Capability development and collaboration for Kenya's solar and wind technologies: analysis of major energy policy frameworks

Aschalew Tigabu
PhD, Research Fellow
African Centre for Technology Studies, Kenya

Rebecca Hanlin
Innovation and Development Specialist
African Centre for Technology Studies, Kenya

Ann Kingiri
PhD, Senior Research Fellow
African Centre for Technology Studies, Kenya

Margrethe Holm Andersen
Senior Advisor
Aalborg University, Denmark

Faith Hamala Wandera
IREK PhD Fellow
Moi University, Kenya, Aalborg University, Denmark

Rasmus Lema
IREK PI, Associate Professor
Aalborg University, Denmark

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1. Introduction

The Kenyan energy sector is dominated by traditional biomass, which accounts for about 68% of the total energy supply. Much of the biomass is obtained from unsustainable sources, putting pressure on the dwindling forest stock (Kiplagat et al., 2011). The electric power sector, mainly from hydro, accounts for 9% of the total energy consumption. This sector is constrained by high cost, insufficient supply and increasingly by adverse effects of climate change in cases of power produced from hydroelectric dams. As of 2014, over 77% of the Kenyan population does not have access to electricity.[2] The coverage is worse in rural areas where over 94% of the population is not connected to the national grid (Gitone, 2014). Despite the current low electrification rate, demand for electricity is projected to surge due to rapid economic and population growth. Such challenges necessitate alternative and complementary ways of energy generation, mainly from renewable sources. Despite abundance, the contribution of many renewable energy sources to Kenya's installed generation capacity has remained insignificant. For example, wind and solar power input accounts for only 1.2% of installed power capacity as of 2014 (Ministry of Energy, 2015c).

Kenya's Government increasingly considers renewable energy sources as an important mean to ensure energy security, power Kenya's development, diversify energy sources and create employment and income generating opportunities to the growing population of Kenya. As such, it has put in place a number of policy frameworks that encourage the development and diffusion of renewable energy technologies. These include Sessional Paper No. 4 of 2004, the Energy Act 2006 and the Feed-in-Tariff (FiT) policy[3].

The main purpose of this report is to briefly explore such policies and highlight the extent to which these policies reflect capability building and collaboration, which are needed for widespread diffusion and adoption of renewable energy technologies. Arguably, capability issues are important because promoting growth of specific sectors would enable a country like Kenya to create and strengthen its value addition activities including ability to design, build and operate in these sectors. Empirical research has shown that introduction of solar PV in Kenya initially failed because of lack of capability for appropriate installations and maintenance (Ondraczek, 2013). In addition, local technological and managerial capabilities in renewable

[2] This percentage is expected to reduce given the different government initiatives like the Rural Electrification Programme (REP) implemented by Rural Electrification Authority (REA) and 5,000+MW Project.

[3] These documents have been under review (see for instance the draft National Energy and Petroleum Policy 2015 and the draft Energy Bill 2015).

technologies like wind and solar PV technologies are perceived to be important in addition to the degree to which capabilities are sort, and utilized by local actors, from outside Kenya.

The report is structured as follows. The following Section presents an overview of the Kenyan solar PV sector. Section 3 highlights the Kenyan wind energy sector. It is followed by Section 4, which presents a brief overview of the Kenyan solar and wind energy policy environment. Finally, Section 5 and 6 provide brief reflections on capability development and collaboration within the major energy policy frameworks and concluding remarks, respectively.

2. The Kenyan solar PV sector

Utilising solar resources in Kenya started in the 1870s, following government's use of solar photovoltaic (PV) systems to operate broadcast installations (masts) in remote areas (Hansen et al., 2014a; Hansen et al., 2015). In the 1980s, international donors and NGOs played a key role in the development of solar energy sector to provide electric power to social services, such as school lighting, water pumping and vaccine refrigeration (Ondraczek, 2013). However, donor support has gradually reduced over the years; and since 1990s the sector has been mainly driven by the private sector. Arguably, the growth of solar home systems market in Kenya is mainly attributed to marketing efforts of the private sector with little support from the government (ATPS, 2014). Donor support is also considered as a crucial and complimentary factor in facilitating the development of solar home systems niche market in Kenya (Byrne et al., 2014). Lately, the government has shown increasing interest for solar electric energy. For instance, since the mid-2000s, the government has been providing boarding schools and health facilities in remote areas access to electricity through PV panels. From 3000 institutions in remote areas, about 2050 institutions, including primary and secondary schools, dispensaries, health and administrative centres, have been electrified by solar PV systems (Ministry of Energy, 2015)[4]. In the early years of PV sector development in Kenya, solar systems were relatively larger, complicated and expensive. Most of them failed because of lack of capability for appropriate installations and maintenance (Ondraczek, 2013). Despite the challenges, significant success was achieved in the commercial diffusion of battery-based solar home systems, driven by a desire for TV viewing of the rural community (Ondraczek, 2013).

