

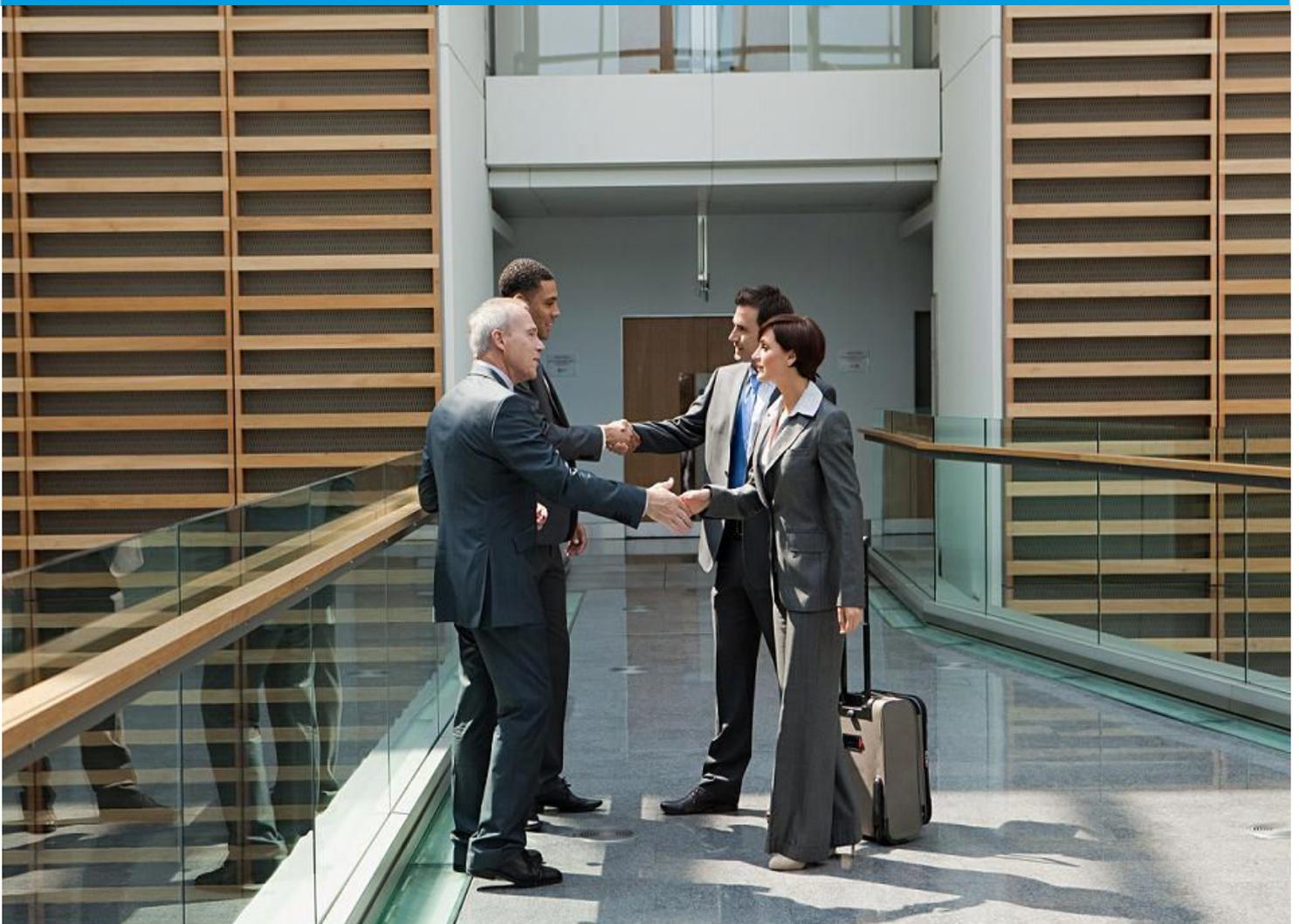


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Business Opportunities for Renewable Energy in Ghana

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Sector Report on Business Opportunities for Renewable Energy in Ghana

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With cooperation from Fred Smiet, First Secretary

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1.0 Summary

The Ghana government has created a conducive environment for business in the Renewable Energy (RE) sector by putting the following in place;

- Explicit Feed-in Tariffs (FITs) for energy generated by renewable sources
- Ghana Investment Promotion Centre, which is a one stop shop for all investment enquiries and assistance

An enabling policy environment and higher electricity/gas tariffs provide increasing opportunities for investments in renewable energy. Moreover, if designed well, such investments could benefit from subsidies provided by donors and/or climate financing instruments¹. Opportunities for investment and trade relate to hardware and software; consultancy, advisory services, project development, import, manufacturing, distribution, sales. The market exists, is growing and there is plenty of scope for new players.

When it comes to Renewable Energy investments and trade, yes, Ghana is ready for business!

If you have any specific questions or need more information on any of the areas mentioned and their prospects kindly contact the Netherlands Embassy in Ghana or the Netherlands Enterprise Agency (RVO).

