

# DELTA STATE RENEWABLE ENEGRY POLICY ROADMAP

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# FOREWORD

Clean Technology Hub (CTH), with the support of the Heinrich Boell Foundation (HBF), is pleased to present this Consultation Paper to propose that the Delta State Government adopts a renewable energy policy roadmap. Such a policy document will serve as a blueprint to achieve the Delta State Government's vision for universal access to electricity, climate resilience and economic growth beyond oil in the State. It would also complement the social and economic development aspirations of the State as part of the Delta State Medium-Term Development Plan (DSMTDP) (2020-2023) and subsequent plans. As the world moves towards cleaner and more sustainable forms of energy, and as the Federal Government implements its national renewable energy policies, it is important that Delta State is not left behind and instead stimulates renewable energy investment in its territory and promotes a Delta State beyond oil. This document has passed through several consultations with a variety of private sector, civil society and government stakeholders in Delta State. The final draft of the policy roadmap will be handed over to the Delta State Ministry of Energy, with the goal of domiciliation and eventual adoption by the Delta State Government.

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# **INTRODUCTION**



Delta State is blessed with many natural resources. As the second largest oil-producing state in Nigeria, for decades it has focused on the production of fossil fuels while relying on the national grid to provide electricity to its residents. This situation has, however, neither enabled the state to industrialize and diversify away from oil dependence, nor supply the energy needs of its 5.4 million residents.

Located in the South-South geopolitical zone, it is part of the Niger Delta region which straddles the Atlantic coast. Although a majority of its population is engaged in agriculture and fishing, the state features vibrant commercial activities. In addition, with projected population growth over the next half decade, and with increasing vulnerability to climate change, not only is there a need to identify new avenues for increasing the supply of energy, the role of renewable energy solutions must specifically be explored.

The present national grid capacity and power distribution system is inadequate to supply Delta State's electricity needs. Available estimates from the National Bureau of Statistics (NBS) show that 78.3% of households in Delta State were electrified by 2014.<sup>1</sup> This is higher than the household electrification South South percentage of 68.3% and the national percentage of 55.6%.<sup>2</sup> However, due to the limitations of the national grid, more than half of Delta State's population is either off-grid or highly underserved by the national grid. For many communities, electricity may be unavailable 87.4% of the time. Moreover, fossil fuels (particularly gas-fired power plants) make up 87.5% of the electricity mix supplied to Delta State.

Additionally, with proximity to the Atlantic Ocean, approximately 30% of the surface area of Delta state is covered by water. Although the level of water security is high with over 80% of Delta State residents having access to water, water quality and safety levels vary wildly. In terms of energy for cooking, fuel wood constitutes about 80% of fuel used for cooking in Delta State.<sup>3</sup> Hence 43% of Delta State residents depend on depleting the tree stock in the forest in Delta State.<sup>4</sup> This contributes to deforestation, climate change and health problems, especially for women and children.

According to a comprehensive assessment report conducted in 2013, the state is also very vulnerable to the impact of climate change. Research sponsored by the World Bank in 2020 estimates the cost of environmental degradation for Delta State is estimated at 5.7% for the state, with most of the damage being due to flooding, water pollution and erosion.<sup>5</sup> On one hand, since about 75% of the vast majority of greenhouse gas

<sup>&</sup>lt;sup>1</sup> GIZ (2015). The Nigerian Energy Sector: An Overview with a Special Emphasis on Renewable Energy, Energy Efficiency and Rural Electrification. Bonn: Deutsche Gesellschaft fürInternationale Zusammenarbei (GIZ), p. 119.

<sup>&</sup>lt;sup>2</sup> Ibid.,, p. 119.

<sup>&</sup>lt;sup>3</sup> Rosemary H. Okoh (2013). Biophysical and Socio-Economic Assessment of the Nexus of Environmental Degradation and Climate Change, Delta State, Nigeria. Assessment Report submitted to Territorial Approach to Climate Change (TACC) In Delta State, Climate Change Unit, Ministry Of Environment, Delta State, Nigeria, p. 22.

<sup>&</sup>lt;sup>4</sup> Ibid., 22.

<sup>&</sup>lt;sup>5</sup> Croitoru, Lelia, Miranda, Juan J., Khattabi, Abdellatif and Lee, Jia J. (2020). The Cost of Coastal Zone Degredation in Nigeria: Cross River, Delta and Lagos States. Washington, DC: The World Bank, p. 50.

emissions from the state are due to oil and gas exploration,<sup>6</sup> a separate concerted policy approach would be needed as part of climate adaptation and mitigation for the state. On the other hand it is expected that the anticipated increase in temperature due to climate change will continue to lead to increased pressure and demand for various energy sources, which is partly addressed by this document.

There is therefore a pressing need to transition from an oil-based economy to a more diversified one in which renewable and clean energy plays a more prominent role. The goal is to improve the electrification rate and to replace existing sources of energy that are not climate- and health-friendly in Delta State. Yet there has hitherto been an absence of coordinated efforts by all stakeholders (government, civil Society organizations and communities) towards improving energy access through renewable energy adoption, both as a solution to energy poverty and as a climate change mitigation and adaptation measure. In the past, different ministries and departments have pursued green initiatives - the State Ministry of Energy has done some work on solar street lighting; the State Ministry of Environment has been involved with

waste recycling plants, disbursing clean cookstoves and biogas digesters. There is a need to harmonize and consolidate these efforts.

While the federal government has a national renewable energy policy, state governments are not closely involved. Most states have also not produced their own renewable energy policies, and therefore much has been left to the central government to design and implement. There is, however, a need to complement and supplement these national efforts in order to make Delta State energy-secure, self-reliant and prosperous. This would contribute to the prosperity and energy security of the State and nation. This is in line with Section 14 of the Constitution of the Federal Republic of Nigeria of 1999 which gives state governments the authority to provide for and regulate their electricity systems.

This Roadmap outlines our plan to create an enabling environment and take an active role in improving the access to renewable energy for Delta State residents. It specifies targets and means for renewable energy development in Delta State over the next five years. The focus is on off-grid renewable energy solutions, with specifications for measures to be taken in the short-, medium- and long-term.



<sup>&</sup>lt;sup>6</sup> Delta State Government (2013). Delta State Climate Change Policy. Asaba: Delta State Government, p. 1.

# BACKGROUND

Delta State is one of the six states that make up what is known as the South-South geo-political zone of Nigeria. Its capital city is Asaba, while Warri is its economic center. The State lies roughly between longitude 50.00 and 60.45 degrees east and latitude 50.00 and 60.30 degrees north. The total land area is estimated at 18,050 km<sup>2</sup> with the Atlantic Ocean coastline of about 163 km in the South, a substantial part of which is swampy and waterlogged. It is characterized by flatland in the south and central areas and low-lying plains/undulating terrains with low hills and valleys in the northern areas. The land area comprises rain forest in the central areas 57%, mangrove swamp/forest along the coast 33% and fresh water 10%. Average rainfall ranges from 1,910 mm in the northern areas to 2,670 mm in the coastal parts.

With its location in the oil-rich Niger Delta region of Nigeria, Delta State provides about 30% of Nigeria's total oil and gas output. Its gas reserves account for an estimated 40% of the national total gas reserves of 150 trillion cubic feet. The State has 25 local government areas (LGAs). It is estimated to have a population of 5,663,362 as of 2016,<sup>7</sup> making the state slightly larger than small African countries such as Botswana and Mauritius. It also has a population density of 228 persons/km<sup>2</sup>. About 19% (1.1 million) of its population resides in its coastal zone, almost entirely composed of rural dwellers.<sup>8</sup> The state is ethnically and culturally diverse, with the main ethnic nationalities being the Urhobos, Igbos, Ijaws, Isokos and Itsekiris, reflecting the rich cultural diversity of the people. It is characterised

by an active, young and thriving population (15-59 years) of about 64% while those less than 15 years old make up about 34%.

#### Delta State Economic Context

According to the NBS, Delta State's GDP was estimated at N4.471 trillion in 2019,9 about the same as the combined GDP of Liberia, Sierra Leone and Burundi. In 2019 the oil and gas sector represented about 47.1% of its GDP, production of which is concentrated in 9 out of 25 local governments areas. While agriculture represents 13% of GDP, 80% of land is devoted to agriculture and forestry,<sup>10</sup> and the majority of its population (75%) depend on agriculture for their livelihood, as well as the informal sector. Data collected by the National Bureau of Statistics and the Small and Medium Enterprises Development Agency of Nigeria shows that there were 1,536,158 microenterprises which employed 2,403,576 people in Delta State in 2013.<sup>11</sup>

Delta State ranks fourth in Nigeria both by Gross National Income (GNI) and GNI per capita.<sup>12</sup> After Lagos State, Delta State ranks second in Nigeria in terms of the poverty headcount ratio estimated by the NBS. NBS figures indicate that only 6% of the population survive on the breadline of less than N11,500 per month or N383.03 per day.<sup>13</sup> The State also ranked fourth in Nigeria on the Human Development Index rankings in 2018, classified as medium human development.<sup>14</sup>

<sup>&</sup>lt;sup>7</sup> NBS (2017). Demographic Statistics Bulletin. Abuja: National Bureau of Statistics, p. 7.

