Renewable Energy for Sustainable Development: An Assessment of Solar Energy Adoption among SMEs in the City of Accra, Ghana

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Abstract

Energy demand continues to drive sustainable development in all countries of the world. As Ghana is accelerating her transition to a low carbon economy, this paper aims to investigate the nature, opportunities and challenges of the solar energy market in the City of Accra. This paper used a qualitative inquiry approach to investigate the solar energy market development in Accra. The Ghana Government's policy framework for achieving sustainable energy in the country as well as the emerging opportunities and barriers relating to market development of this energy sub-sector in Accra are analysed. The paper found that inadequate institutional and service-provider's financial support, after-sales technical support, limited consumer credit facilities, a dearth of public education and general awareness among the public about solar energy technology remain important barriers to solar energy development in Accra. In addition, the Net Metering policy dissonance constitutes a critical barrier to solar energy transition and market development in the city. In conclusion, government programming and increasing industrial sector participation will provide a vital catalyst for the development of the solar energy sub-sector and market in Accra.

Keywords: Adoption; barriers; renewable energy; solar; sustainable development

INTRODUCTION

Energy is probably one of the most globally discussed development challenges in recent times. A number of studies have suggested a close relationship between energy and sustainable development (Hoogwijk, 2004; International Energy Agency, 2015; World Health Organization, 2016). Although energy has been touted as one of the indispensable drivers of sustainable development, about 1.4 billion people still have no access to it. Twenty two per cent (22%) of this population is living in developing countries and a chunk of this proportion is in Sub-Saharan Africa (SSA) (International Energy Agency, 2015). However, in recent years, the environmental impacts of energy production have become important in the sustainable development discourse (Jianzhong et al., 2018).

The energy sector in SSA is currently facing numerous challenges such as unreliability of supply and insecurity. The region currently has the lowest electricity generation capacity in the world and experiences the most acute forms of energy poverty. Approximately 630 million people live without reliable access to electricity and 790 million people are forced to rely on solid biomass to cook food and heat their homes (Catellano et al., 2015). The unsustainable energy trend will likely exacerbate because of the projected rapid increase in population growth, growing urbanization and expanding economic activities (Sovacool, 2012).

Renewable energy sources such as solar energy continue to play a critical role in the delivery of sustainable and clean energy solutions for the populations of developing countries (Hoogwijk, 2004). Despite the potential of solar energy to contribute significantly to well-being in developing countries, it continues to be constrained by a number of challenges (Sawin, 2004; UNDP, 2004; IEA, 2017). The solar energy sub-sector has not been able to reach its full potential due to barriers in market penetration, growth and development across most economies in the world (Painuly, 2001).

However, the growing and unsustainable exploitation of conventional energy sources such as crude oil, coal, hydro, natural gas, and the accompanying concerns for environmental sustainability in developing countries lend support for the development of solar energy (Dincer, 2000). Renewable energy sources such as solar holds enormous potential for abating the growing impacts of climate change. A study conducted by Deichmann et al. (2011) argued that solar energy is the best renewable option for Africa, because it is naturally decentralized resource, available in large supply, falling initial costs of solar energy utilities as the technology advances, and its immunity from supply or price volatilities. Sub-Saharan Africa (SSA) is richly endowed with solar energy resources suitable for photovoltaic solar systems and solar thermal facilities; most of the region has average annual Direct Normal Irradiance (DNI) greater than or equal to 5kWh/m2/day, the critical minimum required for an efficient provisioning of power from solar facilities (Boyle, 2004). This reported daily threshold of solar irradiation presents ample opportunity for the development of solar energy infrastructure.

One important megatrend driving energy insecurity across SSA is the region's changing demographics, as well as the region's vulnerability to climate change (Cervigni *et al.*, 2015). In many parts of the region, several pockets of urban populations continue to remain underserved by inefficient and unreliable power systems (Deichmann et al., 2011). This problem of widespread urban energy and power underservice remains a major challenge for SSA countries like Ghana. One striking feature of the changing demographics is the region's current explosive and rapid pace of urbanization (UN, 2014). In the last few decades, Africa has experienced an incredibly fast pace of urbanization (Jiang and O'Neill, 2017). Reports estimate that the continent's current 1.1 billion people will double by 2050—and more than 80 % of that increase will occur in cities (Muggah and Kilcullen, 2016). This presents a dire need for a sustainable for energy infrastructure.

Unfortunately, the slow pace of diffusion of solar energy technologies is widespread across many parts of SSA despite the prevailing market opportunity, characterized by urbanization and population growth. Moreover, renewable energy development presents a critical frontier for climate action. But the adoption of market-based solutions to the climate change challenge remains a largely untapped research frontier. According to Ndzibah (2010), Ghanaians consider solar as the most viable energy alternative. However, one of the underlying reasons for the slow-paced development of solar

energy is its capital-intensive nature; most costs are incurred upfront, unlike non-renewable sources where costs are spread over time, although operational costs are low (Larbodenna *et al.*, 2017). Despite remarkable promotion and commitment from various nations, only a small percentage of energy is generated from renewable energy such as solar, especially in developing countries. This scenario is because of the numerous barriers that control the diffusion of renewable energy. These barriers prevent renewable energy from effectively competing with traditional energy and hamper achievement of the necessary large-scale deployment (Nasirov et al., 2015).