It is estimated that over 320,000 rural households have solar home systems (SHSs) as of 2012 (Lay et al., 2012). PV systems commercially distributed to rural areas of Kenya typically consist

[4] The Kenyan government's support to development of solar PV particularly through public institutions since 2005/06 to date including creation a conducive environment for entry of the private sector has not been explicitly documented hence the need to generate empirical evidence in this regard.

of 14 to 20Wp, wiring, rechargeable battery, sometimes a charge controller system, lighting systems, and connections to small appliances (such as a radio, television, or mobile phone charging units) (Lay et al., 2012).

Despite the tremendous market growth of pico-solar and SHSs in Kenya, the diffusion of large-scale (grid-connected) solar plants is relatively limited, and solar energy potential of the country is untapped[5]. This is due to attributed to high capital investment requirements, limited awareness of potential investors and the government on the opportunities and risks of large-scale solar investment (Ministry of Energy, 2015)[6].

3. The Kenyan wind energy sector

According to the Energy Regulatory Commission (2015), wind energy in Kenya was first introduced by European settlers at the turn of the 20th century. Wind mills, imported from Europe, were used for agricultural water lifting purposes. These were later replaced by diesel and petrol engines. During the late 1970s and early 1980s, a number of windmill projects were started. Most of these projects were later abandoned because of inadequate feasibility assessment, poor planning and lack of funding. In 1993, the Belgium government funded the first wind energy farm in Ngong hills that consist of two 200 kW wind turbines (Energy Regulatory Commission, 2015).

Wind energy in Kenya has remained untapped (only 20 MWp as of December 2014)[7]. This is attributed to lack of sound data on wind power potential spots in the country, large initial capital requirement of wind projects, high cost of investment for transmission lines, poor infrastructure and lack of stable grid and disconnect among potential stakeholders (Ministry of Energy, 2013; Government of Kenya, 2011).

In 2008, the government of Kenya launched the 'Wind Energy Data Analysis and Development Program' within the 'Energy Sector Recovery' project funded by the World Bank to supplement the Wind Atlas of Kenya. Within this program, the Ministry of Energy installed 95 wind speed measuring masts (data loggers) across different regions of Kenya. Subsequently, the Ministry of

[5] Kenya has abundant solar energy resources. Its daily average solar insolation is estimated to be about 4-6 kilowatt hours per square meter, which is considered one of the best for solar electric energy production in sub-Saharan Africa. Depending on the conversion efficiency of solar modules, 10-14% of this energy can be converted to electric power (Government of Kenya, 2011).

[6] There has been expression of interest in Feed in Tariff policy for solar PV although no significant progress has been recorded since very few solar PVs have materialised into actual grid connected projects. The underlying factors are not very clear which calls for further interrogation.

[7] Kenya's wind potential is estimated to be as 1604GW in wind speed of Class III, 642GW in Class II and 4.6GW in Class I. Despite this potential, wind contributes to only 3% of the country's installed electric power capacity in 2012 (Torrie, 2014).

Energy hired WinDForce Management Services Private Limited Company to carry out a wind resource assessment. The assessment showed that 73% of the total area of the country experiences annual mean wind-speeds of above 6 m/s at 100m above ground[8]. It further revealed that the wind regimes in many parts of Kenya, especially in the northern and eastern regions, such as Marsabit, Ngong and the Coastal region, are suitable for large-scale wind power generation (Ministry of Energy, 2013).

Following the national wind resource potential assessment, a number of large-scale wind projects have been initiated. These include Lake Turkana Wind Power Project (LTWP), Kipeto wind farm, Kinangop wind farm, Isiolo wind project, and Baharini Electra Wind Farm.