<sup>&</sup>lt;sup>8</sup> Croitoru, Miranda, Khattabi and Lee, The Cost of Coastal Zone Degredation in Nigeria, p. 50.

<sup>&</sup>lt;sup>9</sup> Osayande, Monday (28 June 2021). "Delta economy grows by 51% as non-oil sector boosts GDP",

<sup>&</sup>lt;sup>10</sup> Ministry of Environment (2013). *Delta State Climate Change Policy*. Asaba, Delta: Ministry of Environment, p. 35.

<sup>&</sup>lt;sup>11</sup> SMEDAN and NBS (2013). SMEDAN and National Bureau of Statistics Collaborative Survey: Selected Findings (2013). Abuja: SMEDAN and NBS, p. 21.

<sup>&</sup>lt;sup>12</sup> NBS (2016). Computation of Human Development Indices for the UNDP Nigeria Human Development Report. Abuja: NBS, p. 31.

<sup>&</sup>lt;sup>13</sup> NBS (2019). 2019 Poverty and Inequality in Nigeria: Executive Summary. Abuja: NBS, p. 15.

<sup>&</sup>lt;sup>14</sup> CSAE (2018). Beyond Country-level Averages: Construction of Sub-National Human Development Index for the Nigerian States. Abuja: Centre for the Study of the Economies of Africa (CSEA), p. 9.

Sector	Population	Demand (per year)	Applicable Renewable
			Energy Technology
Residential	3.1 million <sup>15</sup>	180 Kwh <sup>16</sup>	Mini-grid, Solar Home Systems and
			clean cookstoves
Commercial			
MSMEs	1.5 million MSMEs	NA	Mini-grid and Solar Home Systems
Agriculture	2 million <sup>17</sup> agriculture	NA	Solar irrigation, cold storage and
	workers		solar dryers
Health	550 public health	NA	Mini-grid and Solar Home Systems
	centers		
Education	2,187 public basic,	NA	Mini-grid and SHS
	secondary and tertiary		
	educational		
	institutions <sup>18</sup>		

#### Energy demand Economic Sector Energy Demand

According to the National Bureau of Statistics (NBS), Delta State's rural electrification rate is 2.7%.<sup>19</sup> In addition, 61% of SMEs in Delta, Bayelsa and Rivers States are off-grid or suffer from a bad grid.<sup>20</sup> As a result, 55% of Delta State households and 90% of SMEs make use of diesel- or petrol-powered generator sets as a source of electricity.<sup>21</sup>

According to the IEA, Nigeria's electricity consumption is 140 kWh per capita. However, the South-South region generally has higher electricity consumption rates due to greater levels of urbanization, incomes and literacy rates than states in the North. If the national estimated electricity consumption per capita is used, Delta State would need at least 11,043 MWh of electricity per month to satisfy its energy demand. Estimates suggest that energy demand between 2020 to 2025 may grow by 16.7% in Delta State.<sup>22</sup> It is estimated that Delta State, as with the rest of the South South zone, requires about 537 kWh of electricity per capita per year in the future for a sustainable development, which is significantly more than the 2015 estimation of 144.5 kWh for Nigeria as a whole.<sup>23</sup>

However, the current use of generators to meet energy demand in the South South generates an estimated annual 3,442 kg of CO2 per household.<sup>24</sup> Moreover, the cost of unit electricity from diesel generators in the South South is estimated at 0.886 \$/kWh, which is on average 35.68% more than the cost of energy for a solar PV system.<sup>25</sup>

<sup>20</sup> AllOn, Nigeria, p. 19. <sup>21</sup> Ibid., p. 19.

<sup>24</sup> Ibid., p. 7. <sup>25</sup> Ibid., p. 7.

 $<sup>^{15}</sup>$  Derived by multiplying the population of 5,663,362 with 55% (percentage of households which own generator sets).

<sup>&</sup>lt;sup>16</sup> Derived by multiplying annual South South residential electricity demand of 180 KWh by the estimated number of households which own generators in Delta State. <sup>17</sup> NBS (2020). *Labor Force Statistics - Volume 2: Unemployment and Underemployment by State Q4 2020.* Abuja: National Bureau of Statistics, p. 53.

<sup>&</sup>lt;sup>18</sup> Federal Ministry of Education (2021). "Nigeria Digest of Education Statistics". <u>https://education.gov.ng/nigeria-digest-of-education-statistics/</u>.

<sup>&</sup>lt;sup>19</sup> GIZ (2015). The Nigerian Energy Sector: An Overview with a Special Emphasis on Renewable Energy, Energy Efficiency and Rural Electrification. Bonn: Deutsche Gesellschaft fürInternationale Zusammenarbei (GIZ), p. 119.

<sup>&</sup>lt;sup>22</sup> All On (2017). Nigeria: Energy Needs Assessment and Value Chain Analysis. Lagos: AllOn, p. 11.

<sup>&</sup>lt;sup>23</sup> E. O. Diemuodeke, A. Addo, I. Dabipi-Kalio, C. O. C. Oko & Y. Mulugetta (2017) Domestic Energy Demand Assessment of Coastline Rural Communities with Solar Electrification. Energy and Policy Research, 4(1): 1-9, p. 7.

#### **Government Sector Energy Demand**

Budget Item	Amount Allocated in 2021 Budget (millions)
Generator procurement	N203.6
Generator fuel costs	N54.6
Generator maintenance	N426.8
RE technology procurement	N2891.5
Total	N3,576.5

Within the public sector, there are 63 state government administrative units (ministries, departments and agencies). Although they are typically connected to the main grid, the instability and low levels of power supply forces them to resort to the use of diesel-powered generator sets. The 2021 budget shows that the Delta State Government allocated N426.8 million for the maintenance of plants/generators, N54.6 million for plant/generator fuel cost, and N203.6 million for the purchase of power generation sets. This makes a total of N684.9 million on purchasing, fueling and maintaining diesel generators in a year. Indeed the State Government also allocated N2.9 billion in its 2021 budget for renewable energy projects, mostly towards the installation of solar street lights.

This therefore reflects the size of a potential annual "government market" for off-grid renewable energy solutions to replace the more expensive diesel-powered solutions for powering government offices, buildings, and public utilities such as traffic lights and boreholes. Public procurement may therefore be used to stimulate the State's renewable energy sector.

#### Energy supply

Nigeria's installed electricity production capacity on the national grid is 12,900 MW, with available capacity being 5,400 MW. This is nowhere near the needs of large states such as Lagos alone, and therefore inadequate for the entire country. Indeed, of the total energy consumed by Nigerian industries only 4% is from grid-connected electricity, while 96% is self-produced, using natural gas, diesel, or biomass and waste (usually wood products and agri-waste).<sup>26</sup> Thus it is estimated that between 8 and 14 GW of decentralised diesel generator capacity is currently installed in the country.<sup>27</sup>

Delta State receives electricity from the national grid through the Benin Electricity Distribution Company (BEDC). It is home to three major electricity generating plants in Nigeria. For coastline areas which have dispersed settlements located mainly in rugged terrain, and coupled with the privatization of the power sector, this makes their electricity supply economically impossible (at least in the next decade)—in spite of the region's large daily production of oil and gas. The pump prices of petroleum products in the coastline rural communities are normally above the official pump prices worldwide, seemingly due to their dispersed settlement, rugged remote location, terrains, and inaccessible road networks.

Therefore, renewable energy technologies (RETs) as alternative or complementary energy sources in these coastline rural communities would be of great benefit. Yet it is estimated that renewable energy use in Warri metropolis may be up to 23% among households, with little to no utilization among commercial and industrial ventures.<sup>28</sup>

<sup>&</sup>lt;sup>26</sup> EUEI-PDF (2016). Captive Power in Nigeria: A Comprehensive Guide to Project Development. Hesse, Germany: European Union Energy Initiative Partnership Dialogue Facility . (EUEI PDF), p. 6.

<sup>&</sup>lt;sup>27</sup> Ibid., p. 6.

<sup>&</sup>lt;sup>28</sup> Oyelenke O. Oyerinde (2021). Renewable Energy Penetration in Warri Metropolis. European Journal of Environment & Earth Sciences, 2(2): 19-23.

#### National Renewable Energy Context

Nigeria's electricity supply has been generated through centralized stations (hydro and thermal) with high capacities (above 100MW). The major operators in the Nigerian electric power station are six generating companies (unbundled from the Power Holdings Company of Nigeria), the Transmission Company of Nigeria (TCN) which manages the electricity transmission network in the country, and 11 distribution companies. Every distribution company operates across three to four states. The national grid system is regulated National Electricity Regulatory by the Commission (NERC).

The energy mix in Nigeria is dominated by thermal (75%) and hydro (25%) power generating sources. The national grid supplies about 80% of the total official electricity consumption in the country with about 6000MW installed capacity from three (3) large hydro power stations, Shiroro, Jebba and Kainji with other five (5) thermal power stations, its maximum suppressed demand is about 3,500MW. Despite the presence of a centralized national electricity generation and distribution network, 40.7% of the population is not connected to the grid, a figure which rises to 79% in rural areas.

