**Renewable energy incentives in Kenya: Feed-in-tariffs and Rural Expansion**

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Abstract

Kenya has recently enacted policies seeking to expand electricity access through the use of renewable energy sources. This paper discusses the regulatory environment, policies, and tariffs used by the government for this effort, focusing on two important programs: the feed in tariff scheme and the creation of the Rural Electrification Authority. These policies and the use of clear targets have increased access and the use of renewable energy. Current challenges, including access to financing and expansion to the rural poor, are also discussed.

Keywords: Feed-in-tariff, renewable energy, solar photovoltaic, geothermal, Kenya.

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## 1. Introduction

Governments in developing countries are considering various ways to increase access to modern energy services using renewable energy sources. This study looks at the regulatory environment, policies, and tariffs used by Kenya to increase the deployment of renewable energy thereby increasing energy access, particularly in rural off-grid areas. While several studies have discussed the use of policies for increasing the use of renewable energy sources, very few have focused on areas in Sub-Saharan Africa, where access levels, the urban/rural distribution, and high use of firewood and kerosene present unique challenges. Renewable energies provide an opportunity to address climate change and development goals at the same time.

Of the world's 1.267 billion population without electricity access, 1.265 billion live in developing countries. An estimated 2.8 billion people in developing countries use solid fuel such as charcoal, wood, or other traditional biomass for cooking and heating (Legros et al. 2009). Low access to electricity in rural areas, the unreliable nature of power supply in urban areas, and the continued reliance on traditional methods of lighting, cooking, and heating have constrained economic growth and resulted in roughly two million deaths per year from pneumonia, chronic lung disease, and lung cancer associated with indoor air pollution (Legros et al. 2009).

In order to curb this trend, the United Nations launched the "Sustainable Energy for All" initiative with the following goals in mind: (1) ensuring universal access to electricity and clean cooking solutions, (2) doubling the share of the world's energy supplied by renewable sources from 18% to 36%, and (3) doubling the rate of improvement in energy efficiency (World Bank 2013).

So far 77 countries, most of them from the developing world, have opted to pursue the objectives of “Sustainable Energy for All.” The initiative’s second objective of increasing energy supplied by renewable sources from 18% to 36% has been well taken by stakeholders. Almost all developing countries are now considering renewable energy as one of their main resources for increasing energy supply in urban areas. Renewable energy technology has also been replacing diesel powered generators as the main source of off-grid power for the electrification of rural areas, especially in regions where grid extension is not economically feasible.

An opportunity exists for investors and enterprises to supply renewable energy products in these markets. The opportunity in each market is, however, affected by the regulatory environment, consumer awareness, consumer finance, product quality, and presence of policy advocacy groups in each country. The purpose of this paper is to present the current state of renewable energy diffusion in Kenya, with an emphasis on its regulatory environment, incentives set to increase access to electricity and clean energy.

According to the International Energy Agency (IEA 2015), Kenya has a population of 44.35 million and gross domestic product of 28.05 billion in 2005 US dollars (USD). In 2015, its energy production totaled 17.59 million tonnes of oil equivalent, with electricity consumption[1] of 7.33 terawatt-hours and $CO_2$ emissions from fuel combustion totaling 11.70 million tonnes of $CO_2$. Kenya has pledged to cut greenhouse gas emissions 30% below their “business as usual levels” by 2030. The government plans on meeting this target by expanding the use of solar,

[1] Calculated as gross production + imports – exports – losses.

wind, and geothermal generation, and bringing forest cover up while reducing reliance on wood fuel[2] (Bounagui 2015).

According to the Global Tracking Framework Report (Angelou et al. 2013), access to electricity has been improving over the years, increasing from 11% of population with access in 1990, to 15% in 2000, to 23% in 2010. The country has 71% and 8% access in urban and rural areas, respectively. The electricity mix relies heavily on hydropower, fossil fuels, geothermal and wind generating sources (Ngui et al. 2011). Geothermal energy, a renewable energy source consisting of energy that comes from the earth's heat, became the largest player in the energy mix (51%) with the addition of two plants with a combined capacity of 280 megawatts (MW) in 2015 (World Bank 2015).

The percentage of renewable energy share as of 2010 was 58.1% of electricity capacity and 69.5% of electricity generation. Kenya's electricity sector currently experiences the following challenges: high frequency of outages, low access rate, an inability to meet demand (particularly when hydrological conditions dip[3]) and high power system losses (Mutua et al. 2012; Economic Consulting Associates 2012). Installed capacity as of 2011 was 40 watts (W) per capita, which is low compared to South Africa's 800 W per capita (Economic Consulting Associates 2012). Table 1 provides a summary of installed capacity (in MW) as of 2014 by generation source.

[2] The country estimates an approximate cost of 40 billion USD for achieving its climate change goals (Bounagui 2015).

[3] In the short term, lack of electricity when there is a drop in water levels has been addressed by increasing the use of thermal power (diesel) generation (Ngui et al 2011).

