RENEWABLE ENERGY POLICY REVIEW, IDENTIFICATION OF GAPS AND SOLUTIONS IN GHANA

The Renewable Energy Policy Review, Identification of Gaps and Solutions in Ghana Report was commissioned by the Energy Commission under the China-Ghana South-South Cooperation on Renewable Energy Technology Transfer (SSC RETT) with funding from the Government of Denmark. The Energy of Commission Energy of Ghana, the Ministry of Science and Technology in China and the UNDP Country Offices in Accra and Beijing are jointly implementing the project.

The Report was prepared Dr. Essel Ben Hagan, Accra Institute of Technology. The objective of the assignment was to identify barriers and policy gaps that constrain growth in the development and deployment of renewable energy technologies in Ghana, and to recommend strategic interventions to facilitate the exchange of expertise and technology, as well as best practices on renewable energy between China and Ghana.

Renewable Energy Policy Review, Identification of Gaps and Solutions in Ghana

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Acronyms

AFD	Agence Française de Développement
AfDB	African Development Bank
BMZ	German Federal Ministry for Economic Cooperation and Development
BPA	Bui Power Authority
CIC	Climate Innovation Centre
DP	Development Partner
EC	Energy Commission
ECG	Electricity Company of Ghana
EnDeV	EnerGIZing Development Program
EP	Enclave Power
EPA	Environmental Protection Agency
EPRAP	Poverty Reduction Action Plan for Ghana
EU	European Union
FiT	Feed-in Tariffs
GCSA	Government consent and support agreement
GDP	Gross Domestic Product
GEDAP	Ghana Energy Development and Access Project
GH¢	Ghanaian cedi currency
GIZ	Deutsche Gesellschaft fur Internationale Zusammenarbeit (German Agency for International Cooperation)
GoG	Government of Ghana
GRA	Ghana Revenue Authority
GRIDCo	Ghana Grid Company
GSGDA	Ghana Shared Growth and Development Agenda
IPP	Independent Power Producers
KfW	Kreditanstalt für Wiederaufbau (German Development Bank)
KITE	Kumasi Institute of Technology, Energy and Environment
MCC	Millennium Challenge Corporation

MoP	Ministry of Power
NEDco	Northern Electricity Distribution Company
PPA	Power Purchase Agreement
PURC	Public Utility Regulatory Commission
RE	Renewable energy
SE4ALL	Sustainable Energy for All Initiative
SME	Small and Medium sized Enterprises
SNV	Netherlands Development Organization
SECO	Switzerland State Secretariat for Economic Affairs
UNDP	United Nations Development Program
VRA	Volta River Authority

Executive Summary

1. Background

Ghana has embarked on a project to enable the country to share China's immense experience and skills on renewable energy technologies. The project aims to facilitate the exchange of expertise and technology on renewable energy between China and Ghana, with focus on building the institutional framework and capacity required to facilitate the local absorption of the technologies. The project also seeks to promote the production of renewable energy technologies in Ghana with a strong focus on private sector development and inclusion.

In the first year of implementation, the project is focusing on establishing an enabling environment for the transfer, production and regulation of the use of renewable energy technologies in Ghana. As part of this process, the project has embarked on an assignment on "Renewable Energy Policy Review, Identification of Gaps and Solutions in Ghana." The assignment includes a review of past and current Chinese and Ghanaian renewable energy policies and strategies, as well as stakeholder consultations to identify policy gaps and propose solutions to boost the renewable energy sub-sector in Ghana. The outcomes of these activities are expected to feed into subsequent project activities. This report is the draft final report on the "Renewable Energy Policy Review, Identification of Gaps and Solutions in Ghana."

2. Renewable Energy Sub-sector in Ghana

2.1 Renewable Energy Resources

The major renewable energy resources in Ghana are:

- Mini/small and medium capacity hydropower;
- Solar energy;
- Wind energy;
- Biomass and waste-to-energy;
- Wave and tidal energy.

Mini/small and medium capacity hydropower: There are about 17 medium and 22 mini/small hydropower sites with exploitable capacities ranging from 15 kW to 100 MW. The estimated total exploitable capacity of these sites is 800 MW. The main barriers preventing the development of this resource have been climate variability and the unavailability of the data needed to assess the viability of the sites.

Solar energy: The solar irradiation level in Ghana ranges from 4.5 to 6.0 kWh/m^2/day with the highest irradiation levels occurring in the northern half of the country. The Government is piloting a number of initiatives on the deployment of solar energy systems.

Wind energy: Ghana has moderate wind energy potential, and the Ministry of Power, with support from the World Bank, has been conducting wind resource assessments at 15 sites with total potential power generation of about 1,100 MW. Average annual wind speeds along the coast and some islands range from 4.0m/s to 6.0m/s at 50m-hub height.

Biomass and waste-to-energy: Nearly 50% of the country's overall primary energy use is obtained from biomass. This energy is consumed mostly in the household sector in the form of charcoal or firewood. Biomass resources include supply from agricultural residues from maize,

sorghum, rice and from agro-based industries such as shea butter, cocoa, rubber, sawmills, and palm oil.

Wave and tidal energy: Tidal energy is produced using tidal energy converters. These huge underwater turbines are placed in areas with high tidal movements and are designed to capture the kinetic motion of the receding and rolling ocean tides to produce electricity. Tidal power has abundant potential for future power and electricity generation because of the enormous size of the oceans.

2.2 Regulatory Framework for Promotion of Renewable Energy

Ghana's policy commitment towards renewable energy has been translated into actions to support renewable energy development. In 2011, the Renewable Energy Act was enactedto provide for the development, management, utilization, sustainability and adequate supply of renewable energy for the generation of heat and power, and thereby increase the proportion of renewable energy in the national energy supply mix while contributing to the mitigation of climate change. The Act calls for:

- A framework for the utilization of renewable energy sources;
- An enabling environment to attract investments in renewable energy sources;
- The building of indigenous capacity in technologies for developing renewable energy renewable energy sources;
- Public education on renewable energy production and utilization; and
- Regulation of the production and supply of woodfuel and bio-fuel.

3. Renewable Energy Sub-sector of China

The key drivers of the growth of the renewable energy sub-sector in China through the implementation of the Renewable Energy Law are

- Overall targets mechanism;
- Pricing mechanism;
- Renewable energy subsidies;
- Taxation policy; and
- R&D facilitation.

3.1 Impact of Chinas' Renewable Energy Policies / Regulatory Instruments

The major impacts to the economy of China resulting from the implementation of its renewable energy policies and regulatory instruments are:

- Fossil-fuel substitution and environment benefits; and
- Green industries development and jobs creation.

3.2 Policy Challenges for China's Solar PV Power Development

The incentives promulgated or implemented in China demonstrate the determination of the Chinese government to promote domestic solar PV power market in China, but policy challenges do exist. The major barriers for the development of renewable energy in China are:

- Deficiencies of the national FiT scheme;
- Weak and incomplete incentives and supervision mechanisms;
- Poor policy coordination and consistency;
- Conflicts between renewable energy power generators and grid companies; and
- Poor coordination of Research and development, demonstration and development (R&DDD) on renewable energy and regional policy.

4. Barriers in Ghana's Renewable Energy Sub-sector and Recommended Interventions

4.1 Barriers in Ghana's Renewable Energy Sub-sector

The key barriers and policy gaps identified by the stakeholders as the factors that constrain the development and deployment of renewable energy (RE) technologies in Ghana are:

- Low level of research, development, demonstration and deployment (R&DDD) on RE;
- Poor knowledge management and information sharing on RE technologies;
- Concern on waste disposal of RE appliances waste;
- Poor financing of RE investments;
- Lack of affordability of RE systems;
- Cumbersome licensing processes;
- Challenges with enabling instruments for RE investment;
- Unbalanced emphasis on on-grid RE systems; and
- Inadequate indigenous capacity building.

4.2 Gap Analysis of Renewable Energy Policies and Regulatory Instruments of Ghana

The review and gap analysis of renewable energy policies and regulatory instruments of Ghana was conducted under four major indicators: i) Effectiveness; ii) Efficiency; iii) Equity; and iv) Institutional feasibility. Additionally, the replicability of Chinese renewable energy policies and regulatory instruments in Ghana was also analysed.

- The Energy Strategy, Renewable Energy Law and supporting instruments are considered to be only moderately effective, in terms of growth in power capacity from renewable energy compared to the set targets;
- In terms of fiscal incentives to leverage private investment as well aspublic and private finance on R&DDD, the judgement of renewable energy developers reflects that the efficiency of the Energy Strategy, Renewable Energy Law and supporting instruments is poor.
- In terms of fair access to support policies and instruments, as well as participation of stakeholders, the level of equity in the development and deployment of renewable energy technologies is good.

- The institutional capacity and feasibility of Ghana's renewable energy sub-sector is considered to be good.
- The replicability of the enabling environment of China in Ghana is considered to be moderate. The replicability can be improved if the recommended economic, regulatory and institutional strengthening are implemented.

5. Recommended Strategic Interventions to Address Barriers/ Policy Gaps

The gap analysis of renewable energy policies and regulatory instruments in Ghana was validated by the various levels stakeholder consultations, with due consideration of some best practices on renewable energy development and deployment in China. The analysis has provided the following recommendations of strategic interventions to address the various barriers and policy gaps that constrain the growth in the development and deployment of renewable energy in Ghana:

1. Low level of R&DDD and poor knowledge management and information on RE

- Establish national competitive bidding system for granting financial support to critical areas of R&DDD, particularly renewable energy technologies;
- Relevant research institutes and universities should be granted technical assistance and financial support to develop the state-of-the-art laboratories to conduct R&DDD in renewable energy technologies;
- Energy Commission should play the role of initiating and coordinating R&DDD in renewable energy technologies by universities and research institutes;
- Energy Commission should organize regular interaction among universities and research institutions, the private sector and Ministry of Power.

2. Concern on waste disposal of RE appliance wastes

- Government should expedite the enactment of the Bill on Control and Management of Electronic Waste which includes:
    - The requirement for manufacturers or importers of electronic equipment to pay electronic waste levy on locally manufactured or imported electronic equipment to the Environmental Protection Agency to cover management of electronic waste;
    - Establishment of an Electronic Waste Recycling Fund from the electronic waste levy and other sources.

3. Poor financing of RE investments and lack of affordability of RE Systems

- Implement reforms to improve the company finances and credit-worthiness of Electricity Company of Ghana (ECG) and Northern Electricity Distribution Company (NEDCo), as a major off-takers of electricity from RE;
- Intensify public education and awareness campaigns on the benefits of renewable energy technologies;
- Review the tenor of the feed-in-tariff, with the possibility to increase the year duration;

- Incentivize financial institutions to support renewable energy investments; and
- Harmonize the public messages on renewable energy from government institutions.

4. Licensing process for RE investments and other challenges with enabling instruments

- Create a platform for potential renewable energy technology developers to complete the licensing process on-line via the internet;
- Review the renewable energy provisional licence requirements, with the possibility to reduce the number of exhibits required to be submitted;
- Develop clear regulatory guidelines on renewable energy off-grid and mini-grid systems;
- Develop a framework to clearly define how renewable energy projects can qualify for government-backed credit support and partial risk guarantees.

5. Unbalanced emphasis on on–grid renewable energy systems

- Develop a clear plan or roadmap for transitioning all off–grid systems in communities to be grid-connected as and when the grid becomes available;
- Provide adequate funding from the Renewable Energy Fund to support extensive public awareness creation among various stakeholders on the different RE system options available; and
- Provide incentives and support schemes for productive uses of off–grid systems.

6. Inadequate indigenous capacity building

- Develop standardized curriculum for competency-based training on all renewable energy technologies, with emphasis on the technical and entrepreneurial aspects;
- Provide incentives for private sector support for competency-based training in technical and entrepreneurial aspects of all renewable energy technologies;
- Reduce over-reliance on foreign expertise for execution of renewable energy projects, through deliberate efforts to improve local expertise through capacity building; and
- Provide incentives for female participation in the various activities in the renewable energy sub-sector.

6. Conclusions

Following the analysis of the renewable energy policy and regulatory instruments as well as national initiatives of Ghana and China, it is evident that learning lessons from successful national initiatives on renewable energy in China will be instrumental in overcoming many of these barriers. In line with this, the national initiatives of China on renewable energy need to be carefully examined to identify some best practices that may be replicated in Ghana.

Ghana needs to consider two major lessons from the national initiatives of China that drove the growth of the renewable energy sub-sector in China under its Renewable Energy Law. These lessons are:

i) Combining government's responsibility and active participation of the private sector; and

ii) Combining actual demand and future development.

1. Introduction

1.1 Background

Ghana was one of the first United Nation (UN) member nations that embraced the UN's Sustainable Energy for All (SE4ALL) initiative, and it conducted rapid assessment and gap analysis of its energy sector as the first step to participate in the initiative. Ghana subsequently developed its SE4ALL Country Action Plan, based on the three objectives of the SE4ALL initiative: i) ensuring universal access to modern energy services; ii) doubling the rate of improvements in energy efficiency; and iii) doubling the share of renewable energy in the global energy mix.

Ghana has made remarkable progress at expanding access to electricity to its population, with over 70% nationwide electrification rate, but rural areas still lag behind with only 40% of the rural population enjoying access to electricity. Further expansion of access to electricity to rural communities would enhance the development of these areas through the creation of commercial opportunities and jobs, access to water and health care, provision of lighting, and the connection of the rural communities with urban centres through information technology. However, geographic barriers and financial constraints have posed serious constraints towards the connection of rural communities to the national grid (Ministry of Power, Ghana (MoP), 2015).

It has therefore become necessary for Ghana to consider the option of expanding access to electricity to rural communities through off-grid community-based electrification, based on increasing the share of renewable energy, and promoting the productive uses of energy. This option has great potential to support broader socio-economic and environmental objectives, particularly poverty reduction through employment generation and supporting action on climate change mitigation.

In line with this, the project was developed to enable Ghana to share China's immense experience and skills on renewable energy technologies. The project aims to facilitate the exchange of expertise and technology on renewable energy between China and Ghana, with focus on building the institutional framework and capacity required to facilitate the local absorption of the technologies. The project is collaboration between the Energy Commission in Ghana, the Ministry of Science and Technology in China together with the UNDP Country Offices in Accra and Beijing. The project also seeks to promote the production of renewable energy technologies in Ghana with a strong focus on private sector development and inclusion.

In the first year of implementation, the project is focusing on establishing an enabling environment for the transfer, production and regulation of the use of renewable energy technologies in Ghana. As part of this process, the project has embarked on an assignment on "Renewable Energy Policy Review, Identification of Gaps and Solutions in Ghana." The assignment includes a review of past and current Chinese and Ghanaian renewable energy policies and strategies, as well as stakeholder consultations to identify policy gaps and propose solutions to boost the renewable energy sub-sector in Ghana. The outcomes of these activities are expected to feed into subsequent project activities. This report is the final report on the "Renewable Energy Policy Review, Identification of Gaps and Solutions in Ghana."

1.2 Objective and Organization of Assignment

The objective of the assignment is to identify barriers and policy gaps that constrain the growth in the development and deployment of renewable energy in Ghana, and recommend strategic interventions to facilitate the exchange of expertise and technology, as well as best practices on renewable energy between China and Ghana.

The assignment was conducted under five key tasks:

- Information gathering on Ghanaian and Chinese renewable energy policies and regulatory instruments;
- Desk review and gap analysis of renewable energy policies and strategies of Ghana;
- Stakeholder consultations;
- Facilitation of Stakeholder's Consultation Workshop; and
- Preparation of report on identified gaps and solutions for the Ghanaian renewable energy sub-sector.

2. Regulatory Framework of Ghana's Energy Sector

2.1 Overview of Ghana's Energy Sector

The total energy consumption of Ghana was 10.13 million tons of oil equivalent (MTOE) in 2012, of which 0.4 MTOE consisted of net imports. Total primary energy consumption in Ghana was 0.4 tons of oil equivalent (TOE) per capita in 2012, which is among the lowest in the world and about two-thirds of the average consumption in sub-Saharan Africa – which stood at 0.68 TOE per capita in 2012 (MoP, 2015).

The energy sector of Ghana is heavily dependent on biomass and oil, which account for about 90% of the country's primary energy supply. Together with oil and gas, hydropower is a major resource of generation of electricity. Ghana's generation capacity is currently about 3,000 MW of which 54% is hydropower, the remainder being mainly thermal generation and little contribution from renewable energy. The demand for electricity demand has been growing at about 10% per annum and it is estimated that the generation capacity will need to increase to about 4,200 MW by 2026 to keep up with the demand (MoP, 2015).

As previously mentioned, about 70% of the population of Ghana has access to electricity, which is among the highest connection rates in sub-Saharan Africa. A considerable proportion of the remaining 30% of population are in communities, which are remote and often inaccessible, including islands and lakeside communities. For most of these communities, extension of the grid network would be challenging due to geographical and financial constraints, and off-grid and mini-grid options may be the technology of choice for meeting their electricity needs.

The vision of Ghana's energy sector is a developed "energy economy" with reliable high quality energy services. In order to achieve this vision, the national energy policy goals are (MoP, 2015):

- Universal access to electricity by 2020 (recently moved forward to 2016) from 70% today (though access in rural areas is only 40%);
- 5,000 MW of generation capacity by 2020 (recently moved forward to 2016);
- 10% contribution of renewable energy (excluding hydro with capacity of 100 MW or larger) in the electricity generation mix by 2020; and
- Access to liquefied petroleum gas (LPG) by 2020 for 50% of the population.

Renewable energy has great potential to contribute towards meeting the ambitious national policy goals of Ghana's energy sector in a sustainable way.

2.2 Policies Related to the Energy Sector

Ghana's current medium term national policy framework for overall national development is the Ghana Shared Growth and Development Agenda (GSGDA II) for 2014-2017. The main energy policy that guides the energy sector of Ghana is the National Energy Policy, which is supported by the Energy Sector Strategy and Development Plan. In 2011, the Renewable Energy Act came into force with the goal to provide the legal and regulatory framework necessary for developing and expanding the country's renewable energy sub-sector. Other sectors of the economy are also implementing policies that have components on the development and utilization of alternative energy, particularly renewable energy. Additionally, Ghana developed its Country Action Plan for Sustainable Energy for All (SE4ALL) in 2012.

2.2.1 Ghana Shared Growth and Development Agenda

Ghana's current medium term national policy framework is the Ghana Shared Growth and Development Agenda (GSGDA II) for2014-2017, which is built on the lessons learnt from the performance of the previous GSGDA for 2010-2013 (Government of Ghana, 2015). The GSGDA II identifies power as the major binding constraint to the accelerated economic growth and development of the economy. The GSGDAII indicates that: "*In the medium-term, Government policy will focus on increasing the proportion of renewable and other sources of energy in the supply mix, particularly solar, wind, mini- hydro and waste-to energy. The strategies to be implemented will include:*

- Accelerating the implementation of the 87 provisions of the Renewable Energy Act 2011, Act 832;
- Providing access to waste-to-energy technologies; and
- Facilitating access to the grid for stand-alone renewable energy power plants."

2.2.2 National Energy Policy / Energy Sector Strategy and Development Plan

The key policy that guides the development and management of Ghana's energy sector is the National Energy Policy, 2010, which states that "*the goal of the renewable sub-sector is to increase the proportion of renewable energy, particularly solar, wind, mini hydro and waste-to-energy in the national energy supply mix and to contribute to the mitigation of climate change* (Government of Ghana, 2010)" The vision of the energy sector is stated in the Energy Sector Strategy and Development Plan,2010as"*to guarantee the availability of an adequate level of energy supply to meet the country's internal demands and ensure universal access to modern energy by 2020 as well as provide surplus energy for export (*Government of Ghana, 2010)". The key challenges in the energy sector to be overcome to realize this vision are:

- Developing infrastructure for the production and supply of adequate energy services to meet national requirement and for export;
- Expanding the requisite infrastructure to ensure universal access as well as the efficient and reliable supply of energy services;
- Ensuring energy is produced and supplied in a form that has no adverse health, safety and environmental impact; and
- Guaranteeing the efficient production, transportation and use of energy.

The Energy Sector Strategy and Development Plan mentions that for the wind, solar and mini-hydro technologies, the Government of Ghana will focus on:

- Promoting the exploitation and use of mini hydro, solar and wind energy resources;
- Supporting indigenous research and development aimed at reducing the cost of renewable energy technologies;
- Providing tax incentives for all equipment imported for the development of renewable energy projects; and
- Supporting the use of decentralized off-grid alternative technologies (such as solar PV and wind) where they are competitive.

2.2.3 Renewable Energy Act, 2011

Under Ghana's Energy Sector Strategy and Development Plan, the goal set for renewable energy was to constitute 10% of the national energy generation by 2020. To facilitate the achievement of this goal, the Parliament of Ghana passed the Renewable Energy Act 2011, Act 832 to provide the legal and regulatory framework necessary for developing and expanding the country's renewable energy sub-sector. The Act seeks to create favourable regulatory and fiscal regimes as well as attractive pricing incentives for the development and use of its renewable energy resources. Its provisions support the development, utilization and efficient management of renewable energy sources in the country (Government of Ghana, 2011). It also provides for the utilization, sustainability and adequate supply of renewable energy for electricity and heat generation and related matters. The Renewable Act is discussed further in the next chapter.

2.2.4 Country Action Plan for Sustainable Energy for All (SE4All)

The Government of Ghana has committed to meet the three objectives of the Sustainable Energy for All (SE4ALL) initiatives by 2020. These objectives are: i) ensuring universal access to modern energy services; ii) doubling the rate of improvements in energy efficiency; and iii) doubling the share of renewable energy in the global energy mix. The Rapid Gap Analysis and SE4ALL Country Action Plan were completed in 2012. Ghana is also developing its SE4ALLl Action Agenda and Investment Prospectus (SE4ALLAA-IP) to facilitate the mobilization of funding from government, private sector and development partners to finance projects and other interventions to achieve the objectives of the SE4ALLinitiatives.

2.3 Other Relevant Policies

Policies of other sector which support the development and utilization of renewable energy include:

- National Climate Change Policy;
- Food and Agriculture Sector Development Policy;
- Irrigation Policy;
- Industrial Policy;
- Health Policy;
- Science, Technology and Innovation Policy;
- Technology Transfer Regulations; and
- National Policy on Public Private Partnerships

2.3.1 National Climate Change Policy

Ghana's National Climate Change Policy was developed in 2013 to provide a clearly defined pathway for dealing with the challenges of climate change within the socio-economic context of Ghana. The vision of the National Climate Change Policy is "*to ensure a climate-resilient and climate-compatible economy while achieving sustainable development through equitable low-carbon economic growth for Ghana.*" The Policy has prioritized five main areas: i) Agriculture and food security; ii) Disaster preparedness and response; iii) Natural resource management; iv) Equitable social development; and v) *Energy*, industrial and infrastructural development. The

policy recognizes that there are many opportunities for the private sector and industry to benefit from addressing climate change, including:

- Waste to energy by pyrolysis;
- Gas capture from landfills; and
- Renewable energy technology, equipment and services.