¹ Such as the Green Climate Fund and Worldbank managed instruments for climate change adaptation and mitigation, which promote renewable energy, and for which Ghana is eligible. In 2016 also the Ghana Climate Innovation Centre, co-funded by the Netherlands, will become operational in assisting local companies to invest in clean energy technology (<http://www.ghanacic.org/>).

2.0 General Information: overview of relevant government plans

Ghana is eligible for most Dutch trade promotion instruments, which enhances opportunities for doing business with Ghana. Compared to the region, Ghana still offers a relatively good business climate, both economically and politically.

Economy

While the Ghanaian economy showed significant economic growth over the past decade, economic growth has slowed down recently. Peak economic growth was recorded in 2011, partially due to a competitive business environment and a fast growing private sector. The country's real GDP growth slowed down from the peak of 14% in 2011 to 9.3% in 2012, 7.3% in 2013, 4.0 % in 2014, and is expected to have dropped further to 3,5% in 2015. Ghana's GDP is \$38.6 billion (2014)² with inflation 19.0% year-on-year in January 2016. .

Governmental plans and efforts to improve investment climate

In August 2014, Ghana started talks with the International Monetary Fund (IMF) on a programme to help stabilize the macroeconomic situation. This program, worth \$918 million, was eventually concluded in April 2015. While compliance by the Ghanaian government has been broadly satisfactory, challenges persist.

The Ghanaian government has put in place incentives and policies that are geared towards attracting more investments. Some of these include Tax holidays, Locational incentives and Investment guarantees. The Ghana Investment Promotion Centre (GIPC) and Ghana Free Zones Board (GFZB) are also avenues where various degrees of assistance are provided to foreign investors. The GIPC ought to act as the first port of call for investors. The operation of the GIPC is governed by the 2013 Ghana Investment Promotion Centre Act 865 which was enacted as an instrument to show the Ghanaian government's commitment to encouraging foreign investment in its economy, including the renewable energy sector.

The GFZB on the other hand helps with licensing and permitting required by certain industries to operate in Ghana. The board was set up after the Free Zone's Act 504 was enacted in 1995. The act allows a free zone company in Ghana to be 100% foreign owned, 100% Ghanaian owned or investors can come together to form a company or a joint venture between a Ghanaian and a foreigner.

For some large commercially viable projects, counterpart funding for investment could be provided by the Ghana Infrastructure Investment Fund (GIIF). The fund which was set up by the Ghanaian government helps in mobilizing, managing and providing financial resources for investments in a diversified portfolio of infrastructure projects for national development.

² Ghana Statistical Service, Revised 2014 Annual Gross Domestic Product, June 2015 edition
[http://www.statsghana.gov.gh/docfiles/GDP/GDP2015/Annual_2014_GDP_Rev2_June_2015%20edition.pdf]

3.0 Country Energy Situation

Overview

Ghana's energy mix is comparatively simple but it is not without challenges. The country relies on biomass/charcoal (39.8% in 2014), gas and crude (plus petroleum products-46.6%), and electricity (13.6%) to meet the total energy needs of its population and industry³. Currently however, electricity demand outweighs supply thereby creating an erratic electricity distribution situation. Electricity is therefore rationed (load shedding). The potential of renewable energy is therefore huge, but has yet to be optimized.

Installed Generation Capacity and Electricity Supply

Ghana's total electricity demand in 2015 was between 14,000 GWh to 16,400 GWh⁴ while its available supply is approximately 15,000 GWh. Up until 1998, the supply of electricity in Ghana was mainly from hydropower sources with the Akosombo Dam (1020 MW installed capacity) being constructed in 1966. Since then other dams have been added. The current power generation plants in Ghana include the Bui and Kpong hydro plants with 400 MW and 160 MW installed capacities respectively (total hydro 1,580MW thus 49.9%), 330MW thermal from Takoradi Power Company (TAPCO, T1), 220MW thermal from Takoradi International Company (TICO, T2), 200MW thermal from SunonAsogli, 125MW Osagyefo Power Barge, 40MW thermal Mines Reserve Plant (MRP), 132MW thermal from Takoradi (T3), 126 and 50 MW from Tema Thermal Plant 1 and 2 respectively, and 126 MW thermal from CENIT Energy Ltd, 225 MW from Karpower barge, 5 MW from Genser Power (total thermal 1579 MW thus 49.8%). VRA's solar plant has 2.5 MW installed capacity, Noguchi solar has 0.72MW, other solar (off-grid& net-metered installations) 3.8 MW, Juabeng Oil Mill biomass has 1.2 MW (total Renewable 8.2 MW-0.3%)⁵. Hence total installed capacity in Ghana is approximately 3200 MW. Ghana's power generation trend has been influenced by rainfall conditions, mishaps and delays in construction of new plants. Ghana's Volta River Authority (VRA) runs 83% of the generation capacity while the Independent Power Producers (IPPs) share the remaining 17%. The Dutch bank FMO is involved in the financing of the expansion of thermal plants in Takoradi and Tema.

