



Action Agenda of Ghana



SUSTAINABLE ENERGY FOR ALL (SE4ALL)

COUNTRY ACTION AGENDA

December, 2015

Executive Summary

The Sustainable Energy for All (SE4All) initiative was launched in 2011 by the UN Secretary General Ban Ki-moon, with the three global 2030 objectives of:

- i. Achieving universal energy access,
- ii. Doubling the global rate of improvement in energy efficiency; and
- iii. Doubling the share of renewable energy in the global energy mix.

In spite of the global launch, implementation of SE4All is country-led, and this SE4All Action Agenda documents Ghana's response to the Secretary-General's initiative and defines the country's specific goals as aligned with the global objectives. The Action Agenda estimates the costs of achieving these goals and identifies actions that need to be taken, whilst providing an overview of all the programmes and initiatives being pursued in the energy sector towards achieving the country's long-term goals.

Ghana's SE4All Action Agenda is based primarily on the country action plan developed through a rigorous consultative process in 2012, and updated to reflect the ECOWAS action agenda template. It incorporates the country's energy sector policies and the programmes of the two energy sector ministries, namely the Ministry of Power and the Ministry of Petroleum. Input has also been obtained from other stakeholder ministries and agencies in the agriculture, environment, gender and trade sectors. The Action Agenda therefore reflects the inputs from all these groups.

Prior to the SE4ALL initiative, Ghana already had an established institutional structure for its energy sector designed to achieve the country's energy policy objectives. In fact the country has already made significant strides in achieving its electricity access objectives, which is one of the three main pillars of SE4ALL. In addition, in the area of renewable energy, Ghana is certain of exceeding its share of the global SE4ALL goal of doubling the share of renewable energy in the energy mix before the end of 2015. Whilst the rate of improvement of energy efficiency is more difficult to quantify, Ghana already has several initiatives planned, and under way, which are likely to outperform the SE4ALL goals.

It was observed that Ghana's significant progress in the target areas of SE4ALL created a risk that the SE4ALL initiative in Ghana could become an expensive exercise in reorganising the country's energy sector interventions under the SE4ALL banner. To ensure that SE4ALL had a meaningful impact in Ghana, a strategic decision was taken to focus Ghana's action agenda on interventions that are likely to produce tangible additional benefits, by accelerating the pace of implementation through an increase in the available technical and financial resources or by unlocking or eliminating barriers to progress. This document provides targets up to 2020¹. This is because the national targets for 2030 are yet to be defined by the Strategic National Energy Plan which is currently under review. The 2020 targets focused mainly on the area of energy access, but have significant impact on renewable energy and energy efficiency.

¹ Ghana prepared a 30-Year Strategic National Energy Plan which ends in 2020. The plan is yet to be reviewed to enable targets beyond 2020 to be set.

In order to maintain the spirit of SE4ALL however, the overall scope of Ghana's energy sector is captured within this document to ensure that the context of Ghana's Action Agenda for SE4ALL is clearly understood within the context of Ghana's energy policy, strategy and objectives. Interventions outside the high impact opportunities will continue to be pursued using existing institutional arrangements, with minimal involvement of the SE4ALL secretariat.

Ghana's Action Agenda can be summarised as follows under the three pillars of SE4ALL, namely energy access, renewable energy and energy efficiency.

Energy Access (EA)

Ghana has made major strides over the years in increasing access to grid-supplied electricity in the country. In 2009 for example, 67% of the population had access to electricity; in 2011 the access rate was 72% and as of 2015 (January), the rate was estimated at 76% (Abavana, G. Clement Noxie Consult 2010; Ministry of Power, 2015). This sustained year on year increase in electricity access has been achieved through the country's National Electrification Scheme (NES) initiated in 1989 to extend the reach of reliable electricity supply to all parts of the country over a 30-year period (1990 – 2020). The NES is complemented by the Self-Help Electrification Project (SHEP) which accelerates the connection of communities within 20 km from an existing 33 kV or 11 kV sub-transmission line to the grid. Under the SHEP, communities bear the cost of all poles required for the LV network and ensure that a minimum of 30% of houses within the communities are wired.

This has however not been achieved without challenges, and the remaining communities that are yet to be electrified pose increasing challenges of cost-effectiveness due to the prohibitive cost of extending the transmission and distribution network, some through expensive underground cabling. These un-served communities are either small, sparsely populated or distant from the current transmission and distribution network; or are remotely located along river banks and island areas which could only be reached by expensive underground cabling. In the meantime, further extension of the grid is also constrained by the fact that over the last few years the country has been suffering from debilitating power cuts due to insufficient generation capacity in the country. Ghana's installed generation capacity has grown from 1,418MW in 2000 to 2,847MW in 2013. However, the unmet demand in 2013 was between 240 – 330MW. As a result, a total of about 700 – 800MW of additional generation capacity equivalent is needed to cover the shortfall of 2013 and a minimum of 20% reserve margin for 2014 (Energy Outlook for Ghana, EC 2014).

Following a similar generation shortage in the late 1980s, Ghana's power sector underwent a major reform, leading to a decision to attract private capital in the form of independent power producers (IPPs) to play a major role in supplying Ghana's generation requirements. The reforms included the formation of the Ghana Grid Company Limited (GridCo) to provide equal access to the transmission system, and the creation of the two regulatory bodies, the Energy Commission and the Public Utilities Regulatory Commission (PURC). The country currently has four IPPs in production with several new ones in various stages of preparation.

A major challenge faced by generation companies is the inadequate supply of gas as the preferred fuel for thermal generation. As a consequence, the country is forced to use the more expensive light crude oil (LCO) for a significant proportion of its thermal plants, which makes the generated electricity significantly more expensive than existing tariffs can fully support. The country is therefore seeking to ensure sufficient supply of natural gas through a combination of the West Africa Gas Pipeline (WAGP), domestic fields (the first of which is being supplied from the

recently commissioned Ghana Gas Plant at Atuabo), and liquefied natural gas (LNG) imports through private initiatives.

The generation of electricity from renewable sources avoids the requirement of fossil fuels, and this is also being actively pursued in Ghana. The government has a policy objective to increase the proportion of renewable energy in the national electricity mix to 10% by 2020. Towards this end, the government is promoting the exploitation and productive use of biomass, mini hydro, solar, tidal, waste-to-energy and wind energy resources.

Ghana's Energy Sector Strategy and Development Plan has set the vision to overcome the key challenges in the provision of adequate energy supply that would ensure universal access to modern energy by 2020. There are several simultaneous initiatives underway to increase the country's generation capacity, ensure sufficiency of gas supply, and provide the required electricity transmission and distribution infrastructure to deliver this electricity to a greater proportion of the Ghanaian population. Grid infrastructure has now been increased to 4,313.8km. This includes 219.5km of a high voltage (330 kV) line to curb transmission losses.

In assessing these initiatives however, it was observed that a particular segment of the Ghanaian population was at risk of being left behind because there was little likelihood of the grid being extended to them within the next 5 to 10 years. This segment of the population is dominated by those living around the Volta Lake, either on islands on the lake or within riverside communities accessible only by boat. These communities are therefore being provided with electricity using renewable energy technologies such as standalone solar PV and or hybrid mini-grids.

Ghana's first high impact SE4ALL target for electricity access is therefore to provide universal access to electricity for Ghana's island and riverside communities. This provides a strategic focus on an area which critically requires policy and investment interventions to ensure that a critical section of Ghana's population is not left out of the provision of electricity.

Another observation from the successes achieved in Ghana's grid extension programmes is that the availability of grid electricity did not generally produce the expected increase in productive activities in electrified communities. This is a significant source of concern as the vast amounts of money spent on grid extension schemes is partly based on an expectation of increased productivity and consequently prosperity of electrified communities. The absence of this increase in productivity provided the second high level opportunity in the electricity access sector, namely the increase in productive use of electricity.

Ghana's second high impact SE4ALL target for electricity access is therefore to increase the productive use of electricity in both on and off-grid electrified communities, through targeted interventions.

Whilst electricity usually captures all the focus when energy access is discussed, it is not the dominant form of energy consumed in the country. Woodfuel (in the form of charcoal and firewood, used for cooking and heating) comes second after petroleum products contributing about 38.9% of the total energy consumed in 2013 (Energy Statistics, 2013). Woodfuel is identified as an area of great importance in this Action Agenda. About 72.8% of Ghanaian households use woodfuel as their primary fuel for cooking (Ghana Living Standards Survey Round 6, 2014), and most do so with traditional, inefficient and unhealthy cook stoves.

Several programmes have been undertaken over the years to create awareness on the availability of improved cook stoves, and to facilitate the distribution of modern cooking appliances and fuels with positive health implications. A number of initiatives have also been undertaken under the National LPG Promotion Programme to encourage the use of LPG for cooking.

Ghana's third high impact SE4ALL target is therefore to provide universal access to clean cooking solutions by 2020. This is to be achieved by transitioning 50% of households to the use of LPG as their primary cooking fuel, and providing access to improved and efficient cook stoves for those that continue to use woodfuels.

Renewable Energy (RE)

Ghana is committed to the sustainable development and productive use of renewable energy to address energy access issues, contribute to the fight against climate change, resolve sanitation problems and create sustainable green jobs for Ghanaians. The renewable energy resources currently being exploited are wind, solar, biomass, ocean energy and (mini)hydropower. Considerable research work has been completed on all these identified resources and sustainable exploitation has already begun.

Existing renewable energy power plants in Ghana include the Volta River Authority's 2.5 MW solar plant at Navrongo, Noguchi's 0.72 MW solar plant at Legon in Accra and Juabeng Oil Mill's 1.2 MW biomass plant. There are other renewable energy projects in the pipeline. These include a 20 MW solar plant under construction in Winneba and a 14 MW tidal wave project at Ada Foah.

To achieve sustainable access, programmes on the sustainable exploitation and efficient use of renewable energy resources are vigorously being pursued locally. The Government of Ghana also strives for an alignment of its national policies and programmes with the ECOWAS regional policies and initiatives. For example, the National Energy Policy (2010) aims to ensure its efficient production and productive use and to increase the proportion of renewable energy in the national electricity mix to 10% by 2020; the policy further aims to convert most of the waste generated in municipal activities, industrial and agricultural operations to energy and to contribute to the mitigation of climate change (Energy Statistics, 2013). Renewable Energy Act, 2011, Act 832, provides incentives, especially a feed-in-tariff mechanism which guarantees rates, purchase obligations and connection to transmission and distribution lines for renewable energy production; so far 52 companies have taken advantage of this law and they are at various stages of the licensing process².

Renewable energy is currently (2015) contributing 0.3% to the electricity generation mix, but the National Energy Policy (2010) has a goal of reaching a 10% contribution of renewable energy in the electricity generation mix by 2020.

As mentioned previously, renewable energy is being used to provide electricity to island and lakeside communities that cannot be connected to the national grid in the immediate future. Implementation has begun for four pilot mini-grid projects, and this is expected to be scaled up to cover more communities once the business model is finalised.

Energy Efficiency (EE)

The Strategic National Energy Plan (Updated 2015) indicates that electricity supplied to consumers is wasted through transmission and distribution losses, inefficient electrical equipment, and poor attitudes towards energy conservation and illegal connection. The Government of Ghana intends to improve energy efficiency by reducing transmission

² Source: www.energycomm.gov.gh 15/02/15

losses from the 2015 rate of 4.0% to 3.8% by 2020 and distribution losses reduced from 9.0% (2015) to 8.5% in 2020 given a combined total loss of 12.3% by 2020 (See section 2.3) to ensure effective supply and utilization of energy. To this end, several measures aimed at improving energy efficiency in the country have been introduced including the following:

- i. Automatic capacitor banks were installed in 32 public institutions between 2009 and 2012 and 3,726kVA were being saved monthly;
- ii. The government has also begun to replace 50,000 old and inefficient refrigerators through a rebate scheme and this action was estimated to save 27,000MWh at the end of the first phase of the project, 2012. The project is ongoing but an evaluation at 2013 showed that the importation of used refrigerators had dropped from 420,000 units in 2012 to 152,000. This is translated into savings in electricity consumption of 160.8MWh per year.;
- iii. For savings in petroleum products, importation of over aged vehicles (10 years and above), has been banned. The target was to achieve 15% savings on petroleum product consumption by 2012. (Energy Sector Strategy and Development Plan, 2010; Energy Statistics, 2013).

Energy efficiency is also being sought for by reducing losses in electricity transmission and distribution. Transmission losses in 2014 were 4.1%, which shall be reduced further to 3.8% in 2020. For distribution losses, the aim is to reduce them from the 2014 level of 10% to 8.5% in 2020. (Strategic National Energy Plan updated, 2015).

In the cooking sector, the promotion of improved and efficient cook stoves is expected to significantly reduce the consumption of charcoal and firewood.

The SE4ALL target is to ensure that all households using charcoal or firewood for cooking will use improved energy saving cook stoves by 2020. Woodfuel stoves in Ghana should have a minimum efficiency of 30%.

Legal and regulatory framework

To achieve the targets of the SE4ALL, the supporting policies, regulatory and legal framework are also being tackled. A total of 18 policies, legislative instruments (LI) and acts have been passed. These cover areas such as funding, regulations, fiscal, standardization, utilisation and access towards renewable energy, energy efficiency and energy access. These are meant to provide step by step procedures by which all actions in relation to renewable energy, resource development and distribution can be procured.

In 2011, the Renewable Energy Act 832, was passed by parliament which provides the legal and regulatory framework for renewable energy. Importantly, it introduced the feed-in-tariff mechanism. This guarantees the feed-in-tariff rates, renewable energy purchase obligation and connection to the transmission and distribution system.

Capacity building

In envisaging an increased RE contribution up to 10% in the energy generation mix by 2020, there is the challenge of limited capacity to install, operate, maintain and manage the RE systems. This is being addressed through capacity building programmes which have been initiated. For example:

- i. The University of Energy and Natural Resources was established during the 2012/2013 academic year. This brings the total of public universities in Ghana to nine (9), all of which offer science and engineering courses. In 2012/2013 the number of science and engineering students increased by 10.1% (4,588) compared to the previous year. (Source: NCTE Statistical Digest, 2012/2013);
- ii. The KNUST Energy Center has initiated a graduate programme in renewable energy development. The Center offers professional training to RETs practitioners and policy makers;
- iii. DENG Solar Training Center, a private company, also offers training for technicians in solar energy and technologies.
- iv. Kumasi Institute of Technology, Energy and Environment also offers capacity building courses in energy, technology and environment

These and all other implemented and planned measures contained in this SE4ALL Action Agenda are to work concurrently and in a complementary fashion to ensure the attainment of the SE4ALL target of universal energy access by 2020. To further support the development of the renewable energy and energy efficiency sectors, national action plans for renewable energy and energy efficiency are currently being drafted, containing concrete targets and projections together with policy measures for implementation.

Preamble

Effective and sustained access to energy plays a significant role in improving people's living conditions, and contributes to economic and human development. Energy provides services to meet many basic human needs, particularly heat, mechanical power (e.g. water pumps and transport) and light. Business, industry, commerce and public services such as modern healthcare, education and communication are also highly dependent on access to energy services.

Based on this, Ghana, among other African countries, signed up to the ECOWAS Renewable Energy Policy and the ECOWAS Energy Efficiency Policy (2013)³ that enjoined all fifteen (15) ECOWAS member states to develop a National Renewable Energy Action Plan (NREAP) and a National Energy Efficiency Action Plan (NEEAP) by the end of 2014. The entire process was to be coordinated by ECREEE which was also to be aligned with the road map for developing the Sustainable Energy for All (SE4ALL) initiative. The process was to be based on eight (8) key principles being:

- (i) Building on existing plans/programmes/strategies;
- (ii) Political commitment and leadership;

³Supplementary Act A/Sa.3/07/13 on the ECOWAS Renewable Energy Policy; Supplementary Act A/Sa.2/07/13 on the ECOWAS Energy Efficiency Policy

- (iii) A balanced and integrated approach;
- (iv) An inter-ministerial and cross-sectoral approach;
- (v) Adherence to sustainable development principles;
- (vi) Participation and meaningful involvement of all stakeholders;
- (vii) Gender equality and inclusiveness; and
- (viii) Transparency and accountability.

Ghana has shown substantial commitment to these key principles as seen in its medium term development plan for 2014 – 2017 under the theme: Ghana Shared Growth Development Agenda II (GSGDA II). The thematic areas of this medium term plan include:

- i. Ensuring and sustaining macro-economic stability;
- ii. Enhancing competitiveness in Ghana's private sector;
- iii. Accelerated agricultural modernisation and sustainable natural resource management;
- iv. Oil and gas development;
- v. Infrastructure, energy and human settlement;
- vi. Human development, productivity and employment;
- vii. Transparent and accountable governance;
- viii. Enabling environment for effective plan preparation and implementation;
- ix. Monitoring and evaluation.

These thematic areas are supportive of the principles guiding the preparation, implementation and the achievement of the SE4ALL initiative. To this end, the Government has committed itself to the medium term plan and is vigorously pursuing the attainment of the goals in each thematic area. For example, the 2015 National Budget which has the theme "Transformational Agenda: securing the bright medium term prospects of the economy" is to oversee the implementation of the GSGDA II for 2014 – 2017. The total expenditure budget for 2015 for the Ministry of Energy and Power is estimated at GHS799, 615,234ie. 19.3% of the national budget (Budget Statement and Economic Policy, 2015 financial year, November 2014).



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ABBREVIATIONS AND ACRONYMS

ATK	Aviation Turbo Kerosene
BDC's	Bulk Distribution Companies
CAP	Country Action Plan
CAPEX	Capital Expenditure
CBO	Community Based Organizations
CEPS	Customs Excise and Preventive Service
CC	Climate Change
DP	Development Partners
EA	Energy Access
EC	Energy Commission
EE	Energy Efficiency
ECG	Electricity Company of Ghana
ECREEE	ECOWAS Center for Renewable Energy and Energy Efficiency
EDEEB	ECOWAS Directive on Energy Efficiency in Building
EPC	Enclave Power Company
ESM	Environmental Sound Management
GCMC	Ghana Cylinder Manufacturing Company
GDP	Gross Domestic Product
GEDAP	Ghana Energy Development and Access Projects
GRIDCO	Ghana Grid Company
GSA	Ghana Standards Authority
GSB	Ghana Standard Board
GSGDA	Ghana Shared Growth Development Agenda
GLSS	Ghana Living Standard Survey
GWh	Gigawatt-hour
ha	hectare



HDI	Human Development Index
ICS	Improved Cook stoves
IMIAM	Inter Ministerial and Inter Agency Meeting
IPP	Independent Power Producer
KNUST	Kwame Nkrumah University of Science and Technology
ktoe	kilotonne of oil equivalent
kV	kilo Volt
kVA	kilo Volt Amperes
kW	kilo Watt
kWh/m ²	Kilo Watt hour per square metre
LPG	Liquefied Petroleum Gas
MEPS	Minimum Energy Performance Standards
MMDA	Metropolitan, Municipal and District Assemblies
MoP	Ministry of Power
m/s	metre per second
MSA	Meteorological Service Agency
MVA	Mega Volt Amperes (1,000,000 Volt Amperes)
MVE	Monitoring Verification and Enforcement
MW	Mega Watt
NEDCo	Northern Electricity Distribution Company
NEEAP	National Energy Efficiency Action Plan
NES	National Electrification Scheme
NITS	Network Integrated Transmission System
NPA	National Petroleum Authority
NREAP	National Renewable Energy Action Plan
OMCs	Oil Marketing Companies
OPEX	Operating Expenditure



PSFM	Participatory and Sustainable Forest Management
PPA	Power Purchase Agreement
PPP	Public Private Partnership
PURC	Public Utilities Regulatory Commission
PUE	Productive Use of Energy
RE	Renewable Energy
REEEP	Renewable Energy and Energy Efficiency Partnership
REPO	Renewable Energy Programme Office
SE4All	Sustainable Energy for All
SHS	Solar Home System
SMEs	Small to Medium Enterprises
SNEP	Strategic National Energy Plan
SPPD	Strategic Planning and Policy Division
TPES	Total Primary Energy Supply
VRA	Volta River Authority
WACCA	West African Clean Cooking Alliance

1. Introduction

Geography

Ghana is located within latitudes 4°44'N and 11°11'N and longitude 3°15'W and 1°12'E. It shares boundaries with Cote d'Ivoire (west), Burkina Faso (north), Togo (east) and the Gulf of Guinea in the south. It lies about 750 km north of the Equator and has a total surface land area of 238,539 km² of which 3,275 km² is occupied by water bodies. The coastline is about 539 km long.