In Ghana, there is a strong case for developing a robust market for the solar energy industry. For example, over the past two decades, the electricity sector in the country has experienced several challenges, including inadequate supply of power as a result of low inflows into the reservoirs of the Akosombo Hydroelectric Dam and inadequate alternative generation capacity (Ghana Energy Commission, 2004). More recently, the country's energy supply experienced severe crises leading to load shedding and cyclic power outages with disproportionate impacts on urban centres such as Accra, Kumasi, and Tema (Kumi, 2017). These recurrent energy supply crises have negatively impacted economic growth in the country. Available economic data show that electricity supply crises pose the second most important constraint to business development in Ghana. The country lost about 1.8 percent of its Gross Domestic Product (GDP) during the 2007 power crisis (World Bank, 2011).

Okoye et al. (2016) observed that solar energy is economically and technically viable in three major cities in Nigeria and recommend research to generate relevant data to understand solar energy markets in urban hubs of the country. However, in the context of Ghana, much of the research underpinning the solar energy industry is largely focused on rural development—with scant research output on solar energy development in urban areas. Renewable energy is key to the development of Ghana's power sector especially for the replacement of fossil fuels, which have become much a talk globally for contributing to climate change. Unfortunately, Ghana has seen little development and deployment in the renewable energy sector mainly due to the numerous challenges/obstacles hindering the growth of the sector. According to Ghana's Renewable Energy Master Plan, although the Government of Ghana has demonstrated strong policy commitments towards the development and promotion of renewable energy, investment in the renewable energy sector has been limited due to various factors including the challenging investment climate, limited technological capacity, insufficient experience in renewable energy development and human and socio-cultural challenges. There still remains an insufficient adoption of solar energy infrastructure in urban areas, where the majority of Ghana's population resides (Energy Commission, 2018). Obeng-Darko (2018) revealed that the key bottleneck that is hindering Ghana from achieving its sustainable energy target critically revolves around policy, legal and regulatory dimensions of the market. Since Ghana has adopted a low carbon development approach, this paper analyses the solar energy regulatory framework, opportunities for private sector and barriers underlying the solar energy market development in the country.

ENERGY AND SUSTAINABLE DEVELOPMENT NEXUS

Globally, energy demand and its associated services continue to drive social and economic development, and ultimately improve human development and wellbeing (Edenhofer *et al.*, 2011). Energy services is a critical facet of every country on which other development aspirations hinges. Lipton and Ravalion (1995) suggest a close relationship between paucity of energy services and indicators of poverty, including illiteracy, life expectancy, and infant mortality, among others (World Health Organization, 2016). Harnessing the potential of the Earth's solar energy for electricity generation is not only pivotal to poverty alleviation and economic development but a smart and cost-effective alternative for climate mitigation and a low-carbon future economy (Creutzig *et al.*, 2017). Solar energy provides people disconnected from the global economy and without access to power grids the opportunity to light their homes and businesses in places where grid power can either be extremely expensive or unreliable (International Trade Forum [ITF], 2011). The Global Green Growth Institute (GGGI) reveals that urban

infrastructure is one of the most critical pathways/sectors in reducing global GHGs emissions. The reason is that they account for about a third of the world's energy use. This reinforces the need to understand solar energy markets in cities.

Urbanization and Ghana's Energy Realities

Since Independence in 1957, Ghana's electricity supply has been driven primarily by the county's hitherto abundant hydropower resources (Gyamfi, Modjinou, and Djordjevic, 2015). Currently, the UN estimates that Ghana's total population is about 30 million, of which about 54 % is urban (UN World Population Prospects, 2017). This rapid growth of the population has significantly affected the ability of the country's hydro-resources to meet the growing energy demands of the country. A review by Miesher (2017) reveals that in recent times, nearly three decades after the inauguration of the Akosombo Dam, the facility struggles to supply less than 50 % of the nation's power needs. This is perhaps underpinned by the colossal increase in urban population and the concomitant industrialization processes in the country. Over the last decade, Ghana has continually experienced several power infrastructure failures, including incessant repetitive power outages in 1983, 1998, 2006/2007, and most recently during 2015/2016 (Eshun and Amoko-Tuffour, 2017). Theses outages occurred despite the fact the installed electricity generation capacity has more than doubled within the last decade (Kumi, 2017). Unfortunately, much of the installed power generation capacity has been contingent on external foreign investment in fossil fuel-based infrastructure, at the expense of harnessing the existing renewable resources, including solar energy which has a huge potential in the country (Energy Commission, 2018).

Business Opportunities for Solar Energy Development in Ghana

Solar energy is one of the most important renewable energy options for Africa because the primary resource (solar irradiation) is naturally decentralized, available in colossal supply, increasingly dwindling costs of the technology, insulation from international price uncertainties and its qualification to receive significant funding support from multilateral agencies (Deichmann *et al.*, 2011). Therefore, developing, harnessing, and utilizing this resource present a critical business opportunity which can boost productivity in several sectors of the Ghanaian economy and contribute significantly to reducing the fuel import deficits of the country (Mensah, Boahen, and Amoabeng, 2017). The energy sector presents investment opportunities for private sector firms in Ghana especially solar energy. A study by Ahenkan (2020) identified investment opportunities in the renewal energy sector in Ghana.