2.3.2 Food and Agriculture Sector Development Policy

The current Food and Agriculture Sector Development Policy (FASDEP II) was developed in 2007 by the Ministry of Food and Agriculture in 2007, as a follow-up of FASDEP I that was developed in 2002. The FASDEP II mentions *energy availability and costs* among the crosscutting constraints in the food and agriculture sector, together with gender inequality and discrimination against women as well as access to land and finance. The policy document indicates that the cost and demand for energy (fossil fuel and electricity) in all sectors of the economy is growing rapidly, with dire consequences for agricultural production and processing. The policy indicates that the potential of *alternative energy sources (particularly renewable energy)* in the sector is largely unexplored due to inadequate research and knowledge. The policy objective for irrigation development is to enhance production potential of existing schemes by raising productivity of irrigation water from 30% to 80% in a ten-year period (by 2018). The strategies to be pursued includes the development of alternative ways of water delivery for irrigation schemes to reduce operational cost associated with *energy*.

2.3.3 Irrigation Policy

By 2003, the Ghana Irrigation Development Agency (GIDA) had 22 irrigation schemes under its jurisdiction covering about 14,700 ha of, which 60% were developed and about 9,000ha actually put under irrigation. The Government plans to add a total irrigable area of 500,000ha or more. The National Irrigation Policy, Strategies and Regulatory Measures Irrigation Policy was formulated in 2011, with the goal "*to achieve sustainable growth and enhanced performance of irrigation contributing fully to the goals of the Ghanaian agriculture sector*". The policy is complemented with a strategic framework called National Irrigation Development Master Plan (NIDMAP) to specify how the strategies in the policy document will be implemented with the aim to put an area of 500,000 ha under irrigation in the medium to long term. The implementation of the proposed NIDMAP could be enhanced with improved access to *modern energy services, including renewable energy* to rural communities that are engaged in agriculture.

2.3.4 Industrial Policy

Ghana's Industrial Policy was developed in 2011, within the context of Ghana's socio-economic growth through transformation into an industry-driven economy capable of delivering decent jobs with widespread, equitable and sustainable growth and development. The policy recognises that the provision of adequate, efficient and *cost-competitive electricity* and water supplies is a pre-requisite for accelerated industrial development. There is therefore the need to ensure reliable and sustainable supply of electricity and water to industry. In this context, the policy prescribes that Government will: i) ensure that industry's requirements of electricity and water are met at competitive prices and in *an environmentally sustainable manner*; ii) encourage private sector participation in the supply of *electricity and water*; and iii) draw up and implement *energy and water* efficiency and conservation programmes.

2.3.5 Health Policy

The Health Policy was formulated in 2006, with the ultimate goal "*to ensure a healthy and productive population that reproduces itself safely*". The policy seeks to address the objectives, concerns and challenges in the health sector through simultaneous action in priority areas, including: i) Promoting healthy lifestyles and healthy environments; ii) Providing health, population and nutrition services; and iii) Promoting the use of Information for planning and management of the health sector. The priority areas of "providing health, population and nutrition services" and "promoting the use of Information for planning and management of the health sector," in particular, could be enhanced with improved *access to modern energy services* to rural communities.

2.3.6 Science, Technology and Innovation Policy

The Science, Technology and Innovation Policy (STIP) was formulated in 2009, with the goal "*to achieve national development goals for poverty reduction, competitiveness of enterprises, sustainable environmental management and industrial growth*". The sectoral objectives on energy under the STIP are: i) to ensure the supply of *sustainable, affordable, safe and reliable energy* for domestic and industrial use; and ii) to provide an *appropriate mix of energy sources*. The key strategies to be pursued include: i) Promote a research and development programme relating to *alternate energy sources such as solar energy, biomass, wind and other renewable energy sources* to supplement the current traditional energy sources; ii) Facilitate efforts to acquire and adapt *sustainable safe and economical energy technologies for national development*; iii) Support research aimed at upgrading *hydropower energy production technology*; iv) Promote research and development efforts aimed at popularization and dissemination of *energy technology for rural development*; v) Promote public support for energy conservation and encourage *private investment in energy technologies*; and vi) Encourage community investment and ownership of energy systems e.g. *solar farms, windmills and biomass plants*.

2.3.7 Technology Transfer Regulations

The Technology Transfer Regulations, LI 1547 came into force in 1992, and they require all technology transfer agreements under the Ghana Investment Code, 1985 (including those in the renewable energy sub-sector) to be registered with Ghana Investment Promotion Centre (GIPC). Under the Regulations, a technology transfer agreement is inapplicable and unenforceable if contains clauses that imply:

- Transferring technology that is freely and easily available in Ghana;
- Requirement of the technology transferee to export exclusively through the transferor;
- Obligation on the technology transferee to procure its inputs (equipment, tools, raw materials etc.) from the transferor;
- Restriction of R&D activities of transferee to improve and adapt the licensed technology; and
- Forbidding the use by transferee of complementary technologies.

The Regulation further directs that the technology transfer agreement should include a provision by the technology transferor to train the transferee and its personnel in the effective utilization of the transferred technology. The duration of the technology transfer agreement shall not

initially exceed 10 years, but it may be renewed for further5 years.

2.3.8 National Policy on Public Private Partnerships

The Ministry of Finance developed the National Policy on Public Private Partnerships and Economic Planning and it came into force in 2011. The objective of the Policy was to enable the Government of Ghana to provide better infrastructure and services through private sector financial, human and technical resources, thereby freeing Government resources for other equally important programs and projects. The Policy provides a clear and consistent process for all aspects of PPP project development and implementation from project identification, appraisal and selection to procurement, operation and maintenance, and performance monitoring and evaluation. The Policy has the following guiding principles:

- Value for money;
- Efficient risk allocation;
- End-user ability to pay;
- Local content and technology transfer, including;
    - Safeguarding public interest and consumer rights; and
    - Safeguards to users, particularly vulnerable groups
- Setting affordable user charges and tariffs; and
- Environmental, climate and social safeguards.

2.4 Policy Oversight and Institutional Framework of the Energy Sector

The key players in Ghana's energy sector are:

- National Institutions;
- Development partners;
- Private sector;
- Non-governmental organizations; and
- Financial sector.

The major national institutions are presented in Figure 2.1.

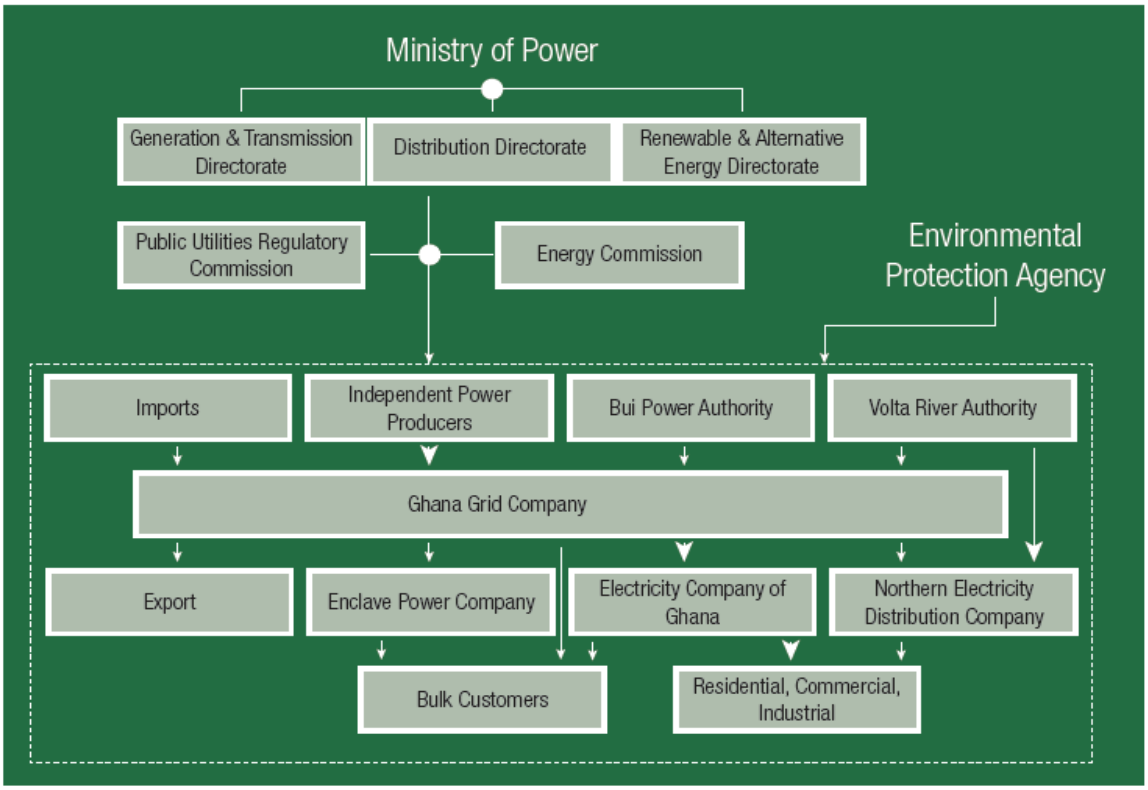

Figure 3.1: Key national institutions in Ghana's energy sector
Source: Ministry of Power, Ghana, 2015

2.4.1. National Institutions

Ministry of Power*:* The Ministry of Power (MoP) oversees the energy sector, and is responsible for energy policy formulation and implementation. There are three mainline technical directorates: i) Generation and Transmission Directorate; ii) the Distribution Directorate; and iii) Renewable and Alternative Energy Directorate (RAED). In line with provisions of the Renewable Energy Act 832, the MoP established the RAED, which has the legal mandate to coordinate all efforts and manage the development and promotion of renewable energy technologies in Ghana. More specifically, the RAED oversees: i) the implementation of renewable energy initiatives; ii) executes renewable energy programs and projects initiated by the State, or in which the State has an interest; and iii) manages the renewable energysub-sectorassets on behalf of the State until such a time when the Renewable Energy Authority (specified by the Renewable Law) is established. The MoP has eight technical agencies or departments.

Ministry of Petroleum: The Ministry is responsible for developing and implementing policies for the petroleum and gas sector in Ghana.

Energy Commission (EC)*:* The Energy Commission is the technical regulator of Ghana's electricity, natural gas and renewable energy industries, and the advisor to the Ministries of Power and Petroleum on matters relating to energy planning and policy.

Public Utilities Regulatory Commission (PURC): The Public Utilities Regulatory Commission was set up as a multi-sectoral regulator by the Government of Ghana in October 1997 as part of the utility sector reform process to regulate the provision of utility services in the electricity and water sectors. The PURC also has regulatory responsibility over charges for supply, transportation

and distribution of natural gas services. The PURC is responsible for setting and approving rates chargeable for the purchase of electricity from conventional and renewable energy sources including mini-grids.

Environmental Protection Agency (EPA)*:* The EPA is the leading public body for protecting and improving the environment in Ghana. It is responsible for regulating the environment and ensuring the implementation of Government policies on the environment.

Electricity generation and transmission utilities*:* The bulk of the generation assets are owned by state-owned utility companies and Independent Power Producers (IPPs). The Volta River Authority (VRA) and Bui Power Authority (BPA) are the main public generation companies that operate Ghana's hydropower plants and some thermal power plants. A number of IPPs have also been licensed to build, own and operate power plants. The Ghana Grid Company (GRIDCo) owns and operates the transmission network.

Electricity distribution utilities: The distribution utilities are the Electricity Company of Ghana responsible for distribution services within the southern zone, Enclave Power Company for the Free Economic Zone, and the Northern Electricity Distribution Company (NEDCo) responsible for distribution services in the northern belt.

2.4.2 Development Partners

Ghana's development partners have provided significant support to its energy sector through harmonized assistance, which is aligned with national priorities and strategies (MoP, 2015). Ghana has a well-coordinated working group of Development Partners involved in the energy sector, which is currently being co-chaired by the African Development Bank on the Development Partners' side and the Chief Directors of the Ministry of Petroleum and Ministry of Power on the Government of Ghana side. The energy sector working group comprises the various Development Partners assisting the country through various financing instruments including: African Development Bank (AfDB), World Bank (WB), European Union (EU), United Nations Development Program (UNDP), Agence Française de Développement (AFD), Kreditanstalt für Wiederaufbau (KfW), Deutsche Gesellschaft fur Internationale Zusammenarbeit (GIZ), Millennium Challenge Corporation (MCC) and Switzerland State Secretariat for Economic Affairs (SECO).The group meets regularly to discuss key sector issues and challenges, as well as Development Partners' approaches and interventions to address them.

The AfDB, SECO and the World Bank are supporting the Ghana Energy Development and Access Project (GEDAP) in which one component promotes a mix of renewable energy-based models including four pilot mini-grids to serve nearly 10,000 people in selected deprived communities. The Government of Ghana intends to scale-up this initiative, building on the success of the GEDAP mini-grid project. KfW is working with the Volta River Authority to develop a 12 MW solar PV project. The Volta River Authority will own and manage the solar plant, which is expected to be constructed in early 2016.KfW is keen to continue investing in the renewable energy sub-sector in the coming years as their new programming cycle starts in 2017. The GIZ's support on renewable energy focuses on technical assistance for the implementation of the Renewable Energy Act and implementation of productive use of energy for on-grid and off-grid operations, as well as financing for small-scale projects with successful results-based-evidence schemes (MoP, 2015), including:

- Productive use of energy in agriculture: which involves grid electrification and solar PV pumping for irrigation, and productive use of electricity in 18 light industrial zones in five regions (EnDev);

- Improved cooking stoves for gari (processed cassava) processing in partnership with the SNV, a Dutch NGO (EnDev); and
- Advisory services on the capacity for successful implementation of the Renewable Energy Act on renewable energy scenarios, including a preliminary grid impact study, the FiT scheme (including tariffs and renewable energy purchase obligations), net metering, standardized renewable energy power purchase agreements (PPAs), pilot tenders for variable renewable energy, credit support and technical and organizational development training (Ghanaian-German cooperation).

The EnerGIZing Development Program (EnDev) is managed by GIZ, and it is supporting a range of pilot small-scale renewable energy activities promoting access to energy and productive use of energy. The program is funded by:

- Dutch Ministry of Foreign Affairs (MFA NL);
- German Federal Ministry for Economic Cooperation and Development (BMZ);
- Norwegian Ministry of Foreign Affairs (MFA NO);
- Australian Agency for International Development (AusAID);
- UK Department for International Development (DFID), and
- Swiss Agency for Development and Cooperation (SDC).

InfoDev, a global multi-donor program in the World Bank Group, supports growth-oriented entrepreneurs through creative and path-breaking venture enablers. InfoDev is supporting the establishment of a Climate Innovation Centre (CIC), with support from the Danish Ministry of Foreign Affairs and led by the Ashesi University College in Ghana. CICs are designed to provide climate technology entrepreneurs with the mentorship, financing, networks, and business services they need to scale-up their innovations, driving down carbon emissions and creating sustainable, inclusive jobs.

2.4.3 Private Sector

In 1994, the Government of Ghana launched the Power Sector Reforms (PSR) to catalyze the rapid expansion of infrastructure in line with its socio-economic development agenda. The PSR sought to enhance transparency in the regulation of the power sector and to open up the industry to private sector participation by dismantling the vertically integrated utility structure and availing the generation and distribution aspects of the industry to market competition. The implementation of the reform process has resulted in the current unbundled structure with separate operational functions in respect of power generation for the Volta River Authority (VRA), transmission for the Ghana Grid Company (GRIDCo) and distribution for the Electricity Company of Ghana (ECG) and the Northern Electricity Distribution Company (NEDCo). As a result of the PSR, the sector has, since 1997, been regulated by the Energy Commission (EC) the Public Utilities Regulatory Commission (PURC). The reformed structure is expected to encourage the participation of Independent Power Producers (IPP) in a competitive generation market as well as bi-lateral contracts with bulk customers in a deregulated market (MoP, 2015). As a result of the reform, there is now substantial private sector participation in the sector with a growing portfolio of private sector driven IPPs. The growing renewable energy sector has attracted a wide range of private sector players, ranging from solar PV distributors and associated investors to agro-industries that use biomass by-products for process-heat generation. Recent private

sector entrants include a solar PV assembler and a number of potential wind-farm developers and dedicated energy plantation developers.

In the biomass sector, the private sector has traditionally been active mainly through informal sector enterprises and entrepreneurs involved in the production of and distribution of woodfuels, as well as biofuel stove manufacture and sales (MoP, 2015).

2.4.4 Non-governmental Organizations

Some international and local non-governmental organizations (NGOs) have also been actively supporting development and deployment of renewable energy in Ghana. The Netherlands Development Organization (SNV), an international not-for-profit development organization contributes to poverty reduction with the implementation of several renewable energy projects including, activities on the role of gender in agro-processing, improved cook-stoves, improved fish-smoking and small-scale energy enterprises.

The Kumasi Institute of Technology, Energy and Environment (KITE) a Ghanaian NGO has been involved in the development and implementation of public benefit projects in the energy and environment sectors of Ghana. KITE developed the Energy for Poverty Reduction Action Plan for Ghana (EPRAP) and the business development services package for African Rural Energy Enterprise Development (AREED) to promote private partnerships in the clean energy sector. SNV and KITE are already active partners in the Ministry of Power's renewable energy initiatives including the GEDAP project. New Energy, another Ghanaian NGO in Tamale in the Northern Region of Ghana has been engaged in activities on renewable energy services, environmental conservation, enterprise development training, microcredit support, water and sanitation services as well as policy advocacy.

2.4.5 Financial Sector

The macroeconomic factors in Ghana such as inflation, high interest rates and foreign exchange volatility have largely hindered the ability of local banks to provide long-term financing beyond 3-5 years. Consequently, the support of the financial institutions to renewable energy projects has been very poor, and a wide gap exists between available local financing options and the special financing demands of renewable energy projects, such as non-recourse financing, longer tenors and lower interest rates (MoP, 2015).

3. Renewable Energy Sub-Sector of Ghana

3.1 Renewable Energy Resources

The major renewable energy resources in Ghana are:

- Mini/small and medium capacity hydropower;
- Solar energy;
- Wind energy
- Biomass and waste-to-energy;
- Wave and tidal energy.

3.1.1. Hydropower

There are about 17 medium and 22 mini/small hydropower sites with exploitable capacities ranging from 15 kW to 100 MW (see Figure 3.1). The estimated total exploitable capacity of these sites is 800 MW. The main barriers preventing the development of this resource have been climate variability and the unavailability of the data needed to assess the viability of the sites.

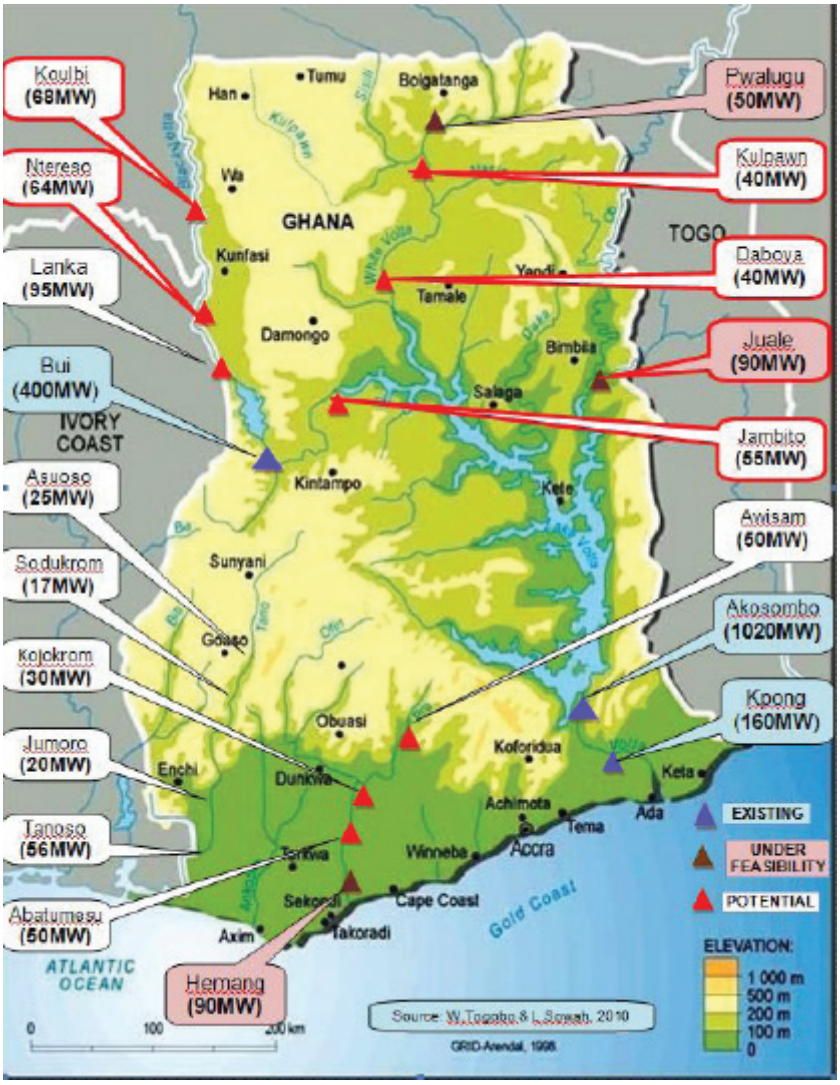

Figure 3.1: Existing and potential hydropower sites in Ghana
Source: Ministry of Power, 2015

Some initiatives have been recently launched by the Government of Ghana to assess the viability of these hydropower sites (MoP, 2015):

- The Swiss Government through SECO is funding a Hydropower Sustainability Assessment Project (HSAP) on six hydropower sites on the Black and White Volta Rivers. These sites are Lanka, Ntereso, Koulbi, Daboya, Kalpawn, and Jambito with aggregated exploitable capacity of 362 MW;
- The Agence Française de Developpement, the World Bank and the Volta River Authority are jointly funding various aspects of ongoing feasibility studies on the Pwalugu (40 MW) and Juale (90 MW) hydropower sites;
- China Water Electric (CWE) and Bui Power Authority have funded the full feasibility study of Hemang (60 MW) hydropower project; and
- The African Development Bank and the Ministry of Power (under the GEDAP project) are in the process of commissioning prefeasibility studies on 10 additional small and medium hydropower sites with aggregated exploitable capacity of 248MW.

3.1.2. Solar

The solar irradiation level in Ghana ranges from 4.5 to 6.0 kWh/m^2/day with the highest irradiation levels occurring in the northern half of the country (see Figure 3.2). The Government is piloting a number of initiatives on the deployment of solar energy systems, including:

- The Energy Commission has issued Siting Clearance Permits to sixteen independent power producers' for utility-scale solar projects. However, only one of these IPP's has proceeded with the construction of utility-scale solar plant, with capacity of 20MW. There is already a 2.5 MW solar plant in operation in Pungu-Talania, together with other smaller-scale plants in other parts of the country;
- The Ministry of Power and Energy Commission are developing a new private sector- led framework to promote the installation of solar home systems across the country;
- The Solar Lanterns Promotion Program (SLAP) is working toward its goal of distributing 2 million high quality solar lanterns in deprived remote/off-grid communities by 2020 through various subsidy schemes. Since the launch of the SLAP in 2013, a total of 80,000 solar lanterns have been procured through the Government of Ghana budget and over 50,000 solar lanterns have been sold at a 70% subsidy to target beneficiaries. Funds that once made up the kerosene subsidy were used for this program;
- A 715kWp solar PV net-metered installation is in operation at the Noguchi Memorial Institute for Medical Research of the University of Ghana with funding support from the Japanese Government;
- An additional 25 grid-tied solar PV systems were installed at the end of 2014 through private sector initiatives bringing total national capacity to 8 MW;
- The Ghana Renewable Energy Fair was organized in 2015as one of the key publicity initiatives to make the renewable energy industry visible, to promote the rapid utilization of renewable energy resources in the country; and
- A net metering code has been developed with technical assistance from the German Government.

