All (SE4ALL) initiative reports that sub-Saharan Africa was the only region in the world where the rate of progress in expanding access to electricity and non-solid fuels fell behind population growth between 1990 and 2010.[20]

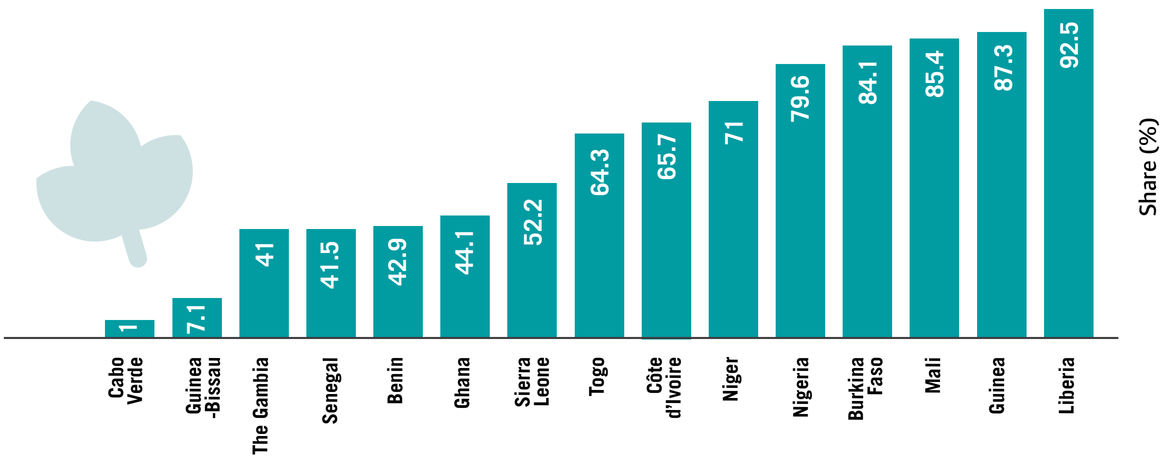
The ECOWAS region's total final energy consumption (TFEC) reached approximately 5,687 petajoules in 2010, accounting for about 35% of the sub-Saharan total.[21] Across the region, traditional biomass resources such as wood and charcoal play a central role in fulfilling basic energy needs. In 2010, traditional biomass accounted for more than half of TFEC in nine Member States.[22] (See Figure 2.) Households in particular depend heavily on these resources. In the Gambia, for example, the International Renewable Energy Agency (IRENA) estimates that traditional biomass accounts for 90% of household energy consumption (rising to 97% in some rural areas).[23] In Côte d'Ivoire, wood and charcoal account for about 70% of household energy consumption.[24]

TABLE 2 | GDP per Capita and Share of Final Energy Consumption by Sector in Selected ECOWAS Member States

		Niger (2012)	Guinea-Bissau (2010)	Nigeria (2011)	Ghana (2012)
GDP per CAPITA (USD)		800	1,200	2,800	3,500
Share of Final Energy Consumption by Sector (%)	**Household**	90	89	80.1	38.8
	Transport	8	8	7.5	38.9
	Industry	2	2	11.9	18.8
	Other	—	1	0.5	3.5

Note: The consumption data compiled for this table reflect a variety of methodologies and years; GDP per capita is also an imperfect measure of economic development. However, the comparison made here can be used to illustrate the links between regional disparities in energy consumption and economy.
Source: see endnote 15 for this section.

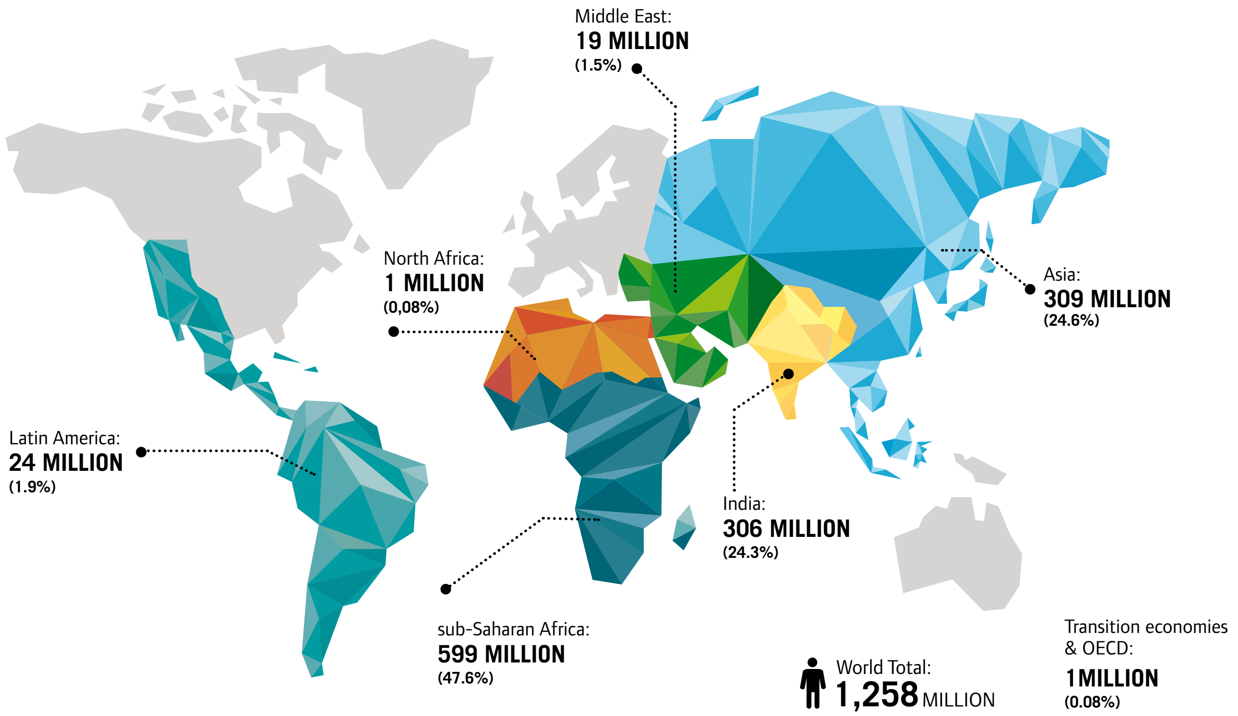
FIGURE 2 | Share of Traditional Biomass in Total Final Energy Consumption, 2010



Source: SE4ALL

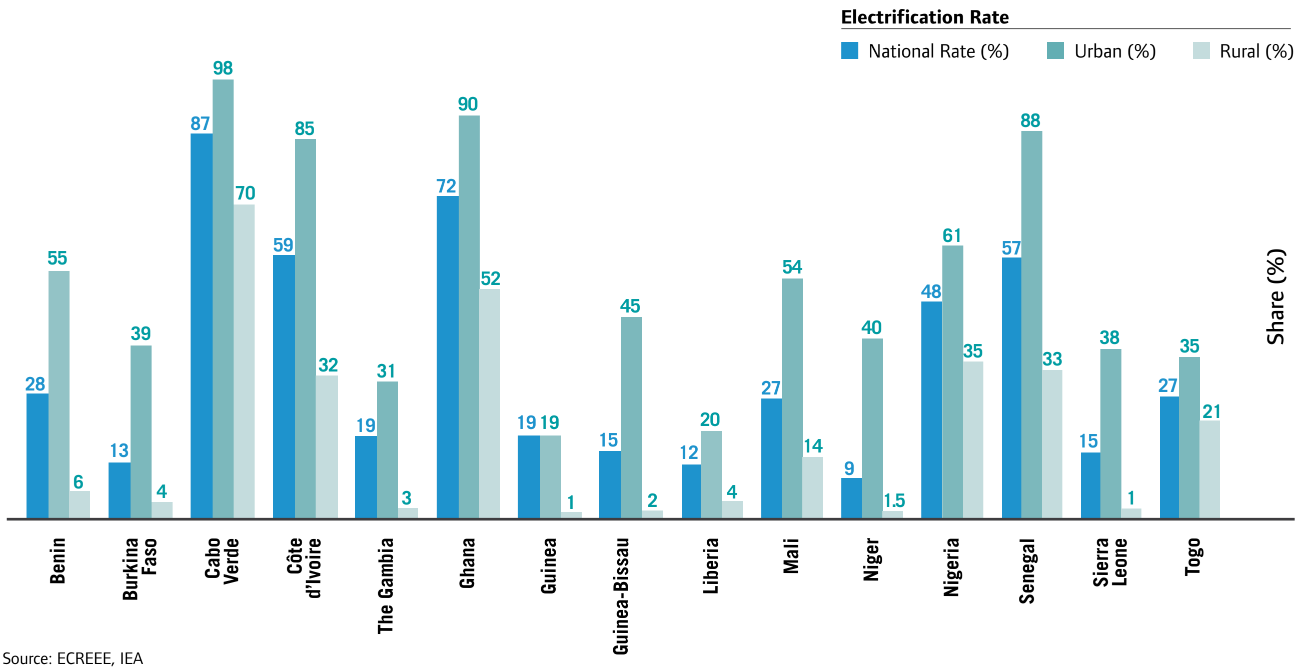
In 2011, sub-Saharan Africa accounted for almost half (47.6%) of all people without access to electricity.[25] (See Figure 3.) Within ECOWAS, national electricity access rates vary widely, from Niger which had an electrification rate of just 9% in 2011, to Cabo Verde, which is approaching nearly universal access.[26] (See Figure 4.) National rates mask wide disparities between access in rural versus urban areas. In many ECOWAS Member States, major power grids provide service only to major cities, leaving rural and peri-urban areas unelectrified. Globally, about 85% of those without electricity access live in rural areas; within ECOWAS, the estimated share of rural populations with access to electricity ranges from 70% in Cabo Verde to just 1% in Guinea and Sierra Leone.[27] (See Figure 4.)

FIGURE 3 I Population Without Electricity Access, 2011



Source: IEA World Energy Outlook 2013

FIGURE 4 I Electricity Access Rates in ECOWAS Member States, 2010-2011



Source: ECREEE, IEA

Applying these electricity access rates to population figures provides an estimate of each Member State's share of the region's total population without access to electricity.[28] (See Figure 5.) In 2010, Nigeria accounted for nearly half (48%) of all ECOWAS inhabitants without access.

Between 2000 and 2010, West Africa added an estimated 50 million people to the grid.[29] However, in energy scenarios to 2030, ECREEE projects that without significant investment in access expansion, energy poverty will continue to have considerable negative consequences on regional economies and societies.[30] The United Nations Development Programme (UNDP) reports that under a business-as-usual scenario, approximately 21% of households in the ECOWAS region (mostly in rural areas) will still lack electricity in 2030, illustrating the need to revamp national and regional approaches to electrification.[31] Access to modern cooking fuels is also severely limited in ECOWAS Member States. In sub-Saharan Africa as a whole, the average share of national populations relying on solid fuels for cooking is just over 79%; within ECOWAS, this figure rises to 85.7%.[32] (See Chapter 2 for a more detailed examination of cooking fuels.)

The positive correlation between energy access and human development has been widely noted; for this reason, SE4ALL commits to ensuring universal access to modern energy services as a means to reduce poverty, improve education and human health, and power economic growth.[33] SE4ALL has established a template for Country Action Agendas—defining and articulating countries' visions and targets to 2030, priority action areas, and follow-up mechanisms—to serve as a framework for donor coordination, assistance, and participation by the private and civil sectors.[34] ECOWAS governments have recognised the limitations that energy poverty poses on development and have committed to improving access rates and reliability of modern energy services, notably by working with ECREEE to develop Action Plans for renewable energy and energy efficiency in each Member State by December 2014. (See Chapter 4 for a more detailed examination of this process.)

Energy Security

Additional factors pose significant threats to energy security. In the electricity sector, high commercial and technical losses and a growing gap between projected power demand and generation capacity make it increasingly difficult to provide reliable, affordable electricity.[35] The Africa-European Union Energy Partnership (AEEP) estimates that average transmission and distribution network losses in West Africa decreased from 45.3% in 2000 to 21.5% in 2010,[vi] highlighting both the progress being made and the need to make further improvements.[36] Even in areas with electricity access, frequent power outages and unreliability—particularly during hours of peak demand or during the dry season in areas largely dependent on hydropower production—limit electricity consumption and its attendant benefits.[37] In Côte d'Ivoire, the quality of electricity service in electrified areas has reportedly improved in many neighbourhoods since 2012, although outages continue to occur several times per month.[38]

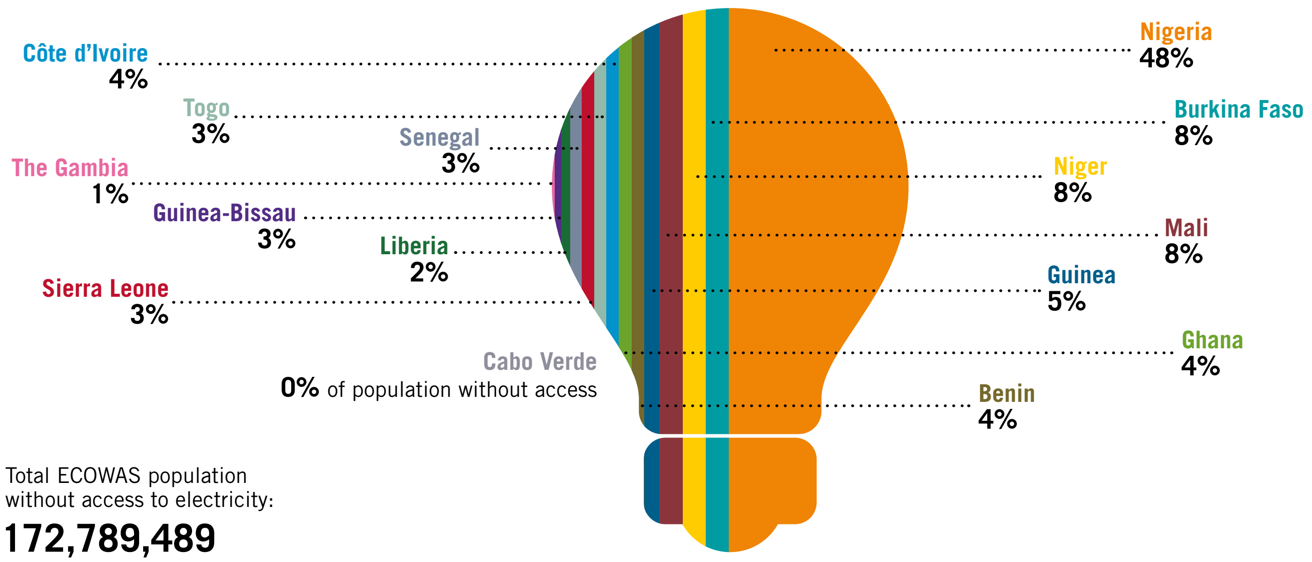
Throughout the region, problems with maintenance and upkeep reduce functional capacity, creating further challenges. In Guinea-Bissau, it has been estimated that as a result of obsolete equipment and limited maintenance, available capacity in the public network fell from 12.7 megawatts (MW) in 2003 to 2 MW in 2013, and available self-generation capacity declined from 15 MW to 2.5 MW over the same period.[39] In Ghana, an estimated more than 400 MW of generation capacity is currently unavailable due to expansion and maintenance issues.[40] In countries with limited capacity, problems with even a single generation unit can have significant negative impacts throughout the entire electricity system.[41]

ECOWAS GOVERNMENTS HAVE RECOGNISED THE LIMITATIONS THAT ENERGY POVERTY POSES ON DEVELOPMENT AND HAVE COMMITTED TO IMPROVING ACCESS RATES AND RELIABILITY OF MODERN ENERGY SERVICES, NOTABLY BY WORKING WITH ECREEE TO DEVELOP ACTION PLANS FOR RENEWABLE ENERGY AND ENERGY EFFICIENCY IN EACH MEMBER STATE BY DECEMBER 2014.

Heavy dependence on either fossil fuels or hydropower can pose additional challenges. In 2010, four Member States produced refined petroleum. Only Côte d'Ivoire produced more than it consumed, demonstrating the region's exposure to global price volatility and supply disruption.[42] (See Figure 6.) While fossil fuel extraction has been an important economic factor in specific ECOWAS countries—including Côte d'Ivoire, Ghana, and Nigeria—the vast majority of Member States remain reliant on fuel imports to meet their needs, and only five Member States have proven oil reserves.[43] (See Figure 6.) In Ghana, rising fuel prices and uncertain inflows to hydropower plants, particularly during the dry season, have resulted in a failure to achieve full generation capacity.[44]

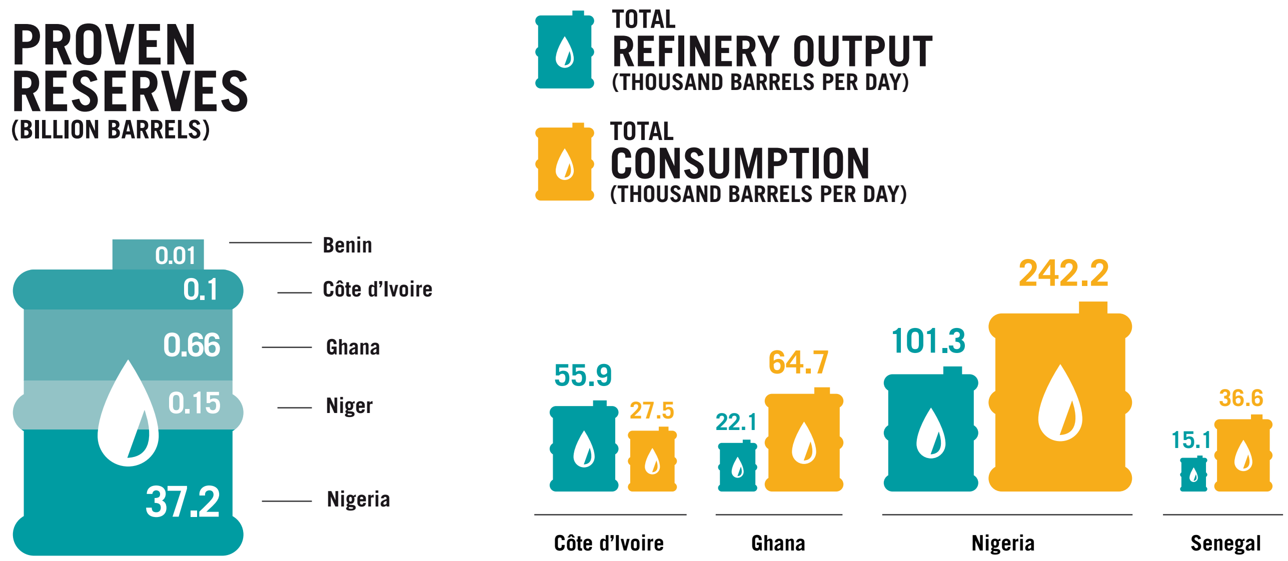
vi. Based on data for West Africa from Africa-EU Energy Partnership (AEEP), Status Report: Africa-EU Energy Partnership.

FIGURE 5 | Share of ECOWAS Population Without Access to Electricity, 2010



Source: ECREEE, IEA, World Bank

FIGURE 6 | Oil Reserves, Refinery Output and Consumption in ECOWAS Member States, 2014



Source: see endnote 42 and 43 for this section.

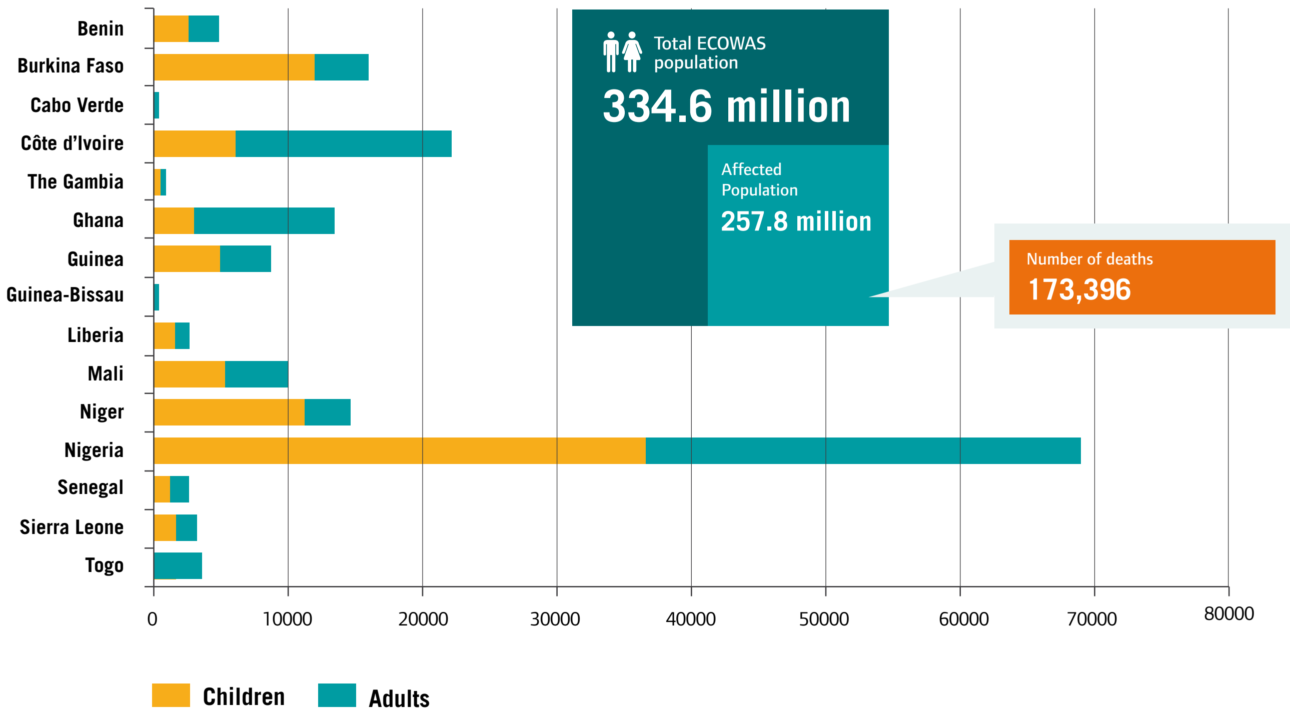
In some ECOWAS Member States, generation capacity and related infrastructure have been destroyed during periods of armed conflict, creating a need to rebuild functional systems. Liberia's civil war (1989–2003) resulted in the destruction of the country's major hydropower plant and other generation facilities, as well as of the transmission and distribution network, and resulted in the national utility temporarily ceasing operations.[45] Sierra Leone's electricity system faces a similar challenge; ECREEE estimates that in 2012, a decade after the end of that country's civil war, the functional installed capacity was just under 53 MW, compared with a demand of 125 MW.[46] Damage to the West African Gas Pipeline infrastructure has resulted in significant supply disruptions in Ghana, prompting extended periods of load shedding.[47] In Nigeria, Africa's largest oil producer, aging and damaged pipeline infrastructure has led to major supply disruptions and unplanned outages of 500,000 barrels per day.[48]

Heavy reliance on traditional biomass resources creates additional energy security challenges. In some countries, dependence on fuel wood for cooking has contributed to significant deforestation, driven predominantly by demand from urban and peri-urban centres. Ghana projects domestic consumption of more than 25 million tonnes of fuel wood between 2012 and 2020, more than half of which will come from standing stocks—leading to increased deforestation and a dwindling supply of biomass resources.[49] Increasingly, the combined effects of deforestation and climate change are making it more difficult to collect traditional biomass, requiring women and children to venture farther from their homes to collect fuel wood and contributing to shortages and rising prices in urban markets.[50]

Health and Environment

The region's reliance on traditional biomass and solid fuels has enormous negative effects on health, particularly for women and children, who tend to spend more time near open fires and traditional cook stoves. Globally, the World Health Organization (WHO) estimates that approximately 4.3 million people die prematurely each year as a result of household air pollution from the inefficient use of solid fuels. The WHO also estimates that exposure to household air pollution doubles a child's risk for childhood pneumonia and accounts for more than half of all deaths among children under five from acute lower respiratory infections. Roughly one-quarter of all premature deaths due to stroke are tied to chronic household air pollution from cooking with solid fuels.[51] Other injuries, particularly burns, pose additional severe risks.[52]

FIGURE 7 | Deaths per Year from Household Air Pollution



Source: WHO, Global Alliance for Clean Cookstoves

Within ECOWAS, it is estimated that more than 257.8 million people (nearly three-fourths of the region's population) are affected by household air pollution from indoor smoke, small particle pollution, carbon monoxide, and nitrogen oxides, predominantly as a result of cooking and heating with solid fuels.[53] This results in the deaths of an estimated 173,396 people each year, roughly half of them children.[54] (See Figure 7.) Collecting fuel wood and traditional biomass also exposes women—mostly in rural areas—to risks of injury, rape, and harassment.[55] In the Gambia, respondents in a household energy survey noted additional problems related to inefficient stoves, including heavy smoke and emissions, the expense of fuel wood and charcoal, frequent equipment breakdown, considerable time spent collecting fuel wood, and the scarcity of fuel wood in certain areas.[56] (See Chapter 2 for further discussion of the distribution of cooking fuels within individual ECOWAS Member States.)

