GCIC Market Analytics
Industry Report Brief

Energy Efficiency

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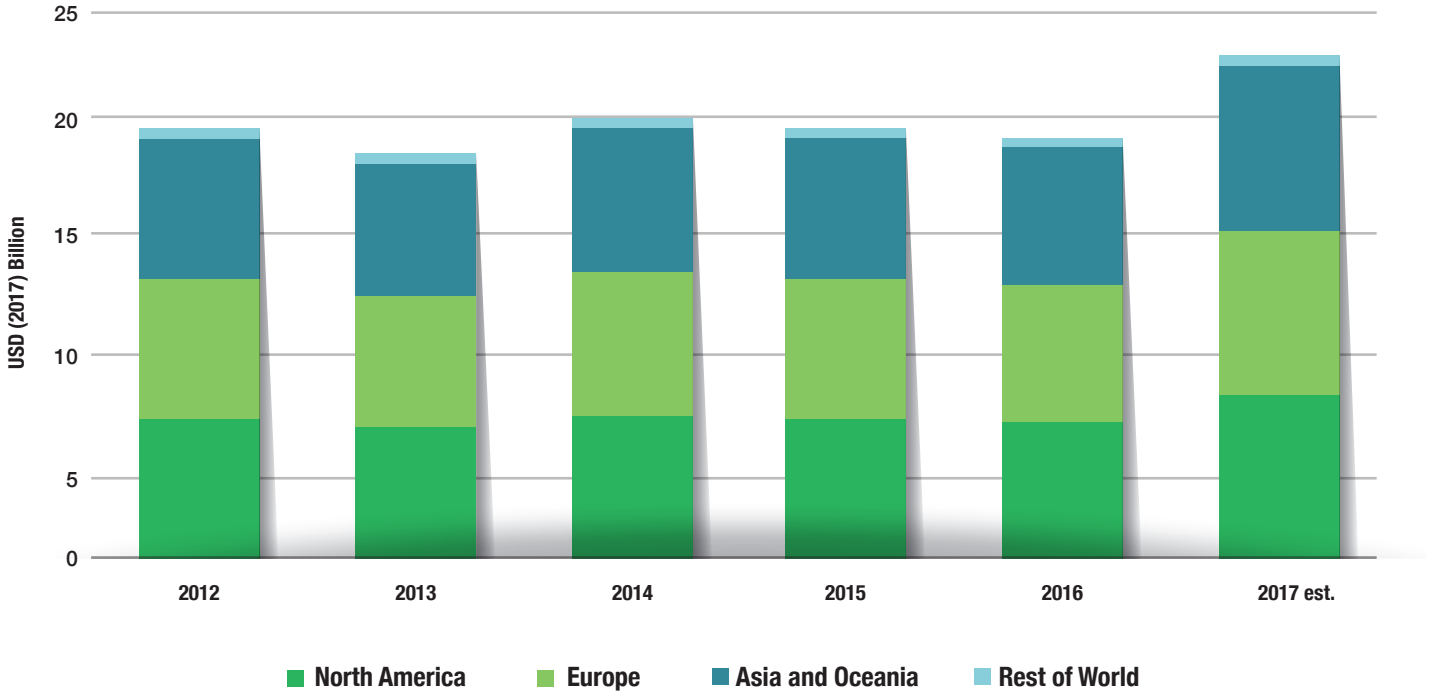
Contents

Global Outlook of Industry

According to the International Energy Agency (IEA), energy efficiency describes efforts, initiatives, and technologies to reduce the amount of energy required to provide services and build products (Hebden, 2006; Kok, Lo, Peters, & Ruiter, 2011). The sector, valued at over US $310 billion, has received tremendous investments and support from governments, and is the largest contributor to energy services in IEA countries (United Nations Economic Commission for Europe, 2015). This is reflective of governments' commitment to reducing carbon emissions and ratifying multilateral agreements, like the 2015 Paris Accord. In addition to enacting policies around energy efficiency standards, these governments have also increased spending on research, development and deployment (RD&D) of energy efficient practices (International Energy Agency, 2017).