Figure 1: Regional Map of Ghana



The climate is tropical; comparatively warm and humid in the south but hot and dry in the north. The average daily temperature is about 30°C and the annual rainfall varies between 2,200 mm in the south, 900 mm in the north and about 700 mm along the eastern coastal belt. Ghana has 22,754 km² of *on* and *off* forest reserves under protection.

Demography

The population of Ghana is estimated at 26.3 million (2013) with a growth rate of 2.4% which is below the average growth rate of Sub-Saharan Africa of about 2.9%. Females constitute 51.7%, males 48.3% while 50.2% are urban

and 49.8% rural (GLSS 6, 2014). The population density is 102 persons per square km (2010 Population Census). The average life expectancy in Ghana is 62.25 years for women and 59.78 years for men. The overall life expectancy is 61 years (2011 estimates).

As at 2013, females constituted 48.2% of persons enrolled in basic, secondary and tertiary educational institutions in Ghana and of the total (males and females) enrolled, 38.2% were studying science and engineering at the tertiary level (NCTE Statistical Digest 2013).

Politics

Ghana is governed by a parliamentary democracy headed by an Executive President with a four year term renewable for one additional term only. Administratively, Ghana is divided into 10 regions. As at 2013 Ghana had 216 metropolitan, municipal and district assemblies (MMDAs) in support of a decentralized system of governance as approved by the 1992 Republican Constitution. Each of these MMDAs is headed by a chief executive of which 17 (7.8%) are women; there are 275 members of parliament and 30 (10.9%) are women.

Economy

The Ghanaian economy grew at an average annual rate of 5.9% in 2010 (Ghana Statistical Service, 2010). In 2013 the gross domestic product (GDP) was US\$48,678m and the per capita income was US\$1,858.24m. The Human Development Index⁴ (HDI) was 0.573 in 2013. At this level, Ghana ranked 138th in the world's league table and 13th in Africa (HDR 2013 & 2014). The employment rate is 97.7% with 86.1% being in the informal sector. Agriculture employs 51.2% but those employed in the energy sector account for only 0.2%. By the sector, the industrial sector recorded the highest growth of 7% and contributed 28.3% to GDP, followed by the services sector at 6.1% which contributed 38.7% to GDP. The agriculture sector also recorded 4.8% and contributed 35.6% to GDP (Ghana Statistical Service, 2012). Ghana produces gold, bauxite, oil and gas in commercial quantities and has reserves of iron ore.

Energy sector

The energy sector in Ghana is considered a key to achieving the economic development goals; as such it has been structured in a manner to function efficiently. To this end, the sector operates under three main sub-sectors, namely the power (hydro and thermal), petroleum and the renewable energy sub-sectors. The power and renewable energy subsectors are overseen by the Ministry of Power (MoP) while petroleum is handled by the Ministry of Petroleum (MoPet). MoP and MoPet formulate policies, monitor and evaluate the implementation of government programmes in the energy sector. There are also regulatory agencies that provide licensing for operation of upstream and downstream operations. These agencies further ensure standardization of equipment and technology for the purpose of energy efficiency and improved access. Ghana Standards Authority which operates outside the direct control of MoP and MoPet, develops standards for both imported and locally produced energy equipment.

⁴HDI measures the well-being of the individual in terms of life expectancy, length of education and income.

Ghana relies on imported and indigenous sources for energy. Among the imports are petroleum and petroleum products, electricity and gas. Locally, petroleum has been produced in commercial quantities since 2010; hydro power is also generated locally while other locally available renewable energy sources also compliment the indigenous sources. Apart from hydropower, the renewable sources currently being exploited are solar, wind, ocean or tidal wave, biomass, biogas and bio fuels.

The total energy consumption increased from 5,670.2 ktoe in 2010 to 6,886.2 ktoe in 2013, representing an increase of 21.4% (see Table 1). Table 2 presents energy consumption by sector and by source. It shows that firewood remains the dominant energy source for residential consumption, between 2010 and 2013, 40.2% and 41.3% respectively. Charcoal consumption reduced by 2.2% in 2013 compared to 2010 while electricity consumption increased by 1.7% for the same period.

In terms of consumption by sector, the residential sector is the highest consumer (43.4%) of energy in Ghana as of 2010. This is followed by the transport sector (34.3%) in the same year. The main sources of energy (energy carriers) are petroleum products and firewood. Petroleum products account for 43.9% and firewood accounts for 26.8%. Woodfuel, consisting of charcoal and firewood contributes 43.5% of the total energy supplied in 2010 (see Table 2 & Figure 2).

From Table 1, the Total Primary Energy Supply (TPES)⁵ in 2010 was 6,865 ktoe and this has increased to 8,556 ktoe in the most recent year, 2013.

Table 1: Total primary energy supply

Year	Total primary energy supply (ktoe)
2010	6,865
2011	7,557
2012	8,316
2013	8,556

Source: Energy Commission, Energy Statistics 2014

In 2010, (Table 2) the residential and transport sectors consumed 43.3% and 34.3% respectively of the total energy.

⁵Total Primary Energy Supply (TPES) is made up of: Indigenous production + imports - exports - international marine bunkers - international aviation bunkers +/- stock changes.

Table 2: Energy consumption by sector and energy carrier⁶ in ktoe for the year 2010

Sector	Petroleum products	Electricity	Firewood	Charcoal	Total per sector	% by sector
Transport sector	1,947.3	-	-	-	1,947.3	34.3
Industrial sector	311.5	255.3	326.7	47.2	940.7	16.6
Tertiary sector (commercial and services)	18.9	120.2	83.6	28.3	251.0	4.4
Agriculture and fisheries sector	72.2	1.4	-	-	73.6	1.3
Residential sector	141.4	338.3	1,109.1	868.8	2,457.6	43.3
Total	2,491.3	715.3	1,519.3	944.3	5,670.2	100
% by Energy Source	43.9	12.6	26.8	16.7	100	

Source: Energy Commission, Energy Statistics 2014

Institutional and regulatory framework

The Ministries of Power and Petroleum are the key actors in the energy sector. Their major role is to formulate policies, monitor and evaluate the implementation of government programmes.

Table 3 shows the key institutions in the energy subsectors and their responsibilities.

The power sub-sector has multiple bodies such as VRA, IPPs, GRIDCo, ECG, NEDCo, and EPC who are in charge of either power generation or transmission or distribution. The Petroleum sub-sector also has bodies such as GNPC, Tema Oil Refinery and the bulk distribution companies which are in charge of production, refining, transportation and distribution of oil products.

Five bodies are key in the area of regulations: the Public Utilities Regulatory Commission, the Energy Commission, the National Petroleum Authority, the Petroleum Commission and the Environmental Protection Agency. Their combined operations include approval of tariffs, licensing operators both upstream and downstream of the petroleum sector and enforcing technical standards in the entire energy sector.

⁶This is referred to as 'energy source' in the text.

Table 3: The key energy subsectors and institutions

MINISTRY/AGENCY	RESPONSIBILITIES
MINISTRY OF ENERGY MINISTRY OF PETROLEUM	Policy formulation, monitoring and evaluation, and implementation of government programmes
POWER SUB-SECTOR: i. Volta River Authority (VRA); ii. Bui Power Authority; iii. Independent Power Producers (IPPs); iv. Ghana Grid Company (GRIDCo); v. Electricity Company of Ghana (ECG); vi. Northern Electricity Distribution Company (NEDCo); vii. Enclave Power Company (EPC).	i. Power generation; ii. Power generation; iii. Power generation; iv. Power transmission; v. Power distribution in southern Ghana; vi. Power distribution in northern Ghana; vii. Power distribution in the Free Zone Area.
PETROLEUM SUB-SECTOR: (i) Ghana National Petroleum Corporation; (ii) Tema Oil Refinery (TOR); (iii) Bulk Distribution Companies; (iv) Bulk Oil Storage and Transportation; (v) Company (BOST); (vi) Oil Marketing Companies (OMCs); (vii) Ghana Cylinder Manufacturing Company; (viii) Ghana National Gas Company.	(i) Oil and gas exploration, development and production; (ii) Crude oil refining and sale of petroleum products (iii) Petroleum products importation and sale (iv) Bulk petroleum products transportation and storage (v) Petroleum products distribution (vi) LPG cylinder manufacturing (vii) Processing of natural gas products
REGULATORY AGENCIES: i. Public Utilities Regulatory Commission (PURC); ii. Energy Commission (EC); iii. National Petroleum Authority (NPA); iv. Petroleum Commission;	i. Approval of electricity, water and natural gas tariffs; monitoring of quality of service and consumer protection; ii. Licensing of operators in the power, natural gas and RE sectors and setting technical standards for their performance, sector planning and policy advice to the Minister



<p>v. Environmental Protection Agency.</p>	<p>of Energy and Petroleum;</p> <p>iii. Licensing of operators in the petroleum sector at the down stream and setting of technical standards and enforcement;</p> <p>iv. Licensing and regulating of operators in the petroleum sector at the upstream;</p> <p>v. Provides exploration and production permits to operators in the petroleum sector.</p>
<p>GHANA STANDARD AUTHORITY</p>	<ul style="list-style-type: none"> • Develops standards for energy equipment, both imported and locally produced and passed on to the regulatory agencies for enforcement.

1. Vision and targets until 2020

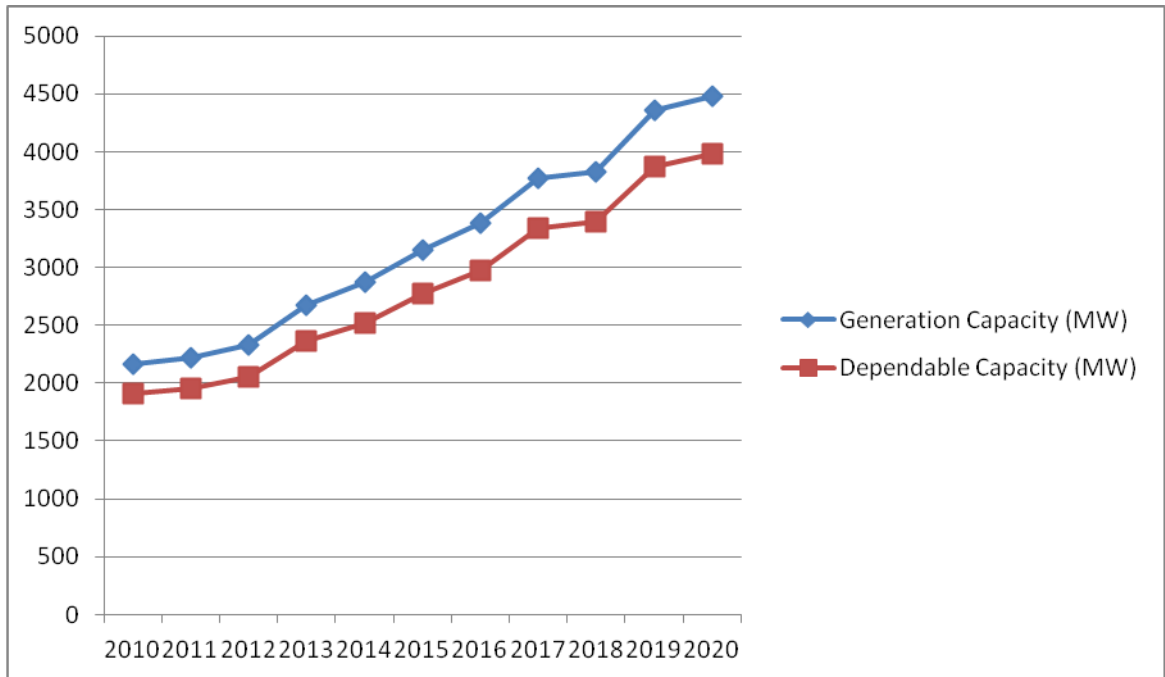
1.1 Energy sector trajectory

The vision of the Ghanaian energy sector is to develop an energy economy that will ensure the secure and reliable supply of high quality energy services for all sectors of the national economy, and to become a net exporter of oil and power by 2020. The goal of the sector is to make energy services universally accessible and readily available generated and used in an environmentally friendly and sustainable manner.

The generating capacity has grown from 1,418 MW in 2000 to 2,165 MW in 2010 and was projected to be 3,154 MW in 2015 (Figure 2). However, the current (2015) installed capacity is 2,955 MW of which 54% (1,588.2 MW) are large hydro and modern renewable. The goal of the power sub-sector is to increase installed generation capacity to about 5,000 MW in 2020 (see Figure 2). The dependable capacity⁷ is expected to increase from 2,769 MW in 2015 to 3,984 MW in 2020, see Figure 2 (Energy Commission, SPPD, 2015).

⁷Dependable capacity level is the actual generation capacity. The installed capacity (name plate) as of 2013 was 3,081.0 MW (Source: Energy Statistics, Technical Division; Energy Commission, 2013)

Figure 2: Installed electricity generation capacity (MW) trajectory in Ghana: 2000-2020



Source: Energy Commission (SPPD 2015) & GRIDCO Sources

Delays in implementation of power projects have contributed to the debilitating power crisis that Ghana continues to face. Immediate plans to resolve this crisis (as of November 2015) include the contracting of independent power producers (IPPs) to bring in emergency power generation of about 700 MW. These include two power ships from Turkey to be berthed in Tema and Takoradi. The first of which arrived at the end of November 2015.

In the longer term, the strategies to increase the capacity beyond 5,000 MW are based on attracting IPPs to invest in power generation in Ghana. Already a number of these IPPs are in various advanced stages of implementing their projects. The CENPOWER project in Kpone⁸ has started construction, likewise Jacobsen and Amandi projects⁹ that are located in Aboadze.

Apart from the electricity generation capacities that are to be improved, there are other sub-sector plans. The petroleum sub-sector has a goal to pursue sustainable exploration, development and production of the country's oil and gas endowment. Gas fields are being actively developed with a view to meeting the needs of existing and future thermal power generation plants. The Jubilee field is already serving the VRA power plants at Aboadze, and the Sankofa fields of the Off-Cape Three Points (OCTP) project is set to meet the needs of the new power plants planned for the next few years.

With the RE sub-sector, the target is to increase the proportions of renewable energy in the total national electricity mix by 10% in 2020 and ensure its efficient production and use. This is to be achieved through a combination of

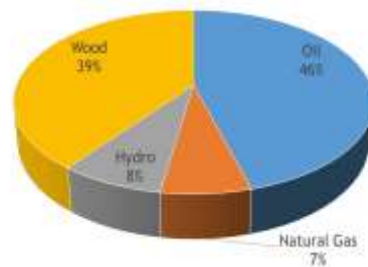
⁸This is a 340MW gas and oil fired combined cycle power plant been developed by Infra Co African. Commercial operation begins by 2016.

⁹Jacobson and Amandi projects are 360MW and 239MW combined cycle power plants, respectively, that have begun construction and expected to begin operation in 2017.

utility scale renewable energy power generation that will be connected to the national grid, rooftop and other distributed generation that will be located in the premises of the consumers and also connected to the grid, and finally a number of off-grid systems, both stand-alone solar home systems and community mini-grids.

The entire sector is to provide sufficient energy for development to meet the energy demands by 2020 to sustain a middle income economy. The total primary energy supply (TPES) in 2010 was 6,865 ktoe and increased to 8,556ktoe in 2013 and 9,147 ktoe in 2014 (see Figure 3). Even though there was a percentage increase of 6.9% over 2013 TPES, it still fell short of the projected total energy required (11,620 ktoe) in 2014. The projected demand for 2015 is 11,911ktoe and is expected to increase to 13,509 ktoe in 2020 (Table 4).

**Total Energy Supply in 2014
(9,147ktoe)**



Source: National Energy Statistics, 2005-2014

Wood fuel energy supply is expected to dwindle from 61.4% in the overall energy mix in 2012 to 53.7% in 2020. However, the share of petroleum products will ascend from 28.8% in 2012 to 33.1% in 2020. Electricity supply is expected to grow from 9.7% of the market share to 13.1% over the same period.

Table 4. Total energy required by 2020*based on business-as usual economic growth rate

Year	2012	2013	2014	2015	2016	2017	2018	2019	2020
ENERGY FORM	1,000 Tonnes of Oil Equivalent								
Biomass energy required	6,737	6,844	6,880	6,952	7,023	7,095	7,167	7,238	7,260
% share	61.4	60.1	59.2	58.4	57.5	56.6	55.7	54.8	53.7
Petroleum products required	3,161	3,251	3,392	3,549	3,715	3,890	4,075	4,271	4,478
% share	28.8	28.6	29.2	29.8	30.4	31.0	31.7	32.4	33.1
Electricity required	1,066	1,289	1,348	1,410	1,475	1,544	1,616	1,691	1,771
% share	9.7	11.3	11.6	11.8	12.1	12.3	12.6	12.8	13.1
Total	10,964	11,384	11,620	11,911	12,213	12,529	12,858	13,200	13,509

±2%

Source: Energy Commission, Ghana; Energy Projections 2012-2020

*Projections beyond 2020 are not available.

1.2 Energy access target until 2020

Ghana has made considerable gains in respect of expanding energy access and has major ongoing programmes that are likely to lead to the achievement of universal access¹⁰ by 2020. Aspects of the programme include the following:

I. Electricity (on-and off-grid access)

Access to electricity in particular is a function of availability and affordability, therefore a number of measures (see 2.1.3) have been put in place to achieve universal access. In 2009, electricity access was 67% and in 2011 access increased to 72% and as of 2015, the coverage is 76%.

II. Productive use of energy (PUE) ¹¹

The productive application of energy has the potential to boost local economy, improve income, and stimulate social development. The general perception is that providing access to electricity will stimulate some energy based economic activities. The targets for PUE by 2020 are:

- (i) 250 grid connected irrigation schemes for small scale farmers in remote areas;
- (ii) 50 aquaculture ventures that would be fitted with cold store facilities;
- (iii) Establishing 10 medium scale salt production ventures.

The technologies or the energy sources on which these measures would be based will be identified in a feasibility study to be conducted during the implementation of the programmes.

III. Non electricity: clean cooking (improved cook stoves and LPG)

The government has introduced improved cook stoves on the Ghanaian market as part of the effort to improve energy efficiency and its productive use. The improved cook stove market in Ghana is dominated by charcoal and firewood stoves. Stoves using pellets and other biomass fuels form the minority. There are four distinguished local manufacturers of improved charcoal stoves; six manufacturers of firewood stoves (commercial size) and two manufacturers of stoves using pellets. There are also a couple of entrepreneurs from the diaspora who are actively promoting solid biomass and bio-gel .

