National Bioenergy Action Plans (NBAPs)

GHANA

Period [2020-2030]

Within the implementation of the

ECOWAS Bioenergy Policy (EBEP)

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TOWARDS SUSTAINABLE ENERGY

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An initiative of the Clean Energy Ministerial

Within the framework of

SUSTAINABLE ENERGY FOR ALL

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ABBREVIATIONS AND ACRONYMS

CC	Climate Change
DDO	Distillate Diesel Oil
EBEP	ECOWAS Bioenergy Policy
ECOWAS	Economic Community of West African States
ECOW-GEN	ECOWAS Programme on Gender Mainstreaming in Energy Access
ECREEE	ECOWAS Centre for Renewable Energy and Energy Efficiency
EE	Energy Efficiency
EEEP	ECOWAS Energy Efficiency Policy
EREP	ECOWAS Renewable Energy Policy
ETBE	Ethyl-tertio-butyl-ether
FIT	Feed-in-Tariff
GDP	Gross Domestic Product
GWh	Gigawatt-hour
ha	hectare
ICS	Improved Cookstoves
ktoe	kilotonne of oil equivalent
kV	kilo Volt
kVA	kilo Volt Amperes
kW	kilo Watt
LPG	Liquefied Petroleum Gas
MFP	Multi-Functional Platform
MTBE	Methyl—tertio-butyl-ether
MW	Mega Watt
MWh	Mega Watt hour
NBEAP	National Bioenergy Action Plan
NEEAP	National Energy Efficiency Action Plan
NGOs	Non-Governmental Organizations
NREAP	National Renewable Energy Action Plan
PPO	Pure Plant Oil
PV	Photovoltaic
RE	Renewable Energy
SE4All	Sustainable Energy for All
SSHP	Small Scale Hydro Power
SVO	Straight Vegetable Oil

TGC	Tradable Green Certificates
TPES	Total Primary Energy Supply
UNIDO	United Nations Industrial Development Organization
VAT	Value Added Tax
VRA	Volta River Authority
WACCA	West African Clean Cooking Alliance
WAGP	West Africa Gas Pipeline
WAPP	West African Power Pool

1 INTRODUCTION

The ECOWAS Bioenergy Policy (EBEP) was adopted by the ECOWAS Minister of Energy in December 2016 and the ECOWAS Heads of States on 4 June 2017. In an effort to approach the challenges of providing sustainable and efficient Bioenergy services without compromising food security, it is necessary to develop appropriate and adequate policy instruments for Bioenergy at both regional and national levels. ECREEE, together with its partners, therefore elaborated and validated a Regional Bioenergy Strategy in Bamako Mali on the 22 March 2012. The Bioenergy Strategy document was adopted by the ECOWAS Ministers of Energy in Accra, Ghana on the 31 October 2012. One of the principal components of the Strategy Framework is the development of a regional Bioenergy policy. The ECOWAS Bioenergy Policy was developed with the financial support of UNDP and involved a multi-sectoral approach with active participation of all the major stakeholders of Energy, Agriculture, Forestry and the Environment. The ECOWAS Bioenergy Policy (EBEP) was finally adopted by the Authority of the ECOWAS Heads of State and Government in Monrovia in June 2017.

This policy seeks to promote a modern, sustainable and vibrant bioenergy sector in the region by creating an enabling environment that can unlock the potential by removing the institutional, legal, financial, social, environmental and capacity gaps and barriers. It is aimed at addressing the needs and constraints of the governments, the private sector and the local communities in using existing biomass resources including household, agricultural, fish/sea food, and industrial processing wastes and residues.

The policy document was prepared with technical support of the ECOWAS Centre for Renewable Energy and Energy Efficiency (ECREEE) and a broad range of international partners (UNDP, Austria, and Spain). The policy includes minimum targets and scenarios for bioenergy and measures, standards and incentives to be implemented at both regional and national levels.

The following targets are proposed for the modern bioenergy sector:

Table 1: ECOWAS Bioenergy Policy Targets

Main Bioenergy target by 2020 / 2030	**baseline: 2012**	**2020**	**2030**
Share of efficient charcoal production	17%	60 %	100 %
Share of population using alternative modern fuels for cooking	27%	36 %	41 %
Biodiesel and bioethanol as share of fossil fuels consumption	<1%	5%	10%
Bioelectricity	+/- 100 MW	634 MW	2008 MW
Fuelwood saved from 2012[1]	NA	700 million tons	3 billion tons

Table 2: ECOWAS Bioenergy Policy Targets (With LPG and ICS as Alternative to reduce Traditional Wood energy consumption)

Main Bioenergy target by 2020 / 2030 (for LPG & ICS)	**baseline: 2012**	**2020**	**2030**
Share of population using improved cook stoves[2]	29%	60%	100%
Share of efficient charcoal production	17%	60 %	100 %
LPG penetration household level[3]	8%	20 %	26 %

[1] Saving 700 million of fuels wood correspond to roughly 18 billion USD based on current price of wood in Burkina Faso
[2] Improved cook stoves refer here to wood and charcoal burning stoves
[3] LPG is taken here in the table because of its capacity to replace traditional biomass use

Bioenergy Policy targets by 2020:

1) Universal access to clean, safe and affordable cooking energy, including 26% of LPG users. Such a scenario represents:
   a. over 10 million of additional household users of LPG as primary fuel in comparison with the 2012 situation,
   b. about 15 million additional households using ICS as main cooking device and/or sustainable biomass fuel as primary fuel,
   c. 700 million tons of wood saved between 2012 and 2020 e.g. 18 billion USD

2) 26% of electricity from Renewable Energy source (2,425 MW) in the region; of which 634 MW is generated from biomass residues or dedicated plantations with the deployment of sustainable and efficient technologies and application including:
   a. Biomass heat and power: systematic approach to sugar processing companies and other large-scale producer of biomass to valorise their waste stream to electricity.
   b. Waste-to-energy: connecting with cities/municipalities, agro-industries, slaughterhouses, and waste water treatment plant to convert waste into electricity, biogas, pellets/briquettes, etc.
   c. Electricity from wood plantation in countries such as Liberia, Guinea and Sierra Leone
   d. Biogas production, gasification of agricultural residues for energy (electricity, heating and cooking) in association with NGOs and local communities, including women in the rural areas.

Bioenergy Policy target by 2030:

1) Universal access to clean, safe and affordable cooking energy, including 50% of LPG usage/penetration by 2030 and 100% of improved cookstoves (ICS) and/or sustainable biomass fuels users. Such a scenario represents almost 3 billion tons of wood saved between 2012 and 2030. The graph below represents the expected situation by 2020 and 2030 with regards to improved solid biomass fuels, the dissemination of improved stoves and the sustainable production of biomass.
2) Electricity from biomass will account for 5% of the total installed capacity in the region, which corresponds respectively to 686 MW by 2020 (28% of RE capacity) and 2008 MW (13% of RE Capacity) by 2030.

For domestic applications, transportation and financing:

- Ensure universal access to improved cook-stoves to 100% by 2020;
- Increase the share of the population served with modern fuel alternatives for cooking to 36% by 2020 and 41% by 2030;
- Increase the penetration of LPG for cooking to 20% by 2020 and 26% by 2030;
- Increase the share of efficient charcoal production to 60% by 2020 and 100% by 2030;
- Introduce blending ratios for Ethanol/bio-diesel in transport fuels of 5% by 2020 and 10% by 2030;
- Conduct research on the use of ethanol and other fuels as domestic cooking fuels;
- Reduce fuelwood consumption, as a result of the Policy implementation, by 700 million tons by 2020 and 3 billion tons by 2030;
- Create instruments for financing sustainable energy, including carbon finance in the longer term, establish a regional fund for the development and implementation of sustainable energy projects.

For minimizing health risks, gender imbalance and improve socio-economic wellbeing

- Reduce health risks associated with smoke inhalation and long distances travelled by women and children by introducing very efficient burners for cooking and heating that consumes less woodfuels and reduce travel time;
- improve livelihoods through involving small-scale farmers as direct producers or out-growers enabling them to generate new income, opening up employment opportunities, and thereby alleviating poverty and boosting rural incomes;
- Use of agricultural residues can lead to more investments and modernization of the agricultural sector by increasing mechanization, but taking measures to minimize the impact on biodiversity, land use, soils, and water resources.

For enhancing Agricultural productivity

- reduce the poor practices of “slash and burn” as a way to clear land, as such practices negatively impact on biodiversity (insects, plants, etc) and contribute to soil erosion;

- The use of slurry (residue of biogas production) and nutritive ash (residue of controlled combustion processes or biochar) can greatly improve the soil and increase agriculture yields.

For enhancing the Environment:

- Stimulating farmers to collect and/or use agricultural waste, rather than burning it as an additional source of income and/or increase energy access and reduce dependence on the natural forest;
- Use of agro-industrial waste coupled with use of efficient devices and systems will help save 700 million tons of wood by 2020 and 3 billion tons by 2030.

This document presents two major components, Part A which is the baseline situation of the Ghana Bioenergy sector and Part B which covers the Bioenergy Action Plan of Ghana aligned to the Regional Bioenergy Targets and Trajectories. The contents have been structured into nine chapters including Introduction, Socioeconomic situation of Ghana, Energy sector overview, Bioenergy Situation in Ghana, Institutional Arrangements, legal and Regulatory framework, Bioenergy targets and Trajectory and measures and actions to achieve targets in the Bioenergy Action Plan of Ghana.

2. SOCIO-ECONOMIC SITUATION

Spanning a land mass of 238,535 km2 (92,099 sq mi), Ghana is bordered by the Ivory Coast in the west, Burkina Faso in the north, Togo in the east and the Gulf of Guinea and Atlantic Ocean in the south. Ghana's population of approximately 30 million spans a variety of ethnic, linguistic and religious groups. Ghana population is equivalent to 0.39% of the total world population. The population density in Ghana is 132 per Km2 (343 people per mi2). 54.8 % of the population is urban (16,507,512 people in 2019). The median age in Ghana is 20.5 years. Ghana's population is projected at about 37 million by 2030 of which around 23 million representing about 61% of the population would be living in urban areas. With a population growth rate of 2.2%.

Ghana has a market-based economy with relatively few policy barriers to trade and investment in comparison with other countries in the region, and Ghana is endowed with natural resources. Ghana's economy was strengthened by a quarter century of relatively sound management, a competitive business environment, and sustained reductions in poverty levels, but in recent years has suffered the consequences of loose fiscal policy, high budget and current account deficits, and a depreciating currency.

The main sectors within the economy are agriculture (cocoa, rice, cassava (manioc, tapioca), peanuts, corn, shea nuts, bananas; timber, etc.), industry (mining, lumbering, light manufacturing, aluminium smelting, food processing, cement, small commercial ship building, petroleum, construction, etc.) and services (finance, telecommunication, transportation, utilities, etc.).

Ghana's economy is largely service driven. By the end of 2019, the agriculture, industry and services contributed 17.31%, 31.99% and 44.14% to GDP respectively. Agriculture being the least contributor to GDP, it is the most labour-intensive sector by occupation representing 44.7% followed by service 40.9% and industry 14.4%. Table 3 presents the socio-economic situation of Ghana.

Table 3: Socio-economic situation

	Population			*GDP*	*GDP per capita*	Population growth rate
	Total	*urban*	*Rural*			
2020	31, 072,945	57.3%	42.7%			
2019	30,417,856	56.7%	43.3%	72,350M$	1940$	2.19
2018	29,463643	54.4%	45.6%	65,557M.$	2,202$	2.22
2017	28,833629	53.9%	46.1%	58,978M.$	2,025$	2.25
2016	28,2006728	53.4%	46.6%	54,989M.$	1,931$	2.24
2015	27,582821	52.9%	47.1%	48,595M.$	1,745$	2.27

3 PRIMARY ENERGY SUPPLY AND CONSUMPTION

3.1 Country brief

Ghana is a lower middle-income country with a strong market-based economy. It has relatively few barriers to trade and investment compared to other countries in the region. Real GDP growth was 8.5% in 2017, 6.3% in 2018 and, 6.5% in 2019.[4] Poverty has steadily declined in Ghana, but still afflicts more than one-third of the country's rural inhabitants. While the country is transitioning to a services-oriented economy, about half of the labor force remains in the agricultural sector. Ghana is undertaking proactive measures to increase productivity through a phased approach to industrialization, as defined in the country's 10-point industrialization agenda. See Table 1 for key indicators about the country.

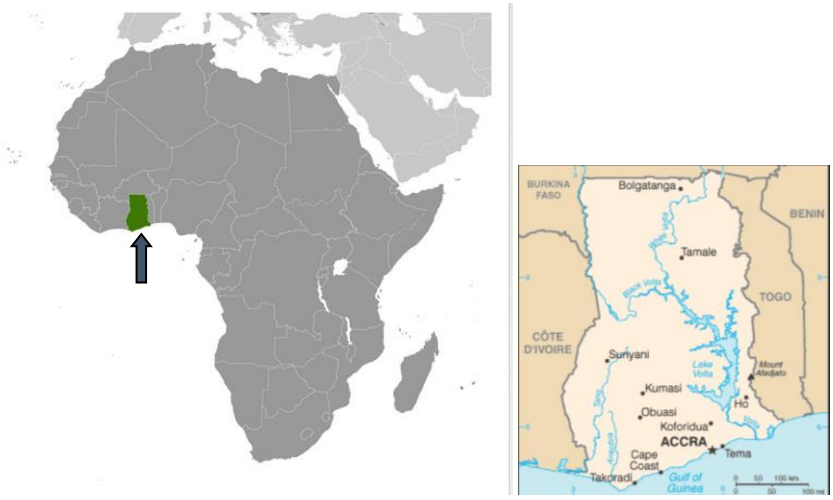


Figure 1Map of Africa Showing Ghanaat the tip of the arrow.

(source: https://www.cia.gov/library/publications/the-world-factbook/attachments/maps/GH-map.gif)

Key indicators about Ghana

Indicator	**2019**	**2020**
Population	30, 417,858	31, 072,945
Urban Population	17,249,055	17,820,023
GDP (US$)	68.34 billion	68.53 billion
Real GDP growth	6.5%	0.41%
GNI per capita, PPP (current international $)	2,226	184.34
Currency	Ghanaian Cedis (GH₵).	
Official language	English	
Natural resources	Gold, Cocoa, Oil, Natural gas, Bauxite, Diamonds, and Manganese.	

[4] "Ghana Economic Outlook," African Development Bank, (2019); Bloomberg (2019)

World Bank data on Ghana (2019 and 2020).

3.2 Energy sector overview

Ghana's energy sector is heavily dependent on biomass and oil, which account for close to 90% of the country's primary energy supply. While remaining the dominant fuel since 2016, oil and biomass have contributed 51% and 37% to the country's Total Primary Energy Supply (TPES) respectively. Woodfuels account for more than 60 percent of total energy used in Ghana. It is the traditional energy source of Ghana. The bulk of the country's primary energy supply comes from firewood and charcoal i.e. biomass with the exception of Accra, the national capital where LPG and charcoal dominate (Figure 2a). The proportion of the population using LPG as the primary source for cooking has been increasing since 2010. In 2010, 18.2% of the national population were using LPG with 28.9% urban and 4.8% rural population using LPG as compared to 2021 estimates of 25.3% National population using LPG, with 34.1% Urban and 12.8% Rural population using LPG.

From the 2021 population and housing census in Ghana, charcoal as the main cooking fuel declined from 73.9 percent in 2010 to 54.4 percent in 2021, but more than six in every ten households, still use wood or charcoal in 11 regions as depicted in Figure 2b. Charcoal use, in the short to medium term, is expected to continue to be a principal household energy source, particularly, in urban areas of the country given the projected growth of the urban population in Ghana and also due to number of factors from relatively easy accessibility to lower price as compared to LPG.

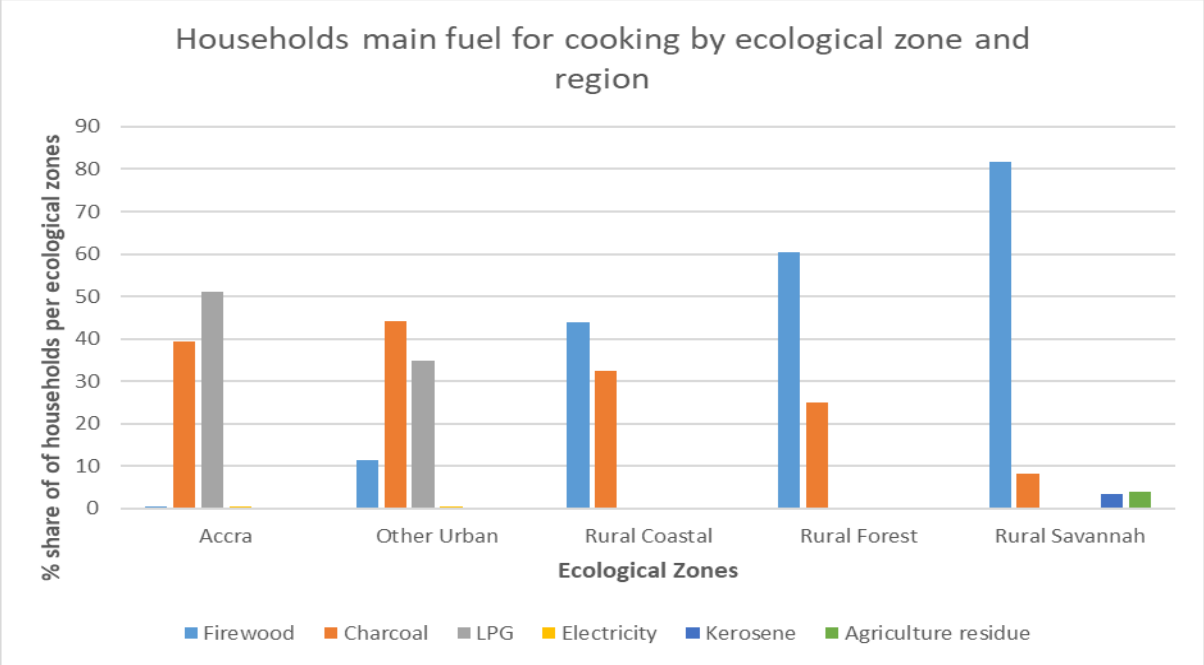


Figure 2 Percentage share of domestic energy usage in Ghana

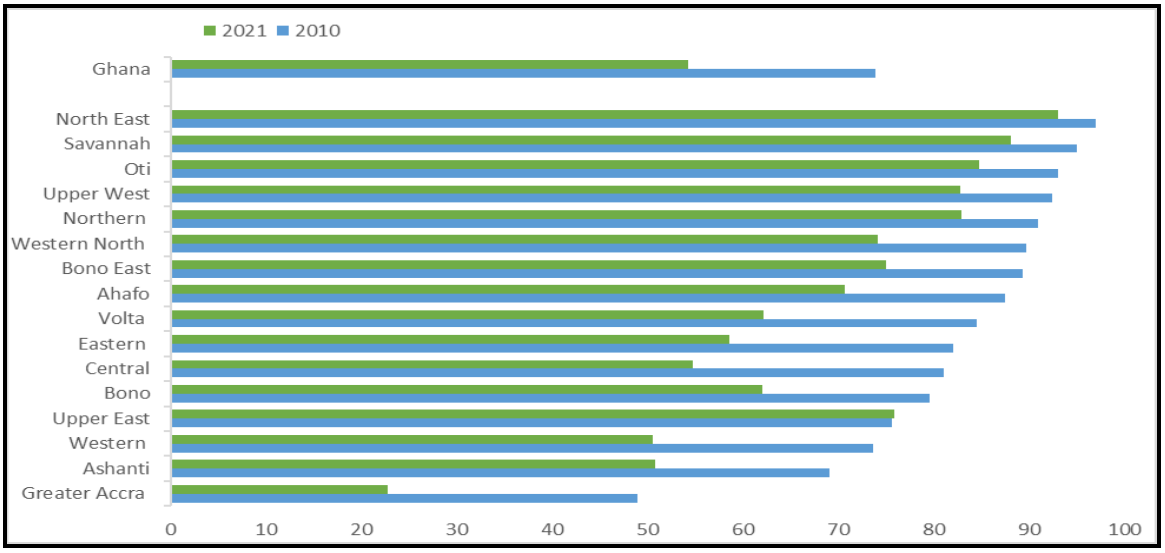


Figure 2b Charcoal as the main cooking fuel by Regions in Ghana (GSS 2021)