Since 2003, there has been inclusion of renewable energy in federal energy plans and policies. These include the National Energy Policy 2003 (NEP), the Electric Power Sector Reform Act 2005 (EPSRA), the Renewable Energy Master Plan 2006 (REMP), the Renewable Electricity Policy Guidelines 2006, Renewable Electricity Action Programme (REAP) 2006, National Biofuel Policy and Incentives 2007, the Renewable Energy Master Plan 2012, and the National Renewable Energy and Energy Efficiency Plan (NREEEP) 2015. The EPSRA 2005 created the Rural Electrification Fund (REF) and Rural Electrification Agency (REA).

The REMP 2006 aimed at increasing the supply of renewable electricity (wind, solar, biomass and small hydro) from 13% of total installed electricity generation capacity in 2015 to 23% in 2025 and 36% by 2030. This was nowhere near achieved. In 2007, Nigeria formulated a national biofuel policy that would help the nation produce about two billion litres by 2020, helping it cut billions in spending on ethanol imports. However, its targets were nowhere near achieved by 2020.

The National Renewable Energy and Energy Efficiency Plan (NREEEP) was launched in 2015 and forms the overarching policy on renewable energy and energy efficiency in Nigeria. This has been complemented by the Rural Electrification Strategy & Implementation Plan 2016 (RESIP). Other federal electrification plans and vehicles Rural Electrification include the Strategy Implementation Plan (RESIP) and the operationalization of the Rural Electrification Fund (REF).29

<sup>&</sup>lt;sup>29</sup> CTH (2020). Nigeria's Energy Situation. Abuja: Clean Technology Hub (CTH).

#### National Targets

There are existing national targets for renewable energy adoption that the Federal Government has set. These, however, have not been disaggregated by state, and it is left for state governments to set their own targets which would contribute to the achievement of national targets.

#### Table 1: Targets for Grid Connected Renewable Energy under the NREEEP

In MW Installed Capacity	2020	2030
Renewable energy installed capacity in MW (excluding medium and large hydro)	2785	9100
Renewable energy share of the total installed capacity in % (excluding medium and large hydro)	27	28
Large and medium scale hydropower capacity installed in MW (more than 30 MW)	2540	4700
Large and medium scale hydropower (more than 30 MW) share of total electricity generation in %	25	15
Total renewable energy capacity in MW (including large and medium scale hydro)	5325	13800
Renewable energy share of the total installed capacity in % (including medium and large hydro)	52	45

#### Table 1: Targets for Off-grid Applications under the NREEP

In MW Installed Capacity	2020	2030
Share of population served	75	90
by electricity services (%)		
Share of population	70	80
connected to the grid (%)		
Share of rural population	5	10
served by renewable energy		
and hybrid mini-grids (%)		
Share of rural population	4.5	5
served by stand-alone		

In MW Installed Capacity	2020	2030
renewable energy systems		
(%)		
Mini-grids powered purely	180	5314
by renewables (in MW of		
installed capacity)		
Mini-grids powered by	4	171
hybrid systems (MW)		
PV and Pico-Hydro rural	3.5	60
systems (MW)		
Total off-grid renewable	187.5	5545
energy installed capacity		
(MW)		

Specific targets for Delta State will be included in a complementary implementation plan.

#### State level Renewable Energy Policies

NREEEP recognized the need The for government units responsible for renewable energy and energy efficiency matters at the state and local government levels. It encouraged the establishment of necessary links between federal and state Government for the formulation of renewable energy and energy efficiency policies, framework and programmes, as well as for the execution of some of the programmes both at federal, state and local Government level. However, the only specific mention of an explicit link was for the Federal Ministry of Power to support renewable energy project developers to secure land for project development in various States of the Federation.

On the other hand, Section 14 of the Concurrent Legislative List of the Constitution of the Federal Republic of Nigeria 1999 charges State Houses of Assembly, respectively, with the responsibility of making laws to regulate electricity. The Law empowers State Governments to provide:

- Electricity and the establishment, in that state, of electric power stations;
- The generation, transmission and distribution of electricity to areas not covered by a national grid system within that state; and
- The establishment within that state of any authority for the promotion and management of electric power stations established by the state.

Yet many States have relied on the national grid for decades. This means that state governments have powers to attract and regulate energy investments that have been underutilized. Lagos State, for example, has argued that because it receives barely 5.5% of its required electricity supply needs from the national grid, it cannot rely on the national grid alone for a sustainable, long term, socio-economic growth and significant growth in its citizens' standard of living. In 2018 Lagos State became the first in Nigeria to enact a power sector reform specific legislation with the Electric Power Sector Reform Law, 2018. The Law aims to boost electricity supply in Lagos State through the establishment of a power scheme with the aim of generating and distributing approximately 3,000 MW for public use in the State using off-grid energy generation installations. Other states have developed their own off-grid electrification policies, including Jigawa, Katsina and Lagos.

On the other hand, a survey conducted by Clean Technology Hub in 2020 estimated that 95% of Deltan respondents believed that a lack of policies to support the development of the offgrid sector at the state level is a major factor affecting the energy sector. Across the country, many ministries, departments and agencies of State Governments have engaged in projects and programmes for renewable energy solutions, but without a consolidated renewable energy policy or implementation plan.

Indeed in Delta State, over the years different ministries and departments have pursued green initiatives – the Ministry of Energy has done a lot of work in solar street lighting and work on methanol cookstoves and solar lanterns in 2004 (Project Gaia); the Ministry of Environment has been involved with waste recycling plants, disbursing clean cookstoves, providing household biogas digesters, solar boreholes and water heaters; the Ministry of Transportation has been involved with solar street lights; and the Ministry of Science and Technology through the Delta State Innovation Hub offers a course in advanced solar and inverter installation and repairs under the ICT for Self-Employment Training programme aimed at young aspiring entrepreneurs. In addition, multiple Memoranda of Understanding (MoUs) have been signed with

foreign companies at least since 2014 for the installation of solar power plants, although much remains to be seen. The Delta State Climate Change Policy 2013 document allocates only two pages to energy supply through renewable energy. The Delta State Medium-Term Development Plans (DSMTDP) of 2016-2019 and 2020-2023 make only very brief mentions of renewable energy. There has therefore been no specialized renewable energy policy created and implemented by the State.

#### Renewable Energy in Delta State

Renewable energy covers all forms of energy generated from natural resources such as sunlight, wind, water (or hydro power), tide, geothermal heat, biomass and biofuels. They are derived from natural processes that are constantly replenished. Solar energy can be seen as the anchor behind various forms of renewable energy, as well as the most abundant. This is why Nigeria has focused on solar energy in its renewable energy policy and attraction of foreign funding towards it.

#### Renewable Energy Potentials

Nigeria receives abundant sunshine all the year round being just above the equator. The sunshine duration averages 6.5 hours daily with an average flux of 5.55 kWh per square meter (m<sup>2</sup>) per day. The solar radiation intensities range from 3.5-7.0 kWh m<sup>2</sup>/day, increasing from the South to the North.



Figure 1: Nigeria's solar radiation exposure (Source: World Bank ESMAP)

Indeed, it is estimated that Delta State has an annual averaged solar irradiance of 4.53 kWh/m2/day, which is the third highest in the South South region. Solar PVs can produce 1683.8 MWh per m<sup>2</sup> in the state.<sup>30</sup> There is therefore good potential for solar-based renewable energy solutions for Delta State. According to the Global Solar Atlas, medium size commercial solar PV systems of 100 kWp capacity would be able to generate 130.6 MWh per year (or 1.7 MWh per m<sup>2</sup>) in Delta State.<sup>31</sup>

#### Table: Solar energy potential in Delta State.

Solar PV System	Installed Capacity	Total Annual Energy Output
Small residential	1 kWp	1.28 MWh
Medium size commercial	100 kWp	130 MWh
Ground-mounted large scale	1000 kWp	1.348 Gwh

<sup>&</sup>lt;sup>30</sup> Global Solar Atlas (2021). "Delta".

https://globalsolaratlas.info/detail?c=5.527144,6.178436,11&r=NGA&s=5.527306,6.178417&m=site&pv=medium,1\_\_80,7,100

Biofuels apply to solid, liquid, or gaseous fuel produced from biological materials (biomass), which can be used for the generation of power, heat, or fuel for motive power. Biomass is the major energy source in Nigeria, contributing about 78% of Nigeria's primary energy supply.<sup>33</sup> Fuel wood constitutes about 80% of fuel used for cooking in Delta State.<sup>34</sup> Households could benefit from the supply of over 320,000 clean biomass cookstoves,<sup>35</sup> and the creation of a self-sustaining clean cookstove market in Delta State through strong government support. Clean cookstoves can help reduce the amount of wood needed for cooking by 60%.<sup>36</sup>

Biomass resources include agricultural crops, agricultural crop residues, fuel wood and forestry residues, waste paper, sawdust and wood shavings, residues from food industries, energy crops, animal dung/poultry droppings, industrial effluent/municipal solid waste. These are the feedstock meant for conversion into biofuels. Biofuels include bioethanol (a substitute for gasoline), biodiesel (a substitute for diesel), and biogas (a substitute for cooking gas). Ethanol and biodiesel are mainly used as transport fuels, with ethanol being the most important biofuel in terms of volume.