Barriers to Solar Energy Development

Over the years, the global renewable energy sector (including in Ghana) continues to be inundated with numerous challenges, including costs and the general lack of awareness of the importance of renewable technologies like solar (Kochtcheeva, 2016). Some of these barriers have implications on social acceptability and cultural integration of these technologies in some places, especially in developing countries such as Ghana. The human dimensions of these technologies have continually come under public scrutiny. Literature indicates that progressive societal choices to leapfrog traditional energy sources to alternative energy sources have depended on the availability of land resources (Pimentel et al., 1994). This competition for resources between land and energy has introduced a new form of conflict that borders on the use of land for energy production or food production (Wolfenson, 2013; Graeub *et al.*, 2016).

A couple of studies (Blechinger & Richter, 2014; Ahiekpor, 2013; Energy Commission, 2017 Mahama, Derkyi, & Nwabue, 2021) have shown that, the most challenging obstacles facing the solar energy development in developing countries include; startup capital, high interest rate, lack of incentives, inadequate access to finance and long-term capital, grid connection constraints and lack of grid capacity, instability of the local currency (currency fluctuations), insufficient technical know-how for the operation and maintenance of renewable energy technologies. Goldsmith (2015) has noted that the transition from conventional resources to renewable energy has encountered

public resistance and opposition. This is due to a lack of awareness of the benefits of renewable energy, disruption of seascape, and acquisition of land which could have been used for agriculture, tourism, etc. According to Ansari, Kharb, Luthra, Shimmi, Chatterji S (2016), the lack of experienced professionals is affecting renewable energy development in developing countries. The Government of Ghana has demonstrated strong policy commitments towards the development and promotion of renewable energy. However, investment in the renewable energy sector has been limited due to the challenging investment climate; uncertainty of available resources; limited technological capacity; insufficient experience in renewable energy development; human and socio-cultural challenges; and information and awareness barriers.

Solar Energy Regulatory Framework of Ghana

Renewable Energy is central to the achievement of both the 2030 Agenda for Sustainable Development and the Paris Agreement on climate change. Several countries around the world are searching for sustainable and renewable alternatives to their energy supply due to factors such as the increasing demand for energy, the decline in fossil fuel reserves, CO2 reduction and global climate change (Abanda 2012). Government of Ghana has identified renewable energy as one of the options that could contribute to the overall energy supply mix and minimise the adverse effects of energy production on the environment within the framework of the country's low carbon development pathway. The country has a huge potential for renewable energy which remains underexploited. To convert these renewable potentials into actual energy, the government in 2006 set a target of achieving 10 per cent in the energy mix by 2020 through the Renewable Energy Act (832) as main regulatory framework for solar development in Ghana. The Renewable Energy Act (832) was formulated to create an enabling regulatory environment to attract private sector involvement in the development, management and utilisation of renewable energy in an efficient and environmentally sustainable manner, with Energy Commission as the regulator.

METHODOLOGY

The study was conducted in the City of Accra. Accra is the capital and the largest city in Ghana, covering an area of about 225.67 km² (87.13 sq. miles) and an estimated population of 2.4 million, with about 56 % being below age 24 (UN, 2018). The city is the economic hub of the country and hosts several manufacturing firms, oil companies, financial institutions, telecommunications companies, tourist sites, educational institutions, health institutions, and other important establishments (Ghana Statistical Service, 2010). A mixed research approach comprising literature review, interview and consultations with experts of the energy landscape in Ghana guided the preparation of this paper. The first phase of the investigation involved a review of literature on solar energy development in Ghana and some jurisdictions of Africa. Relevant national policy documents related to renewable energy and sustainable development were reviewed. The aim was to identify knowledge gaps and understand concepts and their linkages with sustainable development. Secondly, key-informant interviews were conducted with solar energy companies, policy-makers and relevant state agencies to collect their views on government renewable energy policies and solar energy investment opportunities in the country.

Key informant interviews were also conducted with top-level management of licensed solar energy companies in Accra. According to Energy Commission of Ghana, over 100 licensed solar energy firms are currently operating in Accra. A total of 11 solar energy companies were purposively sampled based on license-holding to participate in the study. These companies deal in the importation, installation and maintenance of solar energy equipment. Two key informants were purposively sampled from the Licensing and Enforcement Directorate of the Renewable Energy Promotion Unit, and Policy and Strategy Directorate of the Energy Commission. The key informants' interviews allowed for the collection of detailed information on the solar energy market. The concept of saturation (Sandelowski, 1995) was used to determine the market saturation point with regards to the recruited solar energy companies. Data saturation is reached when there is enough

information to replicate the study when the ability to obtain additional new information has been attained, and when further coding is no longer feasible. The study operationalized the concept of saturation by concurrently conducting qualitative analysis of interview transcripts during the data collection phase. This allowed the researchers to progressively monitor the key themes that emerged across the samples until it became apparent the issues perpetual. In the case of recruitment of participating solar energy companies, key informant interviews were transcribed and analyzed soon after every interview session as described. The transcripts showed recurring themes before the "10 companies" mark was attained.

The data was analysed using qualitative techniques. The interviews were processed by transcribing audio recordings into words (verbatim) and subjecting the information to thematic content analysis. Common patterns and themes were generated and presented according to the objectives of the study (Yin, 2003; Miles & Huberman, 1994; Ellram, 1996). Bryman and Bell (2011) describe two data analysis methods for qualitative data which include condensation and categorization. Firstly, condensation implies that the researcher reduces long statements into shorter ones. Categorization implies that long statements transferred into categories (Bryman and Bell, 2011). For the analysis, the statements from each respondent were categorized on the basis of two key factors. The next step was reducing long statements into shorter and clearer statements and exploring the differences and similarities. Nuanced qualitative themes obtained from the interviews on enforcement of the solar energy regulatory framework and key themes that emerged from the content analysis were compared to the qualitative themes obtained from the key informants from the solar energy companies that participated in the study (Miles and Huberman, 1994).