Although improved cook stoves were introduced in Ghana as far back as the 1990s by the Ministry of Energy (the *Ahibenso* stove and others) stimulating the market and attracting private sector participation and drive, awareness on the products available and benefits is still limited. The cook stove subsector is largely unregulated. To increase awareness of improved cook stoves and benefits, and boost consumer confidence in the products on the market, the government is developing standards and labels to regulate the subsector and challenge the manufacturers to improve the quality of their stoves. National awareness raising campaigns will be organised to sensitize and

¹⁰Universal Access refers to all forms of electricity – both on-grid- and off-grid/mini-grid,

¹¹This programme does not have a target date yet as it is now being formulated and much also depends on funding sources

educate the general populace on the cook stove standards and labels to be developed, and the benefits of using improved cook stoves and cleaner cooking fuels like LPG.

Full implementation of these measures will reduce traditional biomass consumption, alleviate the impact on natural resources (forests, habitats, etc.) and on climate and will significantly reduce particulate and carbon monoxide emissions (reducing adverse health effects). At the same time, they will reduce the time people (usually women and girls) have to spend collecting fuel, allowing the accumulated time saved to be spent on a range of livelihood-enhancing activities (e.g., income-producing enterprises for women, health care, and school attendance for children). Reductions in emissions achieved by clean cook stoves can also potentially create revenues from carbon credits. More broadly, the entire clean cook stove supply-chain can be a potential source of economic opportunity and job creation at the local level. For example, the vision of GoG to promote the adoption of improved charcoal stoves through the *Ahibenso* Project was carried on by organisations such as Enterprise Works Ghana, Climate Care and Toyola Energy Limited (indigenous private 21 sector firm) who actively promoted improved cook stoves in 2002. These organizations sold over 480,000 stoves (as at 2011) and have trained the manufacturers of improved cook stoves, they have also established markets for cook stove distributors and retailers that are currently operating self-sustaining businesses.

The main factors to be considered in scaling up the adoption and use of improved cook stoves include:

- Needs and preferences of users, i.e. ensuring that cook stove designs are based on needs and preferences of the users, shape, color, and size;
- Durability and performance of devices, i.e. the need to ensure quality control and standards;
- Access to finance, i.e. facilitating credit for SME manufacturers of cook stoves and ensuring affordability for majority household consumers, including consumer credit;
- Stakeholder participation, i.e. ensuring active participation of the private sector, banks, communities, community-based organizations, government and NGOs;
- Public awareness, i.e. sustaining education, awareness and outreach activities to accelerate adoption; and
- Market-based programme design and implementation, i.e. ensuring relevant investment and marketing partners are in place for commercialization and scaling up.

The targets for access to clean cooking solutions are adoption of LPG as the primary cooking fuel by 50% of the Ghanaian populace by 2020; adoption of improved and energy efficient biomass stoves by two (2) million households and 1,000 institutional and commercial users.

1.3 Renewable energy target until 2020

Ghana's policy objectives for renewable energy (RE) are the following:

- To support sustained development of RE technologies through legislation, fiscal incentives, and attractive pricing;
- To support the use of decentralised off-grid technologies;
- To promote the establishment of dedicated woodlots / energy crops for biofuel production for cooking, heating, power generation and transportation;
- To balance biofuel development against food security;
- To promote the production and use of improved and more efficient biomass utilisation technologies;
- To promote the use of alternative fuels; and
- To support indigenous research and development to reduce the cost of RE technologies.

The combined effect of these policy objectives is to achieve 10% RE in the electricity mix by 2020 from its current (2015) level of 0.3%. These are mainly to be derived from wind, biomass/waste to energy, solar PV systems and small hydro sources (SNEP 2006-2020).

In terms of contribution to grid generation capacity, it is projected that RE will contribute 0.39% in 2016, 1.40% in 2020 (Table 5).

It is also projected that households using RE would have increased from 0.17% in 2010 to 0.28% in 2014 and finally to 2.15% in 2018. This growth in the use of RE by households would be a result of increased availability of RE products on the market along with the projected increased generation capacity during the respective period (PHC of Ghana 2010).

Table 5: Projected RE % share of RE grid generation capacity and household use of RE products

Year	2010	2012	2014	2016	2018	2020
% of grid generation capacity*	0.0	0.0	0.11	0.39	0.73	1.40
% share of households using RE**	0.17	0.22	0.28	0.92	2.15	-

Source: * Energy Commission SPPD 2015, **Population and Housing Census of Ghana 2010

This has led to the passage of the RE Act, 2011 Act 832. To support the implementation of this policy and its programmes, about seven enabling regulations have been passed in the EE, EA, RE areas since 1970 (Annex 1); these include those that promote direct investment, while others provide tax relief and some remove discriminatory laws. These regulations are meant to attract independent power producers (IPPs), individuals and companies to invest in RE based on a net-metering scheme.

The forms of renewable energy that are being exploited in Ghana are tidal wave, wind, biomass, bio-fuel, solar and hydropower. It is expected that in the first two years, solar energy will dominate, followed by wind, waste-to-energy and hydro power (it takes a relatively long period to develop hydro power). About 52 companies have secured licenses for utility scale RE power generation plants. Two of these (one solar and the other wave energy) have already started construction works, and several other solar projects are expected to commence construction by the end of 2015.

A major drive to implement distributed grid-connected RE generation (mainly solar) is also being promoted under the net-metering scheme. Special bi-directional meters have been procured by the ECG and these will be installed at selected customer premises to pilot the billing and metering procedures required to implement the net-metering scheme. Net-metering sub-code for connecting renewable energy generating systems to the distribution network in Ghana have been completed (January 2015)¹². It is expected that the programme will go live nationwide by the end of 2015.

In addition to the above, other off-grid solutions using various RE systems are being implemented. These include solar lanterns, solar home systems (SHS) and micro-and mini-grid RE systems. The energy services of all the above mentioned solutions will contribute to the achievement of universal access to electricity within the planned period.

The target for the renewable energy policy and efforts by 2020 are:

- i. 10% renewable energy in the national electricity generation mix;
- ii. 55 renewable energy mini grids built;
- iii. 33,000 stand-alone electrification schemes in remote and off-grid communities;
- iv. 200,000 roof top solar systems (including net metering schemes);
- v. 2 million solar lanterns distributed nationwide;
- vi. 1,500 sustainable woodlots;
- vii. 500 irrigation schemes (wind and solar);
- viii. 250 solar dryers;
- ix. 200 biogas systems.

The following measures have been proposed to be implemented to ensure the attainment of the targets:

- The regulatory instruments will be fully developed and made operational. These include RE Act 832, feed-in-tariff, the Renewable Energy Programme Office (REPO), technical codes, the RE Fund and GIPC tax exemption regulations;

¹² The sub-code constitute an addendum to the National Electricity Distribution Code.

- The following utility scale RE will be promoted for adoption and implementation through private participation: biomass/waste-to-energy, small hydro, 150 MW solar PV and 300 MW wind power generation plants;
- Standards will be developed and testing centres for solar PV systems will be established;
- independent power producers would be encouraged through regulatory instruments to contribute to power generation and reduce demand on public utility companies;
- Tax exemptions on renewable energy systems would continue to be implemented;
- Local content policy will be developed and made operational to ensure that the citizens of Ghana benefit from any foreign investment to ensure the retention of capital in the country for improving the standard of living of the people;
- Develop and implement bioenergy policy:
 - Develop the supply chain of the woodfuel sector;
 - Promote alternative fuels e.g. briquettes and pellets using crop residue and carbonized bamboo;
 - Liquid bio-fuels for cooking, heating and transportation.
- Conduct feasibility studies to establish the viability or otherwise of the interventions;
- Develop sustainable business models;
- Capacity building on productive uses of energy;
- Awareness creation on productive uses of energy;
- Improve access to finance.

Charcoal production and utilisation

Sustainable charcoal production and utilisation programmes are being implemented in a bid to improve PUE from RE sources. For example it takes 4-6 units of wood (depending upon the type or species and also the moisture content) to produce one unit of charcoal. Charcoal for the export market is regulated by the Energy Commission to ensure that the feedstock used is from a sustainable source (off-cut from forest resources, sustainable woodlot, or waste wood from saw mills) and not harvested from the wild. Currently, most efficient technologies used in charcoal production are used by exporters of charcoal and not local producers. The government has also embarked upon the establishment of woodlots and forest plantations during which 500,000 ha of plantation would be established. (Ghana Forest Plantation Strategy: 2015-2040, Forestry Commission 2013). The primary focus is to produce round wood for both local and external markets but the off-cuts and the residue from the timber industry could be used for charcoal production. The Energy Commission is promoting the establishment of woodlots in senior high schools for cooking and other purposes and has under the pilot phase of the project facilitated the establishment of a total of 15 ha of woodlot in four schools in the Volta and eastern regions of Ghana. The target is to establish 1,500

sustainable woodlots across the country. The Renewable Energy Act, 2011 (Act 832) also provides clear policy and regulatory support with respect to fiscal incentives, competitive pricing and establishment of dedicated woodlots for woodfuel production in the country.

Biogas

The government spear-headed the promotion of biogas technologies for the production of electricity, fuel for cooking and as a waste management intervention as far back as 1992 (the Appolonia Electrification Project) and has supported the development of several personnel in the design, construction and management of biogas systems in collaboration with development partners. About 49 biogas systems have been installed to date by the Ministry of Power in secondary schools, hospitals and other communal facilities for the purpose of waste management and supplementary fuel for cooking. Evaluation of the systems by the Ministry of Power is ongoing in order to apply operational knowledge to improve future constructions. Two hundred (200) biogas systems have been targeted for installation in public institutions and commercial ventures for waste management and production of energy for productive uses (such as thermal and electrical energy).

The government's active promotion of biogas technologies in Ghana over the past two decades has facilitated private sector interest in the technology. The private sector is currently the most active promoter of biogas technologies in Ghana. Current users include the hospitality industry, educational and health institutions, corporate institutions and residential properties.

In spite of the great progress made in the promotion of biogas technologies in Ghana, the subsector is still largely unregulated. There are no guidelines or regulations to guide the design, construction and management of biogas systems for specific applications. The result is the upsurge of private biogas installers who lack the requisite technical expertise to design and construct biogas systems to perform specific functions that have added environmental and economic benefits. The government will therefore develop the necessary guidelines to regulate the biogas subsector in Ghana to ensure quality control and increased adoption of biogas technologies in Ghana, especially by public institutions where the benefits are more profound.

1.4 Energy efficiency target until 2020

The national policy objectives for energy efficiency include the following:

- To establish the appropriate pricing regime for energy services that would provide incentives to domestic and industrial consumers to voluntarily manage their energy consumption;
- To implement programmes and measures to help consumers optimise their energy use;
- To support a sustained and comprehensive public education and awareness creation campaign on the methods and benefits of energy conservation;
- To promote the establishment of a centre for energy efficiency;

- To discontinue, through legislation, the local production, importation and use of high energy consuming vehicles and inefficient electricity consuming equipment and appliances;
- To reduce technical and commercial losses in power supply;
- To implement measures to reduce petroleum product consumption in transportation;
- To enforce a zonal system for lifting of petroleum products from dedicated storage depots; and
- To encourage the use of fuel enhancing additives.

The target of these policy objectives is twofold:

- Achieve efficient production and transportation and also to promote efficient devices; and
- Ensure all households using charcoal or firewood for cooking will use improved energy saving cook stoves by 2020. Woodfuel stoves in Ghana should have a minimum thermal efficiency of 30%.

In order to achieve these targets, a number of measures have been adopted or are planned:

- All single cycle plants are to be converted to combined cycle plants;
- Grid transmission and distribution losses are to be reduced by replacing the old lines and laying higher thermal capacity cables equipped with smart grid solutions;
- The Government has developed and is implementing standards and labels for all end use devices. Currently, refrigerators, air-conditioning units, and lights have labels indicating the consumption levels of the devices (see Figure 4);

Figure 4: Air conditioning label (The number of stars corresponds to the level of efficiency)



- The Government is promoting an efficient conversion rate of wood to charcoal through the use of efficient carbonization technologies and the promotion of more energy efficient wood fuel cook stoves;
- There is also the proposed establishment of two test and expertise centers for the production of cook stoves by 2015;
- There are plans to build the capacity of local artisans in the manufacture of energy efficient cook stoves and to identify and build the capacity of local entrepreneurs on the distribution chain of the cook stoves;
- Other measures include the creation of public awareness on the benefits of clean cooking, energy efficiency in buildings and to develop standards for building materials.

On the demand side and management of electricity, the measures adopted are to increase awareness of energy conservation and management in residential, public, industrial and commercial facilities. There is also the need to sensitize institutions in the use of energy and to train energy managers. There are also tax exemptions on importation of energy efficient lamps.

1.5 Relevant nexus targets until 2020

All the three energy targets (i.e. access, renewable energy and energy efficiency) are meant to improve the socio-economic environment and the well-being of the target population. As such, before grid power (and for that matter gas/oil pipelines and infrastructure) will be extended to any community or locality, social and environmental impact assessment is first conducted to ensure the environmental friendliness of the project. Further economic analyses is conducted to understand and appreciate the aspects of productive uses of energy: the volume of consumption and consumption carriers; benefits it will provide, e.g. to schools, health facilities, agricultural services (small scale food processing e.g. palm oil production, corn milling), small scale industries (such as seamstresses, beauticians, artisans) and recreational centres and its total contribution to local (usually rural) development. These are to ensure that the energy sector is appropriately linked with other socio-economic factors and contributes to the improvement of the standard of living, including the empowerment of women from the target community.

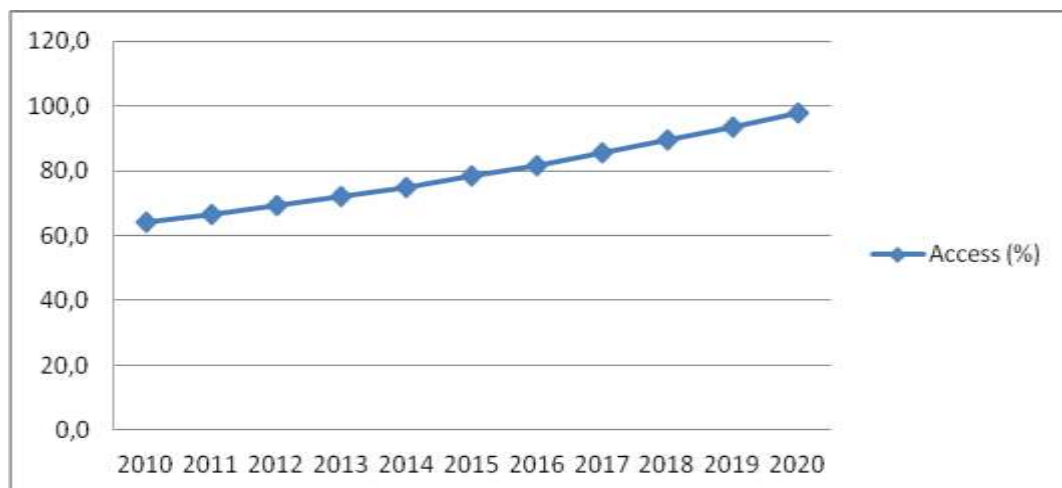
2. Priority action areas

2.1. Energy access

2.1.1 Current status and trajectory

In 2010, 3,936,338 out of 5,467,136 households, (i.e. 72% out of a total population 24,658,823) had access to electricity¹³. The current (2015) electricity access rate is 76%¹⁴ (19,576,162)¹⁵ and it is projected that universal coverage will be reached by 2020 (Figure 5). Other sources of energy such as clean cooking fuels using energy efficient cook stoves have also been introduced to ensure that the pace of energy access is quickened. To ensure rapid access, incentive-based legal framework and regulatory laws have been enacted to guide the operators in the energy access regime (see Section 2.5.1). However, in energy access, the question of affordability by individual households also arises. A Ghana living standard survey (GLSS 2013) showed that a household spends 4.8% of its income on all forms of energy and this is on the higher side for the majority, especially for those in the rural areas. Measures have therefore been put in place to relieve rural households, specifically, to enable easy access to energy. These have been presented in the sections below.

Figure5: Trajectory of % of population with access to electricity: 2010—2020



Source: Abavana, 2010- 2013; MoEP, 2013- 2014; EC, SPPD 2014-2020

Besides electric energy, other priority action areas to accelerate the SE4ALL attainment by 2020 are outlined in Table 10. The goal of extending energy in any form to a community or an area is to contribute to the economic empowerment of the beneficiaries. Actions needed to ensure this include the following:

¹³Source: Electricity Access Progress in Ghana 2010; Clement G Abavana, Noxie Consult: www.energymin.gov.gh (accessed on February 5 2015)

¹⁴The 76% with access includes 1.4% of those who are solely served by 2.5 MW of renewable energy from the Navrongo Solar Plant (Source MoP, Renewable Energy Directorate 2015)

¹⁵The projected population of Ghana for 2014 is 25,758,108 (Source: www.indexmundi.com/ghana/demographic profile, February 5 2015)

- (i) A local capacity needs assessment must be carried out to determine locally adaptable systems for target beneficiaries. The local economy must also be well analyzed to know the kind of community development that must take place to receive energy and the best institutions that can be partnered with to ensure the continuous availability of the energy for their use.
- (ii) Another area that needs priority attention is facilitating access to modern energy for cooking in the urban and rural areas, including the hospitality industries, health and educational institutions. In this direction, there is a need to ensure the adequate supply of LPG. It will require the involvement of the private sector and a business environment should be created that supports access to finance which will be needed to set up retail centres within localities.
- (iii) A conscious effort must also be made to make available and promote cleaner cooking solutions. A national policy on partnership for production and marketing must be designed to serve as incentives for local investors to produce the systems for use.
- (iv) Ghana must take advantage of the support from the ECOWAS Programme on Gender Mainstreaming in Energy Access (ECOW-GEN) as a priority action. It has been established to support women in particular as their energy needs differ from men. ECOW-GEN aims to factor in these differing needs in the planning and execution of clean-energy related interventions in the region to ensure universal access to energy services.

2.1.2 The existing plans/strategies and the gaps

To meet the challenge and also bridge the gap between the urban and the remote island communities both supportive and regulatory measures have been put in place to promote the agenda. It is emphasised that all projects¹⁶ are funded by the government but implementation, ownership and management are in the hands of quasi government agencies to run the programmes.

In all, there are 5 national rural electrification strategies to promote energy access in the field of electricity:

- (i) **Electricity Company of Ghana Northern Electricity Distribution Company (ECG/NEDCo):** This agency operates in the three northern regions and Brong Ahafo region. ECG and NEDCo declare an area to be supplied with power and pass on the information to the MoP which releases funds for the project. The agency supervises the implementation and manages the distribution of the power and remains in charge of its operation and maintenance.
- (ii) **Turn Key Project:** These are large scale donor funded projects. These projects usually involve the provision of grid electricity that covers several hundreds of communities. Contractors are engaged through a bidding process under the procurement law to implement such projects and upon completion, the operation and maintenance of the system is handed over to the regional Electricity Company of Ghana.
- (iii) **Ghana Energy Development and Access Project (GEDAP) Extensions:** This is a government funded project where smaller communities that are left in between turnkey projects are supplied with energy to

¹⁶Projects are singular activities in a programme and strategies are the means by which a programme may be achieved.

ensure a continuum of energy supply. Implementation is by contract and on completion, handed over to the regional Electricity Company of Ghana to operate and maintain.

- (iv) There are 216 district assemblies in Ghana. Each district assembly prepares medium term plans on a three year cycle. In each year, the assemblies prioritize communities that require electricity. Any of these communities may either fall within GEDAP, turnkey or a NEDCo project. The strategy however is that each district must have at least five communities covered annually. When the projects are commissioned, the regional Electricity Company of Ghana operates and run the facility.
- (v) There is the plan to provide electricity to the district capitals of all the 216 districts in Ghana by 2020 to increase the electrification rate. The operation and maintenance of these projects are also in the hands of the regional Electricity Company of Ghana.