Kenya liberalized its power sector in 1996 and unbundled the state owned utility in 1997. An Electricity Regulatory Board was established in 1997 (Republic of Kenya 2011). Table 2 describes the main institutions involved in Kenya's electricity sector.

Among renewable energy sources, Kenya has high potential for the use of geothermal energy, but faces several challenges in its use. These include: high upfront investment costs, high resource exploration and development risks, land use conflicts, inadequate expertise, and high investment in infrastructure due to long distances from geothermal sites to existing load centers (Ministry of Energy and Petroleum 2014). Government policies that encourage resource assessment, development, and capacity building have been considered as part of the government's policy agenda. A recent Least Cost Power Development Plan (Republic of Kenya 2011), identified renewables as a major upcoming development, with a plan to use geothermal generation for base load (Economic Consulting Associates 2012).

Kenya also has potential for solar photovoltaics (PV). Kenya's solar PV market was established in the 1970s mostly by donor investments. It became a "donor hub" for solar PV, which allowed for a market to emerge early on. Donor investments still contribute to the development of renewable energy in Kenya. For instance, the International Finance Corporation (IFC) invested 5 million USD for market development of solar PV between 1998 and 2008 through its PV Market Transformation Initiative (Bawakyillenuo 2012). In the geothermal sector, the World Bank has been involved in several facets such as feasibility studies, exploration, geothermal steam development, and plant construction. It has also provided investor risk mitigation (World Bank 2015).

## 2. Methodology

In order to evaluate the development of renewable energy markets in Kenya an extensive literature review was carried out covering the academic literature, mass media, and government reports. We review Kenya's recent renewable energy policies in section 3. We then describe the markets for renewable energy, with an emphasis in solar PV and geothermal, in section 4. We discuss current progress in the sector in Section 5. Section 6 concludes.

## 3. Renewable Energy Policies

Policies can help determine the extent to which renewable energy resources are adopted in a given country. Kenya has enacted several policies that promote the use of renewable energies. In adopting these policies they have taken into account lessons learned from other countries' experiences, such as making sure Feed in Tariffs (FIT) offer less risk to investors by ensuring them that prices negotiated in 20 year contracts can only change based on inflation.

The first relevant renewable energy policy passed in recent years was Energy Act 12 of 2006, enacted by the Ministry of Energy and Petroleum. The Energy Act set up an independent regulator for the sector, the Energy Regulatory Commission (ERC), whose role included the approval of Power Purchase Agreements (PPA) and the preparation of national energy plans. The Act puts the responsibility for developing renewable energy frameworks in the Ministry of Energy and Petroleum. As is the case in many countries, there is special emphasis on the expansion of local manufacturing and incentives to existing renewable sources such as bio-digesters, solar, and hydro turbines (IEA 2016). The act also encourages the use of biomass co-generation (heat and power) and alternative fuel production using sugar mills. The Energy Act also provides other incentives expected to increase the use of renewables, such as an authorization for 4 MW capacity systems of renewable energy to produce energy without a license, income tax holidays for some generation and transmission projects, and tax exemptions for imports that are to be used for renewable energy equipment (IEA 2016). The Act also created the Rural Electrification Program, promoting off grid renewable energy generation for households and income-generating activities.

FITs offer long term contracts to renewable energy producers to supply energy to the grid at a pre-determined rate, typically based on the average cost of generation of each technology (different technologies can be paid different amounts per megawatt-hour (MWh) of electricity provided). Kenya’s first FIT policy was enacted in 2008 by the Ministry of Energy. It applied to generators of wind, bioenergy, and hydropower. The policy required system operators to connect plants generating renewable energy and guaranteed priority purchase of their electricity. Grid operators were allowed to recover some of the cost from the FIT directly from consumers, up to 2.6 cents/kilowatt-hour (kWh). The policy set tariffs that were technology and capacity-specific and expected to apply for 15 years. Investors’ Expressions of Interest were evaluated by a panel with representatives from the Ministry of Energy, grid operator and regulator (IEA 2016). Kenya’s FIT was revised in 2012. The revision standardized PPA templates to be used in negotiations, issued guidelines for connection of small scale renewables to the grid, added a standardized application form and progress reporting / monitoring frameworks, changed FIT levels, and expanded the list of renewable energy sources qualifying for FITs (IEA 2016). One of the major goals of standardized PPAs and technology-based FIT values, was to reduce time and transaction costs that would be incurred if negotiations took place instead.

More recently, in 2015, Kenya introduced new renewable energy tax incentives. Kenya now offers and exemption from Value Added Tax to several components of renewable energy sources, including certain solar cells and modules and PV semi-conductor devices (IEA 2016).

## 4. Renewable Energy Projects

The market for renewable energy in Kenya can be divided into two broad categories: On grid renewable energy projects and off grid projects. Two renewable energy sources that have been promoted in Kenya are solar PV and geothermal.

Kenya is located near the equator, which provides it with 4-6 kilowatt-hour per meter squared per day ($kWh/m^2/day$) levels of insolation. The average daily radiation in over 28,000 square kilometers is above 6 $kWh/m^2/day$. The government estimates that 20,000 PV home systems are currently in use in Kenya, generating 9 Gigawatt-hours (GWh) of electricity annually, and accounting for 1.2% of households (Republic of Kenya 2011). Given Kenya's insolation levels and large rural population, there is potential for solar PV penetration.