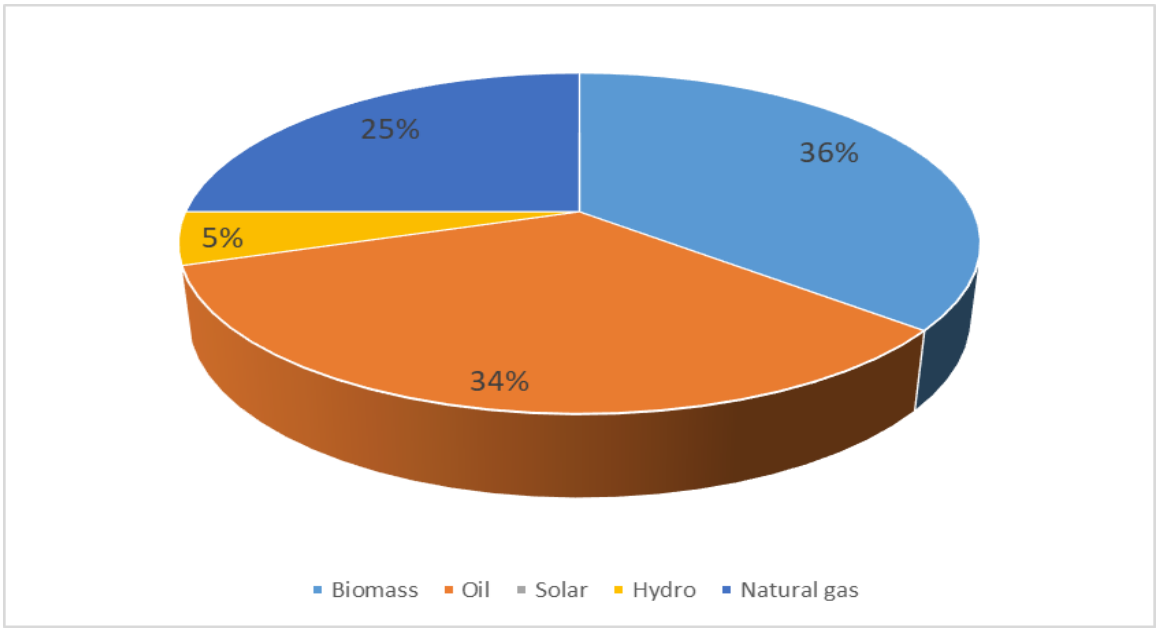


Figure 3 Total Primay Energy Supply by Fuel

Regarding electricity, the national electrification access rate is estimated at 86.3% (GSS 2021) as indicated in figure 3b and generation sources are mainly hydro and thermal. In recent times, modern renewable energy resources including solar, biomass, wind and waste-to-energy are making noticeable appearances in the energy mix. The policy goal is to achieve at least 10% renewable energy in the electricity generation mix. However, the 2021 Energy Outlook projections by the Energy Commission presented estimates of 32.9%, 66.4% and 0.7% hydro, thermal and renewable (including solar, PV and Biogas) respectively. Currently, the total contribution of modern renewable energy to the national electricity generation mix is very minimal (Figure 4).

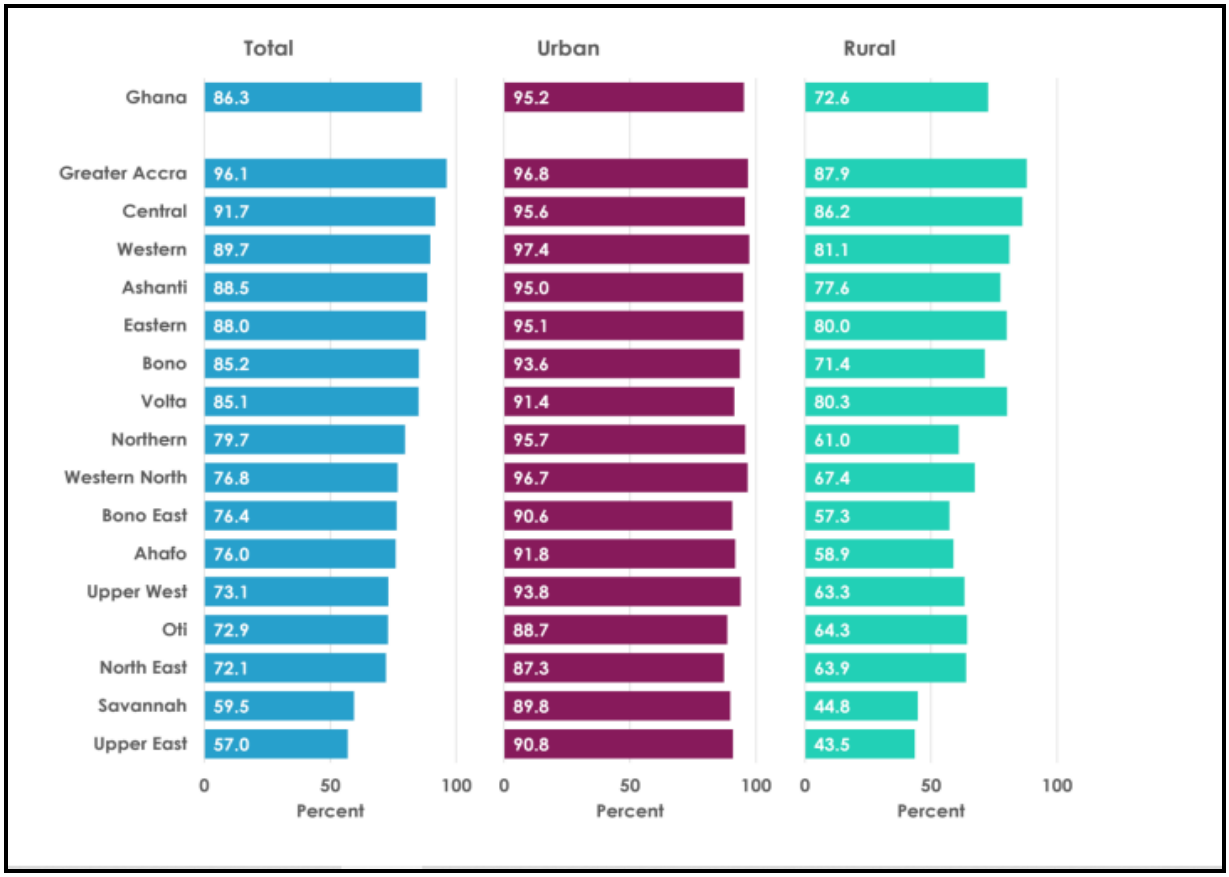


Figure 3b Use of Electricity as main source of Lighting by Region and Type of Locality (GSS 2021)

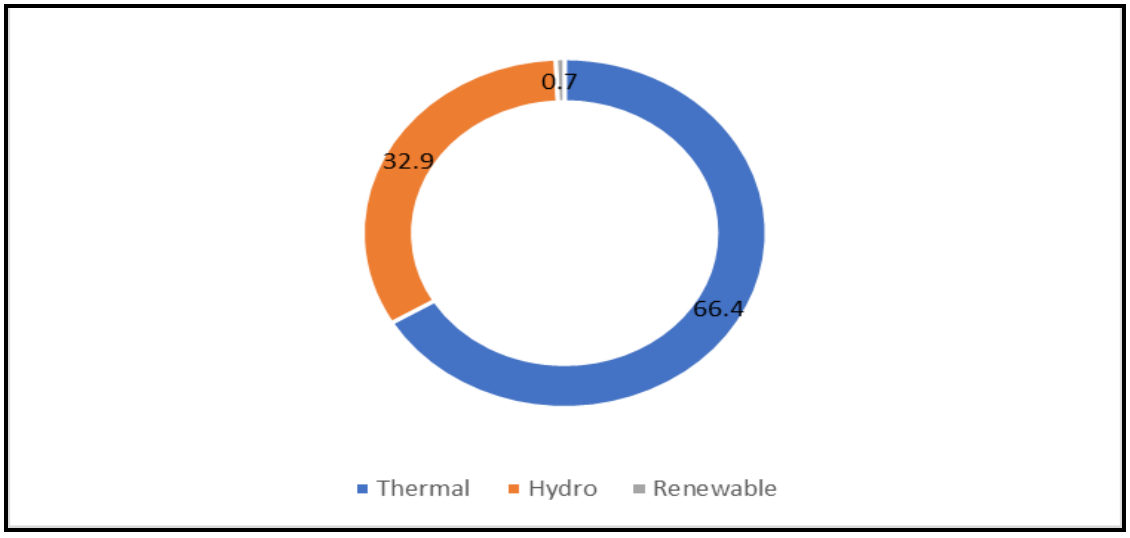


Figure 4 Sources of Electricty Generation in 2021

At the end of 2020, the dependable installed generation capacity was about 4710 MW an increase of 3.1 percent over 2019. Electricity demand growth has been about 10 percent per annum. Expansion planning studies estimate that through 2026, electricity demand will need to increase nearly three-fold to 28,000 GWh compared to 2010 consumption.

Overview of Energy Supply and Demand In Ghana

Table 4 : Total primary energy supply

Year	Total Primary Energy Supply (ktoe)
2020	12,038
2019	11,094
2018	10,791
2017	9,614
2016	9,520
2015	9,550

Total Primary Energy Supply (TPES) is composed of production + imports –export +/-stock changes.

Table 5: Energy Consumption by Sector in ktoe

2020 (or most recent year)	Oil Products	Électricity	Firewood & Charcoal (Biomass)	Coal	Others	Total
Transport sector	3292	1	NA	NA	NA	3293
Industrial sector	413	473	279			1165
Tertiary sector (commercial and service)	23	279	131	NA	NA	433
Agriculture and Fisheries	152	1	NA	NA	NA	153
Residential sector	242	668	2567			3477
Other sectors			0.00			0
Non-energy use	15	NA	NA	NA	NA	15
Total	4137	1422	2977	0	0	8536

***NA = Not Available. Oil Products include all petroleum products, including LPG

According to the Ministry of Energy, around 80% of communities with more than 500 people are qualified to have access to grid electricity. This was to be achieved mostly through grid extension in the framework of the Self-Help Electrification Project (SHEP) and the National Electrification Scheme (NES). See Box 1 for more information. The remaining communities that are currently without access to electricity are mainly rural communities living on islands in Lake Volta and in isolated lakeside locations. These communities will be best served with distributed energy solutions such as mini-grids and standalone solar systems.

Box1: Self-Help Electrification Project (SHEP) and the National Electrification Scheme (NES).

In line with the National Energy Policy's objective of achieving universal access by 2020 the Government of Ghana is operating two electrification programs:

- **National Electrification Scheme (NES)**—the Government's principal initiative to extend the reach of reliable electricity supply to all parts of the country over a 30-year period from 1990 to 2020. The NES manages funds raised through the National Electrification levy to fund electrification projects
- **Self-Help Electrification Project (SHEP)**—complementary electrification programs to support the NES. Under the SHEP, communities that are within 20 km from an existing medium voltage line can qualify for electrification if they procure all the power poles and have a minimum of 30 percent of the houses within the community wired. Once these conditions are met, the Government provides the conductors, pole-top arrangements, transformers and other installation requirements needed to provide supply to the community.

3.3 Analyses of the energy situation showing the energy balance of the country

Total Primary Energy Supply and Demand (Consumed) in Ghana have been increasing since 2010 (Table 6). The energy sector has initiated several projects including National Electrification Scheme, a Self - Electrification Program, A National Off-grid Rural Electrification Program and a Renewable Energy Development Program (REDP). The REDP aimed to assess the available renewable energy resources, examine the technical feasibility and cost-effectiveness of promising renewable energy technologies, ensure the efficient production and use of Ghana's renewable energy resources, and develop an information base that facilitates the establishment of a planning framework for the rational development and use of the Ghana's renewable energy resources.

Energy Supply sources in Ghana include petroleum (oil and gas) woodfuels/biomass and power. Statistics published by Energy Commission of Ghana in 2020 showed total primary energy supply exceeding total primary demand (consumed). The National LPG penetration rate increased from 6% in 2000 to 18% in 2010 and of 25.3% in 2021. The Energy ministry was targeting 50% penetration by 2020 but this was achieved. Figure 5 presents an overview of the Energy Situation in Ghana, showing the primary energy supply, total final energy consumed and the biomass consumed from 2010 to 2020 while figure 6a shows the energy consumption by sector in 2020. Total Primary Energy Supply estimated in 2020 was 12,038Ktoe. Percentage distribution of Energy by sector in 2020 were as follows: Residential (41%), Transport (38%), Industrial (14%), Commercial & Service (5%) and Agriculture and Fisheries (2%) as indicated in Figure 6b.

Table 6: Energy situation in Ghana showing the energy balance (2010 – 2020)

Energy Indicator	Unit	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Total Primary Energy Supply	KTOE	6,946	7,609	8,362	8,564	9,147	9,550	9,660	9,150	10,791	11,094	12,038
Total Final Energy Consumed	KTOE	5,629	6,174	6,613	6,887	6,983	7,162	7,086	7,209	7,792	8,051	8,591

Total Electricity Generated	GWh	10,167	11,200	12,024	12,870	12,963	11,492	13,022	14,067	16,246	18,188	20,170
Total Electricity Consumed	GWh	8,317	9,187	9,258	10,583	10,695	9,685	11,418	13,036	14,401	15,232	16,531
Total Petroleum Products Consumed	KTOE	2,491	2,827	3,318	3,422	3,377	3,545	3,320	3,162	3,593	3,849	4,255
Total Biomass Consumed	KTOE	2,464	2,576	2,589	2,676	2,792	2,785	2,783	2,925	2,961	2,892	2,977
Total Biomass Consumed/capita	TOE/capita	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.1	0.1	0.1	0.1

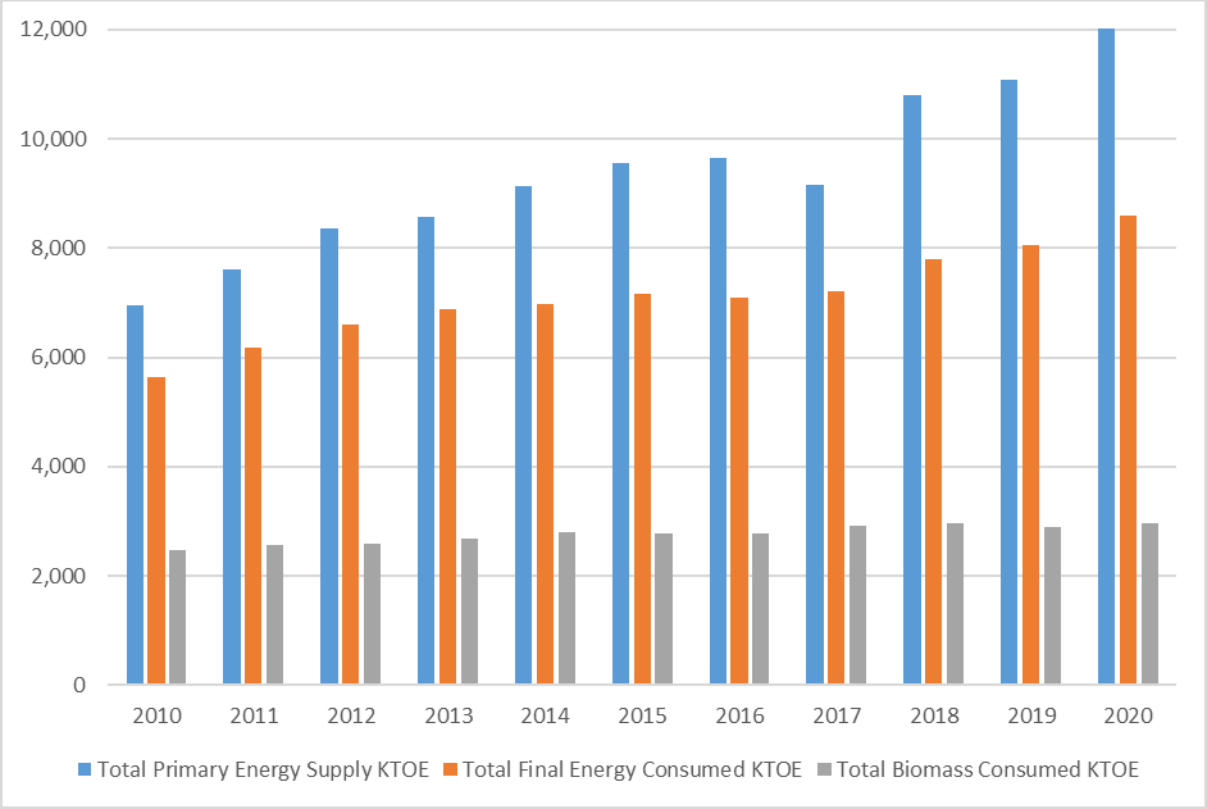
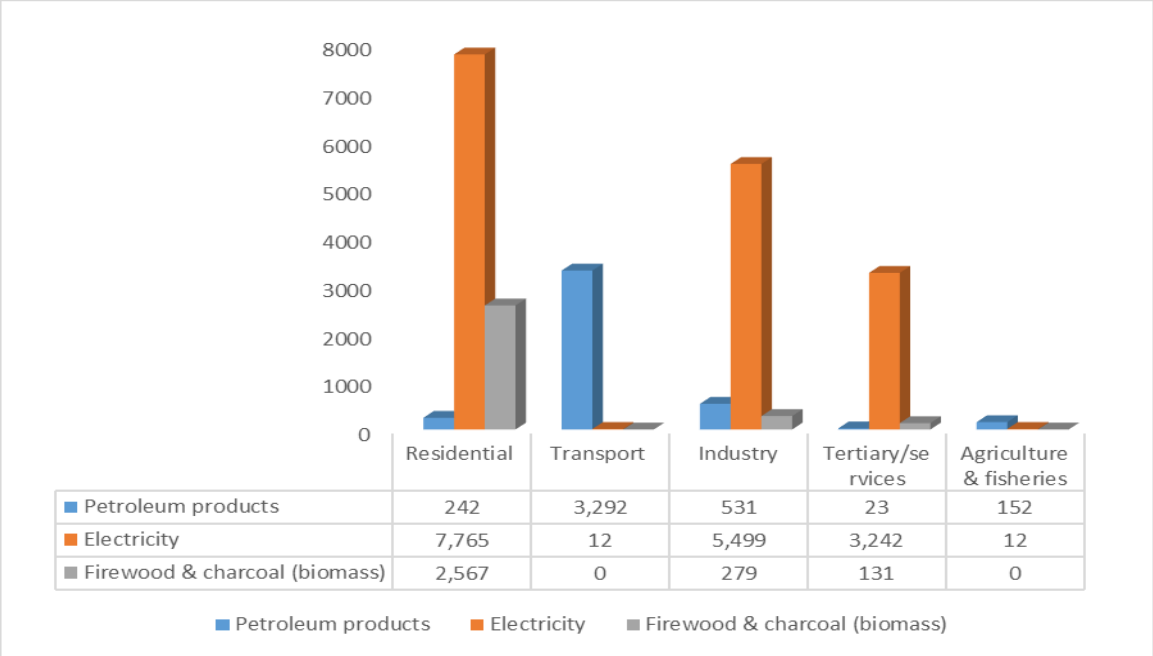


Figure 5 Energy Situation in Ghana, 2020 (Ktoe)



	Residential	Transport	Industry	Tertiary/services	Agriculture & fisheries
Petroleum products	242	3,292	531	23	152
Electricity	7,765	12	5,499	3,242	12
Firewood & charcoal (biomass)	2,567	0	279	131	0