Figure 1: Public spending on energy RD&D



Source: (International Energy Agency, 2017)

Private companies and venture capital firms have also increased investments in the sector, in an effort to reduce their carbon footprint - and this has subsequently impacted industries such as power generation, construction and transportation (Beder, 2000). These investments have resulted in more energy efficient products being manufactured and promoted globally (United Nations Economic Commission for Europe, 2015; Yau, 2010).

Despite the numerous policies, efforts and improvements, the industry, however, showed signs of slowed growth in 2017. This was due to weakened energy efficiency policy coverage and stringency, as well as lower energy costs (International Energy Agency, 2017)

Industry in Ghana

The erratic supply of power, coupled with the increasing demand of energy in Ghana, with a penetration rate of about 82.5% according to the Ministry of Power (2016), which makes it imperative for the exploration into alternative sustainable, renewable and energy efficient technologies to address the energy demands (Kumi, 2017). The World Bank ranked electricity as the second most important constraint to business activities in the country and estimated that Ghana lost about 1.8 percent of GDP during the 2007 power crisis (Mathrani, et al., 2013).

Despite the efforts to introduce renewable energy sources into the electricity generation mix, it has contributed only 0.2 percent to the power generation mix as of the year 2016. A 2.5 MW solar plant owned and operated by the Volta River Authority in Navrongo used to be the major solar plant contributing to the national grid, but the completion of a 20 MW solar plant owned by BXC Ghana has helped boost the contribution of renewable energy source. Other renewable sources include a 100-kW biogas electricity connected to the national grid in 2016, and a 500 kW of installed solar PV systems owned by institutions and individuals. The following figure gives a snap view of the electricity generation mix in Ghana.

The Institute of Statistical, Social and Economic Research (ISSER) at the University of Ghana estimated in a 2014 study that Ghana, on the average, lost production worth about US $2.1 million per day (or, US $55.8 million per month) through the power crisis alone (ISSER, 2015). Government's initial response to the energy crisis in Ghana was the building of new power generation plants which involved huge capital investment. However, the Energy Commission since 2007 has adopted policies and energy efficient strategies to decrease aggregate energy utilization thereby providing energy to cater for increased demands. The government considers energy efficiency as the low hanging fruit in protecting the energy resources available in Ghana, as it's cheaper to conserve than build capital intensive energy generation units (Ministry of Power, 2015). The Economic Community of West African States (ECOWAS) Commission developed the ECOWAS Energy Efficiency Policy (EEEP) which includes targets, measures, standards and incentives for energy efficiency (EE), to be implemented at both regional and national levels (Ministry of Power, 2015). Ghana's ratification of the policy has led to the creation of the National Energy Efficiency Action Plan in Ghana spanning from 2015 to 2020.

In 2007, the government of Ghana on the advice of the Energy Commission procured and distributed six million Compact Fluorescent Lamps for free as direct replacement of six million incandescent lamps as a load reduction measure to reduce impact of power shortages in Ghana. Ghana is the first country in Africa to take such action. The review indicates that EE measures carried out especially in the replacement of incandescent lamp with compact fluorescent light (CFL) made significant savings that offset the national electricity peak demand by 200–240 MW (Kumi, 2017) with an annual savings of US $33 million (Ministry of Power, 2015).

The Energy Commission in partnership with the Ghana Standards Authority (GSA) rolled out standard labelling for electrical appliances and enacted the law LI1815 which makes it an offence to import, display for sale or sell Air Conditioners, Refrigerators and Compact Fluorescent Lamps in Ghana unless they meet the minimum performance standards and are properly labelled. Labels, after a decade of its implementation, have become a feature that contribute to consumer choices for electrical appliances with the number of stars representing how efficient the device is. With energy consumers experiencing tangible decreases in energy expenditure with the purchase of energy efficient appliances, purchasing of labelled appliances has, over time, become a lifestyle.

Nationally, the import of electricity decreased from 864 GWh in 2000 to 27 GWh in 2013. This decline is due to Ghana's energy

efficiency and conservation policy that discontinued, through legislation on standardization and labelling, the local production, importation, and use of inefficient electricity consuming equipment and appliances (Asumadu-Sarkodie & Owusu, 2016). The Energy Commission through its refrigerator turn-in and rebate scheme in partnership with UNDP saw 7,257 old refrigerators replaced with efficient ones, and intercepted 25,000 old refrigerators at Ghanaian ports saved the country 400GW of energy (Energy Commission, 2016) showing significant successes with energy efficiency measures.