The implementation of these strategies requires the following:

- Needs assessment mapping to provide off-grid systems is about 80% complete. The objective is to identify communities that will require off-grid and stand-alone systems and can put it to productive use.
- Further resource assessment for wind and biomass potentials is on-going. The objective is to identify which type of RE resource is available in what quantities that can be used to provide sustainable energy.
- Documentation on 4 mini-grid systems with different business models¹⁷ has been completed and construction began in the first quarter of 2015. A financing arrangement with AfDB and the World Bank under the climate change programme is in the advanced stages for the construction of another 20 mini-grid systems. It is expected that construction works will begin by 2016.
- Provision of stand-alone solar systems for public institutions such as schools, health posts, police and immigration offices in the rural areas is being pursued vigorously. This project will be funded under the GEDAP where 50% of the cost will be borne by the beneficiary institution.

To provide sound administrative support to ensure electricity access, a directorate known as the Power Directorate has been created at the Ministry of Power under which are sub directors in charge of:

- Generation and transmission;
- Distribution;
- Rural electrification; and
- Materials.

They report to the Director of Power to ensure effective control, monitoring and evaluation.

¹⁷The business model could either be a community ownership or co-operate entity ownership.

In support of the strategies above, a number of financing schemes have been put in place. These include:

- (i) **Exim Bank:** The bank provides grants/loans to finance projects. The government accesses this loan to finance the power projects.
- (ii) **Rural Electrification Taxes:** Urban dwellers are charged a fee every month alongside the energy consumed by households. This sum is aggregated to support rural electrification.
- (iii) **Renewable Energy Support:** Organisations such as UNDP, GIZ, the Spanish Government and the World Bank provide grants to support the development and implementation of renewable energy programmes mainly for rural communities' access.

The ECOWAS region has also been engaged in a series of activities for improving access to energy in support of member countries, including:

- The ECOWAS White Paper on a regional policy for increasing access to energy services in peri-urban and rural areas by 2015;
- The West Africa Power Pool (WAPP) revised master plan for an integrated regional power market;
- The West Africa Gas Pipeline Initiative (WAGP);
- ECOWAS Rural Electrification Project;
- West African Clean Cooking Alliance (WACCA).

Moreover, the ECOWAS Programme on Gender Mainstreaming in Energy Access (ECOW-GEN) is being implemented by ECREEE. Its overall objective is to contribute towards increased access to modern, affordable and reliable energy services, energy security and environmental sustainability by tailoring national and regional policies, projects and programmes to the energy needs of men and women. The strategy for achieving the programmes' objective will include:

- Building and strengthening capacities for gender mainstreaming in energy policies and projects;
- Steering and supporting the development of gender-sensitive policies within the region;
- Promoting knowledge management , awareness creation and advocacy on gender and energy issues;
- Implementing gender-responsive investment and business promotion in sustainable energy development in the ECOWAS region.

Synergies between these regional programmes for energy access under the planned measures in this SE4ALL Action Agenda, as well as in the NREAP and the NEEAP of Ghana will be created so that the best possible use can be made of the regional initiative.

The gap, and therefore the challenge, in providing energy access is how to actually reach the island and isolated communities which for all practical reasons require extra effort to provide electricity access. These isolated and island communities are part of the 24% of the population that are yet to access electrical energy as of 2015 estimates.

2.1.3 Actions needed to achieve the overarching objective in the field of energy access

Ghana has prepared an Energy Sector Development Plan which cuts across petroleum, power and renewable sub-sectors. Among them are cross cutting issues such as environmental impact, contribution towards the energy mix, equity in energy access and promotion of gender equity, see Figure 6 below. Measures to achieve this target include the following:

LPG:

- The Government has developed a draft national policy on liquefied petroleum gas promotion which seeks to facilitate investment for increase supply, storage, distribution and retail of LPG nationwide. The policy would also promote the manufacture of smaller sized cylinder bottles (e.g. 6 kg) to make it affordable to low-income earners.
- The Government is to increase LPG storage infrastructure in the localities and to ensure supply of both the cylinders and the gas to meet demand. The commissioning of the Ghana Gas Company at Atuabo is envisaged to boost the supply of the gas.
- By the year 2016, LPG stoves will be added to the list of end use devices that would have standards and labels which will indicate their consumption and efficiency levels.
- A public campaign will be mounted to create public awareness on the benefits of using LPG by 2016.

Grid Extension:

- Measures include grid extension by strengthening the transmission networks by GRIDCo through West African Power Pool (WAPP), through the National Electrification Schemes (NES), the Ghana Energy Development and Access Project (GEDAP) and the Self Help Electrification Programme (SHEP).
- Another measure to increase access is through GIS mapping of island and riverside communities that cannot be connected to the grid in the medium term so that renewable powered mini-grids and solar home systems can be used as the primary solutions to provide these communities with access to electricity.

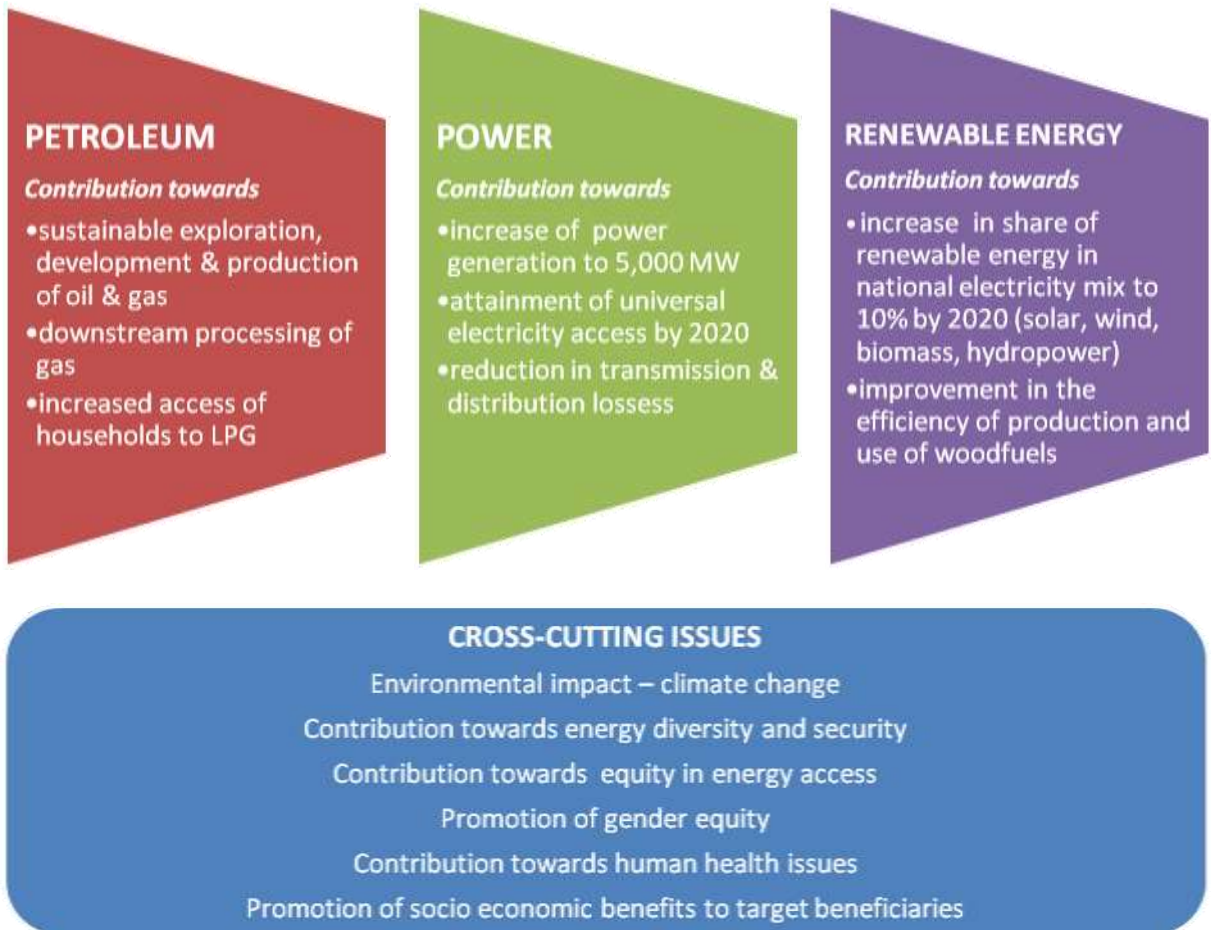
- The Electricity Company of Ghana (ECG) is to be re-structured to improve its revenue collection by expanding the coverage of the prepaid meters and also to reduce system losses by establishing task forces that conduct on site inspection to detect and remove illegal and unsafe connections and to replace old and inefficient wiring systems.
- Regulatory and supportive policies have been enacted through Act 832, to encourage independent power producers (IPPs) to invest in energy to increase generation capacity and total primary supply. This act includes the feed-in-tariffs which guarantees purchase, price and transmission onto the national grid.

Renewable Energy:

- The Government is giving support to private individuals and institutions to explore alternative energy generation options especially in the renewable sector such as wind, solar, biomass and biogas;
- In the island and remote communities the Government is set to provide decentralised electricity access for ICT education, health centres, energy service centres, residential and communal facilities;
- Feasibility studies will be conducted to identify localities within which the interventions will be viable. The criteria could include gender considerations, market accessibility and soil suitability for specific crops in the case of the irrigation schemes;
- Ownership and management models would be developed for sustainable operation of the businesses. Such models may include joint ownership, community ownership and a build, operate and transfer model;
- There will be capacity building and awareness creation on PUE to ensure that the energy supplied is put to efficient and productive use for the anticipated benefits.
- The operational areas will be introduced to financial institutions with the possibility of guarantees to improve access to finance by the beneficiary communities.

To support these, strategies to build human capacity to carry through the implementation have been planned. (See Sections 2.2.3 and 2.3)

Figure 6: Prioritization criteria of energy sector development plan/projects



In all three sub-sectors, it is expected that the prioritized projects would incorporate minimum environmental impact and abatement of climate change, and should contribute towards greater diversity in the energy resources, energy access and higher security in energy supply.

The action needed on this plan is to raise the funding to continue the implementation of the strategic projects after the donor funding for the pilot phase is completed.

2.1.1.1. Grid infrastructure and supply efficiency

The remaining 24% of the population, approximately 6,312,000 (1,578,000 households)¹⁸, have yet to access electricity as of 2014. Besides decentralized supply options, this also calls for extension of grid infrastructure and the improvement of supply efficiency in order to meet the 2020 target. The total length of the grid infrastructure is currently 4,313.8 km (Table 6). This includes high voltage transmission lines and domestic distribution lines. It must be noted that 219.5 km of 330 kV line have already been constructed and further extension is ongoing. This line has a higher thermal capacity and it is being laid to fulfill three main objectives:

¹⁸The average household size is estimated at 4.04 (Source: Ghana Living Standard Survey 6 Report 2014)

- i. It is part of the strategy to expand and increase electricity access;
- ii. It is also to curb transmission losses thereby improving supply efficiency;
- iii. It also serves as the national response to the West African Power Pool (WAPP).

On completion, the system is to be equipped with smart grid solutions¹⁹ to ease monitoring; to check power theft and to reduce losses all in a bid to improve efficiency and total access. Information on the current status of transmission and supply efficiency as well as their planned improvements is provided in Chapter 2.3.

Table 6 : Grid infrastructure in Ghana by type and length

Type of grid (kV)	Length (km)
330	219.5*
225	73.4
161	3,888.1
69	132.8
Total	4,313.8 km

*On-going extension Source: GRIDCO, 2015

To support marketing and consumer consumption in the rural areas, urban fringes and among the urban poor, individual households are encouraged to wire their houses and get connected to the grid. In the rural areas, the government pays for the power for the first six (6) months before the consumer is made to pay for the power and the service charges. In terms of paying for power, the rates differ according to levels of consumption. For example, consumption up to 50 kWh/month attracts a tariff of 33.55 GHp/kWh²⁰ and the tariff for consumption between 50 and 300 kWh/month is 67.32 GHp/kWh, etc. Because a majority of the rural population fall within the 0-50 kWh/month range²¹ they tend to pay less. Both the urban and rural areas pay for service charges but those in the urban areas are further taxed to support street lighting and rural electrification. There is no time limit to this policy.

2.1.1.2. Distributed electricity solutions

¹⁹This is an equipment that automatically monitors sudden power fluctuations to aid monitoring

²⁰The bills are prepared in Euros and consumers pay in local currency based on the exchange rate at any point in time.

²¹This range is termed as 'lifeline' and all consumers who fall within, either in the rural or urban area; pay 50% less than those who consume 50 kWh/month and above.

To ensure decentralized energy services delivery, the system is open to power purchase agreements (PPAs). In this system there is room for direct bilateral contracts in which the cheapest combination²² is sold first before the others. This system makes it possible for the negotiation of bilateral contracts²³ all in a bid to improve access.

2.1.1.3 Modern cooking appliances and fuels

The Government has embarked on public awareness campaigns and promotion of cleaner cooking fuels and improved cook stoves. The awareness campaigns involve sensitization on the social, economic, environmental and health benefits of switching from either the use of wood fuels to LPG or inefficient woodstoves to improved stoves. To promote the adoption of LPG for cooking in rural areas, the government is implementing a rural LPG promotion programme to remove the adoption barrier of the high cost of LPG cylinders, stoves and accessories (the beneficiaries only pay for the cost of the gas) and facilitate the establishment of LPG refilling stations by businesses by creating demand for the commodity. As of the close of 2015, the government has distributed about 39,000 6kg LPG cylinders, cook stoves and accessories to low access rural areas. The target is to distribute 50,000 cylinders, stoves and accessories by 2016 (Petroleum Directorate, MoP).

The Government of Ghana has invested over US\$800m in the development of the Ghana Gas Processing Plant located at Atuabo in the Western Region of Ghana. The gas plant is currently (September 2015) producing 140 million standard cubic feet of gas daily to the Aboadze Thermal Plant and processed for industrial and domestic use. When the gas plant is in full operation, it is expected to produce 150 million standard cubic feet of gas daily (cityfmonline.com/2014/08/11; visited on 2015/10/17).

ECREEE initiated a regional clean cooking Initiative called West African Clean Cooking Alliance (WACCA). The specific objectives of WACCA are:

- Promote the implementation of policies and regulatory framework on clean cooking initiatives in the ECOWAS region;
- Enhance capacity building in clean cooking initiatives in the region;
- Support and harmonize standards and labeling practices in the region.

At the national level, WACCA is assisting in mapping the existing initiatives on fuel and cooking equipment and updating national strategies for cooking energy. Through the evaluation of solutions and bottlenecks, the initiative will enable the development of approaches for the local production of equipment and fuels and market development for technologies. Key elements of the initiative will be the establishment of financing mechanisms and the implementation of awareness campaigns.

Strategies:

²² There are 6 factors that combine to determine the price at which PURC will purchase the electricity: technology being used; location of the generation facility; operating norms of the specific technology; costs associated with the O&M of the plant; reasonable rate of return and balance between the interest of the consumer and the investor (Source: Renewable Energy Act, (Act 832) 2011 Section 27).

²³Contracts between public and private sectors in specific locations, either with NEDCo, GEDAP or turnkey projects.

- Improvement of national cooking policies, strategies and targets, including legal and regulatory mechanisms in line with the existing ECOWAS regional policies and the WACCA initiative;
- Develop gender-responsive actions and the economic empowerment of women, and integrate gender aspects in national planning and strategy and decision-making processes;
- Support cross-sectoral coordination through the inclusion of clean cooking across sectors, e.g. through inter-ministerial task teams;
- Improving the efficiency and sustainability of the energy value chain through Participatory and Sustainable Forest Management (PSFM);
- Monitoring system for the fuel wood value chain;
- Establish SMEs for distribution of efficient fuels at the local level, and establish public bodies to support and stimulate private sector involvement;
- Capacity building programmes for public and private actors, and in collaboration with local communities;
- Standards and labeling for improved cook stoves and fuels;
- Information dissemination and knowledge sharing (e.g. catalogue of best practices and strategies, information materials on clean cooking fuels and stoves, awareness raising campaigns and capacity building workshops);
- Programmes to enhance access to finance, increase the use of carbon financing and improve the regulatory framework.

2.1.4 Ghana's SE4ALL priority action areas

Ghana's high impact SE4ALL strategies for energy access are as follows:

- The government intends to use liquefied natural gas to power equipment in electricity generation instead of crude oil which is relatively expensive. It thus limits the quantity to be produced and supplied to consumers and money needed for alternative investment opportunities in the sector is limited;
- Attention is being given to the exploration of alternative energy sources such as:
 - Clean coal: the government of Ghana is in the process of signing an agreement with the Chinese government to set up a 700 MW electricity generation plant that will be powered by coal. Coal is relatively cheap and can support electricity supply to ensure energy security and increased access but not necessarily sustainable energy;
 - Nuclear: Ghana is in discussion with the International Atomic Energy Agency (IAEA) to set up a nuclear power plant to power electricity generation as one of the options to compliment hydro electric,

thermal and gas energy for electricity generation. Ghana already has the institutional setup, the Ghana Atomic Energy Commission that can serve as the basis for the setup.

- Petroleum storage capacity: Ghana is expanding petroleum product storage capacity by building jetties along water transport systems. This is because it is cheaper to transport bulk petroleum products by water transport and distribute them through a distribution infrastructure than the normal oil tankers by land. In that vein Ghana has commissioned the Debre jetty on the Volta Lake in the northern region. The Bulk Oil Storage & Transport (BOST) intends to construct a 160,000 m³ petroleum terminal at Apowa near Takoradi as part of the national petroleum storage and distribution network.
- LPG: The government is creating avenues to increase the supply of LPG to improve energy access. Measures outlined include:
 - To increase LPG storage facilities by identifying entrepreneurs in remote areas and supporting them to set up storage facility depots;
 - To recapitalize GCMC or assist other cylinder manufacturing companies to manufacture 500,000 smaller and user friendly cylinders (6 kg and below) per year;
 - To establish large LPG bottle refilling plants that will be supplied with gas from the Atuabo gas plant when the plant is processing 150 million cubic feet of gas per day;
 - To double the distribution network and retail outlets through LPG distribution franchise operators;
 - To develop, monitor and enforce standards to improve safety.

The implementation of the priority action areas as outlined above will ensure the achievement of these high impact opportunities of relevance in Ghana.

2.2. Renewable Energy

2.2.1. Current status and trajectory

Ghana is endowed with renewable energy resources which include solar, wind, biomass and hydro. Below are the details of the level of exploitation of the renewable energy potential of Ghana.

Wind

The Meteorological Service Agency (MSA) is the statutory body responsible for wind resource measurement activities in Ghana since 1921. In 2006, the Energy Commission collaborated with UNEP to install and measure wind resource data at 12 m, 20 m and 30 m heights at thirteen (13) sites (Table 7). Analysis of the data indicated that the wind power potential along the coast of Ghana is about 250 MW at a capacity factor of 28%.



From 2011 to date, the Energy Commission further conducted wind resource assessment at 60 meters of height at eight (8) locations along the coast in Ghana, namely: Mankoadze (central region), Sege (Greater Accra region), Atiteti, Denu and Anloga (Volta region). Others are Ekumfi Edumafa, Gomoa Fete in the central region and Avata (Volta region). The monthly average wind speeds at these new sites above 7 m/s at 60 m height is recorded along the coast during multiple months of the year, particularly in July, August and September.

Ocean energy

Ocean energy (tidal wave) potential is now being exploited. Construction of a 14 MW tidal wave plant has commenced in the country at the cost of \$4 billion²⁴ (Daily Graphic 27th October, 2014).

