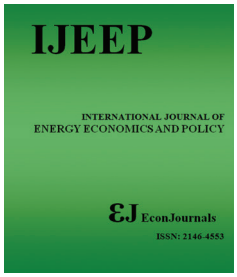

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Review and Assessment of Energy Policy in the Economic Community of West African States Region

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ABSTRACT

The ECOWAS region has one of Africa's highest potentials for energy production, including both non-renewable (oil, gas, and uranium) and renewable sources (hydroelectric, solar energy, wind energy). Despite this significant potential, the region deals with a number of issues that affect its energy strategy. A review and analysis of the social, political, and economic factors influencing regional energy policy are provided in this paper, along with an assessment and forecast of energy policy in the ECOWAS. The analysis of regional energy policy then takes into account demand management, clean energy production, regional energy trade, and hydrocarbon exploration and production. The results show that the ECOWAS nations have started their transition to a renewable energy-based economy. These policies have long-term implications on the world's energy system and have the potential to improve the region's energy policy, even if the consequences are not immediately noticeable.

Keywords: ECOWAS, Energy Sources, Energy Policy, Energy Transition, Renewable Energy
JEL Classifications: Q20, Q21, Q28, Q40, Q41, Q42, Q48, Q54

1. INTRODUCTION

One of the consequences of the COVID-19 pandemic is that worldwide energy demand is expected to fall to a 70-year low in 2020. This, therefore, raises concerns about the chances for recovery of economies that rely on energy earnings, such as the major economies in the ECOWAS region.

Poverty, inequality, climate change, food insecurity, education, and health are all development issues that are intricately linked to the lack of access to sustainable, reliable, and contemporary energy sources (Bazilian et al., 2010). Increased access to modern energy services is intrinsically important in tackling these global concerns. Access to modern, high-quality, and reliable energy has helped advanced countries achieve economic development and wealth. Energy access facilitated the provision of services such as lighting, transportation, heating, mechanical, and communication, all of which impacted education, healthcare, and overall quality of life (Energy and Special, 2018).

The ECOWAS energy policy is being established against the backdrop of worldwide and regional changes. Energy policy is concerned with political decisions for implementing programs that fulfill energy-related societal goals, such as universal access to reliable and affordable energy sources that drive economic development (ECOWAS, 2014).

ECOWAS is one of Africa's greatest economic areas, having the continent's largest GDP (Nigeria). The combined energy capacities of the ECOWAS countries exceed their needs. Nigeria, as a leader, supplies the majority of energy to neighboring nations and should not be regarded as a country with electrical problems; nonetheless, it is disheartening to know that a part of their people is without electricity. The similar issue may be seen in countries like Ghana. This poses the issue of how to handle energy policy.

Unlike prior studies that looked at a single factor, this one looks at all of the elements that influence energy policy implementation in the ECOWAS area.

As a result, ECOWAS energy policy must take into account the interconnected social, economic, and political aspects that underpin energy systems. As a result, this paper opens with an overview of the ECOWAS region, as well as an examination of both global and regional issues influencing the region's energy strategy. The evolution of the ECOWAS energy system is then examined, with special attention paid to the major concerns of energy supply diversification, demand, and trade. Finally, a synthesis of the topics explored yields policy implications.

2. THE ECOWAS REGION CONTEXT

The Economic Community of West African States was formed to promote economic and development growth in West Africa. Major exports from the region include energy products, minerals and agricultural products. Regional leaders created ECOWAS on May 28, 1975 in Lagos, Nigeria (ECOWAS, 2010). ECOWAS is comprised of 15 countries, which include: Benin, Burkina Faso, Cape Verde, Cote d'Ivoire, The Gambia, Ghana, Guinea, Guinea-Bissau, Liberia, Mali, Niger, Nigeria, Senegal, Sierra Leone, and Togo. The leaders established ECOWAS to promote regional integration and economic growth in West Africa, as well as to create a monetary union in the region.

The social, political, and economic situations in these ECOWAS nations must be assessed as they have an effect on their energy systems. Depending on the situation, different forces—such as energy access and poverty, economic development, climate and health concerns, and energy poverty—have variable degrees of impact on the change of the energy system.

2.1. Social and Economic Context

The ECOWAS member states differ widely in population size and economy. The following Table 1 presents the major social and economic indicators of each member state. As can be seen in Table 1, the largest economy in the ECOWAS region is Nigeria (which alone accounts for 64% of this region's GDP), distantly followed by Ghana. Furthermore, Nigeria and Ghana are among the four fastest growing national economies in the sub-region (the other two being Liberia and Sierra Leone). In per-capita terms, Cape Verde is the region's richest country with a per-capita PPP adjusted GDP figure of over USD 4,300, which is more than twice the regional average. In contrast, five ECOWAS nations' PPP-adjusted GDP is lower than USD 1,200, namely Liberia, Niger, Mali, Togo and Guinea. Rapid population expansion, along with intensified economic activities and ongoing household welfare development, as evidenced by progressively improving economic indicators, is likely to push energy consumption to much higher levels. It may be difficult to mobilize the natural and financial resources needed to generate the additional electricity required, and putting in place new electricity generation capacity to fulfill the region's continually expanding needs will take time. To control this electrical demand and meet the current and future energy needs of the local people, it is now more important than ever to take early steps to reduce energy usage.

2.2. Energy Sector Overview

West Africa's energy mix comes from three primary sources of wood fuel (firewood and charcoal), petroleum (Kebede et al., 2010). West Africa's energy use is marked by a high reliance on biomass, low per-capita energy use, and a low rate of access to modern energy, particularly in rural areas. The following section discusses the ECOWAS member countries' key characteristics. The bulk of ECOWAS inhabitants still lack direct electricity access. This condition is exacerbating poverty by reducing the population's ability to generate economic value through the transformation of goods and the provision of professional services. Most Western African countries' socioeconomic progress is impeded by their poor energy sector (Trotter, 2016). Most ECOWAS countries rank among the poorest, having Low Human Development (ECOWAS, 2014). Access to electricity in the region is at 52%, with shortages of up to 80 h/month and yet electricity prices in WA remain among the costliest in the world, at 0.21 €/kWh, more than twice of the global average (Energy and Special, 2018). In the whole region, in

Table 1: Social and economic situation of ECOWAS (data from [populationdata.net, 2020])