Member States that extract fossil fuels have experienced severely negative impacts on the environment. In the Niger Delta, aged and damaged infrastructure, as well as natural gas flaring, results in damage to air, soil, and water, reduces arable land and diminishes vital fish stocks.[57]

The urgent need to expand energy access and secure a reliable, affordable energy supply is compounded by climate change, which has and will continue to have significant impacts across the energy sector. Although the region's contribution to anthropogenic greenhouse gas emissions is very small (9.8% of territorial emissions in Africa and less than half of 1% of the global total in 2012), climate change's projected impacts in the region are significant.[58] In the energy sector, these include changing demand profiles in response to rising temperatures, shifting land use and productivity, as well as changes to hydropower capacity and the efficiency of thermal facilities.[59] If climate change leads to increasingly variable rainfall in West Africa, dependence on hydropower, which requires reliable water supply, could become more costly and less secure.[60] The combined effects of a changing climate and deforestation are already reducing available biomass in many ECOWAS Member States, creating challenges for those dependent on fuel wood and other resources for their energy needs. Although the impacts of climate change on hydropower will vary significantly and are difficult to project, it is clear that they will affect generation potential in some parts of the ECOWAS region.[61] Investment in energy infrastructure will have to consider climate resilience in the context of projected impacts and community needs.

The full impact and severity of these changes on ECOWAS communities and populations depends on many inter-related and multi-dimensional factors. In its Fifth Assessment Report, released in 2014, the Intergovernmental Panel on Climate Change (IPCC) makes clear that climate vulnerability is a complex and multi-dimensional concept—closely intertwined with non-climate stressors including structural poverty and inequality—and is therefore often particularly severe in low-income economies.[62] In the ECOWAS region, populations without the means to access alternative energy supply options or to relocate to areas where energy services are available will face particular challenges. Given the long-term nature of energy investments, it will be important to assess likely climate change impacts on existing energy infrastructure within the region, to evaluate the viability of future investments, and to identify potential adaptation strategies for populations most at risk.

PLATFORMS FOR REGIONAL ENERGY COOPERATION

Since the 1990s, ECOWAS has engaged in numerous efforts to address these inter-related challenges, modernise the region's approach to energy development, and facilitate energy cooperation throughout West Africa. (See Figure 8.)

The West African Power Pool (WAPP), created by ECOWAS in 1999, works to integrate national power systems into a unified electricity market, ensuring stable, reliable, and affordable electricity supplies by supporting generation, transmission, and power trade among Member States.[63] The WAPP Master Plan for the Generation and Transmission of Electrical Energy (ECOWAS Master Plan) developed in 2004 and revised and adopted in 2011, aims to articulate an optimal plan for regional generation and transmission of electricity, and proposes a list of regional priority projects and an inter-connected regional network enabling power exchange among all Member States by 2018. Implementation of the Plan's priority projects would be expected to increase the share of renewable generation capacity from 27% in 2011 to 36% (mostly large hydropower) by 2025.[64]

The ECOWAS Energy Protocol, modelled after the European Energy Charter Treaty and signed by the region's Heads of States and Governments in 2003, establishes a framework to promote energy cooperation—aiming ultimately to increase investment and trade in the region's energy sector. Among other things, the Protocol ensures open and non-discriminatory access to power generation and transmission facilities while respecting national sovereignty, ensures freedom of transit, encourages open access to capital markets, and requires that Member States strive to minimise environmental impacts in an economically efficient manner.[65]

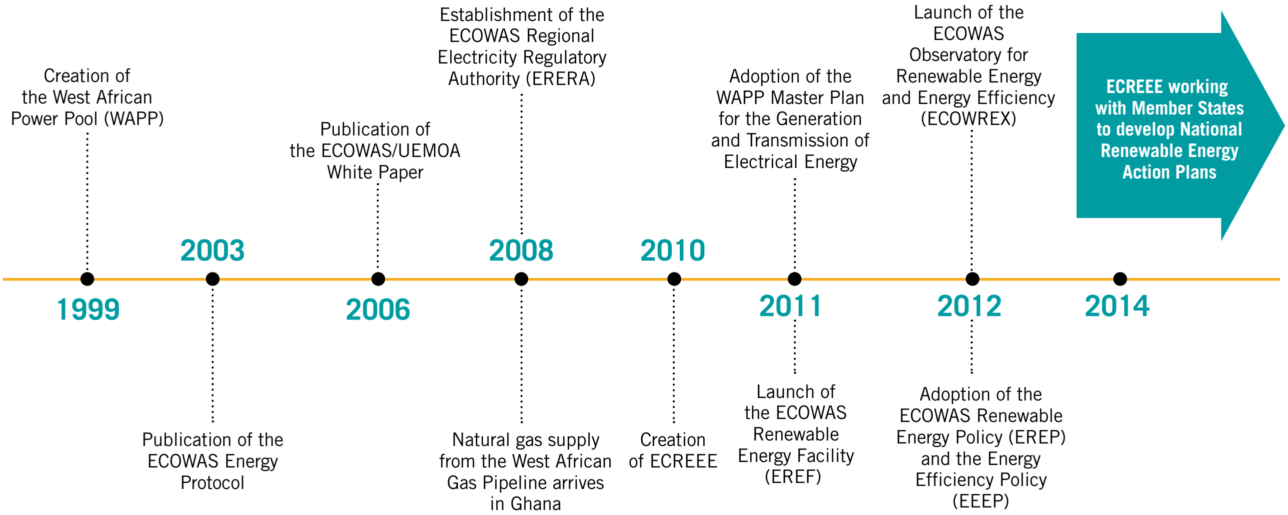
In 2006, ECOWAS and the West African Economic and Monetary Union (UEMOA) published the *White Paper for a Regional Policy*, which examined energy access in the context of the Millennium Development Goals and established three energy sector targets to be achieved by 2015: 1) 100% access to modern cooking fuels; 2) at least 60% access to productive energy services in rural villages; and 3) two-thirds of the population with access to an individual electricity supply.

Infrastructure developments have also facilitated regional integration. The West African Gas Pipeline (WAGP) has a mandate to supply natural gas from Nigeria to neighbouring Benin, Togo, and Ghana at competitive prices. The WAGP is owned and operated by the West African Gas Pipeline Company (WAPCo), a public-private joint venture between companies from each of the four countries. The first natural gas supply from the pipeline arrived in Ghana in 2008.[66] Earlier that year, the ECOWAS Regional Electricity Regulatory Authority (ERERA) was established to regulate cross-border electricity interconnections and support national regulatory bodies.[67]

Following the creation of ECREEE in 2010, ECOWAS launched the ECOWAS Renewable Energy Facility (EREF)—a grant-making platform targeting small- to medium-scale renewable energy and energy efficiency projects and businesses, particularly in rural and peri-urban areas.[68] In 2012, the region launched ECOWREX, which aims to address critical knowledge and data gaps and provide stakeholders with updated information on energy systems, resource potential, and country data.[69] In October of that year, Member States adopted the ECOWAS Renewable Energy Policy (EREP) and the ECOWAS Energy Efficiency Policy (EEEP). Each of these important documents includes regional targets and objectives, as well as strategies to achieve them. ECREEE is currently providing technical support to Member States so that the EREP and the EEEP can be mainstreamed into National Renewable Energy Policies (NREPs) and Action Plans (NREAPs).[70] This collaboration marks an important step forward and serves as a potential model for other regional communities looking to harness renewable resources, mainstream policy development, and scale up investment in sustainable energy solutions, in turn helping to increase energy access and improve energy security.

While by no means exhaustive, the initiatives listed above highlight the wide range of energy sector priority areas being addressed through regional collaboration, including grid infrastructure, energy access, and energy efficiency. These efforts, along with others, will be discussed in greater detail in the rest of the report.

FIGURE 8 | Milestones for Energy Cooperation and Integration in ECOWAS



Source: see endnotes 63-70 for this section.

02

RENEWABLE ENERGY MARKET AND INDUSTRY OVERVIEW

02 RENEWABLE ENERGY MARKET AND INDUSTRY OVERVIEW

In the face of severe energy challenges, ECOWAS Member States are embracing a variety of sustainable energy solutions across major sectors. While the region remains heavily dependent on traditional solid fuels like wood and charcoal for household energy use, efforts to expand deployment of efficient cook stoves and increase access to modern fuels are growing. Renewable contributions to the power sector are increasing and becoming more diversified. Although hydropower has been widely used throughout the region for many decades, deployment of non-hydro renewables is now beginning to accelerate. In the past few years, the region's first large-scale commercial wind and solar projects have been deployed in Cabo Verde and Ghana, establishing these countries as regional leaders.

Distributed renewable generation, mainly through solar PV, has been promoted through government and donor-based initiatives as a way to power schools, health clinics, community centres, and households, especially in rural areas. More concerted efforts to create commercial markets for these technologies and to use them as the basis for community development through mini-grids (see Sidebar 2) and other applications are now beginning to take shape throughout the region. This section assesses sustainable energy developments mainly in cooking and the power sector, as well as for water pumping, heating and drying.

DISTRIBUTED RENEWABLE GENERATION, MAINLY THROUGH SOLAR PV, HAS BEEN PROMOTED THROUGH GOVERNMENT AND DONOR-BASED INITIATIVES AS A WAY TO POWER SCHOOLS, HEALTH CLINICS, COMMUNITY CENTRES, AND HOUSEHOLDS, ESPECIALLY IN RURAL AREAS.

FINAL ENERGY CONSUMPTION

The share of renewables in the region's TFEC is relatively minor, although Member States' specific shares vary significantly. According to SE4ALL's *Global Tracking Framework*, as of 2010, Guinea-Bissau, Ghana, and Sierra Leone stood out as regional leaders in terms of the renewable contribution to their final consumption—at 30.3%, 22.4%, and 19%, respectively—largely as a result of their use of what SE4ALL refers to as modern biomass.[vii,1] (See Table 3.) The other major renewable contributor to final energy consumption in the ECOWAS region is hydropower, which accounted for 6.7% of Ghana's TFEC in 2010 and also played a relatively significant role in Togo (2.6%), Côte d'Ivoire (1.9%), and Mali (1.5%).[2] Since 2010, renewable capacity has expanded significantly in some Member States, particularly Cabo Verde and Ghana.[3]

vii. SE4ALL's *Global Tracking Framework* uses the United Nations Food and Agriculture Organization's definition of "modern biomass," which is biomass produced in a sustainable manner from solid wastes and residues from agriculture and forestry.

TABLE 3 | Share of Renewable Energy in Total Final Energy Consumption, 2010

	MODERN BIOMASS	HYDROPOWER	SOLAR	WIND	OTHER	TOTAL
	%					
Benin	8.7	—	—	—	—	8.7
Burkina Faso	0.8	0.4	—	—	—	1.2
Cabo Verde	—	—	—	0.5	—	0.5
Côte d'Ivoire	7.8	1.9	—	—	—	9.7
The Gambia	—	—	—	—	—	—
Ghana	15.7	6.7	—	—	—	22.4
Guinea	0.5	1.1	—	—	—	1.6
Guinea-Bissau	30.3	—	—	—	—	30.3
Liberia	—	—	—	—	—	—
Mali	1.4	1.5	—	—	—	2.9
Niger	2.8	—	0.0	—	—	2.8
Nigeria	8.8	0.4	—	—	—	9.2
Senegal	0.2	0.8	0.0	—	—	1.0
Sierra Leone	18.9	0.1	—	—	—	19.0
Togo	9.2	2.6	—	—	—	11.8

Note: "–" indicates that data are not available.
Source: see endnote 1 for this chapter.

COOKING

Because household energy consumption, primarily for cooking, makes up such a large share of regional energy use, expanding access to sustainable solutions in the form of efficient cook stoves and modern fuels will have a large positive impact. As of 2014, energy consumption for cooking is dominated by traditional solid fuels. Across the ECOWAS region, an average 85.7% of each country's population uses solid fuels for cooking, although national figures range from 98% in Guinea-Bissau, Liberia, Mali, and Sierra Leone, to just 31% in Cabo Verde.[4] (See Table 4.)

TABLE 4 | Fuels Used for Cooking in ECOWAS Member States, 2010

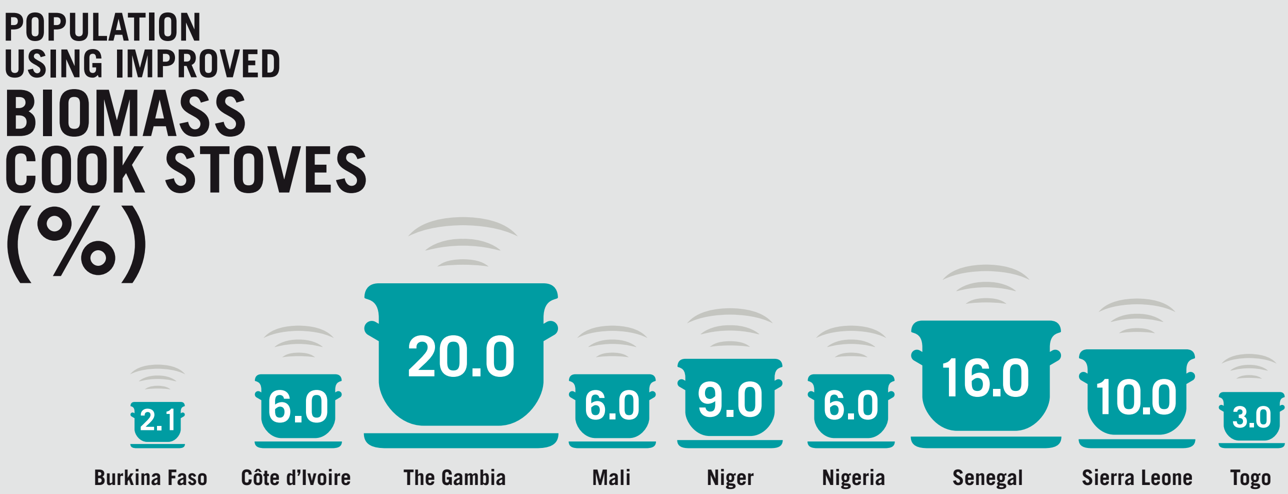
	Share of Population Using Solid Fuels for Cooking			Fuels Used for Cooking, by Share of Population							
	TOTAL	URBAN	RURAL	WOOD	DUNG	CHARCOAL	COAL	KEROSENE	GAS	ELECTRICITY	OTHER
	%			%							%
Benin	94	87.7	97.2	72.2	0	21.1	0	1.9	3.7	0	1
Burkina Faso	95	81.8	99.2	88.5	0	4.3	0	0.4	6.3	0.1	0.4
Cabo Verde	31	11.9	72.5	35.1	0	0	0	0	62.5	0	2.4
Côte d'Ivoire	79	64.2	>95	66.3	0	19.6	0	0	13.7	0.1	0.3
The Gambia	95	91.1	>95	78	0	12.8	0.1	0.2	4.6	0.1	4.2
Ghana	84	74.3	>95	50.8	0	34.8	0	0.6	10.4	0.1	3.3
Guinea	96	>95	>95	76	0	23	0	0.2	0.1	0.3	0.3
Guinea-Bissau	98	>95	>95	69	0	29.3	0	0	0.6	0.6	0.5
Liberia	98	>95	>95	58.9	0	40.5	0	0	0	0	0.6
Mali	98	>95	>95	82.6	2	14.5	0	0	0.2	0	0.7
Niger	94	>95	>95	94.2	2	2.8	0	0	0.7	0.2	0.1
Nigeria	75	40.4	91.6	72.3	0.5	2.2	0.1	23	1	0.3	0.6
Senegal	56	17.4	85.9	47.7	0.6	7.8	0	0	41.1	0	2.8
Sierra Leone	98	>95	>95	85.2	0	13.8	0	0.7	0.1	0	0.2
Togo	95	>95	>95	54	0	43.8	0	0.5	1.2	0.1	0.4

Source: see endnote 4 for this section.

Globally, about 78% of people relying on solid fuels for cooking live in rural areas.[5] This trend holds true in the ECOWAS region, where in every Member State, the shares of people in rural areas relying on solid fuels either equal or exceed those in urban areas.[6] Even so, most people in urban environments also rely on solid fuels, which represent the primary energy source for urban cooking in all Member States except Cabo Verde, Nigeria, and Senegal. In the ECOWAS region as a whole, wood represents the predominant cooking fuel, followed by charcoal. Common technologies for wood users remain the traditional "three-stone" fire or other conventional cooking stoves, while the majority of charcoal users rely on conventional metal charcoal stoves.[7]

Efficient cook stoves, gas, and electricity represent options to expand access to clean cooking fuels while reducing or avoiding the environmental and social costs associated with dependence on traditional biomass. As of early 2014, reliable data on efficient cook stove penetration is not available for all ECOWAS Member States. However, the Global Alliance for Clean Cookstoves reports population shares using improved biomass cook stoves from 2.1% in Burkina Faso to 20% in the Gambia.[8] (See Figure 9.) Worldwide, SE4ALL expects the number of people relying on more efficient solid fuel cook stoves to grow as governments and donors continue to promote them as relatively low-cost and accessible solutions.[9] (See Section 3 for a discussion of regional programmes and initiatives to promote efficient cook stove technologies.)

FIGURE 9 | Penetration of Clean Cook Stoves



Source: see endnote 8 for this section.

Significant population shares in Cabo Verde (62.5%), Senegal (41.1%), Côte d'Ivoire (13.7%), and Ghana (10.4%) rely on gas—primarily liquefied petroleum gas (LPG), which—although not renewable—has significant environmental benefits over wood and charcoal. In Senegal, the expanded use of LPG—particularly in urban centres—is estimated to have reduced annual consumption of wood fuel and charcoal by 70,000 and 90,000 tonnes respectively.[10]

Very few people in the region rely on electricity for cooking; Guinea-Bissau has the highest rate of electricity use for cooking at just 0.6%.[11] This reflects challenges related to both access and cost; even in electrified households, electricity is not often an economically feasible option for cooking. For example, in the Gambia, households report that cooking with electricity is too expensive, whereas wood and charcoal are relatively cheap and widely available.[12]

Many households that rely primarily on one energy source for cooking may also be using additional fuels to supplement or complement their supply. Examining the primary fuel used for cooking fails to capture the complex and widespread practice of "fuel stacking," or the parallel use of multiple fuels and types of cook stoves.[13] In the ECOWAS region, consumption of traditional energy resources often co-exists with use of modern energy technologies and practices. For example, IRENA notes that in both the Gambia and Niger, even relatively high-income households often use a mix of traditional biomass, kerosene, and LPG.[14] Examining rates of solid fuel use also fails to capture improvements in modern cooking solutions such as stoves that use modern biomass or that consume traditional solid fuels more efficiently.

RENEWABLE ENERGY IN THE POWER SECTOR

ECREEE, in partnership with Member State governments, has emphasised renewable energy deployment as a way to improve the region's power sector and expand electricity access.[15] To date, conventional grid systems have supplied most of the region's electricity, although the considerable challenges they face (see Chapter 1) make it increasingly apparent that distributed systems, including mini-grids and stand-alone technologies, will play a significant role in achieving the region's energy goals.[viii] The region's grid expansion plans being developed through the WAPP will have a significant impact on the region's ability to scale-up grid connected renewable power (see Sidebar 1.)

Renewable energy technologies currently account for an estimated 28.8% of the region's total grid-connected installed capacity.[16] Hydropower has been used widely to generate electricity in the region for decades and represents more than 99% of existing renewable capacity.[17] Installed capacity of grid-connected non-hydro renewables (wind, solar, and modern biomass) is just 39 MW and is concentrated mainly in Cabo Verde and Ghana, which have emerged as early leaders in the region.[18] (See Table 5.) While significant off-grid capacity has been added in recent years across a range of renewable technologies—particularly solar PV (See Figure 13)—consistent and reliable data across the entire region is not available and, therefore, these figures have been separated from the grid-connected figure presented here. Renewable energy deployment in the power sector is likely to increase in coming years, supported by the renewable power targets and support policies being implemented by most Member States, ECREEE's ongoing efforts to streamline policymaking (see Chapter 4), and the growing number of renewable energy projects in development.

viii. The scope of this report does not consider the region's technical capacity to implement new renewable projects or scale-up related activities; instead, it aims to provide an overview of what has been implemented to date.

TABLE 5 | Installed Renewable Energy Capacity (Grid-Connected) in ECOWAS Member States, 2014

	HYDROPOWER	WIND	SOLAR PV	BIOMASS	TOTAL	
	Installed Capacity	Installed Capacity	Installed Capacity	Installed Capacity	Installed Renewable Capacity	Share of Total Overall Capacity (including non-renewable generation)
	MW	MW	MW	MW	MW	%
Benin	2	0	0	0	2	1.9
Burkina Faso	29	0	0	0	29	14.7
Cabo Verde	0	26	6.4	0	32.4	23
Côte d'Ivoire	604	0	0	3	604	42.9
The Gambia	0	1	0	0	1	0
Ghana	1,580	0	1.92	0	1,582	56.9
Guinea	126.8	0	0	0	126.8	29.7
Guinea-Bissau	0	0	0	0	0	0
Liberia	4.6	0	0	0	4.6	21
Mali	300	0	0	0	300	65.5
Niger	0	0	0	0	0	0
Nigeria	1,977	0.03	0	0.5	1,978	16.2
Senegal	0	0	0	0	0	0
Sierra Leone	56	0	0	0	56	35.6
Togo	65.6	0	0	0	65.6	28.8
TOTAL ECOWAS	**4745**	**27.03**	**8.32**	**3.5**	**4781.4**	**28.8**

Source: see endnote 18 for this section.