Figure 6 Energy Cosumption by Sector (Ktoe), 2020

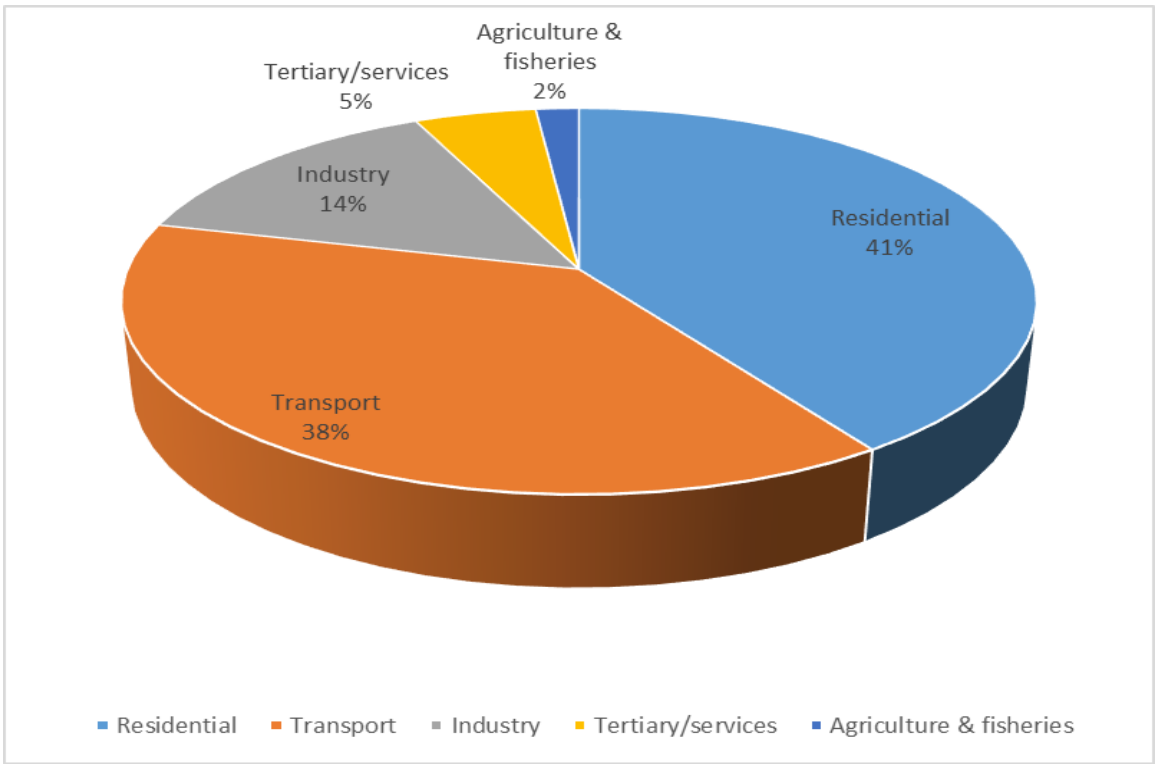


Figure 6b Percentatge Distribution of Energy Consumption by Sector in 2020

3.4 Institutional framework

The Ministry of Energy is responsible for energy policy formulation, implementation, monitoring, and evaluation and in charge of the management of energy resources as well as the implementation of the national electrification schemes in Ghana. The Minister of Energy is the key technical advisor to Government on energy matters. The ministry has a directorate responsible for Renewable Energy. The Energy Commission was set up by an Act of Parliament (Energy Commission Act, 1997 (Act 541)) to perform regulatory function in the energy sector. The Commission is the technical regulator of Ghana's electricity, natural gas and renewable energy industries.

Over the years, the energy sector in Ghana has been undergoing transformation to allow for active participation of the private sector in the management, and utilization of energy resources in Ghana. For example, reforms in the Power generation gradually removed barriers for the participation of independent power producers, an area which hitherto was restricted to the public sector players. Both petroleum and electricity markets have been restructured to allow for private sector participation. In line with the Renewable Energy Act, 2011 (Act 832), the Ministry of Energy is implementing The Renewable Energy Master Plan through a Coordinating Unit (REMP-CU). Chapter 4 has a section on private sector players. An overview of the roles of the public entities with jurisdiction over the energy y sector has been presented below.

Institution / Company	Role in the Energy Sector
Ministry of Energy (MoEn)	Ministry responsible for energy policy formulation, implementation, monitoring and evaluation and in charge of the implementation of the National Electrification Scheme (NES).
Energy Commission (EC)	The Energy Commission is the technical regulator of Ghana's electricity, natural gas and renewable energy industries, and the advisor to Government on energy matters.
Public Utility Regulatory Commission (PURC)	Government-funded independent regulatory body established to approve tariff rates for electricity customers and to enforce performance standards for energy sector operators
Ghana Standard Authority	Develops standards for energy equipment and passes them on to the regulatory agencies for enforcement
National Petroleum Authority	Regulator of petroleum sector.
Ghana National Petroleum Corporation	National Oil Company responsible for oil exploration and production activities.
Volta River Authority (VRA)	Utility responsible for electricity generation across Ghana. Under the public sector-led business model for mini-grids, VRA shall be responsible for managing and operating the generation and distribution assets and customer services of all Government of Ghana funded island-based mini-grids on the Volta Lake and Volta Rivers.
Bui Power Authority (BPA)	State electricity generation company managing and operating hydro and variable renewable power portfolios.
Electricity Company of Ghana Limited (ECG)	Owner of electricity distribution assets for the southern sector. Operation and management responsibilities concessionalized to Power Distribution Service (A Philippine company)
Ghana Grid Company (GridCo)	Public transmission company responsible for undertaking dispatch and transmission of electricity to all power market participants and managing the Wholesale Power Market

Northern Electricity Distribution Company (NEDCo)	Subsidiary of VRA responsible for electricity distribution in northern parts of Ghana. Under the public sector-led business model for mini-grids, NEDCo shall be responsible for managing and operating both generation and distribution assets and customer services of all GoG funded mainland mini-grids, including lakeside mini-grids within its operational areas.

4 SUMMARY OF THE CURRENT BIOENERGY SITUATION

4.1 Institutional arrangement

An overview of Institutions and brief descriptions' of their roles and responsibilities in the bioenergy sector in Ghana have been presented in this section. These institutions include those in the public sector, academia and research (4.1.1), private sector players (4.1.2) and NGO/Civil Society and other association(4.1.3) playing critical roles in the bioenergy sector including clean cooking, institutional framework including Institutions dealing with Bioenergy Programs and Projects and the interaction between these different institutions.

4.1.1 Public institutions and research centres

Public Sector Institutions	Brief Description of Roles and Responsibilities
Ministry of Energy (MoEn)	The goal of Government through the MoEn regarding bioenergy is enunciated in the energy sector policy is to modernise and maximise the benefits of bioenergy on a sustainable basis. The MoEn through the Renewable Energy directorate has been championing the activities to ensure that the policy strategies and targets are met.
SEforALL Secretariat	Coordinate interventions and Programmes aimed at providing universal access to efficient energy use including Clean Cooking Solutions
Ministry of Environment, Science, Technology and Innovation (MESTI)	Developing and executing policies and strategies and support the distribution of clean energy technologies (For example improved charcoal making technologies) Develop and implement policies on environmental pollution and sustainability • Communicates to UNFCCC on national actions for meeting GHG reduction targets
Environmental Protection Agency (EPA)	Regulatory and compliance as well as support to establish standards and operational procedures for woodfuel operators Facilitate environmental protection awareness programmes in bioenergy subsector
Energy Commission	The Energy Commission regulates and manage the development and utilization of energy resources in Ghana as well as provide the legal, regulatory and supervisory framework for all providers of energy in the country, specifically by granting licenses for the transmission, wholesale, supply, distribution and sale of electricity and natural gas and related matters. Formulated National Bioenergy Policy, the Revised Energy Policy, and Strategic National Energy Program, the Woodfuel Regulations, Charcoal Production and export requirements.
Public Utilities Regulator Commission (**PURC)**	Prepare guidelines on tariff approval process; set and approve feed-in-tariffs (including power from biogas)

Forestry commission	Woodfuels regulations, development and implementation of programmes to sustain woodfuel production and consumption
Forest Service Division (FSD)	Could support to Identify, survey, map, assess and register the potential woodfuel resource stock outside the forest reserves. Enforce regulations on the control of fringe communities in the harvesting and sale of the woodfuel in the forest reserve
Ministry of Food and Agriculture (MoFA) Agricultural Extension Units of MoFA	MoFA will play a role in the create awareness on the need for sustainable supply, production and utilisation of woodfuel. Also critical role in the production of Biomass (Waste to Energy) Establishment of Forest Plantations
Energy Foundation	PPP arrangement to promote energy efficient and Renewable energy technologies
CSIR Institute of Industrial Research	One of the 13 institute under the Council for Industrial Research (CSIR), Institute of Industrial Research has developed two types of biogas plants; the floating metal dome digester and a fixed brick dome digester. CSIR-IRR is also involved in research into improved household energy cookstoves. The twin or single hybrid energy saving stove is an improvement over existing traditional stoves with emphasis on the mode of air flow to facilitate combustion and enhance efficiency.
Ghana Standards Authority	Develop standards for renewable energy technologies and biofuel. Testing, Certification and Regulatory Services
Environmental Protection Agency	Regulatory and compliance
KNUST Technology Consultancy Centre	Research into development, testing and transfer of improved technologies including improved cookstoves to support small and medium scale industries in Ghana. Key role in Bioenergy sector will be Construction and testing of Institutional and household cookstoves.
Ashesi University (GCIC)	Support entrepreneurs to develop and commercialise innovative clean technologies including biodigesters
National Development Planning Commission	Development of Planning Guidelines within the context of a coordinated national socio-economic growth and development agenda
Bulk Oil Storage and Transportation Company (BOST)	Biofuel transportation and storage
Motor Traffic Unit of the Ghana Police Service	Check on conveyance permit to dealers and transporters of commercial woodfuel.

4.1.2 Private sector (individuals included here)

Name	Address	Location	Telephone	Contact	Fax	Email	Website	Field of RE	Date of Contact - RE Dir
BIOCE FUEL FARM GHANA LTD	BOX PMB, ACCRA-NORTH	Accra	+233 277174049	Theophilus Aboakye	N/A	bioceff@yahoo.co.uk	N/A	Biofuel	N/A
BIOGAS ENGINEERING LTD.	P.O. BOX GP 170 KNUST	Plt P Blk3 Ahinsan Residental	+233 208138451 +233 244365596 +233 322060242 +233 243205762	Dr. E. B. Aklaku Samuel Aklaku	N/A	edaklaku@yahoo.com, aklaku@yahoo.com	N/A	Biomass	N/A
END-I OSAM ENERGY AND ENVIRONMENTAL CONSULTING LTD	P.O.BOX CT 3041 Cantoment	19 B Liberation between Royal Granda Hotel and West Sun Hotel	+233 276998416 +233 302775344	Mary Sarkode Urike Daniel Mr. Pasch Nana Richmond Aggrey	+233 302774880	u.daniel@end-i.ag, osamenergy@gmail.com,	www.end-i.ag	Biogas & Biomass	N/A
GREENFUEL BIODIESEL GH LTD	P.O. BOX PMB 198, Accra-North	North Industrial Area	+233 243265450	Oioio Daniel Nashief	N/A	dawig_energie@yahoo.fr Danielnashief@hotmail.com	N/A	Biofuel	N/A
Kumasi Institute of Technology Energy and Environment (KITE)	72 Olusegun Obasanjo Highway, Dzorwulu P. O. BOX AT 720, ACHIMOTA, ACCRA, GHANA	72 Olusegun Obasanjo Highway, H/No 73	+233 302256800-1 +233 302256800 +233 302256801 +233 244340734-6	Ishmael Edjekumhene (Director)	+233 302256800	info@kiteonline.net	www.kiteonline.net	Biofuel and Solar	N/A
NEHLSEN GHANA LTD.	P.O.Box AS 628 Ashiaman-Tema	Plot No 1&2 Blk 1 comm. 22 Annex	+233 266452296 +233 307033585 +233 541425222	Elvis Owusu-Adansi(CEO) Alex Nartey	N/A	nehlsen.ghana@nehlsen.com	www.nehlsen.com	Biomass (Waste to Energy)	September 19,2011
OHENENANA BIODIESEL INDUSTRIES	C/O P.O.Box 1 Offinso Ashanti Region	Plot 90, Tutuase,Offinso Municipality.Ashanti Region	+233 269581411 +233 243351251	Francis Mensah Alice Mensah Alex Mensah	N/A	ohenenana_4@hotmail.com Ohenenanabiodiesel@yahoo.com	N/A	2.Biomass energy generation and distribution (off grid).	N/A
OSKAN INDUSTRIES LTD / ENERGY POOL LTD	P. O. BOX GP 14730, ACCRA, P.O.BOX GP 14378, KUMASI	Labone Junct. Karma Conference Premises	+233 277212121 +233 322040666	Erasmus Osafo Kuffour	+233 302507607 +233 322040665	info@eplghana.com	www.eplghana.com	5.Woodlot plantation for energy purposes.	N/A
PGBI ENGINEERS & CONTRACTORS LTD	P.O. BOX TS 73, Trade Fair,La	Accra	+233 244328517	Kojo Agyepong		k2agyepong@yahoo.com ,	www.pgbi.co.za	Biofuel and Solar	N/A

Name	Address	Location	Telephone	Contact	Fax	Email	Website	Field of RE	Date of Contact - RE Dir
	Accra					kwadwo08@gmail.com			
SD RENEWABLE ENERGY CONSULT (changed name to GBI -HANJER GHANA LTD)	Hse No.2, 1st K.Portuphy,Avenue, West Legon	HSE NO.2, IST K.Portuphy,Avenue, West Legon	+001(416)5730778 +233 243060044 +233 208166072 +233 260996362 +233 243060044	Kwesi Bissi Prosper Gladzah	+001(905)2659805	kpbissii@yahoo.com	www.dhanjer.com	Biomass energy, Biogas sector, Waste Management, consulting	N/A
SOLAR HARVEST LTD	Solar Harvest Ltd. PMB 183 KAPT Accra,Ghana	Bolgatanga Irrigation Site	+233 200313113 +233 200313133	Steiner Johnes	N/A	info@biofuel.no	www.biofuel.no	Biofuel	N/A
TRAGRIMACS	P. O. BOX AD 464, Adabraka, Accra	Lashibi, Com. 20, Tema	+233 208135861 +233 302251130 +233 543613112 +233 302251489	Issah Sulemana Martin Ofori	N/A	sulemana.issah@gmail.com	www.gragrimacs.com	Biofuel	N/A
TRANS-ATLANTIC ENVIRONMENTAL, INC.	9758 Horned Lark Way, Elk Grove,CA 95757	U.S.A	+916 2965906	Dr. Daniel Kwame Acquah	N/A	kwame@taenvironmental.com	www.taenviromental.com	Biomass	June 22,2011
TROPICAL ENERGY RESOURCE	P. O. BOX KIA 30432, Airport, Accra	East Legon, Accra	+233 244214228	Major Ibrahim Rida(Rtd)	N/A	topicalenergyresouce@yahoo.com	N/A	Biofuel	N/A
WASTE RECYCLING GHANA LTD. (Changed to GOLDEN FALCON COMPANY LTD.)	P.O.Box CT 5419 Cantoment Accra	CFC BUILDING, OPP. MANTRAC GH. KWAME NKRUMAH CIRCLE-ACCRA	+233 208483377 +233 277529033 +233 266239651 +233 302239099		+233 302221184	fbamohtwum@yahoo.com,gfalconwaste@yahoo.co.uk	www.wasterecyclingghana.com	Biomass	N/A
WIENCO GH. LTD	P. O. BOX 7593, Accra	Airport Residential Area, Accra	+233 302776447 +233 302762830 +233 302763179	Mr. Daniel Ruegg(CEO)	+233 302772239	wienco@wienco.com	www.wienco.com	Biofuel	N/A
MAATAP COMPANY LIMITED	P.O.BOX CT 1947, Cantonments Accra	Sokoban Wood Village,Kumasi -Ashanti Region	+233 208110415 +233 268110415 +233 202222077 +233 245526105	Mike Amponsem Rose Nsiah		maatapcomm@yahoo.com,nsiahrose@yahoo.com		Biomass	

4.1.3 NGO/Civil Society or other association

NGO/CSO	Brief Description of Roles and Responsibilities
Ghana Alliance for Clean Cookstoves	Promotes partnerships among members of the alliance and other actors to ensure synergy in influencing policies and stimulating actions that contribute to a vibrant cook stove industry and sustainable utilization of biomass. • Supports the development of a thriving national market for clean cook stoves • Create a platform for enhancing capacity development of member and promoting best practices in the cook stoves sector. • Mobilizes resources for actors in the sector to upscale the production and distribution of clean cook stoves. • Strengthens coordination, innovative ideas, influence policy and enhance information sharing among members, state sector to upscale the production and distribution of clean an improved cook stove. • Creates a collective voice for actors in the clean cook stoves sector • Promotse awareness and raise the profile of the sector's positive work in Ghana at the international level • Standardizes issues in production, operations, implementation, technical requirements of products quality and services in the cook stoves sector. • Sensitizes and educate citizens on the benefits and importance of using clean cook stoves.
Kumasi Institute of Technology, Energy and Environment (KITE)	KITE is a leading non-profit development intermediary organization based in Ghana. Its core mandates are; • To promote policy research on technology, energy and environment; • Undertake training and the dissemination of information in the areas of energy, technology and environment • Provides project development and consulting services relating to technology, energy and environment.
Clean Cooking Alliance	The Clean Cooking Alliance works with a global network of partners to build an inclusive industry that makes clean cooking accessible to the three billion people who live each day without it. Clean cooking transforms lives by improving health, protecting the climate and environment, empowering women, and helping consumers save time and money. • Partnering with Ghana Alliance for Clean Cookstoves (GHACCO), to improve the locally produced Gyapa-style cookstove through a variety of innovations to further increase efficiency and reduce emissions • Supporting enterprise development through the Alliance Spark Fund, foster investment-ready entrepreneurs through capacity building and the Alliance's Catalytic Small Grants Facility • Partnering with World Education International and the Ministry of Education to launch a project to teach students the benefits of clean cookstoves and fuels. • Working with an international coalition to integrate household air pollution into the air quality management program for Accra, Ghana's capital. • Partnering with the Ministry of Petroleum, National Petroleum Authority, and Global LPG Partnership to develop and implement a new cylinder re-circulation LPG policy

	• Partnering with Energy Commission and Ghana Standards Authority to help develop local standards, labeling, and modern testing centers
SNV	Established in Ghana in 1992, SNV together with its national partners, work to contribute to economic, institutional, social and environmental development and poverty reduction in line with the policy priorities of the government of Ghana and the recently launched sustainable development goals (SDGs).
German Development Cooperation (GIZ)	The GIZ's EnDev program focuses on three main pillars. The biomass energy sector focuses on support to small-scale agro processors of agricultural produce access and use improved institutional cookstoves (ICS).
SECO	The Swiss Development Cooperation is active in the renewable energy sector. SECO also active in the biomass to electricity sector where SECO are providing funding for various biomass studies and pilot projects.
Institute for sustainable Energy and environmental solutions-ISEES	ISEES works to achieve access to modern, affordable and reliable energy products and services as a precondition for development. ISEES promotes access to clean energy (solar, clean cookstoves, and biogas 'waste-to- energy') for households and small enterprises in Ghana. ISEES also advocates for energy efficiency by promoting behavioral change communication and the deployment of efficient appliances for households and institutions in off-grid communities. ISEES seeks to reduce energy expenditure, deforestation and air-pollution by providing clean energy solutions with focus on bottom-of-the-pyramid households and agro-processing groups in rural and peri-urban areas.
Traditional Authorities (TAs) and District Assemblies (DAs)	Awareness Creation on sustainable management of woodfuels. Also critical in capturing relevant data relating to the transportation of woodfuel at the district level. Land for the cultivation of biofuel crops acquired through private negotiation with traditional landowners
Community Based Organisations (CBOs)	Critical role to create awareness for the development and management of suitable woodfuel species.
Other value chain actors such as feedstock owners, producers, dealers/transporters, bulk sellers, retailers and exporters	Production, marketing and distribution of wood fuels
Development Partners	World Bank, African Development Bank, United States Agency for International Development (USAID).

4.2 Legal and Regulatory Framework

Sustainable development and productive use of renewable energy resources is at the heart of Government of Ghana policy strategies to address energy challenges and contribute to the fight against climate change and promote creation of green jobs in the renewable energy sub-sector. The sub-sector faces a number of challeges including (i) High upfront capital cost; (ii.) Inadequate financial solutions in terms of affordability and sustainability; (iii.) Challenging and relatively untested regulatory and legal framework; and (iv.) Limited capacity to operate, maintain and manage renewable resources. Table 7 presents an overview of policies and measures that have been developed to create the enabling sustainable Bioenergy service delivery in Ghana.