Country	Population (million)	Territory (1000 km^2)	GDP (PPP) (Billion USD)	GDP (PPP) Per Capita (USD)	Average annual GDP growth (%)
Benin	12.506	115	15,505	1658	3.5
Burkina Faso	21.510	274	24,027	1374	5.9
Cape Verde	0.504	4	2175	4303	4.5
Cote d'Ivoire	26.491	322	39,635	1925	2.0
Gambia	2.207	11	3495	1916	2.9
Ghana	30.280	239	83,176	3256	7.4
Guinea	12.559	246	12,250	1169	2.7
Guinea -Bisseau	1.655	36	1902	1204	3.0
Liberia	5.310	111	2693	635	7.4
Mali	20 933	1240	17,355	1063	3.8
Niger	24.118	1267	13,530	813	5.3
Nigeria	212.871	924	450,535	2704	7.2
Senegal	17.215	197	26,504	2022	3.9
Sierra Leone	8.567	72	8376	1367	7.2
Togo	7.352	57	6899	1098	3.3
Total			708,057		
Average	-	-	-	1767	4.7

PPP: Purchasing power parity

2000, the electrification rate was 33%, but by 2016, the rate jumped to 52% (International Energy Agency, 2017) and the electrification rate was below 40% in 10 of the 15 countries, with Guinea-Bissau, Liberia, with 13 percent, 12%, 11%, and 9%, respectively, Niger and Sierra Leone are at the bottom. In 2015, the average annual electricity consumption in WA was around 145 kWh/capita. Nigeria (oil and gas), Guinea (hydro), Côte d'Ivoire (oil and gas), Ghana (hydro, oil and gas), Niger (uranium), and Benin and Togo (uranium) currently account for the majority of the region's energy generation potential (hydro). The hydropower potential of the region is concentrated in five of the 15 member states, particularly in the Senegal, Niger, and Volta river basins. Solar and wind energy, in contrast to traditional energy sources such as oil, gas, coal, and water, have more fairly distributed potential in the region and could give opportunities for all ECOWAS member states. Nigeria which has more than half the population of the ECOWAS bloc (International Energy Agency, 2014) and has the largest economy in Africa (International Energy Agency, 2014), is recognized as the leading consumer of solar energy technology in the west African region (IRENA, 2021). Nigeria is the region's primary natural gas supplier, and also generates about 43.4% of regional hydropower, closely followed by Ghana, which generates 40.9% of regional hydropower. Côte d'Ivoire, Guinea, Mali, and Burkina Faso split the remaining production.

As said in Table 2, Nigeria owns about 98% of proved crude oil and natural gas reserves in West Africa. Nigeria's oil and gas industry contributes 75% of the overall government revenue and thus, is the most important sub-sector in Nigeria currently. It is known that the manufacturing companies that service the oil and gas industry account for a major share of the energy consumed in the manufacturing sector. Also, the application of solar energy in the oil and gas sector (especially upstream) is a major way to drive solar energy integration and environmental sustainability (Bender et al., 2021). Nigeria, Ghana, and Côte d'Ivoire are the obvious leaders in terms of actual power generation. Their combined installed and usable capacity covers 82.5% and 90% of the territory, respectively, with thermal power plants generating two-thirds of the electricity and hydroelectric power plants generating one-third.

Table 2: Sources of energy and distribution in ECOWAS region (data from [International Atomic Energy Agency 2016])

Source of energy distribution in the region	Distribution in the region
Oil and gas	Nigeria has over 98% of West Africa's proven crude oil and natural gas reserves, while West Africa controls 30% of proven African crude oil reserves (3017 million tonnes) and 31% of natural gas reserves (3581 billion cubic meters)
Hydropower	While West Africa has a total hydropower potential of 23.9 GW, 91% of that potential is concentrated in five countries: Nigeria (37.6%), Guinea (25.8%), Ghana (11.4%), Côte d'Ivoire (10.9%), and Sierra Leone (10.9%). (5.2%)
Solar irradiation	Solar irradiation is higher than 5 kilowatt-hours per square meter/day, available practically in all West African countries

Oil and gas reserves, as well as hydroelectric power, are location specific, which is critical to comprehending the state of play in West Africa's energy sector. Landlocked and sparsely populated Mali, Burkina Faso, and Niger; and small coastal countries such as Liberia, Sierra Leone, Guinea, and Guinea-Bissau are not particularly well endowed with readily exploitable energy, forcing some of these countries, such as Benin, Burkina Faso, Mali, Niger, and Togo, to rely on expensive imported heavy fuel oil or diesel, or electricity imports from neighboring countries, in contrast to Nigeria, Ghana. However, when it comes to electricity rates, which are still among the lowest in the region, this has little impact. Only Senegal, Nigeria, Côte d'Ivoire, Ghana, and Cabo Verde are able to provide power for at least over 45% of their people (Cabo Verde being the only providing universal access).

The WAPP Master Plan classifies the ECOWAS countries into three categories:

- Countries with potential for a self-sustained supply: After 2020, Senegal, Côte d'Ivoire, Ghana, Nigeria, Togo/Benin, and Niger will be among them (when a large coal based thermal production plant is expected).
- Countries with continued dependence on power imports: These are the Gambia, Guinea Bissau, Mali, Burkina Faso and Niger before 2020.
- Countries with the potential to become power exporters (typically through the development of hydropower): such as Côte d'Ivoire (during a period) Guinea, Sierra Leone and Liberia after 2018. For all of these countries, the amount of extra hydro power will be determined by how well the WAPP investment program is implemented according to the agreed-upon schedule.

The 15 ECOWAS Member States' energy situation develops within a complicated framework of regional and sub-regional policies that coexist with long-term initiatives to overcome energy poverty and promote energy efficiency in the region:

- By 2025, the revised WAPP Master Plan estimates that renewable energy sources will account for about 36% of total installed capacity in ECOWAS. Large hydro would account for roughly 28% of the total, while "new renewables" would account for 8%.In parallel to the regional renewable energy policy; ECOWAS is currently developing an energy efficiency policy. Both policies are complementary. The RE scenario considers possible energy savings.
- The UEMOA' Regional Initiative for Sustainable Energy (IRED) targets a 78% RE penetration in the power grid by 2030, with 62 % coming from wind, solar, and biomass.
- The CILSS initiative covers 7 of the ECOWAS countries (Niger, Burkina Faso, Mali, Senegal, Cape Verde, Guinea Bissau and the Gambia) and focuses on woody biomass, sustainable management of forest and wooded lands and sustainable use of wood-fuel, including substitution strategies (LPG and kerosene).

Key matters: Energy poverty, energy efficiency, renewable energy, regional interconnection and energy access, management framework.

Action priorities: Energy efficiency, renewable energy.

3. GLOBAL FACTORS INFLUENCING ECOWAS ENERGY POLICIES

3.1. Climate Change

Globally, the necessity for coordinated measures to mitigate the threat of climate change and eliminate widespread energy poverty is evident in the Paris Climate Agreement's and Sustainable Development Goal No. 7's viewpoints (SDG 7)(Delina et al., 2018).

Climate change is already having an impact in Sub-Saharan Africa. These consequences have ramifications for energy supply security as well. (Avila et al., 2017).