Throughout most of the ECOWAS region, transmission and distribution networks are insufficient and unreliable, serving only limited portions of the population, mostly in urban areas. Decentralised and off-grid renewable technologies provide opportunities to generate electricity in areas without access, often at lower cost. In the Gambia, where rural villages are typically 5–25 kilometres from the grid, the high cost of extending transmission lines, combined with the financial challenges posed by low electricity demand in rural communities, makes grid extension to many locations infeasible.[19] Likewise, in Niger, the cost of extending transmission lines to villages with low electricity demand is often prohibitively expensive, and grid connection fees are too high for low-income households.[20] These factors, combined with the falling costs of renewable technologies and the chance to avoid high network losses, make distributed and off-grid generation very attractive. Recognising this, several Member State governments have begun prioritising such projects. In Sierra Leone, where the national grid was destroyed during the Civil War and currently serves only the capital, the government's efforts to expand electricity access focus largely on off-grid installations, particularly solar, hydropower, and conventional thermal generation.[21]

HYDROPOWER

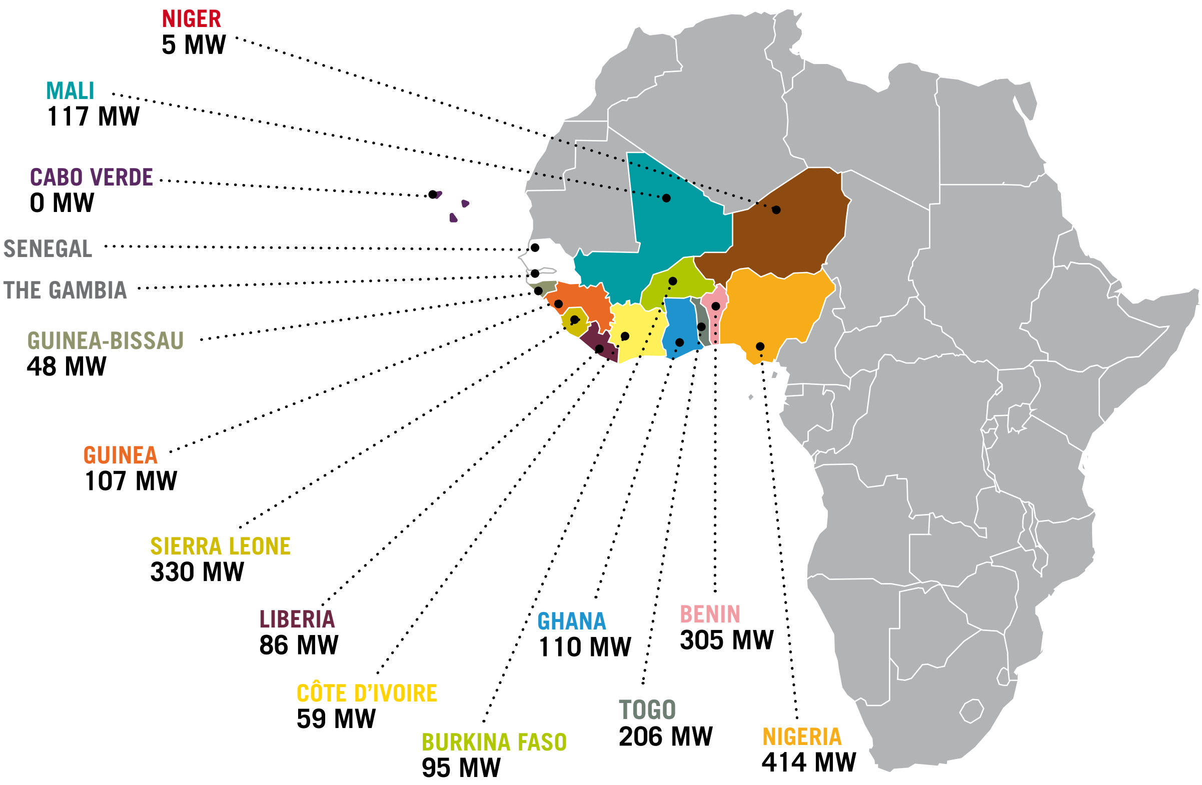
Hydropower is the most well established and widely used renewable energy technology in West Africa, and in most Member States, represents the only renewable technology currently being implemented on a commercial scale. Historically, ECOWAS utilities and international financiers have primarily targeted large, rather than small or medium-sized, hydropower projects.[22] Recently, however, interest in small hydropower development (defined by ECREEE as plants between 1 and 30 MW[ix]) has increased, and initiatives aimed at accelerating deployment of such projects are under way across the region.[23]

Potential

With a region-wide hydropower potential of some 25 GW, only 19% has been exploited as of early 2014.[24] Ghana, Guinea, and Nigeria have particularly significant resources.[25] Although available estimates for hydropower potential vary widely and are not all reliable, most Member States demonstrate potential for small-scale hydropower development.[26] (See Figure 10.)

> **HYDROPOWER IS THE MOST WELL ESTABLISHED AND WIDELY USED RENEWABLE ENERGY TECHNOLOGY IN WEST AFRICA, AND IN MOST MEMBER STATES, REPRESENTS THE ONLY RENEWABLE TECHNOLOGY CURRENTLY BEING IMPLEMENTED ON A COMMERCIAL SCALE.**

FIGURE 10 | Estimated Small-Scale Hydropower Potential



Note: Data unavailable for the Gambia and Senegal. Data for Burkina Faso calculated as the average of an estimated range (52 to 138 MW).
Source: ECREEE

ix. Classifications of "small hydropower" vary by Member State: Benin (10–30 MW); Ghana (up to 1 MW); Mali (1–10 MW); Nigeria (<10 MW); Sierra Leone (1–30 MW). This report uses the ECREEE definition of 1-30 MW.

Installed Capacity

Ten Member States have existing hydropower capacity as of mid-2014.[27] (See Table 6.) Nigeria has the region's largest installed hydropower capacity at just under 2,000 MW.[28] The country's major large-scale plants include Kainji (760 MW), Jebba (578 MW), and Shiroro (600 MW).[29] Together, these plants accounted for 16.2% of the country's grid-connected installed capacity as of late 2012.[30] In recent years, momentum behind small-scale hydropower has grown, and Nigeria now has several plants in operation including Kurra Falls (19 MW), Kwali Falls (6 MW), Lere I (4 MW), Lere II (4 MW), Oure (2 MW), Bangel I (2 MW), and Bengel II (2 MW).[31] The United Nations Industrial Development Organization (UNIDO) has played a significant role in developing small-scale hydropower in Nigeria, installing the Ezioma Mgbowo (0.03 MW) and Waya Dam (0.15 MW) projects and making Nigeria the seat of the UNIDO Regional Centre for Small Hydro Power in Africa.[32]

Ghana also has significant installed hydro capacity, totalling 1,580 MW in 2014.[33] This comprises the Akosombo (1020 MW), Kpong (160 MW), and Bui (400 MW) plants, the last of which was brought on line in 2013.[34] Together, these account for roughly 57% of the country's total installed capacity.[35]

Côte d'Ivoire has 604 MW of installed hydro capacity, including the Ayamé I (20 MW), Ayamé II (30 MW), Kossou (174 MW), Taabo (210 MW), Buyo (165 MW), and Grah (5 MW) plants, all of which were built before 1984.[36] In 2010, hydropower accounted for 28.2% of electricity generation in Côte d'Ivoire.[37] The government intends to add an additional 19.5 MW of hydro capacity in the coming years.[38] Several hydropower projects are identified in the Government's *Strategic Development Plan*: a commercial contract for the 275 MW Soubre plant was signed with SINOHYDRO in 2009, and commission is expected in 2019; four hydropower plants on the Sassandra River (totalling 580 MW) are planned for 2016–2030; and the 150 MW Aboisso Comoé hydropower plant is also listed.[39] Côte d'Ivoire has short-listed seven private companies to develop grid-connected small-hydropower plants under a buy-own-operate agreement.[40]

TABLE 6 | Installed Hydropower Capacity in ECOWAS Member States, 2014

	TOTAL HYDROPOWER CAPACITY	SHARE ≥ 30 MW	SHARE < 30 MW
	(MW)	(%)	(%)
Benin	2	0	100
Burkina Faso	29	0	100
Côte d'Ivoire	604	96	4
Ghana	1580	100	0
Guinea	126.8	96	4
Liberia	4.6	0	100
Mali	300[a]	98	2
Nigeria	1977	98	2
Sierra Leone	56	89	11
Togo	65.6[b]	98	2

[a] Manantali (200 MW) supplies both Mali and Senegal.
[b] Nangbeto Kipme (64 MW) supplies both Togo and Benin.
Source: see endnote 27 for this section.

In Mali, installed hydropower capacity stands at roughly 300 MW. Operating hydro installations include the Sélingué I and II (47.6 and 46.2 MW respectively) and Sotuba (5.7 MW) plants. The Manantali hydropower plant (200 MW), commissioned in 2002, supplies power to both Senegal and Mauritania.[41] Mali, with support from international partners, has indicated an intention to scale-up development of small-scale hydropower projects in the near future; eight projects, ranging from 55 kilowatts (kW) to 10,000 kW for a total installed capacity of 21,600 kW, have been identified under the Climate Investment Funds' Scaling Up Renewable Energy in Mali Investment Plan.[42]

Guinea's installed hydropower capacity of 126.8 MW includes three small-scale hydropower installations: Kinkon (3.2 MW), Tinkisso (1.5 MW), and Loffa (120 kW), all in need of refurbishment.[43] In 2010, hydropower accounted for 34.2% of grid-connected generation.[44] The Promoting Development of Multi-purpose Mini Hydropower Systems (2012–2016) project, financed by the Global Environment Facility (GEF), aims to address barriers and establish a total of 800 kW of generation capacity.[45]

Hydropower currently accounts for 28.8% of installed capacity in Togo, and accounted for 24% of generation in 2012, with the remainder coming from thermal plants.[46] The Nangbeto Kipme plant, with an installed capacity of 64 MW and an annual production of 150 gigawatt-hours (GWh), was commissioned in 1987 and supplies both Togo and Benin.[x,47] Togo's Kipme plant, commissioned in 1963, has an installed capacity of 1.56 MW and an annual generation of 2.46–4.14 GWh; it functions from November to January and is in need of rehabilitation.[48] The 147 MW WAPP Adjarala Hydropower Facility is scheduled for implementation in 2017; as of January 2014, the project was in the pre-investment stage.[49]

Sierra Leone has an installed hydropower capacity of 56 MW, accounting for 35.6% of total capacity in 2014.[50] Bumbuna I (50 MW) came on line in 2010.[51] Two smaller hydropower stations (6 MW and 250 kW) are also currently operating.[52] Two plants (2.2 MW and 0.12 MW) are planned for construction in Charlotte and Makali.[53]

Burkina Faso has a total 29 MW of installed hydropower capacity, comprising Kompienga (12 MW), Bagré (14.4 MW), and two small hydropower plants: Tourni (0.6 MW) and Niofila (1.7 MW), both built in 1996.[54] In the pipeline is a 2.5 MW plant to be built at Samendeni Dam and two additional mini hydropower plants.[55] In 2012, hydropower accounted for 7.4% of Burkina Faso's electricity generation.[xi,56]

In Liberia, one privately owned small hydropower plant (4 MW) is in operation, along with the grid-connected Yandohun project (60 kW), commissioned in 2013.[57] This plant, originally 30 kW, was destroyed during the country's civil war and was redesigned in 2009 to double the original capacity, with support from the World Bank's Africa Renewable Energy Access Program.[58] The 1 MW (rainy)/ 0.3 MW (dry) Mein River Hydropower Pilot Project in Bong County is expected to be commissioned in 2015. The project, which will serve 2,500 households and 250 commercial customers in addition to Cuttington University and Phebe Hospital, will be community owned and operated.[59] Rehabilitation of the 80 MW Mt. Coffee Hydropower Plant is expected by end-2015.[60]

As of 2009, a total 2 MW of micro-hydro plant capacity (10–1,000 kW) had been completed in Benin.[61]

Although as of early 2014, Niger had no installed hydropower capacity, the 130 MW Kandadji Dam is under construction in Niger and is expected to come on line by 2017; the plant is expected to produce roughly 630 GWh per year.[62]

> POTENTIAL FOR WIND POWER GENERATION IS GENERALLY BEST ALONG THE COASTS OF ECOWAS MEMBER STATES, PARTICULARLY IN CABO VERDE, WHICH THE AFRICAN DEVELOPMENT BANK (AFDB) HIGHLIGHTED AS HAVING THE BEST WIND POTENTIAL IN WEST AFRICA. MEAN WIND SPEED AT 50M AVERAGES ABOVE 6 M/S IN NORTHERN MALI AND MUCH OF NIGER.

WIND

Potential

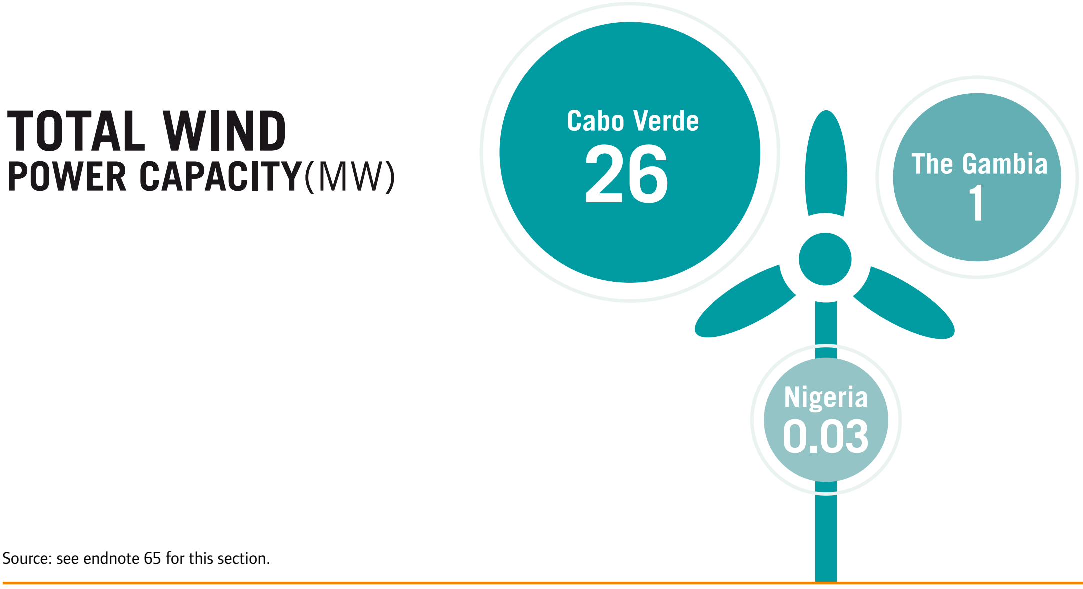
Potential for wind power generation is generally best along the coasts of ECOWAS Member States, particularly in Cabo Verde, which the African Development Bank (AfDB) highlighted as having the best wind potential in West Africa.[63] Mean wind speed at 50m averages above 6 m/s in northern Mali and much of Niger. Potential is also favourable along the coasts of Senegal, the Gambia, Ghana, and Togo.[64] Although few Member States have significant experience with wind power to date, interest is growing, with several major projects having come on line recently or in the pipeline.

Installed Capacity

As of mid-2014, three Member States have existing wind power capacity.[65] (See Figure 11.)

x. Average estimated for the period 1987–2009.
xi. This figure does not include self-generation by private industrial companies (total capacity of 13.45 MW).

FIGURE 11 | Installed Wind Power Capacity in ECOWAS Member States, 2014



Source: see endnote 65 for this section.

Cabo Verde has established itself as a forerunner in wind power deployment in the region. By 2011, two small-scale wind farms had been installed: São Vicente (0.9 MW) and Praia (0.9 MW).[66] The Cabeolica wind farm is the first commercial-scale, public-private partnership (PPP) wind project in sub-Saharan Africa (See Sidebar 4.)[67] It consists of four separate sites, with a total of 30 turbines and an installed capacity of 25.5 MW.[68] The first site to go on line began generating power in September 2011, and the project as a whole produces up to 76 GWh per year.[69] In 2011 a small private company, ELECTRIC, established a 0.5 MW wind project in Santo Antão.[70]

The Gambia showcases several examples of small-scale, community-based wind projects.[71] A 150 kilovolt-amp windmill, community-managed by Batakunku Village and commissioned in 2009, produces electricity mainly for local household consumption and supplies 20% of its power to NAWEC, the national utility.[72] The Tanji Wind Park, comprising two 450 kW turbines, is a grid-connected demonstration project under the GEF designed to showcase the technical feasibility of using renewable technologies to power rural communities. The Park was commissioned in July 2012 and uses turbines acquired second-hand from Europe, which reduces project lifetimes but reduces costs by 50–75%. [73]

Several projects are scheduled to come on line elsewhere in the near future. In Senegal, Sarreole signed a 20-year power purchase agreement with SENELEC in January 2014 for a 151 MW wind farm in Taiba Ndiaye, 75 kilometres northwest of Dakar. When completed, this will be the country's first commercial wind project. The farm is designed to accommodate 50 turbines at two sites, connected underground via cable and tied to the local grid.[74] In 2012, the Togolese government signed a contract with EcoDelta to develop a 25.2 MW wind farm at Kagomé, expected to be completed in 2015; once operational, the farm will produce some 7% of the country's electricity generation.[75] Several other projects in Togo have been identified as ECREEE priorities, including a 5 MW grid-connected project in Kara and the 49.5 MW wind farm on the coast between Aklakou, Grand Popo, and Dakonji.[76]

SOLAR

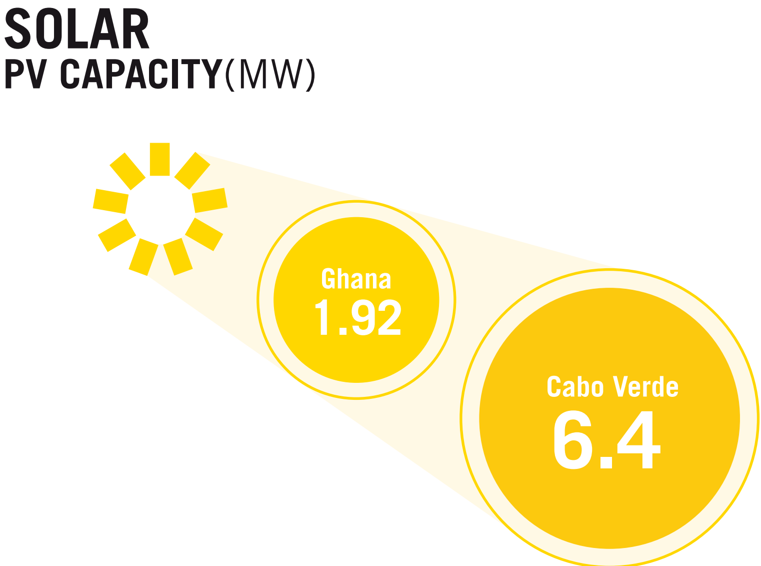
Potential

Technologies to convert solar energy into electricity generally fall into one of two categories: photovoltaic (PV) modules that convert light directly into electricity, and concentrating solar thermal power (CSP) systems that convert sunlight into heat energy that is later used to drive an engine. Although solar power can be generated at any scale, PV technology is modular and can be scaled for anything from household use to a large network of PV farms, whereas CSP is typically considered viable only as a utility-scale plant. Direct Normal Irradiance (DNI) values, used to measure potential for CSP, are high across the region; however, due to the scarcity of transmission and distribution infrastructure, ECREEE estimates that CSP is currently technically feasible only within a certain geographic band through the Sahel.[77] As of mid-2014, no Member States have developed CSP technology. The resource potential for solar PV is generally good and relatively homogenous throughout all of West Africa, except in Mali and northern Niger, where the resource is particularly strong.[78]

Installed Capacity

Recently, several Member States have demonstrated a growing interest in grid-connected and large-scale solar projects.[79] (See Figure 12.) Cabo Verde has an installed grid-connected solar PV capacity of 6.4 MW.[80] This includes two solar farms on the islands of Santiago and Sal (4.3 MW and 2.1 MW, respectively), both developed by Portugal's Martifer Solar and commissioned in 2010.[81] As of June 2014, Cabo Verde was planning to launch an auction for small-scale grid-connected PV projects on several islands.[82] Ghana's Navrongo PV plant, which came on line in 2013 with an installed capacity of 1.92 MW, is the largest grid-connected solar PV installation in West Africa outside of Cabo Verde.[83] The Volta River Authority ultimately plans to expand the plant to 2.5 MW.[84] Several additional PV plants are scheduled to come on line in Ghana in 2015. Norwegian company Scatec Solar has an agreement in place with Ghana's Energy Commission and the country's Public Utilities Regulatory Commission (PURC) to construct a 50 MW PV plant with local partner Scatec Solar Ghana.[85] Plans for the 155 MW Nzema solar PV park have been finalised, with construction scheduled to begin in September 2014 and power generation expected by mid-2015; the plant will have an expected annual generation of 240,000 megawatt-hours (MWh).[86]

FIGURE 12 | Installed Grid-Connected Solar PV Capacity in ECOWAS Member States, 2014



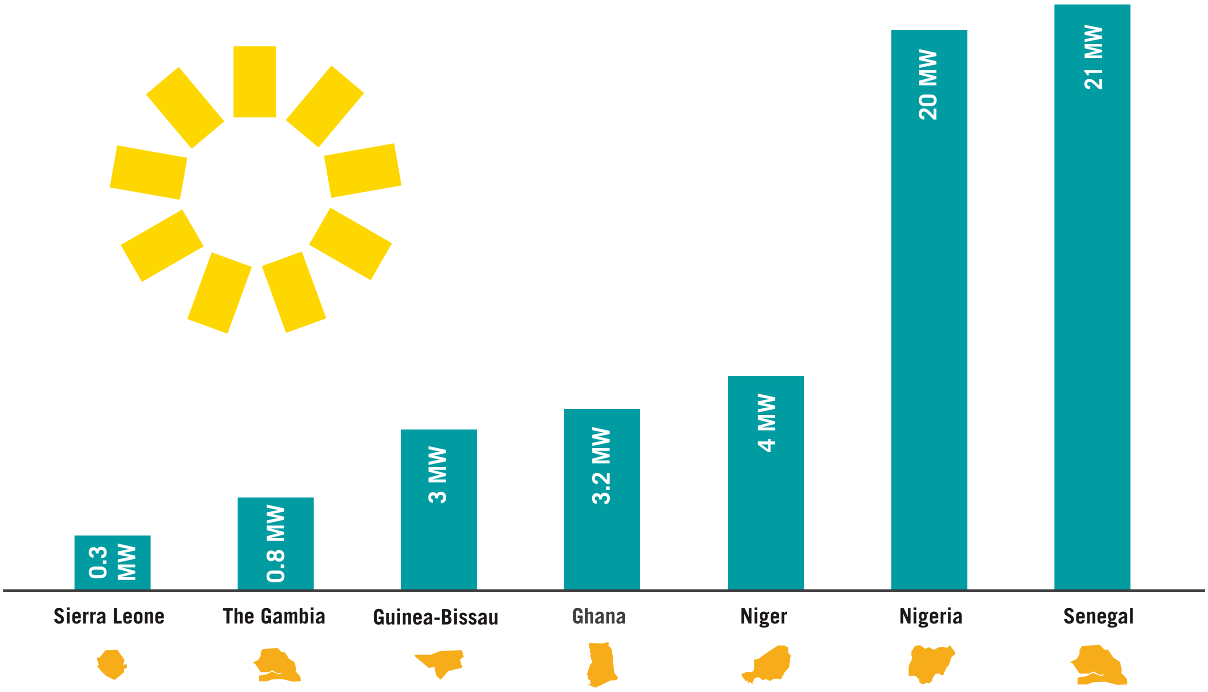
Source: see endnote 79 for this section.

Interest in grid-connected solar PV is also expanding elsewhere in the region. In Burkina Faso, construction of the 33 MW Zagtouli PV plant is scheduled to begin in 2015 and the government is currently exploring five additional sites for 10 MW plants.[87] Côte d'Ivoire has shortlisted eight private firms to develop grid-connected PV plants under a buy-own-operate agreement.[88] Niger has begun preparatory work for a 5 MW plant in the north of the country.[89] As of early 2014, 9 PPAs have been signed in Senegal for 10-20 MW PV plants, totalling 180 MW.[90] In 2014, Sierra Leone secured a loan from the Abu Dhabi Fund for Development to build the 6 MW Solar Park Freetown project, located in the capital city.[91]

As of 2014, the region's use of solar PV technology remains largely limited to distributed and off-grid functions, including for rural electrification and to power community centres, health clinics, and individual homes, as well as street lights. Distributed solar PV generation has often been linked to development-orientated projects implemented by governments or donor partners to supply schools, health centres, or rural communities. In Member States including Côte d'Ivoire, the Gambia, and Togo, PV development is limited largely to pilot-scale and rural energy service projects and where active commercial markets have not yet developed.[92]

Estimates of total installed solar PV capacity are unreliable, as few Member States collect data on self-generation or off-grid projects; however, data on distributed PV capacity in the Gambia, Guinea-Bissau, Niger, Nigeria, and Sierra Leone indicate widespread use of the technology.[93] (See Figure 13.)

FIGURE 13 | Estimated Installed Capacity of Distributed Solar PV in Selected ECOWAS Member States, 2012



Sources: Gambian Ministry of Energy & Petroleum; National Focal Institution for Guinea-Bissau; IRENA; National Focal Institution for Nigeria; UNDP; ECREEE.