4. The Kenyan solar and wind energy policy environment

4.1. Policies related to renewable energy

The Kenyan Government has developed and adopted several policies, strategies and regulations that encourage the promotion of renewable energy in the short, medium and long term[9]. One of the landmark national energy policy frameworks is the Sessional Paper No. 4 of 2004 on Energy. This policy document was passed and adopted by the Kenyan Parliament on October 7, 2004, with the goal of ensuring "adequate, quality, cost effective, and affordable supply of energy to meet development needs, while protecting and conserving the environment" (ATPS, 2014: 9). The Energy Act No. 12 of 2006 further operationalizes it. The Act strongly encourages the development and use of renewable energy in Kenya in the short to long-term. It offers the regulatory conditions for cost-effective and environmentally friendly energy generation and use from biomass, solar, wind, small hydro, municipal waste, and geothermal heat. Within the Energy Act 2006, the 'Promotion of Renewable Energy and Energy Conservation' section has given the mandate to promote the use of renewable energy generated from a range of renewable sources, including wind and solar, to the Ministry of Energy. The Energy Act also has put in place the Rural Electrification Authority (REA) and the Rural Electrification Fund to facilitate the provision of electricity to remote and off-grid locations (Ministry of Energy, 2013). On the other hand, the draft Energy and Petroleum Policy (Ministry of Energy, 2015a) recognises the potential of renewable energy sources to ensure energy security, improve

[8] It is likely that most of the data collected from the installed wind masts is more useful to grid connected wind generation as opposed to decentralised generation. This is because studies on decentralised generation are lacking. Review of available literature suggests that although the government take cognisance of the role of decentralised systems, the policy focus has been development of grid connected wind.

[9] It is important to note that the Energy sector policy documents give more prominence to solar PV compared to wind mainly in greening of the thermal power generation which serves areas that are not in close proximity to the grid.

livelihoods through increased income generation, employment and foreign currency earning, and climate change mitigation. The draft Energy bill 2015 (Ministry of Energy, 2015b) devotes the whole of Part IV to renewable energy and necessary measures for promotion of different sources. Unlike the Energy Act, 2006, it sets out provisions for ownership of renewable energy resources and establishment of renewable energy resource advisory committee. It also provides for establishment of a renewable energy Feed-in-Tariff (FiT) System and the necessary FiT regulations thereby consolidating the 2012 revisions of FiT policy of 2008. The draft Energy bill 2015 (Ministry of Energy, 2015b) in addition to promotion of renewable energy, it reinforces the function of the Rural Electrification Authority (REA) and provides for National and County Government functions in relation to energy. The draft Bill 2015 reviews the Energy Act 2006 and operationalises the draft National Energy and Petroleum policy 2015. Both the draft policy and the draft bill reiterate the government's interest in increasing the share of renewable energy in the total energy installed capacity.

Other strategies that encourage the promotion of clean and renewable energy alternatives include the Climate Change Action Plan, the Updated Least Cost Energy Production Plan (LCEPP), the Power Purchase Agreement, the FiT Policy, Kenya Vision 2030 and the Kenya Rural Electrification Master Plan.

4.1.1. Policies related to solar PV

There are a number of policies, regulations, and strategies currently in place that support the diffusion and adoption of solar PV in Kenya. These include the Sessional Paper No.4 of 2004, the Energy Act 2006, the Kenya Rural Electrification Master Plan, the Feed-in Tariff Policy, the Kenya Vision 2030, and the Kenya National Climate Change Response Strategy of 2010.

The government has put in place solar energy targets in its 2012 National Energy plan, in which it stipulates the installed PV capacity to be 200 MWp by 2022 and 500 MWp by 2030. The government has also set up the Green Energy Fund Facility within the National Taskforce on Accelerated Development of Green Energy with the aim of offering loans to entrepreneurs who wish to invest in renewable energy projects, including solar PV (Hansen et al., 2014b).

To guarantee investment security and market stability for investors in the renewable energy sector, the Ministry of Energy developed a FiT policy in 2008. The FiT allows independent power producers (IPPs) deliver power generated from wind, small hydro and biomass sources to the national grid at a predetermined tariff rate. The FiT was revised in 2010 and 2012 to include solar power and amend tariffs, respectively. The FiT scheme for Solar PV is 12US cents/kwh (grid connected), 20 US cents/kwh (mini grids). The scheme was to remain applicable for 20 years from the start of the project (Ministry of Energy, 2010).

In addition to the FiT, net-metering policy for solar PV systems was introduced in 2012[10]. The Energy Regulatory Commission (ERC) has also put in place a zero-rated (0%) import duty and removed Value Added Tax (VAT) on imported renewable energy equipment and accessories in 2011. There is an exemption from VAT and duties for imported solar PV and SHSs accessories, including locally manufactured solar batteries. The VAT exemption is applicable for buying a complete package of SHSs (Government of Kenya, 2011).