West Africa is responsible for only a small percentage of worldwide energy-related GHG emissions. Longer droughts and shifting river flow patterns are already being noticed in many parts of West Africa as a result of a warming environment (ECREEE, 2015). The risks of climate change, as well as the requirement for a stable and inexpensive energy supply to provide energy security and access, present a dilemma. On the one hand, there is a pressing need for investment. Expanding energy supply based on inefficient low-cost fossil fuel combustion technologies, on the other hand, will increase GHG emissions and accompanying negative climate change impacts, primarily affecting Sub-Saharan Africa. Despite being one of the least responsible for climate change, the region is sensitive to its effects, which include decreasing agricultural output, droughts, and dwindling biomass potential (Suberu et al., 2013). Climate change impacts (temperature rise, extreme weather events, droughts, etc.) will challenge the energy security of ECOWAS countries and have to be mainstreamed into energy policy planning. This is particularly important with regard to hydro power due to the possible changes in the rain patterns and river flows.

3.2. Evolution of Renewable Energy as a Cost-competitive Energy Source

ECOWAS countries have the opportunity to address two basic energy concerns in the coming decades. First, they can meet the United Nations' Sustainable Development Goal of universal access to affordable, dependable, sustainable, and modern energy services by 2030, thereby improving the lives of hundreds of millions of their residents (ECOWAS, 2014). At the same time, ECOWAS countries can use renewable energy to avoid becoming reliant on fossil fuels. Renewable energy has evolved as a technologically viable and economically attractive alternative to fossil fuels.

Technology advancements, lower renewable energy costs, novel approaches, network effects, and digitalization are creating new opportunities and making renewables a compelling economic case. West Africa is well positioned to take advantage of this potential due to its extensive indigenous resources. However, the potential and availability of low-cost technologies are insufficient on their own. To fully harvest the benefits of renewable energy, strong political will, appealing investment frameworks, and a holistic policy strategy will be required. Furthermore, the region still has significant untapped potential with abundant renewables that do not cause climate change (Avila et al., 2017).

In this perspective, investments committed to address the severe economic effects of the COVID-19 problem in West Africa must help the continent transition to a more sustainable energy future. As a result, prioritizing renewable energy investments becomes a requirement.

4. REGIONAL FACTORS INFLUENCING ECOWAS ENERGY POLICIES

4.1. Natural Resource Endowments

4.1.1. Hydrocarbon resources

West Africa accounts for 30% of the oil reserves found and 30% of Africa's natural gas reserves found. Nigeria owns about 98% of proved oil and natural gas reserved in West Africa while the region possesses 30% of proven African crude oil reserves (3017 million tonnes) and 31% of natural gas (3581 billion cubic meters).

As shown in Figure 1, Nigeria has the greatest proven oil reserves in the region (36,97 billion barrels), followed by Ghana (0.66 billion barrels), Ivory Coast (0.1 billion barrels), and Benin (0.1 billion barrels). Figure 2 shows that Nigeria has the greatest proven gas reserves in the region, with 124000 bcf, followed by Ivory Coast (1000 bcf), and Ghana (800 bcf).

Figure 1: Proved oil reserved history in ECOWAS countries

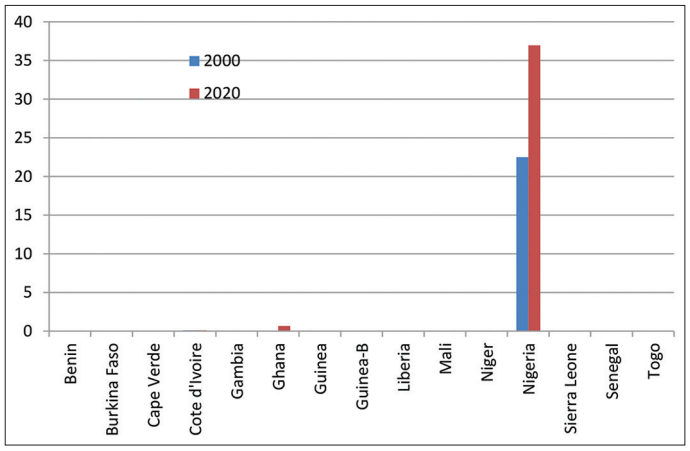
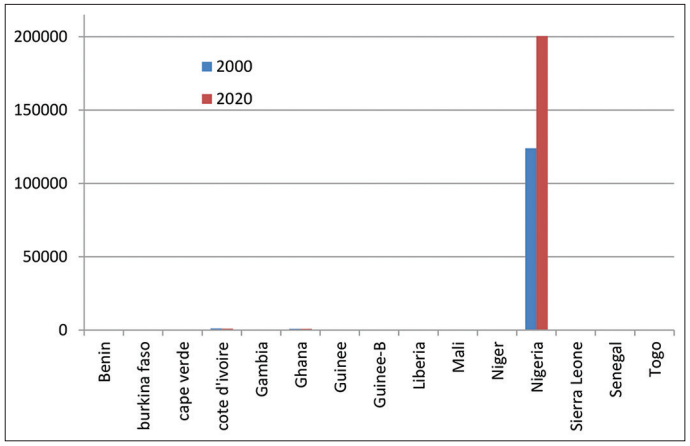


Figure 2: Proved gas reserved history in ECOWAS countries



4.1.2. Renewable energy resources

Cape Verde has been, in general, the pioneering country making renewable energy a priority for the development of the country. It has taken a number of steps towards implementation (e.g. RE law and other incentives). Recently, Cape Verde installed 25.5 MW of grid-connected wind farms and 7.5 MW of grid-connected solar PV plants. Senegal, Ghana, Mali, Liberia, Guinea, and Nigeria have developed a detailed renewable energy policy. Ghana and Senegal have passed a renewable energy law and feed-in-tariff systems are under preparation. Liberia, Mali, and Senegal have adopted ambitious RE targets of 30%, 25% and 15% (of installed capacity) respectively by 2023, and Ghana and Nigeria 15% by 2025.

There is a huge technically and economic feasible potential for renewable energy development in West Africa. These resources are generous and well distributed among the countries.

Wind potential is concentrated in the costal zones (Cape Verde, Senegal, Gambia) as can be seen in Figure 3. The overall wind assessments provide only general information on the potential. Site specific surveys and measurements are required to verify the seasonal variation of wind regimes and determine the financial viability of the potential.