In Cabo Verde, the Monte Trigo facility (.039 MW) operates as part of a micro-grid and includes a back-up diesel generator.[94] Mali has a total of 13 off-grid solar PV projects, ranging in size from 0.02 MW to 0.24 MW.[95] Nigeria has six off-grid solar PV projects, with capacities between 0.01 MW and 0.06 MW.[96] In Sierra Leone, distributed solar PV projects include one implemented by the Safer Future Youth Development Project to supply rural households with rooftop solar panels for lighting and charging mobile phones.[97] The Beacon Solar Energy Project, implemented by Engineers Without Borders from Princeton University and the local partner Energy For Opportunity, installed solar panels at the National Organization for Wellbody Clinic, which serves approximately 300,000 people.[98] In the Gambia, Suleiman Junkung General Hospital is equipped with solar PV panels and net metering.[99] And in Niger, villages such as Moli Haoussa and Banigueti have been electrified with solar technologies through financial assistance from the Government of India and the ECOWAS Development Bank.[100]

Many Member States are also implementing national initiatives centred on distributed solar PV. In Guinea-Bissau, the Ministry of Public Health, with support from the World Bank, equipped 127 health centres with solar PV panels for lighting and water pumps.[101] The Ministry of Energy is also implementing a Decentralized Rural Electrification Project in the country's Bafata, Oio, and Screens regions, installing solar PV equipment in schools, health centres, youth centres, and other establishments in small villages.[102] In 2012, the North American International Organization in Dakar installed PV systems in the villages of Mabonco, Sintcham Botche, and Cambadju.[103] In Liberia, solar PV has been installed in 205 public health facilities through the Rural and Renewable Energy Agency's Renewable Energy for Health Care Facilities project, which also trains clinic staff in maintenance and system management. The Liberia Energy Assistance Program (LEAP), implemented by the U.S. Agency for International Development (USAID), installed solar PV at 19 schools, clinics, and public buildings.[104]

Elsewhere in the region, the Senegalese Agency for Rural Electrification is implementing Rural Electrification Projects (ERILs) using solar systems to electrify more than 650 community centres and more than 120 rural localities.[105] In Ghana, the Ghana Energy Development and Access Project (GEDAP), implemented by the Ministry of Energy and Petroleum with national and international partners, aims to deploy approximately some 7,500 solar PV systems in schools, hospitals, and off-grid communities. The project includes financing schemes to make solar feasible for consumers by providing discounts on equipment and providing rural households with solar home systems via subsidised loans from local banks.[106]

Solar Lighting

Solar technology is also being used throughout the region to supply lighting, either through PV lighting systems or solar lanterns. In Togo, the African Biofuel and Renewable Energy Company (ABREC) has installed approximately 13,000 solar street lights.[107] Guinea-Bissau's Development Programme for Renewable Energy and Energy Efficiency (PRODERE) project, developed by ECOWAS, aims to replace public lighting with PV-powered lighting throughout the country.[108] The Solar Street Lighting Project in Sierra Leone plans to install 10,000 stand-alone solar street light units in Freetown, Lungi, and 12 district capitals.[109] Lighting Lives in Liberia, implemented by the World Bank, focusses on developing a market for distribution of solar lanterns through private retailers.[110] Ghana's Solar Lantern Distribution Programme, launched in February 2013, distributes solar lanterns to rural off-grid communities to replace kerosene, aiming to provide 200,000 lanterns over five years. Composed of three phases, the work targets communities on islands or with no access roads, to establish a local assembly plant and build awareness, and to distribute lanterns.[111] In Senegal, the Lighting Africa project conducted a market analysis, designed an awareness plan, and initiated a pilot programme to distribute solar lanterns in schools.[112]

Solar Heating, Cooling, and Drying

Use of solar-powered dryers and water heaters is evident throughout the region, although estimates of total penetration are limited and difficult to assess. Mali's Ministry of Energy and Water Resources estimates that the country has about 1,500 200-litre solar water heaters and 1,000 solar dryers.[113] In Niger, solar water heaters are used in various schools, clinics, and some households. The country also produces solar water heaters and dryers domestically.[114]

In the Gambia, solar water heaters have been used for several decades, resulting in significant in-country experience with the technology. The country's Kombo Beach Hotel installed a solar water and hot water storage system to shift from electric/diesel to solar, which has been operational since 2007. The annual savings from the project are estimated at USD 18,000, resulting in pay back over three years.[115] Although most hotels in the Gambia continue to use either electricity or fuel-oil boilers to heat water, many smaller hotels—especially those located away from the grid—are increasingly investing in solar systems.[116]

BIOMASS POWER

Biomass power is derived from the conversion of plant materials and organic wastes into electricity. In ECOWAS this refers mainly to three different fuel groups: wood fuel, by-products from crops production, and energy crops for power generation.[117]

Potential

Overall statistics on the availability of biomass resources in ECOWAS are often unreliable.[118] A basic assessment of the potential for producing bioenergy crops shows divergent potentials for different fuel crops across the region. Based on ECREEE's initial assessment, the potential for producing a number of crops is high in countries such as Benin and Nigeria, while Cabo Verde, Liberia and Sierra Leone appear to show more limited potential.[119] A more detailed assessment of the potential availability of four newer fuel crops—sweet sorghum, jatropha, cassava, and cashew—was conducted by ECREEE and UNIDO under the "Regional potential assessment of novel bio energy crops in fifteen ECOWAS countries" project, again with widely divergent results by crop.[120]

Installed capacity

Several biomass projects throughout the region produce power for the grid. The Abidjan Municipal Solid Waste-to-Power biogas project provides 3 MW of capacity.[121] The 42 MW Biovea Biomass Plant, located in Aboisso, Côte d'Ivoire is a registered Clean Development Mechanism (CDM) project that would use woodchips from forestry residues at palm oil plantations to export power to the national grid; commission was planned for June 2013, but the current status remains unclear.[122] In Nigeria, the Ibadan GNEEDER biogas plant (0.5 MW) began operating in 2010, producing power from slaughterhouse waste.[123] Ghana has four small biomass plants with a total installed capacity of 2 MW.[124]

To date, most biomass power production is used for self-generation in industrial plants. In Senegal, a biogas digester at a slaughterhouse in Dakar has a capacity of 1000 m3/day and can annually produce 876 MWh of electricity to power the slaughterhouse (reducing consumption from the utility by 48%) and 1752 MWh of heat to produce more than 25,550 m3 of hot water.[125] Several other ECOWAS Member States use biomass for co-generation: Ghana has 4 MW of biomass co-generation; Nigeria is home to a 5 MW biomass plant that produces power for a cement plant; and Guinea-Bissau has a 150 kW co-generation pilot project using cashew shells.[126] In Côte d'Ivoire, a number of industries use biomass (including sugar bagasse, palm husks, cotton husks, coco, and other agricultural residues) for self-generation, totalling 80 MW of installed capacity.[127]

As momentum behind biomass generation grows, several major projects are under development. In Sierra Leone, the Addax Makeni Bioethanol and Power Plant, financed and under construction as of December 2011, will annually produce 80 million litres of fuel ethanol from sugar cane and 32 MW of electricity from residual bagasse, of which 15 MW will be fed into the national grid.[128] Côte d'Ivoire has shortlisted seven private companies to develop grid-connected biomass plants under a buy-own-operate agreement.[129]

Sidebar 1. West African Power Pool

The West African Power Pool (WAPP) is a cornerstone of the ECOWAS strategy to expand access to affordable, reliable electricity services across the region. IRENA has identified regional and intra-continental renewable energy based power systems as an opportunity to provide cost effective solutions that support continued economic growth.[130] Recognising the need for new and improved power sector infrastructure across ECOWAS, WAPP was created in 1999 to serve as a regional body dedicated to the promotion and development of power transmission and generation facilities in the ECOWAS Member States. WAPP supports domestic infrastructure development as well as inter-country connections allowing for the cross-border trade of electricity within the region. This has allowed countries such as Côte d'Ivoire, Ghana, Mali and Nigeria to become net electricity exporters within the region, simultaneously providing an opportunity for neighbouring countries to overcome capacity-demand gap challenges.[131] By facilitating the development of an integrated regional electricity market, WAPP will play an important role in expanding access to affordable energy services, increasing the security of energy supply, and decreasing dependence on fossil fuel resources through increased efficiency and by overcoming a number of barriers to expanded renewable energy penetration.

The expanded regional power network being developed under WAPP allows the ECOWAS Member States to overcome a number of economic and technical challenges associated with renewable power. Financially, WAPP presents opportunities to reduce the cost and financing constraints that often limit deployment of renewable energies in the region. Power pool projects in ECOWAS and elsewhere on the continent have the ability to reduce capital and operating costs by improving coordination between utilities; allowing for the development of larger, more cost-effective infrastructure than could be supported by the needs of the immediate area where a resource is located; and improving the ease of financing new projects by reducing investment risk.[132] These are all particularly acute issues in the development of renewable power systems, as financing remains one of the greatest barriers to renewable development in ECOWAS and around the world.

The expanded grid network can also balance a number of technical challenges, allowing for more stable and reliable access to renewable energy resources. Although each ECOWAS Member State has significant renewable energy potential, these resources are not evenly distributed. (See Chapter 2.) WAPP allows resources to be tapped where available and utilised throughout the region. These benefits can also advantage variable renewable resources such as wind and solar, which can be developed in zones where resource potential is particularly strong, generating higher output.

System stability is further strengthened by the development of a regional power infrastructure network. Integrated systems making use of multiple technologies can help deal with periods of reduced output from a specific technology. Additionally, enabling variable renewable energy installations to be spread over a large geographic area can increase the amount of firm capacity available from a given technology. Regional diversity in project citing decreases the impact of any specific localised events or weather conditions on region-wide system output. Reliability of service—for renewable and non-renewable sources—can also be improved through the regional system by allowing for greater access to backup facilities which can be utilised to make up for unplanned plant outages or reduced output from variable renewable sources.[133] Overall, WAPP stands to play a central role in accelerating deployment of renewable energy sources and meeting the energy needs of ECOWAS Member States.

Source: see endnote 134 for this section.

WIND AND SOLAR FOR WATER PUMPING

Throughout ECOWAS, renewables have long played a significant role in supplying power for activities like water pumping. In the Gambia, the main application of solar, used in the country since the 1980s, has been for on-site water pumping; Gam-Solar has installed solar pumping systems in nearly 80 villages, providing potable water to more than 200,000 people.[134] The Gambia Rural Water Supply and Sanitation Project, expected to be completed by end-2014, plans to install 18 solar-powered drilled boreholes and pumping units, with financing from the AfDB. The Gam-Solar for Horticulture project (8.4 kW) aims to pump water to community-owned gardens and to provide surplus energy to local schools.[135]

A solar-wind hybrid water pumping installation in Mali, supported by the GEF Small Grants Program and Implemented by the Mali-Folkecenter, will pump water for sale, train local technicians in operations and maintenance, and stimulate economic development.[136] Mali also has an estimated 150 small-scale wind mills for pumping water and other uses.[137] In Niger, experience with wind generation is limited to water pumping; IRENA estimates that about 30 small-scale wind pumping installations operate throughout the country, mostly implemented with donor and community financing.[138]

MINI-GRIDS

Mini-grids are a tool to provide cost-effective, reliable electricity service to populations not served by the current grid infrastructure. Mini-grids can be developed around a number of business models and power generation options, and are increasingly incorporating renewable generators—mainly solar PV, wind, and small-hydro—into their design.[139] (See Sidebar 2.) Hybrid mini-grid systems combining multiple renewable energy technologies or renewable and fossil fuel generation are also featured across the region. In July 2014, ECREEE completed a survey of mini-grid initiatives throughout the ECOWAS region.[140] The results are summarised in Table 7.

TABLE 7 | Renewable and Hybrid Mini-Grid Projects and Initiatives, July 2014

	STATUS OF RENEWABLE AND HYBRID MINI-GRID PROJECTS AND INITIATIVES (JULY 2014)	
	Existing	Planned
Benin	—	The Agency for Rural Electrification and Energy Management (ABERME) is developing Terms of Reference for the country's first hybrid PV-diesel mini-grid.
Burkina Faso	The Ministry of Energy's Electrification Development Fund has financed 3 hybrid PV-diesel projects, each with an installed capacity of 15 kWp.	The Ministry of Energy is undertaking 7 additional hybrid PV-diesel projects. The EU Energy Facility plans to implement PV mini-grids in communities throughout the country.
Cabo Verde	Two projects, Monte Trigo (PV-diesel) and Vale da Custa (PV-wind-diesel), have a combined capacity of 50 kW.	The General Directorate of Energy is currently studying load demand in unelectrified communities to determine appropriate project size and investment costs.
Côte d'Ivoire	—	The Ministry of Energy has shortlisted developers to install PV, biomass, and hybrid mini-grids under a Build-Own-Operate model.
The Gambia	A 350 kW wind park.	—
Ghana	—	The Ghana Energy Development and Access Project includes a tender for the installation of 4 PV-diesel pilot mini-grid projects.
Guinea	Two operational hydropower mini-grids.	A government initiative to support wind-powered mini-grids is being planned.
Guinea-Bissau	—	A hybrid PV-diesel mini-grid providing electricity to the village of Bambadinca is planned to come online in September 2014.
Liberia	The 60 kW micro-hydro mini-grid, which came online in 2013, is operated and managed by the village of Yandohun.	There is growing interest in biomass-powered mini-grids.
Mali	The Malian Agency for the Development of Household Energy and Rural Electrification has developed a successful Public-Private-Partnership model in which private operators apply for Rural Electrification Authorizations and financial support from the Rural Electrification Fund. twenty-one hybrid PV-diesel projects (totalling 2.1 MW) exist in Mali.	In 2015, AMADER will begin an initiative to convert 50 diesel mini-grids to hybrid PV-diesel systems.
Niger	—	—
Nigeria	Several renewable mini-grids exist, including a 4 kW PV mini-grid system in the isolated community of Ofetebe, which now has approximately 4 hours of electricity per day.	—
Senegal	The Senegalese Agency for Rural Electrification has installed 107 mini-grids, totalling 1 MW of installed PV capacity.	—
Sierra Leone	A hybrid hydro-PV mini-grid supplies the community of River Number 2.	—
Togo	—	Companies have been shortlisted to promote renewable mini-grids in the country.

Note: "–" indicates that data are not available.
Source: see endnote 135 for this chapter.

Sidebar 2. Business Models for Mini-grids for Rural Electrification

Mini-grids were developed as an alternative to centralised expansion of the main electricity grid, which can be economically prohibitive for remote rural locations, and may require long periods of time to materialise. There is no absolute definition of a mini-grid; they vary widely in terms of size, technology, and business model, and must be designed to fit specific social contexts, resource availability, and the quantity and quality of service intended. While most existing micro-grids are isolated systems powered by diesel generators, a growing number of systems use renewable energy sources and innovative service delivery models.

In the Gambia, the Mbolo Association in Tujereng has an 8.3 kW solar-wind hybrid system installed, comprising three solar PV arrays, a wind turbine, and a fuel oil generator. The system, funded with support from GEF/UNIDO, aims to ensure a 24-hour power supply to the community association for workshop activities and to reduce fuel use. The Gambia also has a PV-diesel mini-grid operating in the village of Darsilami, which supplies power for a local health centre and water pumping; its diesel component provides less than 5% of the system's total energy mix. The NAWEC-Kaur Hybrid PV-Gasoil Mini-Grid, currently being developed, will be state owned, with a capacity of 60 kW.

Given the low-demand profiles in many rural areas, developing a working business model for a mini-grid can be difficult. Globally, there are generally three types of business models: for-profit, fully subsidised, and partially subsidised. For-profit systems cover operational costs from tariff collection, in addition to a return on their capital investment. They tend to utilise an industrial or commercial anchor client to ensure a steady level of tariff revenue and to achieve the necessary return on investment.

Fully subsidised systems are usually funded by governments and charge zero or below cost-recovery tariffs, making additional subsidies necessary to fully cover operational costs. These systems tend to focus on achieving high levels of coverage with a limited amount of power capacity. Establishing a local committee or co-operative to manage, operate, and maintain the system is necessary and may require significant capacity building. Moreover, community involvement at the outset of the project is instrumental to ensuring its success.

Partially subsidised systems tend to cover capital costs through subsidies and depend on tariff collection to cover the management, operational and maintenance costs; as such, they lie in between for-profit and fully subsidised models. Thus, they must focus on providing reliable service to gain and maintain the trust of the community, and in turn ensure constant tariff collection for its continued operation.

While each of these business models has its own set of operational structures and best practices, no matter the model, there must be sufficient funding for ongoing management, operation and maintenance of the mini-grid system to ensure its continued operation and financial viability. Furthermore, the systems' future sustainability and expansion can be incentivised through appropriate regulatory frameworks that allow future access to the central grid once it is extended to the rural population; financing through greenhouse gas emission abatement credits; and government guarantees on private capital to afford project developers with cheaper capital from diversified sources.

Source: see endnote 139 for this section.

03

ENERGY EFFICIENCY

ECOWAS

03 | ENERGY EFFICIENCY

INTRODUCTION

ECOWAS member states face rising energy costs, an unpredictable and uncertain energy supply, and a growing demand for energy services. (See Chapter 1.) Energy efficiency improvements often present the most cost-effective solutions for overcoming these challenges, offering a less expensive alternative to constructing new generation capacity and reducing the amount of new capacity needed to meet demand.[1] Additionally, energy efficiency can contribute to advancing important social and economic development goals, including literacy, safety, productivity, and gender equality. (See Sidebar 3.) Energy efficiency is also a strong complement to renewable energy development.

In recognition of this potential, the ECOWAS Heads of State have prioritised energy efficiency[xii] as an essential tool to meet the region's energy supply challenge.[2] The EEEP, adopted in 2013, has formalised the regional strategy for implementing successful energy efficiency actions. It identifies certain priority sectors (cooking, lighting, buildings, and electricity distribution) for achieving technical improvements, and outlines targets and priority measures to reduce energy use and increase productivity. (See Chapter 4.) At the national level, ECOWAS Member States have introduced various initiatives and programmes to improve energy efficiency as a way to face the national and regional energy challenges prevalent in the region.[3] (See Table 8.)

In spite of these efforts, numerous challenges persist. The region's continued reliance on old and inefficient equipment (often acquired second-hand) and inefficient use of traditional biomass results in low efficiency ratings. Although the total primary energy supply per country remains low (an additional challenge that the region seeks to address), energy use is often inefficient. Overall, national energy intensity[xiii] in the region in 2010 ranged from a low of 3 Mejajoules (MJ)/USD in Cabo Verde to a high of 71.1 MJ/USD in Liberia.[4] (See Figure 14.) Collectively, the 15 ECOWAS Member States have an average energy intensity of 14.5 MJ/USD, well above the continental average of 11 MJ/USD.[5]

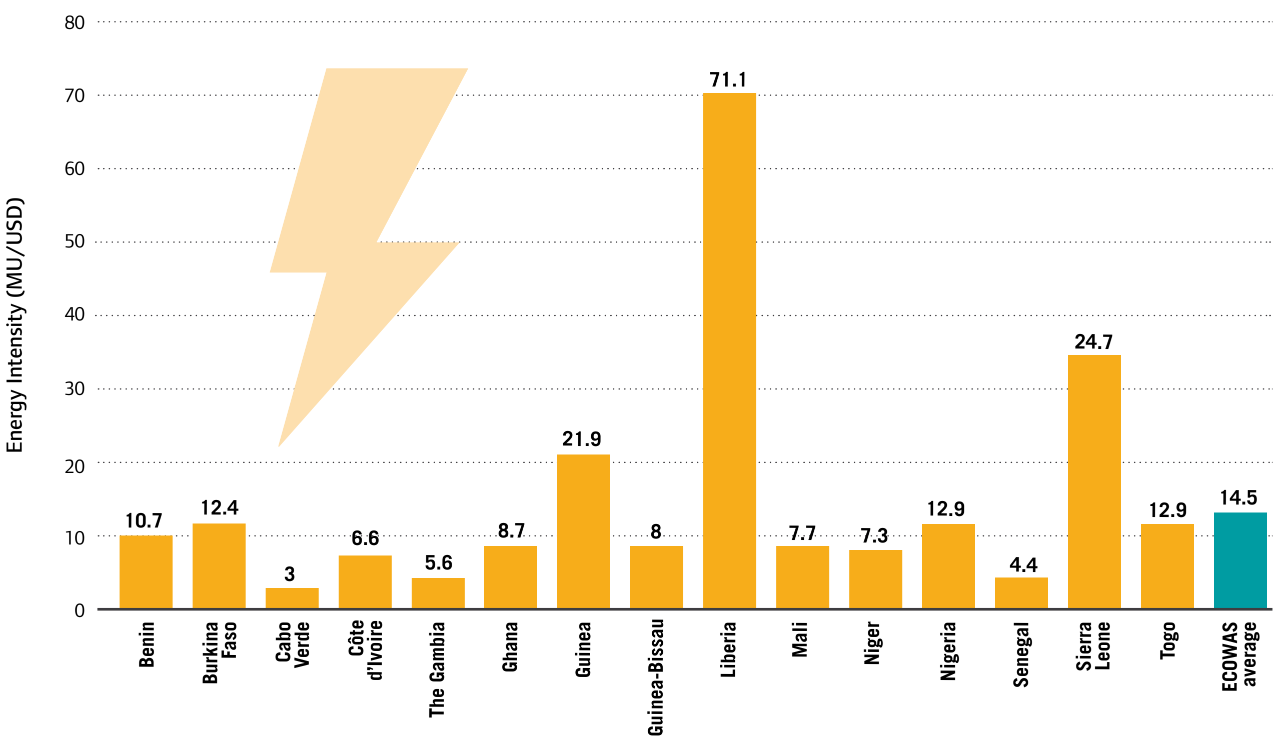
TABLE 8 | Energy Efficiency Activities in ECOWAS Member States

	CAPACITY BUILDING	AWARENESS RAISING	DISSEMINATION OF EFFICIENT LIGHTS	PROMOTION OF EFFICIENT COOK STOVES	REFRIGERATION AND AIR CONDITIONING	BUILDING EFFICIENCY	ENERGY MANAGEMENT	MINIMUM ENERGY PERFORMANCE STANDARDS (MEPS)	SUPPORT FOR EE MARKETS	FEASIBILITY STUDIES, DATA COLLECTION
Benin	x		x	x		x				
Burkina Faso	x		x	x						
Cabo Verde	x		x							x
Côte d'Ivoire	x	x				x			x	x
The Gambia			x	x						x
Ghana	x	x	x	x	x		x	x	x	x
Guinea	x		x	x						x
Guinea-Bissau	x									
Liberia										
Mali	x		x	x						x
Niger	x	x		x	x					x
Nigeria		x	x			x		x		
Senegal	x		x	x						x
Sierra Leone	x									
Togo	x		x	x			x			

Source: see endnote 3 for this chapter.

xii. Energy efficiency is used to refer to both energy efficiency and energy conservation measures.
xiii. Energy intensity is a measure of energy use per unit of GDP and is often used as a proxy measure for energy efficiency.

FIGURE 14 | Energy Intensity of Final Energy in ECOWAS Member States, 2010



Through the development of National Energy Efficiency Action Plans (NEEAP), Member States' national governments are playing a central role in meeting the goals expressed in the EEEP. This section describes the current status of energy efficiency in the Member States, and highlights those initiatives that have been developed to increase energy efficiency in the prioritised areas of lighting, cooking, electricity distribution, and buildings.[xiv] (See Chapter 4 for a discussion of specific energy efficiency policies and targets.)

ENERGY EFFICIENCY IN ELECTRICITY SUPPLY

Electricity losses vary across ECOWAS Member States—ranging from 15% to 50%.[6] (See Table 9.) Although comprehensive and reliable data on system losses are limited, average losses across the region are estimated between 21.5% and 25%.[7] In response, ECREEE has established the Alliance on High Performance Distribution of Electricity, with the goal of meeting the EEEP's target of reducing network losses from 21.5% in 2010 to below 10% by 2020.[8] By implementing efficiency improvements, the Alliance aims to free 2,000 MW of power generation capacity and help reduce suppressed demand.[xv,9]

Technical and non-technical losses in the region's grid networks are a major barrier to further development of the energy sector. Technical losses often result from inefficient or undersized power transmission infrastructure. Non-technical (or commercial) losses include electricity theft from illegal connections as well as unpaid bills from connected consumers, including public entities.[10] Lost revenue reduces the funding available to utilities to re-invest in the existing grid network, meaning that necessary upgrades or extensions go undeveloped.

Increasing energy efficiency in electricity distribution is a clear priority for the ECOWAS region, although success has been limited to date. Despite the lack of formalised initiatives, ECREEE has identified two successful programmes in Ghana and Nigeria. These programmes include measures to reduce both technical and non-technical losses by improving and maintaining existing equipment, removing illegal connections, and optimising billing to increase cost recovery.