Table 7 : Overview of policies and measures

Name of the measure	Type of measure*	Expected results**	Target group***	Sector or activity	Start and end dates of the measure
1. Renewable Energy Act 832	Provides for the development, management, utilization, sustainability and adequate supply of renewable energy.	Grants license for the production of biofuel feedstocks. Designation and pricing of biofuel blend Create market for the sale of biofuel blend Legal framework for sustainability of woodfuel production	All actors in the renewable energy industry	Renewable energy	2011 – present
2. Draft Bioenergy Policy	Seeks to modernise and maximise the benefits of bioenergy on a sustainable basis				AUGUST, 2010
3. Strategic National Energy Plan (SNEP).	Intensify renewable energy investments and dissemination; Promote and support increased utilisation of improved Biomass;	Promote the use of waste to energy resources as a significant part of the national energy mix; improved efficiency cookstove penetration.	increase modern energy forms to all, especially low income households and communities, while maintaining efficient end-use energy.	Energy Sector	
4. National Energy Policy 2010	Regulatory	Support sustained regeneration of woody biomass resources through legislation, fiscal incentives, and attractive pricing Promote the establishment of dedicated woodlots for wood fuel production Promote the production and use of improved and more efficient biomass utilisation technologies Promote the use of alternative fuels such as LPG as substitute for fuel wood and charcoal by addressing the institutional and			2010-2018

		market constraints that hamper increasing access of LPG in Ghana			
5. National Energy Policy (Draft)	Regulatory Policy framework and strategies	The goal is to systematically integrate renewable energy in the overall energy production mix of the country.	All actors in Power (generation, transmission and distribution), Petroleum (upstream and downstream) and Renewable energy	Power, Petroleum and Renewable energy	March 2019
6. Renewable Energy Master Plan (REMP) 2019	Regulatory	Increase the supply of renewable energy1 in the national interconnected grid electricity supply system and Reduce the dependence on biomass as main fuel for thermal energy applications;	All actors in the renewable energy industry	Renewable energy	2018 to 2030
7. Sustainable Energy for all Action Plan	promotion of energy efficiency and renewable energy	develop an "Energy Economy" to secure a reliable supply of high quality energy services for all sectors of the Ghanaian economy	All Ghanaians	All the energy sector	2012
8. Sustainable Management of Land and Environment under the Ghana Agriculture Investment Plan	Seeks to promote conservation of natural resources, protect biodiversity and ensure sustainable management of forest resources.	Behavioural change in Agricultural practices and building resilience to Climate Change effects and impacts	Targets farmers and stakeholders who engage in natural resource conservation	Agric Sector	2018-2021
9. Promoting the conservation and sustainable management of forestry resources.	enforcing conservation and sustainable use regulations; (ii) disseminating information on the importance of forestry conservation	Behavioural change	Benefiting individuals and organizations who engage in sustainable use practices		2018-2021
10. Climate Smart Action Plan		promoting green/growth agriculture concepts, principles and the use of energy generated from natural sources	Farmers	Agric sector	

11. Promoting the reduction of deforestation and adopting afforestation measures.					
12. Tree Crops Policy	Regulatory And a framework to organize interventions along the tree crops value chains	Improve efficiency in tree crops subsector for economic growth	Farmers, FBOs, small-scale processors and potential investors-		
13. The National Land Policy of Ghana	Regulates land and natural resources in support of socio-economic development	The policy guidelines include the facilitation of equitable access to land, security of tenure and protection of land rights, ensuring the sustainable use of land and enhancing land capability, and conservation			1999
14 Administration of Stool lands Acts 481 of 1994	Regulatory	enhance stool lands revenue mobilization and disbursement in an equitable accountable and transparent manner and to facilitate the efficient management of stool lands for present and future generations	Communities	Ministry of Land, Natural Resources	1994
15 Land Commission Act 2008 (767)	Regulatory	This Act establishes the Lands Commission, in accordance with article 258 of the Constitution as a body corporate, defines the functions of and assigns powers to the Commission and makes provision with respect to its composition and administration and the qualification and appointment of members of the Commission.		Ministry of Land, Natural Resources	2008
16. NATIONAL ROAD SAFETY COMMISSION ACT - 1999 (ACT 567)	Regulatory and awareness creation	undertake nationwide road safety education	All road users	Transport Sector	1999
17. ICT4AD Policy 2003 The 5th Rolling ICT4AD Plan [2019- 2022]	Information campaigns	to increase access to information, especially environmental information, through			

		the application of modern tools such as ICT and GIS			
18. Forest and Wildlife Policy (1994, 2012)	Regulatory	Rehabilitation and Restoration of Degraded landscapes Development of forest based Industries		Ministry of Land, Natural Resources	2012
19. Forest protection (amendment) Law of 1986 The Forest Protection (Amendment) Act, 2002. Act 624	Regulatory	AN ACT to amend the Forest Protection Decree 1974 (NRCD 243) to provide for higher penalties for offences therein and to provide for related purposes	All Ghanaians	Ministry of Land, Natural Resources	2002
20. Control and prevention of bushfires Law of 1990	Regulatory	Control and prevention of bushfires		Forestry Commission	1990
21. Trees and timber (chain saw operation) regulation of 1991	Regulatory				
22. National Environmental Sanitation Policy 2010	Regulatory	It lays the basis for developing and maintaining a clean and safe environment and to promote the well-being of all.	All Ghanaians	Ministry of Sanitation and Water Resources	2010
23 National Renewable Energy Action Plans (NREAPs) of Ghana (2015-2020)	Regulatory	renewable energy targets uoto 2020 Increase RE supply in national grid; promote RE-based electricity in 1000 off-grid areas.		Ministry of Energy	2015
24. National Environmental Sanitation Strategy and Action Plan 2010 (NESSAP)	Regulatory	Serves as a guide for implementation of policy actions in the NESP. Provides basis for MMDAs to plan and execute sanitation actions.	Proposed installation of biodigesters (with reuse of treated effluent) in regional-level/specialist hospitals, and 50% of district hospitals	Ministry of Sanitation and Water Resources	

4.3 Overview of Bioenergy Technologies and Services

4.3.1 Cooking Fuels

Universal access to clean cooking options is the ultimate aim of every government and Government of Ghana is no exception. The full range of cleaner energy and clean cooking options including solar, LPG, electricity, biomass, biogas/bio-digesters. The main sources of cooking fuels over the past decade are firewood, charcoal and LPG. wood or charcoal as the main source of cooking fuel has declined over the last two decades (from 73.9 percent in 2010), Gas (LPG) as main source of cooking fuel increased from 6.2 percent in 2000 to 36.9 percent in 2021: it is substantially lower in rural areas (14.8%) than urban areas (51.3%); highest in Greater Accra Region (68.2%) and lowest in North East Region (4.2%).

Table 8: Cooking fuels consumption over the past decade (ktoe)

Quantity of domestic fuels and stoves	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Firewood (Metric tons)	1,490	1,535	1,520	1,535	1,550	1,545	1,540	1,550	1463	1418	1438
Charcoal (Metric tons)	944	1,010	1,039	1,212	1,212	1,210	1,214	1,250			1637.35
Briquettes/pellets (Metric tons)	1.4	0.8	2.0	0.8	0.5	0.4	2.7	2.5			
Bioethanol (Litres)	-	-	-	-	-	-	-	-			
Biodiesel (litres)	-	-	-	-	-	-	-	-			
Biogas (CUM)	-	-	-	-	-	-	-	-			
Agro-industrial waste (Metric tons)*		12.6[5]	-	-	-	-	-	-			

* Provide estimates where possible

Average prices of charcoal in the country has been increasing since 2010. In 2017, the average prices of the mini-bag rose to a little over GH¢25 from about GH¢22 in 2016 whilst for the maxi-bag, it was from about GH¢35 in 2016 to about GH¢38. Usually, the high-price regions have largely been Upper East and along the coast whilst the Savannah regions on the average have had lower price hikes. Table 10 presents prices of cooking fuels in Ghana while figure 7 shows the increasing prices of both charcoal and LPG since 2015. The data suggests relatively marginal price increase of charcoal as compared to LPG year-on-year. As shown in Figure 7, price of charcoal is far less than LPG and this has been one of the contributing factors limiting demand for LPG aside high initial investment for the purchase of cylinders and safety concerns.

Table 9: Price of cooking fuels (GHS/kg) AVERAGE YEARLY ENERGY COST FOR COOKING /HOUSEHOLD (GHS)

Prices of domestic fuels and stoves	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
FIREWOOD											
CHARCOAL	0.28	0.30	0.33	0.39	0.46	0.62	0.68	0.76	0.82	0.94	1.00
KEROSENE/Liters	0.91	0.91	0.91	2.02	3.25	3.32	3.59	3.69	4.85	4.71	4.25
LPG	0.84	1.36	1.29	2.52	2.94	3.00	3.89	4.56	5.04	5.22	5.18
ELECTRICITY (300kwh)	0.26	0.26	0.18	0.32	0.41	0.67	0.67	0.67	0.56		
ELECTRICITY (600kwh)	0.29	0.29	0.23	0.41	0.53	0.89	0.87	0.87	0.72		

Source:PURC, http://www.npa.gov.gh/downloads, Ministry of Energy, Energy Commission

[5] *F.Kemausuor et al, Resources, Conservation and Recycling86(2014)28–37 ; Exchange rate GHS to USD 2015 (3.8), 2016 (4.4), 2017 (4.5)&2018 (4.8)*

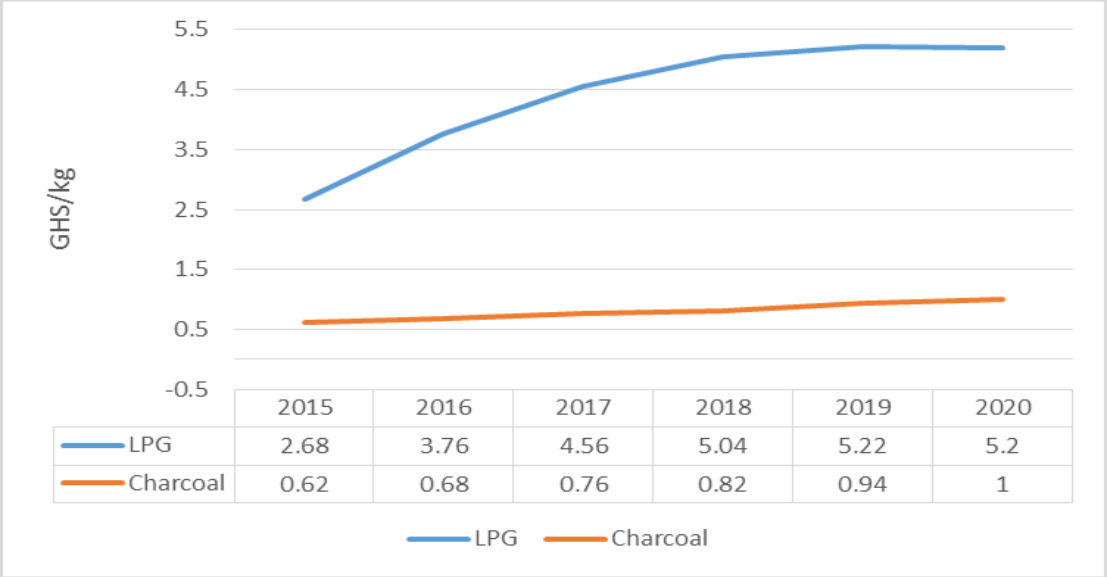


Figure 7 Comparing Unit Prices of LPG and Charcoal

4.3.2 Bioenergy Devices

The global economy of the future will be driven by increasing investments in the renewable energy resources and more efficient use energy. The Clean cooking sector in Ghana is evolving. The Government of Ghana is creating the necessary enabling environment to develop, maintain and sustain a competitive advantage in the sub-regional energy marketplace and is pursuing policies and programmes in the renewable energy, energy efficiency and clean cooking.

This section provides a snapshot of bioenergy devices for cooking in Ghana including solar cookers, Improved Cookstoves (ICS) using biomass and ethanol cookers. As indicated in Table 11 the quantities of ICS Biomass produced in Ghana has been increasing over the years. Under the Ghana's Flagship 500,000 Improved Cookstoves (ICS) distribution Project, 54,743 households received cookstove each. The project was financed by the Climate Change Centre of South Korea. There were installation of 836 Solar Home Systems supported by the Republic of China in 2020. These were actions taken under the GHANA'S SE4ALL Agenda which seeks to ensure universal access to Modern Energy Services, increase the share of Renewable Energy in the National Energy Mix and increase the National Rate of Improvement in Energy Efficiency. Table 12 presents the prices of both domestic and institutional ICS produce in Ghana.

Table 10: ICS and other cookers (Quantity produced)

(Type of stove) Quantity produced	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	**2018**
Solar cookers	-	-	-	-	-	-	-	-	-	-	-	**-**
ICS Biomass	12,923	74,820	95,808	123,870	105,533	172,224	174,358	207,072	213,352	201,334	216,076	
ethanol cooker	-	-	-	-	-	-	-	-	-	-	-	**-**

Source: Ministry of Energy, 2017

Table 11: Price of devices (US$/stove)

Devices		**1990**	**1995**	**2000**	**2005**	**2010**	**2015**	**2018**

Solar cookers		0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Commercial	**0.00**	**0.00**	0.00	0.00	-	150	150
Improved cookstoves	**Domestic**					25	30	35
ethanol cooker		0.00	0.00	0.00	0.00	0.00	0.00	0.00

Most recently, in 2020, CSIR-IIR has designed and constructed an Integrated Biodigester (IBD). The development of the IBD has been supported by the ACTUATE project, funded by the GCRF-EPSRC Global Research Translation Award linked to the RECIRCULATE project, also funded by GCRF. The IBD has been designed to resolve problems associated with FDBDs, both the costs of construction and identifying and repairing digester leaks. Table 13 presents available data on number of installed bio-digesters as of 2018 and some bio-digester service providers in Ghana.

Table 12a: number of Installed Bio-digesters per capacity (complete the table with existing volumes)

Capacity	1990	1995	2000	2005	2010	2015	2018	2019
5-30 m^3	N/A	N/A	N/A	N/A	N/A	N/A	**573**	N/A
30 – 60 m^3	N/A	N/A	N/A	N/A	N/A	N/A	**315**	N/A
>60m^3	**N/A**	**N/A**	**N/A**	N/A	N/A	N/A	**67**	N/A
…..								
Total number							**955**	N/A

Source: GCIC Biogas Study 2018 by SNV Ghana

Table 13b Some Bio-digester service providers in Ghana

No.	Name of installer/ company	Office location Permanent	No of Installations	No. of installationsa
1	Impact Environment Ltd.	Obuasi, Ashanti Region	200	
2	Biogas Technology Africa Ltd.	Afienya, Greater Accra Region (GAR)	100	
3	SBP Biogas Ltd.	Kasoa, Central Region	100	
4	Beta Civil Engineering Ltd.	Dome, GAR	90	
5	Africa Renewable Energy Ltd.	Lashibi-Tema, GAR	80	
6	Timeless Bio-engineering Ltd	Accra New Town, GAR	60	
7	Biogas Engineering Ltd.	Kumasi, Ashanti Region	50	
8	CSIR-IIR	Accra, GAR	47	
9	Apana Solutions	Ashaiman, GAR	34	
10	DAS biogas construction limited	Juaben, Ashanti Region	28	
11	Enoch Biogas Technology	Kenyasi, Kumasi, Ashanti Region	25	
12	Step Engineers Ghana Ltd.	McCarthy Hill, Accra, GAR	21	
13	Biogas Experts Tropical	Abelenkpe, Accra, GAR	15	
14	Prudential Institute of Science and Biogas Technology	Ashaley Botwe, Accra, GAR	10	
15	Kozobiz Biogas Technology	Pankrono, Kumasi, Ashanti Region	7	

16	Rajo Construction Ltd.	Ayigbe town, Weija, GAR	5
17	Brotherhood Construction Limited	Ablekuma, Agape Down, GAR	1
18	Divine Name Biogas Construction	Buoho, Kumasi, Ashanti Region	-
19	CEESD	Kumasi, Ashanti Region	3
20	Others		73
21	Industrial systems (Foreign Companies)		6
Estimated Total			955

Source: Bensah 2009; Source: Bensah et al. 2017.

Table 13: Price of installing Biogas Digesters (US$/m^3)

Capacity/Prices	1990	1995	2000	2005	2010	2015	2018
10 m^3	**N/A**	**N/A**	**N/A**	N/A	N/A	N/A	1000-4500
20 m^3	**N/A**	**N/A**	**N/A**	N/A	N/A	N/A	2000-9000
30 m^3	**N/A**	**N/A**	**N/A**	N/A	N/A	N/A	3000-15,000
…..							
…..							

Source: GCIC Biogas Study 2018 by SNV Ghana

The national target of 50% LPG penetration rate by 2030 would require a huge investment on the part of the government (for example re-capitalisation of Ghana Cylinder Manufacturing Company to expand production capacity) and investment incentives to encourage private sector participation in LPG storage and distribution outlets nationwide to improve accessibility. From the 2021 Ghana Energy Statistics, LPG consumption is expected to grow by 5.0% from 332 kilotonnes in 2020 to about 349 kilotonnes in 2021, which would reflect in increasing demand for LPG Cylinders as shown in Table 15.

Table 14: LPG cylinders data

Cylinder	1989	1990	1997	2000	2010	2015	2017	2018
3kg-15kg	65000	42,344.059	458,000	102,981.230	306,685.796	809,086.639	1,252,046	
>15kg	15000	15,693.815	142,000	38,167.537	113,665.776	299,868.667	464,041	
…….								
Total	80,000	58,038	600,000	141,149	420,352	1,108,955	1,716,087	

Source: http://worldpopulationreview.com/countries/ghana-population/

Table 15: LPG Cylinder prices (USD equivalent)

Cylinder	1990	199..		2000	2015	202017	2018	2019
3-15Kg								65.5
12Kg								
15-15Kg								

Source: https://www.made-in-china.com/products-search/hot-china-products/Ghana_Lpg_Cylinder_Price.html

4.3.3 Electricity production

Electricity generation in Ghana is mainly from hydro (small, medium and large), thermal and renewables (wind, solar, W2E, biomass). Grid Electricity Generation by Plant (GWh) and Total Installed Capacity (MW) are indicated in the Table 17. Electricity generation capacity has been increasing over the last few years as a result of additional capacities from thermal and renewable energy sources year on year. In 2018, 2019 and 2020, energy generation from renewables were 34.1, 76.7 and 105.79 respectively.