Table 7: Wind measurement sites

Site	Position		Altitude (m)	Height (m)	Annual mean wind speed at 12 m (m/s)	Predicted wind speed at 50 m (m/s)
	Latitude (°N)	Longitude				
Adafoah	5.79	0.55°E	5.2	12	5.3	7.05
Aplaku	5.32	0.20°W	50	12	5.2	6.92
Asemkow	5.21	3.27°W	10	12	3.7	5.16
Kpone	5.68	0.07°E	96	12	4.9	7.18
LolonyaOshiyie	5.79	0.44°E	73	12	5.43.9	7.15
Pute	5.30	0.22°W	3	12	5.5	5.18
Tema	5.79	0.52°E	50	12	5.0	7.37
Warabeba	5.62	0.07°W	50	12	3.9	6.66
Anloga	5.22	0.35°W	-7	12	5.4	5.38
Amedzofe	5.47	0.55°E	740	20	3.9	6.80
Kue	6.50	0.25°E	327	20	2.9	5.00
Nkwanta	8.30	0.35°E	295	30	3.5	3.40
	8.15	0.30°E		30		4.00

Source: Energy Commission, Ghana; Renewable Energy Department

Biomass

²⁴This is a Private Sector initiative to be completed in phases at the total cost stated

Biomass resources that are available in Ghana include woodfuels, sawmill residues, and municipal waste. Biomass resources cover about 20.8 million hectares of the land mass of Ghana (23.8 million hectares) and are the source of supply of about 60% of total energy consumed in the country annually. The trend is however reducing as a result of increasing access to other forms of energy.

Municipal waste is generated in large quantities in the cities and big towns. It is estimated that between 150 kg and 200 kg per capita of municipal solid wastes are generated in Ghana annually which is estimated to be over 2 million tonnes per year. Unlike other energy sources, waste-to-energy projects have two objectives: generating energy, and ensuring safe and effective disposal of municipal wastes. However, municipal solid wastes are hardly exploited for energy purposes. Currently (2015), there are three engineered landfill sites: Tema, Kumasi and Tamale which have been constructed to produce gas by 2024.

Woodfuel (firewood and charcoal) have a total stock of about 832 million tonnes whilst the potential annual production is estimated to be about 30 million tonnes. However, not all of this production is available. Actual logging is 2.0 - 2.7 million m³ per annum. This generates as much as 1.0 to 1.4 million m³ of logging residues on an annual basis (Figure 6). In addition to logging there are several other potential sources of biomass. Total land area under tree plantation is estimated at 75,000 ha. Non-commercial trees that are removed from these plantations together with the residues from the harvesting of lumber grade trees are also reckoned as potential sources of energy.

Wood processing residues from sawmills are estimated to be 1.0 million m³ per annum. These include slabs, edgings, off cuts, sawdust and residues from plywood manufacturing (see Figure 7). Sawmill and ply-mill residues are mostly concentrated in the Kumasi area and large-scale furniture mills are predominately in Accra. There is also potential for wood residues from forest clearings for agriculture and surface mining activities.

Woodfuel consumption in 2010 was 3,206 ktoe and this has increased to 3,553 ktoe in 2013. In 2000, it accounted for 62% and in 2005, woodfuel consumption in the energy mix was 55%. Percentage-wise, the importance of woodfuel in the energy mix is showing a decrease, as total consumption rises and is provided for by other energy carriers than woodfuel²⁵.

Solar

Ghana is well endowed with favourable solar resources ranging from 4.5 to 6.0 kWh/m²/day of solar radiation which is very conducive to the installation of solar energy systems such as solar PV, water heating, drying and cooking systems. The total installed capacity of solar PV is estimated to be about 5 MW which constitutes about 0.16% of the total national electricity mix. About 3.3 MW are grid connected solar PV systems. The newly installed PV plant at Navrongo, in the upper east region is expected to feed 3 183 MWh/year into the national grid.²⁶

Solar water heaters are being used increasingly in the hospitality industry. However, solar potential is yet to be harnessed for cooking.

²⁵ Source: Energy Statistics, Energy Commission, 2014

²⁶Source: <http://www.ecowrex.org/eg/navrongo-solar>.

Further, the potential for direct solar radiation (DSR) is low for Ghana. This is due to the presence of high water vapour, cloud cover and dust particles that absorb and/or scatter the direct solar radiation as it reaches the ground. The total land area of 48,701 km² receiving the highest DSR level (above 4.5 kWh/m²/day) is in the northern sector of the country comprising the northern, upper east and upper west regions. This level of direct solar radiation is received during 6 months of the year. The resource here can be said to be high enough to support the deployment of solar concentrators for electricity generation for a period of six months within a year (i.e. between October and February).

Hydroelectricity

The country's hydro power resource potential is estimated at 2,000 MW. The Akosombo and Kpong hydroelectric plants on the White Volta and the Bui plant on the Black Volta have a total installed generation capacity of 1,580 MW. There are 22 exploitable mini-hydro sites identified in the country with an estimated total potential between 5.6 MW – 24.5 MW (Table 8). Hydroelectric plants of over 10 MW are possible²⁷ on 17 sites on the Black Volta, White Volta, Oti River, Tano River, Pra River and Ankobra River.

Table 8: Total potential of mini hydropower by region

<u>Region</u>	<u>Potential (kW)</u>
Volta	3,117 - 12,065
Eastern	226 – 1,150
BrongAhafo	364 - 1,900
Central and Western	472 - 2,150
Ashanti	720
Northern	913 - 4,420
Upper East and West	499 - 2,100
TOTAL	5,591 - 24,505

2.2.2. Existing plans/strategies and the gaps

²⁷These sites are recommended by engineering studies, other studies such as EIA or socio-economic impact analysis etc. have not been done

The existing plans are to develop RE based electricity generation in order to increase the available power in the grid. The challenge is the grid integrity. To ensure grid integrity, the following regulations²⁸ apply for all IPPs seeking license to generate electricity by solar PV:

- i. In order to maintain the integrity of the national grid, the total capacity of solar PV plants shall not exceed the total national capacity approved by the Energy Commission;
- ii. A maximum of 20 MWp per plant without storage shall be allowed to be connected to the National Interconnected Transmission System (NITS) at any solar PV generation site;
- iii. Solar PV plants with a capacity of more than 20 MWp supplying power into the NITS will not be permitted unless it is equipped with a storage system with capacity equivalent to the excess;
- iv. A maximum of 10 MWp per plant without storage shall be allowed to be connected to the distribution system at any solar PV generation site;
- v. Solar PV plants with a capacity of more than 10 MWp supplying power into the distribution system must be equipped with a storage system with capacity equivalent to the excess.

Among the existing plans to achieve the objective in the renewable field, the Renewable Energy Act of 2011, Act 832, Section 25 makes provision for a feed-in tariff (FIT) mechanism. The mechanism guarantees three major relieves:

- i. A feed-in-tariff rate;
- ii. A renewable energy purchase obligation;
- iii. A connection to the transmission and distribution system.

These provisions ensure that a bulk customer purchases all the quantities of power that the independent power producer (IPP) has been licensed to produce at the agreed rate; the Public Utility Regulatory Commission (PURC) will have to approve all PPAs taking into consideration the technology, location and operating norms; it will also guarantee the rate for the first 10 years and subsequently be subject to review every 2 years among others. Act 832 further provides that the IPP will be permitted to upload its production onto the national grid for distribution. These are incentives to guarantee returns on the capital expenditure (CAPEX) and also to minimize the operational expenditure (OPEX) by the investors. This section of the act also intends to mitigate political and economic risks in that once a contract has been signed, irrespective of the existing political regime, the contract will be honored.

However, the SREP Investment Plan (2015) indicates that the FIT cannot be wholly honored due to multiple IPPs. In this light, priorities should be given to investment in remote areas and at a certain minimum production capacity level.

²⁸Source: A circular published on October 2014 by the EC, These regulations apply to solar PV only {www.energycom.gov.gh (27/02/15)}.

A number of companies have been licensed to provide various types of RE services, Table 9. The total number of the license holders is 109 and these include wholesale suppliers and generation, charcoal export, installation and maintenance and importation of RETs. Among them, those who have a supply and generation license dominate the list with 61.5% while the least is the briquette export constituting 2.8% of the total.

Table 9: Companies issued with RE license by type

Type of license	Number	Percentage
Provisional wholesale suppliers and generation	67	61.5
Charcoal export	12	11.0
Installation and maintenance	23	21.1
Importation	4	3.6
Briquettes export	3	2.8
Total	109	100

Source: Energy Commission; Renewable Energy: (www.energycomm.gov.gh, License Register; as at 26/08/2015)

Among the 67 companies registered as 'wholesale suppliers and generation', 52 of them have a license to generate electricity using RE resources at various capacity ranges. Out of these, 21 have provisional²⁹ licenses; the licenses of 13 applicants have expired and 16 others have obtained siting permits while two have received construction permits (Table 10).

Table 10: RE-generation license holders issued under the FIT scheme

Type of license	Number	Proposed Capacity (MW)* range
Provisional	21	2-150
Expired	13	5-157
Siting permit	16	2-400
Construction permit	2	20-1000

²⁹Provisional Licence (PL) is a preliminary license issued to a company that meets the statutory requirements. The PL therefore does not imply approval of the proposed power plant, nor authorise the construction or operation of the proposed power plant.



Total	52	
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Source: www.energycom.gov.gh (16/02/15)

*These are the proposed capacities of plants indicated by the applicants in their application. The actual capacity allocation will be based on the power purchase agreement to be signed between the off taker and the applicant.

As indicated in Table 9 no company has started production yet as only 2 companies has received the construction permit, an advanced stage of the licensing process. The RE resources include solar systems; biomass; wind; hydro; waste to energy and wave (tidal) energy. One of the 2 companies with a 'construction permit' has the highest proposed capacity of 1,000 MWp by utilizing tidal resources.

The Energy Commission is promoting the development of renewable energy in Ghana through developing and elaborating national policies and strategies for all renewable resources such as biomass, solar, geothermal, hydro and wind, as well as for technologies, demand and supply side management, including solar photovoltaic systems for both stand-alone and grid connected, wind energy resource assessment and generation, small-scale hydro (mini and micro) development in Ghana including, biomass/biofuel and woodfuel resource assessment, development and generation.

In addition to the above efforts, the Commission is also resolved to tackle the difficult problems of changing consumption patterns and negative attitudes of the energy users which otherwise result in wastage and high energy expenditures. Among others, the general public is being reached through RE fairs and providing educative information at a well-crafted and regularly updated website.

As part of the existing plan in addressing the capacity and management gap to implement the energy sector plan, the University of Energy and Natural Resources was established during the 2012/2013 academic year. This brings the total of public universities to 9. All the universities offer science and engineering courses. during the 2011/2012 academic year, there were 45,283 science and engineering students in all the Universities and this was 41.4% of the total enrollment. During the 2012/2013 academic year the total number of engineering and science students increased by 10.1% (4,588) over the previous year. However, the percentage over the total enrollment was lower (38.8%) compared to the previous year (Source: NCTE Statistical Digest 2012-2013).

Similarly, intake of science and engineering students at the 10 polytechnics in Ghana also increased by 21.9% (3,505) during the 2013 academic year over the previous year's total enrolled students of 15,985 which accounted for 36.7% of the total enrolment. In 2012, science and engineering students in the polytechnics constituted 33.8% (15,985) and in 2013, they constituted 36.7% of the total enrolled (Source: NCTE Statistical Digest 2012-2013).

In addition to the above, the KNUST Energy Center has initiated a graduate programme in renewable energy development. The Center offers professional training to RETs practitioners including technicians, engineers and policy makers. The Deng Solar Training Centre, a private company, also offers training for technicians in solar energy technologies.

Importantly the University of Energy and Natural Resource has established strategic collaborations with some key stakeholder organizations including Copenhagen University; Department of Mossrich Energy and Solar Grid, and Naresuan University, Thailand. In the collaboration on the solar grid, a MoU has been signed to help build the

capacity of the Department of Energy and Environmental Engineering in the area of solar energy. The Department is in collaboration with DSTC to offer certificate courses for solar design and installation. The first training programme was successfully completed in July 2014 (Source: uenr.edu.gh –as at 18/02/2015).

The increased enrolment of science and engineering students and the local and international collaboration in training professionals in the field of RE reflect the additional efforts by the government to build the human resource base to implement the energy sector plans towards the SE4ALL agenda.

There are other operational laws that provide tax incentives in relation to the geographical locations of investments; the more remote a rural location is, the less the tax (GIPC Act, 2013, Act 865).

At the ECOWAS regional level, there are series of on-going initiatives in the field of renewable energy. These include:

- The ECOWAS White Paper on a regional policy for increasing access to energy services in peri-urban and rural areas by 2015;
- The formal launch of ECREEE in 2010;
- Adoption of the ECOWAS Renewable Energy Policy (EREP) in which a vision and targets for renewable energy to be achieved by the region in 2020 and 2030 were established and agreed upon;
- The ECOWAS Small Scale Hydropower Programme that started in 2013;
- The ECOWAS Bioenergy Strategy Framework; and
- The ECREEE Rural Electrification Programme.

These measures coupled with local initiatives as contained in this SE4ALL National Agenda and the NREAP will contribute to improve the development and sustainable use of RE.

2.2.3 Actions needed to achieve the overarching objective in the field of renewable energy

Table 11 presents the initiatives/actions being undertaken to achieve the objectives in the field of RE by 2020. The actions include mini-grid RE electrification of about 50 communities, deployment of 50,000 SHS, 2 million solar lanterns and solar electrification of 6,000 public institutions such as schools and health facilities.

Table 11: Initiatives on RE (2015)

Area (RE)	Project / Programme Name	Target	Funding(donor organisation and committed)	Project Implementation	Implementation Status	Implementing Organisation or

EE, EA)			amount)	Period		Institution
RE	Mini Grid Renewable Energy based electrification in isolated communities	A target of 20 to 50 communities shall be supplied with 2 MW of mini grid RE.	Funding for 5 communities secured	2015 - 2020	Under implementation	MoE
RE	Deploy Solar Home Systems (SHS) in isolated off-grid households	A target of 50,000 SHS shall be supplied with solar energy with 15 MW.	Funding for 75,000 SHS secured ³⁰	2015 - 2020	Under implementation	MoE
RE	Deploy solar lanterns (SL) with mobile phone charging facilities through local assembling and partial subsidy	2 million lanterns shall be supplied under this programme with 20 MW of power.	Funding for 20,000 lanterns secured	2015 – 2020	Under implementation	MoE
RE	Solar electrification in off-grid public facilities (schools, clinics, security outposts)	6,000 public facilities with 1.5 MW.	Funding for 150 schools for ICT and 100 health facilities secured	2015 - 2020	Under implementation	MoE

Source: Ahiataku-Togobo, July 2014, Universal Access to Modern Energy Services in Ghana

To support the achievement of the overarching objective in the field of renewable energy, respective policies have been developed and a number of regulatory measures been passed. These include the Energy Fund Act, Act 541 that supports the development and promotion of EE and RE resources. In 2003, the Public Procurement Act was passed; this is an economic instrument to promote direct investment in RE. The RE Act of 2011, Act 832 is also to support the development, management, utilization, sustainability and adequate supply of RE. The government has also put in place the policy to replace kerosene lanterns with SHS.

2.2.3.1 Renewable power generation

A master plan for renewable power generation is currently being prepared that will set the goals and targets and determine the potential sites and their capacities until 2020. It will also include indicators to track progress on meeting the targets. This plan will provide direction for investors and will guide the development process of renewable power generation in the country. As earlier mentioned, a 14 MW tidal power generation plant was commissioned in 2014 and construction is on-going. However, immediate attention is being given to solar energy which is currently contributing less than 0.16% to the electricity mix. Vigorous research is ongoing with the off-shore and on-shore wind, see section 2.2.1.

³⁰The SHS project has received funding beyond the target

2.2.3.2 Grid infrastructure and supply efficiency

Sufficient grid infrastructure has been laid with grid efficiency well considered in the design (Section 2.1.3). Legal provisions have been made to encourage IPPs to take advantage of the grid infrastructure, see Section 2.2.3.

2.2.3.3 Industrial and agricultural processes

Attempts are being made to make use of solid biomass to ensure that both agricultural and industrial waste is processed for power generation. The current installed capacity of biomass-fired co-generation plants in Ghana is 4,034 kW (see Table 12). These plants use palm kernel husk to provide energy for agricultural processing. The challenge in setting up a large plant is the scattered nature of the solid biomass. The cost of transporting the waste from the scattered sources to a production center increases the OPEX, thus few investors are attracted to it. However, the feed-in-tariff mechanism (of Act 832, 2011) could serve as an incentive to attract investment into agri-waste to energy projects.

Table 12: Biomass-fired co-generation plants in Ghana

Plant Location	Installed Capacity, kW	Average Annual Production, GWh
Ghana Oil Development Company, Kwae	2,500	6.8
Juaben Oil Mill, Juaben	424	1.5
Benso Oil Mill, Benso	500	1.9
Twifo Oil Palm, Twifo	610	2.1

Source: Energy Commission, 2011

2.2.3.4 Buildings and appliances

Building codes are being developed and the newly emerging estates are being urged to adopt the codes into the construction to allow the use of solar panels for power generation and also to capture sunlight in the buildings during the day to minimize the use of electric power. Further information on ECOWAS regional programmes as well as national programmes and measures with regards to buildings and appliances are contained in Chapter 2.3.3.1.

2.2.3.5 Transportation

In 2005, the Energy Commission set up the Biofuel Committee (BFC) with the policy objective of substituting 20% of national gasoil consumption and 30% of national kerosene consumption with jatropha oil by 2015³¹. As at 2007, 1,534 ha of jatropha had been cultivated. The progress of the project has been slowed down considerably as a result of several land litigation issues that confronted land acquisition.

2.2.4 SE4ALL priority action areas

The major priority action for SE4ALL is to achieve 10% contribution of RE in the electricity generation mix by 2020. The RE Act of 2011 Act 832 was enacted to enable IPPs to participate in the implementation of RE projects to achieve the 2020 target.

Implementation has begun for four pilot mini-grid projects, and this is expected to be scaled up to cover more communities once the business model is finalized. Another strategic intervention is the promotion of RE technologies for productive uses in agriculture (such as wind and solar PV for irrigation, solar dryers for processing of agriculture produce, etc), fisheries and other economic activities, and the establishment of sustainable woodlots.

2.3. Energy Efficiency

Targeted energy efficiency measures are one of the world's most crucial contributions to mitigate climate change. The SE4ALL Energy Efficiency Accelerator Platform has been created as a nexus for a public/private partnership programme to scale up energy efficiency, policy action and investment. The Accelerator Platform provides the Government with the means for engaging with the variety of stakeholders whose knowledge of technologies, markets, financial instruments and implementation approaches can support scaling up of energy efficiency actions in different sectors.

The accelerators are transportation, lighting, domestic appliances, buildings, industry and finance. Ghana is working on these accelerators to ensure energy efficiency in the economy.