In Ghana, the objective is to reduce system losses from 23.6% in 2012 to 18% by 2015 (9% technical, 9% commercial).[11] In response, Ghana's PURC set a target of 21% for the electricity distribution companies ECG and NEDCO and a target of 3.5% for the transmission utility GRIDCO.[12] EGC has instituted an automated meter reading programme and has already installed 350,000 smart units in a further effort to reduce losses through meter tampering in Ghana. Additionally, the World Bank-supported Emergency Infrastructure Rehabilitation and Energy Project includes a component for Togo to rehabilitate distribution lines and networks in the country.[13]

xiv. The ECOWAS Energy Efficiency Policy sets targets in six key areas: lighting, electricity distribution, cooking, standards and labelling, building codes, and financing. Standards and labelling as well as financing are discussed in Chapter 4.

xv. Suppressed demand—or the inability to meet the desired demand of citizens for energy services—is due to unavailable or unaffordable energy options.

TABLE 9 | Electricity Network Losses in Selected ECOWAS Member States

COUNTRY	LOSSES AS SHARE OF TOTAL GENERATION
Benin	20.1%
Cabo Verde	26.1%
Côte d'Ivoire	23.5%
The Gambia	22%
Ghana	23.58%
Guinea	> 50%
Guinea-Bissau	47%
Nigeria	17.3%
Senegal	21.7%
Togo	53%

TARGET: UNDER 10% BY 2020

Source: see endnote 6 for this section.

For future infrastructure planning, decentralised renewables have the potential to mitigate losses by reducing the need for extensive transmission infrastructure. Particularly for currently un-electrified, dispersed communities, localised generation through renewable sources—either at the household or mini-grid scale—reduces the need to transmit centrally generated power across long transmission lines to reach consumers. This offers the opportunity for optimising the efficiency of delivery.

PROMOTION OF ENERGY-EFFICIENT LIGHTING

Globally, lighting accounts for 15% of total electricity consumption.[14] Despite newer, more efficient alternatives, inefficient incandescent and halogen lamps remain a major source of lighting in ECOWAS member states. Eliminating the use of these lamps would have a significant impact on the region. Studies demonstrate that introducing energy-efficient lighting worldwide could save an estimated USD 140 billion per year in reduced energy costs.[15] The SE4ALL initiative has identified energy-efficient lighting as one of its Energy Efficiency Accelerators, giving further impetus to the promotion of energy efficiency in the lighting sector.[16]

The transition to energy-efficient lighting is one of the most cost-effective ways to reduce electricity consumption during peak periods. Lighting is a significant energy consumer in the ECOWAS region; Nigeria estimates that up to 60% of peak load goes to lighting services.[17] A region-wide switch to energy-efficient lighting therefore will have a significant impact on the energy sector as well as on the broader development priorities of ECOWAS Member States.

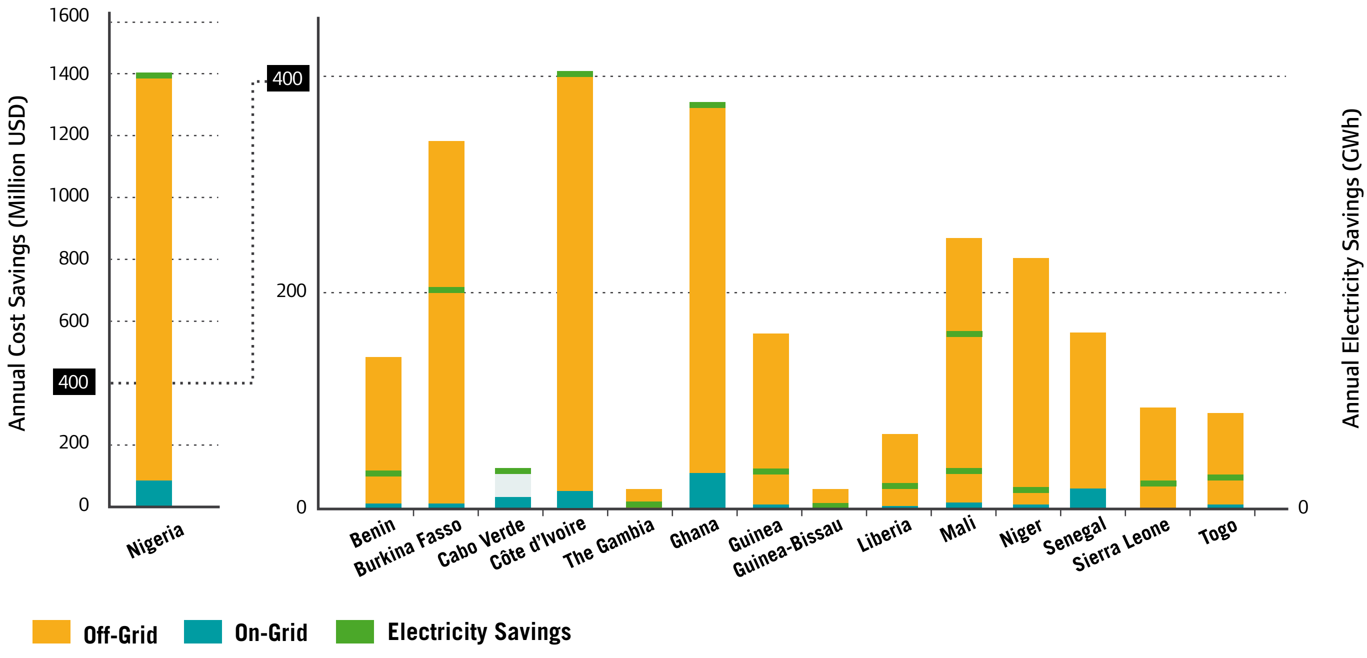
ECREEE is spearheading this transition with development of the Regional Energy Efficient Lighting Strategy as well as the ECOWAS Regional Efficient Lighting Status Report. The complete phase-out of incandescent lamps by 2020 is expected to significantly reduce peak demand and to result in annual energy savings of some 2.43 Terawatt-hours, equal to 6.75% of the region's annual consumption.[xvi,18] These savings are enough to meet the annual electricity needs of an estimated 2.4 million households and will save the region more than USD 200 million per year.[xvii] Combining grid and off-grid lighting, the financial savings in the ECOWAS region are anticipated to be USD 4 billion.[19]

Electricity and cost savings for on- and off-grid consumers at the national level are estimated to be extensive. For rural consumers, efficient lighting provides significant savings over the current costs of kerosene, candles, and batteries.[20] (See Figure 15.) As ECOWAS Member States seek to extend electricity coverage, the use of energy-efficient lighting offers the potential to reduce the volume of new capacity needed to supply demand in currently un-electrified regions. Yet the rate of adoption remains low. Global market penetration for efficient lighting technologies is estimated at 10–15%.[21] Unfortunately, it is difficult to quantify the uptake of efficient lighting products in the ECOWAS region.

xvi. The United Nations Environment Programme (UNEP) estimates that replacing one million incandescent lamps in Africa with energy-efficient compact fluorescent lamps (CFLs) could reduce peak demand by 50 MW and save 47 GWh per year, per UNEP, *Regional Report on Efficient Lighting in Sub-Saharan African Countries* (Nairobi: 2012), http://www.enlighten-initiative.org/portals/0/documents/country-support/en.lighten_Sub-Saharan%20Report.pdf

xvii. Estimate of 2.4 million households based on assumed consumption of 1,000 kWh/year.

FIGURE 15 | Projected Electricity and Cost Savings from Efficient Lighting in ECOWAS Member States



The higher cost of energy-efficient lamps, compared to current less-efficient alternatives, is one of the largest obstacles to full deployment. In addition, technical challenges as well as a lack of information and societal acceptance of efficient lighting technologies have yet to be fully reconciled.[22] To overcome these challenges, policies (see Chapter 4) or initiatives to introduce energy efficient lighting are active in the majority of ECOWAS Member States, although implementation varies widely by country.

Various Member States have introduced programmes to distribute energy-efficient lamps to overcome the barriers to market uptake.[23] (See Table 10.) Most programmes are designed to distribute compact fluorescent lamps (CFLs) for residential and/or commercial lighting; however, more-efficient light-emitting diode (LED) lamps are also being introduced in select markets, such as Nigeria.[24] Mali has also introduced a pilot, efficient street lighting programme, which aims to install 15,000 demonstration projects.[25]

TABLE 10 | Energy-Efficient Lighting Initiatives in Selected ECOWAS Member States

	PROJECT DESCRIPTION
Benin	Planned distribution of 350,000 CFLs
Cabo Verde	Distribution of 300,000 CFLs in 2009–2010
The Gambia	Promotion of fluorescent tubes or CFLs in public buildings
Guinea	ELSEWEDY project: Supply 3,500,000 lamps ECOWAS programme: Replace 750,000 incandescent lamps with CFLs PASE project: Distribute 600,000 CFLs to Kaloum area
Mali	Planned distribution of one million CFLs Efficient street lighting demonstration project (15,000 street lamps)
Nigeria	1 million CFLs LED lamp distribution CDM project to distribute 150 million bulbs
Senegal	Bulk procurement and distribution of 500,000 CFLs in 2010
Togo	Planned distribution of at least 400,000 CFLs CDM project to distribute one million CFLs

Source: see endnote 23 for this section.

In addition to the targeted distribution of CFLs, national strategies include capacity building and public outreach components designed to increase the use of efficient lighting. Energy-efficient lighting programmes feature a variety of stakeholders, both from the public and private sectors. While the national government often takes a leading role in the design and execution of these programmes, they are typically carried out in partnership with domestic or international actors. National programmes have been supported by domestic banks, such as the National Development Bank in Guinea, or national utilities, such as SENELEC in Senegal.

Beyond household lighting, energy efficient streetlights can play a large role in reducing municipal lighting costs and improving quality of life for urban residents. Scaling up the use of efficient streetlights has been identified as a priority area by ECOWAS under the EEEP. Street lighting provides social benefits including increased safety and social cohesion, and increases economic opportunities. The costs associated with providing public lighting fall on the often limited budgets of municipal governments, a cost which can be reduced through more efficient solutions. Mali has taken a leading role in seeking to introduce this switch through a demonstration project aimed at installing 15,000 energy efficient street lamps across the country.

International support has come from a variety of institutions. The United Nations Environment Programme (UNEP) has taken a leading role by implementing the UNEP-GEF en.lighten initiative in West Africa. En.lighten seeks to scale-up the global transition to energy-efficient lighting solutions through policy and strategy development, overseeing technical and quality issues, identifying and disseminating best practices, and facilitating stakeholder collaboration. This initiative, in collaboration with ECREEE, led to the development of the ECOWAS Regional Efficient Lighting Strategy and the Minimum Energy Performance Standards for Grid and Off-grid Lighting.[26]

A major initiative promoting the transition to efficient off-grid lighting in the ECOWAS region is Lighting Africa, a joint programme of the International Finance Corporation (IFC) and the World Bank that works with the private sector to build sustainable markets that provide safe, affordable, and modern off-grid lighting to communities in Africa that do not have access to electricity.[27] To date, Lighting Africa and its stakeholders have provided close to 1.5 million people with improved lighting and energy access.[28] In the ECOWAS region, the programme currently operates in Ghana, Mali, and Senegal.[29]

ENERGY EFFICIENCY IN COOKING

The transition to energy-efficient cook stoves and cleaner cooking fuels is a critical component of the EREP. The use of advanced cook stoves can mitigate many of the negative health, environmental, and social impacts associated with the use of traditional biomass. Reliance on wood or charcoal for cooking contributes to forest degradation, results in an estimated 500,000 premature deaths from indoor air pollution annually in sub-Saharan Africa, and contributes to lost economic and educational opportunities for women and girls.[30]

In recent years, projects in the ECOWAS region have demonstrated many of the benefits of using energy-efficient stoves. These include cost, time, and fuel savings; easier and faster cooking; decreased smoke and the negative health impacts from indoor air pollution; and the reduced occurrence and risk of fires and burns. In the Gambia, the average cooking time for households using new, efficient stoves has been reduced from 2.39 hours to 1.31 hours, with the average monthly expenditures for cooking fuel reduced by about one-third.[31] Similarly, fuel switching and introducing efficiency improvements to the production of fuel sources such as charcoal can further reduce the need for and impact of fuel use in the cooking sector. A variety of stove options now exist at various price points.

The Global Alliance for Clean Cookstoves has mobilised support around the goal of providing clean cook stoves to 100 million households by 2020.[32] Two of its eight prioritised focus countries—Ghana and Nigeria—are ECOWAS member states. The ECOWAS Initiative on Safe, Sustainable, and Affordable Cooking was initiated to ensure universal access to efficient, sustainable, and modern cooking fuels and devices by 2030.[33] ECREEE launched the West African Clean Cooking Alliance (WACCA) in 2012 to support this vision through policy and regulatory design, capacity building, and technology promotion.[34] Other initiatives in the region include the World Bank-led African Clean Cooking Energy Solution Initiative (ACCES), which aims to promote market-based, large scale dissemination of clean cooking solutions in sub-Saharan Africa.[35]

Clean cook stove programmes have often received support from the CDM. (For more on CDM programmes in the region, see Chapter 5.) Senegal's renewable energy and rural electrification programme (PERACOD) includes a CDM-registered component to distribute 25,000 improved cook stoves.[36] The Promoting Efficient Stove Dissemination and Use in West Africa programme was established to scale up the use of charcoal and fuel wood stoves in urban, peri-urban, and rural areas of Burkina Faso, Ghana, Mali, Senegal, and Togo.[37]

Several national level programmes have been developed in ECOWAS countries. In the Gambia, the Energy Efficient Cooking Stove Project (REAGAM), implemented in 2013, trains youth, artisans, metal workers, and women to produce energy-efficient stoves; provides stoves to targeted communities at minimal costs, with proceeds going to stove producers; and creates consumer demand for the efficient stoves.[38] Additionally, an estimated 900 households in the Gambia use solar cookers, and training programmes have been conducted in villages around the country.[39]

In Ghana, the government plans to further disseminate improved cook stoves while simultaneously increasing access to LPG for households and public institutions. The programme targets greater efficiency in the cooking sector, including reducing the average energy intensity of wood fuel in urban households and reducing the firewood intensity in rural households. Specific programmes have been enacted in Ghana to distribute efficient charcoal and fuel wood stoves, and small-scale manufacturing of solar cookers is also developing.

Mali has initiated programmes to produce household fuels from biomass waste, as well as to promote household charcoal stoves. Nigeria has enacted several clean cook stove programmes, including the Rural Women Energy Security (RUWES) Project, designed to promote the adoption of clean cook stoves along with solar driers and other technologies for use by women in rural, off-grid communities.[40] The National Clean Cooking Scheme (NCCS) component of the RUWES aims to distribute 20 million clean cook stoves throughout the country, working with women's co-operatives to provide the stoves to households and to institutional firewood consumers such as schools and hospitals.[41]

In addition to programmes providing advanced cook stoves, a select group of ECOWAS Member States has developed testing facilities to assess different cook stove options. Testing facilities for analysing the energy efficiency and air pollutant output of different clean cook stove technologies now exist in Ghana, Nigeria, and Senegal.[42] Policies and financial incentives to promote energy efficiency in the cooking sector—often implemented in tandem with the programmes described above—are slowly gaining support from national policymakers. (See Chapter 4 for more information on the current policy landscape for cooking technologies.)

ENERGY EFFICIENCY IN BUILDINGS

Globally, buildings account for 30–40% of total final energy demand.[43] They are also the largest sectoral consumers of electricity, at 42%.[44] With a rapidly growing population, a rate of urbanisation of 3.5% per year (the highest in the developing world over the past two decades), and projected economic growth, the energy demand of buildings is projected to rise throughout Africa.[45] Buildings house a wide array of energy consuming products, including lighting, heating and cooling, refrigeration, and electrical equipment. Well-designed and constructed buildings can significantly reduce energy use from current levels.

Energy efficiency improvements for buildings typically fall under two main categories: improvements in building construction and improvements in building energy use through advanced equipment. Changes made under both categories can significantly reduce energy demand for heating, cooling, ventilation, lighting, water heating, and electricity consumption.[46] Building construction improvements can be achieved through building design and the use of improved materials and new technologies, often aided by energy efficiency standards in building codes. End-use improvements can be made through technologies such as solar water heating, efficient lighting, and advanced appliances, in addition to the energy savings that can be achieved through behavioural change. Overall, building efficiency improvements can provide ancillary economic benefits which include increased property value and the reduction in expenditures for stand-alone diesel backup generators, which are often used to overcome load shedding and supply disruptions.

Only three ECOWAS Member States have established domestic programmes for energy efficiency in the building sector, although similar efforts are under development elsewhere. These programmes focus predominantly on assessing the current energy use of buildings and increasing the uptake of efficiency in construction through the development of building codes. Benin has emerged as a leader on the introduction of building efficiency. The country's Ministry of Energy and Water initiated a programme to design energy efficient building codes for use in administrative buildings, including offices, hospitals, schools, and military barracks.[47] The programme analysed electricity and heating, ventilation and air conditioning (HVAC) systems and studied the impacts of various construction materials (insulation, lighting, etc.) to identify standards for reducing energy use. Benin has identified potential energy savings of 35% from the adoption of energy-efficient building codes.[48] This programme has been used as the model for the development of the UEMOA voluntary codes.

Additionally, the Laboratory for the Construction of Public Works (LBTP) in Côte d'Ivoire has carried out various activities assessing building energy use in the country.[49] The Nigeria Energy Support Programme is conducting baseline studies for energy efficiency in building and is initiating pilot projects. Nigeria's energy efficiency programme covers the formulation of an energy building code, the design of an energy efficiency catalogue, and the design and implementation of pilot projects in both the industrial and building sectors.[50] In Senegal, the Parliament adopted initial legislation in 2008 and 2009 introducing energy efficiency requirements in building codes; however, they are awaiting Presidential Decrees before entering into force.[51]

Regionally, a number of initiatives have focused on awareness raising, capacity building and technical support. The ECOWAS Initiative on Energy Efficiency in Buildings has been developed to address the concern over inefficient building energy use in the region. The programme has identified several common challenges across the region, including poor awareness, a lack of trained workers and energy experts, and a lack of compliance, control, monitoring, and enforcement of energy efficiency activities.[52] The programme aims to facilitate the dissemination of energy efficiency in the region through a targeted mix of technical improvements, the establishment of community energy efficiency funds, and marketing, education, and training programmes.[53]

UEMOA has also taken up the issue of building energy use at the regional level. UEMOA, with assistance from the Renewable Energy and Energy Efficiency Partnership (REEEP), initiated a programme in 2013 to develop a standardised model building code for use within its eight member countries.[54] The voluntary code will target improvements in residential, commercial, and institutional buildings. In addition to the model code, the programme (to be completed by 2015) is designed to provide guidance on the technical components required to introduce energy efficiency improvements, as well as trainings and certifications for stakeholders and implementation partners.[55] The International Programme to Support Energy management (PRISME)—an initiative of 33 French-speaking countries, including nine ECOWAS members—has conducted training and capacity building programmes to equip local experts with the tools to undertake energy use audits, with a primary focus on public buildings.[56]

Sidebar 3. Gender and Energy in the ECOWAS Region

Within the ECOWAS region—as in most parts of the world—significant disparities exist between the socioeconomic status of women and men. (See Table 11.) For example, ECREEE has noted that throughout the region's Member States, women are underrepresented in decision-making processes and that as a result, their needs are less often accounted for in policy design and implementation.[57] In 2012, the share of seats in national parliaments held by women ranged from 41.6% in Senegal to just 6.7% in Nigeria, illustrating a trend of disparity in public representation.[58] In most Member States, women are also less likely to achieve an education.[59] This can have significant effects on their capacity to earn higher incomes, participate in public policy, and achieve improved health and living standards for their families. It is clear that the unique societal roles and responsibilities held by men and women influence not only relationships, but also the resources available to groups and individuals.[60]

TABLE 11 | Indicators of Gender Inequality in the ECOWAS Region

	GENDER INEQUALITY INDEX (2013)[a]	SEATS IN NATIONAL PARLIAMENT HELD BY WOMEN (2012)	POPULATION WITH AT LEAST SECONDARY EDUCATION (% AGES 25 AND OLDER) (2006-2010)[b]	
	Rank	% (women)	Women	Men
Benin	134	8.4	11.2	25.6
Burkina Faso	133	15.7	0.9	3.2
Cabo Verde	—	20.8	—	—
Côte d'Ivoire	143	10.4	13.7	29.9
The Gambia	139	7.5	16.9	31.4
Ghana	123	10.9	45.2	64.7
Guinea	—	—	—	—
Guinea-Bissau	—	14	—	—
Liberia	145	11.7	15.7	39.2
Mali	148	10.2	7.7	15.1
Niger	149	13.3	44.5	49.5
Nigeria	—	6.6	—	—
Senegal	119	42.7	7.2	15.4
Sierra Leone	141	12.4	9.5	20.4
Togo	129	15.4	15.3	45.1

Note: "-" indicates data not available.
[a] The Gender Inequality Index ranks 152 countries in terms of inequality in achievement between women and men in reproductive health, empowerment and the labour market, with 1 being the highest score and 152 being the lowest.
[b] Data refer to most recent year available for each Member State within the period specified.

Source: United Nations Development Programme (UNDP), Human Development Report 2014: Sustaining Human Progress - Reducing Vulnerabilities and Building Resilience (New York: 2014); see also endnote 58 for this section.

In the face of these challenges, ECOWAS adopted a Gender Strategy (2010-2020) designed to ensure that women and men act as equal stakeholders in the design, implementation, and benefits of development.[61] The region has designated sustainable energy as a linchpin in this effort, acknowledging the extent to which access to modern energy services could be "an engine for industrial development and employment creation" throughout the region; moreover, deploying renewable energy technologies could put Member States on a "more gender-balanced path" to sustainable development.[62] The EREP requires every Member State to develop a Gender Action Plan, and has mandated ECREEE to develop guidelines for mainstreaming gender into NREAPs.[63]

Throughout the ECOWAS region, many women depend on traditional biomass for household tasks and income-generating activities. However, despite their significant roles collecting and using energy resources, few women are engaged in the formal energy sector and their work is largely unaccounted for in national energy statistics.[64] Women benefit from improved access to modern, sustainable energy services through improved health, decreased risks associated with collecting traditional biomass and cooking with open fires, savings in both time and money, and the potential for increased income generation.[65] ECREEE has placed a particular focus on energy as means to build women's capacities as entrepreneurs and successful income generators.[66] As the sustainable energy sector expands, so will opportunities including roles as fuel suppliers, stove producers, promoters of efficient stove technology, and as entrepreneurs in catering businesses.[67] To date, common barriers preventing women from entering the energy services sector include a lack of access to formal capital, limited market information or technical experience, and systemic underrepresentation in public institutions and policymaking.[68]

Several major initiatives throughout the region aim to expand access to these opportunities. The ECOWAS Programme on Gender Mainstreaming in Energy Access, which emerged out of a training workshop on gender and sustainable energy in June 2012, works to build capacity for gender mainstreaming in energy policies, promote gender-sensitive policies, and implement gender-responsive investment and business strategies.[xviii,69]

WACCA, created in October 2013, works to promote modern, efficient production of biomass and modern bioenergy, expand regional dialogue and peer-to-peer learning, support bioenergy policy planning and implementation, and facilitate creation of a thriving bioenergy sector that contributes to regional development.[70] By 2020, the programme aims to create at least 10 million additional users of LPG and modern biofuels and 15 million additional households using improved cook stoves and/or sustainable biomass as their primary fuel. By 2030, they hope to raise these figures to 25 million and 45 million respectively.[71]

Gender-focused initiatives are also being implemented on the national and local levels, often providing case studies for potential replication throughout the region. In Burkina Faso, local beer breweries depend on the time-intensive labour of women and account for an estimated 20% of national firewood consumption.[72] The Dolo Project trains cook stove artisans and manufacturers on designs to improve efficiency, trains brewers on cook stove maintenance and operations, and works to enforce quality and technical standards for cook stoves. The project model focuses on raising awareness of opportunities for energy efficiency and attendant benefits among communities of women brewers, generate demand for improved cook stoves, and establish links between the women brewers and supply chains.[73] Other energy intensive food processing activities, including bakeries, have enormous potential for energy efficiency improvements; involving women in the design and implementation of activities to improve efficiency could have enormous benefits for their ability to build and expand businesses. In Sierra Leone, women trained to install and maintain solar-powered home systems at the Barefoot College of India returned home to assemble solar units at the Barefoot College in Konta Line Village, which opened in August 2011. These women now train others in solar installation and maintenance, illustrating the potential for entrepreneurship and peer-to-peer learning.[74]

As the region continues to move toward universal energy access, initiatives like these—along with ECREEE'S efforts to mainstream gender priorities and female representation in decision-making and policy implementation—will expand the benefits of sustainable energy deployment and create positive ripple effects in economic and social development.

xviii. "Gender mainstreaming" refers to incorporating the needs, priorities, and capacities of both women and men into policy design and implementation, with the ultimate goal of ensuring that intervention impacts do not disproportionately benefit one group over the other.