RESULTS AND DISCUSSION

This section of the paper presents the data analysis and discussion of the results relating to solar energy opportunities and barriers and the regulatory framework for energy development in Ghana.

Opportunities for Developing Solar Energy in Accra

Government Policies

Policies such as tariff exemptions for solar panels, renewable energy purchase obligations enshrined in the Renewable Energy Act 2011, are among Ghana Government's strategy to accelerate solar energy development in the country. Interviews conducted indicated that some of these government-driven programmes are effective and provide a recipe for the growth of the solar energy market. According to some of the solar energy companies, government has somewhat helped the market through implementation of some of its policies. A key informant from a dual-operation solar energy firm commented on the National Rooftop Solar Programme—a Government of Ghana's solar panel-subsidized programme that was piloted in major cities including Accra to promote nationwide adoption of rooftop solar energy—as follows:

> Obviously, we had more clients when the Energy Commission introduced this Rooftop Programme. We were part of the national rooftop programme. We had more clients in Accra in the residential areas when the national rooftop programme started. It is effective…We are in Accra. So, when the programme started we actually got more residential users to sign up. What the Energy Commission did was when you qualify, they give you the panels, but you need to meet some requirements which include the Balance of Systems. This programme actually worked for us because we had more people coming to us. (Key Informant Interview, SIMC/SIC)

Well-established indigenous solar energy firms dealing in the importation as well as installation and maintenance of solar energy equipment recognize that government has made significant efforts to promote the development of the sub-sector. For example, the government provides incentives for the importation of solar energy equipment. The incentives include the expansion of tax breaks for only solar panels but excludes batteries and other essential accessories of the technology to make

solar more affordable. For example, one Key informant interviewee revealed the following:

> There is a tax exemption good but that is for the panels but not the batteries. They classify the batteries as normal car batteries. The batteries too are very expensive. Definitely, if the taxes on the batteries are high the end-user will get higher prices for the batteries. Yeah, it is good they have exempted the panels, but they can do more and that is the only way that will make people not really rely on the national grid to meet their energy needs. If we get these things right, a lot of people will go for solar.(Key Informant Interview, SIC/SIMC)

Numerous opportunities for solar energy market development and strategic action by the government are perceived by many stakeholders to be limited to the industrial sector. The existing opportunities within both government and industrial sectors are summarized in Figure 1. According to Eshun and Amoako-Tuffour (2016), the fast-pace of growth of Ghanaian cities is a driver of the exponential growth of both the industrial and domestic demand for electricity. Gboney (2009) observed that Government policies and programmes have been a recipe for solar energy transition in Accra. For example, the National Rooftop Solar Programme provided a huge market for solar energy service providers during its implementation in Accra. However, the non-exempt of taxes for batteries and other essential accessories for solar energy provide an opportunity for government policy intervention.

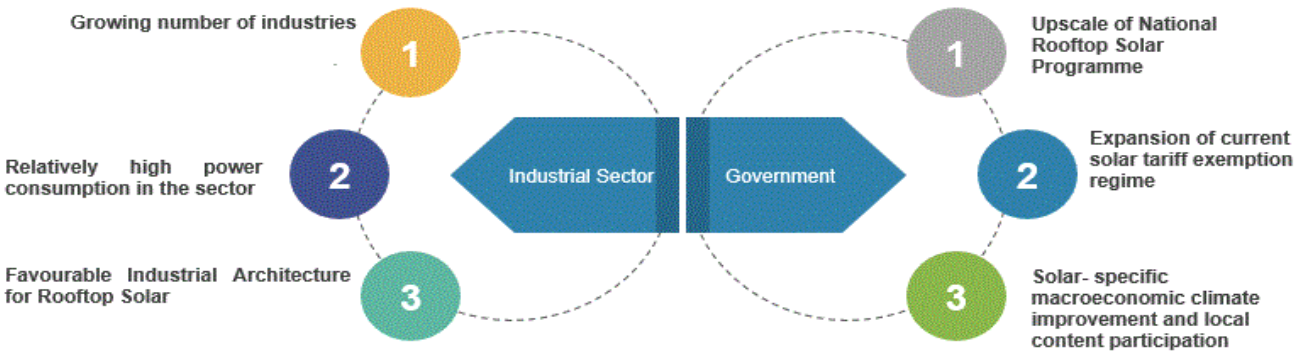


Figure 1: Service Providers' Perspectives on the Dichotomy of Solar Market Opportunities,

Solar Energy Market Entry Barriers

Market entry processes in relation to solar energy include all activities that companies undertake to enable them to provide solar energy equipment and services to their target markets. From the Key informant interviews with top-level management (including managing directors, chief operating officers, engineers, procurement officers, marketing executives, renewable energy executives) of the surveyed solar energy companies revealed the existence of unfavourable market entry conditions.