With success chalked in the implementation of standards and efficiency labelling for air conditioners, refrigerators and CFLs, the Commission and GSA ventured into the development of energy efficiency standards for buildings and other electrical appliances in Ghana. The rapid expansion of the real estate sector and construction of high rise buildings across the country has required the scrutiny of building standards and eradication of building materials that create inefficient use of energy in buildings across the country. In 2016, according to Kofi Agyarko, the Energy Commission initiated a baseline study towards the review of the Building Code for developers of public buildings to utilise standard energy efficiency architecture and materials to conserve energy (Energy Commission, 2016).

In October 2018, The Ghana Building Code, GS1207, was launched to regulate the construction industry and promote green and energy efficient architecture in Ghana. The code presents seven energy efficiency recommendations mandatory for private buildings above 5,000m2 total gross floor area throughout Ghana and public buildings located in all regional capitals that are above 500m2 in total gross floor area during the first 3 years of its operation (Ghana Green Building Council, 2018). The operational code will be supervised by the Ministry of Water Resources, Works and Housing (MWRWH), Ghana Green Building Council and the EC. These regulatory bodies will ensure the certification of buildings. The Ghana Standards Authority, in 2018, upgraded existing standards and adopted new ones for the following products: refrigerators, air conditioners, ceiling fans and regulators, television sets, satellite decoders and TV signal boxes, and lighting (i.e. domestic/commercial lighting/ street lighting). The industry has been largely public sector-led with the private sector especially appliance manufacturers like Samsung, Philips, Bosch etc. adjusting to changes in standards, policies and regulatory frameworks.

The implementation of energy efficient strategies across the country, particularly the use of efficient domestic appliances is, however, bedevilled by corruption with importers of inappropriate electrical appliances circumventing inspection at the ports under the guise of diplomatic cargo, hence providing consumers' access to inefficient appliances across the country. In addition, industries have been slow at adopting energy efficient production methods to reduce energy consumption. For example, the equipment replacement scheme for industries established in 2012-2013 saw an abysmal uptake due to little interest from industrial operators and limited funding for implementing partners. Ackah (2017) reveals that energy consumption by rural SMEs is not efficient citing the concentration of the Energy Commission and Energy Foundation's education in the urban areas making the lack of education on energy efficiency a main factor for the inefficient use of energy in rural Ghana. Quite simply, there is a need to expand educational efforts to rural parts of the country.

Although challenges persist in the implementation of energy efficiency measures, the government, Energy Commission, GSA and Energy Foundation are not relenting in their efforts to promote and fund energy efficient schemes to reduce energy consumption nationally and have set energy efficiency targets for 2020. The government is encouraging the use of improved and fuel efficient cookstoves which have been introduced in the Ghanaian market for households, institutions and fish smoking businesses. The national plan is to introduce two million improved clean cookstoves onto the Ghanaian market by 2020 (Ministry of Power, 2015). The Energy Commission, once funded, will expand its "refrigerator turn-in and rebate" scheme to other domestic devices like air conditioners, washing machines and electric

heaters to replace inefficient appliances with efficient models.

By the year 2020, the GSA will standardize and label other identified appliances such as solar systems, batteries, power convertors, motors, transformers, water heaters and washing machines, other appliances yet to be identified may be brought under standardization and labelling beyond 2020 (Ministry of Power, 2015).

Global Industry Innovations

Traffic Energy Systems - Green Kinetic Power (GKP), LLC.

Green Kinetic Power (GKP) is a Puerto Rican based company that created the Traffic Energy Bar System (TEBS). TEBS is a patented technology that captures kinetic energy from the weight of moving vehicular traffic and converts it into electrical energy. The electricity is produced by electromagnetic generators that can be interconnected and synchronized in a scalable manner to generate large-scale clean energy. The mechanism is installed in the roads and is activated when a vehicle travels over the unit (Energy Vulture, n.d.).