2.3.1 Current status and trajectory

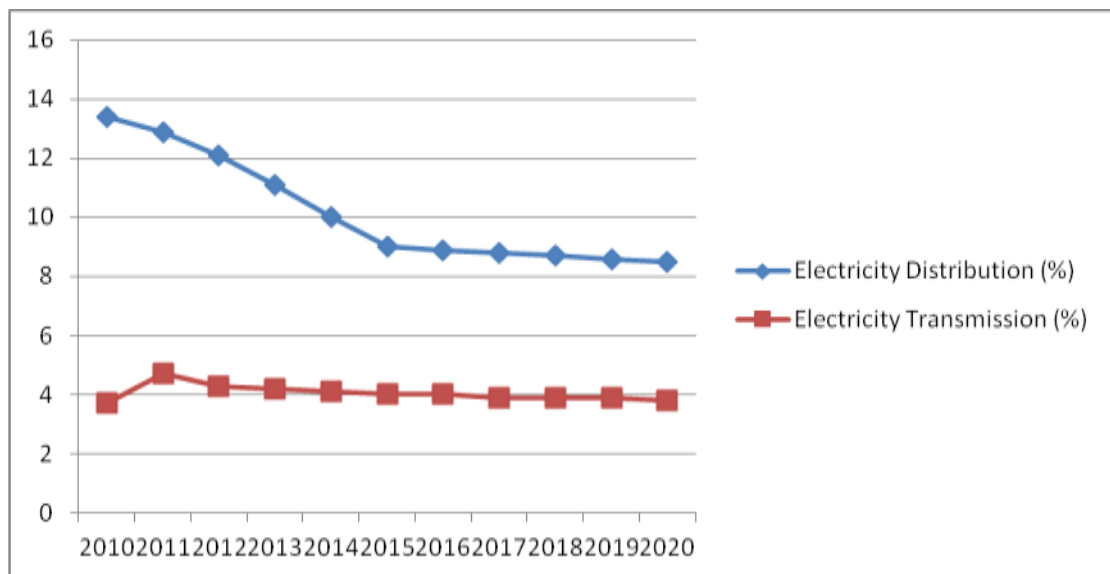
A study³² shows that electricity supplied to consumers is wasted during transmission and distribution through multiple factors which include inefficient electrical equipment, poor attitude towards energy conservation and theft. Current trends in distribution and transmission losses are presented in Figure 7. It shows that distribution

³¹Biofuel Assessment Report, ECOWAS Sub-region, Aug 2007: Essel Ben Hagan

³²Energy Sector Strategy and Development Plan, 2010

accounted for 13.4% of losses in 2010 while transmission losses were 3.7% in the same year. The projection is that distribution losses will decrease to 8.5% in 2020 while transmission losses decrease to 3.8% by 2020. In order to achieve this, 330 kV distribution lines, which have a higher thermal capacity to curb transmission losses, are being laid. So far, 219.5 km have been laid and implementation is ongoing. In the area of distribution losses, an inspectorate division has been set up by the Electricity Company of Ghana to inspect household meters to detect technical mal-functioning and/or illegal connections to minimize distribution losses.

Figure 7: Current status and trajectory in Distribution and Transmission losses 2010-2020



Source: Energy Commission; SPPD 2015

2.3.2 The existing plans/strategies (Energy Efficiency strategy in electricity)

An initial programme that was set to achieve 10% savings in electricity consumption between 2009 and 2012, has not achieved its targets. In order to achieve the planned target and to make further savings in energy consumption by 2020, the following programmes and strategies are to be pursued:

- A power factor correction programme in public institutions, commercial and industrial entities;
- A public awareness campaign programme on energy efficiency and conservation, which has already been launched;
- Implementation of legislation on the ban of importation and use of inefficient electrical appliances; and

- 330 kV grid lines which have a higher thermal capacity to reduce transmission losses and are also fitted with smart grid solutions³³.

The possible funding sources were identified and the verifiable indicators stated. This was well followed through as presented in Table 13. The following programmes have been implemented:

- **Automatic capacity banks:** The Government in 2009 installed automatic capacitor banks in six public institutions (Osu Castle, Parliament House, Accra Sports Stadium, the Food and Drugs Board, Korle-bu Teaching Hospital and the Ministry of Defence). As a result, a peak load reduction of 1,854 kVA was made on all 6 installations. In 2012, 26 other public institutions were selected and installed with similar equipment and 1,875 kVA peak load were reduced. This is set to be further extended with the government making provisions for it in the annual budget.
- **Refrigerator Energy Efficiency project:** Another programme is the Refrigerator Energy Efficiency project. It seeks to gradually replace about 50,000 old and inefficient refrigerators within three years by providing a rebate for the purchase of efficient refrigerators. The programme was launched in July, 2012 and is expected to save up to 27,000 MWh³⁴. Through this scheme, the importation of used refrigerators dropped from 420,000 units in 2012 to 152,000 in 2013. This is translated into savings in electricity consumption of 160.8 MWh per year.

A law has been passed where the maximum energy performance level is defined for refrigerators that are allowed to be imported into the country. The allowed maximum consumption is 600 kWh per year.

- **Compact fluorescent lamps:** The Energy Commission also led the compact fluorescent lamps (CFL) exchange programme in 2007. In the programme 6 million lamps were distributed to households for free and installed as a direct replacement for incandescent filament lamps. This led to the reduction of 124 MW in peak load and energy cost savings of US\$ 33,000,000 annually. There was also a reduction of 496,000 kWh per day resulting in cost savings of US\$38,558,000 per annum. The penetration of CFLs in the country increased from 20% in 2007 to 79% in 2009 as a result of the programme (Energy Commission, 2010). Further, the Commission in collaboration with Ghana Standards Authority has developed standards for LED street lights in which each 100-watt LED light has the capacity to replace each 400-watt sodium light. These plans are project specific but are set to continue with funding availability.

Table 13: Strategies to reduce wastage and ensure more efficient use of electricity³⁵

Objectives to be achieved	Key programme and projects	Possible financing sources	Timeframe	Verifiable indicators / Milestones	Responsible Agency
Achieve 10% savings	1) Power factor correction programme in public	GoG (Electricity Demand	2009 –	1) Equipment installed in first 25 public institutions by December	Energy Commission

³³The smart grid solutions are supposed to aid in monitoring the distribution lines when installed.

³⁴This programme had 3 year of donor support (2012 – 2014) and the government is to make financial provisions for its continuation in the annual budget. The period to achieve the target therefore depends on the availability of funds provided in the budget

³⁵The programme has been rolled forward as the targets were not fully achieved and are still relevant for the purpose



in electricity consumption through electric power efficiency and conservation measures	institutions, commercial and industrial entities	Management Fund) / Private sector	2012	2010; 2) Equipment installed in all 100 public and commercial and industrial businesses by 2012.	
	2) Public awareness campaign programme on energy efficiency and conservation	GoG / ECG/ VRA / independent power producers	2009 – 2012	1)Public awareness programme submitted and approved by EC by March 2010; 2) Commence implementation by April 2010.	Energy Commission / Energy Foundation
	3) Implementation of legislation on banning of importation and use of inefficient electrical appliances	Energy Fund	2009 – 2012	1) Importation of inefficient electrical appliances eliminated by Dec 2010 to Dec 2012	Energy Commission / Ministry of Energy ³⁶ / CEPS /GSB ³⁷

Source: Energy Sector Strategy and Development Plan, 2010

2.3.3 Energy efficiency strategy: petroleum products

A programme was initiated to achieve 15% savings in petroleum products consumption between 2009 and 2014. To achieve this, a number of strategies were put in place (Table 14). These included:

(i) Strict implementation of petroleum products lifting zoning mechanism

A directive to this effect was issued in 2010 even though actual implementation started in 2009. BOST/Ministry of Energy and TOR were the responsible agencies in the implementation.

(ii) The prohibition of importation of over-aged vehicles (above 10 years)

A law prohibiting the importation of over aged vehicles was passed in 2011. A public awareness campaign programme on fuel efficiency and conservation in transportation was also launched and sustained between 2009 and 2014. All these are meant to reduce petroleum power consumption and to increase efficiency.

(iii) Public awareness campaign on fuel efficiency and conservation in transportation

In the Ghana Power Compact³⁸, \$25.4 million has been budgeted to help improve energy efficiency and demand-side management policies and support investments to cost-effectively bridge the gap between supply and demand. The project will develop and enforce energy-efficient standards and labelling, build capacity for improve energy auditing, launch a public-awareness campaign to promote energy efficiency, and launch a pilot project to introduce

³⁶ Renamed as the Ministry of Power as at December 2014

³⁷ Ghana Standard Board (GSB) is now Ghana Standard Authority

³⁸Ghana Compact II, August 2014

distributed applications like solar photovoltaic backup power for lighting and electronics, off-grid solar systems, and grid-connected solar systems.

The targets were not fully met, as a result, there is the need to re-launch the programme in order to achieve its objectives.

Table 14: Strategies to reduce wastage and ensure more efficient use of petroleum products³⁹

Objective to be achieved	Key programme and projects	Possible financing sources	Timeframe	Verifiable indicators/milestones	Responsible agency
Achieve 15% savings in petroleum products consumption	1) Strict implementation of petroleum products lifting zoning mechanism	GoG (Petroleum Demand M'gt. Fund)/ OMCs/NPA /Private sector	2009-2012	-Letter to re-introduce zoning issued by Minister of Energy by January 2010; -Programme commences December 2009.	-BOST/Ministry of Energy/TOR
	2) Prohibition of importation of over-aged vehicles above 10 years	GoG	2009-2011	-Bill available by June 2000; -Parliamentary approval by December 2010.	-Ministry of Energy/Energy Commission
	3) A public awareness campaign programme on fuel efficiency and conservation in transportation	GoG/NPA/BOST/OMCs	2009-2014	-Public awareness programme approved by Ministry of Energy /EC by March 2010; -Programme under implementation.	-Energy Commission / Energy Foundation
	4) Promotion of the use of improved fuel performance additives	OMCs/NPA	2009-2012	-Sale of new petroleum products formulations for transportation by 2015.	-Ministry of Energy
	5) Establishment of centre for research in petroleum efficiency and conservation	GoG/Development partners/OMCs/NPA/Private sector	2009-2012	-Feasibility studies completed by June 2010; -Recommendations approved by cabinet by August 2012.	-Ministry of Energy

Source: Energy Sector Strategy and Development Plan, 2010

The ECOWAS region has developed a series of on-going regional policies and initiatives in the field of energy efficiency:

- The ECOWAS Energy Efficiency Policy (EEEP);

³⁹The programme is rolled on as the targets were not fully met and it still relevant

- ECOWAS Energy Efficiency Programme (SEEA-WA);
- The West Africa Clean Cooking Alliance (WACCA);
- The ECOWAS solar thermal Programme;
- Specific EE initiatives:
 - Standards and labelling initiative;
 - Efficient lighting initiative;
 - Energy Efficiency in buildings initiative;
 - High performance distribution of electricity initiative;
 - Safe, sustainable and clean cooking initiative.

Synergies between these regional programmes for energy efficiency and the measures contained in this SE4ALL Action Agenda, as well as in the NEEAP of Ghana, will be created so that the best possible use can be made of the regional initiatives in implementing the planned measures.

2.3.4 Priorities to be addressed to achieve the overarching objective in the field of energy efficiency

2.3.4.1 Cook stoves

To achieve Ghana's SE4ALL energy efficiency target, regulations (standard and labels) are being developed to regulate the cook stove subsector of Ghana and facilitate the displacement of inefficient cook stoves from the market. To ensure that stoves on the market meet the basic standard requirements, a cook stove testing centre have been established at the Council for Scientific and Industrial Research, Institute of Industrial Research (CSIR-IIR), in Accra and a cook stove testing and expertise laboratory has been established at the KNUST- Technology Consultancy Centre in Kumasi, with the support of the Global Alliance for Clean Cook Stoves and Fuels and UNDP, respectively.

On the supply side, a bioenergy policy has been drafted to promote the sustainable production, harvest, and utilization of wood resources for cooking and other applications. Strategies proposed in the draft bioenergy policy include the promotion of the development and utilization of energy efficient end-use devices; and improved carbonization technologies for the conversion of wood to charcoal.

2.3.4.2 Buildings and appliances

The government intends to provide building codes that shall review building materials such as glass windows and doors to improve energy efficiency in buildings. As previously mentioned, a number of interventions have been made to promote the adoption of energy efficient household appliances such as light bulbs, air-conditioners, and refrigerators. In the public sector, the promotion of capacitor banks to correct power factor is still ongoing, and awareness raising on energy conservation and management measures and benefits in industries is also still ongoing. To ensure sustainability of these energy efficiency interventions, most are implemented in partnership with the private sector.

To sustain efforts being made to enforce standards and labels development to regulate the importation and use of electrical appliances in Ghana, the government recognizes the need to build the technical and institutional capacity of the responsible agency, Ghana Standard Authority to effectively perform its regulatory role.

ECOWAS through ECREEE is supporting the development and implementation of energy efficiency interventions by West African states through the development to regional policies to facilitate the creation of an enabling environment for inter- and intra- state initiatives. Examples include: the development of the ECOWAS Regional Strategy on Energy Efficient Light (for on- and off-grid lighting) and the ECOWAS Directive for Energy Efficiency in Buildings.

2.3.4.3 Industrial and agricultural processes

The Government, with support from development partners and the private sector has been conducting energy audits and promoting the adoption of energy efficiency measures in industry.

The promotion of renewable energy technologies for irrigation and agro-processing increases energy efficiency in the agricultural sector since renewable energy technologies are very energy efficient.

2.3.5 SE4ALL priority action area

Ghana's SE4ALL target for energy efficiency is to ensure that all households using charcoal or firewood for cooking will use improved energy saving cook stoves by 2020. This should lead to at least a 30% increase in the efficiency of woodstoves in the country. Other priority areas in energy efficiency will be in lighting, building and household appliances, industrial and agricultural processes and in the cooking sector. The strategies to achieve this objective have been formulated but the targets are yet to be set in most of these areas.

2.4. Relevant (global) high-impact opportunities (HIOs)

Ghana's SE4ALL priority action areas and targets are linked to the following global high impact opportunities (HIOs).

ENERGY ACCESS

- (i) Energy and women's health: women and children are the most vulnerable to smoke related health cases resulting from cooking-related air pollution. These groups will therefore benefit most if cleaner cooking fuel like LPG and improved cook stoves are adopted for cooking by residential and commercial users. This will call for the production of 500,000 6 kg cylinders per annum, increased LPG storage facilities and establishment of LPG bottle refilling plants and the doubling of the LPG distribution network and retail outlets.
- (ii) The use of liquefied natural gas in electricity generation and exploring alternative energy sources such as clean coal and nuclear power increases the potential of Ghana to meet its growing electricity demand and achieve universal access to electricity and energy security.
- (iii) Petroleum product storage capacity will be expanded and bulk distribution infrastructure (e.g. jetty facilities) of petroleum products should be expanded to all parts of the country.
- (iv) Universal adoption of clean cooking solutions. The adoption of clean cooking solutions has the environmental benefits of reduced consumption of fuelwood, reducing the rate of deforestation due to indiscriminate harvesting of trees for fuelwood and conservation of the forest for other productive uses.
- (v) Ghana has a zero gas flaring policy which not only prevents environmental pollution from gas flaring but ensures that associated gas produced as part of oil production is processed as liquefied natural gas and other by-products.

RENEWABLE ENERGY

- **Promote IPPs in utility scale RE:** The role of IPPs to accelerate the rate of energy access is found to be crucial especially in the RE sector; the Government will therefore ensure the full implementation of Act 832 with reference to the feed-in-tariffs, the setting up of the Energy Fund and the incentive given to establishments in remote areas as found in the Ghana Investment Promotion Council, Act 865.
- **Implement net metering scheme:** The net metering scheme will enable individuals to install solar systems in their private estates and excess power generated would be credited to their accounts and recycled annually⁴⁰. This will create an incentive for individuals to install solar systems to support the drive towards increased access to energy.
- **Implement 200,000 rooftop solar systems:** the Government has targeted the installation of 200,000 rooftop solar systems by 2020. Estate developers would be engaged to include rooftop installations in

⁴⁰Excess power is not carried from one year into another year but circulated within any given year.

their designs; installation technicians would be trained alongside the electrical wiring professional training courses implemented by the Energy Commission in Ghana.

- **Deploy mini-grids and stand-alone systems:** There are island and isolated communities that cannot be reached with grid power systems. These communities must be identified through GIS mapping and published as priority areas for electrification using decentralized energy solutions.
- **Promote solar water heaters in commercial facilities:** Solar water heating is an emerging facility in the hospitality industry and health institutions. The Government would promote increased uptake of solar water heater in commercial as well as residential facilities.
- **Capacity building for the energy sector:** There is a chain of entrepreneurs in the energy sector. This includes manufacturers, importers, marketing agencies, storage facilities, distributors and installation and maintenance technicians. Skills needed in the energy sector would be identified and the capacity of relevant persons built.
- **Strengthen financial capability of utilities:** The financial capability of utilities and their ability to pay for electricity generated by independent power producers and government institutions is crucial to sustaining the power sector and continuous investment in power generation. A feed-in-tariff mechanism has been put in place as part of provisions in the RE Act 832 to ensure a guaranteed price per kW of electricity produced from renewable energy resources. The Electricity Company of Ghana is undergoing institutional restructuring to strengthen its financial capability and better position it as a more reliable off-taker for IPPs.
- **Sustainable woodlots:** To address deforestation resulting from indiscriminate harvesting of woodfuel for cooking and heating purposes, the Government of Ghana through its sector ministries and agencies would continue to promote the establishment of sustainable woodlots for cooking, heating and other applications.
- **Wind & Solar PV irrigation systems:** The population and housing census (2010) of Ghana indicates that 41.5% of people are engaged in agriculture, forestry and fishing and it is mainly a subsistence practice. Irrigated agriculture has been actively promoted by government over the past years especially for vegetable farmers and paddy rice farmers. There are currently over 20 public schemes (grid-connected, petrol or diesel powered, gravitational flow) operational nationwide and several private schemes. Under the SE4ALL initiative, the government has identified renewable energy technologies such as solar PV and wind powered pumps as a viable solution for irrigation and would be working with the private sector, civil society and development partners to promote and implement RE powered irrigation schemes. Sustainable business models would be developed to enable private companies to install irrigation systems for farmers to use and pay for the cost of installation over a defined period of time.
- **Solar dryers for agro-processing:** The government would work with research and other institutions to develop solar and alternative drying technologies using locally available resources. Technology transfer workshops would be organized to train entrepreneurs in the construction of drying interventions developed for high value vegetables, cereals and grains, etc. The drying interventions would be promoted using sustainable business models that remove the high initial capital usually required for the uptake of such interventions by farmers.
- **Sustainable woodlots:** Woodlots must be created to serve as feed stock for the production of woodfuel for cooking and heating purposes. Sustainable woodlots have associated environmental and economic benefits. Environmental benefits include improved micro-climate and carbon sequestration, tree stands

may serve as wind breaks and vegetation cover to control soil erosion, litter fall from trees could serve as compost and enrich the soil making it more productive, etc. The use of multi-purpose trees for the woodlot could generate economic benefits as fruits for sale, timber for furniture and other purposes, plant leaves, roots or barks for medicinal purposes, etc.

ENERGY EFFICIENCY

Standard and labels for end use devices: as of 2015, three end use devices have standard labels indicating their levels of energy efficiency. These are air conditioners, refrigerators, and lights. For high impact opportunities, energy efficiency standards and labels would be developed and implemented for the following end use devices:

- Televisions;
- Fans;
- Motors;
- Transformers;
- Generators;
- Solar systems ;
- Batteries;
- Power convertors;
- Water heaters; and
- Washing machines.

Industrial energy efficiency: As of 2012, 26 public institutions have been selected and installed with automatic capacitor banks and as much as 1,875 kVA were being saved monthly.

Efficient cook stoves: There is the need to promote the awareness and adoption of improved and energy efficient biomass cook stoves and clean fuels like LPG for both residential and commercial cooking.

Improved carbonization technologies: A number of improved carbonization technologies are currently being used in Ghana by charcoal producers for the export market. However, most charcoal produced for the local market is done using traditional, inefficient technologies. A high impact opportunity identified is the promotion of improved carbonization technologies which would significantly reduce the amount of wood fuel lost using inefficient technologies. The firewood to charcoal conversion rate estimated for inefficient technologies is 6:1. More efficient carbonization technologies with conversion rates above what is currently used would be promoted. Improved

carbonization technologies identified would be adapted to the Ghanaian context and the capacity of local charcoal producers built to facilitate its uptake.