Access to electricity and Demand

According to the Ghana Shared Growth and Development Agenda (GSGDA) II (2014 to 2017), the proportion of the Ghanaian population with access to electricity increased gradually from 67% in 2010 to 72% in 2012. Ghana's current electricity penetration (2015) is at seventy-six percent (76%) as announced by the Power sector minister and it is comparatively the second highest in Sub-Saharan Africa. Demand for electricity are from households/commercial/ industries (about 80%), Mines (10%), VALCO (6%) and export (4%).

Natural Gas

Ghana's demand for natural gas is mainly to feed its ever increasing thermal plants. About 22.5 trillion standard cubic feet (tscf) of natural gas was delivered for this purpose by the West Africa Gas Pipeline (WAGP). The country is also developing its natural gas reserves to meet its needs. The Atuabo gas processing plant has been

³ Energy Commission of Ghana, National Energy Statistics (2005 to 2014), April 2015 [Available online: http://energycom.gov.gh/files/Energy%20Statistics_2015.pdf]

⁴ Electricity requirement in Ghana depends on VALCO's operations. VALCO is an aluminum company built in the 1960s. [Source: Energy Commission, 2015 Energy (Supply and Demand) Outlook for Ghana, April 2015, available at <http://www.energycom.gov.gh/files/Energy%20Outlook%20for%20Ghana%20-%202015.pdf>]

⁵ Installations as at December 2015

strategically established to process gas from the Jubilee fields and other offshore reserves to feed thermal plants and produce Liquefied Petroleum Gas (L.P.G) for households.

Crude oil and Petroleum products

Ghana currently needs between one to two million tons (annual) of crude oil for its refinery operations. The approximate petroleum product supply requirement forecast for 2015 made by the Energy Commission are Gasoline-1.2 million tons, Diesel-1.9 million tons, Kerosene-250,000 tons and L.P.G- 350,000 tons. L.P.G is mainly used by households (49% of consumption) and the transport sector, mainly taxis (44%). A majority of households who rely on L.P.G use it for cooking which means they could be a target for renewables like biogas and refined landfill gas in the future.

Biomass/Charcoal

Wood fuel and Charcoal has been a major source of domestic fuel for Ghanaians both in rural communities and in urban settings for decades. According to a report by the Forestry Commission about 70 million USD is spent on wood as a fuel source by Ghanaian annually⁶. (*Biomass is discussed further as part of Renewable energy in Chapter 4*)

Concluding remarks on the energy situation in Ghana

Energy is the lifeline of the Ghanaian economy and a shortfall in energy supply hampers economic growth. Therefore the Ghanaian government's objectives for the energy sector are; to develop Ghana's oil and gas reserves for domestic use (including for electricity generation) and for export (Togo, Benin and Burkina Faso), and to provide grid access for the whole population (National Electrification Scheme) as soon as generation capacity allows. In specific terms, the Ghanaian government aims to increase the total installed capacity of power generation plants in Ghana to 5000 MW and increase electricity penetration to 90% by 2016.

It is apparent that the generation capacity target for 2015 could not be met. However the ambitious targets set by the government have forced policy makers not to only plan for expansion of generation capacity, but also to promote alternative energy sources for an overall and balanced growth of the energy sector, based on a mix of sources, including renewables. The Government through the VRA recently signed an agreement with a Chinese firm to construct a 1.5 billion USD "clean coal to energy plant". Some analysts have argued that the same investment could have been channeled to build renewable energy plants at a lower cost especially at the wake of global climate change concerns. Nonetheless, this is an indication of the government's desperate attempt to meet its energy targets at all cost. This also indicates that there is a lot more room for renewable technology investment. Institutional reform processes to enhance efficiency and reduce costs are also underway for the main utility providers, led by the Worldbank and US government's Millennium Challenge Power Compact with Ghana⁷.

⁶ Source: Forestry Commission of Ghana,

<http://www.fcghana.org/userfiles/files/Publications/REGULATING%20CHARCOAL%20PRODUCTION%20IN%20OFF%20RESERVES%20AREAS.pdf>

⁷ The Millennium Challenge Corporation will invest approximately 500 million USD for a period of five years to support the transformation of Ghana's power sector and stimulate private investment. [Source: <https://www.mcc.gov/where-we-work/program/ghana-power-compact>]

4.0 Renewable Energy Market

In view of global efforts to reduce carbon emission and the devastating effects of climate change, the need to increase the proportion of renewable energy in every country's energy mix cannot be ignored. In Ghana, renewable energy resources that have been explored include Bio Energy (Biomass including waste-to-energy and Bio fuel), Tidal and Wave power, Solar Energy (Photo-Voltaic and Thermal), Wind Power, and Hydropower (small and large). While some have been constructed and have been added to the energy mix of the country, others have valid provisional wholesale supply licenses for the production of energy⁸. Current Dutch involvement in renewable energy initiatives in Ghana is limited, but interest is growing. Currently Philips through a PPP⁹, GIZ/ENDEV and SNV are involved now but there is room for more Dutch investment and trade.