In Delta State, agricultural crops that have potential as biomass feedstock for biofuel production include cassava, yam, maize, and oil palm. These can provide opportunities for farmers and agro-processors to feed in their crop residue and agro-processing by-products into biofuel processing. However, despite the large amounts of money spent on the federal biofuel program launched in 2007, the outcome at the national level is still very discouraging.

The Delta State Waste Management Board estimates that Delta State generates about 1.2 million tons of solid waste а year, corresponding to an average rate of 0.55 kg/capita/day.<sup>37</sup> Out of this, only about 30% is formally collected, with the rest discharged directly by its producers in open dump fields, rivers, roadsides or burned in backyards.<sup>38</sup> With organic waste generally being 50% of solid waste generated in Nigeria, and with 1 ton of municipal solid waste able to be used to produce about 130 kWh electricity, less than 50 MW can be produced using municipal waste in Delta State.<sup>39</sup> However, due to the high cost of maintenance, repair, and technical expertise required for technologies such as anaerobic digestion and gasification to convert organic waste into energy, mass incineration has been acknowledged as more appropriate in Nigeria.<sup>40</sup> Without the capacity for waste collection for centralized gasification and anaerobic digestion, in the short- to mediumterm, a decentralized system of biofuel production would have to be relied upon through the stimulation of a market for household biogas digesters.

<sup>&</sup>lt;sup>33</sup> Sokan-Adeaga, Adewale Allen and Ana, Godson R.E.E. (2015). A Comprehensive Review of Biomass Resources and Biofuel Production in Nigeria: Potential and Prospects. *Reviews on Environmental Health*, 30(3): 143-162, p. 143.

<sup>&</sup>lt;sup>34</sup> Okoh, Rosemary H. (2013). Biophysical and Socio-Economic Assessment of the Nexus of Environmental Degradation and Climate Change, Delta State, Nigeria. Assessment Report submitted to Territorial Approach to Climate Change (TACC) In Delta State, Climate Change Unit, Ministry Of Environment, Delta State, Nigeria, p. 22.

<sup>&</sup>lt;sup>35</sup> This assumes a household size of 6.

<sup>&</sup>lt;sup>36</sup> Delta State Ministry of Environment (2014). *Delta State Integrated Territorial Climate Plan (ITCP)*. Asaba, Delta: Ministry of Environment, p. 15.

<sup>&</sup>lt;sup>37</sup> Croitoru, Miranda, Khattabi and Lee, The Cost of Coastal Zone Degradation in Nigeria, p. 26.

<sup>&</sup>lt;sup>38</sup> Ibid., p. 26.

<sup>&</sup>lt;sup>39</sup> Somorin, Tosin O., Adesola, Sola and Kolawole, Aisha (2017). State-Level of the Waste-to-Energy Potential (via Incineration) of Municipal Solid Wastes in Nigeria. *Journal of Cleaner Production*, 164: 804-815, p. 7.

<sup>&</sup>lt;sup>40</sup> Ibid., 9.

Resource Type	Reserve	Uses
Solar radiation	4.53kwh/m2/day	Mini-grids & standard-alone solar systems
Organic waste	600,000 million tonnes 78 GW annually	Biofuels
Clean cookstoves	300,000 units	Biomass cookstoves

These renewable energy potentials are not only attractive for the opportunities for electrification and climate change mitigation they provide, but also for their potential to stimulate the economic diversification, growth, employment and building of technological capabilities in Delta State. For instance, it has been estimated that the mini-grid market in Nigeria offers potential annual revenue of **H** 2.8 trillion.<sup>41</sup>

#### Sectoral Needs

Different renewable energy systems may be applicable in different cases, depending on the nature of the respective sector, as well as the pattern of energy demand, geographical and commercial conditions which influence bankability and cost structures.

Moreover, while various sectors may need renewable energy solutions for increased energy access and efficiency, the need for the State to prioritize has led to the identification of six (6) key sectors which may be focused upon. These were identified after consulting with civil society organizations (CSOs), who considered their contributions to the development, livelihood and well-being of Delta State. These sectors are agriculture, Micro, Small and Medium-Sized Enterprises (MSMEs), education, health, ICT and security, and transportation.

#### Agriculture

Typically across Nigeria, about 80% of rural dwellers are engaged in farming and other low income vocations. Although agriculture contributes the most to the employment of Delta State residents, most agricultural activity is conducted traditionally and through small-scale farming. These small-scale farming and fishing account for up to 90% of agricultural output.42 The average farm size per household is 0.95 hectares (Ha), with an estimated 75% of farming households in the state owning less than one hectare of land per household while 20% own between one and three hectares.<sup>43</sup> In the Niger Delta generally, there are an estimated 1,200 large scale farmers (10-1000 Ha) and 5,000 medium scale farmers (6–10 Ha), which supply a small number of large processing industries and about 50 small-medium scale industries.44

Moreover, estimates suggest that in the State, 77.1% of farmland is rain-fed, 22.8% is made up of low-land swamps, while only 0.1% is irrigated. Since the majority of the farms are upland (rainfed), farmers have to rely on rainfall to water their crops which to a large extent can affect the yearly harvest. As a result, the agricultural sector has the largest proportion of Deltans living below the poverty line.<sup>45</sup>

<sup>&</sup>lt;sup>41</sup> Nigerian Economic Summit Group (2018). *Minigrid Investment Report: Scaling the Nigerian Market*. Abuja: Nigerian Economic Summit Group (NESG), p. 9.

 <sup>&</sup>lt;sup>42</sup> Ministry of Environment (2013). Delta State Climate Change Policy. Asaba, Delta: Ministry of Environment, p. 35.
 <sup>43</sup> Ibid.
 <sup>44</sup> PIND (2011). Cassava Value Chain Analysis in the Niger Delta. Abuja: Partnership Initiative in the Niger Delta (PIND).

<sup>&</sup>lt;sup>45</sup> OSAGFR (2014). Delta State Development Performance: Agricultural Sector Report, 1991 - 2014. Asaba: Office of the Senior Adviser to the Governor on Foreign Relations, Delta State Government.

These facts reveal the need for agriculture in Delta State to increase in crop yield, productivity growth, and stronger forward linkages to enable a growth in output and food security, as well as income growth for rural and urban households. Yet without access to energy, farmers continue to grow, harvest, and process manually, restricting their income potential and limiting the growth of the agriculture sector as a whole.

Agricultural and fishing activities will benefit from renewable energy through direct value addition afforded by electricity-dependent technologies for storage, preservation and processing of their products. Some renewable energy technologies that can benefit agricultural activity include minigrid systems, solar irrigation, solar dryers, cold storage technologies and solar business systems. Medium-sized agro-processing plants could also benefit from waste-to-energy projects using biogas digesters.

# Micro, Small and Medium Enterprises (MSMEs) Energizing MSMEs

A 2013 SMEDAN and NBS survey shows that at least 1.5 million microenterprises (employing 1-9 persons) and 1,444 SMEs (employing 10-199 persons) operate in the state,<sup>46</sup> generating about 2.4 million employed persons, 77.8% of whom are female.<sup>47</sup> Most of these enterprises are in the wholesale and retail sector, with others in manufacturing and agriculture. Delta State is home to various industries including brick-making, bottle manufacturing, ceramics, glass manufacturing, chemical/insulators production, chalk manufacturing and sanitary wares, decorative stone cutting, and quarrying which requires energy for production.

SMEs consume about 10% of total energy in Delta State, with other commercial and public actors consuming 78%.48 About 61% of SMEs in Delta, Bayelsa and Rivers States are off-grid or suffer from a bad grid.<sup>49</sup> This may similarly be the case for microenterprises.<sup>50</sup> As a result, 90% of SMEs in Delta State make use of diesel- or petrol-powered generator sets as a source of electricity.<sup>51</sup> Available estimates from neighbouring Akwa Ibom indicate perhaps 58% that of microenterprises in electrified communities and 32% of microenterprises in non-electrified communities own generator sets.52 In Nigeria, the cost of generating power constitutes about 36% of industrial production costs.<sup>53</sup> Yet there are generally lower levels of awareness and utilization of renewable energy technologies among Delta State commercial ventures and industries compared to households, with one survey of ventures in Warri Metropolis estimating awareness levels ranging from 20% to 52%.54

#### **Creating an Indigenous Value Chain**

Distribution of renewable energy products to the Niger Delta can add 30-50% to costs. Attracting and developing distribution networks within Delta State would be more economical for

<sup>54</sup> Oyerinde, Oyeleke O. (2021). Renewable Energy Penetration in Warri Metropolis. European Journal of Environment and Earth Sciences, 2(2): 19-23, p. 21.

 <sup>&</sup>lt;sup>46</sup> SMEDAN and NBS (2013). SMEDAN and National Bureau of Statistics Collaborative Survey: Selected Findings (2013). Abuja:
 SMEDAN and NBS, p. 21. <sup>47</sup> Ibid., p. 24. <sup>48</sup> All On, Nigeria, p. 8. <sup>49</sup> Ibid., p. 6.

<sup>&</sup>lt;sup>50</sup> Akpan, Uduak S., Essien, Maurice A. and Isihak, Salisu R. (2013). Impact of Rural Electrification on Rural Micro-enterprises in Niger Delta, Nigeria. Energy for Sustainable Development,17: 504-509, p. 507.