In regards to geothermal energy, Kenya has over 14 high temperature potential sites along the Rift Valley (Ministry of Energy and Petroleum 2014). A challenge of geothermal energy, compared to other sources is that, in a manner similar to petroleum, it requires large investments in exploration which may not result in a viable site. This imposes a development and exploration risk. Kenya has addressed this by providing government support for resource assessment and development (Ministry of Energy and Petroleum 2014). Geothermal, unlike other renewable sources, can be used as baseload.

### 4.1. On-grid Renewable Energy Projects

On-grid renewable energy projects are products for utility-scale and customer-scale applications where the power generated is sold to others, including the utility. Globally, renewable energy technologies represent alternatives for developing countries to increase their generating capacity and improve their weak and unreliable power sector while responding to the need to transition to more sustainable energy sources. Governments and policy makers can develop incentives to attract private investment to the on-grid electricity sector. Investors, in general, are concerned about the high risks associated with long-term investments in developing countries, for instance, due to apprehensions about political instability. Policymakers can use several financial incentives to mitigate against these high investment risk perceptions.

While the main objective of FIT policies in most developed countries is to shift production of energy from fossil fuels to renewable sources, the main objective of FIT policies in developing countries is to encourage investments in renewable energy sources to supplement the inadequate traditional sources of energy supply.

There are several arguments for and against FIT policies. The main disadvantages of FIT are that: (1) they can lead to upward pressure on prices in the near-term, (2) they do not address the high up-front costs of renewable energy technologies, (3) payment levels are often independent of market signals, (4) they do not encourage direct price competition between project developers, and (5) they make it difficult to allocate costs across ratepayer classes (Couture et al. 2010). It is important to note that what are traditionally thought as advantages and disadvantages of FIT will differ for Kenya compared to developed countries that have ample electricity generation sources and supply. For Kenya's case, most areas where FIT were implemented, did not have enough electricity supply prior to the projects[4]. High up-front costs of renewable energy technologies are especially challenging for developing countries, where there is often times a lack of access to banks and other formal financial institutions. For the case of renewable energy in Kenya, several of these concerns have been addressed with financial help from the government, donor agencies, and mechanisms such as micro-lending.

[4] Additionally, for urban areas that are already grid connected, changes in water levels can have very high price impacts. A drought in 2008-2009 caused an 18.4% drop in power generation from hydro sources. The government responded by using emergency and pre-installed thermal generation to meet the shortfall, which amounted to an almost doubling of consumer charges (Yadoo and Cruickshank 2012).

Some of the main advantages of FIT are that: (1) they limit investment risk for the producer[5], (2) they only cost money to ratepayers if projects are in operation, (3) they lower transaction costs, (4) they settle uncertainties related to grid access and interconnection[6], (5) they enhance market access, and (6) they encourage the use of technologies at different stages of maturity (Couture et al. 2010).

In March 2008, Kenya's Public Procurement Oversight Authority approved the country's first FIT policy for renewable energy technologies. The government sought to meet the following objectives: contribute to increasing the country's energy supply, improve the energy mix, contribute to reductions in greenhouse gases, and generate income and employment[7]. A FIT was considered appropriate by the government because it was expected to provide investment security, reduce transaction and administrative costs, and provide adequate incentives to private investors (Ministry of Energy 2012; Ministry of Energy and Petroleum 2014).

Different rules were enacted for small and large producers. The policy guaranteed renewable energy investors under the FIT policy with priority purchase. Small renewable energy projects (capacity up to 10 MW) were assigned standardized PPAs. The tariffs offered were technology specific, but the PPAs were technology neutral. In order to get a PPA offer, a project had to demonstrate technical and economic viability, meet grid connection requirements, and be able to secure legal and regulatory approvals and financing. Projects were accepted on a first come, first serve basis, without any sort of bidding involved (Ministry of Energy 2012; Ministry of Energy and Petroleum 2014).

[5] This risk is shifted to other participants, such as ratepayers or taxpayers.
[6] FITs settle uncertainties related to grid access and interconnection assuming there were no previous policies to address this.
[7] To our knowledge, there is mixed empirical evidence linking FITs to job creation.

Kenya's FIT policy revision was meant to include technologies that investors had shown interest in but were not contained in the earlier policy or for which the tariffs had not been attractive enough. The December 2012 revised version contains FIT policies for wind, biomass, small hydro, geothermal, biogas, and solar resource generated electricity. The policy allows for tariff differentiation so that each renewable energy technology is paid a different tariff calculated on a technology-specific basis using the principle of cost plus reasonable investor return. All contracts are for a 20 year period and use the fixed FIT value that was applicable at the time the contract was signed, plus an adjustment for inflation. The government set a cap of 10% of cumulative capacity distribution system-wide generation for FIT projects up to 10 MW (Ministry of Energy 2012).