Bio Energy

This includes biomass in the form of wood used as fuel, charcoal, agricultural waste to energy (from plantations, oil processing), palm kernel shell burnt for heating and cooking; Bio fuels (bio gas and bio diesel) and Municipal waste-to-energy.

Biomass

Charcoal made from wood, acacia plant and compressed saw dust are the preferred source of energy for cooking in rural areas and in low-income urban areas. About 40% of households use wood for cooking while about 33.7% use charcoal¹⁰. Everywhere in Ghana, but especially in the middle and the north, charcoal is produced and traded over long distances. Indeed, it has been a reliable source of energy in Ghana for decades. However, available data from the energy commission indicates that biomass is slowly losing its predominance in Ghana's energy consumption in line with the Ghanaian government's plan to reduce it. In comparison to electricity and petroleum energy sources, biomass consumption has fallen from 54% in 2005 to 43% in 2010 to the current 39.8%¹¹. This shows that slowly Ghanaians are adopting the use of other sustainable resources including LPG and biogas. Aside this, there is also great potential to use organic waste material for sustainable charcoal production in the large palm oil extraction factories. Ghana Oil Development Company, Kwae for example with 2,5 MW installed power generation capacity, use part of their waste as feedstock for their plant which powers their operations. But a large part of the agricultural waste remains unused.

Waste-to-Energy and Biogas

The organic composition of waste stream in Ghana makes the production of energy from it viable in most cases. The organic proportion of waste in Accra is more than 60 percent. This makes it viable to use digesters and advanced biomass gasification to produce biogas/syngas which can be used to power generators to produce electricity. Again, faecal matter and cow dung is also used as a feedstock for some applications. The Safi Sana project partially funded by the Ghana WASH Window adopts an approach that mixes faecal matter with organic waste. There are also

⁸ Energy Commission, Renewable Energy Licences as at 1st October 2015 [Source:

<http://energycom.gov.gh/files/Provisional-Wholesale-Supply-and-Generation-Licence-Holders.pdf>]

⁹ This concerns the SESA programme, a PPP for different countries; in Ghana Philips will develop business models for the introduction of clean cooking stoves and the sale of sustainably produced biomass (DGIS contribution for Ghana EUR 110,000).

¹⁰ 2010 Population and housing census, summary report of final results, Ghana Statistical Service, May 2012 pg18

¹¹ Energy Commission of Ghana, National Energy Statistics (2005 to 2014), April 2015 [Available online:

http://energycom.gov.gh/files/Energy%20Statistics_2015.pdf]

open dumps in Accra and elsewhere where landfill gas could be converted to usable energy forms.

Biofuel

Biofuels have not yet gained popularity as an alternative source of fuel for automobiles and industrial engines compared to conventional diesel. In the past, the Government has promoted biodiesel from the Jatropha plant with the result that many farmers opted for Jatropha instead of growing cassava and maize. This, however, proved to affect food security and farmer's income negatively and was subsequently abandoned. Nonetheless other feedstock such as water hyacinth which is abundant on some water bodies like the Volta River could be interesting.

Hydropower (small and large)

As much as four provisional licenses have been obtained by private companies intending to build small hydro power systems in Ghana. This indicates that interest is slowly developing in this sub-sector. According to Ghana's Sustainable Energy for All Action plan, there are about 22 exploitable mini-hydro sites in Ghana. The potential hydro capacities at these sites are estimated to be between 5.6 MW to 24.5 MW.¹² Up to now, the Akosombo, Kpong and Bui dams are the only plants that produce electricity to the national grid.

Wind Power

Studies by the Energy Commission of Ghana have shown that there is enough potential to generate wind energy. Data available to the Ministry of Energy of Ghana indicates that the annual average wind speed above 50m is 8m/s (a few excellent spots with 8.4 to 9.9 m/s are available)¹³. The best wind resources are found primarily along narrow stretches of Ghana's eastern coastline and on the hill tops around the Volta Lake and the border with Togo. Currently, there are about five companies who have acquired sites to establish wind farms in Ghana. One of them, Upwind Akplabnya Ltd is working on a 225 MW wind farm at Nigo Prampram in the Greater Accra region which should be completed by end of 2016 with funding from Lekela & Actors. VRA also intends to develop 100 – 150MW of Wind power in the southern part of Ghana. NEK, a Swiss company, has partnered with Accra-based Atlantic International Holding Co for developing a 50 MW project.