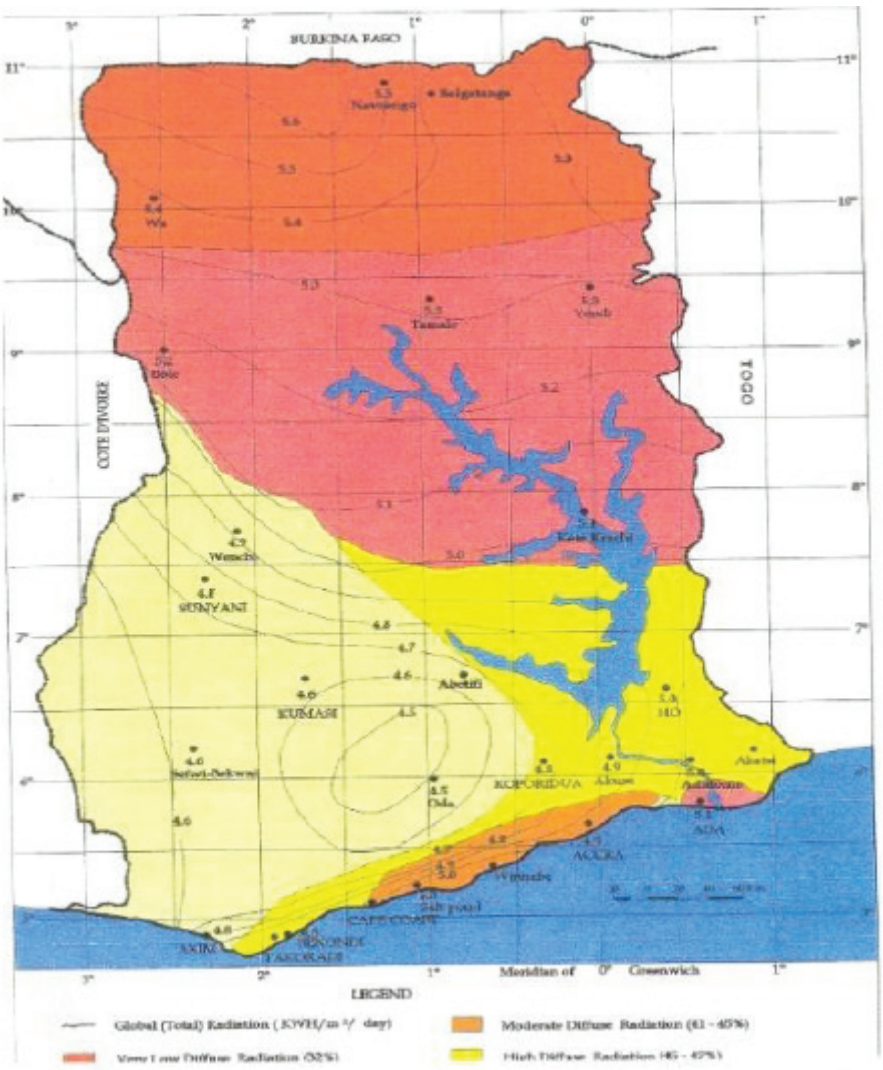

Figure 3.14: Solar resource potential of Ghana (Source: Ministry of Energy, 2011)

3.1.3. Wind

Ghana has moderate wind energy potential, and the Ministry of Power, with support from the World Bank, has been conducting wind resource assessments at 15 sites with total potential power generation of about 1,100 MW. The private sector has complemented this initiative by conducting detailed feasibility studies on potential wind project development. Average annual wind speeds along the coast and some islands range from 4.0m/s to 6.0m/s at 50m-hub height (See Figure 3.3).

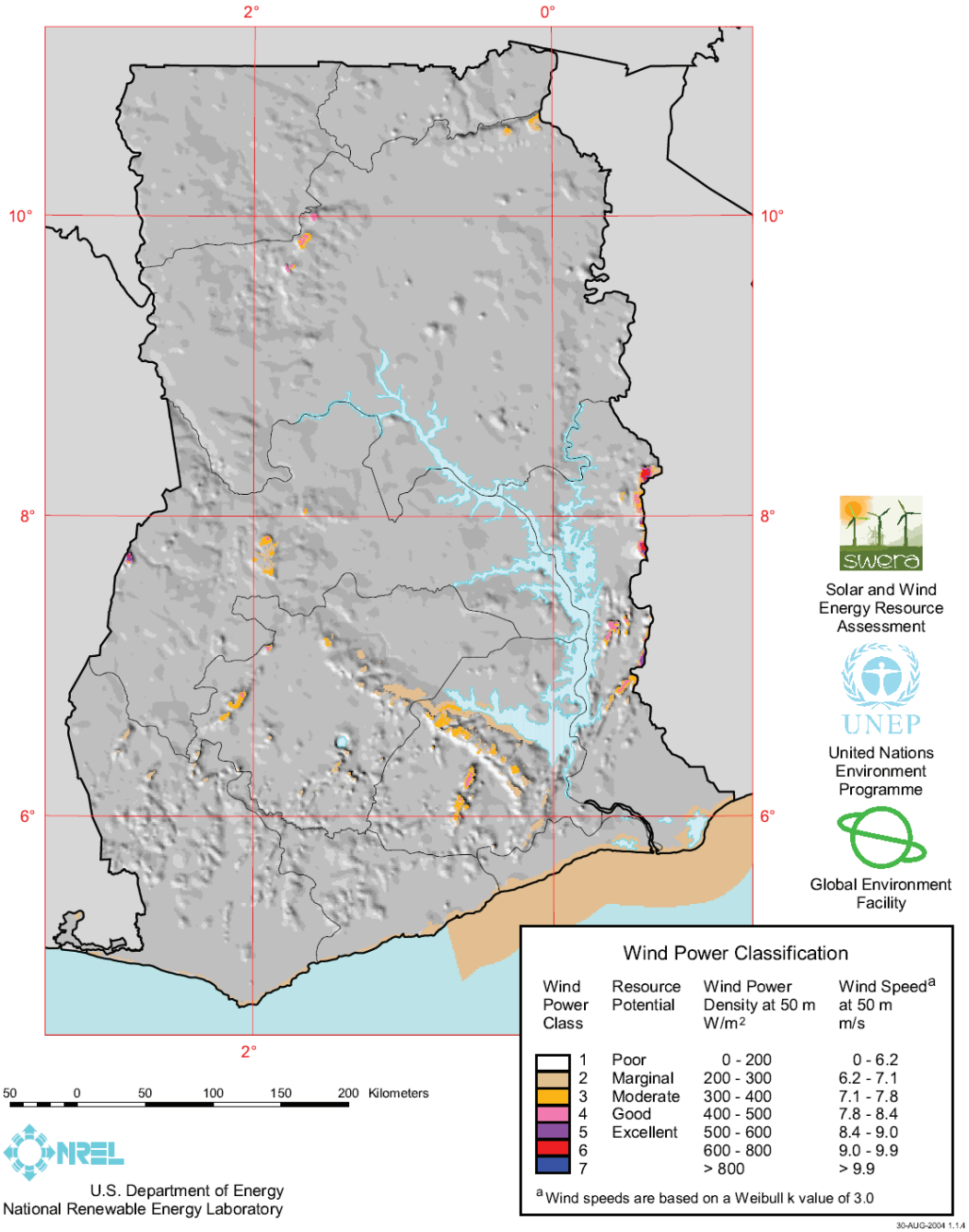

Figure 3.3: Wind resource potential of Ghana (Source: Ministry of Energy, 2011)

The initiatives to develop the country's wind energy resource include:

- The Ministry of Power, with support from the World Bank, has been conducting wind resource assessments at 60 m above ground in more than eight sites since 2012. The aim is to obtain bankable wind data for planning and support wind IPPs. Preliminary results indicate that, with moderately high wind speed (from 6.0 m/s at Anloga to 4.5 m/s in Gomoa Fete), there is potential for commercial wind farm development in these areas;
- The Volta River Authority plans to install up to 150 MW of wind farm by 2020 and commenced wind resource assessments in 2013 at 80m above ground at eight sites across the country;

- The Swiss company NEK/Upwind Ltd. has already secured a provisional license for an aggregate 250 MW wind farm park and is conducting detailed feasibility studies for the project; and
- EleQtra/InfraCo has acquired a site and is conducting wind resource assessments to develop a 30-50 MW wind farm by 2020.

To date, four provisional licenses and one siting clearance permit for wind power plants have been issued. Although there has been strong interest from the private sector in investing in wind in Ghana, no utility-scale wind project is currently under construction.

3.1.4 Biomass and Waste-to-Energy

Nearly 50% of the country's overall primary energy use is obtained from biomass. This energy is consumed mostly in the household sector in the form of charcoal or firewood. The production of charcoal and charcoal stoves are largely informal activities, though improved cook-stoves are promoted by some NGOs and various development projects. Industry and commercial sectors also use some biomass energy. Biomass resources include supply from agricultural residues from maize, sorghum, and rice and from agro-based industries such as shea butter, cocoa, rubber, sawmills, and palm oil. In the agriculture and wood processing sectors, the residues are disposed of by burning, causing the destruction of resource with huge untapped potential for productive power and energy generation.

The Ministry Petroleum commissioned a report, entitled, "*Assessment of the Financial Landscape for Biomass Power and Mini-grids in Ghana*" in 2014 that revealed that there are numerous clustered agro and wood processing sites generating a large amount of biomass residues. The Environmental Protection Agency, in collaboration with the Ghana Cocoa Board, is undertaking detailed studies on cocoa waste for power generation. A local biomass energy developer has now acquired environmental and site clearance permits to develop a 6 MW biomass power project.

Municipalities around the country also generate large quantities of liquid and solid waste. For example, Kumasi and its suburbs generate up to 1,600 tonnes daily while Accra and its environs generate up to 2,500 tonnes daily. Additionally, Accra generates over 800m^3 of liquid waste per month. This could be a good feedstock for biogas production for electricity generation.

The major challenge in the utilization of biomass residues is the uncertainty of uninterrupted supply of the resource for utility-scale energy generation.

3.1.5 Wave and Tidal Energy

Tidal energy is produced using tidal energy converters. These huge underwater turbines are placed in areas with high tidal movements and are designed to capture the kinetic motion of the receding and rolling ocean tides to produce electricity. Tidal power has abundant potential for future power and electricity generation because of the enormous size of the oceans. Ocean waves contain significant energy density and have substantial commercial potential if the energy can be extracted using a reliable, environmentally friendly and cost-effective technology. Wave energy, which is a renewable, sustainable and a free source of energy, would have significant impact on electricity production in the world if feasible solutions in terms of technology, economy and ecology were provided.

A local Ghanaian company, TC Energy, in collaboration with Swede Energy, is installing a pilot 14.5 MW Tidal Wave Power Plant at the confluence of the Volta River and the Gulf of Guinea, at Ada-Foah, in the Greater-Accra Region. The company will utilize sea-based wave energy converters

for the generation of power. The company has signed a Power Purchase Agreement with the Electricity Company of Ghana for the total generation of 1,000 MW of electricity.

3.2 Regulatory Framework for Promotion of Renewable Energy

The regulatory framework for the promotion of renewable energy in Ghana is anchored on the Renewable Energy Act (2011). The objective of the Renewable Energy Act is to provide for the development, management, utilization, sustainability and adequate supply of renewable energy for the generation of heat and power, and thereby increase the proportion of renewable energy in the national energy supply mix while contributing to the mitigation of climate change (Government of Ghana, 2011). The Act calls for:

- A framework for the utilization of renewable energy sources;
- An enabling environment to attract investments in renewable energy sources;
- The building of local capacity in technologies for developing renewable energy sources;
- Public education on renewable energy production and utilization; and
- Regulation of the production and supply of woodfuel and bio-fuel.

The four key mechanisms established by the law are:

- **Mandatory purchase policy** - by which distribution utilities are obliged to procure a specified percentage of total electricity purchase from renewable energy (under the Renewable Energy Purchase Obligation)
- **Mandatory connection policy** – whereby the transmission and distribution system operators are obliged to provide connection services for electricity from renewable energy;
- **Feed-in tariff system**–where electricity from renewable energy is to be purchased by distribution utilities at higher rates that are determined by Public Utilities Regulatory Commission; the rate is guaranteed for 10 years and subsequently reviewed every 2 years;
- **Renewable Energy Fund** - which offers financial support for activities for the promotion, development and utilization of renewable energy, such as financial incentives, feed-in-tariffs, capital subsidies, production-based subsidies and equity participation.

3.2.1 Institutional Framework of the Renewable Energy Act

The key institutions mandated to implement the Act are the Energy Commission and the Public Utilities Regulatory Commission.

The Energy Commission is mandated to:

- Advise the Minister of Power on renewable energy matters;
- Create a platform for collaboration between government and the private sector and civil society for the promotion of renewable energy sources;
- Promote public education and awareness on renewable energy technologies;

- Recommend for exemptions from customs, levies and other duties on renewable energy equipment and machinery;
- Recommend financial incentives for the development, production and utilization of renewable energy, in consultation with the Public Utilities Regulatory Commission;
- Promote the local manufacture of components to facilitate the rapid growth of renewable energy sources;
- Promote plans for training and supporting local experts in the field of renewable energy;
- Promote the benefits of renewable energy to facilitate its utilization;
- Set targets for the development and utilization of renewable energy sources; and
- Implement the provisions of the Act.

The Public Utilities Regulatory Commission is mandated to approve:

- Rates chargeable for the purchase of electricity from renewable energy by public utilities;
- Charges for grid connection; and
- Rates chargeable for wheeling electricity from renewable energy producers.

Other institutions that should collaborate with the Energy Commission under the Act in the development, promotion, management and utilization of renewable energy technologies include:

- Ghana Standards Authority;
- Forestry Commission;
- Lands Commission;
- Environmental Protection Agency;
- Ministry of Food and Agriculture;
- Metropolitan, Municipal & District Assemblies;
- National Petroleum Authority;
- Ghana Cocoa Board;
- Ministry of Environment, Science, Technology and Innovation; and
- Any other institution designated by the Minister.

3.2.2 Supporting Regulatory and Policy Instruments

Some supporting regulatory and policy instruments are at various stages of development or implementation to promote renewable energy development in Ghana, under the Renewable Energy Act. These include:

- National Electricity Grid Code (2009) for renewable energy (being implemented);

- Renewable energy feed-in tariffs, RE FiTs (being implemented);
- Guidelines for a renewable energy purchase obligation, REPO (draft ready);
- Renewable Energy Power Purchase Agreement template, PPA (draft ready);
- Bioenergy and Policy Strategy which calls for modernization of the supply and use of bioenergy on a sustainable basis (draft ready);
- Framework for the establishment of the Renewable Energy Fund (REF)- to provide long-term financing for the promotion, development, sustainable management and utilization of renewable energy resources, including the extension of electrification access to remote off-grid communities using renewable technologies (draft ready); and
- An import tax exemption for solar PV system (being implemented).

3.2.3 Feed-in-Tariff

In accordance with the provisions of the Renewable Energy Act, the Public Utilities Regulatory Commission set the first Renewable Energy Feed-in Tariffs (RE-FiT) in September 2013. The RE-FiT was reviewed less than a year later and gazetted on 1 October 2014. The new RE-FiT is similar to the first RE-FiT but introduces a new guideline for the integration of utility-scale variable renewable energy technologies such as solar PV and wind. The main principles of the new guideline are:

- The total nationwide capacity for solar PV and wind plants without grid stability/ storage systems are limited to 150 MW and 300 MW respectively;
- A maximum of 10 MWp (Megawatts peak) per solar PV plant without grid stability/ storage systems is allowed to be connected to the distribution system at any generation site;
- A maximum of 20 MWp per solar PV plant without grid stability/storage systems is allowed to be connected to the national transmission system (161 kV or 330kV) at any generation site.

The new approved rates for utility-scale renewable energy technologies, as gazetted by the PURC in October 2014 are presented in Table 3.1.

Table 3.1: Feed-in Tariffs for utility-scale renewable energy technologies

Electricity Generated from Renewable Energy Technologies	Feed-in-Tariff*		Maximum Capacity (MW)
	GH¢/kWh	US$/kWh	
Wind with grid stability systems	0.56	0.17	300
Wind without grid stability systems	0.51	0.16	
Solar PV with grid stability systems	0.64	0.20	150
Solar PV without grid stability systems	0.58	0.18	
Hydro ≤ 10MW	0.54	0.17	No Limit
Hydro (10MW> ≤100MW)	0.54	0.17	No Limit
Biomass	0.56	0.18	No Limit
Biomass (enhanced technology)	0.59	0.18	No Limit
Biomass (plantation as feed stock)	0.63	0.20	No Limit

**Effective 1 October 2014; US$1.00 = GH¢3.20*

Source: Public Utilities Regulatory Commission (PURC) Gazette Tariffs

http://www.purc.com.gh/purc/node/178

3.2.4 National Initiatives to Facilitate the Implementation of the Renewable Energy Act

The major national initiatives that have been pursued in Ghana to promote the development and deployment of renewable energy in Ghana include:

- Ghana Energy Development and Access Project;
- Scaling-up Renewable Energy Program (SREP) in Ghana Investment Plan; and
- Technical support for the implementation of the Renewable Energy Act.

3.2.4.1 Ghana Energy Development and Access Project

Currently, communities in remote areas of Ghana, including island and lakeside communities constitute a significant proportion of the population with no access to electricity. For most of these communities, decentralized renewable energy technologies appear to be the most competitive electrification option. To ensure the energy sector policy objectives are on course especially those related to rural electricity access and intensification, the Government is implementing the Ghana Energy Development and Access Project (GEDAP).

GEDAP is a multi-donor funded Project involving the World Bank-International Development Agency (IDA), Global Environment Facility (GEF), African Development Bank (AfDB), Global Partnership on Output-based Aid (GPOBA), Africa Catalytic Growth Fund (ACGF) and the Swiss State Secretariat for Economic Affairs (SECO) The development objective of the project is to improve the operational efficiency of the power distribution system and increase the population's access to electricity and help transition Ghana to a low carbon economy through the reduction of greenhouse gas emissions. The four major components of GEDAP are:

- Component A: Sector & Institutional Development – which includes
    - The development of renewable energy tariff methodology and scheme, and standardization of Power Purchase Agreement
- Component B - Distribution System Improvement
- Component C - Electricity Access and Renewable Energy Development – including the provision of
    - Mini-grids and grid-connected renewable energy;
    - Off-grid electrification with solar-PV systems; and
    - Capacity building of staff of Ministry of Power, private sector, financial institutions and inspection agents on the development of renewable energy projects
- Component D - Transmission and Distribution System Reinforcement

The lessons from the GEDAP provide valuable input to other initiatives to support the development and deployment of renewable energy. The key lessons of GEDAP include:

- Limited impact of subsidies;
- Willingness to pay for solar home systems;
- Financing packages for solar PV suppliers;
- Sustainability and maintenance of renewable energy systems;

- Capacity building of participating banks; and
- Non-replicable business model.

Limited impact of subsidies: GEDAP provided a subsidy set as a fixed percentage of the value of lanterns and solar home systems of various sizes. The subsidy was initially meant to increase the affordability of solar lanterns and systems to consumers. However, this subsidy rather turned out serving as an incentive (in the form of transport-cost subsidy) to the dealers of solar systems to actually engage in remote, rural areas. Consequently, the subsidy failed to drive down the cost of solar systems, increase their affordability and successfully accelerate their penetration in the market.

Willingness-to-pay for solar home systems: The willingness-to-pay for energy services from solar home systems in remote, rural areas of Ghana are high. This is evident from the high demand for large solar home systems that can supply an LED colour TV, which reflects consumer aspirations for modern energy services. Sales of these large solar home systems exceeded all targets and expectations established at the beginning of the project.

Financing packages for solar PV suppliers: Suppliers of solar systems faced challenges to obtain sustainable financing for their business operations. It was found necessary, therefore, to provide support to those suppliers to obtain trade financing and working capital. This was to enable them to purchase solar PV systems in bulk and to build up their capacity and retail networks up-country.

Sustainability and maintenance of renewable energy systems: The sustainability of renewable energy programs is dependent on the quality and reliability of the renewable energy systems. Thus it is important to ensure that repairs and maintenance of renewable energy systems are done by competent technicians and artisans. A sustainable model whereby consumers are charged a maintenance service fee could be explored.

Capacity building of participating banks*:* The dedication of the project officers of supporting rural banks made a strong, positive impact on the operation of the project. They improved the sales of solar systems, accelerated the processing of paperwork, enabled loan recovery and established working relationships with local solar PV dealer representatives. Working closely with project officers in the rural communities to build relevant capacity was therefore imperative to the overall success of the initiative.

Non-replicable business model: In spite of the success of the project, which exceeded its sales targets and served more rural households than anticipated, the participating rural banks (under the umbrella of ARB-APEX Bank) declined to participate in the post-project activities due to internal restructuring and new policy focus. Consequently, it was more difficult to successfully scale-up the business model. It has therefore become necessary to work through other grassroots financing establishments to ensure model replicability and overall project sustainability.

3.2.4.2 Scaling-up Renewable Energy Program (SREP) in Ghana Investment Plan

In 2015, the Ministry of Power developed a **Scaling-up Renewable Energy Program in Ghana Investment Plan** (SREP-Ghana IP) to facilitate the Government's strategy to unlock financing opportunities to accelerate the development of a sustainable renewable energy sub-sector. The SREP-Ghana IP will focus on the following three investment projects (Ministry of Power, Ghana, 2015):

Project 1: Renewable energy mini-grids and stand-alone solar PV systems: The objective of this project is to encourage sustainable public and private financing for scaling-up renewable energy mini-grids and stand-alone solar PV systems to achieve the Government of Ghana's universal access policy by electrifying lakeside and island communities in Ghana, with a special focus on gender. Specifically, the project will result in public sector investment in 55 renewable mini-grids and private sector investment in stand-alone solar PV systems to benefit 33,000 households, 1,350 schools, 500 health centres and 400 communities. There will be associated technical assistance and implementation support. The African Development Bank will be the lead multilateral development bank for the implementation, along with the Ministry of Power on behalf of the Government of Ghana.

Project 2: Solar PV based net metering with battery storage: The objective of this project is to develop a comprehensive net metering program and the deployment of at least 15,000 units of roof-mounted solar PV systems to reduce the economic cost of power on small and medium-sized enterprises (SMEs) and households and increase renewable energy contributions in the electricity generation mix by 25-30 MW. There will be associated technical assistance and implementation support. The African Development Bank will be the lead multilateral development bank for the implementation, along with the Energy Commission on behalf of the Government of Ghana.

Project 3: Utility-scale solar PV/wind power generation: The objective of this project is to assist the Government of Ghana overcome key barriers that prevent the growth and expansion of the utility-scale solar PV and wind market in Ghana by catalyzing the first project financed utility-scale renewable energy plants, demonstrating the Ghanaian renewable energysub-sectorpotential to financiers and helping attract further investment in the future. The International Finance Corporation will be the lead multilateral development bank for the implementation. This project is expected to leverage additional sources of co-financing from the private sector and from the African Development Bank's private sector window.

Table 3.2 presents the targets set by the Ministry of Power on renewable energy projects by 2020, under the Scaling-up Renewable Energy Program in Ghana Investment Plan.