SECTOR SPECIFIC TARGETS

RENEWABLE ENERGY

04

POLICY AND TARGET OVERVIEW

ENERGY EFFICIENCY

GENDER AND ENERGY IN THE ECOWAS REGION

ENERGY EFFICIENCY IN BUILDINGS

EREP OFF-GRID RENEWABLE ENERGY TARGETS

SUSTAINABLE ENERGY ACCESS

04 | POLICY AND TARGET OVERVIEW

Worldwide, targets and policies continue to be a critical component of strategies to promote the development and deployment of renewable energy and energy efficiency solutions. Recognising the essential role that access to a sustainable, reliable energy supply plays in all aspects of national development, the international community has committed to ensuring universal access to sustainable energy under the SE4ALL initiative.[1] To meet these objectives, policymakers in ECOWAS Member States and around the world have turned to renewable energy.

Renewable energy technologies frequently require the support of well-designed policies and programmes to overcome barriers to their deployment. Common challenges include policy, regulatory, financing, investment, technology, and capacity barriers; limited public awareness; a lack of standards and quality control; and inadequate resource assessments.[2] As in many countries worldwide, each ECOWAS Member State faces a variable mix of barriers and opportunities. Policymakers must therefore first identify the specific barriers their country faces and then design a targeted mix of policies designed to mitigate them.

Within ECOWAS, as is the case worldwide, most renewable energy policies and targets enacted to date have focussed on supporting developments in the electricity sector. However, policies and targets for scaling up renewable energy in primary/final energy, heating and cooling, and transportation are now also being implemented. In addition, policies and targets for expanding energy access are increasingly specifying the use of renewables. Energy efficiency is also becoming an increasingly critical component of national energy sector development. (See Chapter 3.) Policies and targets for efficiency are being designed and enacted to conserve and improve energy use across a wide range of sectors where energy is produced, distributed, and consumed, including lighting, electricity distribution, cooking, and buildings. Taken together, these policies and targets are helping to transform the energy mix of the ECOWAS region.

As of early 2014, renewable energy support policies were in place at the national or state/provincial level in 138 countries worldwide, with targets established in 144 countries.[3] The initial expansion of renewable energy policies and targets in the early-to-mid 2000s was led primarily by industrialised countries. However, in recent years developing and emerging economies have taken a leading role in policy expansion.[4] These countries accounted for 95 of the 144 countries with renewable support policies in place by early 2014, up from an estimated 15 in 2005.[xix,5] In Africa, 35 of the continent's 54 countries had adopted a renewable energy policy by early 2014, while 37 had adopted one or more renewable energy targets. This rapid expansion is impressive considering that as recently as 2005, no policies or targets for renewable energy development had been identified on the African continent.[6]

ECOWAS has taken a strong role in designing an enabling policy environment to further the advancement of renewable energy. The ECOWAS and UEMOA *White Paper for a Regional Policy* set the stage by laying out ambitious goals for achieving high-levels of energy and electricity access in the region. This has served as the basis for the region's renewable energy development framework and the ambitious activities led by ECOWAS and ECREEE. (See Chapter 1.) The enactment of the EREP and the EEEP solidified the region as a global sustainable energy leader. The EREP aligns Member States behind a set of ambitious goals and priority initiatives across a multitude of sectors, including on- and off-grid electricity, heating, and transportation. (See Tables throughout this section.) The EEEP formalised the role of energy efficiency as an essential tool to meet the region's energy access challenge and outlines a similar set of policies and targets.[7] Together, these policies outline the region's energy development pathway. The formation of NREAPs for each Member State, which seek to streamline regional policy into national action plans, is expected by December 2014. Expanding on the regional goals established under the EREP and EEEP, this chapter explores the ECOWAS sustainable energy policy landscape at the national level. The SE4ALL framework has also looked to build on the national efforts through the Action Agendas being developed across the region.

xix. This estimate of 15 countries in 2005 is based on the best information available to REN21 at the time of the writing of the 2014 *Renewables Global Status Report*. There are 138 developing and emerging economies, as defined as countries falling within the low-income, lower-middle income, and upper-middle income classifications of the World Bank Country and Lending Groups classification for the 2014 fiscal year.

SUSTAINABLE ENERGY ACCESS

In line with the targets established under the SE4ALL initiative and the EREP (see Table 12), the majority of ECOWAS Member States have established sustainable energy access as a national development priority.[8] Large populations in nearly all of the Member States lack access to electricity and/or modern fuels for cooking and lighting, and nearly all have adopted targets and/or policies to increase access through grid-expansion or the deployment of off-grid technologies. These targets and policies increasingly rely on renewable energy technologies to improve electricity access in off-grid communities.

The expansion of modern fuel alternatives is also a central component of expanding sustainable access. Expanding access to clean cook stoves and higher-quality fuels is a central component of national development strategies. The promotion of sustainable energy sources through additional sectoral policies and targets—including in the cooking, heating and cooling, and transportation sectors—are further discussed in this section (see Sectoral Polices section).

TABLE 12 | EREP Off-grid Renewable Energy Targets

	2020	2030
SHARE OF RURAL POPULATION SERVED FROM RENEWABLE ENERGY OFF-GRID (MINI-GRID AND STAND-ALONE) SYSTEMS	22%	25%
SHARE OF POPULATION USING IMPROVED COOK STOVES	100%	100%
SHARE OF EFFICIENT CHARCOAL PRODUCTION	60%	100%
SHARE OF POPULATION USING MODERN FUEL ALTERNATIVES FOR COOKING	36%	41%
BIODIESEL AS SHARE OF DIESEL AND FUEL-OIL CONSUMPTION	5%	10%

Source: see endnote 8 for this section.

As of early 2014, 12 ECOWAS Member States had national targets to raise the level of domestic electricity coverage.[9] (See Table 13.) Cabo Verde has already made significant progress in achieving near universal access to electricity, and Ghana and Sierra Leone have set ambitious goals to achieve universal access by 2020 and 2030, respectively.[10] Additionally, seven Member States have adopted targets for the use of modern fuel alternatives, and four have adopted targets for the deployment of clean cook stoves and/or solar cookers.[11]

Targets for electrification are often backed by national policies and strategies, providing detailed mechanisms for expanding access. Increasingly, these policies single out renewable energy as an important tool for reaching underserved populations and alleviating poverty. As of early 2014, Benin, Burkina Faso, Cabo Verde, Ghana, Guinea-Bissau, Liberia, Mali, Niger, Nigeria, Senegal, and Sierra Leone all had policy documents in place that include provisions to advance energy access. Additionally, draft policies addressing energy access existed in two ECOWAS Member States: in the Gambia, the draft Renewable Energy Policy 2012 includes a section dedicated to off-grid energy, and in Nigeria, a draft policy includes various targets for sustainable energy access. Data for Guinea and Togo are not currently available.

Within these overarching policy documents, countries have also established specific measures aimed at promoting rural electrification through renewable energy. Benin, Burkina Faso, Mali, Senegal, and Togo have all created dedicated rural electrification programmes that rely specifically on renewable energy technologies to expand access.[12] The majority of programmes in place, however, do not focus exclusively on the use of renewable energy.[13]

TABLE 13 | Sustainable Energy Access Targets in Selected ECOWAS Member States

	ELECTRICITY ACCESS[a]	ACCESS TO MODERN FUELS[b]	CLEAN COOK STOVES
Benin	50% by 2015	40% by 2015; 60% of charcoal produced through efficient carbonisation process by 2015[c]	60% of population with improved cook stoves by 2015
Burkina Faso	60% by 2015		
Cabo Verde	100% by 2015		
Côte d'Ivoire	50% by 2015	60% (no date given)	
Ghana	80% by 2015; 100% by 2020	Reduce wood intensity of charcoal production to 3:1 by 2015 in the Savannah zone and to 4:1 in the forest zone by 2015	
Guinea	15% (no date given)	5% of demand in rural areas covered by biogas in 2013 and 30% in 2025	
Liberia	35% by 2030; 70% of greater Monrovia area by 2030	40% by 2015	40% of population with improved cook stoves by 2015
Mali	55% urban, 15% rural by 2015		
Nigeria[d]	75% by 2020	8,000 biogas digesters installed by 2030	1 million improved cook stoves installed by 2030; 150,000 solar cookers installed by 2030
Niger	15% by 2020; 66% of rural and peri-urban by 2015		
Senegal	60% by 2016		
Sierra Leone	30% by 2015; 50% by 2020; 75% by 2025; 100% by 2030	5% by 2015; 10% by 2020; 15% by 2030	Share of population with access to improved cook stoves: 5% by 2015; 10% by 2020; 15% by 2030

Note: Data were not available for the Gambia, Guinea-Bissau, and Togo.
[a] Targets for share of total population with access to electricity unless otherwise noted.
[b] Targets for share of total population with access to modern fuel alternatives unless otherwise noted.
[c] Efficient carbonisation process defined as wood to fuel efficiencies greater than 25%.
[d] Nigeria's targets are included in its Draft Renewable Energy Master Plan, 2005. They have not been formally adopted.
Source: see endnote 9 for this section.

RENEWABLE ENERGY

Renewable energy targets represent a primary mechanism to promote growth of the renewables sector by articulating a long-term vision and sending a positive signal to investors. These targets take many forms, including technology-neutral or technology-specific shares of renewables in the national energy or electricity mix, or specific installed capacities for individual technologies by a future date. The EREP has established goals for grid-connected renewable energy across the ECOWAS region.[14] (See Table 14.)

TABLE 14 | EREP Grid-Connected Renewable Energy Targets

	2020	2030
RENEWABLE ENERGY INSTALLED CAPACITY	2,425 MW	7,606 MW
SHARE OF PEAK LOAD	10%	19%
SHARE (INCLUDING MEDIUM AND LARGE HYDROPOWER)	35%	48%
RENEWABLE ENERGY GENERATION	8,350 GWh	29,229 GWh
SHARE OF ENERGY DEMAND	5%	12%
SHARE (INCLUDING MEDIUM AND LARGE HYDROPOWER)	23%	31%

Source: see endnote 14 for this section.

Building on these regional goals, 13 ECOWAS Member States have now set targets for the deployment of renewable energy technologies.[15] (See Table 15.) The majority of these targets focus on achieving a specified share of renewables in the national energy or electricity mix. Cabo Verde has emerged as the regional leader, targeting 50% renewable energy in the national electric grid by 2020.[16] The majority of targets fall in the range of a 5% to 35% share to be achieved by 2020 or 2030, mirroring targets being set around the world.[17] A handful of ECOWAS countries have set targets for the deployment of specific renewable technologies, such as for wind and solar in Guinea, the deployment of solar home systems in Sierra Leone, and for hydropower, solar, biomass, and wind in Nigeria (draft targets).[18]

In addition to targets, Member State governments have adopted a mix of regulatory policies such as feed-in policies, renewable portfolio standards (RPS), and energy tendering, as well as fiscal incentives—including tax reductions, loan interest loans, and grants—to drive sector development. Policies for power generation continue to receive the greatest attention from policymakers both within ECOWAS and around the world.[19] Renewable power generation policies take many forms, each with their own targets area of impact, as well as varying strengths and weaknesses.

Policies can be implemented to remove various barriers to renewable energy penetration, and can be targeted at either large- or small-scale projects implemented by a wide range of electricity producers or consumers. Although the benefits of many policy mechanisms for renewable energy support are well established, policymakers face challenges in selecting and designing the right mix of policies to address their unique domestic conditions and achieve their specific development goals. As of early 2014, 13 ECOWAS Member States had adopted some form of policy to promote renewable energy in the electricity sector.[20] (See Table 16.)

TABLE 15 | National Targets for Renewable Energy in ECOWAS Member States

Benin	No target
Burkina Faso	No target
Cabo Verde	50% in the national grid by 2020
Côte d'Ivoire	5% by 2015; 15% by 2020; 20% by 2030
The Gambia	35% electricity by 2020
Ghana	10% of electricity by 2020
Guinea	Solar: 6% by 2025 Wind: 2% by 2025
Guinea-Bissau	2% by 2015
Liberia	30% of electricity by 2021
Mali	10% by 2015; 25% by 2033
Niger	10% share in national energy balance by 2020
Nigeria[a]	Non-technology specific: 18% by 2020; 20% by 2030 Small-scale hydropower:[b] 600 MW by 2015; 2,000 MW by 2025 Solar PV: 75 MW by 2015; 500 MW by 2025 Solar thermal electricity: 1 MW by 2015; 5 MW by 2025 Biomass electricity: 600 MW by 2015; 2,000 MW by 2025 Wind: 20 MW by 2015; 40 MW by 2025
Senegal	20% by 2017
Sierra Leone	18% by 2015; 33% by 2020; 36% by 2030 Solar home systems: 1% penetration in the residential sector by 2015; 3% by 2020; 5% by 2030
Togo	15% by 2020

[a] Nigeria's installed capacity targets are included in the Renewable Energy Master Plan which is currently in draft form. They are yet to be formally adopted.
[b] Nigeria defines small hydro as installations below 10 MW.
Source: see endnote 15 for this section.

Policies take many forms and address different barriers to renewable energy development. Pricing instruments—such as feed-in policies or fiscal incentives—can provide a strong incentive to project developers. While a handful of countries in the region have implemented advanced feed-in policies, they remain absent in the majority of Member States. Fiscal incentives for renewable energy technologies, however, have now been enacted by nearly all Member States. Feed-in policies, taking the form of feed-in tariffs (FITs) or feed-in premiums (FIPs), are one of the oldest and most widely used mechanisms to promote renewable power generation worldwide. Feed-in policies provide guaranteed long-term payments for electricity generation, while guaranteeing grid access for renewable projects. FITs are now in place in 2 of the 15 ECOWAS Member States and are being developed in 2 additional Member States.

Ghana established a FIT in 2011, providing 10-year technology-differentiated payments, with remuneration levels set to be reviewed every two years.[21] Initial FIT rates were established in 2013, with solar PV receiving the highest level of support at USD 0.15/kWh (GHS 0.43/kWh).[22] Nigeria's FIT, established in 2012, supports the development of wind, solar, small hydro, biomass, and biodiesel, with payments guaranteed from 2012 to 2016 and subsequently revised every five years.[23] Draft policies exist in the Gambia, where a FIT to support solar PV, wind, biomass, and biogas installations up to 1.5 MW in size has been included in the Renewable Energy Act 2013, adopted by the National Assembly in December 2013 but still awaiting full ratification; and in Senegal, where the draft FIT policy covers solar PV, solar thermal, wind, hydropower, biomass, and biogas installations.[24]

Cabo Verde is the only ECOWAS Member State to have adopted net metering for renewable energy projects. Net metering provides a strong incentive to spur development of household self-generation. Cabo Verde's policy was first implemented in 2011 with the connection of a 9.9 kW solar PV system installed at ECREEE headquarters.[25] A net metering policy is in the early stages of development in the Gambia. That country's pilot net metering programme features a 2kW connection allowance; a larger-scale programme was tested with the connection of a 20kW solar PV system at Leo's Hotel.[26] Provisions for the proposed FIT and the formal adoption of net metering are included in the Gambia's Renewable Energy Act 2012, which has yet to be adopted.[27] Under the proposed regulations, the Gambia's net metering programme would target systems at or below the FIT's 20kW capacity minimum.[28]

In the ECOWAS region, financial instruments are the predominant means of supporting the renewable energy sector through national policies. Tax incentives take a number of forms, including investment or production tax credits as well as reductions or elimination taxes such as import duties, sales, and value-added tax (VAT). Renewable energy technologies are now supported through the tax code in 13 ECOWAS Member States. Import duties for renewable energy components have now been reduced or removed in Burkina Faso, which provides customs duty exemptions for solar PV and solar thermal technologies.[29] Ghana exempts wind and solar generating systems from import duties,[xx] and Mali exempts solar panels, solar lamps, and other renewables from import levies and duties.[30] Nigeria has placed a moratorium on import duties for renewable energy technologies.[31] Benin, Cabo Verde, Côte d'Ivoire, the Gambia, Guinea, Guinea-Bissau, Niger, and Togo also provide full or partial exemptions from import duties or other taxes for renewable energy components.[32]

Value-added tax reductions for renewable energy projects have been established in Burkina Faso, which instituted a VAT exemption for solar PV and solar thermal; in Ghana, which has removed the VAT on renewable energy power generation equipment; and in Mali, which established a five-year VAT exemption in 2009 for renewable energy equipment.[33] Additional tax incentives are in place in Cabo Verde, which provides a five-year "tax holiday" with an additional five years at a 50% tax reduction.[34] The Gambia exempts renewables from sales tax[35] while Niger has enacted a tax exemption for solar home systems and solar lamps. Nigeria has established a "tax holiday" of five to seven years for any investments in the energy sector, both renewable and non-renewable, as well as a VAT exemption for companies along the biofuel production chain, from the production of feedstocks to the generation of electricity.[36] In Senegal, the government has established full tax exemptions for the purchase of materials or equipment for the domestic consumption of renewable energy.[37]

Governments often play a role in helping overcome the hurdles associated with financing renewable energy projects by providing project grants or preferential loans. This support is often in addition to loans or grants provided by international lending institutions, such as the AfDB, or development partners. National programmes can be designed to directly cover all or part of project costs, or to ease financing costs and access, and are often run through government agencies, specialised funds, or national banking institutions.

ECOWAS Member States have employed various strategies to stimulate project development through financial support. Ghana has established a national Energy Fund—supported by a fixed charge of USD 0.06/litre on gasoline, kerosene, and diesel fuels produced in the country—with revenue going to research and development, as well as renewable energy promotion.[38] In 2011, Nigeria's Bank of Industry established a concessionary lending programme for power sector investments.[39] Senegal provides a subsidy to cover 25% of the investment costs for biogas digesters under the Senegalese National Biomass Programme.[40] Mali also supports renewable energy projects by providing public investment, loans, or grants.

Tendering or auctions for renewable energy projects have rapidly gained the attention of policymakers in recent years because of their

xx. Subsidies are applicable only to whole systems, not component pieces.

potential to identify the most cost-effective project development plans. By allowing developers to bid against each other, a well-designed auction policy allows for projects to be built at minimal costs. Unlike the early development of policy mechanisms such as the FIT, which were centred primarily in industrialised countries, the initial uptake in tendering for renewables is being led primarily by developing countries and emerging economies. Auctions can be designed to award projects utilising a specific technology or can be made technology-neutral, allowing various technologies to compete. In the ECOWAS region, both Burkina Faso and Cabo Verde have utilised renewable energy auctions for project allocation, and Nigeria has promoted a voluntary auction programme through the Nigerian Electricity Regulatory Commission (NERC).

Quantity instruments can also play a key role in the deployment of renewable energy technologies. To date, these mechanisms have not been as widely adopted as price-based mechanisms. RPS or quota policies mandating the use of renewable energy by power utilities have been adopted by two ECOWAS countries. Ghana's Renewable Energy Act mandates the Public Utilities Regulatory Commission to develop quotas for the purchase of renewable power by electricity distribution companies and bulk consumers.[41] However, as of early 2014, the Commission had not achieved the mandated renewable energy share.[42] In addition, Senegal mandates that the national electric company, SENELEC, deploy renewables in its concession areas, though no official quota exists.[43]

TABLE 16 | Renewable Energy Support Policies in ECOWAS Member States

		Regulatory Policies							Fiscal Incentives and Public Financing				
	Renewable energy targets	Feed-in tariff / premium payment	Electric utility quota obligation / RPS	Net metering	Biofuels obligation / mandate	Heat obligation / mandate	Tradable renewable energy credits	Tendering	Capital subsidy, grant, or rebate	Investment or production tax credits	Reductions in sales, energy, CO_2, VAT, or other taxes	Energy production payment	Public investment, loans, or grants
Benin	x										x		
Burkina Faso								x		x	x	x	
Cabo Verde	x			x				x		x	x	x	
Côte d'Ivoire	x										x		
The Gambia											x		
Ghana	x	x	x		x	x	x		x		x		x
Guinea	x										x		
Guinea-Bissau	x										x		
Liberia	x												
Mali	x				x						x		x
Niger	x										x		
Nigeria	x	x							x		x		x
Senegal	x		x			x					x		x
Sierra Leone	x												
Togo	x										x		

Source: see endnote 20 for this section.

SECTOR SPECIFIC TARGETS

Although most regions of the world now acknowledge renewables as a viable contribution to the electricity sector, the role of renewable technologies and fuels in the heating, cooling, and transport sectors has not drawn as much attention. Renewable heating and cooling technologies, such as solar water heaters, can play a critical role in reducing the negative impacts of conventional energy use.

For example, heating and cooling account for almost half of total global energy demand.[44] Despite the tremendous potential and significant impacts that deployment of renewable heating and cooling technologies could have, these technologies are often under-represented in national development plans and strategies. Globally, while policies and targets for renewable heating and cooling are slowly being enacted, they lag far behind those being put in place in other sectors.[45] Recognising the important role that renewable heating technologies can play in the future ECOWAS energy mix, ECOWAS member states have taken a leading role by setting targets for their deployment.[46] (See Table 17.)

TABLE 17 | EREP Solar Water Heating Targets

Sector	2020	2030
Residential sector (new detached house price higher then EUR 75,000)	2020 - At least one system installed per house	2030 - At least one system installed per house
District health centres, maternity clinics, school kitchens, and boarding schools	25%	50%
Agro-food industries (pre-heating of process water)	10%	25%
Hotels for hot, sanitary water	10%	25%

Source: see endnote 56 for this section.

Only a few ECOWAS Member States have targets or policies directed at renewable heat. Sierra Leone is the sole ECOWAS Member State with an established target for the use of solar thermal technology. The country is targeting a 1% penetration of solar water heaters in hotels, guest houses, and restaurants by 2015, 2% by 2020, and 5% 2030, and has set a target of 1% penetration of solar water heaters in the residential sector by 2030.[47] Nigeria's Draft Renewable Energy Master plan includes a target for 150,000 solar water heaters installed by 2030.[48]

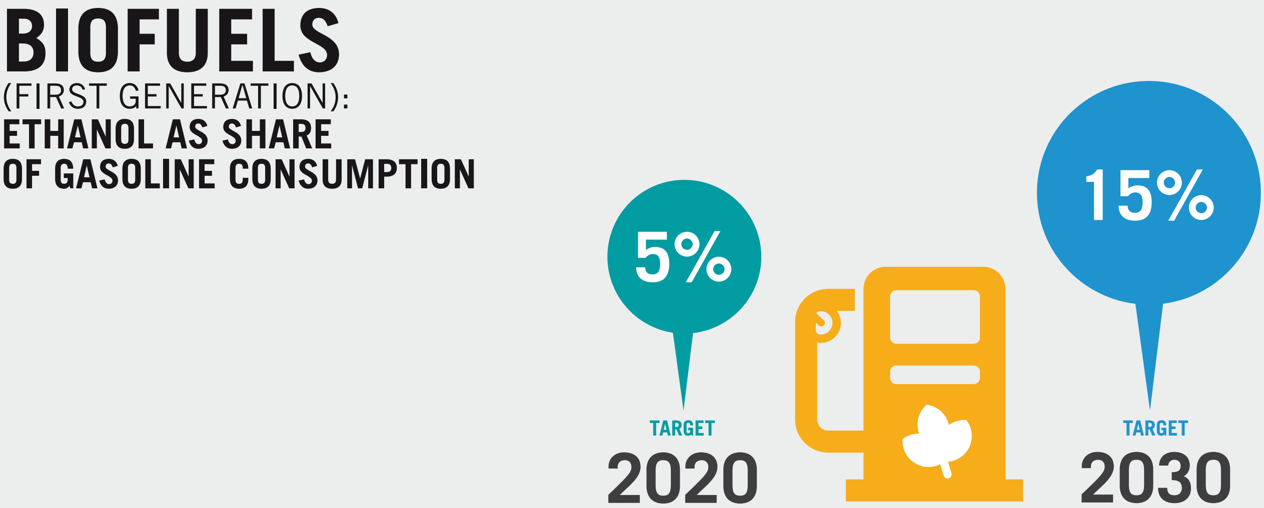
As with targets for renewable heating, few policies have been developed to promote the uptake of renewable energy in the heating and cooling sector. Both Ghana and Senegal have enacted mandates for the use of renewable heat.[49] In addition to full tax incentives for solar electricity components, Ghana has instituted a 50% import tax reduction for solar water heaters.[50] Renewable cooling has yet to receive strong attention from policymakers within the ECOWAS region.