Solar Energy (Photo-Voltaic and Thermal)

Solar resource is abundant in Ghana. The monthly average solar irradiation is between 4.4 and 5.6 kWh/m²/day (16-20 MJ/m/day), with sunshine duration of between 1,800 and 3,000 hours per annum. However, until recently, little was done to exploit this resource and the solar market is relatively untapped, both for photovoltaic (PV) systems as well as for Solar Water Heaters. For example, solar energy for street lighting purposes have recently become accepted by the Ghanaian government and there are some projects that have taken off on the N6 (Accra –Nsawam road). A 20 MW Solar PV farm has been built at Onyadze in Gomoa East to serve communities there. There are more companies with licenses to establish solar farms in Ghana and interest in that regard is increasing slowly. VRA has built a small 2 MW solar PV grid-connected plant as a pilot project in the Upper East Region and it is seeking concessionary funding to develop another 8 MW

^{12&13} Sustainable Energy for All Action plan, Ghana pg 28, 27 [<http://energycom.gov.gh/files/SE4ALL-GHANA%20ACTION%20PLAN.pdf>]

plant¹⁴. Four other sites in the north (Kaleo, Lawra, Jirapa and Navrongo) have been identified with a potential 10MW.

Tidal and Wave power

Technologies to harvest energy from ocean waves are new to Ghana. So far only one company, TC's Energy, has expressed interest. The company acquired a construction permit in late 2013 to build its facility in Ada Foah in the Greater Accra Region. According to documents available to the Energy Commission of Ghana the 14 MW wave power facility by TC Energy using submerged surge technology is expected to be running by early 2016¹⁵.

4.1 Policy Framework for renewable energy

4.1.1 Policies and Strategies for Renewable Energy Promotion

The Government's objective is to create an enabling environment for private investments in renewable energy (RE) projects. The following are some extracts from Ghana's medium term national development policy:

- "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 provision of the Renewable Energy Act, 2011, Act 832; and providing access to waste-to-energy technologies and facilitating access to the grid for stand-alone renewable energy power plants"
- "Promote the use and design of energy efficient and renewable energy technologies in public and private buildings"
- "Facilitate the participation of independent power producers (IPPs) and other private institutions in the generation and distribution sector"
- "Accelerate the replacement of kerosene lanterns with solar lanterns"

GoG has stated that it wants to achieve 10% renewable energy in the generation mix by 2020. Other policy documents which highlight renewable energy include:

Policy/Strategic Framework	Business related issues
National Energy Policy (2010)	PPP for new plants Sector priorities, directions and goals Basis for investment opportunities
Ghana Sustainable Energy for All Action Plan (2012)	PPP orientation Renewable technology options Data on renewable resources Analysis of bottlenecks in the sector
Scaling-Up Renewable Energy Program in Ghana Investment Plan (2015) (SREP)	Implementation plans & future projects Medium term investment & Financing plan Increased use of renewables by SMEs
Strategic National Energy Plan (2006-2020)	Framework for renewables in energy mix
Energy Sector Strategy and Development plan	Framework for renewable energy development
Bioenergy Policy for Ghana, Draft (2010)	Technology options, Biofuel Feedstock, R&D

¹⁴ VRA projects [http://www.vra.com/about_us/projects.php]

¹⁵ Energy Commission, 2015 Energy (Supply and Demand) Outlook for Ghana, April 2015, pg 9 available at <http://www.energycom.gov.gh/files/Energy%20Outlook%20for%20Ghana%20-%202015.pdf> Also visit <http://www.tcenergy-gh.com/>

4.1.2 Main actors

The following are a summary of the main actors in Renewable energy in Ghana¹⁶:

Agency	Responsibilities
Ministry of Power	Oversees the energy sector. It has a Renewable & Alternative Energy Directorate. It is mandated by Renewable Energy Act 823 to develop and promote renewable energy.
Ministry of Environment, Science, Technology and Innovation	Promote the application of science and technology in all sectors
Energy Commission	Technical regulator and advisor to Government on energy matters. Issues licenses for RE business in Ghana
Public Utility Regulatory Commission (PURC)	Multi-Sectorial regulator of tariffs. It sets rates for purchase of electricity from conventional and renewable energy sources
Environmental Protection Agency (EPA)	Protecting and improving the environment and helps with the implementation of environmental policies
Volta River Authority	Power Generation
Bui Power Authority	Power Generation
Independent Power Producers (IPPs)	Power generation from various private companies on a build, own and operate basis
Ghana Grid Company (GRIDCo)	Owns and Operates the transmission network
Electricity Company of Ghana (ECG)	Distribution services within the southern zone of the country
Enclave Power Company	Distribution services within the Free Zones
Northern Electricity Distribution Company (NEDCo)	Distribution services within the Northern belt
Ghana Standards Board	Ensures compliance with standards and Certification for equipment for importation

Specific ventures such as municipal waste-to-energy, however, also require approval from the local Metropolitan, Municipal and District Assemblies.

4.1.3 The Regulatory Framework

Specific incentives are available for investments in the RE sector:

- exemption from import duty on RE equipment is currently under review (http://www.gra.gov.gh/docs/info/customs/common_ecowas_tariff.pdf) to harmonise tariffs in the ECOWAS region;
- grid code for renewable energy: development of codes and standards for solar, wind and bio- energy systems;
- guidelines for renewable energy purchase obligation and draft renewable energy Power Purchase Agreement (PPA);

¹⁶ Distinction must be made between the "Regulated Market" which allows private parties to initiate and develop RE projects as Independent Power Producers and utility-led project development. The most active utility in this field is VRA.