<sup>&</sup>lt;sup>51</sup> All On, *Nigeria*, p. 19. <sup>52</sup> Akpan, Essien and Isihak, Impact of Rural Electrification, p. 19.

<sup>&</sup>lt;sup>53</sup> Ologundu MM (2014). The epileptic nature of electricity supply and its consequences on industrial and economic performance in Nigeria. Global Journal of Researches in Engineering: J General Engineering. 2014; 14(4) ISSN: 2249-4596.

companies and beneficial to Delta State residents than distributing from beyond the Niger Delta. In addition, due to the lack of in-country manufacturing, employment opportunities in the SHS sector are mostly tied to the sale and service of SHS units.

Nonetheless, this represents an opportunity to develop a home-grown renewable energy sector within Delta State through the promotion of renewable energy entrepreneurship among Delta State residents and the promotion of national and foreign investments in renewable energy distribution and production within the State. In other words, there is potential for renewable energy technologies to not only improve energy access at more efficient costs for MSMEs, but also to enable participation of Deltans across the production and distribution value chain of these technologies.

#### Education

In Delta State, there are an estimated 1,024 public primary schools, 866 private primary schools, 801 public secondary schools, at least 403 private secondary schools, 5 technical colleges and 11 public and private universities.<sup>55</sup> Four of the universities are owned by Delta State, five are privately-owned, and two are federal universities. As at the 2015/2016 session, there were at least 697,184 students enrolled in these basic, secondary and tertiary educational institutions.<sup>56</sup> UNESCO estimates that an estimated 65% of public primary schools in Nigeria lacked access to electricity and 38% lacked access to potable water by 2010.<sup>57</sup> Thus public schools generally face the constraint of inadequate and inconsistent power supply from the national grid, pushing institutions which can afford it to resort to the use of generator sets. These institutions are in need of greater access to clean energy to provide lighting, power for laboratories, computer rooms and other educational facilities, and boreholes. There is therefore a key role to be played by offgrid renewable energy technologies, especially mini-grid systems or stand alone solar systems for particular facilities.

While there has been a federal 1.35MW Solar Hybrid Power Project at one of the two federal universities (Federal University of Petroleum Resources, Effurun), the State Government will need to launch solar projects in the four State universities, as well as the over 2,000 public primary and secondary schools. Universities typically require greater energy supply since they need to power faculty and service areas, residential areas and commercial areas.

#### Health

The Federal Ministry of Health's database shows that there are 550 public and 271 private accredited health facilities in Delta State.<sup>58</sup> This averages 1 hospital for 7,000 people, with 61% of these health facilities located in urban areas. The Delta State Contributory Health Commission maps out health centers according to the availability of basic amenities (including constant power supply and availability of potable water).<sup>59</sup> The LGAs with the least scores include Patani, Ndokwa East, Aniocha South, Ughelli North and Warri South-West. Moreover, only a few LGAs host health facilities characterized by high levels of availability of basic amenities such as electricity.

<sup>&</sup>lt;sup>55</sup> Federal Ministry of Education (2021). "Nigeria Digest of Education Statistics".

<sup>&</sup>lt;sup>56</sup> *Ibid*; the number of students in universities excludes colleges of education and include only 22,000 in Delta State University and 7,478 from Delta University.

 <sup>&</sup>lt;sup>57</sup> UNESCO (2012). School and Teaching Resources in Sub-Saharan Africa. UIS Information Bulletin No. 9. Paris: UNESCO, p. 8 - 9.
 <sup>58</sup> Federal Ministry of Health (2021). "Hospitals and Clinics", Nigeria Health Facility Registry (HFR).
 <sup>59</sup> DSCHC (n.d.). Baseline Assessment for Implementation of the Delta State Contributory Health Scheme. Asaba: Delta State Contributory Health Commission.



Figure: LGA by Basic Amenities in Delta State

In a 2013 survey of 52 health establishments across Delta State, 61% of health facilities in urban areas and 100% in rural areas reported lacking adequate electricity.<sup>60</sup> These facilities are typically supposed to have power for 24 hours a day, but get power from the grid for only a few hours a day, with diesel-powered generator sets providing additional supply for a few more hours. The result is a low level of energy consumption that does not meet demand for medical services. In Nigeria, medical facilities typically consume 66.936 kWh/day (rural centers), 343.23 kWh/day (urban centers), 454.872 kWh/day (specialist hospitals), and 1944.394 kWh/day (teaching hospitals).<sup>61</sup> A switch from diesel-powered generator power to solar PV technologies can induce cost savings of up to 53%.<sup>62</sup>

In addition to the electrification of health centers, renewable energy technologies may reduce the health risks associated with the use of conventional energy sources, thereby preventively improving health outcomes. An NBS 2012 survey reveals that about 34.2% of households (322,811 households) in Delta State use firewood for cooking,<sup>63</sup> and 43% of Delta State residents depend on depleting the tree stock in the forest in Delta State.<sup>64</sup> These not only contribute to deforestation, erosion and carbon emissions, but also to in-door pollution and health hazards (such as respiratory and visual challenges) especially among women and young girls. Clean cookstoves are useful for households in rural areas which depend on dirtier sources of cooking energy such as firewood.

 <sup>&</sup>lt;sup>60</sup> Efe, S.I. (2013). Health care problem and management in Nigeria. Journal of Geography and Regional Planning, 6(6): 244- 254.
 <sup>61</sup> Nwanya, N.C., Sam-Amobi, C., Ekechukwu, O.V. (2016). The Energy Performance of Hospital Buildings in Nigeria. International Journal of Technology, 1: 15-25.

 <sup>&</sup>lt;sup>62</sup> Emmanuel E. Ekanem, Akinwunmi O. Fajola, Rebecca Ogbimi and Julius I. Ogieva (2017). Use of Solar Energy for the Provision of Cost-Effective and Environmentally Friendly Power Supply in Health Facilities in the Developing World - Lessons from a Community Cottage Hospital in Southern Nigeria. *International Journal of Research Science & Management*.
 <sup>63</sup> Eleri, Adeola I. (2021). Expanding Demand for Clean-Cooking in Nigeria. Abuja: ICEED, p. 9.

#### ICT and Security

Delta State follows behind Lagos and Abia as the state with the third highest number of criminal cases reported (5.3%) of national cases reported, despite having 2.1% of Nigeria's population.<sup>65</sup> Most of these were offences against persons (especially assault, grevious harm wounding and murder) and property (especially theft, fraud, and store breaking).<sup>66</sup> There are also problems with cultism and recent problems with farmerherder conflicts.

Generally, the federal police force and other security agencies face gross underfunding and are therefore ill-equipped to effectively discharge their duties. Stable power supply is needed to optimize the performance of security-related technologies (such as streetlights, CCTV surveillance cameras and security lighting) and institutions (police stations and the five correctional centres in the state). In the efforts of the Nigerian Police Force (NPF) to rehabilitate police stations in the state, the State Government will collaborate to provide renewable energy technologies rather than diesel-powered generator sets.

#### Transportation

Renewable energy can play a role in the transportation sector through the powering of traffic lights and vehicles. Traffic lights, which are needed to reduce traffic congestion and road accidents, require electricity to be powered. Solar traffic lights have therefore been recognized as a key way of improving the sustainability and performance of traffic lights when power from the main grid is inconsistent.<sup>67</sup>

With respect to vehicles, although there is no estimate for the number of vehicles in Delta State, using the NBS national estimate of 6 people per vehicle by 2018,<sup>68</sup> the number of vehicles in the State could be up to 326,499. There are also a large number of tricycles. These not only contribute to greenhouse gas emissions, but may be more expensive to maintain and fuel than electric vehicles.

The Nigerian electric vehicle (EV) industry is very small and only nascent. Both the country's first EV charging station and its first locally assembled electric car were commissioned in 2021. There is no national policy on EVs yet, although one is in



Solar powered traffic light (Photo Credit - Afrik21. Africa)

<sup>&</sup>lt;sup>64</sup> Okoh, Biophysical and Socio-Economic Assessment, p. 22.

<sup>&</sup>lt;sup>65</sup> NBS (2017). Crime Statistics: Reported Offences by Type and State. Abuja: NBS, p. 1. <sup>66</sup> Ibid., p. 32-33.

<sup>&</sup>lt;sup>67</sup> Zyl, Nicolette P. (23 March 2020). "Pilot project: Solar-powered traffic lights tested in Lagos, Nigeria", ESI Africa.

<sup>&</sup>lt;sup>68</sup> Adesoji, Bamidele S. (11 March 2019). "Number of roads on Nigerian roads hit 11.8m in a year", Nairametrics.

the process of being developed. Activity in the industry is largely driven by individual private actors and corporate consumers. However, it has great potential, economic optimality, climatefriendliness, and greater suitability for local manufacturing due to a substantially lower number of component parts. Several states, such as Lagos, Ebonyi and Enugu Various state governments, including Lagos, Ebonyi and Enugu have sought to encourage local EV production or integration.

Since the industry is very young, there is limited action that can be taken in the short- to mediumterm. At the same time, precisely because it is very young but nonetheless growing, Delta State could seek to be an emerging center of EV distribution, production and human capital in Nigeria. Over the next five years the Delta State Government will encourage EV research in Delta State tertiary institutions, provide incentives for the assembly of electric tricycles for commercial purposes in Delta State, and promote EV business model experimentation within the state in order to make it a leader in the national EV sector.