Key issues relating to market entry by solar energy service providers identified in this paper include threats from unlicensed new entrants; inadequate level of public awareness of solar technology; sophisticated licensing requirements; lack of credit support for consumers, among others. The most problematic market entry barriers are presented in Figure2. Hasnain et al. (1998) argued that much

attention should be focused on public awareness, including networks around the world, to accelerate the dissemination of solar energy technology across societies. This aligns with the finding of this paper regarding the low-level of public awareness about market entry barriers being experienced by solar energy service providers in Accra. The findings reveal that a critical mass of households within the city of Accra lack vital knowledge about solar technology and how it can be integrated with traditional power systems provided by the national grid for cost-cutting and sustainability. One foreign Company described the problem of lack of knowledge among consumes in the market entry process:

> Entering the market is a challenge because the knowledge of solar energy has not settled well with most people in Accra. It also takes longtime for clients to pay companies.(Key Informant Interview, SIC/SIMC)

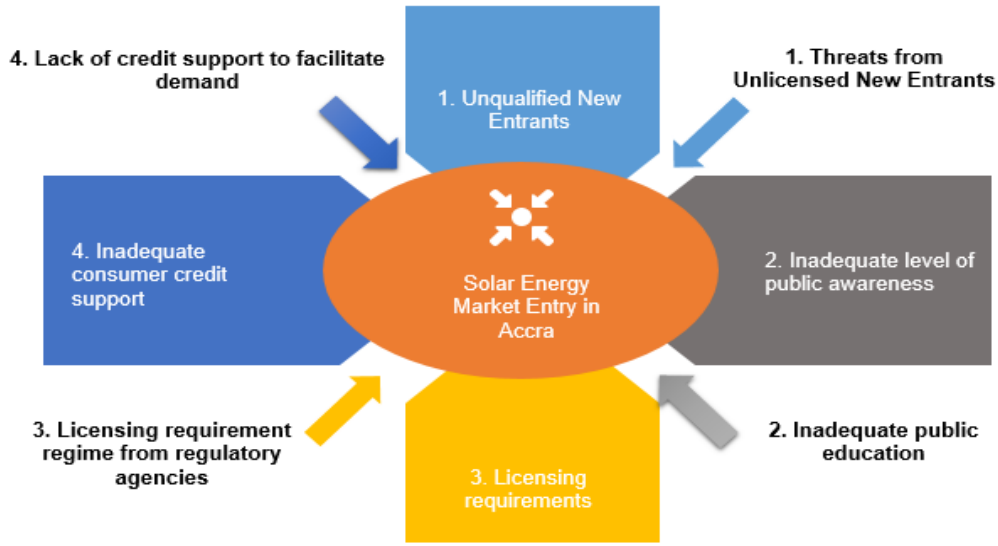


Figure 2: Thematic Issues Underlying Solar Energy Market Entry within Accra,

Source: Researchers' Construction

Inadequate Credit Facilities and High Interest Rates in Ghana

The prevailing unfavorable macroeconomic climate including high-interest rates in Ghana presents a severe bottleneck to solar energy market development in Accra. This challenge exists in many economies as is attested to by Apeaning and Tholander (2013) and Keeley and Matsumoto (2018). Gboney (2009) and Amankwah-Amoah and Sarpong (2016) identified inadequate credit facilities to support consumer transition to solar energy and poor credit ratings among banks in Ghana are fundamental barriers to the development of renewable energy in the country. Lack of credit for renewable energy development is also highlighted by Zaglago et al. (2013). For example, a key informant interviewee from a startup solar energy firm licensed for solar importation, installation and maintenance of solar equipment revealed the following:

> As I told you we are a startup. Yes, so the biggest challenge for us is because there is no financing available. You cannot invest in a product without putting money on the table. And the financing is not very effective in Ghana because the interest rates are too high. You know you go to the bank and they ask for a 30 % interest rate. In Ghana the interest rate is 25-30%. I mean this is very ridiculous. You cannot borrow money with such conditions. (Key Informant Interview).

Net Metering

The current state of the Net Metering regime is a bottleneck that is affecting the growth of the solar energy market in Accra. Net Metering is a billing technology that allows users of non-readily available renewable energy sources, where renewable energy source is not used as a backup, to be credited for the power they contribute to a grid owned by a power distributor. In Ghana, the Net Metering Code (NMC) was developed by the Energy Commission in 2015 in accordance with the object of the Ghana Renewable Energy Act 2011 (Act 832)—to promote the development, management, utilization, sustainability and adequate supply of renewable energy (including solar energy) for the generation of power for varied purposes— for connecting renewable energy to distribution and transmission systems to allow for effective operations. The results of the interviews reveal that 91 % (i.e. 10) of the companies that participated in this study (*including companies operating only as solar equipment installation and maintenance firms, and companies operating both as solar importers as well as solar installation and maintenance firms*) have bad experiences with the current Net Metering regime, especially among the residential segment of the solar energy market in Accra due to conflict of terms of solar companies, the power distribution companies, and the regulator. An interviewee from SESP revealed the following:

> Okay with the regulatory but one challenge we face with ECG or PDS is that they regulated when we get a net meter. People get net meters to enable them to export the excess electricity they produce to ECG now PDS and they are credited when they are exhaust or consume more. This is the sole idea that made people to really want to get solar. It was very encouraging when this regulation came into effect. It is therefore unfortunate that the regulation has been put on hold. Though you find someone who is interested, then he or she gets to know that this regulation is not being implemented is therefore pushed back. But PDS or ECG has not given concrete information or response to this issue. It is a bit of a challenge convincing someone who has much interest to produce her / his own energy and export to PDS and take back but can't have a meter... This slowed things for us but initially when this thing came, we had installed systems for clients who had the chance to get hold of this meter. And they enjoyed it. We have some who have applied for these meters and still their applications are pending and you can't tell them that they are getting the meters...People who are even having this net meter are no longer enjoying it as they are supposed to. (Key Informant Interview, SIMC/SIC)

A key finding of this paper is that the current status of Net Metering regime is one of the most significant barriers in the development of the solar energy market in Accra. The lack of agreement of terms on the implementation of the policy among stakeholders of the power and electricity market is the core of the problem. Ackah *et al.* (2014) observed that Net Metering is one of the critical policy measures that can help to reform the electricity sector in Ghana. However, the current state of this regulatory regime presents a bottleneck to the solar market development in Accra.