- regulations and procedures exist to ensure that all RE service providers are provided with licenses/permits and Power Purchase Agreements;
- clear Feed-in Tariffs (FITs) for energy generated by renewable sources;
- Renewable Energy Fund is to be established in Ghana and managed by the Energy Commission. The fund will be used to pay for the promotion and development of renewable energy sources especially those with high initial investment cost as well as to fund the feed-in tariff.

On December 7th 2015, Ghana's utility regulator (PURC) increased tariffs for electricity and water by 59.2% and 67.2% respectively to service the debt of the state-owned enterprises in the energy sector and in a renewed bid to attract competitive private investment¹⁷. The increase in electricity tariffs makes investment in renewable energy more attractive.

4.1.4 Licensing Procedures for Renewable Energy

According to the Renewable Energy Act 832, 2011, any person or organization that wishes to engage in commercial activity in the renewable energy industry must obtain a license from the Energy Commission before doing so. For production and supply of electricity, Wholesale Electricity Supply License would be granted for 20 years. For installation and maintenance, Installation and Maintenance license would be granted for 10 years. Licenses are only granted to a citizen of Ghana or a body incorporated and registered under the company code 1963 (Act 179) or under any other law of Ghana or a partnership registered under the Incorporated Private Partnership Act, 1962 (Act 152). The acquisition of License for the wholesale supply of Electricity undergoes three (3) main stages. First stage is the acquisition of provisional license, second is the acquisition of siting clearance and the acquisition of construction work permit and the third stage is the acquisition of operational license. To qualify for stage one, the applicant must submit feasibility reports and a financially sound business plan. Stage two requires environmental assessment permit to be granted by Ghana's EPA and an approved Feed-in Tariff from PURC as well as a signed Power Purchase Agreement with one of the electricity distribution utilities or a bulk customer¹⁸.

4.1.5 Feed-in-Tariff

The Public Utility Regulatory Commission in accordance with the provisions of the Renewable Energy Act 2011, Act 823 sets Renewable Energy Feed-in Tariffs (RE-FIT). The second feed-in tariff that was set by the commission was in October 2014. It had the following guidelines for the integration of renewable energy technologies such as PV and Wind:

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

¹⁷ PURC press release, approved electricity and water tariffs effective 14th December, 2015 Source: [\[http://purc.com.gh/purc/sites/default/files/press_release_2015_major_tariff_review.pdf\]](http://purc.com.gh/purc/sites/default/files/press_release_2015_major_tariff_review.pdf)

¹⁸ For more information consult the EC's Licence Manual for Renewable Energy industry available at <http://www.energycom.gov.gh/files/RE%20LICENCE%20MANUAL.pdf>

Below is the Feed-in tariff as at October 2014

Schedule		
Electricity Generated from Renewable Energy Technologies/Sources	FIT (GHP/KWh) Effective 1 st Oct. 2014	Maximum Capacity (MW)
Wind with grid stability systems	55.7369	300 MW
Wind without grid stability systems	51.4334	
Solar PV with grid stability systems/storage systems	64.4109	150 MW
Solar PV without grid stability systems/storage systems	58.3629	
Hydro ≤ 10 MW	53.6223	No limit
Hydro (10 MW $> \leq 100$ MW)	53.8884	No limit
Biomass	56.0075	No limit
Biomass (Enhanced Technology)	59.0330	No limit
Biomass (plantations as feedstock)	63.2891	No limit

Source: PURC [Note the approved rates indicated in the schedule above are based on the average interbank selling rates as of 30th September 2014 obtained from the Ghana Association of Bankers which was GHS 3.1986 to USD 1.00]

4.2 Business opportunities and potentials in Renewable Energy

4.2.1 Bioenergy

The market for biogas installations can be found mainly in small-scale applications for institutions (prisons, hotels, and schools), selected industries and communities where biogas can be used for cooking and lighting. There is no doubt that efficient use of biomass-based energy/biogas such as charcoal, agricultural waste, landfills and municipal waste as well as biodiesel from appropriate organic materials could benefit the country as a whole, while reducing carbon dioxide emissions. Despite food security concerns, there are few entrepreneurs who believe that biodiesel could be profitable but lack the support to produce commercial quantities. They are currently engaged in the production and use of biofuel on a small scale. There is considerable research supported by the Energy Commission ongoing into the development of a process to convert available biomass in Ghana to bioethanol. The following market segments provide investment opportunities relevant for small-scale interventions and SME involvement:

Electricity and lighting

- Design and installation of agricultural waste-to-energy or feed stock to energy systems for Oil Palm plantations, food/fruit processing and packaging companies-Consultancy, technology options (Anaerobic digestion), motors, components of biogas plants, Engineering, Procurement and construction (EPC) contractors;
- Biomass fired cogeneration plants for companies near biomass resources-Technology options, motors, components, consultancy, Engineering, Procurement and construction (EPC) contractors, maintenance & servicing;
- Biogas lanterns and generators for rural communities-sale of equipment and components to landlords and estate companies with biogas digesters;
- Waste water/effluent/sludge to energy by anaerobic digestion from Starch factories, brewery etc- Consultancy, Technology options, motors, components, Engineering, Procurement and construction (EPC) contractors, maintenance and servicing
- Bioethanol based technologies (generators) for electricity generation-sale of equipment;

- Extraction, Cleaning, storage and use of Landfill gas from various open dumps for energy and electricity (Clean Development Mechanism and REDD+ instruments may contribute funding)-Research, Design and testing
- Municipal Solid Waste to Energy-Design, research, testing, technology options
- Combined Faecal Sludge and Municipal Solid Waste to Energy systems-Design, research, testing, technology options

Heating and cooking

- Design and installation of technologies to convert Faecal sludge to biocoal (Charcoal) to be used by rural and peri-urban communities¹⁹
- Efficient biomass cooking stoves aimed at reducing quantities of Charcoal used
- Biomass (Charcoal, firewood) stoves that can produce energy for charging phone batteries and powering basic household appliances-Research, Design, development, testing

Transportation & Agriculture

- Farm tractors that run on biodiesel or bioethanol
- Water hyacinth harvesting from lakes and rivers to be converted to biodiesel or fuel for fishing equipment-Research, development and testing;
- Commercial plantations and tree planting schemes to be used as feed stock for various biomass conversion technologies;

4.2.2 Solar energy

The prospects for grid-connected power generation have somewhat improved because of the recent decrease in the price of solar panels and the recent increase in electricity tariffs. Rural solar power has considerable potential to serve households institutions and small industries in off-grid areas. Some companies like BXC Company Ghana Ltd have taken this up. The main solar technology applications on the Ghanaian market are rural solar home systems (especially lanterns and lighting), urban solar home systems (household appliances, lanterns), solar systems for schools and health centers, vaccine refrigeration, solar water heaters, solar water pumps, telecommunication, battery charging stations and solar streetlights. The demand for small units of 130 –190 liter boilers is rising, with or without electric booster heater. Currently a few suppliers serve this market, but potentially the market is huge and worthwhile to explore. An Indian company (Ecotech) is currently preparing an investment in an assembly plant for solar equipment for subsequent sale and distribution in Ghanaian and neighboring markets. The following market segments provide investment opportunities relevant for small-scale interventions and SME involvement:

Water heaters and Drying

- Solar water heaters and associated services; countrywide-Equipment supply, component parts, consultancy and design
- Solar Driers for food processing/Manufacturing-Technology options, equipment supply, consultancy and design

Electricity and lighting

- PV equipment for small scale domestic applications in off-grid areas: lighting with roof panels, mobile phone chargers, lanterns;
- Solar LED lighting systems to replace conventional lighting for public places, industries and households to complement energy efficiency campaigns;

¹⁹ In 2011 average annual wood production was about 30 million tons. The potential woodfuel supply is estimated at 18 million tons per annum. The rate of deforestation in Ghana is 135,000 hectares per year (equaling 2.19% % of the overall forest cover)

- PV equipment for large scale applications in public places and institutions: 0.5 – 20 MW for electricity generation (solar power plants, off-grid and on grid) and street lamps;
- PV equipment to provide electricity for isolated systems such as telecommunication masts and water pumps-Consultancy, Design, equipment, spare parts;

4.2.3 Wind Power

The opportunities in wind power are emerging with VRA taking the lead. Further, research and development are needed in this area. For Wind power, the following market segments provide investment opportunities relevant for small-scale interventions and SME involvement:

- Testing, Research and development of wind potential at various locations for governmental institutions such as Energy Commission-Consultancy, sponsored research organizations, testing equipment
- Investment and development of inland wind farms (5 MW to 150 MW) to feed into the national grid or for satellite communities/islands (estimated population of 2.9 million people) -consultancy, engineering procurement and construction, equipment, technology options and installation;
- Investment finance for entrepreneurs-Banks, Development funds

4.2.4 Hydro Power: small and large

As previously highlighted, there are about 22 exploitable mini-hydro sites in Ghana with a potential for public private partnerships. Some companies have acquired licenses on for small hydro dam construction but since none of these sites has a full feasibility available yet, and given the long lead time in constructing such plants, it is not expected that any of them could produce power before 2020. A reputable Dutch firm like Witteveen+Bos²⁰ has established a branch office in Accra, Ghana and could be help in this regard. Opportunities for investment relevant for small-scale interventions include:

- Testing, Research and development of Hydro potential at various locations for governmental institutions such as Energy Commission-Consultancy, sponsored research organizations, specialized testing and survey equipment;
- Investment and development of small hydro power (10 MW to 150 MW) to feed into the national grid or for satellite communities/islands -consultancy, engineering procurement and construction, equipment, technology options and installation;
- Investment finance for entrepreneurs-Banks, Development funds