Table 16: Energy production (off-grid) Installed Capacity KW

Production (KW)	2014	2015	2016	2017	2018	2019
Total	1,350	4,023	1,238	678	4	
Solar and Wind	1,350	4,023	1,238	678	4	
Biogas	-	-	-	-	-	-
Biodiesel	-	-	-	-	-	-
Bioethanol	-	-	-	-	-	-
Agro-industrial waste (Bagasse, sawdust, etc)	-	-	-	-	-	-
Pellets/briquettes	-	-	-	-	-	-
Municipal solid waste	-	-	-	-	-	-

Table 17: Existing plant for electricity or mechanical generation

Plant	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Hydro Generation Akosombo	5,961	6,495	6,950	6,727	6,509	4,156	3,854	4,282	4,273	1920	1920
Kpong	1,035	1,066	1,121	1,144	1,148	819	763	752	771	265	300
Bui	0	0	0	362	730	870	944	582	974	760	760
Sub-Total	*6,996*	*7,561*	*8,071*	*8,233*	*8,387*	*5,845*	*5,561*	*5,616*	6,017	2948	2980
Thermal Generation Takoradi Power Company (TAPCO)	1,234	1,137	1,061	1,783	890	1,784	1,204	686	730	630	630
Takoradi International Company (TICO)	1,160	657	1,168	1,032	712	1,336	1,926	1,880	2,211	660	660
Tema Thermal 1 Power Plant (TT1PP)	591	559	622	475	697	541	178	365	314	210	210
Tema Reserve Power Plant (TRPP)	-	-	-	-	-	-	-	-	-	-	-
Emergency Reserve Power Plant (ERPP)	-	-	-	-	-	-	-	-	-	-	-
Kumasi Reserve Power Plant (KRPP)	-	-	-	-	-	-	-	-	-	-	-
Mines Reserve Plant (MRP)	20	12	20	-	195	170	3	-	-	-	
Tema Thermal 2 Power Plant (TT2PP)	28	50	141	94	223	216	25	0.5	3	158.5	157
Sunon Asogli Power (Ghana) Ltd (SAPP)	138	1,224	848	694	1,255	1,185	377	1,417	1,970	1080	1080
Cenit Energy Ltd (CEL)	-	-	94	454	513	317	413	59	2	210	210
Takoradi T3	-	-	-	102	87	31	-	-	-	-	-
Karpowership	-	-	-	-	-	64	1,822	1,814	2,556	920	920
Ameri Plant	-	-	-	-	-	0	1,233	1,229	873	480	480
Trojan*	-	-	-	-	-	-	54	52		83.6	-
Kpone Thermal Power Plant (KTPP)	-	-	-	-	-	-	198	124	317	420	420
AKSA Energy Ltd	-	-	-	-	-	-	-	799	748	720	720

Plant	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Genser									359	180	180
CenPower									79	700	700
Amendi										393	393
Eally Power*											284
Sub-Total	*3,171*	*3,639*	*3,953*	*4,635*	*4,572*	*5,644*	*7,435*	*8,424*	10,162	6845.1	7044
Renewables Safisana Biogas*	-	-	-	-	-	-	0.04	0.08	0.1	0.2	0.2
VRA Solar* (Navrongo)	-	-	-	3	4	3	2.5	3	3	4.5	4.5
BXC Solar*	-	-	-	-	-	-	24	25	27	36	36
Meinergy*									4	36	36
VRA Solar (Lawra)											11
Bui Solar*											18
Tsatsadu Hydro											0.09
Sub-Total	-	-	-	3	4	3	26	28	34.1	76.7	105.79
Total Generation	10,167	11,200	12,024	12,870	12,963	11,492	13,022	14,069	15,820.5	9,866.8	10129.79
Installed Capacity (MW)	2,165	2,170	2,280	2,831	2,831	3,656	3,795	4,398	4,780.5	5,171.6	5,288.1

*connected at the sub-transmission level; 2019 and 2020 data on installed and dependable capacity
Source: GRIDCo and ECG;

4.4 Biomass waste Resources

4.4.1 Biomass from forestry residues:

Ghana is characterized by a tropical climate but the annual rainfall level decreases as the altitude increases to the north, where a savannah climate becomes dominant. Most part of the country belongs to the Tropical Savannas Climate and the Sub-Sahelian African moist region. The annual mean temperature ranges from 25°C to 27°C and is fairly constant throughout the year. The annual rainfall is as high as 2,000 mm in the south-western part of the country but decreases towards the northeast, dropping to 1,000 mm at the northern border area. Ghana's Total Area: 238,533 sq. km (Land Area: 227,533 sq. km, Water Area: 11,000 sq. km (MOFA 2020). Forest Estimate of 48,237sq.km and Agricultural Land of 157,225sq.km. Ghana had 35% of its land under threat of desertification especially Upper East, Upper West and Northern Regions since the 1960s and 1970s and recently in the eastern region of the country.

The main policy promulgated to promote reforestation is called "**Ghana forest and wildlife policy".** The stated objectives of the policy are to manage and enhance the ecological integrity of Ghana's forest, savannah, wetlands and other ecosystems; to promote the rehabilitation and restoration of degraded landscapes through plantations development and community forestry; to promote the development of viable forest and savannah lands in the country.

4.4.2 Biomass from Municipal Waste

There are waste resources being used for power generation, cooking or heating (domestic/institutional) but not fully commercially operational. Examples of waste-to-energy projects are: (i) Hybrid Waste to Energy as a Sustainable Solution for Ghana (WtE) project (a 4-year project with funding support from the German Government) has been launched in January 2020. The project aims to establish a pilot 400 kW hybrid demonstration system in Gyankobaah in the Atwima Nwabiagya Municipal of the Ashanti Region of Ghana (ii) Brew-Hammond Energy Centre Demonstration Biodigester; 20 kW agriculture waste to energy pilot plant at Papase in the Ashanti region (iii) 0.1MW waste-to-energy plant at Safisana, Ashiaman that is connected to a medium voltage network; combined Heat & Power as of timber waste at Samartex Ghana, Samreboi; (iv) 6m3 capacity biogas plant at the University of Energy and Natural Resources (UENR), the Energy and Petroleum Engineering Department that is dedicated to the cafeteria and a couple of biogas to electricity systems in across the country.

There are three main landfill sites for waste disposal in the Accra Metropolitan district namely; Kpone, Nsawam and Pantang landfill sites. However, there are no waste dumpsites specifically created for power generation and or for biogas production. The waste dumpsites are all in the form of landfills. Section 4 of the National Energy Policy of 2010 provides for the mandate to convert most of the wastes generated in municipal activities, industrial operations and agricultural operations to energy. This comprehensive waste management approach will enable Ghana to generate reasonable amount of energy from its wastes. The major challenge is to reduce the high cost of waste collection and management. Ghana National Climate Change Policy 2013 broadly makes provision for the reuse of waste generated from agro-industrial processes. The policy actions among various intervention place emphasis on the need to build capacity for recycling and conversion of agricultural waste. The also provides for the reuse of wastes from agricultural sector as measure to improve economic viability of the agro-industry sector. These policies have created the enabling environment for investment in the agro-waste space.

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4.4.3 Biomass from agricultural-industrial waste

The number of agro-industry wastes sites are specified in the table 18 below. Approximately 24 sites were identified and studied in 2015 by the Ministry of Energy under the Ghana Energy Development and Access Project for the purposes of potential Combine Heat Power production.

Table 18 Agro-industry waste sites in Ghana

Level of priority for a potential CHP plant	SITE IDENTIFICATION				BIOMASS WASTE PRODUCED					
	Site name	Town	Region	Crop		Quantity ton/year	use	how residues are disposed	generator capacity (hp or kW)	fuel type
non priority	Asuogya Agro Processing	Asueyi	Brong-Ahafo region	cassava (gari)	Maize stalk			residues are burnt		
2nd	Benso Oil Palm Plantation (Adum Banso Estate)	Mpohor	Western region	Fresh fruit bunches (FFB-oil palm)	shell	7.000	A fraction is used for steam and power generation	Used for energy generation and surplus sold	Diesel genset 500kW, steam turbine 500kW	Diesel
1st	Ghana Rubber Estates Limited	Apimanim	Western region	Rubber	Overaged Rubber plantation	150.000	8% used by firewood traders capenters		1,500KVA	Diesel
non priority	Worawora rice mill limited	Worawora	Volta region	rice(paddy)	Rice husk			residues are burnt		
non priority	Lartey ventures	Akuse	eastern	rice	Rice husks	85	It's not used	there is an outlet		
non priority	Mawuewoe cooperative rice processing and marketing society	Hohoe	Volta region	rice(milled)	Rice husk	730	no uses for now	there are outlets for that	28KW	diesel

non priority	Praire volta	Aveyime	Volta region	rice paddy	rice husk	36	40% of it is used for the drier	a track disposes it	40kw(1500rpm)	diesel
non priority	K Line Ventures	Akuse	Eastern Region		rice husk	475	burnt	there is an outlet for that		
non priority	Abians agro chemicals enterprise	Akuse	Eastern Region	milled rice	rice husks	438	burnt	there is an oulet for that		
non priority	Bok Nam Kim agricultural schools and farms limited	Akuse	Eastern Region	paddy rice	rice husk	480	burnt	there is an oulet for that		
1st	Juaben Oil Mills	Juaben	Ashanti region	Fresh fruit bunches (FFB-oil palm)	Empty fruit Bunches (EFB)	15.190	use as fuel for boiler	used for energy generation	570 KVA	Diesel
non priority	GADCO Ghana Limited	Sogakope	Volta region	paddy rice	rice husks	356	no uses for now	N/A	350KW	
2nd	Wetta irrigation project	Afife	Volta region	pady rice	rice husk and straw	9.389	burnt as waste/ used to burn charcoal.			
non priority	JM Vitta farms	Bassa	Brong-Ahafo region	maize	maize husk	67	left on the field and sometime burnt	it left on the field since a combine harvestor is used	40KVA	diesel
non priority	Wienco cotton company_bolgatanga	pusu namongo	upper east	lint (fibre)	mote+thrash		its sold	tracks carry it to the damp site in the yard		
non priority	wienco cotton company_tamale	tamale	northern	lint (fibre)	mote+thrash		it sold	tracks carry it to the damp	722KVA	diesel

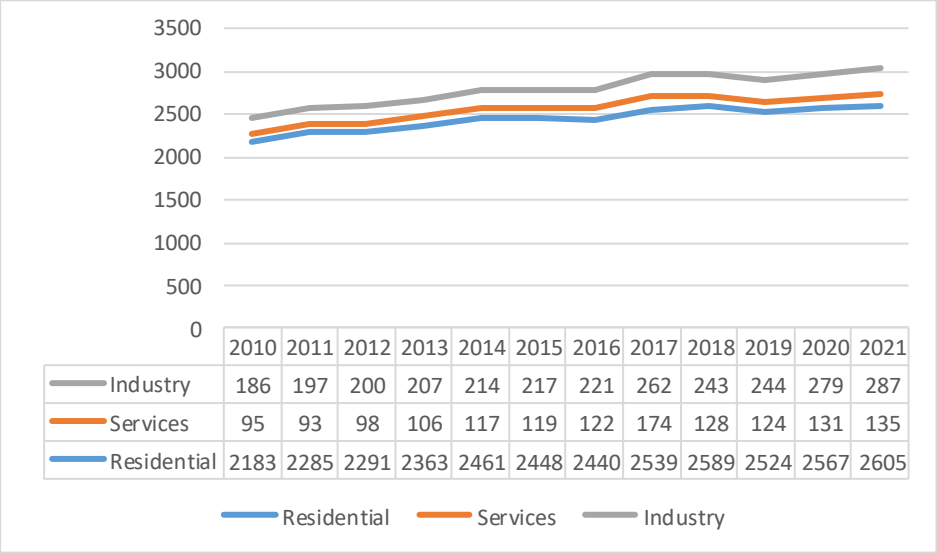
								site in the yard		
non priority	ICOUR silos	Navrongo	upper east	rice paddy	rice husks	173	its sold	there is an oulet for that and there is a grader that pushes them further away	n/a	n/a
non priority	Avnash industries ghana limited	Tamale	northern	rice paddy	rice husks	172	I will be used to fuel the boiler	there will be an ou let for that	1250KVA(2)_ newsite, 250KVA _o;ldsite	diesel
1st	Produce buying company,	Buipe	northerm	sheabutter	cake	16.425	no for now, we will sell it in the future	we don't dispose them but keep them in bags	1050KVA	diesel
non priority	SARI rice mills	nyankpala	northen	rice paddy	rice husks	624	not use	people come to collect them	n/a	N/A
non priority	ADM COCOA FARM	Kumasi	Ashanti	COCOA BEANS	Shell(Cocoa)	2.856	disposed off at the landfill/ sold to farmers for manure	Disposed off at the land fill	1760kW at a power factor of 0.8 lagging	Diesel
non priority	Ayiem oil Mills	Mpohor	Western region	oil palm fruit					N/A	Diesel

Source: Ministry of Energy/GEDAP Biomass to Electricity Study Report 2015

4.5 Overall summary of the National Bioenergy Situation (narrative with the analysed data)

Ghana has a Ministry of Energy with a primary mandate to modernise and maximise the benefits of bioenergy on a sustainable basis. There are existing policies and measures for enabling sustainable Bioenergy service delivery in Ghana For example, the Renewable energy Act 832 which provides for the development, management, utilization, sustainability and adequate supply of renewable energy. Ghana had an Energy Policy spanning 2010-2018, a draft Energy Policy 2019, Bioenergy Policy 2010 and Sustainable Energy for All Action Plan that seeks to develop an "Energy Economy" to secure a reliable supply of high-quality energy services for all sectors of the Ghanaian economy.

Total Primary Energy Supply estimated in 2020 was 12,038Ktoe. The percentage distribution of Energy by sector in 2020 were as follows: Residential (41%), Transport (38%), Industrial (14%), Commercial & Service (5%) and Agriculture and Fisheries (2%). Biomass consumption constituted about 74% of the total energy consumption in the Residential Sector in 2020. Figure 8 shows the increasing trend in biomass consumption by sector. Major cooking fuels in Ghana comprise firewood (35.9 %), Charcoal (36-8%), Gas (26.4%) and others (0.9%). Thus, woodfuel, comprising firewood and charcoal is still the largest home cooking fuel in Ghana.



	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Industry	186	197	200	207	214	217	221	262	243	244	279	287
Services	95	93	98	106	117	119	122	174	128	124	131	135
Residential	2183	2285	2291	2363	2461	2448	2440	2539	2589	2524	2567	2605

Figure 8 Biomass Consumption by Sector (Ktoe)

LPG which is regarded as a cleaner cooking fuel therefore has the potential to reduce woodfuel use as a home cooking fuel. The National LPG penetration share of household cooking fuel increased from 6% in 2000 to 18% in 2010, 22.3% in 2013, 36.4% in 2016/17 and 25.3% in 2021. LPG cylinders data estimates of 420352 (in 2010), 1108955 (in 2015) and 1716087 (in 2017). Production of Improved cookstoves (ICS) is on the increase: estimated quantities of ICS in 2015, 2016 and 2017 were 213,352, 201,334 and 216,076 respectively. The total national LPG storage capacity coverage is however a challenge, since the distribution centres are largely found in southern Ghana, and along the coast. The limited storage capacity nationwide would thus continue to constrain local distribution and access. Data and statistics on solar and ethanol cookers were not available.

Cross-cutting measures like sustainable community afforestation programmes and improved cookstoves programme were vigorously pursued by the related government agencies to curtail or limit potential deforestation threats. Whilst the forestry agencies are still promoting afforestation programmes, improved and efficient cookstoves are now largely being

promoted by the private sector and non-state actors. Forestry Commission that has an oversight responsibility of Woodfuels regulations, development and implementation of programmes to sustain woodfuel production and consumption. Ghana has Forest and Wildlife Policy (1994, 2012) to regulate Rehabilitation and Restoration of Degraded landscapes and Development of forest based Industries.

The National Energy Policy of 2010 which has been reviewed in 2019 makes provision for the conversion of wastes generated in municipal activities, industrial operations and agricultural operations into energy. Approximately 24 agro-industry wastes sites were identified and studied in 2015 by the Ministry of Energy under the Ghana Energy Development and Access Project for the purposes of potential Combine Heat Power production.

HIGHLIGHTS OF BIOGAS DEVELOPMENT IN GHANA

- Research & Development of biogas in Ghana dates back to the late 1960s
- Over 100 biogas plants have been constructed nation-wide.
- Objective has mainly been to provide energy for cooking and electricity generation.
- The treatment of the organic matter to address issues of sanitation and the use of the digested slurry for agriculture have not been the main driving factor for the investment
- Unfortunately most plants failed shortly after duration of project.
- The presentation therefore sought to look at some case studies to establish best application for biogas technology.

4.6 Main Challenges

Major constraints in the bioenergy sub-sector include access to credit, inadequate infrastructure, the need for basic skills and training, limited access to markets, technology gaps, supply-side problems of production, insufficient information, and insufficient institutional capacity.

Challenges regarding wood fuels include:

- Deforestation and Sustainability of wood fuel supply
- Inefficient technology use for woodfuels (particularly charcoal) production
- Challenges associated with substitution of wood fuels with LPGs
- Efficiency in transportation, marketing and distribution of wood fuels such as Inadequate data on woodfuel supply and demand, disposal of charcoal dust, improper handling and packaging and potential fire outbreak in bulk charcoal markets and transportation
- Strengthening institutional and regulatory arrangement

In terms of Electricity/Energy generation from Biomass Waste, there are challenges with the following:

- Bulking and management of wastes, particularly municipal waste poses a serious limitation
- Management of waste and availability of efficient and low cost conversion technology
- Pricing of energy produced from waste
- Regulations and Enforcement

4.7 Opportunities

Opportunities identified for the development of Ghana's Bioenergy Sector include the following:

- Opportunity exist to improve the efficiency of production technologies and techniques of biofuel with the aim of reducing costs and also raising the quality and efficacy of the product through prioritized research and development programmes;
- Training of artisans for the development and use of improved technologies;
- Greater collaboration among relevant MDAs, local authorities and traditional rulers;
- Maintaining a balance in land use between traditional cash and food crop production and utilisation of land for biofuel crop production;
- Opportunities for carbon financing options for reduction in carbon dioxide emission initiatives;

- legislation to be enacted to prohibit unplanned disposal of industrial and municipal waste and also the institution of feed-in-tariffs favourable for electricity generated from waste;
- Opportunities for green job creation in the bioenergy sub-sector; and
- Building effective adaptive capacities of vulnerable groups, individuals, institutions and resilient energy infrastructure to withstand the impacts of climate change and variability.

Part B: NATIONAL ACTION PLAN

5 SUMMARY OF TARGETS

The RE Act, 2011, ACT 832 promotes the regulation of the production and utilisation of Bioenergy which include biomass, bioethanol, biogas in Ghana. The share of efficient charcoal production in 2020, 2025 and 2030 are estimated at 10%, 60% and 100% at the regional level as indicated in the regional bioenergy action plan. However, it must be noted that these targets could be seen to be difficult to achieve in Ghana. Using the data on charcoal consumption and export from the Ghana Renewable Energy Master Plan (2019), given the assumption that charcoal exported are efficiently produced, estimated shares of efficient charcoal production are 40%, 50% and 60% for 2020, 2025 and 2030 respectively as shown in table 19.

Currently, the share of population using bioethanol for cooking is insignificant and the data not available. Although the Renewable energy master plan has some strategies in place to promote the use of biogas for cooking both at domestic and institutional levels, the baseline information (at the national level) is not available. .