Small hydro potential is located particularly but not exclusively in the southern part of the region (Côte d'Ivoire, Ghana, Guinea, Guinea-Bissau, Liberia, Togo and Sierra Leone) while solar resource is abundant in the northern regions (Niger, Burkina Faso, Niger and the northern part of Ghana and Nigeria) as shown in Figure 4. Except for Cape Verde and the Sahelean areas of Mali, Burkina Faso, and Niger, biomass resources are well distributed across the region, with a propitious potential in the Southern region. When considering biomass resources, it is important to distinguish: (i) the diffused biomass resources from agricultural byproducts, which are generally costly to collect and transport in large quantities, and for that reason can be used locally, and (ii) the concentrated resources at the agro-industry sites like rice husk, cotton seed shells, groundnuts and cashew shell, sawdust, manure and dung at dairies or slaughterhouses, which can constitute a proper resource for cogeneration. Under the same category are the urban wastes.

Finally, solar resource is especially favorable in the northern desert areas of the ECOWAS region in Mali and Niger and in the North-Eastern part of Nigeria with a potential of 1,700 kWh/installed kWp/year. The coastal areas of Liberia, Côte d'Ivoire, Ghana and Nigeria do not benefit to the same extent from this resource with an average potential of 1,200 kWh/installed kWp/year. For the remaining areas, the average potential is about 1,500 kWh/kWp/year.

Because three countries (Senegal, Gambia, and Cape Verde) have high wind potential, wind resources are given a high rating for these countries. Mali and Nigeria, which have an equal mix of renewable energy resources, are given a 30% average score for three resources (solar, biomass, and hydro), and a 10% ranking for wind, which is more intermittent than the other resources. Even if Northern Mali has a considerable solar potential, it cannot be completely used because long transmission lines are required to deliver the generated energy to the south. This resource, on the other hand, can be used to supply Northern Mali's major cities. Four countries with significant mining potential (Guinea, Liberia, Sierra Leone, and Guinea-Bissau) can use renewable energy to meet the energy demands of their mining businesses, which are located in remote areas far from the national grid. Small-scale hydropower and solar PV are the two main sources, in order of importance. The mining industry's energy requirement typically ranges from 30 to 150 megawatts. As a result, there is significant potential to meet the region's grid and off-grid energy needs.

4.2. Energy-water Nexus

The Senegal River is West Africa's second longest river (1800 km), with a transboundary drainage basin that spans Guinea, Mali, Mauritania, and Senegal (10, 54, 26, and 15% respectively). Born in the Fouta Djallon massif in Guinea, the Senegal river travels across Guinea and Mali and, after the confluence of the Bafing, Bakoye and Falémé rivers, traces the border between Mauritania and Senegal until it meets the Atlantic ocean near Saint-Louis in Senegal.

Due to the high dependency of the main livelihoods in Senegal River Basin (SRB) on water (agriculture, livestock, fisheries), around 85% of its population lives close to the river (Bender et al., 2021). The SRB is highly vulnerable to climate variability and changes, due to the great interdependence between climate and socioeconomic activities, and it could be further challenged by the increasing pressures posed by its population dynamics on natural resources, the subsequent changes in land use and the competition among sectors and users. There is a high hydropower potential in the basin and even if currently only two

Figure 3: Renewable capacity in 2019

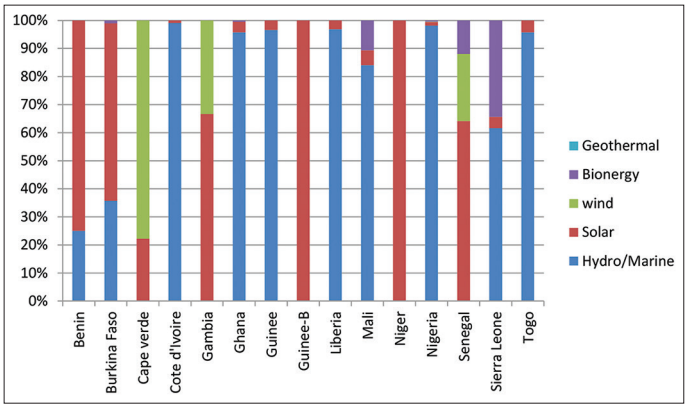
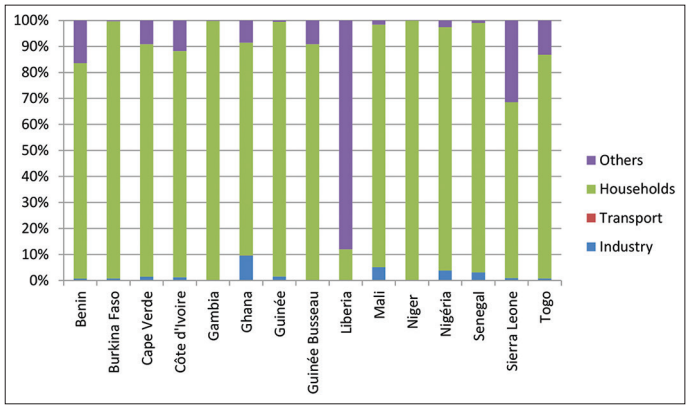


Figure 4: Energy Consumption in ECOWAS countries in 2017



plants are being exploited (one under development), the four riparian countries have planned to increase the number of reservoirs, in order to meet the expected growing demands as well as to regulate the high inter- and intra-annual water availability of the basin (Bender et al., 2021). In the middle valley and delta, agriculture, pastoralism, and fishing are the main activities. This entire region is poor and extremely dependent on the flood-related cropping activities in the depressions along the river for food security (Samaké, 2015).

Renewable energy resources such as wind, solar, hydro, and biomass have a great potential in Sub-Saharan Africa, with the biomass potential projected to be up to 1649 TWh (Stecher and Brosowski, 2013). Indeed, the potential for solar energy in the Senegal river basin is very high (Bender et al., 2021). however, biomass, which is locally produced and often close to demand, could be used in tandem with hydropower and photovoltaic (PV) systems to balance the power system affected by the variable nature of solar energy. As can be seen in Figure 3, Nigeria is the leader of the region in term of Hydro/marine capacity. Senegal, Ghana and Burkina Faso are respectively leaders in term of solar capacity.

5. ECOWAS ENERGY SYSTEM TRANSITION

The energy transition is predicted to result in the creation of new jobs, the transformation or substitution of existing jobs, and the termination of certain jobs, either completely or partially without direct replacement.

Diversification of energy supply, energy demand management, and energy trade, particularly intra-regionally, are all critical concerns for regional energy transformation. Targets and policies are still an important part of efforts to stimulate the development and deployment of renewable energy and energy efficiency technologies around the world. Recognizing the critical role that access to a stable and sustainable energy supply plays in all aspects of national development, the international community has pledged to ensure universal access to sustainable energy. Policymakers in ECOWAS Member States and around the world have looked to renewable energy to achieve these goals. In line with the targets established under the EREP initiative (Table 3), Sustainable energy access has been declared a national development priority by the majority of ECOWAS member states. To enhance electricity availability in off-grid populations, these goals and policies increasingly rely on renewable energy technologies. ECOWAS region aims to increase the share of grid-connected RE in the overall generation mix, including large hydropower, to 35% by 2020 and 48% by 2030. In addition, the share of rural population served by decentralized renewable energy systems is expected to reach 22% by 2020 and 25% by 2030 (ECREEE, 2015).