Given their greater impact on system reliability, larger producers (larger than 10 MW) had to follow a different set of rules. Perhaps the most important rule is that large producers must meet government loadflow/dispatch and system reliability requirements. Once again the government imposed capacity limits. It also specified a competitive bidding process for large projects. The government first identifies the most competitive bidders and then has them compete on a lowest levelized price basis. The government also provides a Standardized PPA for these types of projects (Ministry of Energy 2012).

For both types of projects, access to Kenya's grid is guaranteed. The government also specifies that FITs will be reviewed in set intervals of 3 years from the date of publication of the previous version. Any change to the policy made during the review will not affect power plants contracted under old policy, but will apply to power plants developed after the revised policy is published, following best practices from other countries. The FIT values include a standardized allowance for interconnection costs. All interconnection and construction costs are to be borne by the developers. The developers also bear costs associated with upgrading transmission and distribution lines, substations, and associated equipment (Ministry of Energy 2012).

Table 3 presents values for Small Renewable Projects (≤ 10MW installed capacity), while Table 4 presents values for Large Renewable Projects (> 10MW installed capacity)

### 4.2. Off-grid systems

There are two types of off-grid systems. Small off-grid systems consist of products primarily for residential solar home applications, especially in rural areas, and for small scale commercial PV applications, such as kiosk lighting and mobile phone charging. Large off-grid systems consist of products providing power for larger institutions, such as schools, health centers, missions in rural areas, and water pumping.

In Kenya, the main method of electrification is grid extension. This method is, however, only economically feasible for households in urban areas and towns close to the grid. The rising costs of fuel, materials, and generators for connection to the grid makes grid connection uneconomical for some rural areas at this point in time. The low load demand and the dispersed nature of most rural settlements in developing countries worsens the problem and makes grid extension unlikely even in the long term (Belward et al. 2011). Consequently, grid extension in Kenya has followed a slow pace. Bawakyillenuo (2012) argues that this slow pace of grid extension is one of the main drivers for the growth of PV use in rural areas of Kenya. Traditionally, most African countries had relied on diesel stand-alone generators for the electrification of isolated areas (Belward et al. 2011). Governments in developing countries are now focusing on renewable energy technologies for rural electrification because of diesel costs and environmental benefits of renewable energy.

Replacing diesel generators with renewable energy sources has been criticized. We summarize the main concerns, following Yadoo and Cruickshank's (2012) and Jacobson's (2007) analyses. A common concern is that off-grid renewable energy solutions, particularly solar PV technologies, tend to be more costly and less reliable than diesel. Intermittency from the sun and high up-front costs, while still challenging, have become less problematic during recent years due to lower lifecycle costs and improved efficiency of solar PV technologies. In fact, several renewable energy technologies are, at this point, cheaper than diesel on a levelized cost basis (Yadoo and Curickshank 2012). The use of generators can also be intermittent if households face financial constraints for the purchase of diesel.

Another concern is that solar home system initiatives tend to be donor driven. There is some, anecdotal, evidence of donor driven investments leading to increased adoption of solar systems in Kenya. In the early 1980s, donor agencies donated PV systems for lighting and refrigerators, primarily for off-grid missions and health clinics. As stated in Hankins (2000), when one of these projects, for example, installed solar PV in rural boarding schools, the rural PV agents in charge of installing and selling systems, quickly realized there was a market in community households. Within two years of the project, the headmasters and other community members had purchased PV systems for their own households. By the end of 1990, despite continuing to purchase between 20 and 40% of the PV equipment each year, donors had become much less important for the household market.

There is also a concern about benefits only accruing to rural elites. For Kenya, specifically, Jacobson (2007) conducted research "in the field" and found that the majority of benefits from the solar PV market were obtained by the rural middle class. The author also found that unsubsidized, market-driven approaches to rural PV service provision bypassed poorer[8] rural households. Historically, private businesses in Kenya targeted PV sales to affluent rural communities, which were seen as a commercially viable segment, beginning with the South of Mount Kenya, a well-off rural area of coffee and tea farms in the 1980s. This allowed the sector to be successful without a need for donor assistance, and helped boost entry of other private businesses into the rural PV market (Bawakyillenuo 2012)[9]. In the 2000s, the focus shifted towards middle class families in rural areas as documented by Jacobson (2007) presumably fueled by lower costs of PV systems, higher middle class purchasing power, and a desire of the middle classes to have access to television viewing.[10] This concern can be alleviated by obtaining resources to help these families attain access, such as donor funding, government policies, or financing options that allow users to pay for systems over time.

Another criticism addressed by Jacobson (2007) is that solar PV panels were mainly used for productive applications such as mobile phone communications or television as opposed to income-generating activities, education, or poverty alleviation. Benefits that could accrue from the use of light for evening time studying with children, did not necessarily accrue when lighting was constrained and families preferred to use their limited electricity for television watching. While Jacobson (2007) finds that television viewing in Kenya is a substitute for night time reading, the same author in a later study (Kirubi et al. 2009) mentions how television is a useful medium through which, for example, women can acquire information on health and family

[8] The majority of Kenya’s poor rural population consists of subsistence farmers (Hankins 2000)
[9] This strategy was also followed in several other African countries such as Zimbabwe.
[10] The purchase of solar PV for television viewing is not unique to Kenya’s rural households and has been shown to exist in studies from China, Thailand, Sri Lanka, and Zimbabwe (Jacobson 2007).

planning. Furthermore, according to Hankins (2000), with the growth of the television market in Kenya, "came smaller, cheaper, and incrementally purchased PV systems"[11] (p.94).