The transportation sector is also a significant consumer of energy but often receives less attention from policymakers. Transportation's share of national energy use differs widely across the region. The use of biofuels can significantly reduce dependence on imported fuels and the negative environmental impacts of fossil fuels. Although first-generation biofuels are cleaner burning and offer the potential to be a domestically sourced alternative to often-imported fossil fuels, they are increasingly coming under pressure due to the growing conflict between food and fuel crop production.[51] Likewise, their use in the transportation sector is often challenged by the region's lack of production capacity and by the use of biofuels in other sectors, such as electricity generation.

The use of renewables in the transportation sector has received only limited support from policymakers in the ECOWAS region. Policies to promote biofuels often focus on mandating a specified share of renewable fuels in the total transportation mix—as established at the regional level in the EREP (see Figure 16) —or on specifying biofuel blend mandates which require that a certain share of biodiesel or ethanol be blended with transport fuel.[52]

Mali and Ghana have both established mandates for the use of biofuels in the transportation sector.[53] Nigeria has established a 10% ethanol blend and 20% biodiesel target under its national biofuel policy, although the status of implementation is unclear.[54] It is estimated that the national market will require 2 billion litres of ethanol and 900 million litres of biodiesel to meet these targets by 2020.[55]

FIGURE 16 I EREP Transportation Sector Biofuels Target



Source: see endnote 52 for this section.

ENERGY EFFICIENCY

Energy efficiency forms another important piece of the energy development strategy in the ECOWAS region. The adoption of the ECOWAS Energy Efficiency Policy (EEEP) in 2012 highlights the important need to develop energy efficiency support policies and mechanisms across the 15 Member States. The policy identifies five priority areas for targeting energy efficiency policies and programs: lighting, electricity distribution, cooking; standards and labelling, building codes, and financing.

Several Member States have already taken a leading role in enacting policies and targets to promote energy savings. However, the generally slow adoption of energy efficiency policy mechanisms across the region remains a barrier to full implementation of energy efficiency programmes in ECOWAS. Overall, energy efficiency policies have been identified in four Member States, while national targets have been identified in a handful of Member States.

Energy Efficiency Targets and Policies

Targets for energy efficiency have been adopted at the regional level in the ECOWAS region, as well as at the national level in ECOWAS Member States. Globally, energy efficiency targets often include both multi-sector, economy-wide efficiency aims, such as the reduction of energy intensity, as well as targets for sectoral improvements. Within the ECOWAS region, the EEEP has established region-wide targets for energy efficiency improvements across the identified target sectors.[56] (See Table 18.) These targets aim to free 20 GW MW of power generation capacity and to reduce greenhouse gas emissions by 3 million tonnes of carbon dioxide (CO_2) equivalent.[57] Sector-specific regional strategies, such as the ECOWAS Regional Efficient Lighting Strategy (RELS) developed in collaboration with ECREEE and the UNEP-GEF en.lighten initiative are also being developed.[58] At the country level, ECOWAS energy efficiency targets focus primarily on sectoral improvements, including reductions in electricity use, grid losses, fuel efficiency, fuel switching, and the use of specified energy-efficient technologies.

TABLE 18 | EEEP Energy Efficiency Targets

LIGHTING	Phase out of incandescent bulbs by 2020
ELECTRICITY DISTRIBUTION	Reduce losses to under 10% by 2020 from the current range of 15–40%
COOKING	Ensure universal access to safe, clean, affordable, efficient and sustainable cooking by 2030
STANDARDS AND LABELLING	Adopt initial ECOWAS standards and labels for major energy equipment by end-2014
BUILDING CODES	Develop and adopt ECOWAS standards for buildings (no target date set)
FINANCING	Create instruments for financing by end-2013; establish regional sustainable energy fund

Source: see endnote 56 for this section.

National targets are often found in overarching energy development strategies. As energy efficiency is inherently a cross-cutting issue, targets aimed at energy efficiency in specific areas, such as the electricity grid or sustainable energy access, are addressed in Chapter 3.

A number of additional targets exist for overall energy savings or fuel efficiency. Ghana's National Energy Policy identifies inefficiency in the production, transportation, and use of energy as one of seven key challenges facing the country's energy sector.[59] Under the policy, the national objectives for 2009–2012 were to achieve 10% savings in electricity consumption through electric power efficiency and conservation and 15% savings in petroleum products consumption.[xxi] Additionally, Ghana has established a target to reduce the wood intensity of charcoal production from the existing ratio of 4:1 to 3:1 by 2015 in its Savannah zone and from the current 5-6:1 to 4:1 in the country's forest zone by 2015.[xxii,60]

Guinea has also targeted an increase in the efficiency of wood fuels, aiming for a 20% reduction in use of wood resources. This is expected to be achieved through a strategy aimed at rationalising production and consumption, making local communities responsible for managing forests, and diversifying combustibles by promoting butane as a substitute.

Energy Efficiency Policies

In addition to the established regional energy efficiency framework, a number of ECOWAS Member States have adopted individual policy mechanisms aimed at improving energy efficiency across multiple sectors. Compared to the electricity sector, however, there is a lack of energy efficiency legislation in most countries, including a paucity of standards for end-user appliances and a little to no regulation or appliance monitoring systems. This is often due to limited institutional capacity to develop the legislation. Policy and legislation are typically focused on a wide array of areas and include mandates, incentives, and financing measures to promote efficiency.

Standards and labelling for energy-efficient products are a primary regulatory measure used to promote energy efficiency in the region. Often called Minimum Energy Performance Standards (MEPS), standards provide uniformity among energy uses for similar products, while labelling ensures that consumers have the necessary information available to assess the energy requirements of different product options.

As of early 2014, standards and/or labelling requirements for a variety of products had been enacted or were in development in the majority of ECOWAS Member States. These have been utilised primarily for lighting as well as electrical appliances, such as air conditioners or refrigerators. As of early 2014, only two countries had formally adopted energy standards for electric products. Ghana established standards for CFLs and air conditioners in 2005.[61] These standards were subsequently amended and expanded to include refrigeration equipment as well as mandating energy labelling for selected appliances.[62] Ghana is now developing similar standards for LED lighting. Nigeria has established MEPS for self-ballasted lamps and CFLs.[63]

xxi. As of the writing of this report, data were not available to confirm whether these targets have been met.
xxii. Wood intensity of charcoal production is measured as the ratio of wood input to charcoal produced.

A number of standards and labelling regulations for a variety of products remain under development. With the support of the World Bank, Benin aims to establish CFL standards by 2015; Burkina Faso plans to establish standards for efficient lighting; Côte d'Ivoire and Nigeria are in the process of developing standards and labelling for household appliances; and Senegal has prepared draft MEPS for CFLs and is considering the development of labels for household electric products.[64]

At the international level, Ghana and Nigeria are engaged with the Global Alliance for Clean Cookstoves, the International Organization for Standardization, and a network of 20 countries to develop international standards for cook stoves and clean cooking solutions.[65] To date, only a handful of countries worldwide have developed any national standards for clean cook stoves, with none currently established within the ECOWAS region.[66] International standards for lighting are also in development through the en.lighten initiative which seeks to establish harmonised MEPS for on and off-grid lighting options to serve as a blueprint for increasing the use of energy efficient lamps.

Mandates and/or quotas for the use of energy-efficient equipment or fuels are now in place in 2 of the 15 ECOWAS Member States, and the use of incandescent light bulbs has been the focus of several national mandates. Ghana has banned the manufacture, sale, or importation of incandescent filament lamps since 2008.[67] In addition, Ghana has prohibited the importation and sale of used cooling equipment, including refrigerators, refrigerator-freezers, freezers, and air conditioners.[68] Since 2011, Senegal has outlawed both the importation and manufacturing of incandescent light bulbs and has developed a biomass quota system in an effort to reduce the dependence on forest resources for cooking fuels.[69]

Financing remains one of the largest barriers to implementing energy efficiency projects within the region. A variety of financial incentives have been established in an effort to overcome this challenge. Although many projects have secured support from a mix of domestic and international sources, policy programmes to provide financial incentives to energy efficiency development are not widely utilised. Ghana provides credits of USD 70 (GHS 200) towards the cost of a new refrigerator with the trade-in of the old model.[70] Tax incentives have also been implemented in some countries across the region: for example, the Gambia removed import taxes on CFLs, and Ghana has removed both import duties and the VAT on LED lighting.[71]

05

INVESTMENT

05 | INVESTMENT

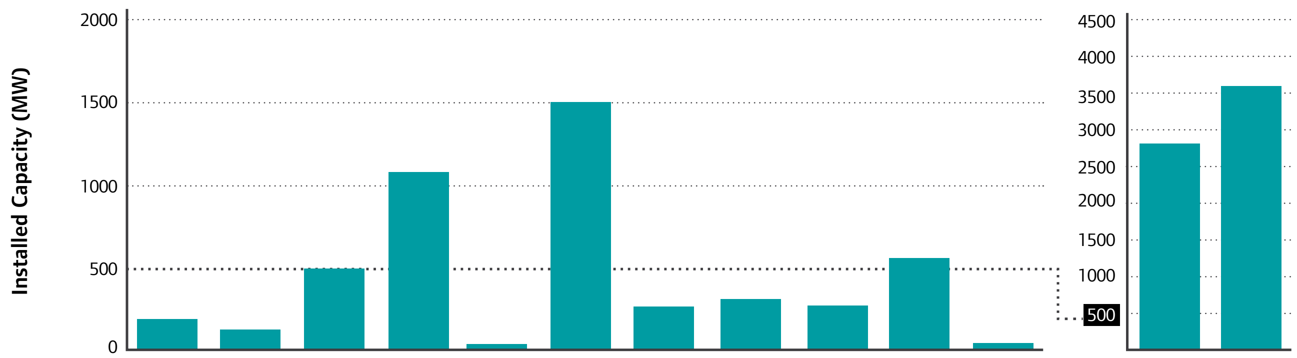
GLOBAL OVERVIEW

Globally, an estimated USD 214 billion was invested in renewable energy technologies in 2013, rising to USD 249.4 billion if large hydropower is included.[xxiii,1] Despite this figure being below the peak investment recorded in 2011, the renewable energy sector remains an attractive market for public and private investors, and gross investment in renewables is closing the gap on fossil fuels. Overall, the Middle East and Africa attracted USD 9 billion in renewable energy investment in 2013 (down from USD 11 billion in 2012), accounting for 4.2% of the global total.[2] After increasing by 228% from 2011 to 2012, the share of global renewable investments for the region remained relatively stable in 2013, declining by approximately 0.3%.[3]

RENEWABLE ENERGY PIPELINE

Renewable energy projects are gaining the attention of government planners and project developers across the ECOWAS region. The Africa-EU Energy Partnership estimates that, including large-scale hydropower, a total of 11.6 GW of renewable energy projects is in the regional project pipeline.[4] (See Figure 17.) (Excluding large hydro, the projected total is 1,171 MW.[5]) Four Member States have projected cumulative project development (including large hydro) exceeding 1 gigawatt: Nigeria (3.9 GW), Guinea (3 GW), Liberia (1.4 GW), and Ghana (1.1 GW).[6]

FIGURE 17 | Renewable Energy Projects in the Pipeline in the ECOWAS Region



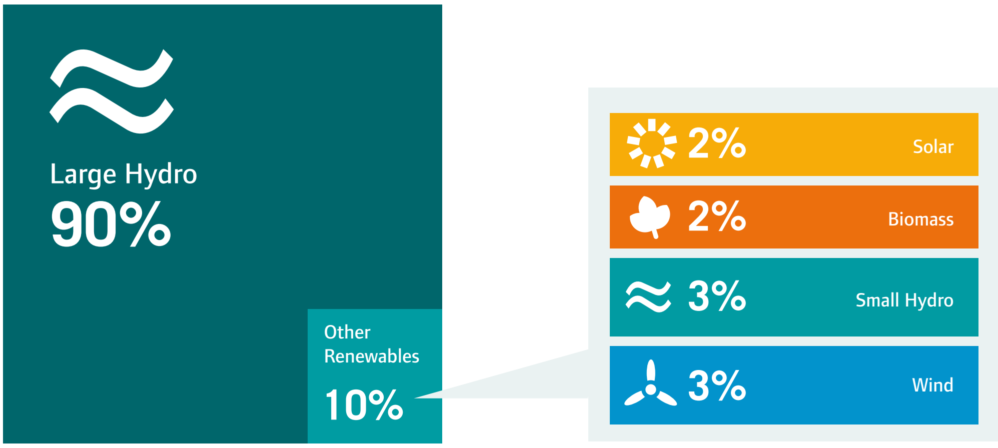
	Benin	Burkina Faso	Côte d'Ivoire	Ghana	Guinea -Bissau	Liberia	Mali	Niger	Senegal	Sierra Leone	Togo	Guinea	Nigeria
Small Hydro (≤30 MW)		2.6		30.3	20		63.5	26		48.7			91.5
Wind				57					125		24		191.2
Solar	6	60		162.9									5
Hydro	147	60	490	837		1380	170	247.5	120	530		2972	3519
Biomass	30		60	22		36			30	30			50

Note: No renewable energy projects in the pipeline for Cabo Verde and the Gambia.
Source: Africa-EU Energy Partnership Status Report

xxiii. For investment figures, large hydropower includes projects of more than 50 MW.

By technology, large hydropower remains the dominant non-fossil fuel energy source in the region, with an estimated 10.5 GW of new capacity in the pipeline, representing 90% of the total (See Figure 18.)[7] Of other renewables, an estimated 397 MW of wind capacity is expected to be added, followed by small- hydropower (≤ 30 MW) (282 MW), modern biomass (258 MW), and solar (234 MW).[8] By Member State, Côte d'Ivoire is the ECOWAS leader in biomass pipeline capacity, at 60 MW, Ghana is the leader in anticipated solar development (162.9 MW), and Nigeria is the leader in anticipated wind (191.2 MW) and small hydro (91.5 MW).[9]

FIGURE 18 | Renewable Energy Capacity in the Pipeline in the ECOWAS Region, by Technology



Source: Africa-EU Energy Partnership

REGIONAL FINANCING SOURCES

The international renewable energy market is becoming an increasingly attractive sector for a host of public and private investors. Overall, consolidated, reliable data on investments in the renewable energy sector is not available for all 15 member states. However, analysis by Bloomberg New Energy Finance of six leading ECOWAS Member States—Côte d'Ivoire, Ghana, Liberia, Nigeria, Senegal, and Sierra Leone — indicates a variable flow of investment into the region (See Figure 19.) Within these six Member States, investments in new renewable energy totalled USD 29.7 million in 2013, down significantly from the high of USD 370 million in 2011.[xxiv,10] Overall, in places where investment has been tracked, countries have seen a sporadic flow of financing to renewable energy development.

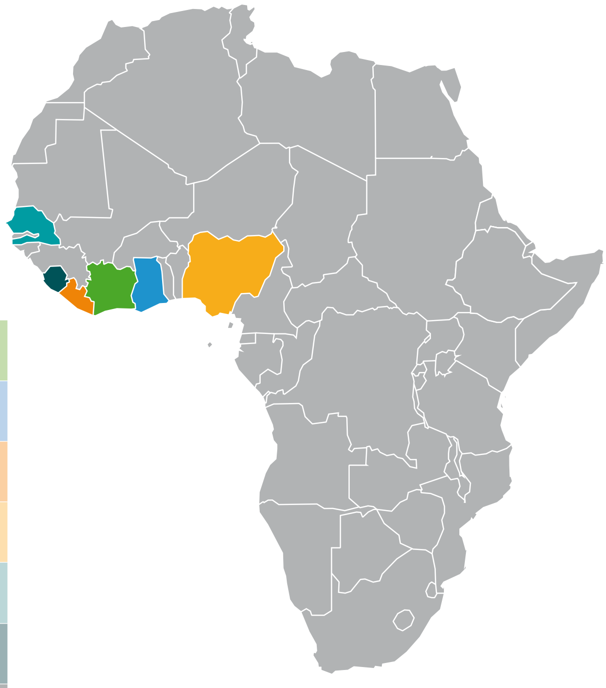
Globally, private finance plays an important role in renewable energy development. Within ECOWAS, incentivising private participation in the sector has been one of the key priorities for policymakers. Although data on private finance flows is not widely available across the region, an analysis of projects shows that it has played a key role in the development of installations such as the Cabeolica Wind Farm in Cabo Verde (See Sidebar 4.)

The public sector has also played an important role in funding renewable energy development, with national governments, international development partners, and multilateral development banks having all allocated funds to energy sector development in the region. As demonstrated, a number of Member State governments are already supporting the renewable energy sector by providing financial incentives and/or public financing to project development. (See Chapter 4.)

In addition to government support, renewable energy has become a key component of the lending activity of international and regional development banks. One of the continent's leading public development institutions, the AfDB, has a large energy sector portfolio and is increasingly active in West Africa. Regionally, West Africa received USD 1.54 billion (Unit of Account (UA) 991 million), or 27.8 % of total loans and grants approved by the AfDB in 2013, of which infrastructure investments—including energy, water and sanitation, and transportation—accounted for nearly USD 500 million, or 31.9 percent.[13] Overall, energy accounted for 16% of the bank's loan and grant activity over the same period.[14] All ECOWAS Member States (with the exception of Cabo Verde) are eligible for the AfDB's African Development Fund (ADF) concessionary window.[15] Other multinational lending institutions, such as the World Bank and the European Investment Bank, have made the development of Africa's sustainable energy sector an important priority.

xxiv. Investment figures include total investments in renewable energy technologies greater than 1 MW. Figures exclude hydropower greater than 50 MW.

FIGURE 19 | Renewable Energy Investment in Select ECOWAS Countries (million USD)



	2008	2009	2010	2011	2012	2013
Côte d'Ivoire	0	11.2	0	0	0	0
Ghana	0	0	0	0	0	29.7
Liberia	112	0	0	0	5.8	0
Nigeria	0	0	23.3	12.6	101.3	0
Senegal	0	69.8	0	0	0	0
Sierra Leone	0	0	0	357.5	6.3	0
Total	112	81	23.3	370.1	113.4	29.7

Note: "0" indicates no investment made for that year.
Source: see endnote 10 for this section.

Sidebar 4. Cabeolica Wind Farm Financing

Established in 2009, Cabo Verde's Cabeolica wind farm is a leading example of successful renewable energy project financing in ECOWAS. Cabeolica is the first commercial-scale privately financed, public-private partnership (PPP) wind farm to be developed in sub-Saharan Africa, serving as a model for future private engagement in the region. The 25.5 MW wind farm is constructed on four islands in Cabo Verde and is the predominant contributor to the island nation's 26 MW of installed wind capacity. It has had a significant impact on the region, establishing a benchmark for public-private development of wind energy.[11]

Cabeolica was not Cabo Verde's first attempt at utility-scale wind development. Two previous tenders for wind projects failed to lead to the desired project development. Cabeolica, by contrast, was made possible due to a larger project size and the participation of new players in the financing process. The wind farm's development was based on a PPP between three parties: the Government of Cabo Verde; Electra, Cabo Verde's government owned national utility; and InfraCo, a private company backed by European Governments and the World Bank, who served as the project's lead developer. The USD 78 million project was financed through debt and equity financing provided by a number of public and private entities. At approximately USD 60 million, debt financing provided by the European Investment Bank and the African Development Bank accounted for roughly three-fourths of the financing requirements, with equity financing coming from the African Finance Cooperation, Finnfund, and InfraCo to cover the remaining portion of projects capital costs.[12] Additionally, the project benefits from its participation in the Clean Development Mechanism (CDM), providing an additional stream of financial support through the allocation of over 70,000 Certified Emission Reduction (CER) credits. Cabeolica's success highlights the multitude of financing options that can be applied within ECOWAS to promote the development and deployment of renewable energy technologies.

Specialised funds for the development of renewable energy are playing an increasingly important role in supporting project development and catalysing financing in the region. The Sustainable Energy Fund for Africa (SEFA), a multi-donor facility hosted by AfDB, provides preparation grants and equity to bring small and medium-scale renewable energy generation and energy efficiency projects to bankability. SEFA was instrumental in the incubation and co-sponsorship of the African Renewable Energy Fund (AREF), a private equity fund with USD 100 million secured in March 2014 to support the development and construction of 5–50 MW grid-connected solar, small hydro, wind, geothermal, biomass, and waste gas projects across sub-Saharan Africa. The fund is managed by Berkeley Energy Africa with capital contributions from numerous actors, including the AfDB and SEFA, the GEF, the ECOWAS Bank for Investment and Development (IBID), The Bank for West African Development (BOAD), the Netherland Development Bank (FMO) and the African Biofuel and Renewable Energy Company (ABREC).[16] The fund is expected to reach a second close at USD 200 million in 2014 with additional contributions coming from commercial and institutional investors. The U.S.-led Power Africa Initiative has pledged USD 7 billion to energy sector development in six African nations, including Ghana, Liberia, and Nigeria.[xxv,17] The programme aims to add 10,000 MW of clean energy capacity across the region.[xxvi,18]

ECREEE has also taken a leading role in supporting project development by creating the ECOWAS Renewable Energy Investment Initiative (EREI) and the EREF. The EREF, created in 2011, offers grant funding for small- to medium-sized renewable energy and energy efficiency projects in rural and peri-urban areas of the region.[19] The programme's first funding window provided approximately EUR 1 million to 41 projects distributed across all 15 Member States.[20] The second funding window under the EREF was opened for the submission of new proposals in summer 2014. The EREI has been established to attract investments to medium- and large-scale renewable energy projects in the region.[21]

Climate Finance

Climate finance funds offer an additional opportunity to support renewable energy projects. A variety of funds have been established by the international community to fund climate mitigation and, to a lesser degree, adaptation measures. Despite accounting for only 0.34% of global CO_2 emissions in 2010, ECOWAS Member States can benefit from financing targeting low carbon development to scale up renewable energy in the region.[22] Unlike private sector project finance, financing from climate finance sources is designed to support project development as well as policymaking and capacity building programmes.

The region already has significant experience in attracting financing from these sources. Among the most successful to date has been the GEF. Operating under the GEF-Strategic Programme for West Africa (GEF-SPWA), the GEF has financed country-specific sustainable energy projects in 12 ECOWAS Member States—Benin, Cabo Verde, Côte d'Ivoire, the Gambia, Ghana, Guinea, Guinea-Bissau, Liberia, Mali, Nigeria, Senegal, and Sierra Leone—along with regional projects. Financing has gone to support renewable energy and energy efficiency projects as well as to develop an enabling environment for scaling up the sustainable energy sector. As of April 2014, nearly USD 100 million[xxvii] had been approved or disbursed through the GEF to support projects in the region. The GEF Small Grants Programme has also been very active in supporting small-scale project development throughout the region. This can be a key funding mechanism for rural renewable energy projects. The programme provides grants of up to USD 50,000 directly to local communities for financing small-scale projects under its target areas.