ECOWAS Member States set national targets to increase home power coverage as of early 2014 (Table 4). Cabo Verde has already made tremendous progress toward obtaining near-universal access to power, and Ghana and Sierra Leone have set aggressive targets by 2030. Seven Member States have also set goals for the use of contemporary fuel alternatives, while four have set goals for the deployment of clean cook stoves and/or solar cookers.

The region is still strongly reliant on traditional biomass resources in 2017. Except in Liberia, where other factors play a significant role, households accounted for the majority of ECOWAS countries' energy consumption (Figure 4). The household sector accounts for the vast majority of energy consumption in low-income ECOWAS nations, while other economic sectors such as transportation and industry account for a substantial portion in other Member

Table 3: ECOWAS renewable energy policy off-grid renewable energy targets

Policy (EREP) off-grid renewable energy targets	Target year	Access rate (%)
Share of rural population served from renewable energy off-grid	2030	25
Share of population using improved cook stoves	2030	100
Share of efficient charcoal production	2030	100
Share of population using modern fuel alternatives for cooking	2030	41
Biodiesel as share of diesel and fuel-oil consumption	2030	10

EREP: ECOWAS renewable energy policy

Table 4: Sustainable energy access targets in selected ECOWAS countries

Country	Electricity access	Access to modern fuels	Clean cook stoves
Benin		0	70,553
Burkina Faso		0	110,135
Cape Verde		0	1451
Cote d'Ivoire		0	165,994
Gambia		0	5215
Ghana	100% by 2030	10	89,063
Guinee		30% of demand in rural areas covered by biogas in 2025	102,992
Guinee Busseau		0	21,996
Liberia	35% by 2030	0	8880
Mali		0	45,160
Niger		0	52,393
Nigeria	80% by 2025	8000 biogas digesters installed by 2030	1 million improved cook stoves installed by 2030; 150,000 sola cookers installed by 2030
Senegal		0	
Sierra Leone	75% by 2025, 100% by 2030	15% by 2030	Share of population with access to improved cook stoves: 10% by 2025; 15% by 2030
Togo		0	

States. Such variation is necessary for focusing energy efficiency improvements and renewable energy installations on certain areas of the economy.

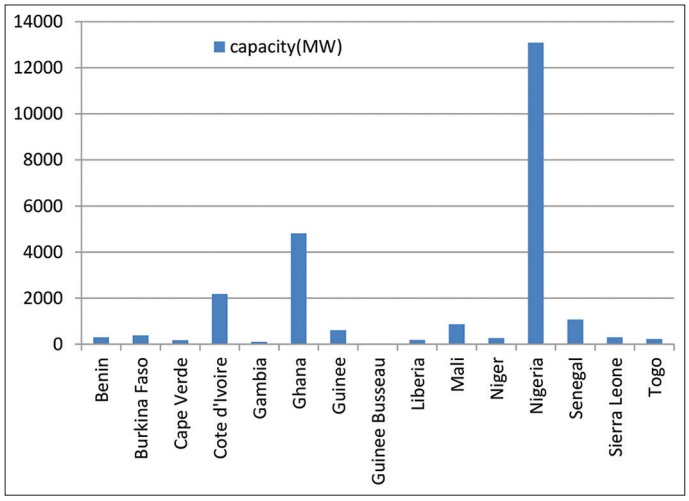
5.1. Demand Management

The WA electricity demand for the power sector is estimated to increase from 60 TWh in 2015 to about 667 TWh in 2050 (International Energy Agency, 2014). The electricity demand is driven mainly by Nigeria, Ghana and Côte d'Ivoire, together they account for about 80% of the regional demand by 2050 (Toktarova, 2017). Despite the vast energy resources available in the ECOWAS region, almost 180 million people have problems of access to electricity, that is, about 60% of the population. Poor system reliability, inadequate infrastructure, and fuel import dependence, as well as a high reliance on fossil fuels, hydropower, and traditional biomass resources, are all threats to ECOWAS Member States' energy security. 65% of electricity is generated from fossil fuels. Furthermore, substantial commercial and technical losses of 21.5% worsen the rising gap between generation capacity and demand. As a result of these characteristics, the region has one of the lowest rates of modern energy use in the world. The power generation capacity in the region is very low. Nigeria is still the leader with 13089 MW as power generation capacity in 2019, followed by Ghana. Cape Verde has the lowest equal to 176 MW (Figure 5).

5.2. Energy Efficiency

To address these multiple challenges, the ECOWAS Authority of Heads of State and Government renewed its commitment to providing access to sustainable energy services in West Africa by adopting the ECOWAS Energy Efficiency Policy (EEEP) and the ECOWAS Renewable Energy Policy (EREP) during its 43rd Ordinary Session, which took place in Abuja, Nigeria from July 17 to 18, 2013. As part of the ECOWAS Energy Efficiency policy, a specific target has been agreed upon by ECOWAS Member States regarding the development and adoption of region-wide efficiency standards for buildings (e.g. building codes). Energy efficiency criteria, for new buildings as well as for existing buildings undergoing major refurbishment, should incorporate the principles of tropical architecture and urban planning standards. Energy efficiency in buildings is a key element of sustainable development in West Africa. The transformation of the buildings sector is a long-term undertaking. For this process to be implemented effectively, a variety of policy tools, such as regulatory measures, financial instruments, awareness raising, and capacity building, are required. In important areas of activity, the ECOWAS Energy Efficiency Policy (EEEP) contains flagship energy efficiency initiatives. This set of measures includes the ECOWAS initiative on building energy efficiency. The ECOWAS Initiative on Energy Efficiency in Buildings aims to enhance dependable and affordable energy services in buildings by building on national efforts and adding value through regional actions.

Figure 5: Power generation capacity in ECOWAS region



Additionally, REP has been considered as an instrument for solving energy efficiency challenges (Asante et al., 2020). Future global energy policies should strongly continue financial and political support of renewable energy technology (Sevim, 2016).

5.3. Energy Efficiency Best Practices

Energy efficiency figures prominently in energy policies of African countries. Energy is a key factor in their economic and social development and the causal effects between energy and growth have been well demonstrated. Christian Aboua (Aboua, 2018) has investigated total factor energy efficiency in the fifteen West Africa economies over the period 1990-2013. They employed standard DEA model to estimate energy efficiency scores with undesirable output (CO_2 emission) and without undesirable output, respectively, found that shows for all the countries energy efficiency changed over time. Their results indicate that in average on the period of the study, Benin Guinea and Senegal, Burkina Faso and Gambia have the highest efficiency score in absence of consideration of CO_2 emission, while Sierra Leone, Togo, Nigeria, Mali, and Liberia are the less energetically efficient. They highest energy efficiency score over the study period is 0.98 (for Benin, Guinea and Senegal).