Another concern is that several projects failed within a number of years due to economic, technical, and organization challenges (Yadoo and Cruickshank 2012). These concerns are typically addressed by setting up policies that can help mitigate these issues. A characteristic of FIT that can help mitigate these concerns, is the fact that a payment only occurs if the project is running.

In 2006, the government set up the Rural Electrification Authority (REA) with the ultimate goal of ensuring that all Kenyan households in rural areas have electricity by the year 2020. It is a special purpose agency, whose goal is to accelerate the pace of rural electrification, through fund allocation and the promotion of renewable energy sources. The function of increasing rural electric penetration had previously been performed by the Ministry of Energy (REA 2015; REA 2012b). Currently, only 26% of all households in the country have access to electricity. The REA has focused on the electrification of secondary schools, health centers, and trading centers. One of the government's goals is to provide access to e-learning and Information, Communications and Technology (ICT) services to schools in rural areas. One of REA's goals was to electrify all secondary schools and health and trading centers by 2013. REA expected to implement its goals using the following strategies (REA 2012a):

1. Setting up targets. These targets included several phases. Phase I involved the connection of all public facilities and took place during the 2008-2012 period. Phase II seeks to increase customer connections during the 2013-2022 period, with a goal of 65%.

[11] Televisions can also be powered by batteries. However, batteries have to be carried to and from battery charging stations (Hankins 2000).

2. Setting up a rural electrification plan. REA identified and listed the number of public facilities requiring electrification. This list with statistics on achievements is available on their website[12].

3. Partnering with local communities. REA involved the community during the implementation process. This included, for example, using community participation to deal with transformer vandalism.

Even though the government promotes the use of all renewable energy sources for rural electrification, since 2009 most of the off-grid generation for schools, health centers, and government institutions has used solar PV. For this reason, the 2012 PPA contains tariffs only for solar technology for off-grid generation. Table 5 shows an extract from the PPA for mini-grid solar technology in Kenya.

Small solar PV units and products have been sold in Kenya for several years. To put the use of small solar PV products in perspective, during the 1995-1999 period, the country's rural electrification program achieved less than 21,000 connections. During the same period, over 80,000 households purchased solar modules (Hankins 2000).

Early rural electrification programs did not focus on the electrification of rural households. Consequently, those in rural areas not connected to the grid have been using small solar-home systems for their lightning and mobile phone charging needs. Small solar home systems, however, do not provide the household with the necessary energy for refrigeration, cooking, or other thermal uses (Hankins 2000).

For very remote areas where grid-connected electrification is not currently considered cost-effective, decentralized systems such as solar lanterns and solar cooking stoves have been

[12] http://www.rea.co.ke/

promoted to increase the adoption of renewable energy and to improve the livelihood of rural households. A major goal is to reduce the use of kerosene and firewood, and the dangers associated with smoke. Electric lighting also provides more lumens per dollar (Hankins 2000). Kerosene lamps and lanterns still remain as the main lighting source in rural areas (and as the main back up source in urban areas). Firewood is the most popular source of cooking fuel (Ngui et al. 2011) and is usually a free resource (Hankins 2000)[13]. Table 6 illustrates estimates of household usage of kerosene and firewood over the years. Additionally, among urban households, charcoal is preferred to gas and electricity because of its lower prices. The use of charcoal is difficult to quantify because it is primarily purchased in the informal sector (Ngui et al. 2011).

Solar lanterns are being promoted across areas of the country as a substitute to the use of kerosene as the main source of lighting in rural areas and as the main back up lighting system in urban areas.

According to Ondraczek (2013), residential solar home systems and small-scale commercial PV applications, such as cell phone charging kiosks, account for three quarters of total installed PV capacity in Kenya. The country offers favorable financing schemes such as micro-credit financing and the Hire Purchase credit system, whereby consumers are able to purchase systems on credit with monthly payment installments (Bawakyillenuo 2012). Table 7 depicts the lighting fuel sources from responses to a preliminary pilot questionnaire conducted on a variety of sample groups in Kenya in 2004-2005.

## 5. Discussion

[13] Firewood does not, however, provide acceptable lighting levels and cannot be used to power televisions (Hankins 2000).