The Energy Solar Photovoltaic Systems Regulations (2012) were put in place to ensure safe, fair and quality business practices around solar technologies. This regulatory instrument specifies the licensing and registration requirements for solar technicians, manufacturers, importers, vendors and contractors. It also specifies the procedures for the design, repair and maintenance of solar PV technologies. The regulations provide for a licensing framework for the solar PV value chain and facilitate proper design, installation and use of solar PV systems while avoiding supply of sub-standard components and installations. Further, the regulations provide for requirement for licensing for installations which are over 500 kW (Ministry of Energy, 2012).

5.1.2 Policies related to Wind

Many of the policies that support solar energy development in Kenya also support wind energy development. The key national economic development plan, the Kenya Vision 2030 for example sets a target of developing 2036 MW of wind power by 2030 to meet the energy requirements of the country, which is growing at 13.5% annually (Ministry of Energy, 2013). The Vision points out the risk posed by climate change in meeting development targets. In response to this, the Government launched the National Climate Change Response Strategy in 2010. The Strategy outlines core principles of sustainability, including the Government's ambitions of increasing the share of renewable energy in the total energy installed capacity.
Similar to solar, the FiT scheme allows a private investor to sell wind electric power to the national grid at a fixed tariff of US $ Cents 11.0 per kilowatt-hour for 20 years. This tariff is applicable if 'effective generation' by independent power producers (IPPs) is between 500 kW and 100 MW (Ministry of Energy, 2010).

The Government has also put in place zero-rated import duty for wind energy equipment. It has also removed VAT on imported renewable energy equipment and accessories (Ministry of Energy, 2013). The Energy Act of 2006, National Climate Change Response Strategy of 2010, the LCPDP all emphasise the facilitation of wind energy development to meet the long-term development strategy of the country stipulated by Vision 2030 (Triple E Consulting, 2014). The

[10] Although the net metering policy was introduced recently in the draft policy 2015, it is necessary to establish the status quo in terms of its impact.

Updated LCPDP for example, projects the share of wind energy to be over 9% of the total generation capacity of the country by 2030 (Triple E Consulting, 2014).

5. Reflections on capability development and collaboration within the major energy policy frameworks

To gain some insights into the emphasis placed on capability development and collaboration for wind and solar, we examined some of the major energy policy frameworks in Kenya. These include the Sessional Paper No. 4 of 2004 on Energy; the Energy Act of 2006; the draft energy policy document (2015); the Draft Energy Bill, 2015; LCPDP and the National Climate Change Response Strategy of 2010.

The Sessional Paper No. 4 of 2004 (Ministry of Energy, 2004) asserts that human resource development and capacity building are critical for the Kenyan energy sector. The policy document (page36) states that "technological and policy issues in the energy sector are highly dynamic. There is therefore need to continuously train and upgrade human resource capacity to keep up with these dynamics. In Kenya's energy sector, specialized research and consultancy services have largely been internationally sourced due to inadequate domestic capacity to undertake such tasks. In addition, specialized training programmes on energy are not available in the country's institutions of higher learning; there is also a discernible gender imbalance in the management of the energy sector, which is dominated by men." The short term (2004–2007) and long-term (2004-2024) implementation plan of the 'Sessional Paper No. 4 of 2004' aim at "undertaking critical analysis of the manpower and capability requirements for the renewable energy" sector and "developing local manufacturing capability for advanced renewable energy technologies (such as photovoltaic and wind power turbines for electricity generation) both for domestic and export markets", respectively. With respect to collaboration, the Sessional Paper states that "promotion of closer collaboration and cooperation in capacity building especially information exchanges with regional governments and international organizations" is crucial to address human resource development challenges in the energy sector.

The Energy Act of 2006, (Government of Kenya, 2006 pp100-101), states that the Ministry of Energy "shall promote the development and use of renewable energy technologies, including but not limited to biomass, biodiesel, bioethanol, charcoal, fuelwood, solar, wind, tidal waves, hydropower, biogas and municipal waste." To do this, the [Energy] Minister shall promote "the development of appropriate local capacity for the manufacture, installation, maintenance and operation of basic renewable technologies such as bio-digesters, solar systems and hydro

turbines". With respect to collaboration, it states the [Energy] Minister shall promote "international co-operation on programmes focusing on renewable energy sources." This may include "harnessing opportunities offered under clean development mechanism and other mechanisms including, but not limited to, carbon credit trading to promote the development and exploitation of renewable energy sources."[11]