Technical Barriers to Solar Energy Market Development

Technical barriers to solar energy market development include inadequate skilled personnel, the proliferation of sub-standard products and services into the market, inadequate housing codes and urban planning and after-sales service. The findings of this paper are supported by Attachie and Amuzuvi (2013) who found that technical barriers significantly hinder the development of the renewable energy sector in Ghana. Generally, after-sales service is largely unavailable in the solar installation and maintenance market. In-depth interviews revealed the lackadaisical attitude of manufacturers to provide after-sales support to solar energy equipment importers and installation and maintenance companies. One of the participants of the interviews lamented thus:

> After sales is a challenge. It is an issue with the manufacturers. We have difficulty with after sales service because manufacturers don't give us spare parts. You need to have technical backup because anything can happen. You need to have access to spare

> parts to be able to offer after sales service. Getting the motherboard and all that. Sometimes it is a bit difficult to get that from the manufacturers after you have bought the items so it becomes difficult for you to do your after-sales service very effectively.(Key Informant Interview, SIC/SIMC)

Regulatory Framework for Solar Energy Market in Ghana

The Energy Commission of Ghana is the primary agency responsible for the enforcement of the Law bordering the renewable energy sector (including solar) in collaboration with other government institutions, ministries, and agencies as the Law holds provision for collaborative enforcement under sections 7 (1) and 7 (2) of the Renewable Energy Act 2011 (Act 832). Sections 8 to 18 inclusive holds detailed provisions for licensing for renewable energy including solar energy in Ghana. Section 8(1) of the Act outlines that a person shall not engage in any commercial activity in the renewable energy line except with a License issued under the Act. Thus, without a license a solar energy company cannot operate legally in the industry. Sub-sections 8(2)(e) and 8(2)(g) identifies the service provider market segments in the solar energy industry which compulsorily require a license for operation—importation, and installation and maintenance respectively. Given these provisions, two licensing manuals and application forms were developed by the Energy Commission in September 2012 to cater for licensing in Solar Importation as well as Installation and Maintenance with a provision for renewals annually. The Energy Commission is primarily responsible for the enforcement of the Law on the renewable energy sector (including solar). The Energy Commission enforces the licensing regime through collaboration with other national agencies and institutions in areas such standards and conformity assessment, environmental impact assessment, spatial planning, tariff setting, public participation as is provided in Section 7(2) of Act and summarized in Figure 3 below.