The CIF, a partnership between the international and regional multilateral development banks, aims to allocate USD 8 billion in an effort to leverage an additional USD 55 billion in financing to 48 select low- and middle-income countries.[23] Both Liberia and Mali have been included in the pilot phase of the Scaling Up Renewable Energy in Low Income Countries Program, for which USD 551 million has been pledged.[24] Within this programme, USD 2.5 million in grant funding has been allocated to two projects in Liberia, and USD 40 million in grant and low-interest financing has been allocated to project development in Mali.[25]

Further development of new and existing sources of climate finance could provide additional funding to renewable energy projects in the region. The CDM has already been used across the region to provide additional financial support to the development of renewables, while the Green Climate Fund—a financing mechanisms similar to the GEF—and Nationally Appropriate Mitigation Actions (NAMAs)—a mechanisms similar to the CDM—are just two of the tools envisioned to support future programmes. Mali has officially registered its proposed NAMA in Renewable Energy and Energy Efficiency with the UNFCCC. Through the NAMA mechanism, Mali's Agency for the Environment and Sustainable Development (AEDD) is seeking USD 840 million in support for a programme aimed at scaling up energy efficiency as well as hydropower, wind, and solar development.[26]

xxv. In addition to the three ECOWAS Member States, Power Africa includes Ethiopia, Kenya, and Tanzania.

xxvi. Technologies utilised include geothermal, hydropower, natural gas, and solar.

xxvii. The exact amount was USD 97.4 million. The total includes USD 20.7 million allocated to the Lake Chad Basin Regional Program for the Conservation and Sustainable Use of Natural Resources and Energy Efficiency Program, of which Niger and Nigeria are partners along with Cameroon and Chad.

06 | CONCLUSION

The ECOWAS region is endowed with tremendous renewable energy resource potential. Countless opportunities exist for deploying solar, wind, hydropower, and biomass technologies across the 15 Member States. Renewable energy and energy efficiency technologies have rapidly become cost effective solutions for overcoming the diverse array of energy challenges currently facing ECOWAS, including: large unelectrified populations, unmet demand, heavy reliance on traditional biomass, and dependence on fossil fuel imports. These technologies also allow the region to build an energy resilient system that prepares Member States for future energy challenges such as rising demand, increasing cost of fossil fuels, deforestation, and the potential impacts of climate change. Recognising this, the 15 ECOWAS Member States are rapidly emerging as global leaders in renewable energy and energy efficiency, facilitating dedicated programs, policies, and investments at the regional and national levels.

Adoption of the ECOWAS Renewable Energy Policy (EREP) and the ECOWAS Energy Efficiency Policy (EEEP) in 2012 marks a tremendous achievement, setting the region on a clear path toward achieving an ambitious set of goals. Ongoing efforts to translate regional strategies into National Renewable Energy Action Plans will galvanise and solidify national commitments, ensuring that every Member State is supported in its efforts to achieve this ambitious transition.

Renewable energy deployment is beginning to accelerate across the region. Hydropower—both large and small scale—has long made up a significant share of the region's electricity mix. Increasingly, however, variable renewable sources such as solar and wind have generated interest among both public and private actors. Cabo Verde has established itself as a regional leader in renewable energy, with 26 MW and 6.4 MW of grid-connected wind and solar capacity respectively. Cabo Verde's accomplishments reflect the strong and consistent support it has provided to the sector, establishing progressive policies including the region's only net metering scheme.

Distributed solar PV systems—well suited for rural electrification efforts—are already widespread in ECOWAS Member States, including Senegal, which has an estimated 21 MW installed distributed capacity nationwide. National governments, local NGOs, and international aid agencies are promoting distributed solar technologies as a way to power community centres, health clinics, and individual homes. Solar lanterns are providing basic lighting services to rural communities, while both solar and wind are being used to power for water pumping. Modern biomass is also a significant part of the region's energy mix and is used particularly by industry as self-generation.

Despite the growing prevalence of off-grid systems, reliable, consistent tracking and reporting of the full scope of projects and initiatives across the region is still lacking. Despite impressive development in recent years, investment in the sector remains sporadic, and while all ECOWAS Member States now have either a renewable energy support policy or a target in place at the national level, increased policy and financial support will be critical in scaling-up renewable energy deployment region-wide.

In addition to new renewable generation, energy efficiency remains one of the most cost effective means of meeting the region's energy needs. Despite the tremendous opportunities that exist for significant cost and energy savings across a number of areas—including lighting, appliances, electricity distribution, cooking, and buildings—energy efficiency has gotten comparatively little attention from policymakers, investors, and project developers. While domestic programmes and international initiatives—such as the UNEP/GEF en.lighten initiative—have laid the groundwork for future improvements, significant progress remains to be made in targeted areas such as reducing electricity losses, improving lighting efficiency, and reducing energy use in buildings across ECOWAS. Countries such as Ghana, Nigeria, and Senegal have taken a leading role in phasing out the use of inefficient equipment by enacting bans on their manufacture, sale or importation, or by establishing Minimum Energy Performance Standards (MEPS) for lighting, air conditioning, and refrigeration products. Expanded standards and the adoption of additional policies such as energy efficient building codes can help Member States further reduce energy use.

Through their commitment to developing renewable energy and energy efficiency across the region, ECOWAS Member States have taken a proactive role in ensuring their ability to address current energy sector challenges while simultaneously building a resilient system that prepares the region to effectively meet future energy needs. While the national and regional actions taken to date have established a strong baseline for future growth, continued support and increased investment in the region's sustainable energy sector will be needed to ensure that this ambitious vision comes to fruition.

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LIST OF ABBREVIATIONS

ACCES	African Clean Cooking Energy Solution Initiative
AfDB	African Development Bank
AEEP	Africa-EU Energy Partnership
AREF	African Renewable Energy Fund
BNEF	Bloomberg New Energy Finance
CDM	Clean Development Mechanism
CFL	Compact Fluorescent Light
CIF	Climate Investment Fund
CO_2	Carbon dioxide
CSP	Concentrating solar (thermal) power
DNI	Direct Normal Irradiance
ECOWAS	Economic Community of West African States
ECOWREX	ECOWAS Observatory for Renewable Energy and Energy Efficiency
ECREEE	ECOWAS Centre for Renewable Energy and Energy Efficiency
EEEP	ECOWAS Energy Efficiency Policy
EREI	ECOWAS Renewable Energy Investment Initiative
EREP	ECOWAS Renewable Energy Policy
EREF	ECOWAS Renewable Energy Facility
FIT	Feed-in Tariff
GDP	Gross Domestic Product
GEF	Global Environment Facility
GW/GWh	Gigawatt/Gigawatt-hour
HVAC	Heating, ventilation, and air conditioning
IFC	International Finance Corporation
IPCC	Intergovernmental Panel on Climate Change
IRENA	International Renewable Energy Agency
KW/kWh	Kilowatt/kilowatt-hour
LED	Light Emitting Diode
LPG	Liquefied Petroleum Gas
MEPS	Minimum Energy Performance Standards
MJ	Mejajoule
MW/MWh	Megawatt/Megawatt-hour
NAMA	Nationally Appropriate Mitigation Action
NREP	National Renewable Energy Policy
NREAP	National Renewable Energy Action Plan
NEEAP	National Energy Efficiency Action Plan
NFI	National Focal Institution
PV	Photovoltaics
REEEP	Renewable Energy and Energy Efficiency Partnership
RPS	Renewable Portfolio Standard
SE4ALL	United Nations Sustainable Energy for All Initiative
SEFA	Sustainable Energy Fund for Africa
TFEC	Total Final Energy Consumption
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNFCCC	United Nations Framework Convention on Climate Change
UNIDO	United Nations Industrial Development Organization
USAID	U.S. Agency for International Development
USD	United States Dollar
UEMOA	West African Economic and Monetary Union
VAT	Value-added tax
WACCA	West African Clean Cooking Alliance
WAGP	West African Gas Pipeline
WAPP	West African Power Pool
WHO	World Health Organization

GLOSSARY

BIODIESEL. A fuel produced from oilseed crops such as soy, rapeseed (canola), and palm oil, and from other oil sources such as waste cooking oil and animal fats. Biodiesel is used in diesel engines installed in cars, trucks, buses, and other vehicles, as well as in stationary heat and power applications. Also see Hydro-treated vegetable oil.

BIOENERGY. Energy derived from any form of biomass, including bio-heat, bio-power, and biofuel. Bio-heat arises from the combustion of solid biomass (such as dry fuel wood) or other liquid or gaseous energy carriers. The heat can be used directly or used to produce bio-power by creating steam to drive engines or turbines that drive electricity generators. Alternatively, gaseous energy carriers such as biomethane, landfill gas, or synthesis gas (produced from the thermal gasification of biomass) can be used to fuel a gas engine. Biofuels for transport are sometimes also included under the term bioenergy (see Biofuels).

BIOFUELS. A wide range of liquid and gaseous fuels derived from biomass. Biofuels—including liquid fuel ethanol and biodiesel, as well as biogas—can be combusted in vehicle engines as transport fuels and in stationary engines for heat and electricity generation. They also can be used for domestic heating and cooking (for example, as ethanol gels). Advanced biofuels are made from sustainably produced non-food biomass sources using technologies that are still in the pilot, demonstration, or early commercial stages. One exception is hydro-treated vegetable oil (HVO), which is now produced commercially in several plants.

BIOGAS/BIOMETHANE. Biogas is a gaseous mixture consisting mainly of methane and carbon dioxide produced by the anaerobic digestion of organic matter (broken down by micro-organisms in the absence of oxygen). Organic material and/or waste is converted into biogas in a digester. Suitable feedstocks include agricultural residues, animal wastes, food industry wastes, sewage sludge, purpose-grown green crops, and the organic components of municipal solid wastes. Raw biogas can be combusted to produce heat and/or power; it can also be transformed into biomethane through a simple process known as scrubbing that removes impurities including carbon dioxide, siloxanes, and hydrogen sulphides. Biomethane can be injected directly into natural gas networks and used as a substitute for natural gas in internal combustion engines without fear of corrosion.

BIOMASS. Any material of biological origin, excluding fossil fuels or peat, that contains a chemical store of energy (originally received from the sun) and is available for conversion to a wide range of convenient energy carriers. These can take many forms, including liquid biofuels, biogas, biomethane, pyrolysis oil, or solid biomass pellets.

BIOMASS PELLETS. Solid biomass fuel produced by compressing pulverised dry biomass, such as waste wood and agricultural residues. Torrefied pellets produced by heating the biomass pellets have higher energy content per kilogram, as well as better grindability, water resistance, and storability. Pellets are typically cylindrical in shape with a diameter of around 10 millimetres and a length of 30–50 millimetres. Pellets are easy to handle, store, and transport and are used as fuel for heating and cooking applications, as well as for electricity generation and combined heat and power.

BRIQUETTES. Blocks of flammable matter made from solid biomass fuels, including cereal straw, that are compressed in a process similar to the production of wood pellets. They are physically much larger than pellets, with a diameter of 50–100 millimetres and a length of 60–150 millimetres. They are less easy to handle automatically but can be used as a substitute for fuelwood logs.

CAPACITY. The rated capacity of a heat or power generating plant refers to the potential instantaneous heat or electricity output, or the aggregate potential output of a collection of such units (such as a wind farm or set of solar panels). Installed capacity describes equipment that has been constructed, although it may or may not be operational (e.g., delivering electricity to the grid, providing useful heat, or producing biofuels).

CAPITAL SUBSIDY. A subsidy that covers a share of the upfront capital cost of an asset (such as a solar water heater). These include, for example, consumer grants, rebates, or one-time payments by a utility, government agency, or government-owned bank.

CLEAN COOK STOVE. Clean cook stove technologies address the negative health and environmental impacts associated with traditional cooking technologies. While a number of clean cooking technologies meet this definition there is currently no definitive standard for what constitutes a clean cook stove.

CONCENTRATING SOLAR THERMAL POWER (CSP) (also called concentrating solar power or solar thermal electricity, STE). Technology that uses mirrors to focus sunlight into an intense solar beam that heats a working fluid in a solar receiver, which then drives a turbine or heat engine/generator to produce electricity. The mirrors can be arranged in a variety of ways, but they all deliver the solar beam to the receiver. There are four types of commercial CSP systems: parabolic troughs, linear Fresnel, power towers, and dish/engines. The first two technologies are line-focus systems, capable of concentrating the sun's energy to produce temperatures of 400 °C, while the latter two are point-focus systems that can produce temperatures of 800 °C or higher. These high temperatures make thermal energy storage simple, efficient, and inexpensive. The addition of storage—using a fluid (most commonly molten salt) to store heat—usually gives CSP power plants the flexibility needed for reliable integration into a power grid.

DISTRIBUTED GENERATION. Generation of electricity from dispersed, generally small-scale systems that are close to the point of consumption.

ENERGY. The ability to do work, which comes in a number of forms including thermal, radiant, kinetic, chemical, potential, and electrical. Primary energy is the energy embodied in (energy potential of) natural resources, such as coal, natural gas, and renewable sources. Final energy is the energy delivered to end-use facilities (such as electricity to an electrical outlet), where it becomes usable energy and can provide services such as lighting, refrigeration, etc. When primary energy is converted into useful energy, there are always losses involved.

ETHANOL (FUEL). A liquid fuel made from biomass (typically corn, sugar cane, or small cereals/grains) that can replace gasoline in modest percentages for use in ordinary spark-ignition engines (stationary or in vehicles), or that can be used at higher blend levels (usually up to 85% ethanol, or 100% in Brazil) in slightly modified engines such as those provided in "flex-fuel vehicles." Note that some ethanol production is used for industrial, chemical, and beverage applications and not for fuel.

FEED-IN TARIFF (FIT). The basic form of feed-in policies. A guaranteed minimum price (tariff) per unit (normally kWh or MWh) is guaranteed over a stated fixed-term period when electricity can be sold and fed into the electricity network, normally with priority or guaranteed grid access and dispatch.

FINAL ENERGY. The part of primary energy, after deduction of losses from conversion, transmission, and distribution, that reaches the consumer and is available to provide heating, hot water, lighting, and other services. Final energy forms include electricity, district heating, mechanical energy, liquid hydrocarbons such as kerosene or fuel oil, and various gaseous fuels such as natural gas, biogas, and hydrogen. Final energy accounts only for the conversion losses that occur upstream of the end-user, such as losses at refineries and power plants.

FISCAL INCENTIVE. An economic incentive that provides individuals, households, or companies with a reduction in their contribution to the public treasury via income or other taxes, or with direct payments from the public treasury in the form of rebates or grants.

GENERATION. The process of converting energy into electricity and/or useful heat from a primary energy source such as wind, solar radiation, natural gas, biomass, etc.

GEOTHERMAL ENERGY. Heat energy emitted from within the Earth's crust, usually in the form of hot water or steam. It can be used to generate electricity in a thermal power plant or to provide heat directly at various temperatures for buildings, industry, and agriculture.

HEAT PUMP. A device that transfers heat from a heat source to a heat sink using a refrigeration cycle that is driven by external electric or thermal energy. It can use the ground (geothermal), the surrounding air (aerothermal), or a body of water (hydrothermal) as a heat source in heating mode, and as a heat sink in cooling mode. A heat pump's final energy output can be several multiples of the energy input, depending on its inherent efficiency and operating condition. The output of a heat pump is at least partially renewable on a final energy basis. However, the renewable component can be much lower on a primary energy basis, depending on the composition and derivation of the input energy; in the case of electricity, this includes the efficiency of the power generation process. The output of a heat pump can be fully renewable energy if the input energy is also fully renewable.

HYDROPOWER. Electricity derived from the potential energy of water captured when moving from higher to lower elevations. Categories of hydropower projects include run-of-river, reservoir-based capacity, and low-head in-stream technology (the least developed). Hydropower covers a continuum in project scale from large (usually defined as more than 10 MW of installed capacity, but the definition varies by country) to small, mini, micro, and pico.

INVESTMENT. Purchase of an item of value with an expectation of favourable future returns. In this report, new investment in renewable energy refers to investment in: technology research and development, commercialisation, construction of manufacturing facilities, and project development (including construction of wind farms, purchase and installation of solar PV systems). Total investment refers to new investment plus merger and acquisition (M&A) activity (the refinancing and sale of companies and projects).

INVESTMENT TAX CREDIT. A taxation measure that allows investments in renewable energy to be fully or partially deducted from the tax obligations or income of a project developer, industry, building owner, etc.

JOULE/KILOJOULE/MEGAJOULE/GIGAJOULE/TERAJOULE/PETAJOULE/EXAJOULE. A Joule (J) is a unit of work or energy equal to the energy expended to produce one Watt of power for one second. For example, one Joule is equal to the energy required to lift an apple straight up by one metre. The energy released as heat by a person at rest is about 60 J per second. A kilojoule (kJ) is a unit of energy equal to one thousand (10^3) Joules; a megajoule (MJ) is one million (10^6) Joules; and so on. The potential chemical energy stored in one barrel of oil and released when combusted is approximately 6 GJ; a tonne of oven dry wood contains around 20 GJ of energy.

MANDATE/OBLIGATION. A measure that requires designated parties (consumers, suppliers, generators) to meet a minimum, and often gradually increasing, target for renewable energy, such as a percentage of total supply or a stated amount of capacity. Costs are generally borne by consumers. Mandates can include renewable portfolio standards (RPS); building codes or obligations that require the installation of renewable heat or power technologies (often in combination with energy efficiency investments); renewable heat purchase requirements; and requirements for blending biofuels into transport fuel.

MARKET CONCESSION MODEL. A model in which a private company or NGO is selected through a competitive process and given the exclusive obligation to provide energy services to customers in its service territory, upon customer request. The concession approach allows concessionaires to select the most appropriate and cost-effective technology for a given situation.

MINI-GRIDS. Small electric grids that serve entire communities through distribution networks. Until recently, most mini-grids relied on diesel fuel. Hydro-powered mini-grids are mature technologies, whereas gas-fired generator mini-grids, powered by agricultural waste or biogas, are maturing technologies. The use of inverter-connected mini-grids that incorporate a variety of renewable and other technologies (including battery banks) is developing rapidly.

MODERN BIOMASS ENERGY. Energy derived from combustion of solid, liquid, and gaseous biomass fuels in efficient small domestic appliances to large-scale industrial conversion plants for modern applications of space heating, electricity generation, combined heat and power, and transport (as opposed to traditional biomass energy).

NET METERING. A regulated arrangement in which utility customers who have installed their own generating systems pay only for the net electricity delivered from the utility (total consumption minus on-site self-generation). A variation that employs two meters with differing tariffs for purchasing electricity and exporting excess electricity off-site is called "net billing."

OCEAN ENERGY. Energy captured from ocean waves (generated by wind passing over the surface), tides, currents, salinity gradients, and ocean temperature differences. Wave energy converters capture the energy of surface waves to generate electricity; tidal stream generators use kinetic energy of moving water to power turbines; and tidal barrages are essentially dams that cross tidal estuaries and capture energy as tides flow in and out.

POWER. The rate at which energy is converted per unit of time, expressed in Watts (Joules/second).

PRIMARY ENERGY. The theoretically available energy content of a naturally occurring energy source (such as coal, oil, natural gas, uranium ore, geothermal and biomass energy, etc.) before it undergoes conversion to useful final energy delivered to the end-user. Conversion of primary energy into other forms of useful final energy (such as electricity and fuels) entails losses. Some primary energy is consumed at the end-user level as final energy without any prior conversion.

PRODUCTION TAX CREDIT. A taxation measure that provides the investor or owner of a qualifying property or facility with an annual tax credit based on the amount of renewable energy (electricity, heat, or biofuel) generated by that facility.

PUBLIC COMPETITIVE BIDDING (also called auction or tender). A procurement mechanism by which public authorities solicit bids for a given amount of renewable energy supply or capacity, generally based on price. Sellers offer the lowest price that they would be willing to accept, but typically at prices above standard market levels.

REGULATORY POLICY. A rule to guide or control the conduct of those to whom it applies. In the renewable energy context, examples include mandates or quotas such as renewable portfolio standards, feed-in tariffs, biofuel blending mandates, and renewable heat obligations.

RENEWABLE ENERGY TARGET. An official commitment, plan, or goal set by a government (at the local, state, national, or regional level) to achieve a certain amount of renewable energy by a future date. Some targets are legislated while others are set by regulatory agencies or ministries.

RENEWABLE PORTFOLIO STANDARD (RPS). An obligation placed by a government on a utility company, group of companies, or consumers to provide or use a predetermined minimum renewable share of installed capacity, or of electricity or heat generated or sold. A penalty may or may not exist for non-compliance. These policies are also known as "renewable electricity standards," "renewable obligations," and "mandated market shares," depending on the jurisdiction.

SMART GRID. Electrical grid that uses information and communications technology to co-ordinate the needs and capabilities of the generators, grid operators, end-users, and electricity market stakeholders in a system, with the aim of operating all parts as efficiently as possible, minimising costs and environmental impacts, and maximising system reliability, resilience, and stability.

SOLAR COLLECTOR. A device used for converting solar energy to thermal energy (heat), typically used for domestic water heating but also used for space heating, industrial process heat, or to drive thermal cooling machines. Evacuated tube and flat-plate collectors that operate with water or a water/glycol mixture as the heat-transfer medium are the most common solar thermal collectors used worldwide. These are referred to as glazed water collectors because irradiation from the sun first hits a glazing (for thermal insulation) before the energy is converted to heat and transported away by the heat transfer medium. Unglazed water collectors, often referred to as swimming pool absorbers, are simple collectors made of plastics and used for lower-temperature applications. Unglazed and glazed air collectors use air rather than water as the heat-transfer medium to heat indoor spaces, or to pre-heat drying air or combustion air for agriculture and industry purposes.

SOLAR HOME SYSTEM (SHS). A stand-alone system composed of a relatively small power photovoltaic module, battery, and sometimes a charge controller, that can power small electric devices and provide modest amounts of electricity to homes for lighting and radios, usually in rural or remote regions that are not connected to the electricity grid.

Solar photovoltaics (PV). A technology used for converting solar radiation (light) into electricity. PV cells are constructed from semi-conducting materials that use sunlight to separate electrons from atoms to create an electric current. Modules are formed by interconnecting individual solar PV cells. Monocrystalline modules are more efficient but relatively more expensive than polycrystalline silicon modules. Thin film solar PV materials can be applied as flexible films laid over existing surfaces or integrated with building components such as roof tiles. Building-integrated PV (BIPV) generates electricity and replaces conventional materials in parts of a building envelope, such as the roof or façade. Bifacial PV modules are double-sided panels that generate electricity with sunlight received on both sides (direct and reflected) and are used primarily in the BIPV sector.

SOLAR PICO SYSTEM (SPS). A very small solar PV system—such as a solar lamp or an information and communication technology (ICT) appliance—with a power output of 1–10 W that typically has a voltage up to 12 volt.

SOLAR WATER HEATER (SWH). An entire system—consisting of a solar collector, storage tank, water pipes, and other components—that converts the sun's energy into "useful" thermal (heat) energy for domestic water heating, space heating, process heat, etc. Depending on the characteristics of the "useful" energy demand (potable water, heating water, drying air, etc.) and the desired temperature level, a solar water heater is equipped with the appropriate solar collector. There are two types of solar water heaters: pumped solar water heaters use mechanical pumps to circulate a heat transfer fluid through the collector loop (active systems), whereas thermo-siphon solar water heaters make use of buoyancy forces caused by natural convection (passive systems).

SUBSIDIES. Government measures that artificially reduce the price that consumers pay for energy or reduce production costs.

TRADITIONAL BIOMASS. Solid biomass, including gathered fuel wood, charcoal, agricultural and forest residues, and animal dung, that is usually produced unsustainably and typically used in rural areas of developing countries by combustion in polluting and inefficient cookstoves, furnaces, or open fires to provide heat for cooking, comfort, and small-scale agricultural and industrial processing (as opposed to modern biomass energy).

WATT/KILOWATT/MEGAWATT/GIGAWATT/TERAWATT-HOUR. A Watt is a unit of power that measures the rate of energy conversion or transfer. A kilowatt is equal to one thousand (10^3) Watts; a megawatt to one million (10^6) Watts; and so on. A megawatt electrical (MW) is used to refer to electric power, whereas a megawatt-thermal (MWth) refers to thermal/heat energy produced. Power is the rate at which energy is consumed or generated. For example, a light bulb with a power rating of 100 Watts (100 W) that is on for one hour consumes 100 Watt-hours (100 Wh) of energy, which equals 0.1 kilowatt-hour (kWh), or 360 kilojoules (kJ). This same amount of energy would light a 100 W light bulb for one hour or a 25 W bulb for four hours. A kilowatt-hour is the amount of energy equivalent to steady power of 1 kW operating for one hour.

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