The Traffic Energy Bar System has one 5kW generator per TEBS unit. 20 TEB unit can generate 90 kW per day and 23,400 Kw per year, with about 22,000 vehicles moving across the technology. 20 tabs can take about 2000, 45W LED public luminaries off grid, and this combined would help avoid the generation of about 12 metric tons of carbon (di) oxide per year.

The product is still in development to increase its efficiency. Since the technology is still in the developmental and testing stages, there is not visible traction for companies developing and installing the technology. It is therefore not ready for commercial uptake in Ghana.

Alcohol Cookstove - Project Gaia

Project Gaia Energy Revolution are the leading experts worldwide in alcohol fuels and stoves for household cooking. They maintain a brain trust of the leading alcohol fuel producers and micro-distillery providers that regularly provide input for partners' projects. They partner with local businesses to jumpstart alcohol-based cooking solutions. They have it as a mission to establish and promote alcohol fuels for household energy among economically disadvantage individuals and in less developed regions with limited access to other sources of energy (Project Gaia, n.d.-b).

Alcohol cookstoves use ethanol and methanol as their main source of fuel. It burns cleanly and emits extremely low levels of carbon monoxide, volatile organic compounds (VOCs) and black carbon (a potent short-lived climate pollutant).

Project Gaia has promoted the adoption of cookstoves around the world, mostly in conjunction with the production of ethanol and methanol. Ethiopia, Haiti, Nigeria, Mozambique, Brazil, Madagascar and Kenya are some of the places where the alcohol cookstove has been promoted by the company. Data gathered from their website suggests a massive uptake of the technology in the respective countries, for which even in some countries it has sparked an increase in production of ethanol and methanol. For instance, with the success of Gaia's studies and projects, the Ethiopian Government has made ethanol for cookstoves a

priority. The National Biofuels Policy promotes ethanol both for stoves and for blending with gasoline as a transport fuel (Project Gaia, n.d.-a).

Even though the cookstoves are not prohibitively expensive (US $25 or GHS 123) the fuels they require (ethanol and methanol) are not manufactured or readily available in the country (except through imports). The industry in Ghana is currently able to produce only 96% grade alcohols (which falls short of the 99% grade required for the stove), and thus the price of the imported fuel would impact the cost of using the stoves.

Rice Husk for Power - Husk Power Stations

Husk Power Station is a leading rural distributed utility company that operates mini-grids in Asia and Africa. These mini-grids are a hybrid system which consists of synchronizing solar Solar Photovoltaic's (PVs), biomass gasification (with rice husks) and batteries to generate electricity. The rice husks are either burned to generate electricity or chemically gasified to produce gaseous fuel for electricity generation.

In Africa, Husk Power has begun operations in Tanzania, with 250 customers on five mini-grids, but the company has a potential market for 800,000 customers on 2500 mini-grids. In India, the company has 12,000 customers on 75 mini-grids, but a potential market for 16 million customers on 40,000 mini-grids. This technology can be successfully integrated into Ghana's electricity infrastructure, increasing access to electricity, especially in low-income and rural areas.

Summary and Conclusion

- Energy penetration rate has increased to 82.5% increasing demand.
- The government recognises energy efficiency measures as a cheaper option to the construction of capital intensive energy generation plants.
- The government has enacted policies which provide a good regulatory framework for the promotion of energy efficient technologies.
- Innovations like alcohol cookstoves from Project Gaia might not be appropriate for the Ghanaian market due to the high cost of alcohol (fuel) as a result of its importation.
- Rice Husk Power Stations presents a viable option for increasing renewable energy options in rural and low-income areas in Ghana and should be pursued.

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Annex 1: List of Innovations – National and Global

Innovation Description	Sub Sector	Type of Technology	Name of Business	Country	Links (Business, Sample Product)
Manufacturing alternative fuel like pellets, briquettes from waste resources or biomass which burns more efficiently	Alternative Energy	Pellets Briquettes	Polytechnik Biomass Energy JSK Renewable Energy Abellon CleanEnergy (Based in India branch in Ghana)	Ghana India	,https://biomass.polytechnik.com/en/ http://cleancookstoves.org/partners/item/999/3032 http://www.abelloncleanenergy.com/
Electricity Power Saver: A technology that saves about 40% of electricity consumption. It also stabilises flow of current thus helping protect electric gadgets	Energy Savings		Tryshapatricia Ltd	Ghana	http://tryshapatricia.com
Acess to finance for solar power products	Financial Inclusion and Energy	Solar	PEG Africa	Ghana	https://www.pegafrica.com/the-gift-of-light/
Body Heat: Harnessing body heat to generate electricity (Research)	Renewable Energy	Body Heat	North Carolina University	United States of America	https://www.designnews.com/medical/device-turns-body-heat-energy-power-wearables/186492468147005