Small-scale renewable energy sources in Kenya, such as solar, have slowly increased from 1% of installed capacity in 2005, to 3% in 2012. The share of geothermal in the country's energy mix increased from 13% to 51% between 2010 and 2015 (World Bank 2015). Kenya appeared as one of the top 5 countries in the Share of GDP 2012 USD invested in Geothermal Power Capacity category of the Renewables 2014 Global Status Report. This report also highlights Kenya as one of 18 countries in the world that generated more than 10% of its electricity from non-hydro renewable energy resources by 2013. Additionally, Kenya was listed as one of Africa's leading investors in renewable energy, with an investment of 249 million USD, which is higher than every other African country with the exception of South Africa. Kenya is also currently in the process of building Africa's largest wind energy farm, the Kale Turkana Wind Power Project, which is expected to generate 20% of the country's power using 365 turbines (with a load capacity factor of approximately 68%). This project is being financed by a consortium of investors under the auspices of the European Union and using the African Development Bank as lead arranger (Mushakavanhu 2015).

So far, the FIT program has received some criticism from investors. For instance a PV trade magazine recently mentioned how some developers believed that the rate offered for solar was too low to encourage viable investments (Willis 2014). Despite what initially appeared like a lack of initial uptake of FITs, there are many projects in the pipeline. A table of projects in the pipeline for the 2012-2018 period for several types of renewable energy is provided in Table 8. Approved projects from the ERC's report for the 2013-2014 period are shown in Table 9. We can gauge the magnitude of completed projects by examining calculations of the potential from renewable energy sources as of June of 2013, shown in Table 10 and installed capacity of main grid connected renewables, shown in Table 11.

According to the ERC (2013), there was an upsurge in solar energy connections, due mainly to off grid projects and heavy consumers seeking to reduce their cost of power. For example, Williamson Tea Kenya Limited, had a 1 MW solar PV plant investment. In the off grid small units segment, Non-governmental organizations distributed solar lanterns, phone charges, and refrigerators. The government also approved PPAs for wind projects such as Lake Turkana and Kinangop. According to the Commission's estimates, total generation from renewable energies increased from 3,625 GWh in 2009-2010 to 6,026 GWh in 2013-2014. During the 2013-2014 period, the ERC approved 25 projects under the FIT policy, with a 93% approval rate[14]. Table 12 shows a summary of applications approved under the FIT program.

The REA increased access to electrification in rural areas. From 2008 to 2011, the installations of solar PV home systems increased at an average of 20,000 units per year (Republic of Kenya 2011). Furthermore, roughly 500 public institutions have been installed with solar power lighting (REA 2013). One of REA's goals was to electrify all secondary schools and health and trading centers by 2013. The agency achieved electricity connections in 89% of public facilities by 2013, with the help of the government, Ministry of Energy and development partners such as the World Bank and the Governments of France and Spain (REA 2012b; REA 2013). Additionally, pilot renewable energy projects through mini hydro, wind, and biogas were started for community generation and distribution of electricity. Immediately after Phase I came to an end, REA developed new strategic plans and reviewed the status of the targets from Phase I. Table 13 presents REA's progress in electrification of off-grid areas.

According to a recent newspaper article (REA Press Release 2015), Kenya's policies have resulted in the following outcomes: (1) an addition of 514.9 MW to the grid, (2) enough

[14] The ERC did not approve one wind proposal and one hydro proposal.

geothermal power additions to make Kenya the world's 8th largest producer with a steam power capacity of 579 MW, (3) 18,424 schools that are connected to the grid (with plans of connecting the remaining 3,076). These changes are, in part, a consequence of the policies examined.

A major concern when increasing use of electricity in Sub Saharan Africa and in developing countries in general is the lack of access to the poor. For many remote rural areas, at least in the early stages of electricity access involving the use of small systems such as solar-powered refrigerators and mobile phone chargers, renewable energy sources seem to be the least cost option. As mentioned earlier, donor and government funding or financing has been one avenue for addressing this. For example, in 2015, the World Bank approved $457.5 million USD funding to increase electricity access for Kenya's low income households and firms. This included a loan of $250 million USD from the International Development Association (IDA)[15] and a guarantee for $200 million USD from the IDA to help improve Kenya Power's creditworthiness. While these funds are not entirely meant to be used for renewable energy, $7.5 million USD were directly allocated to increases in generation from renewable energy sources. The money will be shared by Kenya's Ministry of Energy, Kenya Power and the REA and is expected to provide access to electricity for 630,000 people (Karambu 2015). Another example, the Olkaria geothermal project, received funding from several donor agencies such as the World Bank, the Japan International Cooperation Agency, the European Investment Bank, Agency France de Developpement and Germany's KFW (World Bank 2015).

## 6. Conclusions

[15] The IDA is the World Bank's commercial loan arm and complements the International Bank for Reconstruction and Development.

So far, it seems that Kenya's policies have helped increase connectivity. Perhaps the biggest issue that still needs to be addressed is how to increase connectivity for the poorest households. The Ministry of Energy and Petroleum (2014) mentions insufficient financing mechanisms as a challenge. Connecting schools and health centers is a first step towards reaching the rural poor.

While it is not possible to calculate the employment effects of increases in the availability of renewable energy in Kenya, there is information about the solar industry in Kenya. According to Ondraczek (2013), in 2009, there were approximately 15 to 40 major suppliers of solar equipment, 3 manufacturers of batteries, and 9 lamp manufacturers. There were also several companies dedicated to importing solar systems, hundreds of sales agents, and roughly 2,000 installation technicians (Ondraczek 2013). The author further notes that this makes Kenya an import and manufacturing hub for the area.