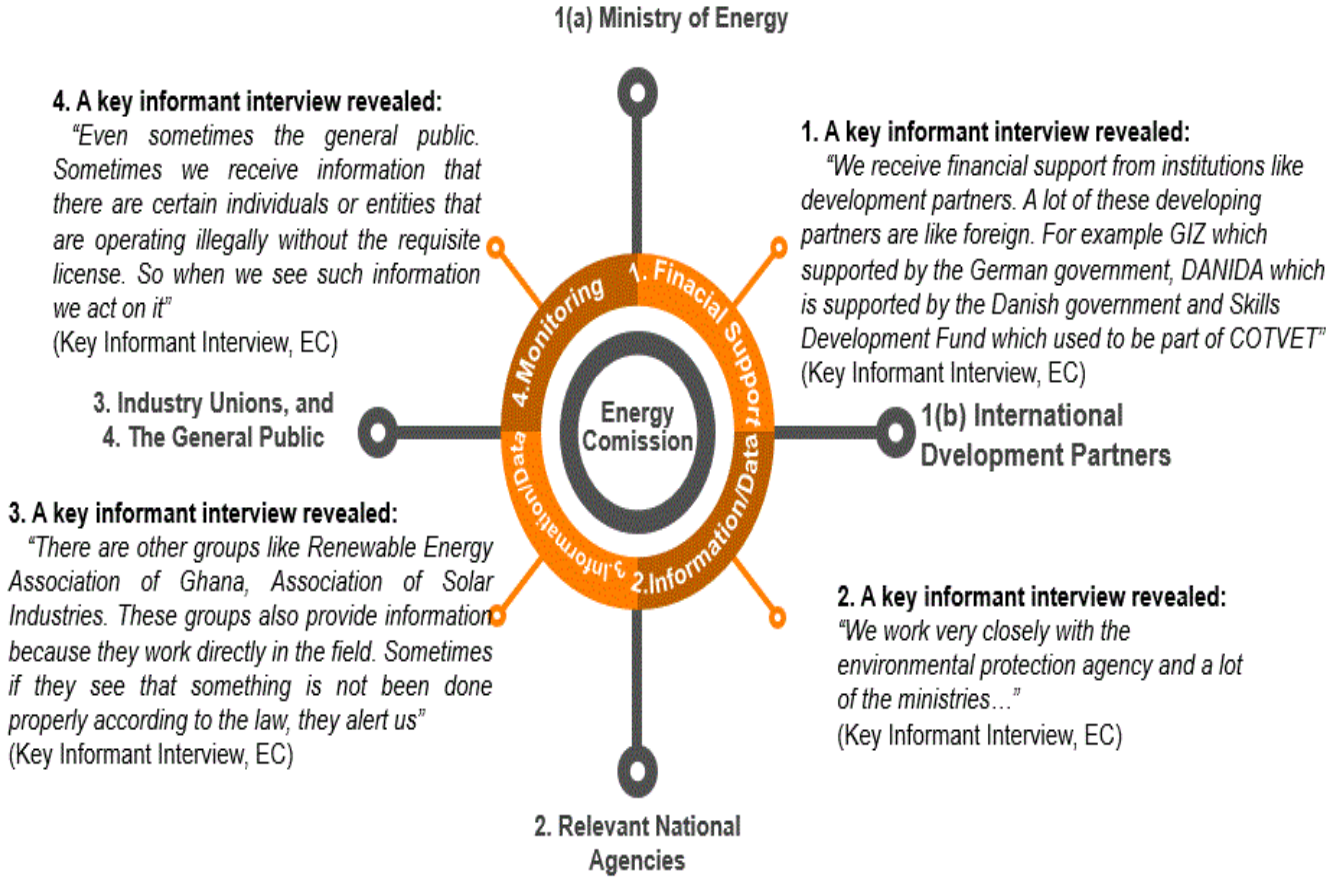


Figure 3: Role of External Actors in the Enforcement of the Solar Energy Regulatory Regime

Evolution and Current Limitations of the Solar Energy Regulatory Regime

While the Ghana Renewable Energy Act 2011 (Act 832) has not been amended since 2012, the regulatory framework for the solar energy market has undergone some modifications to keep up with the demands of the market. The most conspicuous of these changes is the current non-applicability of Renewable Energy Tariff Rates which has been specified in Sections 27, 28, and 29 of the Act because of increased competitiveness of the market. A key informant from the Policy and Strategy Directorate of the Energy Commission during the in-depth interviews revealed the following:

> In the case of Feed-in Tariffs, there are now a lot of interested bidders in the solar energy sector because the price of solar energy systems are going down. Even though in principle more solar systems should be used, it is not the case because the market situation is not favourable. For example, if the government says 20 cents per unit, someone who is bringing solar systems has to be paid 20 cents. Now the price has gone down and someone says as for me I am even prepared to bring in solar for 10 cents even though the Feed-in Tariff says 20 cents. And another person comes and says instead of 10, I will bring it in for 8 cents. So the competition sets in. So what the Energy Commission says is okay then allow it on merits. (Key Informant Interview, Energy Commission)

Similarly, regarding the enforcement of the licensing regime, the experiences of key informants indicate that the solar energy market in Accra has

expanded beyond the scope of the current licensing regime. Emerging fledgling markets for solar energy are not adequately captured by the current licensing regime. As a result, the Energy Commission is reviewing the current licensing regime to take into account these nascent markets. A key informant interviewee pointed out the limitations of the current licensing regime:

> We have a document which is a license manual for service providers in the renewable energy industry. That entire document has not changed. If you look at it, you will still see 2012 but we are reviewing it. By the end of the year, there will be a new one. Basically, that one will say 2019. We are doing these because you know there are new markets that are opening up and the current licensing manuals do not have frameworks for these markets, so we developed frameworks for these markets. For example, marketing and assembly of renewable energy technologies. The first one did not have a licensing framework for marketing and assembly but now companies that are interested to go into marketing and assembly, a regulatory framework has been developed for that.(Key Informant Interview, Energy Commission)

Challenges in the Enforcement of the Solar Energy Regulatory Regime

The enforcement of the regulatory framework for solar energy development in Accra is replete with several challenges which include poor monitoring and information systems, inadequate human and institutional capacity, insufficient finance, and ineffective implementation of the Net Metering policy. An in-depth interview with a key informant in charge of Enforcement and Supervision at the EC remarked thus:

> For companies within Accra, their major challenge is getting the correct data. When licenses expire, companies are supposed to submit data when they apply for renewable of their licenses. But it is sometimes very difficult to get the data on the solar energy systems they have installed because they don't collect the data. You know, as a licensed company you are allowed to operate for only one year and in that one year you can do as many installations as possible. So what happens is that at the end of the year when you are applying for renewable of your license, you are supposed to submit data on all the installations that you have done. So what actually happens is that if you don't happen to apply for a renewal or we don't come across solar systems you have installed, it can actually take 1, 2, 3 years without us knowing the systems you have installed. (Key Informant Interview, Energy Commission)

Another in-depth interviewee from the Policy and Strategy Directorate of the Energy Commission indicated that critical institutions and support schemes for promoting solar energy in the country have still not been put in place. This challenge hindering enforcement of the solar energy regulatory framework is attributed to financing. Below is the key informant's view:

> If you look at the Ghana Renewable Energy Act, it talks about the establishment of a renewable energy authority. It also talks about the establishment of the renewable energy fund. Even though the fund has been established, the amount in it is not enough to take us anywhere. So the establishment of the authority is still incomplete and a sufficient operational renewable energy fund is yet to be. (Key Informant Interviews, Energy Commission)

This is challenge is corroborated by extant literatures that point to institutional financing as an important building block for solar energy market development.