4.2.5 Tidal and Wave power

There is little or no information on Tidal and Wave power potential available for decision making and this presents a good opportunity to research institutions. Currently, TC Energy has taken the lead to start investment in Tidal and wave power using submerged surge technology. The feasibility of other technology options could be tested. Opportunities for investment include:

- Testing, Research and development of tidal and wave power (10 MW to 150 MW) to feed into the national grid or for satellite communities/islands, consultancy, engineering procurement and construction, equipment, technology options and installation;

²⁰ Witteveen+Bos Consulting Engineers [<http://www.witteveenbos.com/?rd=0>]

5.0 Market Risks and Challenges

5.1 Market Risks

Insufficient and unreliable RE resource data

There is insufficient data on renewable energy sources available in Ghana. Even with those that are currently available, there are doubts on their reliability for investment decision making. To overcome this risk, the Ghanaian government will be engaging consultants to provide more site specific technical data on renewable energy resources. The government will then make available this information available to developers.

Crude oil prices and RE investments

Electricity from Thermal Energy plants has become more economical and more financially feasible currently with the price of crude at low prices. Ghana has about 50% of its generation plants being thermal which rely on crude and natural gas. If crude oil/natural gas prices continue to drop, it would affect RE development in Ghana because more thermal technologies may be bankable in Ghana. The expected onset of oil production from the Tweneboa-Enyera-Ntomme (TEN) Project in July or August 2016 could further contribute to this.

Power from national grid

Since many households anticipate getting power from the grid in the short term, there is a reluctance to invest in PV systems and in fact other renewables. Even those who can afford these systems for reliable power supply are leaning on governmental promise of sufficient supply of electricity and nationwide coverage in the short to medium term. The reality is that the government is currently 'cash trapped' therefore grid expansion is now much slower than previously planned.

Subsidies from Government that makes RE unprofitable

Rural renewable energy power supply (for example using solar) has considerable potential to serve households institutions and small industries in off-grid areas. However, households that connect to the national grid receive significant subsidies on every connection. A more cost-effective subsidy policy for rural electrification should include mini-grids and household systems for customers who are not served by the grid in the short or medium term. This would reduce the strain on the power utilities' finances, and also provide quick service to off-grid areas.

5.2 Challenges

The following institutional and economic challenges are applicable to the renewable energy industry in Ghana:

- Although a license has been provided for one tidal and wave power company in 2013, there is still no feed-in tariff specifically for tidal and wave power to electricity;
- Decentralized RE technologies have competitive advantages over grid systems in satellite communities and islands. However, these communities have a poor understanding of the advantages it offers and often request for grid connection;
- Although Ghana has recently instituted some energy efficiency policy measures, such as promotion of CFLs and LED lights, the efficiency agenda is currently not well developed in terms of policy, technology, marketing, equipment, neither for institutions, nor for industries and households;
- Financing terms and conditions currently available in Ghana make funding renewable energy investments challenging.

6.0 Relevant Contacts and Business References

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List of selected organizations, companies and Associations in RE:

Name	Category	Contact	Website
Energy Commission	Licensing	Ghana Airways Ave, Accra Tel: +233302813756 E: info@energycom.gov.gh	http://www.energycom.gov.gh/index.php/contacts
Public Utility Regulatory Commission (PURC)	Regulation and tariffs	53 liberation road, Africa liberation circle, Accra Ghana Tel: +233302244180 E: info@purcghana.com	http://www.purc.com.gh/
NEK Ghana	Wind Energy	Asylum Down, Accra Tel: +233 30 2228214 E: wuddah-martey@atlantic.com.gh	http://www.nek.ch/
Small hydro Development company Ltd	Small Hydro	No. 11 Saflo Street, Abelenkpe, Accra Tel: +233244636563 E: info@shdcl.com	http://www.shdcl.com/
Ghana Oil Palm Development Company Limited	Biomass to energy	GOPDC Kwae Estate near Kade, Eastern-Region Ghana Tel: +233 (0)24 4330090 E: mdsec.gopdc@siat-group.com	http://www.gopdc-ltd.com/
TC's Energy	Tidal and Wave	Dzorwulu, Dideibaa, Ave. 107. Accra Tel : +233342290936 E: info@tcenergy-gh.com	http://www.tcenergy-gh.com/
Persistent Energy Partners	Rural Solar, off-grid applications	Albert Boateng, 1A Silver Star Tower Airport City, Accra Tel: +233 302 776 507 E: info@peg-ghana.com	http://www.peg-ghana.com/#peg-ghana
Ghana Investment Promotion Centre	Investment	The Oval Road, Accra Tel: +233 (0) 302 665 125 E: ebadger@gipc.com	http://www.gipcghana.com/
Ghana Netherlands Business & Culture Council	Business & Investment	PMB 117, Madina, Accra Tel: +233 (0) 302 76 78 25 E: info@gnbcc.net	http://www.gnbcc.net/

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