The use of cleaner cooking and lighting technologies can help reduce the health problems related to indoor smoke, alleviate poverty and climate change concerns, and provide better outcomes for education through the use of night time reading and access to ICT technologies.

Additionally, renewable energy investments have produced positive effects for other sectors. For example, recent geothermal investments led to a reduction in the costs of power to industrial and commercial consumers which in turn reduced the costs of doing business in Kenya (World Bank 2015).

Looking into the future, and as a way to deal with the intermittency issues of solar energy, the government has started an initiative for building combined solar/wind and solar/diesel plants (Ministry of Energy and Petroleum 2014).

Even though Kenya has experienced growth in the use of renewable energy sources, several challenges still remain. For geothermal energy, development and exploration activities continue to be costly and risky. There is also a lack of expertise in the industry and skilled capacity for several sources, such as geothermal, wind, small hydro, and solar. Furthermore, high upfront costs remain a challenge for geothermal, wind, and solar sources (Ministry of Energy and Petroleum 2014). Because of these challenges the country is expected to continue its dependence on aid from donor organizations, at least in the short term. Having clear policies, does, however help by reducing investor risk and attracting foreign investment. In regards to the FIT themselves, the government has identified "insufficient data and analytical tools to inform the level of tariffs" (Ministry of Energy and Petroleum 2014, p.30) as one of its major challenges. Other challenges mentioned include a lack of awareness of the FIT program by investors and inadequate technical and financial capacity. A challenge that is not mentioned but is worth noting is making sure that electricity is provided at the lowest cost possible while taking environmental and health concerns into account.

Table 1: Power Generation Capacity: Installed capacity in MW as of June 30, 2014. (Source: Energy Regulatory Commission 2013)

| Type | Installed capacity (MW) | % of Source of Power |
|---|---|---|
| Hydro | 818.21 | 42.64% |
| Geothermal | 363.40 | 18.94% |
| Wind | 5.3 | 0.28% |
| Solar | 0.7 | 0.04% |
| Cogeneration (Biomass) | 26 | 1.35% |
| Gas Turbine | 60 | 3.13% |
| Medium Speed Diesel | 548.8 | 28.60% |
| High Speed Diesel | 37.6 | 1.96% |

Note: The geothermal share increased to 51% in 2015 thanks to the commissioning of Olkaria I and Olkaria 4 in the Rift Valley (World Bank 2015).

Table 2: Electricity Sector Institutions in Kenya (Source: Republic of Kenya 2011).

| **Institution** | **Description** |
|---|---|
| Ministry of Energy | Establishes energy policies, sets strategic direction for the sector. |
| Energy Regulatory Commission | Regulates the energy sector. Sets tariffs and oversight, coordinates the development of energy plans, monitors and enforces sector regulations. |
| Energy Tribunal | Arbitrates disputes. |
| Rural Electrification Authority | Implements the Rural Electrification Program. |
| Kenya Electricity Generating Company | Main electricity generator (installed capacity of 1,176 MW). Ownership is 70% government, 30% private investors. It accounts for roughly 75% of installed capacity from hydropower, thermal, geothermal, and wind sources. |
| Independent Power Producers | Private investors involved in generation under Kenya's feed in tariff. They account for roughly 26% of the country's installed capacity from thermal, geothermal, and bagasse. |
| Kenya Power and Lighting Company | Off-taker in the power market. Buys power from all power generators under Power Purchase Agreements for transmission and distribution. Ownership is 50.1% Government of Kenya and National Social Security Fund and 49.9% private investors. |

Table 3: FIT values for Small Renewable Projects (Source: Ministry of Energy and Petroleum 2014)

| | Installed capacity (MW) | Standard FIT (USD/kWh) | Percentage Escalable portion of the tariff | Min capacity (MW) | Max capacity (MW) |
|---|---|---|---|---|---|
| Wind | 0.5-10 | 0.11 | 12% | 0.5 | 10 |
| Hydro* | 0.5 | 0.105 | 8% | 0.5 | 10 |
| Hydro* | 10 | 0.0825 | 8% | 0.5 | 10 |
| Biomass | 0.5-10 | 0.10 | 15% | 0.5 | 10 |
| Biogas | 0.2-10 | 0.10 | 15% | 0.2 | 10 |
| Solar (Grid) | 0.5-10 | 0.12 | 8% | 0.5 | 10 |
| Solar (Off grid) | 0.5-10 | 0.20 | 8% | 0.5 | 1 |

* Interpolation is applied to determine the tariff for hydro values between 0.5-10 MW.