#### Enabling Conditions

To build a renewable energy industry in Delta State requires a careful combination of market analysis, specific education of consumers, capital support to a fledgling industry, improved vendor visibility, and the use of regulation to build confidence in the market.

In this renewable energy policy roadmap, Delta State Government will avoid a centralized decision-making approach and adopt a centrally coordinated, but demand-driven approach – a market-oriented approach. This involves a single state- and sector-wide roadmap that identifies the least-cost electrification solution for every unserved or underserved community in Delta State. The owner and implementer of this plan would be the state Ministry of Power and Energy, with the strong involvement of the Climate Change Department of the Ministry. The Delta State Government recognizes that the effective management of climate risks in the country depends on enabling legal, institutional and political environments as well as the participation of all stakeholders. The policy encourages the development of frameworks in the following areas:

- I. Legal framework
- II. Institutional/Governance framework
- III. Education, public awareness, participation and access to information
- IV. Finance, finance mobilization and investment
- V. Technology development and transfer
- VI. Research, innovation and development
- VII. Capacity building, training and institutional strengthening
- VIII. International cooperation
- IX. Monitoring and Evaluation
- X. Gender mainstreaming

These components of an enabling environment will be pursued in an integrated manner to avoid duplication among relevant agencies.

#### Legal Framework

Within the context of climate change governance in Nigeria, government recognises that a functional legal framework to guide national response to climate change will among other things:

- Clarify roles and responsibilities of different layers of governance (state and local government/communities);
- II. Enhance cooperation for problem solving among different sectors – government, private sector, research institutions and CSOs;

- III. Promote the existence of rules, regulations and laws on renewable energy that are needed for compliance and enforcement of measures adopted in the state renewable energy policies, plans and strategies;
- IV. Discourage policy reversal and inconsistency in approach to a sustainable energy transition;
- V. Facilitate the establishment of an authority instrument on the State House of Assembly to appropriate sufficient resources for renewable energy actions;

- VI. Promote coordination of renewable energy goals with other relevant development agendas of the state;
- VII. Continue to mainstream renewable energy and climate change into state development and budget plans and strategies.

The legal framework will encapsulate national and state constitutional and legal provisions whilst also providing for effective implementation and enforcement procedures.



Number of vehicles in Nigerian roads (Photo Credit - Nairametrics)

# MEASURE FOR PROMOTING RENEWABLE ENERGY ADOPTION

To build a renewable energy industry in Delta State requires a careful combination of market analysis, specific education of consumers, capital support to a fledgling industry, improved vendor visibility, and the use of regulation to build confidence in the market.

In this renewable energy policy and strategy, Delta State Government will avoid a centralized decision-making approach and adopt a centrally coordinated, but demand-driven approach – a market-oriented approach. This involves a single state and sector wide roadmap that identifies the least-cost electrification solution for every unserved or underserved community in Delta State. The owner and implementation of this plan would be the state Ministry of Power and Energy, with the strong involvement of the Climate Change Department of the Ministry.

Although it is beyond the power of State Governments to provide trade policy and corporate tax incentives such as import duty waivers and corporate tax holidays, they are able to provide others. This includes subsidies, credit guarantees, corporate tax incentives. complementary infrastructure provision, public procurement, procurement guarantees (buy of last resort), land grants, and capability-building and skills development through public educational, research and training institutions.

General Measures Taken	Institutions Involved
<ul> <li>Mandate the use of renewable energy and energy efficiency technologies in all government institutions and owned buildings.</li> <li>Court partnerships on renewable energy projects with the Federal Government.</li> <li>Court partnerships, investments, grants and technical assistance from domestic and foreign actors and institutions for renewable energy projects and programmes.</li> <li>Provide support through the Ministry of Energy to solar companies in their requests for import duty exemption certificates from the relevant federal ministries when seeking to import components for Delta State public sector off-grid electrification projects.</li> <li>Promote and fund renewable energy research and development capacity in vocational colleges and universities in Delta State.</li> <li>Organize investment and energy summits and expos in the Niger Delta to attract investors, producers, and donors to Delta State's renewable energy market.</li> <li>Embed renewable energy into existing government skills acquisition programme (RYSA) and Girl-Child Empowerment Training Programme.</li> </ul>	<ul> <li>Ministry of Agriculture and Natural Resources</li> <li>Ministry of Energy</li> <li>Ministry of Environment</li> <li>Ministry of Science and Technology</li> <li>Ministry of Trade and Investment</li> <li>Delta State Micro, Small Medium Enterprise Development Agency</li> </ul>

#### Special measures for the promotion of mini-grids

In rural areas which may be remote from the national grid or do not enjoy adequate access to it, mini-grid solutions are often found to be more cost- effective than grid extension. In some particular cases where the level of demand and population density is relatively high, mini-grids may be the most technically and economically viable approach to providing rural electrification. In addition to addressing the immediate need for power, mini-grids can be an important step towards eventual inter-connection to the grid by building upload and willingness to pay for electricity service, thus improving the viability of grid extension to a given locality.

The Rural Electrification Agency's database lists

30 potential mini-grid sites in Delta State which can receive electricity for 87,000 people in mostly coastal communities across six local government areas who are not connected to the grid (Annex II, Table 10). These can sustain mini-grid energy consumption of 14 GWh.

Potential anchor clients include SMEs and Telecom mobile towers. It is estimated that 52% of mobile towers in Nigeria are situated in off-grid regions, and an additional 40% see power outages for more than 12 hours/day. Another proposed set of anchor clients is charging stations for electric two- and three-wheelers.

Measures Taken	Institutions Involved
<ul> <li>Providing support in identifying and mapping potential mini-grid sites across Delta State.</li> <li>Engaging with the Rural Electrification Agency and foreign donors, investors and technical partners in initiating mini-grid projects within Delta State.</li> <li>Procurement of mini-grid systems to electrify public schools and health centers.</li> <li>Engage potential anchor clients, such as telecom companies and electric vehicle producers to be involved in mini-grid project sites to increase commercial viability.</li> </ul>	<ul> <li>Ministry of Energy</li> <li>Ministry of Environment</li> <li>Ministry of Science and Technology</li> <li>Ministry of Trade and Investment</li> <li>Delta State Micro, Small Medium Enterprise Development Agency</li> </ul>

#### Specific measures for the promotion of stand alone solar systems

Particularly in localities with low levels of demand and dispersed populations, even mini-grids may not be feasible. In these cases, stand-alone systems may be suitable. Individual solar photovoltaic (PV) systems can provide sufficient electricity to satisfy the needs of households and small commercial enterprises (e.g., for lighting, radio, TV, fan). If they are offered at affordable terms (i.e., with significant subsidies and long payback periods for the remaining cost), stand-alone systems can provide critical services to the hardest-to-reach customers.

### Solar Home Systems (SHS)

With respect to areas not connected to the grid, the Rural Electrification Agency's database lists 78 potential SHS sites across 8 mostly coastal LGAs which are neither connected to the grid nor viable for mini-grid electrification in Delta State (Annex II, Table 11). These can provide energy access to 26,987 people who may be serviced by 5,397 SHS installations with a total capacity of 0.8 MWh. Beyond these, underserved areas also require SHS technologies to supplement the grid supply.



Measures Taken	Institutions Involved
<ul> <li>Encourage government ministries, departments and agencies to procure SHS for government-owned buildings and offices.</li> <li>Establishing micro-credit facilities for entrepreneurs, especially for women groups, for the establishment and operation of commercial SHS facilities in remote and off-grid areas through the Delta State Micro Small and Medium Enterprises Development Agency (DEMSMA).</li> <li>Embedding SHS installations in Delta State Security Trust Fund procurements.</li> <li>Developing extension programmes to facilitate the use of SHS.</li> </ul>	<ul> <li>Ministry of Energy</li> <li>Delta State Micro Small and Medium Enterprises Development Agency (DEMSMA)</li> <li>Ministry of Basic and Secondary Education</li> <li>Delta State Security Trust Fund</li> </ul>
<ul> <li>Organizing systematic public enlightenment campaigns on the benefits of using SHS.</li> <li>Promoting Research and Development in solar energy technology.</li> <li>Sourcing and providing adequate incentives to local entrepreneurs for the production of solar energy conversion systems.</li> <li>Developing skilled manpower and providing basic engineering infrastructure for the local production of components and spare parts for solar energy conversion systems in line with national targets.</li> </ul>	

### Solar Street & Traffic Light

Measures Taken	Institutions Involved
<ul> <li>Public procurement of solar street lights, traffic lights and installation services.</li> <li>Promote the use of LED lighting to improve energy efficiency of solar street lighting.</li> <li>Ensuring procured technologies possess good quality and appropriate battery boxes.</li> </ul>	<ul><li>Ministry of Energy</li><li>Ministry of Transportation</li></ul>