Table 19 National Bioenergy Targets (With LPG and ICS as Alternatives to reduce Traditional Wood Energy Consumption)

Main Bioenergy target by 2020 / 2030	baseline: 2018	2020	2025	2030
Share of efficient charcoal production in %	10%	40%	50%	60%
Share of population using bioethanol (liquid/gel) for cooking in %	N/A	NA	0.5%	1.0%
Share of population using biogas for cooking in %	N/A	NA	1.0%	5.0%
Share of population using briquettes/pellets for cooking in %	N/A	NA	NA	NA
Biodiesel as share of diesel fuels consumption in %	N/A	NA	NA	NA
Bioethanol as share of gasoline fuels consumption in %	N/A	NA	NA	NA
Bioelectricity	N/A	0.1MW	102MW	132.1 MW
Share of population using improved cook stoves[6]		60%	85%	100%
LPG penetration at household level[7] in %	23%	35%	40%	50%
Fuelwood saved from 2018 in tons		700 million tons		3 billion tons

Source: Renewable Energy Master Plan

20 Targets for Solid Biomass Technologies

TECHNOLOGY / INTERVENTION	UNITS	REFERENCE (2015)	2020	2025	2030

[6] Improved cook stoves refer here to wood and charcoal burning stoves
[7] LPG is taken here in the table because of its capacity to replace traditional biomass use

1. Utility-scale power generation	MW	0	0	72	72
2. Charcoal (export)	1000 t	190	250	350	428
3. Charcoal (local demand)	1000 t	1,551	1,645	1,739	1,840
4. Improved Cookstove (Domestic)	Million Units	0.80	1.3	1.8	3
5. Improved Cookstove (Institutional/commercial)	Thousand Units	1.8	3	10	18
6. Woodlot Cultivation	1000 ha	190	250	350	428
7. Briquetting/Pelleting	1000 t	19.7	40	65	100

Source: Ghana Renewable Energy Master Plan

6 BIOENERGY TARGETS AND TRAJECTORIES

6.1 Domestic cooking Targets

Table 21 Targets for Domestic Cooking Energy (MT)

Quantity of domestic fuels and stoves	2018	2020	2025	2030
Firewood (Metric tons)	464	465	468	471
Efficient Charcoal (Metric tons)	190	250	350	428
Briquettes/pellets (Metric tons)	19.7	40	65	100
Bioethanol (Litres)	N/A	N/A	NA	NA
Biodiesel (litres)	N/A	N/A	NA	NA
Biofuels	0*	100	5000	20000
Biogas (m^3) (sourced from REMP/Domestic)	50	80	130	200
Agro-industrial waste (Metric tons)	10	30	100	200
Municipal solid waste (Metric tons)	N/A	N/A	NA	NA

Table 22 Targets for ICS and Other Cookstoves

Quantity of domestic fuels and stoves	2018	2020	2025	2030
Quantity				
Solar cookers (Water Heaters, units)	N/A	20000	70000	135000
Improved cookstoves (million units)	0.80	1.3	1.8	3
ethanol cooker	N/A	N/A	NA	NA

Table 23 Projections of Number of Bio-digesters Installations

Capacity	2018	2020	2025	2030
05-30 m^3	573			
	315			

Capacity	2018	2020	2025	2030
30-60 m^3				
>60m^3	67			
Total	955			

Table 24Targets for Waste-to-Energy Technologies

TECHNOLOGY / INTERVENTION		UNITS	REFERENCE (2015)	2020	2025	2030
1. Utility scale power	MSW + Biogas	MW	0.1	0.1	30.1	50.1
2. Biogas	Agricultural/Industrial organic waste	Units	10	30	100	200
	Institutional	Units	< 100	180	320	500
	Domestic	Units	< 50	80	130	200

Note: Industrial biogas - estimated 400 m^3 digester capacity per unit; Institutional biogas - estimated 200 m^3 digester capacity per unit; Domestic biogas - estimated 10 m^3 digester capacity per unit (Source REMP 2019)

Ghana Biodigester market study (2018) found about 955 installations counted based on data from installers as well as estimates from previous studies. About one-fifth of biogas installations studied was used for heating or cooking. Electricity generation using biogas was observed in 7% of installations. However, biogas was flared in one-fifth of installations while a little over half of installations surveyed had their gas not being used or flared. Nearly two-thirds of systems were used by households while a quarter was deployed in institutions such as schools, hotels and health centres. A little over a tenth of installations were biolatrines for public toilets.

Table 25 LPG Cylinders Trajectory

Capacity	2018	2020	2025	2030
3-15 kg	1,252,046	1,586,944	2.008.354	2,760,303
>15 kg	464,041	588,162	744,347	1,023,039
Total	1,716,087	2,175,106	2,752,701	3,783,342

Source: Analysis using LPG Penetration rate and projected households in Ghana

6.2 Bioelectricity Targets

Electricity generation capacity from renewables is projected to reach 1353.63 MW by 2030. Of this total, utility scale generation comprises 1094.63 MW (or 80%), with the remaining 259 MW (comprising 20%) coming from distributed generation. Distributed generation sources will include solar home systems (both standalone and net-metering systems), solar street and community lighting systems, standalone wind systems, and mini-grids (which could be made of single or hybrid technologies). Table 26 presents targets in respect of biogas. No estimates could not be generated in respect of biodiesel and bioethanol considering the fact that baseline information was not available.

Table 26 Targets for the share of grid-connected Bioelectricity

Installation Capacity (MW)	2018	2020	2025	2030

Installation Capacity (MW)	2018	2020	2025	2030
Biogas	**0.1**	**0.1**	**30.1**	**50.1**
Biodiesel	**N/A**	-	-	-
Bioethanol	**N/A**	-	-	-
Agro-industrial waste (Bagasse, sawdust, etc)	**N/A**	-	-	-
Pellets/briquettes	**N/A**	-	-	-
Municipal solid waste	**N/A**	-	-	-
Others (specify)		-	-	-
Total				

Ghana does not have any strategic plan for off-grid-connected bioelectricity. The current focus is on the use of solar and wind hybrid together with battery storage systems for off-grid electrification.

Table 27 Targets for National and Rural Population served by Bioelectricity

	2018	2020	2025	2030
Total Rural Population (number of inhabitants)	13,249,882	11,948,000	11,860,000	11,655,000
Rural population served with electricity services (number of inhabitants)	8,069,178	8,602,560	11,860,000	11,655,000
Rural population served with electricity services (% of total)	60.92	70.00	100	100

6.3 Bioenergy applications for domestic uses

Table 28 sets the targets regarding bioenergy applications for domestic uses in 2020 and 2030 as well as its trajectory in Ghana.

Table 28 National Targets and Estimated Trajectory for Domestic Cooking Energy

	2018	2020	2025	2030
Population served with improved cookstoves (number of inhabitants)	**21,000,000**	**31,072,940**	**34,408,768**	**37,833,419**
Share of population using improved cookstoves in %	87%	100%	100%	100%
Total charcoal production in tons (1000)	1,450	1,895	2,089	2,268
Charcoal production with efficient technologies (yield superior to 25%) in tons	1250	-	-	-

Share of charcoal produced with efficient technologies in %	10%	-	-	-
Population using modern cooking fuel alternatives (LPG, biogas, solar cookers,) (number of inhabitants)	8,000,000			
Population using LPG (number of inhabitants)	8,000,000			
Population using biogas (number of inhabitants)	N/A			
Population using solar cookers (number of inhabitants)	N/A			
Population using ethanol cookers (number of inhabitants)	N/A			
Others	N/A			
Share of population using modern fuel alternatives for cooking (e.g. LPG, biogas, solar cookers,) (% of the total population)	27%			
Share of Population using LPG (% of the total population)	27%			
Share of Population using biogas (% of the total population)	N/A			
Share of Population using solar cookers (% of the total population)	N/A			
Share of Population using ethanol cookers (% of the total population)	N/A			
Others	N/A			

** or the most recent year for which statistics are available*

7 MEASURES FOR ACHIEVING THE TARGETS

7.1 Summary tables of all policies and measures to promote the use of Bioenergy resources for grid connected and off-grid electricity generation, cooking/heating energy, and transportation.

Table 29 Overview of Policies and Measures

Name of the measure	Type of measure*	Expected results**	Target group***	Sector or activity	Start and end dates of the measure
Woodfuel Regulations	Regulations	To ensure the enforcement of sustainable management of biomass resources predominantly used as fuel for cooking and heating. (Behavioural change)	All stakeholders in the Woodfuel industry (Charcoal, Briquette, Pellets and Firewood) production, conversion, transportation and marketing.	Regulations which are currently being developed.	2020- it is revised.
Cookstoves standards and Labelling	Regulations	Provide for the enforcement of minimum performance requirements for biomass cookstoves. (Behavioural change)	All individuals who produce, market and use improved cookstoves in the country.	Regulations which are currently being developed.	2020 till it is revised.
Renewable Energy Act 832	Provides for the development, management, utilization, sustainability and adequate supply of renewable energy.	Grants license for the production of biofuel feedstocks. Designation and pricing of biofuel blend Create market for the sale of biofuel blend Legal framework for sustainability of woodfuel production	All actors in the renewable energy industry	Renewable energy	2011 – present
Draft Bioenergy Policy	Seeks to modernise and maximise the benefits of bioenergy on a sustainable basis				AUGUST, 2010

Strategic National Energy Plan (SNEP).	Intensify renewable energy investments and dissemination; Promote and support increased utilisation of improved Biomass;	Promote the use of waste to energy resources as a significant part of the national energy mix; improved efficiency cookstove penetration.	Increase modern energy forms to all, especially low income households and communities, while maintaining efficient end-use energy.	Energy Sector	
Ghana National Energy Policy	Policy	It is expected to ensure the implementation of targeted policies. (Behavioural change to facilitate policy implementation)	All the stakeholders in the energy Industry, especially the Bioenergy subsector. These include energy investors, end-users, project planners and public administrators. These targeted individuals are predominantly biofuel producers and users.	Existing Policy	Starting January 2020- till the time it may be reviewed.
Renewable Energy Master Plan (REMP)	Regulatory	Increase the supply of renewable energy1 in the national interconnected grid electricity supply system and Reduce the dependence on biomass as main fuel for thermal energy applications;	All actors in the renewable energy industry	Renewable energy	2018 to 2030
Sustainable Energy for all Action Plan	promotion of	develop an "Energy	All Ghanaians	All the energy sector	2012

	energy efficiency and renewable energy	Economy" to secure a reliable supply of high quality energy services for all sectors of the Ghanaian economy			
Promoting the conservation and sustainable management of forestry resources.	enforcing conservation and sustainable use regulations; (ii) disseminating information on the importance of forestry conservation	Behavioural change	Benefiting individuals and organizations who engage in sustainable use practices		2018-2021
Tree Crops Policy	Regulatory And a framework to organize interventions along the tree crops value chains	Improve efficiency in tree crops subsector for economic growth	Farmers, FBOs, small-scale processors and potential investors-		

7.2 Specific measures for the promotion of efficient cookstoves

Government involvement in promoting improved cook stove programs in Ghana date back to the 1980s. But significant impact in terms of availability of the product and awareness creation were not until the 1990s when the Ministry of Energy through the Institute of Industrial Research (of the Council for Scientific and Industrial Research-CSIR-IIR) introduced the 'Ahibenso Coalport' program that distributed over 12,000 pre-financed of this product (Energy Commission, 2012).

The cookstove industry in Ghana has since seen several efforts from both government and non-governmental organisations in the bid to promote the production, adoption and use of improved types in the country. This means the sector has witnessed activities of several stakeholders who can be categorised into six main groups along the entire value chain. These stakeholders include stove manufacturers (household and institutional), Fuel Producers (charcoal and firewood), Financial Institutions and International donor agencies, Distributors and retailers of stoves and fuels, cookstove Raw material suppliers, and Training and research institutions.

Regardless of commitments by government and civil society organizations to scale up adoption and utilization of improved cookstoves in Ghana, the market share is low, approximately 18% (as of 2015; REMP 2019) of the total cookstove market. One key challenge confronting actors in the cookstove program in Ghana is absence of empirical studies on factors that influence adoption and utilization

Marketing and promotion of improved/ clean cookstoves in Ghana are mostly done by word-of-mouth; thus, formal promotion in the mass media is almost non-existent. Stoves are sold in shops at prices determined by the seller with the exception of a few where the price is controlled by the manufacturer. Many of the retailers are found in the main market

centres. Poor awareness creation strategies are noted as a major factor inhibiting the growth of the sector. The market price of stoves is influenced by the size, type, material of construction, availability of carbon revenue, and the location. Even for stoves of the same model and size, regional differences in price exist.

Several factors militate against the smooth adoption of improved cookstoves in Ghana as in other sub-Saharan countries. Mainly among them are: 1. Socio-economic (factors such as income, level of education, age, household size, number of adult females, sex of household head and type of residence and ownership) 2. Cultural and behavioural (such as beliefs, cooking practices, food taste and preference) and 3. Others such as government policies and institutional setups.

7.3 Specific measures for the promotion of efficient charcoal production

Charcoal production in Ghana has followed the traditional method using the earth mound technology. However, since the government allowed the export of the commodity, Energy Commission has come out with strategies and requirements that have to be followed by charcoal producers who intend to export their products. To be able to export charcoal, one has to own a woodlot plantation or have to have a contractual agreement with a sawmill operator from where off-cuts could be collected and used for charcoal production. In all these, one has to use an efficient kilns (metal or bricks) moulded for effective combustion to ensure higher output as compared to the earth mound kiln which has been the traditional technology for production of charcoal in the country.

As part of the Woodfuel Regulations development, Energy Commission is undertaking public education and stakeholder consultative meetings where efficient methods of producing charcoal is being promoted during such meetings, power point presentations, displaying pictorial evidence and images of different kinds/ methods of charcoal production have been shown.

Currently, Energy Commission is developing Woodfuel Regulations for the country in which the need to undertake charcoal production using efficient production technologies is emphasised.

7.4 Specific measures for the promotion of modern fuel alternatives for cooking

The government of Ghana is currently pursuing a policy of Cylinder Recirculation to boost the adoption and use of LPG in the country especially in the remote areas where LPG is currently inaccessible. The details of the policy are as shown below purposely to promote the adoption and use of LPG as an alternative to traditional biomass energy use in the country. According to the policy:

a. National Petroleum Authority (NPA) is to create LPG distribution concessions for existing LPG retailers/marketing companies or new actors, to use the “Coca-Cola model” in serving the communities that currently do not have LPG filling stations or have low LPG penetration rates;

b. NPA to establish attractive transportation and distribution margins and redirect the current subsidy on the consumption of LPG towards facilitating the implementation of the “Coca-Cola model”;

c. A national campaign on LPG as the preferred fuel for cooking in households to be mounted;

d. Ensure that gender sensitivity is incorporated into overall LPG planning and policymaking processes so that gender concerns can be fully incorporated.

e. NPA to develop, monitor and enforce clear standards for improving safety, and promote public education in the LPG sub-sector;

f. EC to provide effective leadership in data collection including sex-disaggregated data, and policy studies; and

g. Ministry of Energy to Chair a new Inter-Agency LPG Policy Monitoring Committee (PMC) with two additional Members, one each from NPA and EC, to review progress on all policy measures and report to the Minister of Energy on a quarterly basis. There should be effective representation and participation of women on the PMC.

Unlike LPG, biogas, ethanol and solar cookers have not achieve popular, large scale and nationwide promotion.

7.5 Support schemes to promote the use of biofuels

The revised Renewable Energy Master Plan (2019) gives elaboration on the scheme to promote the use of biofuels with specific targets as indicated in the table below.

Table 30 Renewable Energy Master Plan

	Reference 2015		Cycle I (2019-2020)		Cycle II (2021-2025)		Cycle III (2026-2030)		Cumulative in 2030	
	No. of units	MWp	No. of units	MWp	No. of units	MWp	No. of units	MWp	No. of units	MWp
Biomass/Waste-to-Energy										
Biomass Utility scale	-	0	-	0	-	72	-	0	-	72
Waste-to-energy Utility scale	-	0.1	-	0	-	30	-	20	-	50.1
Biogas-Agricultural/industrial organic waste	10	-	20	-	70	-	100	-	200	-
Biogas-Domestic	100	-	80	-	140	-	180	-	500	-
Biogas-Institutional	50	-	30	-	50	-	70	-	200	-
Woodlot cultivation (ha)	190,000	-	60,000	-	100,000	-	78000	-	428000	-
Charcoal (local demand)	1,551,282	-	94,017	-	93,947	-	100877	-	1840123	-
Charcoal (export)	190,450	-	59,550	-	100,000	-	78000	-	428000	-
Briquetting/Pelleting	19,700	-	20,300	-	25,000	-	35000	-	100000	-
Biofuel (tonnes)	0	-	100	-	4900	-	15000	-	20000	-

Source: Renewable Energy Master Plan 2019

7.6 Specific measures for the promotion of the sustainable use of energy from biomass

Biomass has an important role as primary energy in rural and peri-urban areas. National biomass strategy is crucial to promote the use of biomass sustainably. This section provides information on the specific measures for the promotion of efficient energy generation from biomass resources.

7.6.1 Biomass supply

Biomass in the form of firewood charcoal and agricultural residue accounted for approximately 38% of Ghana's total primary energy supply in 2015. The objective of the national policy is to reduce the dependence on biomass as main fuel for thermal energy applications. There are measures for biomass energy from forest residues, waste-to-energy and agricultural industrial waste,

7.6.1.1 Biomass from forestry residues:

Measures planned to encourage unused arable land and degraded land for energy purposes include the following:

- Collaborate with relevant stakeholders to implement a national programme for woodlot cultivation;
- Collaborate with Ministry of Lands and Natural Resources to make seedlings widely accessible and affordable for afforestation and reforestation;
- Provide adequate incentives for own-plantation based biomass power plants;
- Support MMDAs to earmark land banks for afforestation and reforestation;
- Promote fast-growing, water resistant and multi-purpose species (power generation, poles for distribution networking, etc.); and
- Facilitate establishment of woodlot clubs in basic, secondary and tertiary schools to enhance the programme.

From the Forestry Development Master Plan (2016-2036), some of the thematic areas that relate to improvement in forest management techniques are:

- Rehabilitation and restoration of degraded landscapes through plantations development, community forestry, woodlot development, and natural regeneration

Intervention strategies –

Develop a framework, plan, and incentive packages to support public, private sector and community investment in reforestation and woodlot development in degraded priority savannah areas.

Support increased investments in research and development, training and capacity building in forest plantation and woodlot development in all the ecosystems.

Implement the national plantation development strategy

- Sustainable management and utilization of forests, wildlife, wetlands, and savannah ecosystems.

Intervention strategies –

Sustainably manage and develop commercial woodfuel supplies and other non-timber forest products on both on-and off-reserved forest areas.

Develop systems and technologies for sustainable management of savannah woodland resources for environmental protection and enhancement of socioeconomic development.

Promote urban forestry as landscape intervention enhancement, provision of recreation, erosion control and supply of fruits and woodfuel to the urban areas.

7.6.1.2 Biomass from Municipal Waste

Strategies to improve Municipal Waste to Energy Projects

- Collaborate with relevant sector Ministry to formulate and enforce regulations on waste management (e.g. tipping fee, sorting at source, transportation, etc.);

- Increase public awareness on proper waste management and attitudinal change towards waste sorting, collection and disposal;
- Provide incentives (training, transfer points, financial supports, etc.) for private sector to invest in waste transfer infrastructure to energy projects;
- Enforce existing environmental instruments - e.g., polluter-pays principle; and
- Implement waste-to-energy under PPP arrangements.
- Collaborate with relevant stakeholders (e.g. Health, Education) to promote efficient incineration in public and private facilities which incorporate heat exchangers in incinerators for hot water production and other heat application; and
- Promote use of biogas for institutional cooking.

7.6.1.3 Biomass from agricultural-industrial waste

Strategies to promote agricultural / industrial waste biogas systems

- Collaborate with relevant stakeholders to enforce and promote waste sorting, treatment and material recovery, i.e. waste reduction, reuse and recycling;
- Collaborate with relevant stakeholders to implement environmental instruments for waste management – e.g., polluter-pays principle;
- Collaborate with relevant institutions to integrate biogas technologies into waste management of agro-industries;
- Provide financial incentives to promote biogas as a waste management option to address sanitation and climate change related issues; and
- Build capacities of private sector in the installation, operations and maintenance of biogas facilities.

8 PREPARATION OF THE NATIONAL BIOENERGY ACTION PLAN.

The Renewable Energy Master Plan (2019-2030), an US$ 5.6 billion investment master plan, is expected to attract more than 80% of the total investment from the private sector. The REMP has been designed to be implemented in three (3) cycles; 2019 to 2020 transition of cycle 1; cycle 2 and cycle 3, 2021 to 2025 (cycle 2) and 2026 to 2030 (cycle 2). Provisions are made for each cycle to be reviewed before the subsequent one.

Key activities to be undertaken in Cycle I includes:

- Establishment of REMP-Coordinating Unit;
- Awareness creation and marketing of the REMP;
- Preparation of outstanding regulations, e.g. integration of SWH into buildings;
- Development of outstanding Standards, Codes and Labels;
- Establishment of a Renewable Energy Demonstration Centre;
- Capacity building for technicians, entrepreneurs and local enterprises;
- Studies to identify areas for local assembly and manufacture of RETs;
- Establishment of the Renewable Energy Authority; and
- Development of the 30 kW Tsatsadu hydropower project by Bui Power Authority.

The REMP Coordinating Unit (REMP-CU) is responsible for the overall procurement and financial management, coordination with key REMP Components Implementation Entities and Beneficiaries (CIEB[8]) and reporting obligation. The REMP Coordinating Unit (REMP-CU) is responsible for Monitoring and controlling progress and evaluating REMP activities. A National Steering Committee (NSC) made up of experts drawn from all relevant institutions will be established to provide overall guidance to the REMP. MMDAs are also encouraged to incorporate the strategies into their overall development plans.

The Renewable Energy Purchase Obligation (REPO) will be implemented to ensure that the distribution companies, ECG, NEDCo, and Enclave Power Company (EPC), and all other bulk customers integrate electricity generated from renewable resources in their distribution and consumption mix. Manufacturing and assembling along strategic links in the renewable energy value chain in the REMP would be fully implemented. In accordance with the Local Content Policy for the sector and to boost local production, both state sponsored and private sector renewable energy projects would source a minimum 20% of goods from the local market (where applicable) in the medium term.