Table 4: FIT values for Large Renewable Projects (Source: Ministry of Energy and Petroleum 2014)

| | Installed capacity (MW) | Standard FIT (USD/kWh) | Percentage escalable portion of the Tariff | Min capacity (MW) | Max Capacity (MW) | Max cumulative capacity |
|---|---|---|---|---|---|---|
| Wind | 10.1-50 | 0.11 | 12% | 10.1 | 50 | 500 |
| Geothermal | 35-70 | 0.088 | 20% for first 12 years and 15% after | 35 | 70 | 500 |
| Hydro | 10.1-20 | 0.0825 | 8% | 10.1 | 20 | 200 |
| Biomass | 10.1-40 | 0.10 | 15% | 10.1 | 40 | 200 |
| Solar (Grid) | 10.1-40 | 0.12 | 12% | 10.1 | 40 | 100 |

Table 5: FIT values for Small Renewable Projects (Source: Ministry of Energy 2012).

| | Installed capacity (MW) | Standard FiT (USD/kWh) | Percentage Escalable portion of the tariff | Min capacity (MW) | Max capacity (MW) |
|---|---|---|---|---|---|
| Solar (Off grid) | 0.5-10 | 0.20 | 8% | 0.5 | 1 |

Table 6: Firewood and Kerosene use in households (Source: Household surveys cited in Ngui et al. 2011).

| Year | Households preferring kerosene for lighting | Households preferring firewood | Households using firewood for lighting | Households using firewood for cooking |
|---|---|---|---|---|
| 1989 | 87.3% | 15.5% | 5.6% | 73% |
| 1999 | 78.8% | 17.1% | 4.9% | 68.6% |
| 2005 | 76.4% | 13.2% | 4.6% | 68.4% |

Table 7: Lighting Fuel Sources for Kenya (Lighting Africa policy report: Kenya, 2012).

| Major source of lighting | Frequency | Percent |
|---|---|---|
| Collected firewood | 27 | 13 |
| Purchased firewood | 8 | 4 |

| | | |
|---|---|---|
| Grass | 2 | 1 |
| Kerosene | 144 | 70 |
| Electricity | 16 | 8 |
| Dry cell torch | 1 | 1 |
| Solar | 5 | 3 |

Table 8. Pipeline Projects <30MW 2012-2018 (Source: Economic Consulting Associates 2012).

| Type | Total MW | Number of sites | By when |
|---|---|---|---|
| Small hydro | 119 | 35+ | 2018 |
| Biomass | 65 | 8 | 2016 |
| Small wind | 51 | 2 | 2014 |
| Small geothermal | 36.5 | 8 | 2016 |
| Biogas | 22 | 4 | 2018 |
| Solar PV | 10 | 1 | 2015 |

Table 9: Proposals approved under FIT policy, year 2013-2014 (Source: ERC 2013)

| Type | Number of approved proposals | Total capacity (MW) |
|---|---|---|
| Solar | 18 | 554.6 |
| Small Hydro | 20 | 77.83 |
| Biomass/Biogas | 4 | 52 |
| Geothermal | 1 | 15 |

Table 10: Potential from Renewable Energy Sources, as of June 2013 (Source: ERC 2013)

| Source | Minimum (MW) | Maximum (MW) |
|---|---|---|
| Hydropower | 3,000 | 6,000 |
| Geothermal Power | 7,000 | 10,000 |
| Cogeneration (Biomass) | 193 | 350 |
| Biogas | 29 | 131 |
| Solar PV | 106 | 15,000 |
| Wind | 300 | 1,000 |

Table 11: Installed Capacity of Main Grid Connected Renewables (MW), 2015-2011 (Source: ERC 2011)

| Type | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 |
|---|---|---|---|---|---|---|---|
| Large hydro (>10MW) | 663.3 | 663.3 | 663.3 | 723.3 | 735.3 | 764.6 | 763.3 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Small hydro (<10MW) | 13.7 | 13.7 | 13.7 | 13.7 | 13.7 | 14 | 14 |
| Geothermal | 128 | 128 | 128 | 128 | 163 | 198 | 198 |
| Wind | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 5.1 | 5.1 |
| Biomass | 0 | 2 | 2 | 26 | 26 | 26 | 26 |
| Solar | 0 | 0 | 0 | 0 | 0 | 0 | 0.6 |

Table 12: FIT programs approved, 2013-2014 period (Source: ERC 2013).

| Type | Capacity (MW) | Number of Projects |
|---|---|---|
| Wind | 140 | 2 |
| Biomass | 3 | 1 |
| Hydro | 93.28 | 11 |
| Geothermal | 0 | 0 |
| Solar | 343 | 9 |
| Biogas | 7.2 | 2 |
| Cogeneration | 0 | 0 |
| Sea Waves | 0 | 0 |
| TOTAL | 586.48 | 25 |

Table 13. Electricity for Off-Grid Areas by REA (Source: REA 2012a, REA 2013)

| Facility | Number of facilities electrified from 1973-2003 | Total number of facilities electrified in 2012 | Total number of facilities electrified in 2013 |
|---|---|---|---|
| Trading Centers | 1,096 | 9,234 | 10,658 |
| Public Secondary Schools | 285 | 6,546 | 8,258 |
| Health Centers | 348 | 3,251 | 4,082 |
| Proportion of electrification | | 75% | 89% |

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