Table 3.2: Targets on Renewable Energy Projects by 2020 - Ministry of Power

Potential Renewable Energy Projects	Target	Required Investment US$ million
Development of utility type wind farms	50-150 MW	300-550
Development of grid-connected solar parks	N.A.	400-700
Solar lantern promotion	2 million units	150-200
Medium – small hydro	150-300 MW	450-900
Modern biomass /waste to energy	20-50 MW	60-150
Development of mini-grid	30-42 units	21 - 38.5
Off-grid renewable energy project	30,000 units	10-25
Sustainable energy for cooking	2.0 million units	10-50
TOTAL Investments		**1.4 - 2.6 billion**

Source: Ministry of Power, Ghana, 2015

3.2.4.3 Technical support for the implementation of the Renewable Energy Act

In response to a request by the Ministry of Power, the GIZ (the German technical cooperation agency) has provided support to Ghanaian institutions in the implementation of the Renewable Energy Act, under a 3-year project "Capacity for a Successful Implementation of the Renewable Energy Act (C-SIREA)." The project was initiated in 2013, and its objective is to by provide technical

assistance on the formulation of appropriate strategies and the creation of the necessary political, institutional and administrative framework with the relevant institutions.

The accomplishments of the technical support project include:

- Assessment of potential-costs, performance, and potential quantities of key renewable energy resources;
- Assessment of renewable energy scenarios to identify: (i) appropriate price for distributed and utility scale renewable energy generation; and (ii) amounts of distributed and utility scale renewable energy that could and should be procured;
- Review and finalization of the Renewable Energy License Manual;
- Review and finalization of the draft Net Metering Code regarding: (i) eligibility, (ii) term, (iii) price, (iv) metering/billing arrangement;
- Determination of renewable energy purchase obligations (percentages, technology sub-percentages, caps, timing) on distribution utilities and bulk customers;
- Development of renewable energy tendering rules and process;
- Review and finalization of the format and content of the draft renewable energy power purchase agreements (PPA;
- Training of staff of relevant utilities and regulatory agencies in the energy sector the application of an energy generation model developed for assessment of renewable energy scenarios in Ghana; and
- Review and finalization of the draft "Renewable Energy Grid Code" for utility and distributed scale projects.

The assessment of the renewable energy potential conducted under the C-SIREA project indicates that it is technically and economically feasible for Ghana to reach the goal of renewable energy generation contributing 10% of the national electricity mix by 2020 (Castalia-GIZ, 2015). Figures 3.1 and 3.2 show the projected total installed capacity and generation (including conventional energy sources) with contribution from renewable energy, under various scenarios. "Technically feasible" implies that the cumulative installed capacity of variable renewable energy technologies will not exceed the cap set by the Government of Ghana (maximum of 150 MW of solar and 300 MW of wind without backup storage) and will therefore not affect the system's stability. "Economically feasible" implies that the impact of additional non-least cost renewable energy (compared to conventional power which would be less expensive) on the tariff is reasonable. It is noted that the generation portion of the average electricity tariff from renewable energy will be only 4.2% higher than conventional least cost generation.

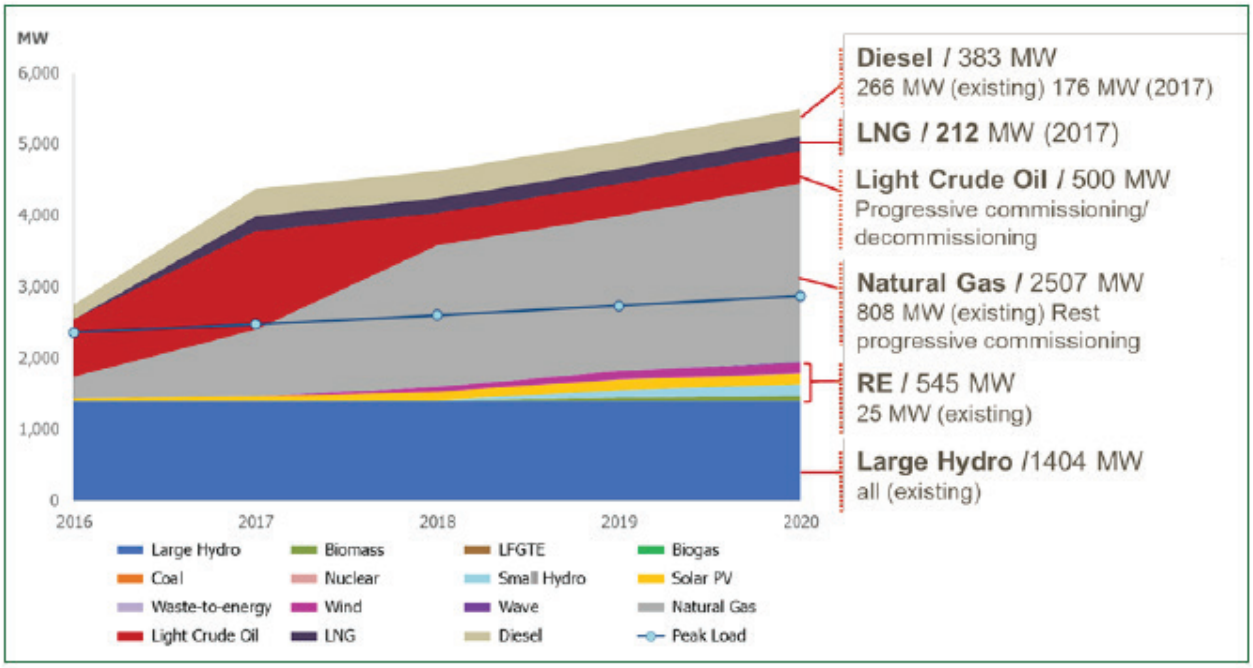

Figure 3.1: Projected Installed Capacity in the Least Cost Scenario including Renewable Energy

Source: Castalia-GIZ and Government of Ghana (2015)

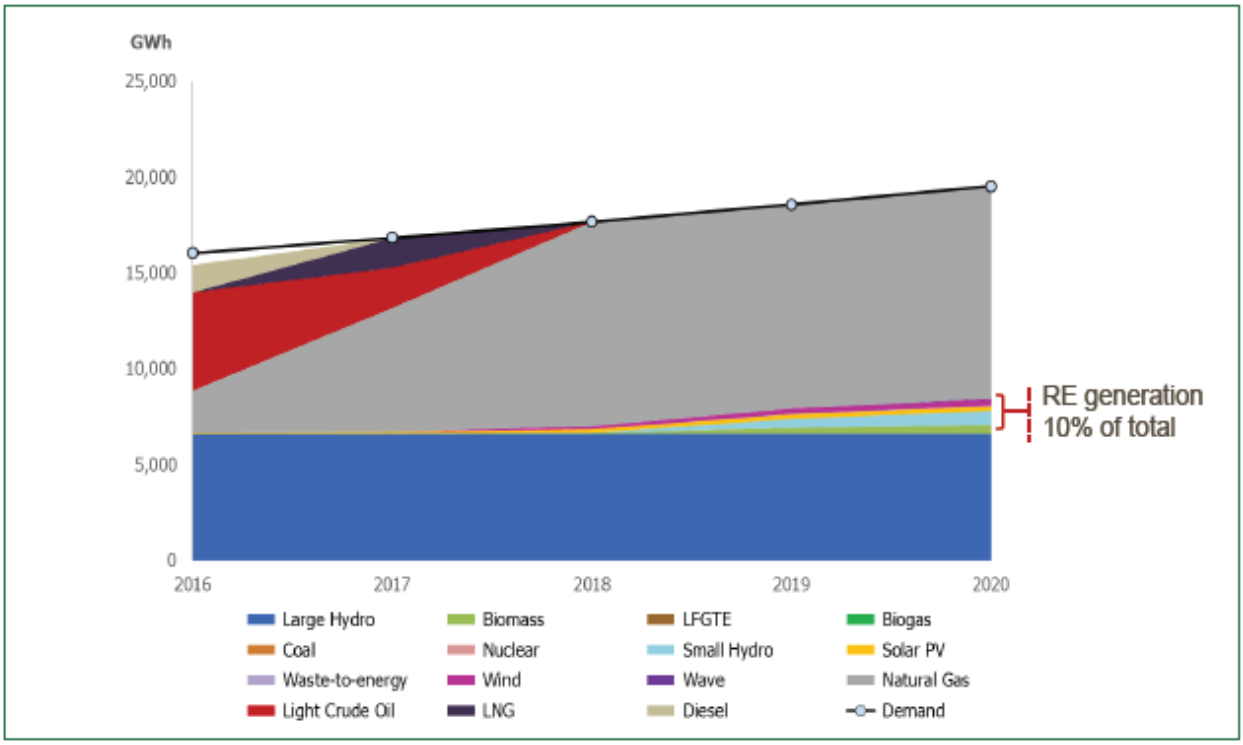

Figure 3.2: Projected Total Generation in the Least Cost Scenario including Renewable Energy
Source: Castalia- GIZ and Government of Ghana (2015)

3.3 Renewable Energy Generation Capacity

Currently there are renewable energy power installations of various sizes with a total capacity of about 9.95 MW, consisting of 93% (7.99 MW) from solar PV and 7% (1.96 MW) from biomass-fired cogeneration plants (see Table 3.3). 4.94 MW of the solar PV capacity is grid-connected whilst 3.00 MW is dedicated to streetlights. Stand-alone power generation from solar PV amounts to about 50 kW. Some solar lanterns, solar water heaters, solar pumps have also been deployed.

Table 3.3: Solar energy generation capacity in Ghana

Facility	Status	Capacity
Solar energy		
Grid-connected power generation, kW	In operation	4,937.42
Solar-powered streetlights, kW	In operation	3,002.93
Stand-alone power generation, kW	In operation	49.96
Sub-total of solar energy generation capacity (as at end of 2015), kW		**7,990.31**
Grid-connected power generation, kW	Expected commissioning in early 2016	20,000.00
Sub-total of solar energy generation capacity (by end of 1st quarter of 2016), kW		**27,990.31**
Biomass-fired cogeneration		
Cogeneration in 4 major oil palm mills, kW	In operation	1,954.00
Total kW		**29,944.31**

Source: Energy Commission, Ghana (2015)

An additional grid-connected solar PV plant with capacity of 20 MW (developed by the BXC Company) is expected to be operational within the first quarter of 2016, to bring the total capacity of renewable energy power installations to 29.94 MW. A company (Safi Sana Waste to Energy) has also secured a construction permit to install a 100 kW biogas-fired co-generation plant.

The major grid-connected solar PV power installations include:

Volta River Authority (VRA), Pungu-Talania, near Navrongo	2,500 kW
Noguchi Memorial Institute for Medical Research, Accra	400 kW
Noguchi Memorial Institute for Medical Research, Accra	315 kW
Trade Works Company Ltd (Office), South Dome, Accra	10.58 kW
Energy Commission, Accra	4.25 kW

The key standalone solar PV power installations include:

Private office building, Taifa, Accra	5.17 kW
Private residence, Manet Estates, Spintex Road, Accra	5.17 kW
SADA-MVP[1] installation, northern Ghana	3.50 kW
Accra Polytechnic, Accra	2.94 kW
Private residence, West Legon, Accra	2.82 kW
SADA-MVP installation, Northern Ghana	2.70 kW
92 installations in various rural communities under GEDAP	8.40 kW

The major biomass-fired cogeneration plants (mainly standalone facilities) are located in the following private oil palm mills:

Ghana Oil Palm Development Co. Ltd., Kwae	420 kW
Juaben Oil Mills Ltd., Juaben	424 kW
Benso Oil Palm Plantation Ltd., Adum Banso Est., Takoradi	500 kW
Twifo Oil Palm Plantations Limited, Twifo Ntafrawaso	610 kW

4. Renewable Energy Sub-Sector of China

4.1 Overview of the Energy Sector of China

Coal supplied the majority (nearly 66%) of China's total energy consumption in 2012. The second-largest source was petroleum and other liquids, accounting for nearly 20% of the country's total energy consumption. Although China has made an effort to diversify its energy supplies, hydroelectric sources (8%), natural gas (5%), nuclear power (nearly 1%), and other renewable energy sources (more than 1%) accounted for relatively small shares of China's energy consumption. The Chinese government plans to cap coal use to 62% of total primary energy consumption by 2020 in an effort to reduce heavy air pollution that has afflicted certain areas of the country in recent years. China's National Energy Agency indicates that coal use dropped to 64.2% of energy consumption in 2014 (Facts Global Energy, 2015). The Chinese government set a target to raise non-fossil fuel energy consumption to 15% of the energy mix by 2020 and to 20% by 2030 in an effort to ease the country's dependence on coal. In addition, China is currently increasing its use of natural gas to replace some coal and oil as a cleaner burning fossil fuel and plans to use natural gas for 10% of its energy consumption by 2020 (World Nuclear News, 2014). Even though absolute coal consumption is expected to increase over the long term as total energy consumption rises, higher energy efficiency and China's goal to increase environmental sustainability are likely to lead to a decrease in coal's share.

The electricity system in China that has grown at an average rate of 10.8% annually over the last decade, doubled power generation in just 7 years with additional 80-90 GW. After a lull in 2012, electricity demand growth recovered in 2013 owing to resurgent of industrial demand (see Figure 4.1). Coal has retained its share in terms of capacity factor, while wind saw a rise in capacity factors. The energy supply mix and renewable energy structure in China is presented in Figure 4.2.

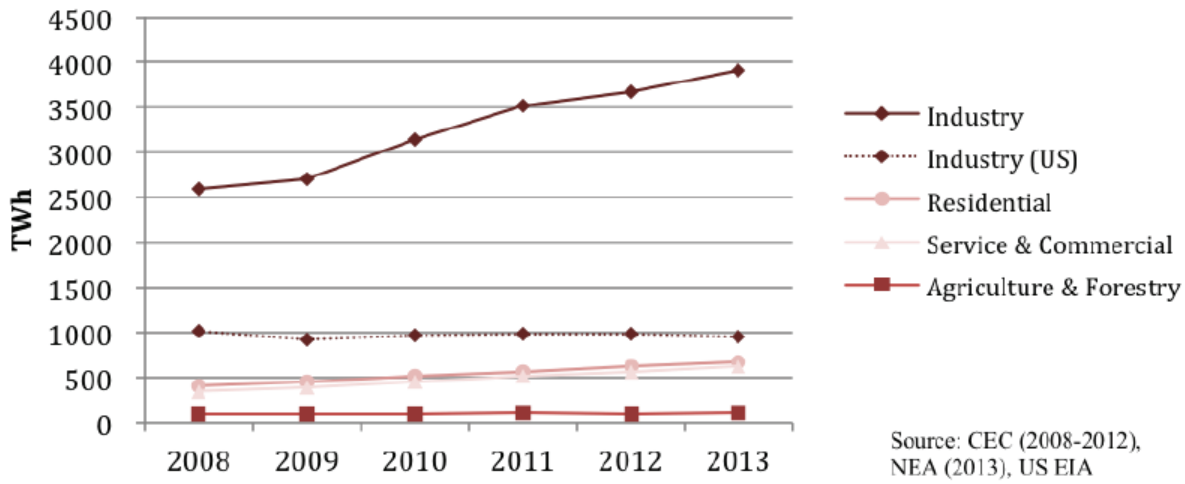

Figure 4.1: Electricity consumption by sector in China (2009-2013)

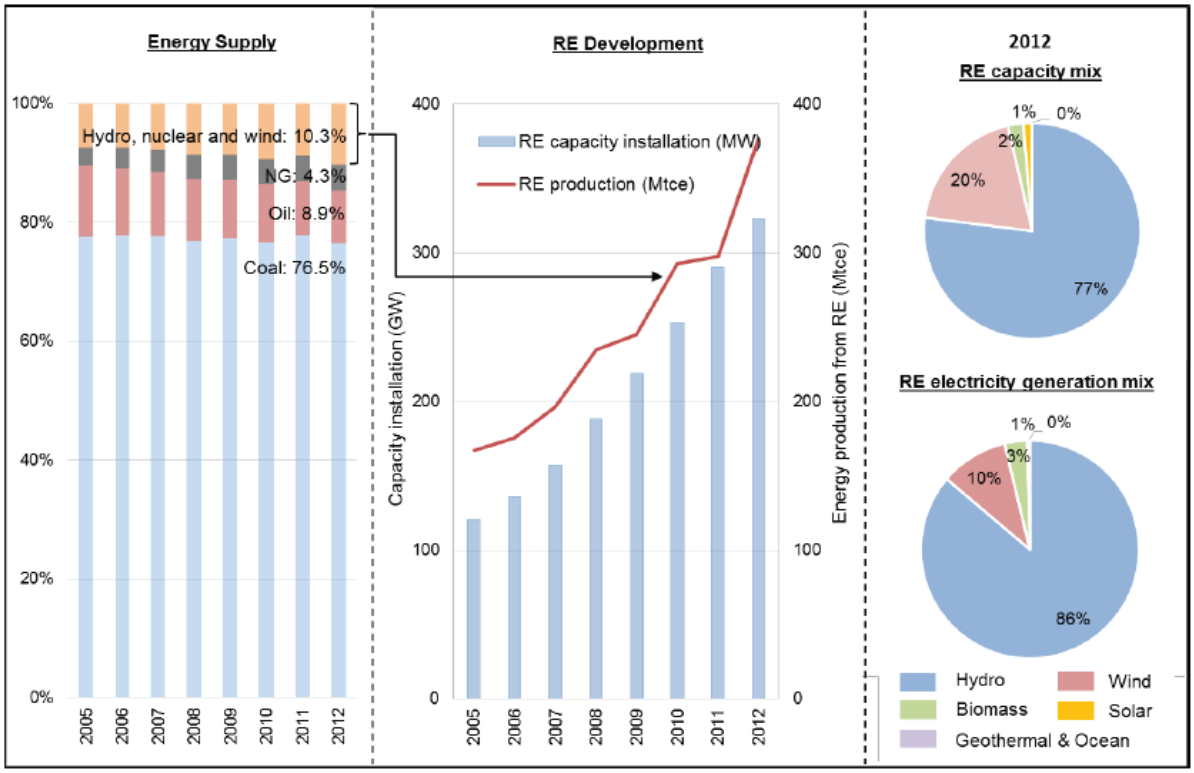

Figure 4.2: The energy supply mix and renewable energy structure in China (Source: Wang, 2014b)

4.2 The Renewable Energy Law

In 2005, China promulgated the Renewable Energy Law, which became effective in 2006 and was amended in2009. By establishing five key mechanisms, the law created for the first time a national framework for the promotion of renewable energy development in China. Pursuant to the law, a series of renewable energy policies were also issued. These include:

- Provisional Administrative Measure on Pricing and Cost Sharing for Renewable Energy Power Generation (2006);
- Tentative Management Method for Renewable Energy Development Special Fund (2006);
- Medium-and Long-term Renewable Energy Development Plan (2007); and
- 11th Five-year Plan of Renewable Energy Development (2008).

The five key mechanisms established by the law are (Zhang et al, 2012):

- **National targets for the development of renewable energy**–through which the government ensures a certain market scale for renewable energy which is crucial in directing investment;
- **Mandatory connection and purchase policy** - by which transmission utilities are required to sign an agreement with renewable electricity generators in their jurisdiction to purchase all of the electricity generated from the generators, and provide grid connection services;

- **Non-grid electricity price for renewable energy similar to a national feed-in tariff system** - which pays renewable electricity generators a fixed, additional amount for each kilo-watt hour of electricity generated, above the wholesale electricity price for desulfurized coal-fired power;
- **Cost sharing mechanism** – whereby the cost of renewable energy generation and grid connection is divided amongst utilities and electricity end-users, with support by a surcharge on electricity sales; and
- **Renewable Energy Development Special Fund** - which offers additional financial support for activities such as science and technology research for renewable energy technologies, standard setting, pilot projects, rural utilization of renewable energy, and renewable resource assessments.

4.2.1 Supporting Regulations

To support the implementation of the Renewable Energy Law, the National Development and Reform Commission in collaboration with other ministries issued some regulations and guidance documents that further outline policy directions for particular renewable energy industries and applications. The regulations are presented in Table 4.1.

The other guidance documents include:

- Opinion on the use of the Renewable Energy Development Fund to promote the wind industry (issued by National Development and Reform Commission and Ministry of Finance);
- Notice to promote the development of the biofuel industry through support for project construction (National Development and Reform Commission and Ministry of Finance);
- Notice on the approach for the assessment of pilot projects for renewable energy integration in buildings (Ministry of Finance and Ministry of Construction); and
- Opinion on fiscal supporting measures to promote bio-energy and bio-chemical industry development (Ministry of Finance).

Additionally, several important technical standards and criteria have been issued by the Standardization Administration of China to support the development of renewable energy. These include:

- Wind power generation Part I: general technical qualification;
- Wind power generation Part II: general testing approach;
- Technical code for wind farms to connect to the grid;
- Technical code for the geothermal power plants to connect to the grid; and
- Technical code for solar photovoltaic power plants to connect to the grid.

The Ministry of Construction has also issued some technical codes relating to the energy systems within buildings, including for solar water heaters in civil buildings, and for soil-sourced heat pump projects.

Table 4.1: Regulations on renewable energy in China

Regulation	Description
Provisional Administrative Measures on Pricing and Cost Sharing for Renewable Energy Power Generation (NDRC Price [2006] No. 7)	Sets out the principles for renewable energy power pricing and cost sharing. In particular, it identifies the level of wind and biomass power pricing and clarifies all costs related to renewable energy power that will be covered by the renewable energy surcharge.
Renewable Energy Surcharge Level Regulation (NDRC Price [2006] No. 28-33)	Establishes the tax-exempt renewable energy surcharge payable by end-users of electricity. This cost sharing arrangement mandates that end users pay a proportion of the higher cost of providing renewable energy, as well as the cost of connecting renewable energy facilities to the grid.
Provisional Regulation on Renewable Energy Surcharge Balancing (NDRC Price [2007] No. 44)	Identifies the procedure for provincial power utilities to collect the renewable energy surcharge, the methodology for allocating this revenue amongst the provinces, and the role of the monitoring body in this process.
Regulation on the Administration of Power Generation from Renewable Energy (NDRC Energy [2006] No. 13)	Sets out approval procedures for renewable energy projects and further identifies the responsibilities of utilities and power generators. Provides that utilities are obliged to allow renewable energy facilities to connect to the grid.
Guiding Catalogue for Development of the Renewable Energy Industry (NDRC Energy [2005] No. 2517)	Identifies the renewable energy technologies that will be supported by the government and identifies the economic policy instruments that will apply to these.
Provisional Administrative Measures on the Renewable Energy Development Fund (MOF Economic and Construction [2006] No. 237)	Sets out the criteria for the use of the Renewable Energy Development Fund, identifies "priority areas", and provides application and approval procedures.
Regulation Governing the use of the Renewable Energy Development Fund to Promote Renewable Energy Integration in Buildings (MOF Construction [2006] No. 460)	Sets out how the Renewable Energy Development Fund will be used to promote the integration of renewable energy in buildings, the application and approval procedures and the criteria for project selection.
Regulation on the Management of Bio-Ethanol Projects (MOF Construction [2006] No. 460)	Sets out the policy for bio-ethanol development, imposes stricter market-entrance standards, project management and supervision requirements, and streamlines the administration system.
Regulation of the Construction and Management of Wind Farms (NDRC Energy [2006] No. 1204)	Obliges local government authorities to develop local wind energy development plans (for facilities smaller than 50MW) according to wind resource availability. The wind tariff is still determined by the State Council through a tender process.
Rural Energy Development Plan	This regulation will require the Ministry of Agriculture to draft a rural energy plan, covering renewable and conventional energy use and energy efficiency measures in rural areas.
Grid Connection and Power Purchasing Regulation	This regulation will require the national grid authority and national standards authority to draft grid connection and power purchase standards to ensure the safety of the grid when it receives electricity from renewable energy sources.