The proposed actions for the Ghana Bioenergy Action Plan (See Annex 1) are aligned with the regional policy frameworks as well other initiatives including the Paris Agreement, the Ghana Nationally Determined Contribution, the National Renewable Energy Master Plan 2019 and the SE4ALL Action Plan. **The regional level, Bioenergy Policy target by 2030 include** 1) Universal access to clean, safe and affordable cooking energy, including 26% of LPG users and 100% of improved cookstoves (ICS) and/or sustainable biomass fuels users. 2) Electricity from biomass will account for 5 % of the total installed capacity in the region, which corresponds respectively to 686 MW by 2020 (28% of RE capacity) and 2008 MW (13% of RE Capacity) by 2030.

8.1 Action Plan (aligned with Regional Policy)

The National Renewable Energy Plan proposed interventions on solid biomass technologies for heat and power generation, and production of solid fuels, such as sustainable charcoal, pellets and briquettes. Proposed interventions cover promotion of energy efficient conversion (improved kilns, pelleting & briquetting equipment) and end-use devices (improved cookstoves, efficient boilers, etc.) and sustainable feedstock cultivation.

Policy guideline 1: Utility scale biomass electricity generation projects

General Objective 1 To promote utility scale biomass electricity generation which is aligned to the Regional level Electricity from biomass accounting for 5 % of the total installed capacity

Expected outcome 1

That Ghana will generate and use significant amount of utility scale energy from biomass resources which will facilitate the achievement of the benefits of biomass energy production.

Expected Outcome 2

That the energy, health and environmental benefits of sustainable use of biomass resources are achieved in the country.

Policy guideline 2: Charcoal Production (local consumption and export)

Actions:

- Develop mobile kiln technologies and promote artisanal interest in improved kiln development;
- Organise training in design, construction, operation and maintenance;
- Promote sustainable woodlot plantations;
- Finalize and implement regulatory framework on fuelwood;
- Enhance standards laboratory for biomass for testing of cookstoves and fuels;

[8] Public and private sector actors implementing aspects and or whose actions are aligned with the REMP.

Objective: to promote improvements in charcoal production

Justification: to address challenges including Inefficient carbonisation technologies; dwindling and unsustainable feedstocks; and high cost of charcoal production kilns

Description: Over 70% of the population of Ghana still rely on biomass energy for cooking and heating. This biomass energy, mainly charcoal and firewood is sourced from natural woodlands. The woodfuel industry is still in the informal sector meaning, sourcing of the feedstock, conversion into charcoal, packaging, storage and transportation remains unregulated. The policy will facilitate the development of woodfuel Regulations to streamline efficient technologies for wood conversion, packaging, transportation, sales and marketing.

Currently, the lack of regulations on the industry has led to uncontrolled felling of trees with no strategy of ensuring sustainability of the industry i.e. ensuring replanting of the trees felled for firewood and charcoal. Studies by a joint team from Energy Commission and Forestry Commission indicate the need for collaboration between the two institutions to produce seedlings and offer technical support for communities, and individuals who want to go into tree planting for woodfuel. The need for national woodfuel Regulations has also been highlighted. Activities to achieve these objectives have been started by the relevant institutions.

Expected Outcome: An industry which is well regulated to ensure sustainability.

Target Population: The main population targeted for this activity are the people in the rural and peri-urban areas whose livelihoods depend on the woodfuel industry as well as people in the urban centres who depend on charcoal and firewood for cooking and heating.

Entity responsible for execution: The main entities responsible for the execution of this project include the Ministries of Energy, Local Government and Rural Development, Forestry Commission, Energy Commission and Ghana Standards Authority. Others include the associations responsible for woodfuel production, transportation, marketing and distribution.

Execution time: The project activities to ensure the achievement of this project have already started and is expected to continue over the next 5 years.

Policy guideline 3: Woodlot Cultivation

Actions:

- Collaborate with relevant stakeholders to implement a national programme for woodlot cultivation;
- Collaborate with Ministry of Lands and Natural Resources to make seedlings widely accessible and affordable for afforestation and reforestation;
- Provide adequate incentives for own-plantation based biomass power plants;
- Support MMDAs to earmark land banks for afforestation and reforestation;
- Promote fast-growing, water resistant and multi-purpose species (power generation, poles for distribution networking, etc.);
- Facilitate establishment of woodlot clubs in basic, secondary and tertiary schools to enhance the programme;
- Support woodlots in schools and communities to reduce dependence on the traditional forests, reduce the chores of women and children in the collection.

Objective: To promote woodlot cultivation

Justification:

To address challenges including Land requirements, cost and tenure systems; High cost of seedlings; lack of incentive for the planting of woodlots; difficulty in getting water during the dry season, especially in arid areas, makes woodlots unattractive; poor financing opportunities; low knowledge of the benefits of woodlots; and long lead time for feedstock cultivation.

Description

Baseline was set based on current woodlot planted by the government (Energy Commission) and three known

private companies. Targets are based on projections in the Ghana Forestry Development Masterplan published by the Ministry of Lands and Natural Resources (2016).

Expected Outcome:

Woodlots or plantations are established across the major firewood and charcoal producing areas in the country as well as major institutions such as prisons, hospitals and second cycle schools which depend on solid biomass for cooking and heating.

Target Population: People in the rural communities where charcoal and firewood production are their main livelihood.

Entity responsible for execution: The main entities responsible for executing this project are the Forestry Commission and Energy Commission.

Cost of the action USD

Execution time: The major activities needed to achieve the objective of this project have started and will continue for the 5 years and beyond.

Policy guideline 4: Briquetting and Pelleting

Actions:

- Promote the use of pellets/briquettes and alternative fuels such as LPG, NG, etc for cooking,
- Use in industries (industrial boilers) and other commercial interventions such as bakeries, gasifiers, etc.;
- Encourage local production/assembly of stoves that use pellets and briquettes;
- Remove import duty and taxes on equipment for production and local use of pellets/briquettes; and
- Promote an export market.

Objective: to promote briquetting and pelleting

Justification: To address challenges including low awareness about the use of pellets and briquettes, hence a low demand as an alternative fuel; Carbonised briquettes are not readily available for purchase; Cookstoves for pellets and briquettes not available on the market; High cost of electricity reduces the net energy derived from pellets and briquettes; and High capital cost for initial set-up an maintenance.

Description: The reliance of the people on solid biomass (charcoal and firewood) is increasingly taking a toll on the natural forest stands in the country. The need to promote the production and use of briquettes and pellets in the country cannot be overemphasised. This is because, the amount of wood waste, saw dust, agro- wastes that are left in the wild to rot is so huge that, it makes sense if these resources are transformed into briquettes and pellets. The revised bioenergy policy is therefore calling for the promotion of briquettes and pellets to augment the use of charcoal and firewood in the country.
Expected Outcome: Significant quantities of briquettes and pellets are produced in the country on commercial basis to support the reliance on traditional biomass sources.

Target Population: The people whose activities are charcoal and firewood production as well as entrepreneurs who are currently into charcoal production for export.

Entity responsible for execution: The Ministry of Energy, Energy Commission as well as the private entrepreneurs who are in the biomass energy business.

Execution time: Private entrepreneurs in the bioenergy industry have started the business of producing

briquettes and pellets for export. Energy Commission currently has a list of companies who have been licensed to produce and export briquettes. The actual business started in 2018 and will continue in the foreseeable future.

Policy guideline 5: Energy Efficient (Improved) Domestic cookstoves
Actions:

- Provide Business Development Supports (BDS) to artisans for improved cookstove manufacture;
- Fast-track the development of standards and labelling which are currently under preparation;
- Explore the automation of cook stove production processes;
- Raise awareness among households; and
- Promote research and development if improved local stoves

Objective: to promote the production and use of domestic cookstoves**.**

Justification to address challenges in adoption of improved domestic cookstoves including low awareness of improved cookstoves; lack of standards and labelling for the local cookstove industry; local manufacture relies more on manual techniques, with some semi-automation; and high cost of improved cookstoves.

Description: Currently in Ghana, over 70% of the population still relies on the use of traditional biomass and stoves for cooking and heating. The sourcing of the biomass feedstock (supply side) and the use (demand side) value chains are all inefficient and unsustainable. Energy Commission is currently developing Regulations for Efficient Cookstoves standards and labelling to facilitate and control the production (locally) and importation (externally) of cookstoves that will meet the international standards for biomass energy use.

Expected Outcome: The cookstove industry will see products that meet international standards for energy efficiency with the aim to safeguard excessive use of biomass.

Target Population: The huge population of the country who still rely on biomass energy (firewood and charcoal) for domestic cooking and heating. These include rural population as well as people in peri-urban and urban communities who still do not use LPG as their main cookstove fuel.

Entity responsible for execution: The Ministry of Energy, Sustainable Energy for All (SE4ALL) unit of the Energy Commission, NGOs and Civil Society Organisations (CSOs) who are currently championing the promotion of clean cooking in the country.
Execution time: The development of the Regulation is currently on-going. The time for execution will depend on how soon the Regulation is passed into an Act of Parliament to become a Law in the country.

Policy guideline 6: Energy Efficient (Improved) Institutional cookstoves

Actions:

- Provide support for research and development into improved designs that provides easy mobility for the units;
- Build capacity of local artisans to assemble/manufacture and maintain the units;
- Provide subsidies for construction of improved cookstoves in public institutions such as hospitals, schools and prisons;
- Facilitate partnerships between local and foreign stove manufacturers and research institutions to improve the quality of stoves on the local market;
- Introduce innovative financing schemes through collaboration with financial institutions; and
- Establish standards and labels for cookstoves and biofuels and briquettes

Objective: to promote production and use of institutional cookstoves

Justification: To address challenges including high cost of improved institutional stoves; poor designs with excessive heat generation and waste or smoke emission; some users have issue with permanent position of the stove; low level of skilled personnel; and Regular maintenance requirements**.**

Description: Since the reliance of institutions (hospitals, schools, prisons etc.) on biomass energy (firewood and charcoal) for cooking and heating still remain high, it has become necessary for the promotion efficient institutional

cookstoves to safeguard excess use of biomass resources (charcoal and firewood). This policy and activity looks to guarantee efficiency in the demand side of biomass energy at institutional level.
The revised Bioenergy Policy looks to align with the ECOWAS Bioenergy Policy (EBEP) and Ghana National Renewable Energy Action Plan (NREAP) in terms of development (production and use) of institutional and industrial cookstoves.

Expected Outcome: The major institutions in the country that rely on biomass energy for cooking and heating will have access to efficient cookstoves.

Target Population: People who benefit from the use of institutional cookstoves such students, prisoners, etc. as well as those in the biomass energy industry (cookstove producers and marketers).

Entity responsible for execution: The Ministry of Energy, Sustainable Energy for All (SE4ALL) unit of the Energy Commission, NGOs and Civil Society Organisations (CSOs) who are currently championing the promotion of clean cooking in the country.

Execution time: The development of the Regulation is currently on-going. The time for execution will depend on how soon the Regulation is passed into an Act of Parliament to become a Law in the country.

8.2 Monitoring and follow-up on implementation

The Bioenergy Action Plan will be followed-up by the Ministry of Energy that has the responsibility to implement national policies on energy. The regulatory responsibilities will be undertaken by the Energy Commission.The Ghana's Renewable Energy Master Plan has a Monitoring and Evaluation Component for the purposes of tracking progress, data collection and for benchmarking of performance against targets for effective decision making. The Monitoring and Evaluation details the resource inputs and outputs, impacts and assumptions as well as the reporting and review.

Key Indicators (as detailed in the set targets) to be tracked using data include the following:

- Share of population using alternative modern fuels for cooking
- Share of efficient charcoal production
- Share of population using improved cook stoves
- LPG penetration at household level in %
- LPG penetration household level
- Biodiesel and bioethanol as share of fossil fuels consumption
- Share of population using bioethanol (liquid/gel) for cooking in %
- Share of population using biogas for cooking in %
- Share of population using briquettes/pellets for cooking in %
- Bioelectricity

In addition to the above-mention key monitoring indicators, the Ghana Renewable Energy Master Plan will collect data on the following:

- Baseline information/ as in Part A of the Ghana Bioenergy Action;
- Broad information on installations done during the period under review;
- Extent to which targets set in the Master Plan are being achieved;
- Bioenergy contribution to energy access;
- Avoided GHG emissions;
- Job creation;
- Trend in cost of technologies;
- Implementation challenges; and
- Research and development activities, among others.

At the country level, the Renewable Master Plan will be evaluated on key outcomes such as installation for energy generation, economic gains (jobs created) and environmental benefits (GHG emissions avoided), market transformation and technology transfer and research & development with the Appolonia Renewable Energy Demonstration Centre assisting.

Annual Reviews: The Ministry of Energy will conduct annual reviews as stipulated in the Renewable Energy Master Plan. The Monitoring and Evaluation Staff will be directly responsible for the organisation of data collection, analysis and reporting to management.

Dissemination of M&E Reports - Ministry of Finance, National Development Planning Commission, Ghana Statistical Services, Development Partners, Energy Commission, PURC, Civil Society Organisations, Private Sector, Academia and Research Institutions.

9 ARTICULATION WITH REGIONAL INITIATIVES

The ECOWAS region has a series of on-going regional initiatives in the field of renewable energy:

- The ECOWAS White Paper on a Regional Policy for Increasing Access to Energy Services in Peri-Urban and Rural Areas by 2015;
- Establishment of ECREEE;
- ECOWAS Renewable Energy Policy (EREP) with targets for 2020 and 2030; Link: http://www.ecreee.org/sites/default/files/documents/ecowas_energy_efficiency_policy.pdf
- ECOWAS Energy Efficiency Policy (EEEP) with targets for 2020 and 2030; Link: http://www.ecreee.org/sites/default/files/documents/ecowas_renewable_energy_policy.pdf
- The ECOWAS Bioenergy Strategy
- ECOWAS Bioenergy Policy and Implementation Plan (EBEP) with targets for 2020 and 2030; Link: http://www.ecreee.org/sites/default/files/ecowas_bioenergy_policy.pdf
- WACCA (West Africa Clean Cooking Energy) Concept Note
- ECOWAS Policy on Gender Mainstreaming in Energy Services
- WACCA Regional Action Plan; Link: http://www.ecreee.org/sites/default/files/documents/basic_page/wacca_action_plan_v2_english.pdf
- Consolidated National Renewable Action Plan (NREAP)
- Consolidated National Energy Efficiency Action Plan (NEEAP)
- SEforAll Action Agenda; Link: http://se4all.ecreee.org/sites/default/files/final_report_on_se4all_consolidation.pdf
- Country National Action Plan for Clean Cooking
- Study Report on Novel Bioenergy Crop Potential in the ECOWAS Region; Link: http://www.ecowrex.org/sites/default/files/documents/news/biocrop_assesment_study_report_en_final.pdf

Besides the activities in renewable energy, the ECOWAS region has also a series of on-going activities in energy access:

- West Africa Power Pool (WAPP) and the ECOWAS Revised Generation and Transmission Master Plan ;
- The West Africa Gas Pipeline (WAGP);
- ECOWAS Rural Electrification projects.

Synergies between these regional initiatives and the proposed measures in this Plan will be created.

In West Africa, bioenergy in the forms of biomass, liquid and gaseous biofuels play significant roles in the total primary energy supply (TPES) and total energy consumption. Ghana which has a relatively matured energy market in the region equally depends heavily on bioenergy especially for cooking and industrial processes. The TPES for biomass consumed has increased from 2493KTOE in 2009 to 2794 in 2018. Even though the consumption per capita has seen a downward trend within the same period as a result of increasing population and growing shift from bioenergy to LPG and other cleaner forms of energy, biomass accounts for over 38% of TPES.

Considering the significant roles of bioenergy in the region, the ECOWAS Heads of State and ECREEE have initiated policy frameworks and strategic roadmaps for the region to guide national bioenergy value chain development for member states. These regional policy frameworks together with other global frameworks on bioenergy have been analysed to draw synergies and alignments between the proposed measures in the Ghana Bioenergy Action Plan.

At the Seventieth Session of the Council of Ministers, held in Abidjan on the 20th and 21st June 2013, the Council agreed on key decisions to achieve improve energy efficiency in the ECOWAS Region by 2020. This included the specific policy targets for universal access to safe, clean, affordable, efficient and sustainable cooking for the population of ECOWAS by 2030. Create instruments for financing sustainable energy, including carbon finance in the short and long terms, establish a regional fund for the development and implementation of sustainable energy projects.

Consequently, at the forty-third ordinary session of the authority of heads of states and government held in Abuja, 17-18 July, 2013, supplementary Act A/SA.3/07/13 on the ECOWAS renewable energy policy, the high contracting parties reiterated the various articles of the ECOWAS treaty, and agreed under Article 2 (3) to (a) ensure universal access to improved cook-stoves to 100% by 2020; (b) increase the share of the population served with modern fuel alternatives including LPG, for cooking to 36% by 2020 and 41% by 2030; (c) increase the share of efficient charcoal production to 60% by 2020 and 100% by 2030; (d) introduce blending ratios for Ethanol/Bio-diesel in transport fuels of 5% by 2020 and 10% by 2030; (e) support the research on the use of ethanol and other fuels as domestic cooking fuels; (f) have a regional policy for sustainable use of bioenergy including biofuels, waste to power, to be adopted by the ECOWAS Ministers in charge of energy; and (g) create instruments for financing sustainable energy, including carbon finance, by end of 2013.

Under Article 4, the Heads of State agreed to work towards the regional manufacturing capacity of renewable energy equipment. They are to ensure that 7% of the renewable energy equipment, by value, installed in 2020 is regionally manufactured. This proportion should reach 20% by 2030.

Subsequently, the ECOWAS Bioenergy Policy and implementation plan was adopted in June 2017 within the frameworks of the fifty-first ordinary session of the authority of heads of states and government held in Monrovia, Liberia. The policy posited the roles bioenergy can play in providing energy services especially to the poor through the various bioenergy-agriculture-nexus including promotion of agro-industrial development and job creation, minimizing health risks and addressing gender imbalance, attracting investment in sustainable agriculture and land use, improve food security, improving government budgets, balance of payment and energy security, impact on biodiversity, natural resource management and climate change.

The policy objective is to promote a modern, sustainable and vibrant bioenergy sector in ECOWAS region by creating an enabling environment that can unlock the potential by removing the institutional, legal, financial, social, environmental and capacity gaps and barriers. It is aimed at addressing the needs and constraints of the governments, the private sector and the local communities in using existing resources including household, agricultural and industrial processing wastes and residues.

The ECOWAS regional bioenergy policy therefore is to encourage the utilization of the Bioenergy resources to provide sustainable energy access to its population prior to any attempt to export the resources.

The proposed actions for the Ghana Bioenergy Action Plan are aligned with these regional policy frameworks as well other initiatives including the Paris Agreement, the Ghana Nationally Determined Contribution, the National Renewable Energy Master Plan 2019 and the SE4ALL Action Plan.

ANNEX I: BIOENERGY ACTION PLAN

Policy Guideline 1 : Utility scale biomass electricity generation projects

Objective1 : To promote Utility scale biomass electricity generation

Outcome 1: That Ghana will generate and use significant amount of utility scale energy from biomass resources which will facilitate the achievement of the benefits of biomass energy production.