# Productive use solar systems Solar irrigation

Measures Taken	Institutions Involved
<ul> <li>Provision of soft loans to cooperatives for the purchase and maintenance of solar irrigation technologies through the Delta State Micro Small and Medium Enterprises Development Agency (DEMSMA).</li> <li>Developing extension, educational and outreach programmes to facilitate the use of solar irrigation technologies.</li> <li>Promoting research and development in solar irrigation technologies.</li> <li>Providing adequate incentives to local farmers especially in rural areas to adopt solar irrigation technologies.</li> </ul>	<ul> <li>Ministry of Agriculture and Natural Resources</li> <li>Ministry of Energy</li> <li>Ministry of Environment</li> <li>Ministry of Science and Technology</li> <li>Ministry of Trade and Investment</li> <li>Delta State Micro, Small Medium Enterprise Development Agency</li> </ul>

## Cold storage and Solar Dryers

Measures Taken	Institutions Involved
<ul> <li>Developing extension, educational and outreach programmes to facilitate the use of cold storage and solar drying technologies in agriculture and fisheries.</li> <li>Promoting research and development in cold storage and solar drying technologies.</li> <li>Providing adequate incentives to local farmers especially in rural areas to adopt cold storage and solar drying technologies.</li> </ul>	<ul> <li>Ministry of Agriculture and Natural Resources</li> <li>Ministry of Energy</li> <li>Ministry of Environment</li> <li>Ministry of Science and Technology</li> <li>Ministry of Trade and Investment</li> <li>Delta State Micro, Small Medium Enterprise Development Agency</li> </ul>

# Specific measures for the promotion of efficient cookstoves

Measures Taken	Institutions Involved		
<ul> <li>Developing extension, educational and outreach programmes to facilitate the use of clean cookstoves in rural and low income areas.</li> <li>Promoting research and development in clean cookstoves.</li> <li>Providing adequate incentives to local farmers especially in rural areas to adopt cold storage and solar drying technologies.</li> </ul>	<ul> <li>Ministry of Agriculture and Natural Resources</li> <li>Delta State Rural Development Agency</li> <li>Ministry of Energy</li> <li>Ministry of Environment</li> <li>Ministry of Science and Technology</li> <li>Ministry of Trade and Investment</li> <li>Delta State Micro, Small Medium Enterprise Development Agency</li> </ul>		

# Support schemes to promote the sustainable of energy from biomass

Measures Taken	Institutions Involved		
<ul> <li>Developing extension, educational and outreach programmes to facilitate the use of new biomass electricity technologies.</li> <li>Promoting research and development in biomass technology and fuels.</li> <li>Establishing pilot projects for the production of biomass energy conversion devices and systems.</li> <li>Cultivating fast growing tree species needed to accelerate the regeneration of forests.</li> </ul>	<ul> <li>Ministry of Agriculture and Natural Resources</li> <li>Ministry of Energy</li> <li>Ministry of Environment</li> <li>Ministry of Science and Technology</li> <li>Ministry of Trade and Investment</li> <li>Delta State Micro, Small Medium Enterprise Development Agency</li> </ul>		
<ul> <li>Developing and training skilled manpower for the maintenance of biomass energy conversion systems, and providing basic engineering infrastructure for the local production of components and spare parts for biomass systems.</li> <li>Providing adequate incentives to local entrepreneurs for the production of biomass energy conversion systems.</li> <li>Developing appropriate technologies for the utilization of alternative energy sources from fuel-wood through the use of improved cookstoves.</li> <li>Promoting non-wood fuel biomass especially in rural areas and its usage for remote and off-grid power generation.</li> </ul>			

# Specific measures for the promotion of electric two and three wheeled vehicles

Measures Taken	Institutions Involved
<ul> <li>Developing educational and outreach programmes to facilitate the use of EVs in mass transportation.</li> <li>Promoting research and development in EV technology and charging stations within Delta State's vocational colleges and universities.</li> <li>Establishing pilot projects for the creation of a charging station at Delta State University.</li> <li>Providing adequate incentives to local entrepreneurs for the production of EVs.</li> <li>Promoting EV charging station investments to mini-grid companies to increase their anchor load.</li> </ul>	<ul> <li>Ministry of Transportation</li> <li>Ministry of Energy</li> <li>Ministry of Environment</li> <li>Ministry of Science and Technology</li> <li>Ministry of Trade and Investment</li> <li>Delta State Micro, Small Medium Enterprise Development Agency</li> </ul>

# **IMPLEMENTATION**

The State Ministry of Energy is to be the lead agency to implement the policy roadmap. Implementation is to occur according to the Policy Implementation Plan developed to lay out the means of implementing the policy roadmap. Inter-Ministerial Coordination is also necessary for the full implementation of the policy roadmap. Key relevant ministries and agencies to be involved in implementing parts of the policy roadmap include the Ministry of Environment, Ministry of Economic Planning, Ministry of Science and Technology, Rural Development Agency, Ministry of Trade and Industry, Ministry of Transport, Ministry of Technical Education, Delta State Micro, Small and Medium Enterprise Development Agency, and any other institution deemed relevant to policy implementation.

Generally, a range of stakeholders have to be involved in various ways in order for project design and implementation to be successful. Besides the relevant Delta State ministries, these include domestic and foreign private investors, the Federal Ministry of Power, the National Electricity Regulatory Commission (NERC), the federal Rural Electrification Agency (REA), foreign donors, civil society organizations (CSOs), Community Based Organizations (CBOs), research centers and universities.

### Sources of funding and financing for renewable energy projects

The financing of renewable energy projects is seen by both practitioners and commentators as the single largest barrier to the expansion of improved uptake of renewable energy. State government budgets are limited, and the diversity of renewable energy systems and projects demand a diversity in financing and budgeting mechanisms. Therefore various internal and external sources of finance will be adopted.

Funding Source	Type of Funding		
Internal	- State Government Budget		
	- State Government loans and grants with		
	support of PPP		
	- Domestic private sector investment		
	- Community saving groups		
External	- International sources such as bilateral and		
	multilateral donors (World Bank, Green		
	Climate Fund, Climate Investment Funds,		
	African Development Bank, Global		
	Environment Facility, German Ministry of		
	Cooperation and Development, Canadian		
	Government and European Development		
	Fund, and ECOW-GEN Facility)		
	- Concessional finance and funds		
	-Co-financing through public-private		
	partnerships		
	- Foreign direct investment		

The Delta State Ministry of Power will collaborate with the Climate Change Department of the State Ministry of the Environment to put forward approved renewable energy actions for budget allocation by the Ministry of Finance. This funding must subsequently be approved by the Delta State House of Assembly.

#### Gender Mainstreaming

Energy access, energy needs and energy poverty affects men and women differently. Moreover, programmes and projects to provide renewable energy access must actively incorporate gender mainstreaming or else they simply reproduce preexisting gender disparities. For instance, femaleheaded businesses, on average, have a reduced ability to invest in productivity enhancing energy assets. Therefore providing loans without actively being gender sensitive may produce an overwhelming male majority in loan applications.

Although the National Renewable Energy and Energy Efficiency Policy (NREEEP) does not include a clear gender mainstreaming guideline, projects under the Delta State Renewable Energy Policy Roadmap should aim to conform to the National Action Plan of the ECOWAS Programme on Gender Mainstreaming in Energy Access (ECOW-GEN).

#### Intergovernmental coordination

In complementing and supplementing the national renewable energy policies, the Delta State Government needs to engage with federal ministries and agencies such as the Federal Ministry of Power, the Rural Electrification Agency (REA), the Nigerian Electricity Regulatory Commission (NERC), the Renewable Energy Division of the Nigerian National Petroleum Corporation (NNPC), the Standards Organization of Nigeria (SON), the National Automotive Design and Development Council (NADDC) and others.

However, there is no standard guideline in Nigeria for intergovernmental coordination for renewable energy policy implementation. Such a framework will be embedded within the action plan to complement this policy roadmap. Guidelines for intergovernmental coordination are necessary for the implementation of renewable energy policies in the following areas:

#### Standards

The Standards Organisation of Nigeria (SON) adopted the IEC quality standards as the mandatory national standards in June 2020 for imported and domestically produced solar photovoltaic (PV) panels, batteries, inverters, charge controllers and energy meters. Collaboration with the Standards Organization of Nigeria (SON) is essential to enable high quality of renewable energy products produced in or brought into Delta State.

#### Import Duty Waivers

Import duty waivers may be requested from the Federal Ministry of Finance through the Federal Ministry of Power, although usually for government or donor-funded projects rather than for off-grid commercial purposes.<sup>69</sup> Such requests typically require detailed information on the renewable energy project and its benefit to the country to warrant a waiver. The Delta State Ministry of Energy would need to provide support to solar companies on government or donor-funded projects in their requests for import duty exemption certificates from the relevant federal ministries when seeking to import components for Delta State public sector off-grid electrification projects.

#### Monitoring and evaluating impact

To ensure the viability of state governmentinitiated renewable energy programmes and projects, there needs to be sustained government and effective commitment management and governance. The Ministry of Power, which will be the lead agency in implementing this implementation plan, will adopt best practices in conducting periodic monitoring and evaluation for renewable energy projects. The implementing agency must embed practices to avoid poor technical system design and installation; inappropriate procurement of poorly integrated installation cheap and components; little or no training given to the end users in the community; and lack of maintenance. The Ministry of Energy will develop Key

performance indicators (KPI) – a summary of the indicators that will be used to track the

performance of the action following implementation.