Source: Baker and McKenzie et al, 2007

Many provincial governments have also implemented local regulations to implement the national framework law and regulations, as presented in Table4.2. Most of the coastal provinces and inland provinces with abundant wind resources have drafted their own wind development plans, including Inner Mongolia, Jiangsu and Shandong provinces. Some provinces with large biomass resources, such as Henan and Guangxi provinces are focusing on biomass development plans. Shanghai Municipality and Yun Nan province have drafted "Codes for Renewable Energy Development". Shanghai has already issued the "White Book for Energy Policy", highlighting the significance of renewable energy. Hainan and Shenzhen provinces have also published their Regulations to promote integration of solar hot water into buildings.

Table 4.2: Local Regulations developed provincial governments

Region Name	Regulations or other Document	Responsible Office
Shanghai	White book for energy policy, which includes the renewable energy development plan	Local Development Research Centre (DRC)
Hainan	Regulation to promote integration of solar hot water into buildings	Provincial Construction Bureau
Shenzhen	Regulation to promote integration of solar hot water into buildings	City Construction Bureau
Yunnan	Certification requirements for installation of solar systems into buildings	Provincial Construction Bureau
Beijing	Regulation for promoting solar systems in rural areas	Local DRC
Shandong	Measures for promoting biogas and renewable energy in rural areas	Provincial government
Hunan	Regulation for renewable energy development in rural areas	Provincial government
Guangdong	Measures for promoting solar energy development	Provincial government
Sichuan	Measures for promoting biogas development in rural areas	Provincial government

Source: Baker and McKenzie et al, 2007

4.3 Revision of the Chinese Renewable Energy Law

The implementation of the Renewable Energy Law (2006) and the related regulations sent signals of positive national incentives for the development of renewable energy in China. The scale of the market for renewable energy technologies was also guaranteed through the setting of explicit renewable-capacity targets.

By the end of 2006, the utilization of renewable energy was about 200 million tce (tons of coal equivalent), not including traditional biomass utilization. Hydropower accounted for a capacity of 125 GW, with an additional 2.6 GW of wind power, 360 MW of solar power, and 100 million m^2 of solar water heaters. Furthermore, the implementation of the Renewable Energy Law induced global wind-turbine manufacturers and domestic-grid companies, power generators and energy companies to enter the market. Almost all the big global wind-turbine manufacturers invested and built factories in China, which resulted in the formation of a renewable energy equipment-manufacturing industry (Li, 2007).

With the rapid development of both manufacturers and developers in the renewable energy sub-sector, the Renewable Energy Law (2006) could not keep up with the pace of the development. So, in 2009, an amended version of the Law was enacted to respond to the new emerging demands of renewable energy and address some of the challenges in the implementation of the 2006 version of the Law (China's State Council, 2009). In the new version of the Renewable Energy Law, some challenges in the implementation of the 2006 version were addressed. Compared to the 2006 version, the 2009 version mainly addresses the following aspects of renewable energy:

- Formulating a more scientific approach to renewable energy planning;
- Power grid connections-quotas for electricity generated from renewable energy; and
- Renewable energy subsidies;

4.3.1 Formulating a Scientific Approach to Renewable Energy Planning

The 2009 version of the Renewable Energy Law (REL) highlighted the importance of increasing the use of science-based planning tools when making large-scale plans for the development and utilization of wind, solar, water, biomass, geothermal, ocean and other renewable energy so that they are coherent within the framework of the national energy system. Additionally, the new REL mentioned the need for coordination between regional and national government for renewable energy planning, in order to help guarantee an efficient allocation of resources. The new REL also reflected elements such as setting targets, regional network design and construction, service systems, and safeguards.

4.3.2 Power Grid Connections-Quotas for Electricity Generated from Renewable Energy

The new REL clarified the delineation of responsibility among the state, grid enterprises, and electricity generating enterprises. At the top level, the state determines the share of total electricity to be generated from renewable energy, and guarantees that electric generated within this target by renewable energy producers will be purchased in full. In order to reach this target, the National Energy Administration (NEA) and the State Electricity Regulatory Commission (SERC) define the responsibilities of grid companies and power generators to implement such measures. At the industry level, grid enterprises are required to sign grid-connection agreements with renewable energy electricity-generation enterprises to ensure that all renewable electricity generated in their region is purchased in full. Additionally, grid enterprises should take responsibility for synchronizing this electricity with the rest of their grid. On the other hand, electricity-generating enterprises need to meet the grid connection technical standards of the power grid, and have to cooperate with the power-grid enterprises in protecting grid stability (Wang, 2014).

4.3.3 Renewable Energy Subsidies

The new REL also enhanced financial incentives for renewable energy development, emphasizing that "*for the access cost and other relevant costs that cannot be recovered from the setting price of electricity, the power grid enterprises can apply to the renewable energy development fund for subsidies*" (China State Council, 2009). Specific measures for the administration, collection, and use of the Renewable Energy Development Fund shall be formulated by the public finance department of the State Council together with the Energy Department and the Price Department of the State Council. Although a renewable energy surcharge of CNY0.001/kWh (US$0.00016/kWh) from the nationwide sale of electricity was set with the goal of supporting renewable

energy development (NRDC, 2007b), this amount has proven insufficient for the subsidies mandated by the REL because of the rapid development of renewable energy. The renewable energy surcharge was increased to CNY0.004/kWh (US$0.00064/kWh), with a total CNY10 billion (US$1.6 billion) of renewable energy surcharge collected in 2010, which only covered 70% of the subsidy needed. Since the beginning of 2012, the renewable energy surcharge has been further increased to CNY0.008/kWh, (US$0.00128/kWh) although this level is still inadequate. According to one forecast, a renewable energy surcharge of CNY0.012/kWh (US$0.00192/kWh) is required to cover the subsidies needed for the development of renewable energy power generation (China Scope, 2011).

4.4 Policy Oversight and Institutional Framework For Renewable Energy

In China, the institutional framework for renewable energy is characterized by a centralized administration combined with decentralized administration of practical implementation at local levels by the requisite departments (Li, 2008; Wu et al., 2008; Xia et al., 2011). As the administrative department responsible for renewable energy, the National Energy Administration (NEA) and the National Development and Reform Commission (NDRC) assume the responsibility for setting medium- and long-term total volume targets for renewable energy throughout the country, compiling national renewable energy development and utilization plans and publishing guidelines for Renewable Energy Development. Figure 4.3 presents the main government institutions involved in the administration of the renewable energy sub-sector in China.

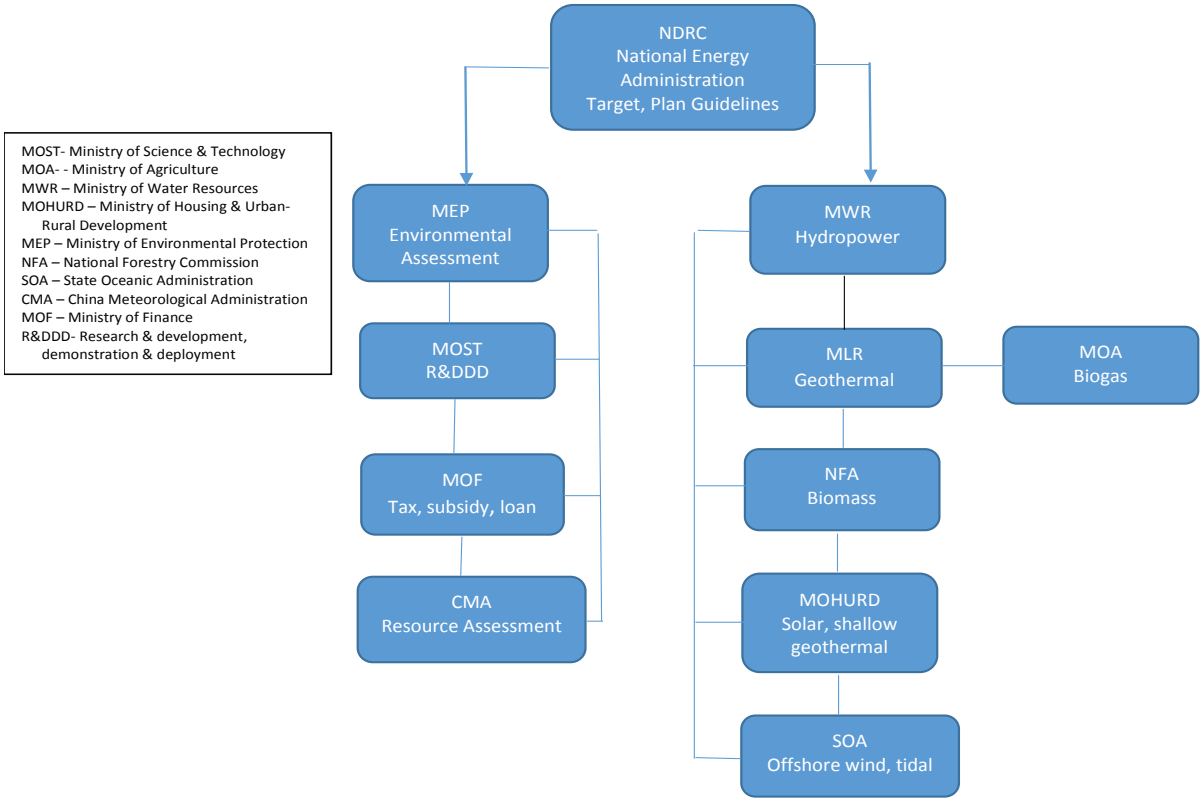

Figure 4.3: Government institutions managing the renewable energy sub-sector in China (Source: Wang, 2014)

Due to the complexity of renewable energy sources, technologies and utilization, many government ministries and departments are involved in the management of renewable energy: i) Ministry of Science and Technology (MOST), China Meteorological Administration, (CMA) Ministry of Environmental Protection (MEP), and Ministry of Finance (MOF) mainly focus on the research and development, demonstration and deployment (R&DDD); wind and solar resources assessments; environmental assessments; and financial incentives on renewable energy development and deployment; and ii) Ministry of Water Resources (MWR), Ministry of Housing and Urban-Rural Development (MOHURD), and the State Oceanic Administration (SOA) are involved in the management and development of various types of renewable energy.

Although the National Energy Administration has centralized the administration of renewable energy, the practical management of renewable energy is still decentralized and localized. For example, the development of wind farms require approvals from both the resource management department, China Meteorological Administration, and the energy management authority, National Development and Reform Commission.

4.5 Key Drivers of the Growth of the Renewable Energy Sub-Sector

Key drivers of the growth of the renewable energy sub-sector in China through the implementation of the Renewable Energy Law are:

- Overall targets mechanism;
- Pricing mechanism;
- Renewable energy subsidies;
- Taxation policy; and
- R&D facilitation

4.5.1 Overall Target Mechanism

There are three overall targets for renewable energy in China set by the central government following the implementation of the Renewable Energy Law, namely:

- Mid-and Long-Term Plan for Renewable Energy Development (MLTPRED) (NDRC, 2007a)
- Eleventh Five year Plan for Renewable Energy Development (EFYPRED) (NDRC, 2008); and
- Twelfth Five-Year Plan for Renewable Energy Development (TFYPRED) (NDRC, 2012).

The increasingly ambitious targets can be seen in Figure 4.4.In the MLTPRED, the Chinese government set a target that renewable energy consumption should account for 10% of total energy consumption by 2010, increasing to 15% by 2020. However, this target was revised in 2009 in advance of the COP 15 meeting in Copenhagen. The revised target was that the share of non-fossil energy would grow to 15% of total primary energy consumption, including not only renewable energy, but also nuclear power (Wang, 2014b). The development of all renewable energy technologies, except for biomass (including biomass electricity generation, biogas and biofuels) exceeded expectations, so that the targets had to be adjusted upward in successive plans to account for the rapid growth of renewable energy (see Figure 4.4).

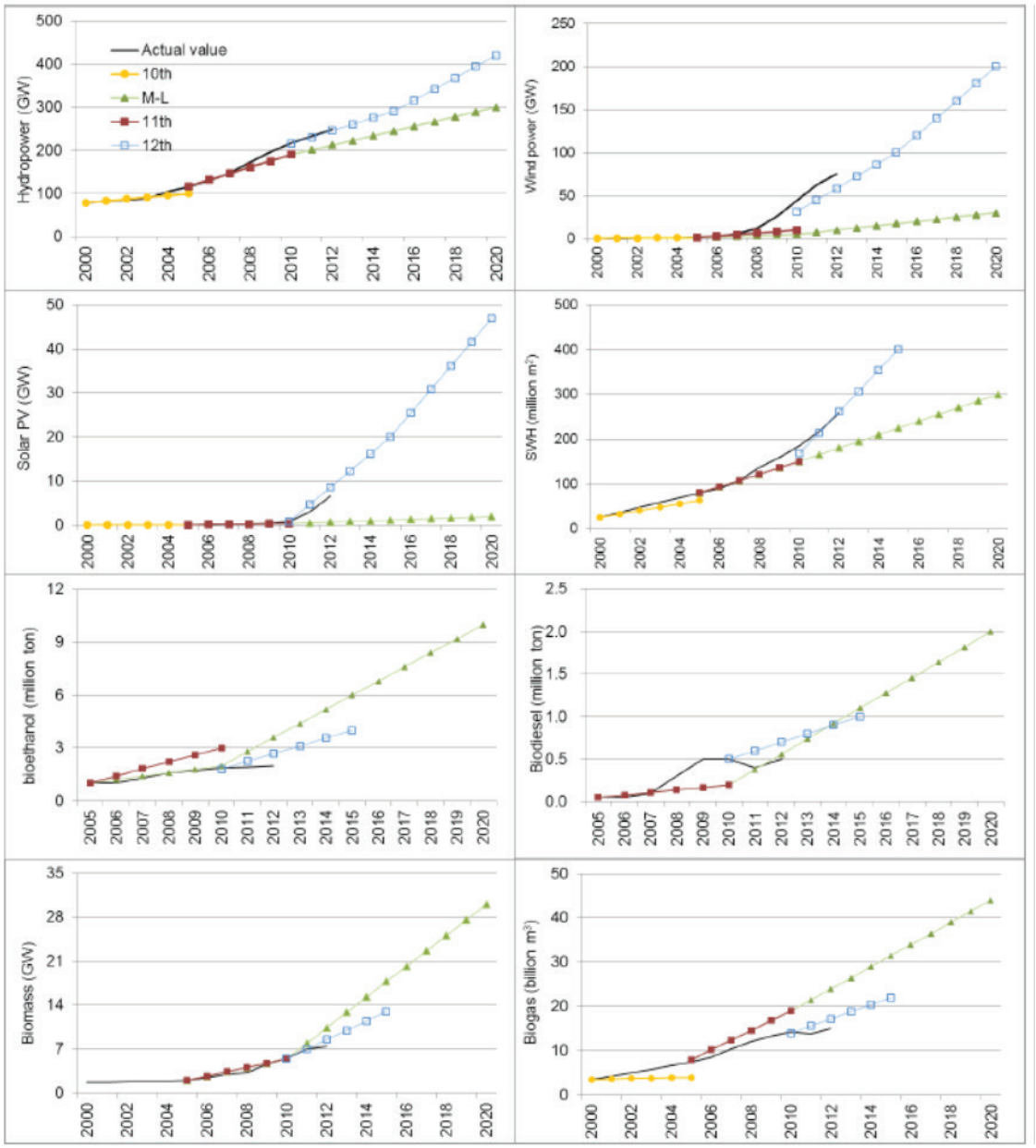

Figure 4.4: Comparisons of Central Government targets and the actual capacity growth
(Source: Wang, 2014b)

The increases in the targets for hydropower and solar water heaters are only very small, because hydropower and solar water heaters are already mature and widely used technologies, so there is little room for major increases in the future. The large differences between the 12th Five Year-Plan targets and previous targets reflect the technological and market breakthroughs of wind power in China. Wind power installation reached 31 GW in 2010, which already exceeds the MLTPRED for 2020 (30 GW), reflecting the rapid development of wind in China (CWEA, 2010; Li 2012).

Solar PV follows a similar trend in growth; although solar lags behind wind power by five years, because of less developed technological state and higher costs of PV compared with wind power. Almost 95% of solar PV modules produced in China were sold to Europe and the United States and the Chinese government has come to encourage development of the domestic solar PV market in order to address the huge capacity of Chinese PV manufacturers. China keeps raising

the national goals for solar PV installation, the "*12th Five Year Plan for Solar Power Development*" released by China's NEA set a goal of achieving 21 GW by2015 (NEA, 2013b), and the goal was further raised to 35 GW by China's State Council in 2013 (Solar Be, 2013; State Council of China, 2013).

In contrast with other types of renewable energy, biomass development fell far below the expectations of government plans. Total biomass utilization, including electricity generation, biofuel, and briquette fuel, was expected to reach 50 million tce in 2015,according to TFYPRED, far lower than former targets. The decrease of biomass targets reflects the fact that the central government has recognized the difficulty of collecting agricultural and kitchen waste on a large scale, and that related industries face technical bottlenecks (Wang, 2014a).

4.5.2 Price Mechanism

The Chinese Government implements separate pricing laws for each type of renewable energy technology, using two primary methods: feed-in tariffs (government-fixed pricing) and competitive tendering (government-guided pricing). These laws and regulations aim to offer renewable energy generators a guaranteed power price, coupled with a purchase obligation on utilities, to stimulate the development of the market. The different pricing mechanisms for the development of renewable energy are presented in Table 4.3.

For biomass, the government initially mandated a subsidy of CNY0.25/kWh (US$0.04). The subsidy encouraged biomass power development, but also resulted in inequitable development between various regions in China (NDRC, 2006a). The subsidy was too low for biomass power projects in central and western regions of China because of the low benchmark price of coal-powered electricity in those regions and the higher costs of the raw material. The government has now implemented benchmark on-grid power pricing for agriculture and forestry biomass power generation projects since 2010. The key issue that has emerged in the implementation of the biomass feed-in tariffs is the need for differentiated treatment based on energy source. Under the current arrangements, all biofuels are treated identically, but the economics of different biofuels mean that different treatment may be required to support the development of all industry sectors.

For solar PV, the NDRC set benchmark prices with the range CNY0.90-1.00/kWh (US$0.14-0.16) for ground-based PV system depending on different solar radiation intensity in various regions of China, and CNY0.42/kWh (US$0.07) of subsidy for distributed PV system since September 2013 (NDRC, 2013). However, FiT is applied in some provinces.

For wind-generated electricity, the wholesale price was initially set in 2003 from a government-organized tendering process. A feed-in-tariff was introduced from 2009, in which the benchmark onshore on-grid wind power prices were set in the range CNY0.51-0.61/kWh (US$0.08-0.10/kWh) depending on the specific resource area (NDRC, 2009). For offshore wind power, pricing was still based on concession bidding. Government pricing covers electricity from oceanic power and geothermal energy.

Table 4.3: Pricing mechanisms for various types of renewable energy technologies in China

Type of Energy	Price-Setting Method	Details
Biomass	Price subsidy (2006) to FiT/ concession bidding (2010, 2012)	Central government mandated a subsidy of CNY0.25 /kWh (US$0.04/kWh) since 2006(NDRC, 2006a). CNY0.75 /kWh (US$0.12/kWh) was set as the benchmark price for agriculture and forest biomass power (NDRC, 2010); while CNY0.65/kWh (US$0.10/kWh) was set as the benchmark price for municipal solid waste power generation (NDRC, 2012b)
Solar PV	Government pricing + concession bidding to feed-in-tariff in some provinces (from 2013)	The benchmark price was set to CNY1.15 /kWh (US$0.18/kWh) for projects approved before July 1, 2011, while it was decreased to CNY1.00/ kWh (US$0.16/kWh) for projects approved after that date. Lower benchmark prices in the range CNY0.90-1.00/kWh (US$0.14-0.16/kWh) was set for ground-based PV system depending on difference in solar radiation intensity; and CNY0.42/kWh (US$0.07/kWh) of subsidy for distributed PV system since September 2013 (NDRC, 2013)
Wind (onshore)	Concession bidding (from 2003) to Feed-in Tariff (from 2009)	Benchmark onshore on-grid wind power prices were set from CNY0.51/kWh (US$0.08/kWh) to CNY0.61/kWh (US$0.10/kWh) depending on the specific resource area (NDRC, 2009)
Wind (offshore)	Concession bidding/auction (from 2008)	The ultra-low price of the four 2010 projects has been blamed on a faulty bidding process. The low price reflected overly optimistic forecasts of both national incentives for offshore wind development and large scale cost decreases in the future
Oceanic power	Government pricing	Set by the government according to the rule of reasonable cost plus reasonable profit (NEA, et al., 2013a)
Geothermal	Government pricing	

Source: NDRC, 2006a

4.5.3 Renewable Energy Subsidies

Though renewable energy systems are favorable energy options because of their sustainable and emission-free characteristics, the main challenge they pose is their uncompetitive cost (Lund, 2009). Thus, subsidies play an important role in the establishment of renewable energy technologies and their market development (Hirschl, 2009). In China, the NDRC grants subsidies to operators of renewable energy projects to compensate them for their costs. A detailed subsidy plan is supposed to be reviewed on a semi-annual basis.

The Renewable Energy Law establishes a long-term, stable subsidization system for setting up a public-financed fund for renewable energy development. The fund is built by charging consumers an additional CNY0.008 (US$0.0013) on every kWh of consumed electricity, and can be used in two forms (NRDC, 2006b). The subsidy may be issued as a grant for renewable energy research and development. It may also be used to subsidize loan interest, whereby eligible renewable projects may obtain public funds to pay part of their loan interest.

Since 2006, eight installments of subsidies have been distributed for renewable energy power-generation projects. According to statistical reports (see Figure 4.6), CNY8.5 billion (US$1.36 billion) of subsidies were granted for 48,438 GWh of electricity generated by renewable energy from November 2010 to April 2011 (NDRC and SERC, 2010). From 2006 to the middle of 2011, a total of CNY32 billion (US$5.12 billion) of subsidies were granted that increased the capacity of renewable energy installations from 1,414 MW to 39,313 MW, while the electricity generated increased from 1,044 GWh to 48,438 GWh (Figure 4.6).