Mali and Liberia present the lowest average energy efficiency scores with respectively 0.78 and 0.69. In the second case, when taking account of the CO_2 emission, they found that the five first countries with a high level of energy efficiency score are Senegal, Niger, Benin, Burkina Faso and Ghana, Nigeria, Togo, Mali and Liberia remained the less efficient in energy use. Senegal presents the highest average energy efficiency score over the study period with a value of 0.92, while Mali and Liberia still present the lowest average energy efficiency score with a value of 0.68 and 0.65, respectively.

5.4. Energy Supply Diversification

5.4.1. Renewable energy

The ECOWAS region has huge RE resource potential, widely distributed across the region and could provide low-cost and reliable energy supply (Sterl et al., 2018). Countless opportunities exist for deploying solar PV, wind energy, hydropower and biomass technologies across the region (Sterl et al., 2018). Currently, RE generation in WA is dominated by hydropower; and is even the main power source for some countries. Solar PV, wind energy and hydropower are anticipated to experience strong growth in the region's power mix (ECOWAS, 2014).Building on the regional goals; ECOWAS Member States have now set targets for the deployment of renewable energy technologies (Table 5). 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 2025. The majority of targets fall in the range of a 5% to 35% share to be achieved by 2025 or 2030, mirroring targets being set around the world. 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). 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. Power generation policies continue to attract the most attention from policymakers in ECOWAS and throughout the world. Renewable energy policies come in a variety of shapes and sizes, each with its own set of objectives and strengths and limitations.

Policies can be established to remove various barriers to renewable energy adoption, and they can be targeted at large- or small-scale projects implemented by a variety of power providers or users. Although the benefits of numerous policy instruments for renewable energy assistance are well known, policymakers have difficulties in selecting and implementing the optimal combination of policies to suit their particular domestic circumstances and achieve their specific development goals. 13 ECOWAS Member States had approved some type of renewable energy policy in the power sector as of early 2014 (Table 6).

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. 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). 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 5 years. 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. Financial instruments are the most common means of assisting the renewable energy sector through national policy in the ECOWAS region. Investment or production tax credits, as well as reductions or eliminations of taxes such as import duties, sales, and value-added tax, are all examples of tax incentives (VAT). In 13 ECOWAS member states, renewable energy technologies are now subsidized under the tax legislation. Quantity instruments can also help with the implementation of renewable energy technology. These mechanisms have not yet gained as much traction as price-based methods. Two ECOWAS countries have enacted RPS or quota rules requiring power utilities to employ renewable energy. The Public Utilities Regulatory Commission is required by Ghana's Renewable Energy Act to create quotas for the procurement of renewable energy by electricity distribution firms and bulk customers. The Commission, however, had not met the necessary renewable energy quota as of early 2014. Furthermore, despite the lack of a formal quota, Senegal requires the national electric company, SENELEC, to develop renewables in its concession regions. In Figure 6, we can see the proportion of renewable energy in ECOWAS countries.

Table 5: National targets for renewable energy in ECOWAS member states

Country	Renewable energy targets
Benin	No target
Burkina Faso	No target
Cape Verde	50% in the national grid by 2020
Cote d'Ivoire	15% by 2020; 20% by 2030
Gambia	35% electricity by 2020
Ghana	10% of electricity by 2020
Guinee	Solar: 6% by 2025 Wind: 2% by 2025
Guinee Busseau	-
Liberia	30% of electricity by 2021
Mali	25% by 2033
Niger	10% share in national energy balance by 2020
Nigeria	Nontechnology specific: 18% by 2020; 20% by 2030 Small-scale hydropower: 2000 MW by 2025 Solar PV: 500 MW by 2025 Solar thermal electricity: 5 MW by 2025 Biomass electricity: 2000 MW by 2025 Wind: 40 MW by 2025
Senegal	-
Sierra Leone	33% by 2020; 36% by 2030 Solar home systems: 1% penetration in the residential sector by 2020; 5% by 2030
Togo	-

Figure 6: ECOWAS Total primary Energy supply (TPES) in 2017

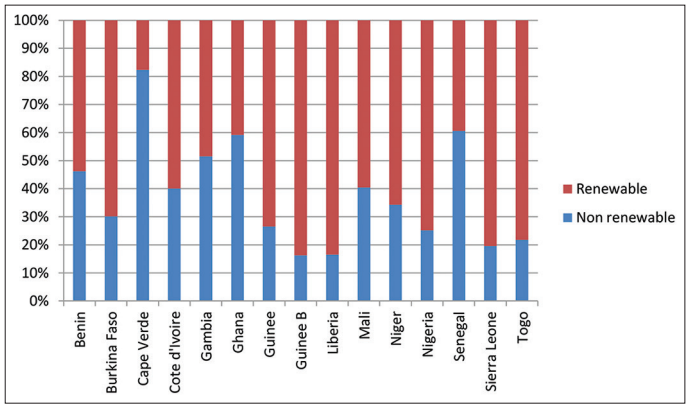


Table 6: Renewable energy support policies in ECOWAS member states

Country	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 product	Reductions in sales, energy CO_2, VAT, or other taxes	Energy production payment	Public investment, lionas, or grants
Benin	X										X		
Burkina Faso								X		X	X	X	
Cape Verde	X			X				X		X	X	X	
Cote d'Ivoire	X										X		
Gambia	X										X		
Ghana	X	X	X		X	X	X		X		X		X
Guinee	X										X		
Guinee	X										X		
Busseau													
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										X		
Togo	X										X		

5.4.2. Nuclear energy

Nuclear power is being considered by ECOWAS countries. Ghana, Niger, and Nigeria have already contacted the International Atomic Energy Agency (IAEA) to assess their readiness to start a nuclear program. As a result, Ghana and key stakeholders have chosen to include nuclear energy in the country's energy mix to supplement the country's two main energy sources, hydro and thermal electricity. Ghana is now actively pursuing the implementation of nuclear power for electricity generation through the Ghana Atomic Energy Commission (GAEC) and other stakeholder organizations. In order to commission the first nuclear power plant in 2029, a roadmap has been developed. Nigeria operates a research reactor and has signed deals to build a proposed 2.4 GW power plant.