Traffic Energy Bar system: a system that makes use of busy roads to generate energy for use elsewhere	Renewable Energy	Kinetic Energy	TEBS	France	https://www.linkedin.com/company/traffic-energy-bar-system/about/ https://www.facebook.com/pages/category/Energy-Company/TEBS-Traffic-Energy-Bar-System-728637007205689/ https://antrocket.com/
Wind Pumps: Devices that use wind energy to lift water from underground	Renewable Energy	Wind	Abswind Vinz Power	India	http://www.abswind.com/
Bioser: Combustion of carbon dioxide to produce hydrogen (research)	Renewable Energy	Recycling technology	Norwegian University of Science and Technology (NTNU)	Norway	https://www.ife.no/en/ife/departments/environmental_technology/projects/bioser-sustainable-hydrogen-production-from-biogas-using-sorption-enhanced-reforming-2012-2015
Fuel Cell: A technology that allows vehicles to run on hydrogen and oxygen releasing heat and water as emissions	Clean Energy	Energy Conversion	Nuvera	Italy	https://www.nuvera.com
Tidal turbines: Harness energy from movement of tides	Renewable Energy	Tidal	Ocean Renewable Power Company	USA	http://www.orpc.co/

Plancha cookstoves: are specialized stoves designed for areas of the world where a hot flat surface is required to prepare meals. The plancha cookstove is designed to enclose a fire and to exhaust the particulate matter and toxic vapours from combustion outdoors via a chimney.	Cookstove	Solar	Environfit International	USA	http://envirofit.org/tag/plancha-cookstove/
Panel solar cooker: Panel cookers are the least expensive and most portable design. They work like ovens. The cookers can heat a cooking pot to temperatures between 250 to 300F (121-177C). Panel cookers use reflective foil that is attached to a backing made of plastic, metal, wood or cardboard. The backing is folded into a clamshell shape to collect sunlight.	Cookstove	Solar	Rudrasolarenergy	India	https://www.rudrasolarenergy.com/solar-cookers.html

Box solar cooker: Work on the same principle as panel cookers. They are bigger and less portable than panel cookers and can be made with cardboard, wood, metal or plastic. Larger models can hold several cooking pots	Cookstove	Solar	GoSun	USA	https://www.gosun.co
Alcohol cookstoves: uses ethanol and methanol which burn cleanly and emit extremely low levels of carbon monoxide, volatile organic compounds (VOCs) and black carbon (a potent short-lived climate pollutant).	Cookstove	Alcohol	Project Gaia	USA	https://projectgaia.com/
Agricultural waste fuel Cookstoves: uses fuel manufactured from agricultural waste	Cookstove	Agricultural waste fuel	Emerging Cooking Solutions Vitalite	Zambia	http://www.emerging.se/ https://www.vitalitegroup.com/

Mobiliteam: an air booster that reduces the energy consumption of electric vehicles by improving the efficiency of air conditioning systems, whilst having no effect on the passenger's comfort	Energy conservation	Air booster	Mobiliteam	India	http://www.mobiliteam.in
CreChar: Material made from waste paper cups and other low-value paper waste designed to stimulate biological activity in order to enhance biogas production or improve plant growth	Energy production	Biogas	Carbogenics	United Kingdom	https://www.crechar.com/
Real Time Adaptive Control System for Wind Turbines: algorithms to optimise end to end performance of wind turbines, while operating in real time, in order to account for local site and operating conditions	Renewable energy	Wind energy	Power Enable Solutions	United Kingdom	https://power-enable.eng.ed.ac.uk/
Rice husk power stations	Renewable energy production	Rice husk	Husk Power Systems	India	http://www.huskpowersystems.com/

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