2.5. Additional nexus targets

The planning and implementation of energy efficiency targets are prepared alongside RE and EA targets.

The use of renewable energy and improvement of energy efficiency and the access (or lack of) to modern and sustainable energy also affect other sectors, such as:

- Health and environment;
- Water and food security;
- Economic and productive sector;
- Society and education.

Planned measures to address the water and food-energy nexus are:

- Introduction of efficient technologies in households and agriculture, e.g. solar PV water pumping under drip irrigation;
- Promoting rainwater harvesting, micro-irrigation and groundwater re-charge schemes in order to make irrigation of crops more energy and water efficient;
- Water supply (manual, direct RE based mechanical and electric motor driven pumps).

In addition, renewable energy and energy efficiency can support the adequate functioning of health care facilities among others through the following measures:

- Vaccine refrigeration and ice pack freezing using solar and wind energy generated on site;
- Enable medical appliances to operate with RES (incorporate inverters that are powered by RES into the system);
- Lighting from renewable energy sources by LED (substitute for kerosene lighting which contributes to poor indoor air quality);
- Use of efficient ceiling fans;

- Solar-based radio and radiotelephone communications (facilitate emergency medical treatment and provide reliable communications to other health clinics and facilities in the region);
- Sterilization (sterilize with thermal energy rather than electricity due to lower costs);
- Water treatment (endorse alternatives to chemical disinfection like UV or ozone treatment using RES sources);
- Solar thermal technologies⁴¹ (e.g. solar water heating, distillation and pasteurization);
- Energy storage technologies in combination with RES electricity generation for medical facilities;
- Make the hospital or health clinic the centerpiece of a village mini-grid.

2.6. Enabling action areas

2.6.1. Energy planning and policies

The vision of the entire energy sector is to provide the secure and reliable supply of high quality energy services for all sectors of the Ghanaian economy, become a net exporter of oil and power with the target of reaching universal access by 2016.

The United Nations declared 2012 as the International Year of Sustainable Energy for All (SE4ALL). Ghana responded to this declaration by preparing the **Ghana SE4ALL Country Action Plan (CAP)** as presented in Table 15⁴². The supporting national policies are presented in Annex 1. The plan highlights four key areas, namely:

- (i) Access to electricity in remote communities using decentralised renewable energy systems;
- (ii) Access to modern energy for productive uses;
- (iii) Access to LPG as a clean cooking fuel;
- (iv) Access to energy efficient and improved cook stoves by woodfuel users.

2.6.2. Business model and technology innovation

The National Energy Policy of 2010 makes provisions for various types of support that encourage individuals and companies to come out with innovative ideas to improve the energy sector in all its operations. The provisions made which have not been fully implemented yet include the following:

⁴¹A solar water heating technology programme should be set up. The programme will build the capacities of the indigenes in the areas of installation technique, quality control, maintenance and follow-up support for SWH technicians and contractors. The programme could also include awareness raising among the general public and introduce and facilitate interested persons to financing sources.

⁴²The SE4ALL CAP presented in Table 14 has been updated from the 2012 plan to include the electricity access intervention for remote (island and lakeside) communities, and the indicators revised

- (i) Support the development of an indigenous alternative transportation fuel industry based on bioenergy resources (biofuels);
- (ii) Support private sector investments in cultivation of biofuel feedstock, extraction of the bio-oil and refining of bio-oil into secondary products by creating appropriate legislation;
- (iii) Support indigenous research and development to reduce the cost of solar and wind energy technologies;
- (iv) Support the use of decentralised off-grid alternative technologies (such as solar PV and wind) where they are competitive with conventional electricity supply;
- (v) Increase the allocation of resources for energy R&D activities;
- (vi) Give priority to adaptive R&D in energy technology while promoting basic research;
- (vii) Support the transformation of Ghanaian energy research institutions into centres of excellence for energy research and development.

These provisions are meant to encourage the development of innovative ideas and technologies by the indigenous people to produce sustainable energy for all.

2.6.3. Finance and risk management (climate change fund, development banks and development agencies)

There are four major national initiatives that may enhance good opportunities for the implementation of the Energy Development Plan:

- National policy on public private partnerships (PPP);
 - Renewable Energy Act, (Act 832);
 - Sustainable Energy for All initiative;
 - Ghana Millennium Challenge Account Compact II.
-
- **Public Private Partnership Policy⁴³**

The National Policy on Public Private Partnerships (2011) seeks to enhance the leveraging of public resources with private sector financial, human and technical resources to close the infrastructure gap and deliver efficient public infrastructure and services. The policy provides a clear and consistent process for all aspects of PPP project development and implementation from project identification, appraisal and

⁴³ For full acceptance and successful implementation of the Public Private Partnership Policy as expressed in the SREP document, a detailed planned measure has been presented in the Country Action Plan, Table 14.

selection to procurement, operation and maintenance as well as performance monitoring and evaluation. The policy encourages and facilitates investment by the private sector by creating an enabling environment for the PPP and protects the interests of both the government and the private sector. The policy is expected to facilitate the mobilization of private sector resources to complement funding from Government and its development partners for the implementation of the energy infrastructure plan.

- **Renewable Energy Act**

The objective of the Renewable Energy Act, 2011 (Act 832) is to support the development, utilization and efficient management of renewable energy sources. The act seeks to increase the proportion of renewable energy including solar, wind and biomass in the national energy supply mix and to contribute to the mitigation of climate change. The act makes it obligatory for power distribution utilities and bulk electricity consumers to purchase a percentage of their energy requirement from electricity generated from renewable energy sources. A feed-in-tariff mechanism has also been enshrined in the act to guarantee the price of electricity generated from renewable energy resources. The act thus presents considerable opportunities for the private sector to invest in viable energy infrastructure based on renewable energy, with an assurance of a ready market for power generation at commercial tariffs.

- **Sustainable Energy for All**

The Government of Ghana as well as the international community and development partners have demonstrated high enthusiasm and interest in the Country Action Plan for Sustainable Energy for All launched in 2012. This created remarkable opportunities for the mobilization of investment for two major projects under the Energy Infrastructure Plan, namely the establishment of:

- Large-scale LPG bottle re-filling plants; and
- Testing laboratories for improved cook stoves.

As earlier indicated, the two testing laboratories have been established to date with support from the Global Alliance for Clean Cook Stoves and the United Nations Development Programme. Discussions are on-going between the Ministry of Petroleum, NPA and the Global LPG Partnership on investment opportunities available to implement LPG infrastructure projects needed to increase and sustain supply of LPG to drive increased adoption of LPG for cooking and other applications.

- **Ghana Millennium Challenge Account Compact II**

Project 3 under the Ghana Compact II in particular presents great opportunities to facilitate investment in the infrastructure for power generation in Ghana, especially by the private sector. Under the Compact II agreement, US\$ 16.3 million has been set aside to finance the alleviation of a major constraint to private sector investment in power generation. The project will leverage ongoing advisory support provided by

USAID to operationalize Ghana's "gas to power" plan and commercialize the country's gas sector; support the development of an independent power producer framework that addresses generation, transmission, distribution and demand-side management in a holistic and integrated fashion; and fund a technical feasibility study to provide a "shovel-ready" project to increase the country's import of liquefied natural gas.

2.6.4 Risks to the energy sector plan

The implementation of the Energy Sector Plan may face two major risks related to:

i. Mobilization of funds

The plan may face the risk of the inability to mobilize adequate funding to implement all the projects under the plan, at the prescribed capacity and specifications and within the specified time frame. Given experiences from other countries, this risk will be averted if the private sector is supported by the government to conduct feasibility studies on their own and provide the enabling environment that will mitigate their investment risks by issuing public guarantees such as FIT in the case of RE to complement the funding from the Government and its development partners.

ii. Management capacity

The plan faces the risk of inadequate local management capacity to ensure effective and efficient implementation, monitoring and administration of the activities under the plan. In consideration of the very high investment required for the Energy Infrastructure Plan, it is important to put in place highly-skilled technical and management professionals teams in the three sub-sectors of energy. The risk will be addressed through additional training programmes for relevant technical and management personnel in the power, petroleum and renewable energy sub-sectors, with particular reference to the prioritized projects under the plan.

2.6.5 Other priorities

Under the Ghana National Energy Policy (2010) the Government will in general ensure the following:

- Provide a legal fiscal and regulatory environment conducive to attracting investment into the energy sector.
- Encourage the capital markets including the Ghana Stock Exchange to raise financing for investment in the energy sector.
- Establish transparent and nondiscriminatory practices in the implementation of rules and regulations and ensure efficient and transparent pricing regimes for energy services.

With specific reference to developing human resource capacity and research and development (R&D) the Government intends, among others to:

- Develop comprehensive Ghanaian local content in all aspects of energy sector operations;
- Support the training of Ghanaians in all fields of energy development and management and build capacity in indigenous manufacture of energy technologies;
- Give priority to adaptive R&D in energy technology while promoting basic research;
- Collaborate with relevant government, local and international agencies to develop capacity of tertiary and allied institutions for training and research.

To achieve the required objective in implementing the energy policy, that is, to make the necessary impact on the national economy, it will require that the management, operations and monitoring of the energy sector receive adequate focus. Therefore the policy, planning, monitoring and evaluation (PPME) divisions of relevant ministries, departments and agencies will be strengthened.

Table 15: Country Action Plan towards SE4All in Ghana⁴⁴

Priority SE4ALL goals	SE4ALL priority objectives	Immediate bottlenecks	Prioritized acceleration solution	Potential partners
Ensuring universal access to modern energy services by 2030 and double the share of renewable energy in the global energy mix	Increase in access to modern energy by households, commercial enterprises, industry and institutions	PUE 1.1 Design feasibility and implementation capacity issues (including incomplete data, inadequate assessment of capacity gaps of MSMEs and PUE service providers, and poor mapping of existing projects, overlaps, implementation synergies and lessons)	<p>1.1.1. Ensure PUE programme design is feasible, with clear objectives and prioritized interventions that take account of and leverage existing MSME programmes; and assess capacity of implementing partners.</p> <p>1.1.2. Irrigation on river banks with electricity: conduct a feasibility study and implement a total of 5,000 ha small-scale irrigation schemes on the banks of the White and Black Volta rivers in northern, upper east and upper west regions.</p> <p>1.1.3. Train engineers for system design and local artisans for installation and maintenance of equipment.</p> <p>1.1.4. Educate and sensitise beneficiary farmers.</p>	MOE, EC, ECG, VRA, NEDCO, GRIDCO, private sector, DP.
		PUE 1.2. Local economy analysis and intervention strategy design issues (including stock taking of local economic activities, analysis of PUE opportunities to promote and selection of local implementation partners)	<p>1.2.1. Analyse local economy and potentials for productive uses of energy; take stock of economic activities in the target area and identify those which could be upgraded through modern forms of energy; select partner institutions and determine what capacity development interventions will ensure the sustainability of productive use.</p> <p>1.2.2. Irrigation on river banks with wind pumps: conduct a feasibility study and install 2,000 Poldaw wind pumps to irrigate 4,000 hectares of farmlands in Central,</p>	MOE, EC, private sector, NGO, CBOs.

⁴⁴ This action plan was first prepared and presented in the 2012 Ghana SE4ALL and it has been updated to reflect the current situation.

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			Greater-Accra and Volta regions 1.2.3. Train engineers for system design and local artisans for installation and maintenance of wind pumps	
Priority SE4ALL goals	SE4ALL priority objectives	Immediate bottlenecks	Prioritized acceleration solution	Potential partners
	Improve access to modern energy for productive uses	PUE 2.1. Inadequate awareness creation of PUE issues and strategies amongst local energy service providers	<p>2.1.1 Facilitate the implementation of grid-connected small –scale irrigation schemes in areas with access to electricity.</p> <p>2.1.2 Promote the implementation of small scale irrigation schemes nationwide using appropriate RE interventions (Solar PV, wind powered pumps and mini hydro plants).</p> <p>2.1.3. Promote the uptake of renewable energy technologies such as solar dryers for agro-processing of high value vegetables and grains.</p> <p>2.1.4. Promote the uptake of renewable energy technologies in aquaculture ventures to boost the fisheries industry.</p> <p>2.1.5. Promote the establishment of a vibrant biogas industry to implement systems in public and commercial facilities.</p>	GIDA, MOFA, MOE, farmer cooperatives, CWSA, MMDAs
		PUE 4.1 Inadequate technical assistance for beneficiary MSMEs (including low level of training and business development services in most	<p>PUE in Agro-processing:</p> <p>4.1.1. Produce drying: establish 100,000 x 1,000 kg natural convection solar dryers for cassava, maize and vegetables for small-farmer cooperatives in the 10</p>	

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		districts).	regions. 4.1.2. Train engineers for system design and local artisans for installation and maintenance of equipment. 4.1.3. Educate and sensitise beneficiary farmers. 4.1.4. Palm oil production: conduct feasibility study and establish 5,000 small-scale oil palm processing plants in palm oil producing areas in central, western, Volta, eastern and Ashanti regions.	
Priority SE4ALL Goals	SE4ALL priority objectives	Immediate bottlenecks	Prioritized acceleration solution	Potential partners
			4.1.5. Train engineers for system design and local artisans for installation and maintenance of equipment 4.1.6. Train women groups: educate and sensitise beneficiary SMEs. 4.1.7 (C). Multifunctional platforms (MFP) for grinding and milling: conduct feasibility study and establish 2,000 MFPs with cassava graters, double screw presses, grinding mills, rice hullers in Brong Ahafo and northern regions 4.1.8. Train engineers for system design and local artisans for installation and maintenance of equipment. 4.1.9. Educate and sensitise beneficiary SMEs.	MOFA, MOE, MOWAC, farmer cooperatives, women groups, MMDAs

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			<p>(D)PUE in fisheries</p> <p>4.1.11. Fisheries landing sites and cold stores: conduct a feasibility study and construct modern landing sites and provision of cold stores and refrigeration facilities at 5 sites in the western, central and greater-Accra regions, and inland sites on banks of Volta lake.</p> <p>4.1.12. Train local artisans for installation and maintenance of equipment.</p> <p>4.1.13. Train women's groups.</p>	<p>MOFA, MOE, DOF,GNCFC, NFAG, GIFA, rural banks, NGOs, CBOs, DAs</p>
Priority SE4ALL goals	SE4ALL priority objectives	Immediate bottlenecks	Prioritized acceleration solution	Potential partners
			<p>4.1.14. Educate and sensitise beneficiary SMEs.</p> <p>4.1.15 (E). Aquaculture: conduct a feasibility study and establish 50 aquaculture ventures in the northern, Brong-Ahafo, Ashanti and Volta regions.</p> <p>4.1.16. Train women's groups</p> <p>4.1.17. Educate and sensitise beneficiary SMEs</p> <p>(F)Other PUE activities:</p> <p>4.1.18. PUE in salt production: conduct a feasibility study and establish 10 medium-scale salt production ventures in the Greater Accra and Volta regions.</p> <p>4.1.19. Train women's groups.</p>	<p>4.1.14. MOFA, MOE, MOWAC, rural banks, NGOs, CBOs, women groups, Das.</p> <p>4.1.15. MOTI, MOWAC, MOE, REP, NBSSI, rural banks, Das.</p> <p>4.1.17. MOE, EC, private sector, financial.</p> <p>4.1.19 MOE, EC, MOE,</p>

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			<p>4.1.20. Educate and sensitise beneficiary SMEs.</p> <p>4.1.21 (G). PUE using biogas: conduct feasibility study and establish institutional biogas systems for 200 boarding schools, hospitals and prisons.</p> <p>4.1.22. Train local artisans for installation and maintenance of equipment.</p> <p>4.1.23. Educate and sensitise beneficiary institutions.</p>	MOI, MOH, NGOs, CBOs, rural banks
Ensure universal access to modern energy services and double the global rate of improvement of energy efficiency.	Improve access to LPG as a clean cooking fuel	LPG 1.1 Inadequate supply of LPG to meet the increasing demand	<p>1.1.1. Ensure that public funded projects underway to improve supply of LPG from Tema oil refinery and imports are completed.</p> <p>1.1.2. Establish 4 x 100 TMTPA – LPG bottle refilling plants that are able to test, certify and refill.</p>	MOE, EC,NPA, private sector, financial institutions, GGs.
Priority SE4ALL goals	SE4ALL priority objectives	Immediate bottlenecks	Prioritized acceleration solution	Potential partners
			<p>LPG cylinders for the market at :</p> <ul style="list-style-type: none"> • Near gas processing plant; • Tema; • Kumasi; • Tamale. 	

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		LPG 1.2. Serious safety concerns on quality of LPG cylinders	1.2.1. Recapitalize GCNC or assist other cylinder manufacturers to manufacture smaller, portable and user-friendly cylinders (5kg and below), and provide these (about 500,000 cylinders per year) at a subsidized cost (using the current LPG subsidy) to LPG distribution franchise operators. Develop, monitor and enforce standards for improving safety.	GSA EC, NPA, NGOs, CBOs.
		LPG 2.1 Inadequate storage, filling and distribution infrastructure, with over concentration of distribution outlets in regional capitals and major urban settlements, especially in southern Ghana	2.1.1. Establish PPP with LPG retailers/marketing companies to build up distribution networks and retail outlets; reintroduce door to door marketing and distribution of filled LPG cylinders.	MOE, EC, private sector, financial institutions
		LPG 3.1. LPG subsidy policy for cooking unsustainable, not equitable, and prone to abuse	3.1.1. Provide a subsidy on domestic LPG equipment/appliances by redirecting the current subsidy on LPG fuel.	MOE, EC, NPA, private sector
	Improved access to energy efficient cook stoves by woodfuel users	ICS 1.1. Lack of national policy, strategy, coordination and partnership framework for improved cook stoves	1.1.1. Develop standards, policy and legislation for promotion and development of the clean cook stove subsector.	MOE, EC, NPA, GSA, private sector.
Priority SE4ALL goals	SE4ALL priority objectives	Immediate bottlenecks	Prioritized acceleration solution	Potential partners
	Urban household woodfuel use intensity reduced	ICS 1.2. Weak regulation of the cooking subsector, including regulation of the charcoal and	1.2.1. Facilitate the uptake of energy efficient biomass stoves for cooking in public institutions, commercial cooking and agro-processing activities.	MOE, EC, women groups, private sector, financial institutions

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		woodfuel supply chain		
	Improved cook stoves use in hotels, restaurants, institutional kitchens increased	ICS 1.3. Lack of incentives to promote the cook stoves subsector – e.g. import duties and taxes on technologies and regulation of raw material inputs (scrap metal).	1.3.1. Undertake consumer surveys and regional energy needs assessment to map socio-cultural variations and priorities.	MOE, EC, MOWAC, women groups, NGOs, CBOs.
		ICS 1.4. Poor quality of stoves, mainly relying on artisanal production with lack of technical standards and quality control	1.4.1. Engage end users in product design and marketing and promotional campaigns and messages; and address roles of men and women as producers, purchasers, and consumers of the solutions.	MOE, EC, MOWAC, women groups, NGOs, CBOs.
		ICS 1.5. Inadequate testing and monitoring mechanisms resulting in poor performance and low durability	1.5.1. Facilitate access to technical support to increase the capacity of local manufacturers of energy efficient stoves to meet consumer demand.	MOE, EC, MOWAC, financial Institutions, private sector, NGOs, CBOs
		ICS 2.1. Poor design of promotional messages that address gender, cultural and behavioural dimensions of cooking	2.1.1 Promote the establishment of sustainable woodlots for cooking and charcoal production	MOE, EC, NPA, women's groups, NGOs, CBOs.
Priority SE4ALL goals	SE4ALL priority objectives	Immediate bottlenecks	Prioritized acceleration solution	Potential partners
		ICS 2.2. Supply-driven promotional projects which lack	2.2.1. Support and promote research and development in	MOE, EC, MOWAC, financial institutions,