5.4.3. Coal

No ECOWAS country has significant coal reserves and so coal has played a limited role in the ECOWAS energy system with the exceptions of Nigeria and Niger. From 2008 to 2017. The average value for Nigeria during that period was 384.04 million short tons with a minimum of 379.19 million short tons in 2012 and a maximum of 391.32 million short tons in 2008. The latest value from 2017 is 379.19 million short tons. The average value for Niger during that period was 6.61 million short tons with a minimum of 6.61 million short tons in 2008 and a maximum of 6.61 million short tons in 2008. The latest value from 2017 is 6.61 million short tons. For comparison, the world average in 2017 based on 190 countries is 6012.16 million tons (the Global Economy.com, 2022).

5.5. Regional Energy Trade

ECOWAS have two strategic priorities: natural gas and power trade. The region faces two critical strategic challenges:

- Securing sufficient gas resources which could save around $121 billion by providing sufficient gas for coastal countries to not only satisfy their own demand, but to also produce power for export to the smaller coastal and inland countries;
- Increasing power trade which could save the region around $32 billion over the coming decade, by bringing low-cost power from areas of surplus to areas of deficit. If both regional power trade is developed, and sufficient low-cost gas is secured, the total benefits for the region would total around $150 billion.

5.5.1. Existing trade

There are seven major interconnectors currently in existence linking countries across West Africa while an eighth link (Ghana-Burkina Faso) was inaugurated in October 2018: Nigeria - Niger Katsina - Gazoua (132 kV) Birnin Kebbi - Dosso (132 kV) Nigeria - Benin Ikeja West - Sakate (330 kV) Ghana - Togo Akosombo - Aflao (161 kV X2) Côte D'Ivoire - Ghana Riviera - Prestea (225 kV), Côte d'Ivoire - Burkina Ferké - Kodeni (225 kV) Côte d'Ivoire - Mali Ferké - Sikasso (225 kV) Mali - Senegal (225 kV) Ghana - Burkina Faso Bolgatanga-Ouagadougou (225 kV).Only Nigeria has been using its interconnections with a high utilization rate, and this is in part a consequence of the liquidity issues within the Nigerian Power sector, which make exports more financially attractive than meeting the demand of the domestic distribution companies.

5.5.2. The West Africa gas pipeline

Natural gas trade within ECOWAS has been very limited and Nigeria has been the dominant player regarding exports to countries of the region. The West Africa Gas Pipeline was built with the aim of exporting Nigeria's gas to its neighbor countries and is managed by a dedicated company, called WAGP Co, based in Accra, Ghana. It is regulated by the WAGPA Authority, based in Abuja, Nigeria. Unfortunately, the pipeline is being utilized below its potential despite the clear benefits it could provide to Benin, Togo and Ghana.

5.5.3. Trading opportunity by 2022

ECOWAS regional trade is less harmful and it can guarantee improved environment quality in the long run (Ali et al., 2016).

By 2022 only three countries are expected to have the potential to be significant year-round exporters: Côte d'Ivoire, Ghana and Mauritania, each of whom will be reliant on natural gas. Guinea's supply and demand balance will be seasonal because of heavy reliance on large hydro projects: with a wet season surplus (July to December) and a dry season deficit (January to June). Nigeria is assumed to continue to suffer from transmission issues affecting domestic power and gas transit translating into underutilized generation capacity. All the other countries are potential importers, with three largest markets being those without access to the sea and so limited to fuel import prospects: Mali, Burkina Faso and Niger. This regional overview gives an idea of the importance of trading, in particular for importing countries that could replace expensive or inefficient diesel- or HFO-based generation (often up to 30 US cents/kWh) with cheaper import (10-14 cents/kWh) to cover their demand and make huge savings.

6. CONCLUSION AND POLICY IMPLICATIONS

ECOWAS region is among the African regions with the most energy production potential both from non-renewable (oil; gas; uranium) and renewable sources (hydroelectric power; solar and wind energy). ECOWAS developed an ambitious regional energy agenda, rooted in the ECOWAS founding treaty of 1975. While significant investments have been made to boost energy production through these regional energy initiatives, almost all of them experienced major challenges in the form of repeated delays and/or increased transaction costs.

With few exceptions, West Africa's energy markets remain inward looking and highly dependent on expensive thermal power. Nigeria, Ghana and to some extent Côte d'Ivoire are net exporters, largely through historical bilateral arrangements while the majority of ECOWAS countries largely depends on imports and fossil fuel for electricity supply. Regional infrastructure has the potential to drive down electricity prices and power development in the long run; however, the poor state of national grids and markets, both in net producing and net consuming countries remains a major obstacle for further integration and prevents interest to converge in the short run.

Our paper also reveals that, despite attempts, energy efficiency remains a severe issue in the ECOWAS region. To accomplish modernization and greening of West African economies, it is consequently vital to boost energy efficiency. Energy efficiency will contribute to the reliability of supply and security energy, by reducing losses in the energy chain. This will allow reducing dependence on fossil fuels. Energy efficiency will also help to raise the region's population's standard of life by lowering energy bills and making energy more affordable and accessible in both urban and rural locations. It would also ensure that all public services, including as education, health, and water quality, have access to electricity. Finally, energy efficiency will reduce negative environmental externalities (e.g. example GHG emissions, air, soil and water pollution and degradation land) energy use.

Ghana occupies a central position in WA energy for a variety of reasons, giving it a potential lead in the regional energy agenda. This is due in part to its location. Ghana is strategically placed in the middle of Nigeria, Côte d'Ivoire, Sierra Leone, and Liberia, all of which are major energy players. As a result, Ghana is seen as having the potential to become a regional service and petrochemical powerhouse. Ghana is also a potentially important regional actor due to its stability, relative predictability, and good relations with its neighbors. Stability and predictability are two important criteria that lower transaction costs for both partner countries and private sector actors interested in investing in energy in, though, or with Ghana. Its positive connections with its neighbors (particularly Côte d'Ivoire), which are founded on political and economic commitment (Côte d'Ivoire sends dozens of Megawatts per year to Ghana), may open up new doors. Both countries, which have huge oil and gas deposits, seek to increase production in order to export to countries like Guinea and Sierra Leone, thereby establishing a regional energy hub.

ECREEE, as the region's RE and EE agency, is well-placed to encourage the breakdown of traditional energy silos and drive new thinking about how to achieve clean, affordable energy that supports climate objectives. The demographic distribution, Gross Domestic Product (GDP), and natural resources of West Africa's 15-country region are all different. Regardless of whether solar, hydropower, biomass, or a combination of the three, they all have a significant RE potential. The area is well positioned to be a pioneer for the continent by making RE and EE a fundamental pillar of its NDCs, demonstrating what a climate-resilient, clean energy future may look like.