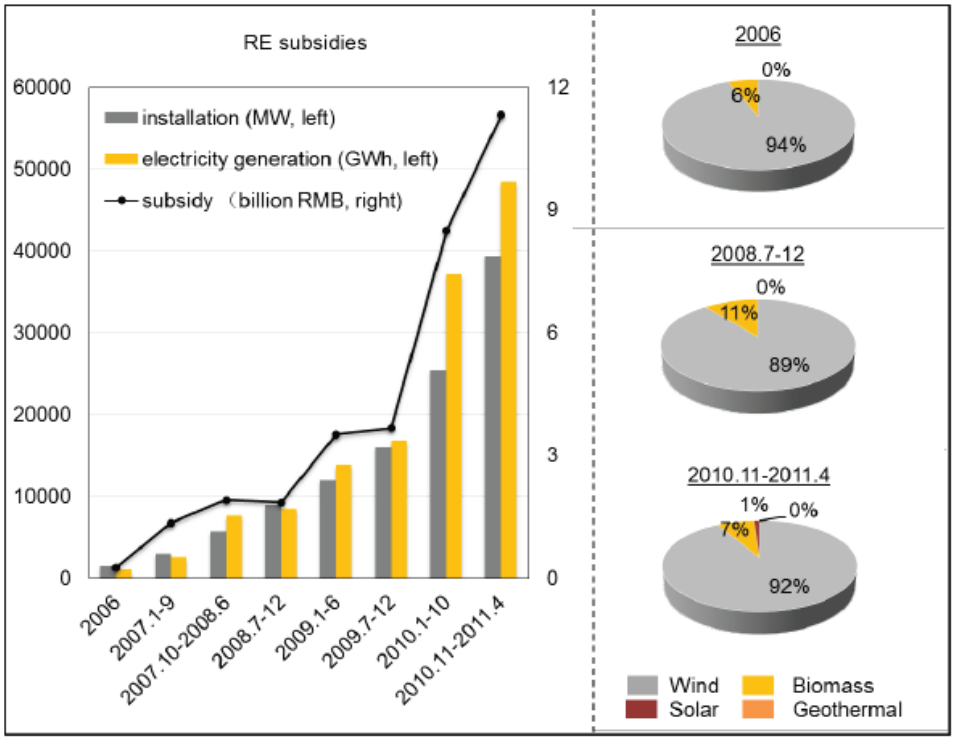

Figure 4.6: Subsidies for different types of renewable energy in China (2006-2011) RMB=CNY (Source: Wang, 2014b)

Large subsidies have stimulated the development of renewable energy in China, with rapid development of renewable energy power installations, especially wind turbines. However, renewable energy developers and manufacturers sometimes receive subsidies two years after their wind turbines have been put into operation, due to subsidy shortage. This situation has had negative impacts on renewable energy developers and manufacturers.

Over 90% of distributed subsidies were granted for wind-power projects, which is consistent with the large share of wind power in China's renewable energy power market. The reason for this is that wind power is the most mature technology compared with other renewable energy technologies (except for hydro power), and needs more government support as it reaches the stage of commercialization. 6% of total subsidies were granted for biomass power generation. The share of biomass increased to 12% from the 2007 to 2008, but fell back to 7% at the beginning of 2011 (Figure 5.5). The change revealed the blooming of biomass power projects at the beginning of the implementation of incentive measures, with a subsequent decrease because of lack of sufficient raw materials and advanced technologies. The structure of renewable energy subsidies also reflects the relatively slow development of solar PV and geothermal power projects, which took only 1% of total distributed subsidies (Wang, 2014b).

4.5.4 Taxation Policy

In China, tax incentives used to promote green electricity (largely from renewable energy) are mainly designed as tax exemptions, rebates on taxes, tax refunds or by applying lower tax rates on activities promoted. The tax incentives are granted only to renewable energy projects that reflect national priorities, and they are not applicable to all available technologies (KPMG, 2011). The three main categories of taxes in China are: i) value-added tax (VAT); ii) corporate income tax (CIT); and iii) customs duties. Various taxation polices have been issued to encourage renewable energy development in China, and these policies have been regularly updated to keep pace with the renewable energy development (Li, 2004; Zhang, 2013; Zhao, 2012).

4.5.4.1 Value Added Tax (VAT)

In 2008, the National Tax Administration (NTA, 2008a) published the "*Circular on Value-Added Tax Policy of Comprehensive Utilization of Resources and Other Products*", and clarified that VAT paid on the sale of goods produced from recycled material or waste residuals is refundable. According to the circular, a 50% refund of the VAT is paid on the sale of wind power, which means that the VAT for wind power was reduced from 17% to 8.5%. A 100% refund of the VAT is paid on the sale of biodiesel oil generated by the utilization of discarded animal fat and vegetable oil as well as electricity generated by the utilization of waste, including municipal solid waste, crops, sewage, and medical waste.

4.5.4.2 Corporate Income Tax

According to the Corporate Income Tax Law, corporate revenues earned by energy conservation and water-saving conservation projects, environmental protection and clean development mechanism projects are eligible for a three-year corporate income tax exemption, followed by another three-year 50% reduction of the corporate income tax rate for income derived from qualified projects, starting from the year in which the first revenue is generated. Applicable fields include biomaterial energy, energy cogeneration, utilization of methane, and technological innovation in energy conservation and emission (NTA, 2008b).

Many enterprises engaged in renewable energy in China are considered as advanced-and new-technology enterprises and they are eligible for corporate income tax rate of 15%, which is below 50% of the normal corporate income tax of 33%. Applicable fields include solar energy, wind energy, biomaterial energy, and geothermal energy (NTA, 2008c). Renewable energy enterprises are eligible for additional incentives if their equipment qualifies as special equipment related to environmental protection, energy saving, water conservation and production safety. 10% of the amount they invest in qualified renewable energy equipment is credited against corporate income tax payable for the current year, with any unutilized investment credit eligible to be carried forward for the next five tax years (Wang, 2014b).

4.5.4.3 Customs Duties

Customs-duty exemptions or reductions are also given to imported renewable energy power-generation equipment and to special items considered to be high technology. According to the "*Import Tax Policy to encourage the Development of Equipment Manufacturing Industry*", solar and wind equipment were included in the duty-free list. Large-scale wind power equipment and some solar PV equipment could be imported without tariff and value-added taxes, so as to stimulate Chinese renewable energy development. However, with the growth of domestic renewable energy industries, this policy has now been repealed (MOF, 2012). According to the new policy published by the government, wind turbines smaller than 3 MW have been removed from the duty-free list, which reflects the advance of domestic technologies (Wang, 2014a).

4.5.5 R&D Facilitation

Research and development in renewable energy has received the support of the Government of China since the enactment of the 1993 Science and Technology Law, which included favorable accounting rules for the capitalization of research and development costs within high-technology institutions. Since 2000, national investment in renewable energy R&D took an average share of 15% of the budget of the science and technology supporting plans of the Ministry of Science and Technology. Wind power, solar energy, and biomass received priority public-investment support, accounting for shares of 40%, 32% and 25%, respectively, of total investments in renewable energy technologies (Su et al., 2008).

R&D facilitation of renewable energy in China has come mainly from government of science and technology projects, while industry has been less involved. One reason for this is that public investments mainly focus on R&D involving mostly universities and research institutes, while demonstration projects involving industry have been few. The other reason is a lack of R&D investment instruments on the part of industry (Wang, 2014a). The low R&D investment in renewable energy also reflected China's low national R&D investment levels compared with most developed countries. China's incentives to promote renewable energy appear inadequate to propel the country into global technological leadership, although they are sufficient to allow China to assume leadership in manufacturing.

4.6 Impact of China's Renewable Energy Policies/ Regulatory Instruments

The major impacts to the economy China resulting from the implementation of its renewable energy policies and regulatory instruments are:

- Fossil-fuel substitution and environment benefits; and
- Green industries development and jobs creation.

4.6.1 Fossil-Fuel Substitution and Environment Benefits

By the end of 2010, the cumulative installed capacity of hydropower had reached 216 GW, having doubled since 2005; the cumulated installed capacity of on-grid wind power reached 31 GW; the cumulative installation of solar PV was 0.8 GW; while the annual growth rate of the utilization of solar water heaters has remained strong, at between 10 and 20% (see Table 4.4). Consequently, the utilization of renewable energy and biomass fuel increased to 286 million tce in 2010 from 166 million tce in 2005, with an average annual growth rate of 11.5 percent (NRDC, 2010a).

Table 4.4: Renewable energy development in China during the 11th Five-year Plan Period

Energy Type	Application	2005	2010	2015 targets	Energy generation (million tce/a)*
Power generation	Hydropower	117GW	216 GW	260 GW	390
	Wind (on grid)	1.26 GW	31 GW	100 GW	
	Solar PV	0.07 GW	0.8 GW	21 GW	
	Biomass	2 GW	5.5 GW	13 GW	
Gas generation	Biogas	8 billion m^3	14 billion m^3	22 billion m^3	17.5
Heat generation	Solar water heaters	80 billion m^2	168 billion m^2	400 billion m^2	60.5
	Geothermal	2 million tce	4.6 million tce	15 million tce	
Fuel generation	Bio-ethanol	1.02 million ton	1.80 million ton	4 million ton	10
	Biodiesel	0.05 million ton	0.5 million ton	1 million ton	
Energy generation		166 million tce	286 million tce	478 million tce	

*tce/a - tce per annum (Source: Wang, 2014a)

Out of China's total primary energy consumption of 3.08 billion tce in 2010, renewable energy accounted for a total of 9.29%. According to the Twelfth Five-Year Plan for Renewable Energy Development (TFYPRED, 2012), total energy generation by renewable energy (including large hydro power) is expected to reach 478 million tce by 2015, which will approach the 15% target set by the national government for 2020. The utilization of renewable energy will also result in the annual mitigation of 1 billion tons of CO_2, 7 million tons of SO_2, 3 million tons of N_xO, 4 million tons of other smoke emissions, and 2.5 billion m^3 of water conservation (NDRC, 2012a).

4.6.2 Green Industries Development and Jobs Creation

Renewable energy development has the potential to encourage technological advances and national manufacturing development. With the growth of renewable energy, China's green power industries have experienced vigorous development (Wang, 2014).

4.6.2.1 Wind Power Manufacturers

In 2011, more than 121 wind-turbine manufacturing facilities, 54 blade facilities, 36 generator facilities, 33 gearbox facilities, 25 bearing facilities, and 43 converter facilities were located in 25 provinces, including foreign-owned enterprises, joint venture enterprises and domestic enterprises. The total capacity of China's wind turbine manufacturers had reached 30 GW in 2011, with nine domestic manufacturers each capable of supplying more than 500 MW annually. In comparison, the number of suppliers with a capacity exceeding 300 MW was 12 in 2010, up from only 1 in 2006 (IEA, 2012). Domestic manufacturers have rapidly increased their market share, and now account for almost 90% of annual additional installations and more than 70% of accumulated installations. In these few years, domestic manufacturers have also entered the international market and, currently, four Chinese enterprises have broken into world's top-ten manufacturers in terms of global sales. However, as new domestic installations supplied only 18 GW and overseas market development was still in its infancy, almost 40% of the Chinese production capacity was idle (Cleantech, 2012; Li, 2012).

4.6.2.2 Solar PV Manufacturers

China's photovoltaic cell-manufacturing industry developed rapidly from 2004 onwards, driven primarily by European market demand, and China became the world's largest manufacturer of PV cells in 2007. Total production capacity was 10 GW in 2010, accounting for 45% of global volume. The top ten solar PV companies in the country accounted for 86% of total national production. However, heavy dependence on European and U.S. markets also resulted in severe blows to solar PV manufacturers in China. Since March 2012, the United States has imposed an anti-dumping duty on Chinese PV products, ranging from 18.32% to 249.96%, and as a countervailing duty of between 14.78 and 15.97% (Caijing, 2012). The 11.80% percent anti-dumping duty imposed by the European Union was more damaging for China's PV manufacturers, since Europe accounts for 70% of the global PV market (ecns.cn, 2013).

4.6.2.3 Creation of Green Jobs

China is pursuing efforts to change the coal-dominated energy structure by incorporating a higher share of renewable energy, so that the energy mix would contribute significantly to environmental protection and to mitigation of greenhouse-gas emissions. According to the World Watch Report, during China's 11th Five-year economic plan period, its solar PV power sector annually generated an average of 2,700 direct jobs and 6,500 indirect jobs (Worldwatch Institute, 2011). According to China's wind roadmap, its wind-power industry, including the power-generation and turbine-manufacturing sectors, created approximately 40,000 direct green jobs and 51,500 indirect green jobs (Wang et al., 2011). With the rapid growth of China's renewable energy industry and potential upward revisions in government projections, the estimates for future green jobs could increase significantly in the coming decade. However, both wind-turbine and PV-cell manufacturers in China face excess capacity and industry restructuring, thereby creating major uncertainties for estimates of future capacity and green-job creation in these two industries (Wang, 2014).

4.7 Policy Challenges for China's Renewable Energy Development

The incentives promulgated or implemented in China demonstrate the determination of the Chinese government to promote domestic solar PV power market in China, but policy challenges do exist (Wang, 2014a). The major barriers for the development of renewable energy in China are:

- Deficiencies of the national FiT scheme;
- Weak and incomplete incentives and supervision mechanisms;
- Poor policy coordination and consistency;
- Conflicts between renewable energy power generators and grid companies; and
- Poor coordination of research and development, demonstration and development (R&DDD) on renewable energy and regional policy.

4.7.1 Deficiencies of the National FiT Scheme

The current FiT scheme in China has three major deficiencies that limit the effectiveness of the scheme (Liu, 2011):

- The FiT do not take into account the vast regional difference in solar resource and the PV cost variation. Although China has abundant solar resources with a daily average radiation

of 4kWh/(m2/day), the resources are greatly diverse in various areas, ranging from less than 2kWh/(m2/day) in parts of the southeast to more than 9kWh/(m2/day) in parts of the west;

- It provides that solar power projects won via the concession process shall not enjoy a price higher than the FiT. This provision tends to discourage investors from participating in the concession program, as investors are reluctant to compete for a non-grid price, which is lower than the FiT. The situation threatens the sustainability of the concession program; and
- It gives no definite period for its implementation.

4.7.2 Weak, Incomplete Incentives and Supervision Mechanisms

The renewable energy development in China still faces technical and economic challenges. Renewable energy has experienced rapid technological innovation and has increasingly become economically competitive, except for large-scale hydropower and solar water heaters. However, cost of renewable energy remains relatively high. The energy authorities have implemented subsidies, tax and R&D policies and other measures to encourage the development of renewable energy, but supporting regulations for the implementation of the Renewable Energy Development Fund are yet to be developed. The rapid growth of renewable energy has resulted in increases in investment in R&D and subsidies. However, financial and managerial instruments are not in place and, consequently, the available financial resources are insufficient for achieving the goals of the renewable energy strategy (Wang, 2014a).

4.7.3 Poor Policy Coordination and Consistency

The responsibility for China's renewable energy business is divided among a number of sectors, unlike the conventional energy business, and this makes it difficult to have a consistent renewable energy policy (Zhang et al., 2009). The revised Renewable Energy Law regulates the integration of provincial targets and plans with the national strategy, but there are still many wind projects that set their capacity below 50 MW (the cap for renewable energy projects at provincial level) so as to avoid the complex approval process at the national level. This has often yielded rather irrational development patterns for China's wind resources and resulted in rapid growth of unused wind power capacity.

4.7.4 Conflicts Between Renewable Power Generators and Grid Companies

Electrical system operation and management have focused mainly on large electrical generating sources and large grids, and there are challenges with integrating renewable but intermittent power systems in the national grid. According to a report of the State Electricity Regulatory Commission (SERC, 2011), a total of 2,800 GWh of wind-generated electricity were not purchased during the first half of 2010. The reasons for the situation could be:

- The government only defines the purchasing relationship between power generation companies and grid companies; there is still a lack of regulating methods for implementing the government's mandatory quotas of renewable energy carriage for power grid companies;
- There are still no transparent and powerful supervision instruments in place. Under the Renewable Energy Law, the grid companies are required to purchase all electricity produced by renewable energy facilities (Chen and Zhu, 2012). However, grid companies do not face any clear punitive measures if the fail to fulfill their mandatory obligations;

- The mismatch between wind power and other power resources (e.g. cogeneration facilities with no peaking capacity) limits the access of wind power to the grid, and the grid companies tend to restrict the access of wind power to the grid in order to protect the stability of the electricity network.

4.7.5 Lack of Innovation in R&D and Regional Policy

In order to maintain and improve the competitiveness of the rising Chinese renewable energy industry, both government and industries should pay more attention to basic research and technological innovation. The renewable energy industry in China industry is largely based on introducing, assimilating and absorbing imported technologies. The government and industry therefore need to increase their R&D contribution to renewable energy to facilitate independent innovation, technology upgrading and talent grooming (Wang, 2014a).

5. Review of Renewable Energy Policy in Ghana and Identification of Gaps

5.1 Stakeholder Consultations

Consultations were conducted with stakeholders in the renewable energy sub-sectorthrough focus group meetings to capture greater insights into the theoretical validity and practical use of the Ghana's renewable energy policies and regulatory instruments. The consultations were also to offer the opportunity to capture the concerns and expectations of the stakeholders, which would reinforce the findings of the desk review and gap analysis of the renewable energy policies and regulatory instruments. The focus group meetings were organised with the following groups of stakeholders:

- Research institutions, civil society, private sector;
- Financial institutions;
- Development partners;
- Public sector institutions; and
- Community near a renewable energy project site.

The list of stakeholders that participated in the focus group meetings is presented in Appendix 1. Figure 5.1 shows the focus group meeting with traditional heads of the Pungu-Talania Community, which is at the site of Ghana's first utility-size (2.5MW) solar power plant in the Upper-East Region.

Figure 5.1: Focus group meeting with traditional heads of the Pungu-Talania Community, near site of 2.5MW solar power plant in Ghana

Following the focused group meetings, a final consultation workshop was held with the stakeholders of the Ghanaian renewable energy sub-sector. The participants at the Stakeholders' Consultation Workshop were representatives of the stakeholder groups that participated in the focus group meetings; the list of stakeholders of participants is presented in Appendix 2. Figure 5.2 shows some of the participants at the sessions of the Workshop. The objectives of the Stakeholders' Consultation Workshop were to:

- Present the findings of the review of the Ghanaian and Chinese renewable energy policies and strategies;
- Present the summary of the barriers and policy gaps identified by the various stakeholders; and
- Allow the stakeholders to provide additional input for the gap analysis on Ghanaian renewable energy policies and strategies and recommend solutions to address them.

Figure 5.2: Participants at the sessions of the Stakeholders' Consultation Workshop

5.2 Barriers and Policy Gaps Identified by Stakeholders

The key barriers and policy gaps identified by the stakeholders during the focused group meetings as the factors that constrain the development and deployment of renewable energy (RE) technologies in Ghana are:

- Low level of research, development, demonstration and deployment (R&DDD) on RE;
- Poor knowledge management and information sharing on RE technologies;
- Concern on waste disposal of RE appliances waste;
- Poor financing of RE investments;
- Lack of affordability of RE systems;
- Cumbersome licensing processes;
- Challenges with enabling instruments for RE investment;
- Unbalanced emphasis on on-grid RE systems; and
- Inadequate local capacity building.

5.2.1 Low Level of R&DDD and Poor Knowledge Management and Information on RE

The major barrier to research and development, demonstration and deployment (R&DDD) on renewable energy is the lack of clear Government policy direction to drive and direct research and development activities on specified thematic areas including renewable energy. Generally, government funding for R&DDD activities is inadequate, and the strategic framework to attract private sector funding for R&DDD has not been developed. Additionally, there is weak linkage between industry and research institutions / universities which would enhance R&DDD activities that provide the technological needs of industry. As a result, R&DDD have played limited role in driving the development and deployment of renewable energy in Ghana.

Knowledge sharing among stakeholders in the renewable energy sub-sector is also weak and ineffective. This has contributed to the lack of interest in R&DDD by industry.

5.2.2 Concern on Waste Disposal of RE Appliance Wastes

The enforcement of regulations on the disposal of electronic waste in Ghana is weak. This raises concern on the possible environmental hazards that may result from inappropriate disposal of waste from renewable energy equipment. For instance, there are currently no clear guidelines for the recycling of solar panels and accessories in Ghana. The most commonly recycled components of the solar panels are glass, aluminum and semiconductor materials that can be successfully recovered and reused. However, if not properly decommissioned, the greatest end-of-life health risk from crystalline solar modules arises from the lead contained in solders, which may lead to leach into landfill soils and eventually into water bodies. Generally, solar PV creates relatively small solid waste, but this amount cannot be ignored during the disposal phase of the solar modules, considering the anticipated expansion of the PV industry in Ghana in the medium to long term.

5.2.3 Poor Financing of RE Investments and Lack of Affordability of RE Systems

The major barrier to the ready financing for renewable energy investments is the poor credit-worthiness of the major off-takers of electricity, the state electricity distribution utilities. The current 10-year tenor of the feed-in-tariff (FiT) also tends to be a disincentive to renewable developers and financiers. Other barriers to renewable energy financing are the single borrower limit and security constraints posed by the financial institutions to renewable energy developers. Some potential renewable energy developers also lack the capacity to develop bankable projects to attract the necessary funding. Besides, some of these developers tend to have divided attention and lack of focus on their renewable energy projects. There is also a perception of a lack of clarity of the regulatory framework for renewable energy.

The generation of power from renewable energy sources has recently become competitive with conventional generation options in many countries. However, the high upfront cost of renewable energy systems, particularly solar PV and accessories, remain unaffordable to many individual customers. For this reason, early adopters of renewable energy systems and services tend to be from higher income brackets, which are exposed to less risk. These first customers may demonstrate aspirational value of the appliances to lower income consumers, especially the long-term benefits of the renewable energy appliances. However, measures need to be put in place to accelerate the adoption of renewable energy appliances by low-income households.

5.2.4 Licensing Process for RE Investments and other Challenges with Enabling Instruments

Renewable energy developers regard the licensing requirements and processes for renewable energy projects as rather barriers to the development and deployment of renewable energy in Ghana. Licensing renewable energy projects generally involves lengthy, complex and cumbersome authorization procedures. With many permits required, many institutions involved, and lack of coordination among those institutions, acquiring all the necessary documents can take an exceptionally long time, whilst responsible authorities are not usually required to respond to applications promptly.

Different permits are required from various government institutions, for example Environmental Protection Authority, Town and Country Department etc. besides the Energy Commission. In some cases, the licensing process is delayed because the potential developer is required to arrange for the preparation and submission of topographical maps of their project sites, since they are often not readily available at Lands Commission. These excessive administrative procedures to secure permits can significantly increase the costs of renewable energy development.

5.2.5 Unbalanced Emphasis on On–Grid RE Systems

For many remote rural communities, including islands, which are relatively far from the national electricity grid, off-grid renewable energy systems remain the most economic option for access to electricity for productive use (e.g. water pumping for irrigation, grain milling etc.) and domestic use. However, there has been relatively little effort to develop and implement enabling instruments and incentives to encourage investments in off-grid renewable energy systems to contribute towards Ghana's expansion of national energy access. There is currently no clear policy framework for the deployment of off–grid systems (stand–alone and mini grids) and for the transitioning of communities with off–grid systems to the national grid in the long term. There is also inadequate public education and awareness on all the different renewable energy systems options available (both on– and off–grid systems). Another barrier is the lack of incentives and support schemes for the productive use of renewable energy off–grid systems, especially in agriculture.

5.2.6 Inadequate Local Capacity Building

An essential requirement for implementing a sustainable renewable energy strategy is sufficient human and institutional capacity among public institutions, non-governmental organisations (NGOs), in the private sector, in academia, and in professional schools. There is generally low availability of a local cadre of trained professionals and policy makers in Ghana to drive the development and deployment of renewable energy technologies within the context of Ghana's unique national energy situation, and to deal with the related technical, legal, regulatory, institutional, and other issues. Although foreign expertise can supplement the local expertise, the use of foreign consultants can only be a stopgap measure.

There is currently a lack of standardized curriculum and comprehensive competency-based training on the technical and entrepreneurial aspects of renewable energy in the technical and vocational institutions in Ghana. As a result, there are inadequate trained personnel to undertake proper planning, design, and installation of renewable energy systems, and to provide excellent after-sales services, particularly repair and maintenance.