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		<p>consumer research and input from end users</p> <p>ICS 2.3. Lack of continuous end-user engagement in design and development of improved cook stoves</p>	<p>clean cooking solutions by local institutions</p> <p>2.3.1 Institute annual forum (including demonstrations and exhibitions) for improved cook stoves practitioners, end-users, policy makers and financial institutions to assess progress in cook stoves subsector.</p>	<p>private sector, NGOs, CBOs.</p> <p>MOE, EC.</p>
		<p>ICS 3.1. Limited budget support and over-reliance on pilot projects with short-term funding</p> <p>ICS 3.2. Limited involvement of banks in formulation and implementation of cook stove programmes</p> <p>ICS 3.3. Lack of access to finance for producers to improve production capacity, quality, and decentralize production and distribution of cook stoves; Limited access for end users to finance for upfront costs.</p>	<p>3.1.1 Establish website as repository of 'clean' cook stove technologies and designs, and update regularly.</p> <p>3.2.1 Institute annual forum (including demonstrations and exhibitions) for improved cook stoves practitioners, end-users, policy makers and financial institutions to assess progress in cook stoves subsector.</p>	<p>MOE, EC, CSIR, financial institutions, private sector, NGOs, CBOs.</p> <p>MOE, EC, private sector, universities, CSIR, DPs</p>
Priority SE4ALL goals	SE4ALL priority objectives	Immediate bottlenecks	Prioritized acceleration solution	Potential partners
		ICS 3.4. Lack of funding for		

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		<p>research and development, demonstrations, M&E and impact analysis</p> <p>ICS 4.1. Low economies of scale and high cost of the improved cook stoves compared to the traditional cook stoves.</p> <p>ICS 4.2. Inadequate attention to long-term marketing and sustainable value-chain development.</p>		
		<p>ICS4.3. Inadequate capacity of key actors across the improved cook stove value chain, including researchers, financiers, manufacturers and distributors to promote cook stove technology innovation and adaptation</p> <p>ICS 4.4. Limited variety of improved cook stoves to support local needs and varied consumer segments.</p> <p>ICS 4.5. Limited technology transfer and diffusion of technical knowhow in improved</p>	<p>4.3.1 Establish repository of 'clean' cook stove technologies along with appraisal data of technologies; sensitize. Improved cook stove manufacturers to promote a range of technologies for varied needs; support technology transfer and partnerships with international manufacturers.</p>	<p>MOE, EC, NGOs, CBOs</p>

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Priority SE4ALL goals	SE4ALL priority objectives	Immediate bottlenecks	Prioritized acceleration solution	Potential partners
		cook stove manufacturing.		
		ICS 4.6. Limited access to raw materials both in terms of quantity and quality	4.6.1 Institutionalize and enforce comprehensive biomass policies and regulations	MOE, NPA, EC
		ICS 4.7. Limited support to strengthen and expand and decentralize local manufacturing of improved cook stoves	4.7.1 Encourage practitioners to participate in collaborative forums, update data and results, and share with others in the sector; Undertake comparative studies to map the sector in the regions and gather evidence on use and best practices; and support demonstrations, exhibitions, seminars, workshops, etc. for knowledge sharing.	MOE, NPA, EC, women groups, NGOs, CBOs.
		CCI 1.1: Gaps in data and research (including consumer research) and lack of funding for regular annual surveys to update date	<p>1.1.1. Conduct periodic surveys to assess progress being made toward achievement offset objectives.</p> <p>1.1.2. Institute annual SE4ALL forum to update key stakeholders on progress.</p> <p>1.1.3. Mainstream gender and climate change issues in SE4ALL activities.</p>	EC, MOE, GSS, NGOs, CBOs
Improving energy efficiency in buildings	Increase management capacity in energy efficiency in buildings	1.1 Limited managerial capacity in energy efficiency in buildings	<p>1.1.1 Introduce curricula into science education institutions on energy efficiency management and entrepreneurship in the buildings industry</p> <p>1.1.2 Build the entrepreneurship capacity of practitioners in the area of sales and marketing of EE</p>	Ministry of Education, Ministry of Energy, Ministry of Power, science and engineering institutions, Energy Commission,

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			<p>building materials</p> <p>1.1.3 Identify and support entrepreneurs in strategic locations to establish the supply chain of energy efficient building materials.</p> <p>1.1.4 Train EE project financing for both private and public construction managers.</p>	tertiary institutions.
Increase the use of solar water heating technology	Improving energy efficiency through solar water heating systems	Inadequate promotion, development and use of solar water heating technology	<p>1.1.1 Set up water heating technology departments in science and engineering institutions to train management skills to install, maintain and quality control techniques</p> <p>1.1.2 Facilitate the establishment of R&D components of solar water heating systems in science and engineering institutions</p> <p>1.1.3 Promote and support the development and use of solar dryers for small scale agriculture</p> <p>1.1.4 Facilitate the installation and use of solar water heating systems in institutions and hospitality industries through subsidized structures</p>	Ministry of Energy, Ministry of Power, Energy Commission, Ministry of Education, tertiary institutions.
Public Private Partnership Policy in RE	<p>1.0. Strengthening public management of the PPP policy.</p> <p>2.0. Awareness creation on financing and value of using RE</p>	<p>1.1. Inconsistent and unclear implementation mechanism of the RE ACT, ACT 832</p> <p>1.2 High initial capital cost of production</p> <p>1.3 Lack of capacities of</p>	<p>1.1.1 Provide a clear and consistent implementation mechanism for the Renewable Energy Act including a tariff available to developers, the conditions of power purchase agreements (PPAs) and the bureaucracy involved in obtaining licenses and permits.</p> <p>1.1.2 Provide financial assistance through the banking system at reduced rates to enable investors to</p>	Ministry of Energy, Energy Commission, NGOs in the sector and Ghana Investment Promotion Council

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		<p>off-takers.</p> <p>1.4 Inappropriate data information flow.</p> <p>2.1 Limited knowledge on the advantages of using renewable energy</p> <p>2.2. Communities perception of the inadequacy of decentralized off-grid RE</p>	<p>overcome the initial high capital cost.</p> <p>1.1.3 Build the capacities of off-takers in project development and negotiation skills in sourcing for loans to implement projects through workshops, seminars and flyers</p> <p>1.1.4 Technical data must be disseminated using public friendly language to enable understanding and application</p> <p>2.1.1. Create awareness raising campaigns through public fora and community level education on the advantages of using renewable energy and funding sources</p> <p>2.2.1. Educate end-users of the adequacy of the decentralized off-grid RE systems and increase the availability of the RE systems at subsidized rates</p>	
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3. Coordination and follow-up

3.1. Implementation arrangements (oversight, coordination and management of the SE4ALL Country Action Plan)

Effective implementation of the Ghana SE4ALL Country Action Plan requires governance arrangements that reflect cross-sectoral cooperation and inter-ministerial coordination. This will ensure that at the policy level, acceleration of sustainable access to energy as an imperative for sustainable growth, employment and poverty reduction remains a major plank of national strategies for shared growth. This is because in the execution of the action agenda, three major functions will be prosecuted concurrently:

- i. The generation, transmission and distribution of energy;
- ii. Financial arrangements and the creation of enabling environment for investors; and
- iii. The coordination of the AA to ensure its success.

Obviously the policies of generation, transmission and the distribution of energy and the enforcement of the governing regulations will be handled by the Ministry of Power. This will be a continuation of the role it is already playing by providing technical support to the government in formulating policies and ensuring its implementation and monitoring.

At the programme level, the mobilization and facilitation of the private sector participation, e.g. through investment partnerships, will be critical to the success of the Country Action Plan. SMEs can drive productive uses of energy as well as sustainable penetration of energy services and devices into underserved peri-urban and rural markets. However, it will take the support of the financial sector to develop relevant and innovative financial products to raise the long-term capital needed. District Assemblies and community-based civil society organizations, are prime agents of change at the local level. This aspect will be coordinated by the MDAs and the district assemblies.

Annual National SE4ALL Forum

A national forum on Sustainable Energy for All will be convened every year by the Ministry of Energy to review progress on the implementation of the Ghana SE4ALL Country Action Plan. It will serve the SE4ALL “annual general meeting” of all stakeholders (government, the private sector, civil society, research community and end-user representatives) and a forum for holding those responsible for implementing the Country Action Plan to account. Presentation of the overall CAP Monitoring and Performance Assessment Report will be the centre piece of the national forum, enabling stakeholders to review progress against the targets set. It will also serve as the principal

forum for private sector partnership and investment promotion. There will be mid-year review prior to the annual forum to discuss progress being made in the implementation of SE4ALL and the Secretariat will be the convener under the auspices of the Ministry.

Inter-Ministerial Committee

An Inter-Ministerial Committee, chaired by the Ministry of Power, has been constituted to provide the required oversight leadership and guidance on the implementation of Ghana's SE4ALL Action Plan as well as to coordinate the SE4ALL interventions of the ministries and provide a high-level forum for setting priorities and strategies for engaging with the private sector and development partners. The committee is comprised of the Ministry of Power; Ministry of Petroleum ; Ministry of Food and Agriculture; Ministry of Fisheries and Aquaculture Development; Ministry of Health; Ministry of Environment, Science and Technology and Innovation; and the Ministry of Gender, Children and Social Protection. This committee will establish three sub-committees on: off-grid renewable energy electrification; productive uses of energy; and clean cooking solutions to provide technical support to the implementation of SE4ALL specific activities representatives of civil society, research community, development partners and the private sector, especially business associations and financial institutions, would be co-opted as members.

This inter-ministerial committee would meet bi-annually while the sub-committees would meet as often as required.

The SE4ALL Ghana Financing Working Group constituted in 2013 with the support of the US State Department would continue to support the SE4ALL Secretariat and the project sub-committee to identify and develop bankable project proposals, and facilitate access to available financing. The Financing Working Group is made up of representatives from the Ministry of Power, Energy Commission, SE4ALL Secretariat, Ministry of Finance, African Development Bank, Delegation of the EU, UNDP, US State Department, and World Bank. This ad-hoc group would meet as and when needed.

The Secretariat

The SE4ALL Secretariat was established at the Energy Commission in September 2013. The Secretariat coordinates the implementation of SE4ALL activities by responsible institutions, monitors and reports on implementation progress against set targets. Due to the limited technical and financial capacity of the SE4ALL secretariat, it would focus on high impact opportunity projects relating to electricity access for off-grid communities using decentralized renewable energy technologies, productive use of electricity and clean cooking solutions. The Secretariat will therefore work closely with the policy planning monitoring and evaluation (PPME) units in the relevant ministries and report on implementation progress.

The Secretariat would also identify funding opportunities for public-private, public-public or private-private partnerships to drive SE4ALL project implementation.

3.2. Monitoring, evaluation and reporting (M &ER)

It is important to establish a flexible but robust monitoring and evaluation framework for the national SE4ALL Action Agenda to monitor implementation, support lessons learning, and make necessary adjustments over time (including provisions for regular review/update of the Action Agenda, which should be seen as a living document).

Ghana has a monitoring, evaluation and reporting (MER) framework or system for tracking implementation progress of SE4ALL interventions. The MER framework was developed with technical assistance from the SE4ALL Africa Hub. To ensure comparability with the global reporting system, the MER framework was developed using indicators and parameters adapted from the World Bank's Global Tracking Framework. The MER system is based on targets, objectives and activities set in the CAP 2012, some of which are updated in this Action Agenda document. The MER system is comprised of a logical framework ("Logframe"), a monitoring plan, an evaluation plan, a reporting plan and a performance assessment framework. The Logframe provides a strategic overview of the activities under the SE4ALL initiative that Ghana pursues, outlining the main results to be achieved at various levels, and their associated key performance indicators. It provides a general frame to focus the monitoring, evaluation and reporting efforts.

The monitoring plan provides a guide on how to monitor data that will show how Ghana is progressing toward the achievement of its SE4ALL goals. It includes a list of specific indicators which will enable tracking all relevant aspects of the implementation of Ghana's activities under the initiative. A monitoring protocol is associated to each indicator with specific indication of the frequency of the data collection as well as the responsible monitoring entities.

Table 16: Indicators currently included in the MER system under each goal and objectives

SE4ALL Global Goal 1: universal energy access by 2030	
SE4ALL Ghana Goal 1: ensure universal access to modern energy services by 2020	
1	National electricity access percentage (%) – measure based on the number of households connected.
2	National access percentage to modern energy for cooking (%) – measure based on number of hh using LPG or non-BLEN manufactured biomass cook stoves as the primary solution for cooking.
1.1) SE4ALL Ghana Objective 1: provide access to electricity in remote communities using decentralized renewable energy systems	
3	Number of households using RE as the primary source of energy for lighting and very low power appliances (≤ 30 kW).
4	Number of households using RE as the primary source of energy for lighting and low power appliances (31-150 kW).



5	Number of households using RE as the primary source of energy for lighting and medium to high power appliances (>150 kW).
6	Number of communal facilities with access to electricity through a decentralized RE system.
7	Number of solar lanterns distributed in off-grid communities.
1.2) SE4ALL Ghana Objective 2: improve access to modern energy for productive uses	
8	Number of water pumps for irrigation (as PUE): 8a): grid-connected; 8b): solar PV connected.
9	Number of businesses with access to energy through decentralized RE systems, focus on solar dryers.
1.3) SE4ALL Ghana Objective 3: improve access to LPG as a clean cooking fuel	
10	Percentage of households using LPG as primary fuel for cooking (%).
11	Number of distributed LPG cylinders in rural areas.
1.4) SE4ALL Ghana Objective 4: improve access to energy efficient and improved cook stoves by woodfuel users	
12	Number of public institutions, commercial cooking and agro-processing activities using improved woodfuel cook stoves as the primary device for cooking.
13	Number of households using improved firewood cook stoves as the primary cooking device.
14	Number of households using improved charcoal cook stoves as the primary cooking device.
15	Percentage of hh using non-BLEN manufactured biomass cook stoves.
SE4ALL Global Goal 2: double the share of renewable energy (RE) in the global energy mix by 2030	
SE4ALL Ghana Goal 2: increase the proportion of RE in the total national electricity mix to 10% by 2020	
16	Percentage of RE in the national electricity mix (%)
16a	On-grid RE capacity (MW)
16b	Off-grid RE capacity (MW)
2.1) SE4ALL Ghana Objective 1: provide access to electricity in remote communities using decentralized renewable energy systems	
17	Installed capacity of RE mini grids in off-grid communities (MW).
18	Total capacity of solar community lighting systems (solar street lights) installed in off-grid communities (MW).
19	Total capacity of solar lanterns distributed in off-grid communities (MW)

20	Total capacity of solar home systems installed in off-grid communities (MW)
SE4ALL Global Goal 3: double the global rate of improvement in energy efficiency by 2030	
SE4ALL Ghana Goal 3: to ensure that all households using charcoal or firewood for cooking will use improved energy saving cook stoves by 2020.	
3.1) SE4ALL Ghana Objective: at least a 30% increase in the efficiency of woodfuel stoves in the country	
21	Annual average firewood consumption for cooking per household (kg/hh*year)
22	Annual average charcoal consumption for cooking per household (kg/hh*year)

3.3. Link to Investment Prospectus (IP)

The Investment Prospectus for the Action Agenda is presented in Table 17. The prospectus gives an indication as to how much money must be mobilized to implement the Action Agenda by item. (The calculation is based on the universal approach to how much money (\$) will be required to produce 1 MW of energy).

Table 17: Investment Prospectus for Ghana

Intervention	Estimated Cost (USD)
Energy Access	
Alternative energy sources;	
• Clean coal of 750MW;	1.5 - 2 b
• Nuclear of 1,000 – 1,200 MW.	4.5 – 5 b
Clean cooking:	
• LPG cylinder recirculation model implementation,	250 m
• Disseminate 200,000 6kg LPG cylinders, stoves & accessories under a rural LPG promotion programme.	10 - 25 m
250 irrigation schemes (grid-powered)	



Energy Efficiency	
Promote adoption of efficient cook stoves by 2 million households.	10-50 m
Renewable Energy	
Utility scale power projects:	
<ul style="list-style-type: none"> • Wind 50 – 150 MW; • Biomass/waste to energy 20-50 MW; • Solar PV systems; • Small hydro (150-300 MW). 	300- 550 m 60 150 m 400- 700 m 450- 900 m
200,000 rooftop solar (including net-metering systems).	250 m
30,000 solar standalone systems in remote communities.	10 - 25 m
Mini-grids (30-42 units)	
PUE:	
<ul style="list-style-type: none"> • 500 irrigation schemes (wind and solar powered); • 250 solar crop dryers; • 50 aquaculture ventures; • 10 medium scale salt production ventures. 	150 m 100 m

Annex 1: National policies, plans and programmes on renewable energy, energy efficiency and energy access

Area	Name	Approval Date	Description	Implementing Government Body	Status
EE, RE, NREAP	Energy Fund, EC Act 541	1997	Promotion of energy efficiency and renewable energy resources	Energy Commission	Operational
EE, NREAP, NEEAP	EDMF	2011	Provides funding for renewable energy development and energy efficiency activities in industrial, commercial, and residential sectors	Energy Commission	Operational
EE, RE, NREAP	Public Procurement ACT 2003 (Act 663)	2003	An economic instrument to promote and regulate direct investment in energy generation	Public Procurement Authority	Operational
EE, NREAP	Value Added Tax Act (Act 870) and, Act 546 1998	2013, 1998	Tax applied to goods and services at each stage of production and distribution chain but exempted petrol, diesel and kerosene	Ghana Revenue Authority	Operational
RE, EE, EA	GIPC-Act 2013 (Act 865)	2013	Provides guarantees including prohibitions & discriminations; tax incentives for investments outside industrialized centres	GIPC	Operational
EE, NEEAP	LI 1815, 1958, 1970	2005, 2008	Labelling for standardization	GSA, EC	Operational
EE, NEEAP	LI 1815, 1958, 1970	2005, 2008	Minimum energy performance standard	GSA, EC	Operational
EE, NEEAP	LI 1815, 1958, 1970	2005, 2008	Comparison label	GSA, EC	Operational
EE, NEEAP	LI 1815, 1958, 1970	2005, 2008	Endorsement label	GSA, EC	Operational
RE, NREAP	RE Act 2011, (Act 832)	2011	For development, management, utilisation, sustainability and adequate supply of renewable	EC, PURC	Operational

			energy		
RE, EA, EE	Ghana Energy Development and Access Project (GEDAP)	2007	To enhance the reliability of adequate power supply	MOEP	Operational
EE, NEEAP	Refrigerator Rebate Scheme		Promotion of energy efficient refrigerators for domestic use	Energy Commission	Operational
EE	Promotion of EE in Public Buildings		Installation of capacitor banks in public institutions		Operational
RE, EE, EA, NREAP	SE4ALL Country Action Plan	2012	Improving access to modern energy services, increasing renewable energy in the national energy mix, and increasing energy efficiency	MoE, EC	On-going
RE, EA, NEEAP	Kerosene lantern replacement programme		Replacement of kerosene lanterns with solar lanterns	MoE	Operational
EA	Self Help Electrification Programme (SHEP)	1990	Increasing access to grid electricity in rural communities	MoE	On-going
EE, NEEAP	LI 1815	2005	Energy efficiency standards and labelling	EC; GSA	Operational
EE, NEEAP	Energy efficiency regulation LI1932	2008	Prohibition of sale of incandescent lamps	EC	Operational
EE, NEEAP	Energy Efficiency standards and labelling	2009, 2010	Household refrigeration appliances conforming to energy efficiency standards for imports and locally made goods	EC	Operational



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