# **CONCLUSION**

With the adoption of a policy roadmap for renewable energy, Delta State Government would be one of the very few states to launch an energy policy roadmap focused on off-grid renewable energy technologies. This document highlights the state's energy needs, with a focus on six key sectors (agriculture, MSMEs, education, health, ICT and security, and transportation). It is expected that this mediumterm plan will form the basis of stimulating, experimenting in, exploring and learning about Delta State's renewable energy market and satisfying its residents' energy needs.

# ANNEX I - Acronyms used in the action plan

DISCOs	Distribution Companies
ECOWAS	Economic Commission of West Africa
EPSRA	Electricity Power Sector Reform Act
GDP	Gross Domestic Product
GENCOs	Generation Companies
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit GmbH (German Agency for international Cooperation)
GW	Giga Watt
GWh	GigaWatt Hour
ІСТ	Information and Communications Technology
KWh	KiloWatt Hour
MW	Mega Watt
MWh	MegaWatt Hour
NERC	Nigerian Electricity Regulatory Commission
NREAP	National Renewable Energy Action Plan
RE	Renewable Energy
SHS	Solar Home System

# ANNEX II - Non-Electrified Potential Mini Grid and SHS Sites Table: Non-Electrified Potential MiniGrid Sites (Source: REA)

LGA	Ward Population		Capacity (kWh)	
Aniocha South	ABA - UNOR	2215.549	369996.7	
Burutu	OPOROMOR III 5280.229		881798.3	
Burutu	OPOROMOR V	2708.435	452308.7	
Burutu	OPOROMOR V	1893.465	316208.6	
Burutu	OPOROMOR V	3913.811	653606.5	
Burutu	EDUWINI I	1629.941	272200.2	
Burutu	EDUWINI I	1068.734	178478.6	
Burutu	EDUWINI I	16426.3	2743191	
Burutu	UGHOTON	1366.418	228191.8	
Burutu	EDUWINI I 1488.419		248566.1	
Burutu	EDUWINI I	1385.938	231451.7	
Ndokwa East	OKPAI/UTCHI/BENEK U	1073.614	179293.5	
Warri North	UGBO V1	1400.578	233896.6	
Warri North	OFUNAMA	5792.636	967370.2	
Warri North	Warri North UGBO V1 1366.418		228191.8	
Warri North	UGBO V1 4177-335		697614.9	
Warri North	UGBO V1	1156.575	193148	
Warri North	rri North UGBO V1 3445.325		575369.3	

### Table: Non-Electrified Potential Mini-Grid Sites (Source: REA)

Warri North	UGBO V1	1727.543	288499.6	
Warri North	UGBO V1	1371.298	229006.8	
Warri North	UGBO V1	5758.475	961665.4	
Warri North	UGBO V1	1220.016	203742.7	
Warri North	UGBO V1	5431.511	907062.4	
Warri South West	UGHOTON	1612.2	269237.4	
Warri South West	UGHOTON	1230.516	205496.2	
Warri South West	UGHOTON	1337.138	223302	
Warri South West	UGHOTON	1085.726	181316.2	
Warri South West	UGBO V1	2005.706	334952.9	
Warri South West	UGBO V1	1981.306	330878.1	
Warri South West	UGBO V1	4719.022	788076.6	
TOTAL		87,270.17	14,574,119	

# Table: Non-electrified Potential SHS Sites (Source: REA)

LGA	Ward	Population	No. of SHS	Capacity (kWh)
Aniocha North	EZI	56.58216	11.31643	1.697465
Aniocha North	EZI	341.6045	68.32089	10.24813
Aniocha North	UKWU - NZU	702.7292	140.5458	21.08188
Aniocha South	ABA - UNOR	649.0485	129.8097	19.47145
Aniocha South	ABA - UNOR	678.3289	135.6658	20.34987
Aniocha South	UBULU - UNOR	59.68258	11.93652	1.790477
Burutu	ALADJA	732.0096	146.4019	21.96029
Burutu	EDUWINI I	488.0064	97.60128	14.64019

# Table: Non-electrified Potential SHS Sites (Source: REA)

Burutu	EDUWINI I	178.2641	35.65282	5.347923
Burutu	EDUWINI I	296.5496	59.30992	8.896487
Burutu	EDUWINI I	284.5033	56.90066	8.535099
Burutu	EDUWINI I	282.6542	56.53083	8.479625
Burutu	OPOROMOR V	40.37383	8.074766	1.211215
Burutu	OPOROMOR V	780.8102	156.162	23.42431
Burutu	OPOROMOR V	649.0485	129.8097	19.47145
Burutu	OPOROMOR V	138.5865	27.71731	4.157596
Burutu	OPOROMOR V	208.4995	41.69991	6.254986
Isoko North	IBREDE/IGBUKU / ONOGBOKOR	741.7697	148.3539	22.25309
Ndokwa East	OGWU-IKPELE	90.83511	18.16702	2.725053
Ndokwa East	OGWU-IKPELE	72.64768	14.52954	2.179431
Ndokwa East	OKPAI/UTCHI/BENEK U	668.5688	133.7138	20.05706
Ndokwa East	OKPAI/UTCHI/BENEK U	561.2073	112.2415	16.83622
Ndokwa East	OKPAI/UTCHI/BENEK U	649.0485	129.8097	19.47145
Ndokwa East	OKPAI/UTCHI/BENEK U	483.1263	96.62526	14.49379
Ndokwa East	OKPAI/UTCHI/BENEK U	63.47343	12.69469	1.904203
Ndokwa East	OKPAI/UTCHI/BENEK U	458.726	91.7452	13.76178
Patani	EBEDEBIRI	26.33263	5.266526	0.789979
Warri North	OFUNAMA	52.88172	10.57634	1.586452
Warri North	OFUNAMA	634.4083	126.8817	19.03225
Warri North	OFUNAMA	268.073	53.6146	8.04219
Warri North	OFUNAMA	23.41716	4.683433	0.702515
Warri North	OLOGBO	400.1652	80.03305	12.00496
Warri North	OLOGBO	161.0421	32.20842	4.831263

# Table: Non-electrified Potential SHS Sites (Source: REA)

Warri North	UGBO V1	561.2073	112.2415	16.83622
Warri North	UGBO V1	814.9707	162.9941	24.44912
Warri North	UGBO V1	390.9013	78.18026	11.72704
Warri North	UGBO V1	281.9513	56.39026	8.45854
Warri North	UGBO V1	358.0123	71.60246	10.74037
Warri North	UGBO V1	53.39311	10.67862	1.601793
Warri North	UGBO V1	180.4021	36.08043	5.412064
Warri North	UGBO V1	39.59917	7.919833	1.187975
Warri North	UGBO V1	4.548966	0.909793	0.136469
Warri North	UGBO V1	605.1279	121.0256	18.15384
Warri North	UGBO V1	97.22669	19.44534	2.916801
Warri North	UGBO V1	326.9643	65.39286	9.808928
Warri North	UGBO V1	204.7884	40.95768	6.143652
Warri North	UGBO V1	125.4823	25.09646	3.764469
Warri North	UGBO V1	214.6836	42.93673	6.440509
Warri North	UGBO V1	800.3305	160.0661	24.00991
Warri North	UGBO V1	614.888	122.9776	18.44664
Warri South	UGHOTON	631.5076	126.3015	18.94523
Warri South	UGHOTON	668.2031	133.6406	20.04609
Warri South West	MEREJE I	717.3694	143.4739	21.52108
Warri South West	MEREJE I	293.6144	58.72289	8.808433
Warri South West	MEREJE I	376.0975	75.21949	11.28292
Warri South West	SAPELE URBAN VII	241.4436	48.28872	7.243309
Warri South West	SAPELE URBAN VII	68.00961	13.60192	2.040288
Warri South West	SAPELE URBAN VII	72.66184	14.53237	2.179855
Warri South West	SAPELE URBAN VII	868.3733	173.6747	26.0512
Warri South West	SAPELE URBAN VII	349.2962	69.85923	10.47888
Warri South West	UGBO V1	61.37412	12.27482	1.841223

# Table: Non-electrified Potential SHS Sites (Source: REA)

Warri South West	UGHOTON	475.5651	95.11302	14.26695
Warri South West	UGHOTON	134.9989	26.99978	4.049967
Warri South West	UGHOTON	292.8038	58.56077	8.784115
Warri South West	UGHOTON	78.46207	15.69241	2.353862
Warri South West	UGHOTON	81.82364	16.36473	2.454709
Warri South West	UGHOTON	57.73242	11.54648	1.731973
Warri South West	UGHOTON	246.3445	49.2689	7.390335
Warri South West	UGHOTON	269.9094	53.98189	8.097283
Warri South West	UGHOTON	441.6548	88.33096	13.24964
Warri South West	UGHOTON	579.1283	115.8257	17.37385
Warri South West	UGHOTON	700.9665	140.1933	21.029
Warri South West	UGHOTON	107.354	21.47079	3.220619
Warri South West	UGHOTON	325.6686	65.13373	9.770059
Warri South West	UGHOTON	395.2852	79.05703	11.85856
Warri South West	UGHOTON	742.0388	148.4078	22.26116
Warri South West	UGHOTON	112.1161	22.42322	3.363483
TOTAL		26987.29	5397.457	809.6186