Table 5.1 summarizes the policy gaps and underlying issues identified by stakeholders in renewable sub-sector.

Table 5.1: Policy gaps and underlying issues identified by stakeholders in RE sub-sector

Policy Gap	Underlying Issues
1. Low level of research, development, demonstration and deployment (R&DDD) on RE	• Lack of clear Government policy to drive and direct R&DDD on specified thematic areas including renewable energy • Inadequate government funding for R&DDD activities • Lack of strategic framework to attract private sector funding for R&DDD • Weak linkage between industry and research institutions / universities to guide demand-driven R&DDD activities
2. Poor knowledge management and information sharing on RE technologies	• Weak and ineffective knowledge sharing among renewable energy stakeholders • Lack of interest in R&DDD by industry
3. Environmentally-unfriendly disposal of electronic waste	• Weak enforcement of regulations on the disposal of electronic waste, including storage batteries
4. Poor financing of RE investments	• Poor credit-worthiness of Electricity Company of Ghana - of the major off-taker of electricity from RE • Short tenor (10 years) of RE feed-in-tariff (FiT) • Single borrower limit and security constraints posed by financial institutions to RE developers • Lack the capacity of RE developers to develop bankable projects to attract funding • Divided attention and lack of focus of RE developers on their projects • Lack of clarity of the regulatory framework for RE
5. Affordability of RE systems	• High cost of RE appliances • Inadequate fiscal incentives on RE appliances • Inadequate public education and awareness on benefits of RE technologies
6. Licensing processes for renewable energy development	• Complicated and cumbersome licensing requirements and processes for RE projects
7.Challenges with enabling instruments for RE investment	• Inadequate enabling instruments for RE investment

Policy Gap	Underlying Issues
8. Unbalanced emphasis on on-grid RE systems	• Lack of clear policy framework for the deployment of off–grid systems • Inadequate public education and awareness on the range of different RE systems options available (both on– and off–grid systems). • Lack of incentives and support schemes for productive use of RE off–grid systems, e.g. irrigation agriculture and agro-processing
9. Inadequate local capacity building	• Lack of standardized curriculum and comprehensive competency-based training on technical/ entrepreneurial aspects of RE in technical and vocational institutions in Ghana • Inadequate trained personnel for proper installation, repair and maintenance of RE systems

6. Gap Analysis of Renewable Energy Policies and Regulatory Instruments of Ghana

The review and gap analysis of renewable energy policies and regulatory instruments of Ghana was conducted under four major indicators: i) Effectiveness; ii) Efficiency; iii) Equity; and iv) Institutional feasibility. Additionally, the replicability of Chinese renewable energy policies and regulatory instruments in Ghana was also analysed.

6.1 Effectiveness of Energy Strategy, Renewable Energy Law and supporting instruments

The effectiveness of the Energy Strategy, Renewable Energy Law and supporting instruments of Ghana was analyzed based on:

- Set targets for renewable energy technologies; and
- Growth in power capacity from renewable energy compared to the set targets.

6.1.1 Set Targets for Renewable Energy Technologies

Ghana's Medium Term Energy Strategy, 2006 set the target for the mix of renewable energy supply in the national energy consumption as 10% by 2015; the target date was later extended to 2020 under the Strategic National Energy Plan 2006-2020, and the Energy Sector Strategy and Development Plan, 2010 (Energy Commission, 2006/2010). Under the Medium Term Energy Strategy, the Government intended to deploy both "command and control" mechanisms and pricing incentives to accelerate the development and utilization of renewable energy sources. The Strategy also emphasized the need for the enactment of a Renewable Energy Law that would give effect to these measures and provide the legislative basis for the development of renewable energy technologies in the country. The Strategy indicated that the Government would enact the Renewable Energy Law by December 2006. The Renewable Energy Law was passed five years later in December 2011.

6.1.2 Growth in Power Capacity from Renewable Energy Compared to the Set Targets

In 2005, there were over 2,500 solar PV systems installed in individual homes, schools, clinics for lighting and vaccine refrigeration and in some remote communities for water pumping, but grid-connected power from renewable energy was not available. As at June, 2013, there were (Ministry of Energy and Petroleum, 2013):

- 112 renewable energy companies registered in the database of the Ministry of Energy and Petroleum (now Ministry of Power) from 2010;
- 21 Expressions of Interest received from local and International companies, after the passage of the Renewable Energy Law in 2011 (see Table 6.1);
- 2,172MW total capacity of renewable energy proposed by these companies (target by the law was 500MW);
- 9 provisional licences granted for wholesale renewable energy electricity generation by the Energy Commission (all based on solar energy); and

- Methodology for renewable energy feed-in-tariff developed.

Table 6.1: Expressions of Interest from Renewable Energy Developers (2015)

RE Technologies	No. of EOI	Proposed Capacity (MW)	Percentage Share
Solar	12	1,140	52%
Wind	4	175	8%
Hydropower	2	557	26%
Waste -to-energy	1	100	5%
Biomass	2	200	9%
Total	21	2,172	100%

Source: Energy Commission, 2015

By October, 2015, there were as presented in Table 6.2:

- 81 Provisional Licenses (up from 9 in 2013) granted by Energy Commission for wholesale renewable energy electricity generation with a proposed capacity of 4,746.61MW (up from 2, 172MW in 2013), comprising the following number of licences for the different renewable energy technologies:
    - 55 solar PV (up from 9 in 2013);
    - 2 biomass;
    - 9 wind; and
    - 1 ocean wave.
- 20 Siting Permits granted for wholesale renewable energy electricity generation;
- 2 Construction Permits granted to BXC Ltd for 20MW solar plant at Gomoa Onyadze, Central Region and 14MW ocean wave plant at Ada Foah, Greater Accra Region.
- Technical standards on solar PV components developed by Ghana Standards Authority (GSA)
- Solar PV testing facility set up at GSA

Table 6.2: Wholesale Electricity Supply Licenses issued to Renewable Energy Developers

Category	No. of Wholesale Electricity Supply Licences Issued (as at 2015)			Total Proposed Capacity, MW	Percentage Share
	Provisional Licenses	Siting Permits	Construction Permits		
Solar	55	16	1	2,742	58%
Wind	9	1	-	951	20%
Hydro	4	-	-	201	4%
Biomass	2	1	-	68	1%
Waste-to Energy	10	1	-	764.61	16%
Wave	1	1	1	20	0.4%
Total	**81**	**20**	**2**	**4,746.61**	**100%**

Source: Energy Commission, 2015

Since the enactment of the Renewable Energy Law in 2011, followed by some supporting instruments including the renewable energy feed-in-tariffs (RE-FiTs), the contribution of renewable energy to the national energy mix is currently only 0.35% (up marginally from 0.19% in 2013), as indicated in Table 6.2. Besides, only three renewable energy developers (Volta River Authority, BXC Limited and TLC Limited) out of the current 81 Provisional Licensees have reached or proceeded beyond the Construction Permit stage. The Volta River Authority commissioned its 2MW (now expanded to 2.5MW) solar plant in Pungu-Taliana in the Upper East Region in 2013. The 20MW solar plant of BXC Limited is expected to be completed and commissioned by the end of the first quarter in 2016, which may increase the contribution of renewable energy in the national energy mix to about 1.04% (up from the current 0.35%).

Table 6.2: Installed electricity generation capacities in 2013 and 2015

Type of Generation	Fuel Type	Installed Capacity (MW)	
		May-13	Oct-15
Total non-RE power	Hydro, LCO,NG, Diesel	2,434.50	2,846.50
RE power			
Grid-connected	Solar	2.65	4.94
Streetlights	Solar	N.A.	3.00
Stand-alone systems	Solar	0.05	0.05
Cogeneration in oil palm mills	Biomass	1.95	1.95
Total RE power		**4.65**	**9.94**
Total power generation capacity		**2,439.15**	**2,856.44**
% RE power generation capacity		**0.19%**	**0.35%**

Source: Energy Commission, 2015

Under the project "Capacity for a Successful Implementation of the Renewable Energy Act in Ghana" (C-SIREA) sponsored by GIZ, it has been estimated that various renewable energy technologies should contribute over 500MW in the national energy mix, in order to achieve the target of 10% (up from 0.35% in 2015) by 2020 (as indicated in Figure 6.2). This rapid growth requires much stronger enabling instruments to attract the required investment in renewable energy technologies. Renewable energy developers have indicated that the licensing requirements and processes for renewable energy projects are complicated and cumbersome, and the enabling instruments for renewable energy investment are inadequate.

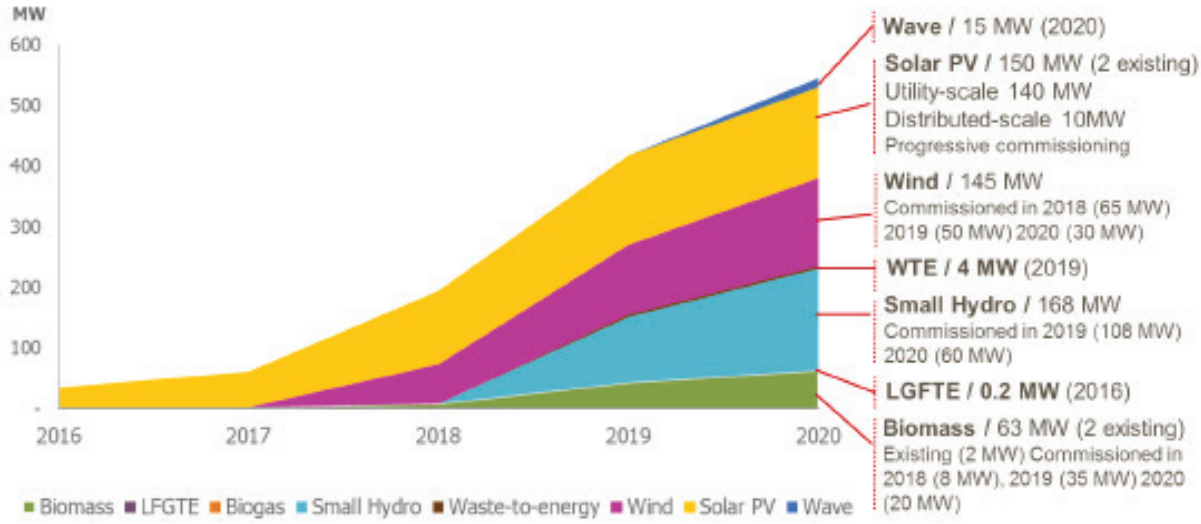

Figure 6.2. Projected generation capacity from renewable energy in the least cost scenario
Source: Castalia-GIZ and Government of Ghana (2015)

In the light of the foregoing issues, the Energy Strategy, Renewable Energy Law and supporting instruments are considered to be only moderately effective, in terms of growth in power capacity from renewable energy compared to the set targets.

6.2 Efficiency of Energy Strategy, Renewable Energy Law and Supporting Instruments

The efficiency of Energy Strategy, Renewable Energy Law and supporting instruments was analyzed in terms of:

- Fiscal incentives to leverage private investment; and
- Public and private finance on R&DDD.

6.2.1 Fiscal Incentives to Leverage Private Investment

The Medium Term Energy Strategy indicates, "Government Support and Consent Agreement (GSCA) will be provided for renewable energy projects". It also indicates that Government will provide fiscal incentives, financial support and technical assistance to attract private sector investment in the development of renewable energy technologies. Additionally, Government will support technological development and cost reduction through pilot demonstration projects and local manufacture of renewable energy technologies. The Renewable Energy Law also stipulates the establishment of a Renewable Energy Fund which will offer financial support for activities for the promotion, development and utilization of renewable energy such as: i) financial incentives, capital subsidies and production-based subsidies to renewable energy developers; and ii) equity participation in renewable energy projects.

6.2.2 Public and Private Finance on R&DDD

The Strategy recognizes that "research and development R&D activities constitute a key source of impetus for energy development, especially in the situation where these activities lead to the indigenous manufacture of energy technology". The Strategy further indicates that the Ministry of Energy (now Ministry of Power) will prepare a "Blue Print" for energy R&D, and establish a focal national energy R&D institution to coordinate the development of energy R&D activities and manage their implementation. Support is also to be provided for the creation of an annual National Energy Forum for the discussion of energy issues, especially with respect to energy R&D. In addition, fiscal incentives, financial support and technical assistance could be provided to attract private sector investment in the development of renewable energy technologies. To facilitate these provisions, Ministry of Power is to establish a National Energy R&D Committee to manage the funds allocated for energy R&D activities. Membership of the Committee will include representatives of the utility companies, Universities, Research Institutes, Industry, and private sector. The Renewable Energy Law also stipulates that the Renewable Energy Fund will provide grants for R&DDD on renewable energy technologies.

6.2.3 Judgment of Developers and other Stakeholders

Notwithstanding the proposals in the Medium Term Energy Strategy and the Renewable Law, stakeholders in the renewable energy sub-sector raise the following general concerns:

- Lack of clear Government policy to drive and direct R&DDD on specified thematic areas including renewable energy;
- Inadequate government funding for R&DDD activities;
- Lack of strategic framework to attract private sector funding for R&DDD;
- Weak linkage between industry and research institutions/ universities to guide demand-driven R&DDD activities;
- Weak and ineffective knowledge sharing among renewable energy stakeholders; and
- Lack of interest in R&DDD by industry.

The Renewable Energy Fund is yet to be operational, and the framework for funds disbursement is not completed. Besides, renewable energy developers have not been offered Government-backed credit guarantees when they request for them to facilitate funds mobilization for their investments.

Currently, imported complete solar systems are zero-rated and are exempted from import duties and taxes. However, Ghana's Harmonized System (HS) codes on imported goods do not classify solar systems appropriately, and individual imported solar components and products (solar panels, batteries and regulators) are not covered by the zero rating. This weakness practically erodes the intended tax incentives on renewable energy technologies to ensure competitive prices.

In terms of fiscal incentives to leverage private investment and public and private finance on R&DDD, the judgement of renewable energy developers reflects that the *efficiency of the Energy Strategy, Renewable Energy Law and supporting instruments is poor*.

6.3 Equity in the Development and Deployment of Renewable Energy

Equity in the development and deployment of renewable energy technologies in Ghana is analyzed in terms of:

- Fair access to support policies and instruments; and
- Participation of stakeholders.

6.3.1 Fair Access to Support Policies and Instruments

The Renewable Energy Law and supporting instruments apply to both "grid interactive renewable electricity" as well as "mini-grid and off-grid renewable power systems for remote areas and islands." However, stakeholders of the renewable energy sub-sector indicate that there is unbalanced emphasis of supporting instruments, such as special tariffs, on on-grid renewable energy systems due to the following factors:

- Lack of clear policy framework for the deployment of off–grid systems;
- Inadequate public education and awareness on the range of different renewable systems options available (both on– and off–grid systems); and
- Lack of incentives and support schemes for productive use of renewable off–grid systems, e.g. irrigation agriculture and agro-processing.

6.3.2 Participation of Stakeholders

The development of policies and supporting instruments in the renewable energy sub-sector appear to have been conducted largely through a participatory approach involving stakeholders in the sector. The Energy Commission championed the development of Renewable Energy Law in collaboration with the Ministry of Energy (now Ministry of Power) through extensive stakeholder consultations. The Energy Commission and the Public Utilities Regulatory Commission through consultations with stakeholders in the renewable energy sub-sector have also developed supporting instruments.

The participation of the local community in the siting of Ghana's first utility-scale solar power plant in Pungu-Talania is assessed in terms of: i) Process for the land procurement; ii) Job creation in the community; and iii) Other impacts of the solar power plant. The traditional leaders of the local community indicated that the Volta River Authority (VRA), the developer of the solar power plant, procured the land for the plant by following the acceptable procedure of approaching the traditional leaders, negotiating on the size and price of the land, and making the necessary payment to the recognized landowners. The leaders are satisfied that the construction and operation of the plant has created middle- and low-level jobs for members of the local community. The leaders express pride that their community is associated with the first utility-scale solar power plant in Ghana that contributes to the national energy mix with renewable energy from the sun. The community now enjoys considerable media publicity due to the solar power plant, which has consequently become a tourist attraction that brings a variety of renewable energy stakeholders to the community.

Thus, in terms of fair access to support policies and instruments, as well as participation of stakeholders, *the level of equity in the development and deployment of renewable energy technologies is good.*

6.4 Institutional Capacity and Feasibility

Ghana has successfully developed and established institutions and capacity in the energy sector that are recognized and highly regarded in sub-Saharan Africa. The institutions are in four major categories:

- National energy policy, planning and regulatory authorities;
- Energy supply agencies;
- Academic and research institutions; and
- Other agencies.

The **National energy policy, planning and regulatory authorities** are responsible for the formulation, coordination, monitoring and review of policies and programmes for the overall development and use of energy resources (including renewable energy) to meet established national socio-economic priorities. They are also responsible for regulating the energy sector institutions. These institutions include: i) **Ministry of Power** and **Ministry of Petroleum**, which are responsible for energy policy formulation and implementation in the power and petroleum sectors, respectively; ii) **Ghana National Petroleum Corporation (GNPC)** with responsible for planning and implementing activities to support the development of Ghana's hydrocarbon resources; (iii) **Energy Commission (EC)** which is responsible for licensing electricity and natural gas operators and playing an advisory role to the Ministries of Power and Petroleum on energy policy and planning matters; (iv) **Public Utilities Regulatory Commission (PURC)** with responsibility for economic regulation of electricity and natural gas utilities; and (v) **National Petroleum Authority (NPA)** which has responsibility for overseeing the activities and regulating the downstream petroleum industry.

The **major energy supply agencies** are responsible for the production and supply of the national energy requirements. These agencies include semi-autonomous state enterprises, with several years of operation and a high caliber of staff, dealing principally in petroleum and electricity. The major agencies in the power sector are: i) **Volta River Authority (VRA)** responsible for electric power generation; ii) **Ghana Grid Company** (GridCo) responsible for and electric power transmission; and iii) **Electricity Company of Ghana (ECG)** and **Northern Electricity Distribution Company (NEDCO)**, both of whom being engaged in electric power distribution. The petroleum sector agencies include: i) **Tema Oil Refinery (TOR)** which refines crude oil; and ii) **Bulk Oil Storage and Transportation Company Limited (BOST)** which is involved in bulk storage and transportation of petroleum products throughout the country and also mandated to keep the National Strategic Reserves of petroleum products.

The **academic and research institutions** articulate and implement a range of research activities to meet some identified needs of the power and petroleum sectors. So far, the research has been biased towards the technologies of conversion and utilization of renewable energy resources. The research centres are organized around the country's **Universities** and some of the institutions under the **Council for Scientific and Industrial Research (CSIR)**.

Other agencies include entities whose activities are critical to the development of the energy sector and are operating with funding support from Government. The **Energy Foundation** was set up by Government to provide the institutional leadership with regards to the promotion of energy efficiency and conservation. The **Ghana Cylinder Manufacturing Company Limited (GCMC)** is a wholly owned Government enterprise that produces cylinder and other equipment for liquefied petroleum gas (LPG).

6.4.1 Institutional Constraints

The Government of Ghana has embarked on a number of reforms in the energy sector aimed at creating a conducive environment for growth in the sector especially with active private sector involvement. The reforms have covered industry re-structuring, comprising institutional, legal, regulatory and pricing reforms. The reforms have had varying levels of impact, but four major barriers still remain to be comprehensively addressed:

- Low level of private sector participation in the development of energy sector infrastructure (including renewable energy);
- Inadequacy of human resource capacity in some strategic areas and disciplines, particularly development and deployment of renewable energy technologies;
- Weak linkage between industry and research institutions and universities to guide demand-driven R&DDD activities; and
- Lack of attention from Government and private sector in energy research and development, demonstration and deployment (R&DDD).

In spite of these barriers, however, *the institutional capacity and feasibility of Ghana's renewable energy sub-sector is considered to be good.*

6.5 Replicability of Chinese enabling environment in Ghana

The key drivers of the growth of the renewable energy sub-sector in China through the implementation of the Renewable Energy Law are:

- Overall targets mechanism;
- Pricing mechanism;
- Renewable energy subsidies;
- Taxation policy; and
- R&DDD facilitation.

6.5.1 Overall Targets Mechanism

The overall targets mechanism practiced in the renewable energy sub-sector of China is replicable in Ghana. Ghana has already set its target to achieve 10% contribution of renewable energy to the national energy mix by 2020. The projected contribution of the different renewable energy technologies (solar, wind, biomass etc.) towards this target is being finalized. The challenge is the ability of the Energy Commission to play the leading role to coordinate the activities of relevant stakeholders in the renewable energy sub-sector towards the attainment of the target. The capacity building of the Energy Commission and other relevant institutions should be pursued in the technical (regulatory etc. issues) and non-technical (marketing, legal, public education etc. issues) areas to enable the Commission to perform this role efficiently and effectively.

6.5.2 Pricing Mechanism

Competitive pricing of electricity from renewable energy is critical for sustainable growth of the renewable energy market in Ghana. Ghana has developed and is already implementing the

feed-in-tariff mechanism for electricity from renewable energy. The framework for tendering for competitive bids on renewable energy developments is also being developed. The feed-in-tariff and tendering schemes may be implemented concurrently for applicable renewable energy developments, as practiced in China, to create and sustain a competitive market for renewable energy in Ghana. As is the concern of renewable energy developers in Ghana, the tenor of the feed-in-tariff should be increased beyond 10 years to attract private investment in renewable energy development.

6.6 Renewable Energy Subsidies and Taxation policy

Renewable energy subsidies are currently non-existent in Ghana, partly due to the delayed establishment and operation of the Renewable Energy Fund. The taxation incentives on renewable energy equipment are also unclear and their application have not made the desired impact in the development of a competitive renewable energy market in Ghana. The situation poses a serious barrier to the growth of the renewable energy market in Ghana in a similar manner as pertains in China. The establishment and operation of the Renewable Energy Fund should be expedited within a clearly defined and transparent disbursement framework to support a sustainable subsidy scheme for renewable energy development. The taxation incentives on renewable energy equipment should be streamlined to cover a broader range of equipment in the category.

6.7 R&DDD Facilitation

There is currently lack of a structured framework and mechanism for mobilizing funding for R&DDD in renewable energy from Government and the private sector. There is also absence of a clear strategy to create an interactive linkage between industry and research institutions and universities to guide demand-driven R&DDD activities on the development and deployment of renewable energy technologies. The Energy Commission should champion the coordination of stakeholders in academia, private sector industry, government and civil society to support vibrant R&DDD activities to contribute towards the growth of the renewable energy market in Ghana.

T*he replicability* of the enabling environment of China in Ghana is considered to be *moderate.* The replicability can be improved if the recommended economic, regulatory and institutional strengthening are implemented.

The results of the gap analysis of renewable energy policies and regulatory instruments of Ghana are summarized in Table 6.3.