Clearly, the current state of the solar energy market in Accra and, to large extent, across the country is due to the dearth of an independent autonomous institution to effectively ensure the promotion and development of the industry. This institutional challenge is linked to inadequate funding. This is because the largesse in the renewable energy fund is limited. Perhaps, the most important challenge service providers in the solar installation and maintenance market are facing is the implementation of the Net Metering policy. A key

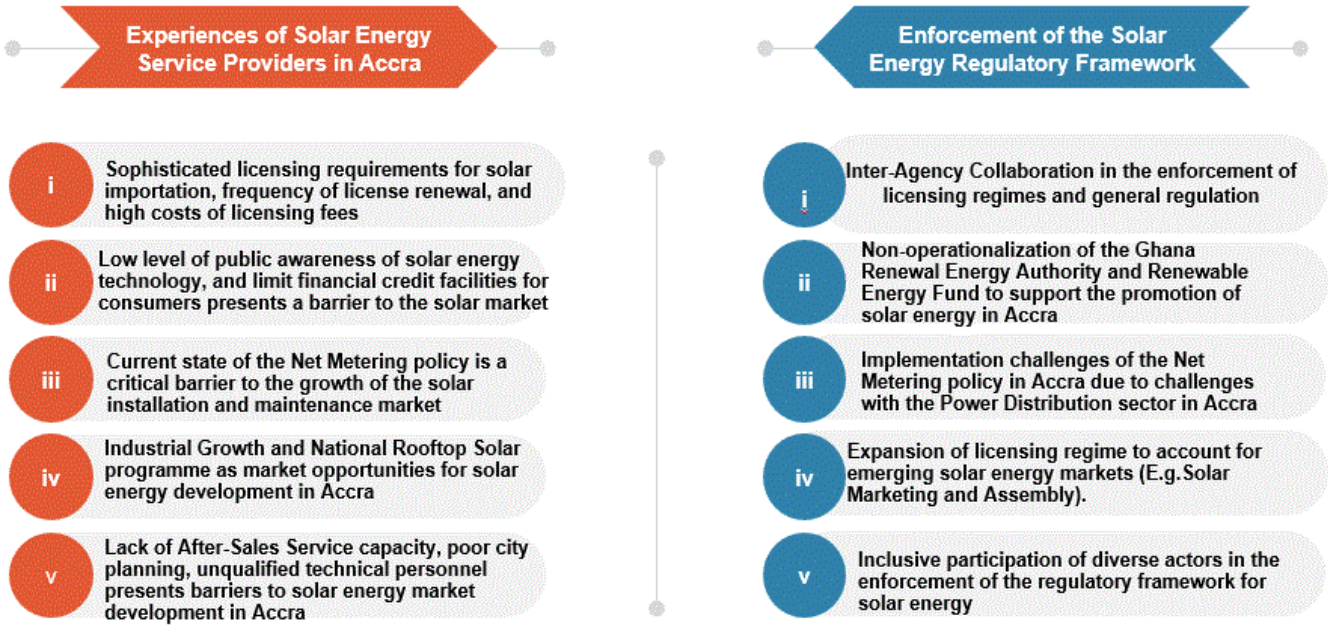
informant from the Policy and Strategy Directorate remarked:

> Implementation of Net Metering will mean if a person is using a renewable system and at some period is not using the energy, any amount that comes from the renewable energy system including solar is credited to him on the grid. And as we all know, ECG now PDS is the main regulator of the grid. So, anything that affects their balance sheets they will be reluctant to take the required. If you bring in a system that will not increase PDS's customer base but rather cause them a shortfall, they will not be eager to reimburse you credit and so and so cost. So, engagement with ECG is quite a challenge…

Relationship between Service Providers and the Solar Energy Regulatory Framework

This section of the paper compares the experiences of service providers in Accra to key issues that underpin the enforcement/implementation of the solar energy market regulatory framework. A cross-case analysis showed that some issues align while others misalign as is shown in Table 4.2. Issues that align include the Industrial Growth and National Rooftop Solar Programme being implemented by the EC and perceived as opportunities by the SESPs within Accra. Secondly, financing is one critical bottleneck intersecting both the SESPs and the regulator in the enforcement and full operationalization of the Renewable Energy Act 2011 (Act 832). The most important barrier to the SESPs is the Net Metering Policy which still faces implementation challenges primarily due to conflict of terms with power distributors. Situating this revelation in previous studies, Atuguba and Tuokuu (2020) also contend that ambiguous regulatory framework, inconsistent policies, implementation challenges and lack of robust coordination hamper the country's efforts towards a clean renewable energy future. This gap reinforces the need for intentional policy development for a successful promotion of renewable energy development in other jurisdictions (Emodi and Ebele, 2016).

Table 1: Comparison between SESPs' Experiences and the Solar Energy Regulatory Regime



CONCLUSION AND RECOMMENDATIONS

The paper concludes that government programming, through consumer and business subsidies of solar technology accessories, and education, as well as growing industrial sector participation provide a catalyst for the development of the solar energy market. However, the Net Metering policy dissonance presents a critical barrier to solar energy transition and market development in the City of Accra. Inadequate institutional and service-provider's financial support, lack of after-sales technical support, limited consumer credit facilities, public education and the dearth of general awareness among the public about solar energy technology remain important barriers to the development of the industry. The implementation of the Net Metering policy should consider a broader stakeholder consultation including strong participation by solar energy service providers to develop a win-win Net Metering regime strategy to break down the legal and technical barriers constraining the policy's implementation process. The paper therefore recommends that future studies should examine ways and means of effectively implementing the Net Metering policy to assure a win-win situation for all stakeholders of the energy market in Ghana.

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