Although renewable energy development is largely viewed as a mitigation strategy, Benin, Burkina Faso, Cabo Verde, Guinea Bissau, Mali, Nigeria, and Togo highlight the potential contribution of renewables to adaptation and resilience in their NDCs. In addition, seven ECOWAS countries have quantified targets for renewables off the grid. This is especially important in nations like Burkina Faso and Mali, where over 70% of the population still does not have access to electricity. By improving energy availability, including targets for decentralized renewables in the NDCs can assist promote inclusive economic development. Due to the dependence of ECOWAS countries on natural gas and petroleum fuels, the share of fuel costs in total system costs must continue to be reduced by half by 2040. That would reduce ECOWAS's exposure to volatile fossil fuel prices and

has the potential to lower the electricity bills paid by consumers. Renewables therefore should be considered as more sustainable alternatives to new natural gas capacity. However, given the challenges of demography, economic growth, and climate change, a real demand-side management strategy, underpinned by a strengthened energy efficiency policy, combined with bioenergy-based decarbonization of the transport and household sectors, could be a viable roadmap for meeting ECOWAS's long-term energy demand. By providing economic incentives that fully reflect the environmental and social costs of fossil fuels and removing barriers to accelerating the deployment of low-carbon solutions, regulatory and policy frameworks can be put in place quickly to give countries a clear and firm long-term guarantee that energy systems will be transformed to achieve climate objectives.

As a final policy consideration, strong regional energy cooperation is critical, but it must be undertaken with caution and realism. To summarize, the ECOWAS energy system's evolution and transition will be difficult, but necessary. For the time being, advances will primarily be built on transactional exploitation of simpler chances, notably bilaterally.

Economic diversification investments, support initiatives that help build and strengthen national supply chains capable of responding to new economic opportunities, adoption of social protection measures for people dependent on declining industries (including fossil fuels), and careful monitoring of the transition in the context of energy access are all things that policymakers can do to aid the transition process. For the energy policy community, this brings up a vast and diverse collection of research problems.

REFERENCES

Aboua, C., Tourr,Y. (2018), Energy Efficiency in West Africa Economies: Implication for Sustainable Energy Use. SSRN Electronic Journal, 3-4.

Ali, H.S., Law, S.H., Zannah, T.I. (2016), Dynamic impact of urbanization, economic growth, energy consumption, and trade openness on CO_2 emissions in Nigeria. Environmental Science and Pollution Research, 23(12), 12435-12443.

Asante D, He, Z., Adjei, N.O., Asante, B. (2020), Exploring the barriers to renewable energy adoption utilising MULTIMOORA-EDAS method. Energy Policy, 142(C), 111479.

Avila, N., Carvallo, J.P., Shaw, B., Kammen, D.M. (2017), The Energy Challenge in Sub-Saharan Africa: Generating Energy for Sustainable and Equitable Development. Oxfam Research Backgrounder Series 100.

Bazilian, M., Nussbaumer, P., Cabraal, A., Centurelli, R., Detchon, R., Gielen, D., Howells, M., McMahon, H., Modi, V., O'Gallachoir, B, Radka, M., Rijal, K., Takada, M. (2010), Measuring Energy Access: Supporting a Global Target. New York: The Earth Institute.

Bender, A., Moner-Girona, M., Becker, W., Bódis, K., Szabó, S., Kararach, A.G., Anadon, L.D. (2021), Dataset for multidimensional assessment to incentivise decentralised energy investments in Sub-Saharan Africa. Data in Brief, 37, 107265.

Delina, L.L., Sovacool, B.K. (2018), Of temporality and plurality: An epistemic and governance agenda for accelerating just transitions for energy access and sustainable development. Current Opinion in Environmental Sustainability, 34, 1-6.

Economic Community of West African States. (2010), ECOWAS Vision. Nigeria: Economic Community of West African States; 2020.

Economic Community of West African States. (2014), ECOWAS, Renewable Energy and Energy Efficiency Status Report 2014, France. Nigeria: Technical Report, Economic Community of West African States. p.186.

Economic Community of West African States. (2015), ECOWAS Renewable Energy Policy. Nigeria: Economic Community of West African States.

Energy and Special. (2018), Africa Energy Outlook. World, and Outlook Special.

International Atomic Energy Agency. (2016), Sustainable Electricity Supply Scenarios for West Africa. Iaea-Tecdoc, 1793, 144. Vienna: International Atomic Energy Agency.

International Energy Agency. (2014), Africa Energy Outlook. A Focus on the Energy Prospects in Sub-Saharan Africa. World Energy Outlook Special Report. Vienna: International Energy Agency Publication. p.1-237.

International Energy Agency. (2017), World Energy Outlook-2017 Special Report: Energy Access Outlook. Vienna: International Energy Agency. Available from: https://www.iea.org/energyaccess/1–143.

International Renewable Energy Agency. (2021), End-of-Life Management: Solar Photovoltaic Panels. Abu Dhabi: International Renewable Energy Agency.

Kebede, E., Kagochi, J., Jolly, C.M. (2010), Energy consumption and economic development in Sub-Sahara Africa. Energy Economics, 32(3), 532-537.

Populationdata. (2020), Social and Economic Situation of ECOWAS. Available from: https://www.populationdata.net/pay

Samaké, L. (2015), Politiques et Mesures d'accompagnement de l'agriculture Familiale Dans un Contexte de Changement Climatique : Analyse des Perceptions des Exploitations Agricoles au Sénégal. Vol. 93. Mémoire de fin d'étude Pour le Diplôme d'ingénieur Agronome à l'école Nationale d'agricultre au Sénégal, p1-93.

Sevim, C. (2016), Strategic trends and barriers for future energy policy. Energy Sources Part B Economics Planning and Policy, 11(8), 698-704.

Stecher, K., Brosowski, A., Thrän, D. (2013), Biomass potential in Africa. Abu Dhabi: International Renewable Energy Agency. p.1-43.

Sterl, S., Liersch, S., Koch, H., Va Lipzig, N.P.M., Thiery, W. (2018), A new approach for assessing synergies of solar and wind Power: Implications for West Africa. Environmental Research Letters, 13(9), 20-29.

Suberu, M.Y., Mustafa, M.W., Bashir, N., Muhamad, N.A., Mokhtar, A.S. (2013), Power sector renewable energy integration for expanding access to electricity in Sub-Saharan Africa. Renewable and Sustainable Energy Reviews, 25, 630-642.

The Global Economy. (2022), Nigeria: Coal Reserves. Available from: https://www.theglobaleconomy.com/Nigeria/coal_reserves

Toktarova, A. (2017), Long-term load forecasting in high resolution for all countries globally. Lappeenranta University of Technology, 53(9), 1689-1699.

Trotter, P.A. (2016), Rural Electrification, Electrification inequality and democratic institutions in Sub-Saharan Africa. Energy for Sustainable Development, 34, 111-129.