Table 6.3: Summary of results of gap analysis of RE policies of Ghana

Assessment Factor	Indicator	Score
Effectiveness	Set targets for RE	moderate
	Growth in RE power capacity	
Efficiency	Fiscal incentives to leverage private investment	Poor
	Public and private finance on R&DDD	
Equity	Fair access to support policies and instruments	good
	Participation of stakeholders	
Institutional	Institutional capacity and feasibility	good
Replicability	Replicability of Chinese enabling environment in Ghana	moderate

7. Recommended Strategic Interventions to Address Barriers and Policy Gaps

The gap analysis of renewable energy policies and regulatory instruments in Ghana was validated by the various levels stakeholder consultations, with due consideration of some best practices on renewable energy development and deployment in China. The analysis has provided the following recommendations of strategic interventions to address the various barriers and policy gaps that constrain the growth in the development and deployment of renewable energy in Ghana:

1. Low level of R&DDD and poor knowledge management and information on RE

- Establish competitive bidding system for granting financial support to critical areas of R&DDD, particularly renewable energy technologies;
- Relevant research institutes and universities – especially the CSIR-Institute of Industrial Research, Accra and the Energy Centre at the Kwame Nkrumah University of Science and Technology, Kumasi - should be granted technical assistance and financial support to develop the state-of-the-art laboratories to conduct R&D in renewable energy technologies and undertake demonstration and deployment projects on RE as well;
- Energy Commission should play the role of initiating and coordinating R&DDD in renewable energy technologies by research institutes; and
- Energy Commission should organize regular interaction among research institutions and universities, the private sector, Ministry of Power and Energy commission:
    - For sharing key research findings on renewable energy technologies;
    - To encourage funding of R&DDD on renewable energy technologies by the private sector.

2. Concern on waste disposal of RE appliance wastes

- Government should expedite the enactment of the Bill on Control and Management of Electronic Waste which includes:
    - The requirement for manufacturers or importers of electronic equipment to pay electronic waste levy on locally manufactured or imported electronic equipment to the Environmental Protection Agency to cover management of electronic waste; and
    - Establishment of an Electronic Waste Recycling Fund from the electronic waste levy and other sources.

3. Poor financing of RE Investments and lack of affordability of RE Systems

- Implement reforms to improve the company finances and credit-worthiness of Electricity Company of Ghana (ECG) and the Northern Electricity Distribution Company (NEDCo), as a major off-takers of electricity from RE;
- Intensify public education and awareness campaigns on the benefits of renewable energy technologies;
- Review the tenor of the feed-in-tariff, with the possibility to increase the year duration;

- Incentivize financial institutions to support renewable energy investments through:
  - Lodging the Renewable Energy Fund with participating banks instead of the central bank;
  - Tax exemptions for financial institutions on their returns on renewable energy financing;
- Harmonize the public messages on renewable energy from government institutions, particularly, Ministry of Power, Energy Commission and Public Utilities Regulatory Commission.

4. Licensing process for RE investments and other challenges with enabling instruments

- Create a platform for potential renewable developers to complete the licensing process on-line via the internet;
- Review the renewable energy provisional licence requirements, with the possibility to reduce the number of exhibits required to be submitted;
- Develop clear regulatory guidelines on renewable energy off-grid and mini-grid systems; and
- Develop a framework to clearly define how renewable energy projects can qualify for government-backed credit support and partial risk guarantees.

5. Unbalanced emphasis on on–grid renewable energy systems

- Develop a clear plan or roadmap (by the Energy Commission in consultation with the Ministry of Power) for transitioning all off–grid systems in communities to be grid-connected as and when the grid becomes available;
- Provide adequate funding from the Renewable Energy Fund to support extensive public awareness creation among various stakeholders (RE developers and financiers, financial institutions, consumers etc.) on the different RE system options available; and
- Provide incentives and support schemes for productive uses of off–grid systems.

6. Inadequate indigenous capacity building

- Develop standardized curriculum for competency-based training on all renewable energy technologies, with emphasis on the technical and entrepreneurial aspects;
- Provide incentives for private sector support for competency-based training in technical and entrepreneurial aspects of all renewable energy technologies;
- Reduce over-reliance on foreign expertise for execution of renewable energy projects, through deliberate efforts to improve local expertise through capacity building; and
- Provide incentives for female participation in the various activities in the renewable energy sub-sector, including development, management and application of renewable energy technologies.

The recommended strategic interventions to address policy gaps in the renewable energy sub-sector, as well as the institutions responsible for the interventions are summarized in Table 7.1

Table7.1: Recommended strategic interventions to address policy gaps in the renewable energy sub-sector

Policy Gap	Underlying Issues	Prioritized Strategic Interventions	Instrument Type	Responsible Institutions
1. Low level of research, development, demonstration and deployment (R&DDD) on RE	1.1 Lack of clear Government policy to drive and direct R&DDD on specified thematic areas within the renewable energysub-sector 1.2 Inadequate government funding for R&DDD activities 1.3 Lack of strategic framework to attract private sector funding for R&DDD 1.4 Weak linkage between industry and research institutions / universities to guide demand-driven R&DDD activities	• Establish competitive bidding system for granting financial support to critical areas of R&DDD, particularly RE technologies • Establish a challenge fund for R&DDD on RE under the Renewable Energy Fund	Public finance/ Institutional	MoF, EC, MoP,
		• Grant technical assistance and financial support to research institutes and universities (e.g. CSIR-IIR and KNUST- Energy Centre) to develop the state-of-the-art to conduct R&DDD in RE technologies	Public finance/ Institutional	MoF, EC, MoP, Private Sector/ AGI/ GNCCI, DP
		• Initiate and coordinate R&DDD in renewable energy technologies by research institutes and universities. • Develop and implement strategy to engage universities/research institutions and industries to address issues relevant to industry. i.e. create a sustainable link between these two sectors	Institutional	EC
2. Poor knowledge management and information sharing on RE technologies	2.1 Weak and ineffective knowledge documentation and sharing among renewable energy stakeholders 2.2 Lack of interest in R&DDD by industry	• Organize regular interaction among research institutions and universities, the private sector, Ministry of Power and Energy commission: ○ for sharing key research findings on RE technologies ○ to encourage funding of R&DDD on RE technologies by the private sector • Institute annual Renewable Energy Fair (Exhibition and Conference) • Establish Ghana Open Data as a one-stop- shop for information with a strong presence of the renewable energy sub-sector	Institutional	EC, MoP, Private Sector/AGI/ GNCCI, NGOs, DP

Policy Gap	Underlying Issues	Prioritized Strategic Interventions	Instrument Type	Responsible Institutions
		• Direct agencies and departments of the Ministries to be more proactive in sharing information • Encourage and award publication on RE in local and international journals and other print media ○ Publication could be a requirement for accessing research funding	Institutional	EC, MoP, Private Sector/AGI/ GNCCI, NGOs, DP

3. Environmentally-unfriendly disposal of RE waste	3.1 Weak enforcement of regulations on the disposal of electronic waste	• Expedite the enactment of Bill on Control and Management of Electronic Waste which include:
		  ○ Payment of electronic waste levy by manufacturers/importers of electronic systems
		  ○ Establishment of Electronic Waste Recycling Fund
		• Make it a requirement for proper disposal of waste during licencing of operators in the renewable energy sub-sector
			Regulatory	EPA, MESTI, Private Sector/AGI/ GNCCI, NGOs, CBOs, DP

4. Insufficient financing of RE investments	4.1 Credit-worthiness of State Distribution Utilities - major off-taker of electricity from RE 4.2 Short tenor (10 years) of RE feed-in-tariff (FiT) 4.2 Lack of tariff structure for off-grid electricity. 4.3 Single borrower limit and security constraints posed by financial institutions to RE developers 4.4 Inadequate capacity of RE developers to structure bankable projects to attract funding	• Implement reforms to improve company finances/ credit-worthiness of State Distribution Utilities- major off-taker of electricity from RE • Promote distributed generation of renewable energy projects	Institutional	MoP, EC
		• Intensify public education and awareness campaigns on the business potential RE sub-sector to financial institutions • Facilitate capacity building programmes for developers by financial institutions on project financing • Organize investment forums to bring together financial institutions and RE project developers	Institutional	EC, NGOs, CBOs, DP

Policy Gap	Underlying Issues	Prioritized Strategic Interventions	Instrument Type	Responsible Institutions
	4.5 Divided attention and lack of focus of RE developers on their projects	• PURC to clarify what happens after the 10 year tenor of FiT • Fast-track development of FiT for off-grid electricity	Regulatory	EC, PURC
		• Incentivize financial institutions to support RE investments	Fiscal/ Institutional	EC, MoP, MoF
5. Affordability of RE systems	5.1 High initial cost of RE technologies 5.2 Inadequate fiscal incentives on RE appliances – ambiguities in the enforcement of import tax and VAT waivers 5.3 Inadequate public education and awareness on benefits of RE technologies	• Streamline and enforce import tax and VAT waivers on all RE systems ○ Duty waivers should be time-limited to reduce the difficulties in withdrawing such incentives ○ Designate strategic RE manufacturing facilities as custom-bonded to streamline the enforcement of the tax waivers • Consider tax waivers for all imported inputs for local manufacturing of RE technologies • Institute and implement Government commitment to procure some quantity of manufactured RE products	Fiscal/ Institutional	MoF GRA, MoTI, MoP, EC, GIPC
		• Intensify public education and awareness on benefits of RE technologies	Institutional	EC, NGOs, CBOs, DP
6. Licensing processes for renewable energy development	6.1 Complicated and cumbersome licensing requirements and processes for RE wholesale supply projects 6.2 No licence process defined for off-grid	• Implement competitive tender for solar wholesale supply ○ Provide necessary support structures to facilitate tender implementation • Develop an agreed procedure to streamline approval process for wholesale RE projects of various state agencies ○ to make the acquisition of licence less cumbersome • Develop a licensing and permitting framework for off-grid electrification	Institutional	EC, PURC, EPA, MoP, Distribution Utilities, other Offtakers

Policy Gap	Underlying Issues	Prioritized Strategic Interventions	Instrument Type	Responsible Institutions
		• Create a platform for potential RE developers to complete licensing process on-line via internet	Institutional	EC, PURC, EPA, MoP, Distribution Utilities, other Offtakers
		• Review RE provisional licence requirements to reduce number of exhibits to be submitted	Regulatory	EC
7.Challenges with enabling instruments for RE investment	7.1 Inadequate enabling instruments for on-grid RE investment 7.2 Requirements of instruments for off-grid RE are unclear	• Develop framework to define criteria for RE on-grid projects to qualify for government-backed credit support and partial risk guarantees • Make provision for off-grid government-backed support whenever required	Regulatory	EC, MoF, MoP
8. Unbalanced emphasis on on-grid RE systems	8.1 Focus of international private sector on on-grid (primarily solar) utility scale projects 8.2 Lack of clear policy framework for the deployment of off–grid systems 8.3 Inadequate public education and awareness on the range of different RE systems options available (both on– and off–grid systems). 8.4 Lack of incentives and support schemes for productive use of RE off–grid systems (including non-electricity) e.g. irrigation agriculture and agro-processing	• Develop a Renewable Energy Master Plan (REMP) that will significantly address the imbalance in focus on on-grid utility scale RE projects • Incorporate in the REMP a clear plan/roadmap for transitioning all off–grid systems in communities to be grid-connected when grid becomes available • Incorporate in the REMP a comprehensive communication plan and awareness creation strategy. • Develop clear regulatory guidelines on RE off-grid and mini-grid systems	Regulatory	EC, PURC, MoP
		• Provide incentives and support schemes for productive uses of off–grid systems • Utilize the platform of the RE Fair to create extensive public awareness among stakeholders on different RE system options available	Fiscal/ Public finance	EC, MoP

Policy Gap	Underlying Issues	Prioritized Strategic Interventions	Instrument Type	Responsible Institutions
9. Inadequate local capacity building.	9.1 Lack of standardized curriculum and comprehensive competency-based training on technical/ entrepreneurial aspects of RE in technical and vocational institutions in Ghana (including people with little or no formal education). 9.2 Inadequate number of trained personnel for assembling, installation, repair, and maintenance of RE systems. 9.3 Lack of assembling and manufacturing base for some RE technologies 9.4 Gender imbalance in the RE sub-sector	• Develop standardized curriculum and apprenticeship programs for competency-based training on technical and entrepreneurial aspects all RE technologies	Institutional	EC, COTVET/ Polytechnic/ Universities and Private operators
		• Regulate the use of only appropriately qualified personnel in RE projects and licenced entities • Provide incentives for private sector support for competency-based training in technical and entrepreneurial aspects of all RE technologies • Initiate the training process to prepare a pool of personnel for specific priority RE projects	Fiscal/ Public finance	EC, Private Sector/AGI/ GNCCI, DP
		• Encourage use of local expertise for execution of RE projects, to promote local capacity building	Regulatory/ Institutional	EC, MoP, Private Sector/AGI/ GNCCI, DP
		• Provideww incentives for gender equity in the participation, in Renewable energy services • Ensure gender balance in engaging end-users in the design and deployment of RE technologies • Build local capacity through south-south private sector partnerships for development of RE projects	Regulatory/ Institutional	EC, MoP, Private Sector/AGI/ GNCCI, DP

*AGI- Association of Ghana Industries; CBO – Community-Based Organizations; COTVET - Council for Technical and Vocational Education and Training; DP – Development Partners; EC – Energy Commission; GNCCI – Ghana National Chamber of Commerce and Industry; GIPC – Ghana Investment Promotion Centre; GRA – Ghana Revenue Authority; MoF- Ministry of Finance; MoP – Ministry of Power; Ministry of Trade and Industry; NGO – Non-governmental Organizations; PURC – Public Utility Regulatory Commission

8. Conclusion

The Government of Ghana has demonstrated its policy commitment towards renewable energy through notable actions to support its development and deployment. Key among these actions has been the establishment of the Renewable Energy Act 2011, Act 832 with the goal to scale-up Ghana's renewable energy capacity. Subsequently, some necessary regulatory and policy instruments have also been established to facilitate the implementation of the Law. Currently, private and public sector support for renewable energy is still emerging and much of it is at rather early stages of development or implementation. In spite of strong policy commitments and the establishment of regulatory frameworks, actual investments in the renewable energy sub-sector have been limited. Ghana also shows some commitment to overcome the remaining barriers needed for the accelerated growth in renewable energy development and deployment. Following the analysis of the renewable energy policy and regulatory instruments as well as national initiatives of Ghana and China, it is evident that learning lessons from successful national initiatives on renewable energy in China will be instrumental in overcoming many of these barriers. It is in this light that the national initiatives of China on renewable energy need to be carefully examined to identify some best practices that may be replicated in Ghana.

Ghana needs to consider two major lessons from the national initiatives of China that drove the growth of the renewable energy sub-sector in China under its Renewable Energy Law. These lessons are: i) Combining government's responsibility and active participation of the private sector; and ii) Combining actual demand and future development.

Combining government's responsibility and active participation of the private sector - Though the government has responsibility to encourage the development of the national renewable energy industry, the cost of developing a sustainable renewable energy capability is expected to be borne incrementally by the private sector, in collaboration with other stakeholders, particularly the financial institutions, academia, and civil society. The Chinese Government clarified its responsibility to promote the production and use of renewable energy in the Renewable Energy Law, which includes renewable energy market rules and mechanisms. At the same time, the Government has, also under the Law, instituted and implemented incentive schemes to support the private sector to undertake the actual development and deployment renewable energy technologies. These schemes include the pricing mechanisms of feed-in tariffs and competitive tendering, with the aim to offer renewable energy generators a guaranteed power price, coupled with a purchase obligation on utilities, to stimulate the development of the market. Other support schemes including subsidies and tax incentives have also made available to the private sector under the Law.

Combining actual demand and future development–Under its Renewable Energy Law, the Chinese government has on one hand, promoted renewable investments to satisfy existing energy demands, while on the other hand, balancing planning for future energy supply and demand. The overall targets that are periodically set for renewable energy generation under the 5-year Plans for Renewable Energy Development have been major drivers for the growth of the renewable energy industry in China. In spite of some challenges, efforts have also been made to promote mature renewable energy technologies to contribute towards improved energy access, whilst facilitation of R&DDD is also supported to improve existing technologies and develop new technologies.

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Appendices

Appendix 1: List of participants of the Focus Group Meetings

1.1 Research institutions, civil society and private sector

No	Name	Organization	Designation
	Thomas K. Adjei	Private Enterprise Foundation	Project Analyst
	Nicholas S. Addo Manu	Cook Clean Limited	Chief Executive Officer
	Moses Henley Duku	Partnership for Sustainable Development	Bioenergy Expert
	Victor Attuah-Asante	Tradeworks Company Ltd	Project Director
	Olivia A Atanga	Tradeworks Company Ltd	Treasury and Financial Accountant
	In attendance		
	Kwabena A. Otu-Danquah	Energy Commission	Ag. Director, Renewable Energy & Energy Efficiency
	Oforiwa Afi Dadebo	UNDP/ Energy Commission	Project Assistant
	Eric Antwi-Agyei	UNDP/ Energy Commission	Project Coordinator

1.2 Financial institutions

No	**Name**	**Organization**	**Designation**
	Florence Nyarkoa Nyame	Unibank	Relationship Manager
	Mabel Serwaa Siaw	Unibank	Relationship Manager
	Hanania Djibom	First Atlantic Bank	Relationship Manager
	Kofi Agyarko-Kwarteng	Ecobank	Risk manager
	Musa Salah	Ecobank	Group Manager/ Head, Environmental & Sustainability
	Kojo Ofori Yeboah	Fidelity bank	Brand Communication Manager
	In Attendance		
	K. A. Otu-Danquah	Energy Commission	Ag. Director, Renewable Energy & Energy Efficiency
	Eric Antwi Agyei	UNDP/ Energy Commission	Project Coordinator
	Oforiwa Afi Dadebo	UNDP/ Energy Commission	Project Assistant

1.3 Development Partners

No	Name	Organization	Designation
1	Prince Bio	Japan International Cooperation Agency (JICA)	Local Consultant
2	Seena Kitami	Embassy of Japan	Economics Researcher & Advisor
3	Emmanuel K. Sackey	Danish International Development Agency (DANIDA)	Programme Officer
4	Celia Perez	Embassy of Spain	Economic & Commercial Counsellor
5	Seth Adjei Boye	Embassy of Switzerland	Infrastructure Specialist
6	Thierno Bah	African Development Bank	Principal Energy Specialist

No	Name	Organization	Designation
	In attendance		
	Kwabena A. Otu-Danquah	Energy Commission	Ag. Director, Renewable Energy & Energy Efficiency
8	Eric Antwi-Agyei	UNDP/ Energy Commission	Project Coordinator
9	Paolo Dalla Stella	UNDP Ghana	Sustainable Development Analyst
10	Yiyang Shen	UNDP China	Consultant
11	Benjamin Noor	UNDP China	Programme Manager

1.4 Public institutions

No	Name	Organization	Designation
	Ekow Appiah Kuofie	Electricity Company of Ghana	Planning Engineer
	Seth Mahu	Ministry of Power	Deputy Director, Renewable Energy
	Wisdom A. Togobo	Ministry of Power	Director, Renewable Energy
	Frederick Ken Appiah	Energy Commission	Principal Programme Officer, Renewable Energy
	Kwabena A. Otu-Danquah	Energy Commission	Ag. Director, Renewable Energy & Energy Efficiency
	Kofi Nuhu	Ministry of Trade and Industry	Director of Manufacturing
	Samuel Sarpong	Public Utility Regulatory Commission	Executive Secretary
	Oscar Amonoo-Neizer	Public Utility Regulatory Commission	Director, Energy Department
	In Attendance		
	Ofonwa Afi Dedebo	UNDP/ Energy Commission	Project Assistant
	Eric Anfui-Agyei	UNDP/ Energy Commission	Project Coordinator
	Yiyang Shen	UNDP China	Consultant
	Benjamin Noor	UNDP China	Programme Manager

Appendix 2: List of participants of the Stakeholders' Consultations Workshop

	Name	Designation	Organisation
1	Eric Ashitey	Head Group Debt	Barclays Bank
2	Abubakar Siddique Salifu	PRO	BXC
3	Niu Tao	Third Secretary	Chinese Embassy, Ghana
4	LI Jiang	Counsellor	Chinese Embassy, Ghana
5	Kofi Ampomah-Benefo	Research Secretary	CSIR-Institute of Industrial Research
6	Kingsley Adofo Addo	Snr. Account Manager	Ecobank
7	Ekow A. Kwofie	Planning Engineer	Electricity Company of Ghana
8	Ethel Limla Mensah	EIC Manager	Energy Commission
9	Agyapong Beatrice	Intern	Energy Commission
10	Issaka Mohammed	Intern	Energy Commission
11	Dr. Nii Darko K. Asante	Technical Director	Energy Commission
12	Prosper. Amuquandoh		Energy Commission
13	Dr.Kwame Ampofo	Board Chairman of Energy Commission	Energy Commission
14	K.A.Otu-Danquah	Ag Director of Renewables and Energy Efficiency	Energy Commission
15	Julius Nyarko	Senior Programme Officer, RE	Energy Commission
16	Wisdom .A. Togobo	Director of Renewable Energy	Energy Commission
17	Carlos Yawson	National Service	Energy Commission
18	Papa Yaw Owusu Obeng	National Service	Energy Commission
19	Nana Asare	Executive Director	Energy foundation
20	Nana Asare	Director	Energy Foundation
21	Lambert Faabeluon		Environmental Protection Agency
22	KwameB. Fredua	Program Officer	Environmental Protection Agency
23	Hanania Djibom	Relationship Manager	First Atlantic Bank
24	Bernard Modey	Director, System Operations	Ghana Grid Company
25	Dr.Chris Mensah-Bonsu	Consultant	Ghana Grid Company/ MB Energy
26	Samuel Amegayibor	Executive Secretary	Ghana Real Estate Developers Association
27	Stephen Kanor Kulaya	Intern	GIZ
28	Seth Adjei Boye	Infrastructure specialist	Swiss Embassy
29	Charles Kofi Owusu	Project Officer	Kumasi Institute of Technology & Environment
30	David A.Quansah	Lecturer	KNUST
31	Isaac Kwasi Yankey	Lecturer	Koforidua Polytechnic
32	Edward Arhin	Centre for renewable energy	Kumasi Polytechnic
33	Esther Tamakloe	Intern	Ministry of Power

	Name	Designation	Organisation
34	Seth Mahu	Dep. Director, Renewable Energy	Ministry of Power
35	Gamel Nuhu Ahmed	Engineer	Ministry of Food & Agriculture
36	John Okine Yamoah		Northern Electricity Company
37	Adjei K. Thomas	Project Analyst	Private Enterprise Foundation
38	Green Martin	Transaction Advisor	Power Africa/USAID
39	Dr. M.H. Duku	Energy Expert	PSD
40	Victor Asante Atus	Plant & Project director	Tradeworks
41	Faustina Affoah	Technical Service Manager	Tradeworks
42	Edward K. Ahiabor	Manager	TTF
43	Paolo Dalla Stella	Sustainable Development Analyst	UNDP
44	Benjamin Moore	Project Manager	UNDP, China
45	Yiyang Shen	Consultant	UNDP China
46	Oforiwaa Afi Dadeso	Project Assistant	UNDP/ Energy Commission
47	Eric Kumi Antwi Agyei	Project Consultant	UNDP/Energy Commission
48	Rexford A Kissudu	Relationship Manager	Unibank Ghana
49	Esinam Gloria Darko	Student	University of Energy & Natural Resources
50	Berenice Yaawa Ocran	Student	University of Energy and Natural Resources
51	Kwame Yeboah	RE Advisor	USAID/NEXANT
52	Ebenezer Antwi	Electrical Engineer	Volta River Authority
53	Elikem Kwame Doh	Engineer	Wilkins Eng. Ltd
54	Patrick Li	Manager	ZTE Ghana
55	Reger Sh	M.D.	ZTE Ghana

(Footnotes)

[1]Savannah Accelerated Development Authority – Millennium Village Project