The draft national energy and petroleum policy document (Ministry of Energy, 2015a) recognises that lack of skilled manpower is among the key challenges constraining wind and solar energy development in Kenya. This policy consequently outlines policies and strategies that are aimed at capacity building within the short term (2015-2019), medium term (2015-2024), and long term (2015-2030). With respect to solar energy, for example, some of the suggested interventions include 'undertaking awareness programs to promote the use of solar energy', 'providing incentives to promote the local production and use of efficient solar systems', 'undertaking Research Development and Dissemination (RD&D) on solar technologies'. The document also aims at developing institutional capacity for widespread use of wind energy and undertaking RD&D activities within the short, medium and long term. However, it does not specify policies and strategies aimed at strengthening or stimulating collaboration in the wind and solar sectors. The draft energy policy 2015 (Ministry of Energy, 2015b) provides for generalised requisite capacity building and collaboration to support renewable energy (not specific to solar and/or wind). Promotion of local capacity building is outlined in Section 90 2(e), collaboration in Section 90 2 (f &g) and enabling framework in Section 90 2(b).
Arguably, for the main policy instruments that recognise the importance of enhancing collaboration and building requisite capabilities for the renewables sector growth, they fail to provide clear and contextually informed strategic directions on how this should be pursued and for what purpose.

The LCPDP and the National Climate Change Response Strategy do not specifically articulate the need as well as ways of strengthening capacity and collaboration in the wind and solar sectors of Kenya.[12]

6. Concluding remarks

[11] Considering that the 2004 policy and 2006 Act are over 10 years old it is paramount to investigate empirically to what extent these policies and provisions in the law have played a role in improving the capabilities and collaboration with respect to solar and wind development in Kenya.
[12] It is possible that lack of skilled man power has persisted since 2004 to date. Critical analysis of the evolution process in terms of milestones taken by the government in this regard may help to expose the critical challenges and how these may be tackled in a sustainable manner.

The major objective of this report is to highlight the degree to which capability development and collaboration building are reflected within current energy policies, regulations and strategies of Kenya, with a particular focus on wind and solar PV. To do so, the key assessment questions were: (a) what are the relevant policies, which shape the development of wind and solar PV in Kenya? And (b) to what extent do these policies reflect capability-building and collaboration? The results show that there are a number of policies currently in place that support solar PV and wind energy. This for example include Sessional Paper No. 4 of 2004 on Energy, the Energy Act of 2006, the draft energy policy document (2015), the LCPDP, the FiT Policy and the National Climate Change Response Strategy.[13] From these policy documents, the Sessional Paper No. 4 of 2004, the Energy Act of 2006 and the draft energy policy document reflect capability development and collaboration with an emphasis on human resource development.

Despite stating the need for human resource development, existing energy policy documents do not sufficiently articulate the merits, strategies, activities or mechanisms of absorptive and innovative capacity development. Current policies, regulations and strategies on wind and solar PV in particular do not sufficiently reflect disaggregated and specific mechanisms of building local capability for equipment manufacturing, project development and investment, construction and installation, and operations and maintenance. They do not also sufficiently reflect on the role of key actors, such as donors, universities, research, and financial institutes in technological capability development. Nor do they highlight the key role played by imported technologies and foreign direct investments in technological capability development at local levels. Similarly, existing policy documents do not sufficiently address the merits and ways of strengthening both local and international collaborations in the areas of financial and project management, and capacity building at sufficient depth.

These results also suggest that energy policy designers in Kenya may have under-appreciated the fact that innovation and diffusion of new technologies, such as Solar PV and wind turbines, into new settings is determined by the degree of interactive learning among key actors and their capabilities. The capacity to identify, diffuse, adopt, modify and adapt new technologies has long been known to be a key determinant of technical change in developing countries (Nelson and Pack, 1999). Technological capabilities are critical components of national innovation systems

[13] Available information on solar PV sector tends to suggest that private sector participation has been improved more for decentralised solar than for the small wind. Grid connected solar is still facing challenges while grid connected wind has taken off well. What could be the contributory factors to this scenario could form an issue that could be investigated.

(Fagerberg & Srholec, 2008), which in turn are determined by systematic policy interventions. Experiences of emerging countries with energy technologies, for example wind turbine development in China, show that focussed institutional support strengthens technology capability development (Ru et al., 2012). The key questions for the renewable energy sector of Kenya will therefore be (a) how can capability and collaboration be strengthened for renewables in Kenya? (b) What are weaknesses and strengths of the renewable energy sector and the interconnected system and how can these be strengthened? Answers to these questions will inform policy formulation on capability development and collaboration in Kenya for renewables. This is what IREK project aims to do over the next couple of years.

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