Total 1 : 6.3 (in million USD)

Action	Indicator	Calendar (Year, Quarter)																Budget USD (M)
		year				year 2				Year 3				Year 4				
		1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	
1.1 Action 1 Collaborate with relevant stakeholders to secure land for woodlot plantations;																		0.2
1.2 Action 2 Strengthen research and development institutions to undertake R&D along the value chain; and support to research centres on various aspects of bioenergy service delivery including gasification technology																		2.6
1.3 Action 3 Build capacities of private sector, utilities and MMDAs in the installation, operations and maintenance of biomass fired electricity generation facilities.																		3.5

Capacity building on all aspects of the Bioenergy value chain Waste to energy: Use of municipal solid and liquid waste to energy for better health and environment, Abbatoire waste as well Enhance standards laboratory for biomass for testing of cookstoves and fuels																			
Policy Guideline 2 : Charcoal Production (local consumption and export) Objective 2 : To promote improvements in charcoal production Outcome 2 An industry which is well regulated to ensure sustainability Total 2 : 21.5 (in million USD)																			
Action	Indicator	Calendar (Year, Quarter)																Budget USD	
		year				year 2				Year 3				Year 4					
		1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4		
2.1 Action 1 Develop mobile kiln technologies and promote artisanal interest in improved kiln development;																		15.5	
2.2 Action 2 Organise training in design, construction, operation and maintenance																		2.5	
2.3 Action Promote sustainable woodlot plantations																		3.0	
Policy Guideline 3 : Woodlot Cultivation Objective 3 : To promote woodlot cultivation																			

Outcome 3 Woodlots or plantations are established across the major firewood and charcoal producing areas Total 3 : 58.6million USD																	
Action	Indicator	Calendar (Year, Quarter)															Budget USD
		year				year 2				Year 3				Year 4			
		1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	
3.1 Action 1 Collaborate with relevant stakeholders to implement a national programme for woodlot cultivation																	0.1
3.2 Action 2 Collaborate with Ministry of Lands and Natural Resources to make seedlings widely accessible and affordable for afforestation and reforestation;																	15
3.3 Action 3 Support MMDAs to earmark land banks for afforestation and reforestation;																	35
3.4 Action 4 Promote fast-growing, water resistant and multi-purpose species (power generation, poles for distribution networking, etc.);																	2.5
3.5 Action 5 Facilitate establishment of woodlot clubs in schools Support woodlots in schools and communities to reduce dependence on the traditional forests, reduce the chores of women and children in the collection, etc																	6.0

Policy Guideline 4 : : Briquetting and Pelleting Objective 4 : Outcome 4 Total 4 : 3.5million USD																		
Action	Indicator	Calendar (Year, Quarter)																Budget USD (m)
		year				year 2				Year 3				Year 4				
		1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	
4.1 Action 1 Promote the use of pellets/briquettes and alternative fuels such as LPG, NG, ethanol, etc for cooking,																		0.75
4.2 Action 2 Encourage local production/assembly of stoves that use pellets and briquettes																		2.5
4.3 Action 3 Remove import duty and taxes on equipment for production and local use of pellets/briquettes																		0.25

Policy Guideline 5 : Energy Efficient (Improved) Domestic cookstoves Objective 5 : to promote the production and use of domestic cookstoves Outcome 5 The cookstove industry will see products that meet international standards for energy efficiency with the aim to safeguard excessive use of biomass Total 5 : 28.15million USD																		
Action	Indicator	Calendar (Year, Quarter)																Budget USD
		year				year 2				Year 3				Year 4				
		1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	
5.1 Action 1 Provide Business Development Supports (BDS) to artisans for improved cookstove manufacture																		11.65
5.2 Action 2 Fast-track the development of standards and labelling which are currently under preparation;																		1.5
5.3 Action 3 Explore the automation of cook stove production processes .Finalizeregulations on fuelwood.																		3.5
5.4 Action 4 Raise awareness among households																		5.5
5.5 Action 5																		6.0

Promote research and development of improved local stoves																	

Monitoring and implementation of bioenergy action plan Total 6 : 2.58miilion USD																		
Action	Indicator	Calendar (Year, Quarter)																Budget USD
		year				year 2				Year 3				Year 4				
		1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	
Outcome 1																		0.25
Outcome 2																		0.75
Outcome 3																		0.45
Outcome 4																		0.45
Outcome 5																		0.68

ANNEX 2 - DEFINITION OF TERMS USED IN THE ACTION PLAN

Agro-fuels: Solid biofuels obtained from crops, and residues from crops and other agricultural products. Residues from agricultural production include animal solid excreta, meat and fish residues. Agro-fuel is subdivided into bagasse, animal wastes and other biomass materials and residues (check definitions for bagasse, animal wastes and other agricultural residues).

Animal waste: Excreta of animals which, when dry, are used directly as a fuel. This excludes waste used in anaerobic fermentation plants. Fuel gases from these plants are under biogases (see biogas).

Bagasse: the fuel obtained from the fibre which remains after juice extraction in sugar processing

Biofuels: liquid or gaseous fuel for transport produced from biomass.

Other vegetable material and residues: biofuels not specified elsewhere and including straw, vegetable husks, ground nut shells, pruning brushwood, olive pomace and other wastes arising from maintenance, cropping and processing plants.

Solid biofuels: solid fuels derived from biomass.

Liquid biofuels: Liquids derived from biomass and generally used as fuels. Liquids biofuels comprise bio-gasoline, biodiesel and other liquid fuels (definitions of biogasoline, biodiesel and other liquid fuels are provided below).

Bio-gasoline: Liquid fuels derived from biomass and used in spark-ignition internal combustion engines. Common examples are: bioethanol; biomethanol; bio ETBE (ethyl-tertio-butyl-ether); and bio MTBE (methyl-tertio-butyl-ether).

Biodiesel: Liquid biofuels which are usually modified chemically so that they can be used as fuel in engines either directly or after blending with petroleum diesel. Biological sources of biodiesel include, but are not limited to, vegetable oils made from canola (rapeseed), soybeans, corn, oil palm, peanut, or sunflower. Some liquid biofuels (straight vegetable oils) may be used without chemical modification their use usually requires modification of the engine.

Biodiesel as a share of diesel and fuel-oil consumption (in %): The EREP sets conventional biofuels targets (1st Generation Biofuels) for the ECOWAS region as a whole, one of which is the biodiesel as a share of diesel and fuel oil consumption. In this template this is calculated by dividing the production of raw vegetal oil/biodiesel by the diesel oil/DDO/fuel oil consumption in the country.

Straight vegetable oil: When vegetable oil is used directly as a fuel, in either modified or unmodified equipment, it is referred to as straight vegetable oil (SVO) or pure plant oil (PPO).

Other liquid biofuels: liquid biofuels not elsewhere specified.

Biogas: gases arising from anaerobic fermentation of biomass. These gases are composed principally of methane and carbon dioxide and comprise landfill gas, sewage sludge gas and other biogases (check definitions for landfill gas, sewage sludge gas and other biogases). They are used mainly as a fuel but can be used as a chemical feedstock. . It is particularly relevant for cooking purposes or in the context of industrial uses (e.g. breweries, slaughter houses).

Landfill gas: biogas from anaerobic fermentation of organic matter in landfills.

Sewage sludge gas: biogas from anaerobic fermentation of waste matter in sewage plants.

Other biogases: biogases not elsewhere specified including synthesis gas produced from biomass.

Biomass: biodegradable fraction of products, waste and residues from biological origin from agriculture (including vegetal and animal substances), forestry and related industries including fisheries and aquaculture, as well as the biodegradable fraction of industrial and municipal waste. The uses of biomass for energy are very diverse: from the traditional, low-efficiency burning of wood in open fires for cooking purposes to the more modern use of wood pellets for the production of power and heat, and the use of biodiesel and bioethanol as a substitute for oil-based products in transport.

Large hydro power is an important renewable energy source for the provision of base load in the ECOWAS region. The significance will grow with the implementation of the WAPP hydropower project pipeline.

Charcoal: The solid residue from the carbonisation of wood or other vegetal matter through pyrolysis. The amount of biomass (usually fuelwood) necessary to yield a given quantity of charcoal depends mostly on three factors:

- *parent wood density – the principal factor in determining the yield of charcoal from fuelwood is parent wood density, since the weight of charcoal can vary by a factor of 2 for equal volumes*
- *moisture content - moisture content of the wood also has an appreciable effect on yields - the drier the wood, the greater is the yield - ; and*
- *the means of charcoal production: charcoal is produced in earth-covered pits, in oil drums, in brick or steel kilns and in retorts. The less sophisticated means of production generally involve loss of powdered charcoal (fines), incomplete carbonization of the fuelwood and combustion of part of the charcoal product, resulting in lower yields.*

Traditional non-efficient charcoal production methods: traditional charcoal production methods include open pits, oil drums and kilns with lower efficiencies. In the ECOWAS charcoal is mainly produced by traditional methods in the informal sector (e.g. open pits and kilns) which are inefficient (60-80% of the energy in the wood is lost) and has impacts on the health and on the environment.

Efficient charcoal production: efficient charcoal is the terminology used on this template for the charcoal produced by modern methods that are more efficient than traditional ones. The modern methods use sealed containers and have higher efficiencies and thus higher yields. Within the EREP, under the targets for domestic cooking, a target for efficient charcoal production is set: 60%/100% of the charcoal production should be by improved carbonisation techniques (yield >25% in 2020 and 2030, respectively. In this template the MS is asked to set out its target and trajectory for efficient charcoal production. This is calculated by dividing the quantity of charcoal produced by improved carbonisation techniques with yield superior to 25% in tonnes by the total charcoal production in tonnes.

Conservation: The reduction of energy usage through increased efficiency and/or reduced waste.

DDO: stands for Distillate Diesel Oil

Distributed and Microgeneration: This is when electricity is generated for local distribution and is not connected directly to the national grid. Microgeneration is typically used to describe smaller scale generating technology.

Energy Efficiency appliances: Electrical devices or appliances that perform their task, and use less electricity than lower-efficient devices. Electrical inefficiency in many devices is directly related to the heat they produce. For example, energy efficient light bulbs use most of the incoming electrical energy to produce light, not heat. Inefficient air conditioning is a major cause of peak hours in the ECOWAS region.

Electricity: The transfer of energy through the physical phenomena involving electric charges and their effects when at rest and in motion. Electricity can be generated through different processes: e.g. by the conversion of energy contained in falling or streaming water, wind or waves or by the direct conversion of solar radiation through photovoltaic processes in semiconductor devices (solar cells); or by the combustion of fuels.

Electricity demand: The total electricity consumption in GWh or MWh consumed by a country annually. This includes the demand of the complete system including the in circuital consumption and the losses.

Electricity mix: The range of energy sources of a region/country (either renewable or non-renewable) that is used to produce electricity,

Energy access: A universal and affordable access to modern means of energy. It implies access to modern cooking solutions defined as relying primarily on non-solid fuels for cooking. It also implies access to electricity, defined as availability of an electricity connection at home or the use of electricity as the primary source of lighting that can provide non-served communities and households with a modern life and economic development.

Energy Efficiency: the ratio of performance or output of performance of services, goods or energy to input of energy. The energy efficiency of a process is improved if it produces the same service using less energy. Energy-efficient light bulbs produce the same amount of light but use up to 75% less energy to do so. Improving energy efficiency helps reducing energy use or bringing more energy services with the same amount of energy consumed.

Ethanol: also called ethyl alcohol, pure alcohol, grain alcohol or drinking alcohol, is a volatile, flammable, colourless liquid that can be used for several different purposes, being one of them as fuel. As fuel, ethanol is used as a motor fuel and fuel additive (e.g. Brazil relies in Ethanol as a motor fuel). Ethanol is also used for household heating as a relatively safe fuels.

Ethanol as share of gasoline consumption: The EREP sets first generation biofuels targets for the ECOWAS region as a whole, one of which is the ethanol as a share of the gasoline consumption. This is calculated by diving the quantity of ethanol produced by the quantity of gasoline consumed in the country and it is show in %.

Fossil Fuel: An energy source formed in the Earth's crust from decayed organic material. The common fossil fuels are oil, diesel, coal, and natural gas. Some ECOWAS countries are highly dependent on diesel electricity generation.

Fuelwood, wood residues and by-products: fuelwood or firewood obtained from natural or managed forests or isolated trees. Also included are wood residues used as fuel and in which the original composition of wood is retained. In the ECOWAS region fuelwood is the principal source of energy for cooking and heating, however statistics on fuelwood are generally poor as it is mainly produced and traded in the informal sector.

Grid-connected: a system (photovoltaic, hydro, diesel, etc.) that is connected to a centralised electrical power network (power grid).

Generation (electricity): This covers the production of electricity at power stations.

Heat: Heat is an energy carrier primarily used for warming spaces and industrial processes

Hybrid System: a power system consisting of two or more power generating subsystems (e.g. combination of a wind turbine or diesel generator and a photovoltaic system)

Improved cookstoves (also called clean/efficient cookstoves): is a device that is designed to consume less fuel and save cooking time, convenient in cooking process and creates smokeless environment in the kitchen or reduction in the volume of smoke produced during cooking against the traditional stove; and thus addressing he health and environmental impacts associated with traditional cookstoves. Traditional cookstoves (open fires and rudimentary cookstoves using solid fuels like wood, coal, crop residues and animal dung) are inefficient, unhealthy, and unsafe, and inhaling the acrid smoke and fine particles they emit leads lead to severe health problems and death. Traditional cookstoves also place pressure on ecosystems and forests and contribute to climate change through emissions of greenhouse gases and clack carbon.
Within the EREP targets are set for improved cookstoves, as the pressure on the ECOWAS woodland will grow exponentially. Thus the policy includes the banning of inefficient stoves after 2020, enabling 100% of the population of the urban areas to use high efficient wood and charcoal stoves (with efficiencies higher than 35%) from 2020 onwards and 100% of the rural population to use high efficient charcoal stoves from the same date on. In this template the MS is asked to set a target for improved cookstoves measured in terms of the % of the population that uses efficient cookstoves. This is estimated by dividing the number of inhabitants that use improved cookstoves by the total number of inhabitants of the country.

Installed capacity: is the rated continuous load-carrying ability of a given electricity generation plant expressed in megawatts (MW) for active power

Kilowatt (kW): 1,000 watts

Kilowatt-hour (kWh): 1,000 watt-hours.

Load: In an electrical circuit, any device or appliance that uses power (such as light bulb or water pump)

Megawatt (MW): 1,000,000 watts

Megawatt-hour (MWh): 1,000,000 watt-hours

Mini-grids: set of electricity generators and, possibly, energy storage systems interconnected to a distribution network that supplies the entire electricity demand of a localized group of customers. This power delivery architecture can be contrasted with single customer systems (e.g. solar home systems) where there is no distribution network interconnecting customers, and with centralized grid systems, where electrical energy is transmitted over large distances from large central generators and local generators are generally not capable of meeting local demand. Mini-grids are

particularly relevant in the rural context of ECOWAS where renewable energy powered hybrids can be the more cost-effective alternative. The EREP includes mini-grid targets.

Modern fuel alternatives (for cooking): known as non-conventional or advanced fuels, these are any materials or substances that can be used as fuels for cooking, other than conventional solid fuels such as coal, fuelwood and charcoal. These alternatives cover Liquefied petroleum gas (LPG), biogas, ethanol, and solar power (e.g. solar cookers). In this template improved cookstoves are not considered within the modern fuel alternatives, as they are object of a separate analysis in this template.

Off-grid applications: is a designation for facilities that produce all their own energy and are not connected to any external source, such as the electrical power grid.

Power grid: a system of high-tension cables by which electrical power is distributed throughout a region

Renewable Energy (RE): 'Renewable energy' is used to describe the energy produced using naturally replenishing resources. This includes solar power, wind, geothermal, bioenergy, wave and tide and hydropower.

Renewable energy sources – in this template the renewable energy sources refer to the following renewable energy technologies:

- *Hydropower which includes:*
    - *Small scale hydropower (small-hydro or SSHP) up to a maximum installed capacity of 30 MW;*
    - *Medium (capacity between 30MW and 100MW) and large hydropower (capacity higher than 100MW);*

  In the EREP hydropower is defined as follows: up to 30 MW small-scale, 30 to 100 MW medium-scale, more than 100 MW large-scale.
- *Bio-energy covering three different fields:*
    - *Woodfuels (firewood and charcoal) used for domestic cooking purposes and commercial applications (restaurants, breweries, potteries, blacksmiths, brick makers). Excess woodfuels resources could be used for power generation with other biomass.*
    - *By-products from crops production for power generation (stalks, straw, husks, shells, kernels, etc.). These can serve as fuel for power generation when gathered together on an agro-industry site. Power can also be generated through biogas production using industrial or urban waste, manure and dung (resource concentration at dairies or slaughter houses or cattle and vegetable markets).*
    - *Energy crops for power generation or sustainable biofuels (e.g. sugar processing waste) offer some interesting perspectives.*

Bioelectricity share in the electricity mix: - is the share of bioelectricity generation in the total electricity generation for a given year, measured in %. This is calculated in the template by dividing the electricity production from renewable energy sources (in MWh/year) by the total electricity production (in MWh/year) – renewable and non-renewable for the same year.

Rural Electrification: Provides a regular supply of electricity to rural residents. It implies the extension of power lines to rural areas, or the use of stand-alone, mini-grids or isolated power systems. The EREP includes targets for rural electrification.

Share of rural population served with off-grid (mini-grids) bioelectricity services: this is the percentage (%) of the rural population as defined above that is served with bioelectricity mini-grids. This is calculated by dividing the number of inhabitants served by bioelectricity off-grid applications by the number of rural inhabitants (as defined above).

Rural communities: These includes population living in rural centres and villages with population between 200 and 2,500 inhabitants and some larger cities that due to its peripheral geographical location are away from the national grid. The EREP refers as well that some of the off-grid rural localities supplied before 2020 might be included in the grid extension as they will potentially grow up.

Solar cookers: or solar oven, is a device which uses the energy of direct sun rays (which is the heat from the sun) to heat, cook or pasteurize food or drink.

Support scheme: means any instrument, scheme or mechanism applied by a Country or group of Countries, that promotes the use of energy from renewable sources by reducing the cost of that energy, increasing the price at which it can be sold, or increasing, by means of a renewable energy obligation or otherwise, the volume of such energy purchased. This includes, but is not restricted to, investment aid, tax exemptions or reductions, tax refunds, renewable

energy obligation support schemes including those using green certificates, and direct price support schemes including feed-in tariffs and premium payments.

Some support schemes for renewable energy:

- *Production based incentives:*
  - *Feed-in-Tariff ("FIT"): is an energy supply policy that promotes the deployment of renewable energy resources. A FIT offers a guarantee of payments to renewable energy producers for the actual electricity produced ($/kWh). These payments are generally awarded as long-term contracts.*
  - *Quota system: is an energy supply policy that awards the generator with certificates that can be sold into a market (with no price guarantee)*
  - *Quota systems with competitive bidding: is the fixation of mandatory production quotas for green electricity supply. These quotas are imposed on power generating utilities and / or electricity distribution utilities (calculated as a percentage of production/sales). Operators can meet these obligations in three ways: (i) by producing their own green electricity, (ii) by buying the electricity under long term contracts, and (iii) by acquiring on the financial market the "Green Certificates" corresponding to the amount of electricity required.*
  - *Decentralized quota system with green certificate market also called tradable green certificates (TGC): is the fixation of mandatory production quotas for green electricity supply. These quotas are imposed on power generating utilities and / or electricity distribution utilities (calculated as a percentage of production/sales). Operators can meet these obligations in three ways: (i) by producing their own green electricity, (ii) by buying the electricity under long term contracts, and (iii) by acquiring on the financial market the "Green Certificates" corresponding to the amount of electricity required.*
- *Investment based incentives*
  - *Capital grants and loans: investment instruments in which government provide grants or loans for the development of renewable energy projects. Grants do not have to be repaid, while loans have to be repaid.*
  - *Microcredits: is the extension of very small loans (microloans) to impoverished borrowers who typically lack collateral, steady employment and a verifiable credit history.*
  - *VAT Exemptions: allows households or investors not to have to pay VAT on renewable energy or energy efficiency equipment*

Watt-hour (Wh): a measure of electric energy equal to the electrical power multiplied by the length of time (hours) the power is applied.

Waste: in energy statistics waste refers to the part of the waste that is incinerated with heat recovery at installations designed for mixed wastes or co-fired with other fuels. The heat may be used for heating or electricity generation. Certain wastes are mixtures of materials of fossil and biomass origin.

Industrial waste: non-renewable waste which is combusted with heat recovery in plants other than those used for the incineration of municipal waste. Examples are used tires, specific residues from the chemical industry and hazardous wastes from health care. Combustion includes co-firing with other fuels. The renewable portions of industrial waste combusted with heat recovery are classified according to the biofuels which best describe them.

Municipal waste: Household waste and waste from companies and public services that resembles household waste and which is collected at installations specifically designed for the disposal of mixed wastes with recovery of combustible liquids, gases or heat. Municipal wastes can be divided into renewable and non-renewable fractions.