Policies and practice for enhanced capabilities in the renewable energy sector in Kenya: perspectives from stakeholders in the energy sector

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Abstract

To enhance inclusive and sustainable development in renewable energy (RE) technological innovations in emerging economies like Kenya, stakeholder groups (policy makers, private sector, researchers and NGOs) can strategically shape the innovation process including the technological field in which these technologies develop and diffuse. Their intervention can occur at different points during the technology development and diffusion continuum but this can also occur through their strategic engagement for policies and practice intervention. A qualitative study was carried out to solicit stakeholders' perspectives about capabilities building and collaboration in RE projects in Kenya and what this means for policy and practice. The study is also concerned about the accumulated capabilities or embedded learning that occurs within collaborative projects that characterize most renewable technologies in African countries. The study draws insights from technology transfer and national innovation system (NIS) literature to expose stakeholders' understanding about the key processes that enhance or characterize local technical and managerial capabilities in the uptake of renewable technologies in Kenya. The study uses the case of renewable electrification with wind and solar PV in Kenya. The findings show that, stakeholders consider solar and wind technologies as opportunities for building local capabilities through their deployment in Kenya. In addition, they offer an opportunity to promote inclusivity through job creation and micro business entrepreneurship among rural community. The stakeholders identify guidance of search, knowledge development and diffusion; legitimization and resource mobilization as key dynamic functions critical for efficient and inclusive deployment of solar and wind technologies in Kenya. The study reflects on key recommendations for policy and practice in RE electrification in Kenya.

1. Introduction

1.1. Renewed impetus for policies and practice that promote sustainable renewable electrification pathways

The adoption of the UN Sustainable Development Goal (SDGs) has triggered a renewed impetus to promote green growth to combat many global challenges including climate change. The UN Goal 7, "affordable and green energy for all by 2030" in particular calls for societies to adopt sustainable and transformative energy production and consumption patterns for social, economic and environmental gains. This would go a long way in promoting access to electricity by a growing population of rural people especially in Sub Saharan Africa (SSA) where majority are off grid (IEA, 2017).

At the African continental level and national levels, there are efforts to align policies and implementation strategies to the UN global agenda. In Kenya, which is the study country, there is what can be perceived to be political goodwill evidenced by development of relevant energy policies and strategies towards the country's electrification and improved economic growth by 2030. The major energy policy instruments reaffirm the government commitment to promoting green growth for social, economic and environmental goals especially in the rural areas. To situate her national ambition within the global and continental agenda, Kenya has been in the forefront to promote innovation led and inclusive developmental approach towards achieving sustainable energy for all (Ockwell and Byrne, 2016). This implies that in addition to promotion of the UN Goal 7, promoting sustainable industrialization and fostering innovation (Goal 9) has also been driving policy and practice efforts. Consequently, there has been increased utilization of renewables and increased uptake of off-grid and mini-grids solutions for rural electrification where grid extension has been a challenge (Magni Johannsen, 2018). Despite these positive policy milestones, evidence based research is needed to inform contextually relevant implementation of strategies that promote local capabilities.

1.2. Why capabilities in renewable electrification?

There has been a significant growth in number of off grid energy firms arising from renewable electrification efforts in many countries. This has opened up research in the innovation and development studies scholarly fields, particularly research that focusses on low carbon technologies in emerging economies. 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 (Fagerberg & Srholec, 2008), which in turn are determined by systematic policy interventions. However, the context within which sustainability technologies are being advanced and the potential for their uptake depends largely on the social and institutional ecosystem that supports deployment process including accumulation of capabilities (Foxon and Pearson, 2008; Geels, Hekkert and Jacobson, 2008; Lema et al. 2018). Experiences of emerging countries with energy technologies show that focused institutional support strengthens technology capability development (Ru et al., 2012). This then implies that paying attention to local capabilities building associated with deployment of technologies is important for strengthening of respective national innovation system.

The key question for the renewable energy sector in Kenya has been how local capability and collaboration can be strengthened for renewables in a way that promotes inclusive and sustainable development. 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 local capability for appropriate installations and maintenance (Ondraczek, 2013). Recent research has attempted to understand the global nature of emerging renewable technologies and what this means for local capabilities (Lema et al, 2018). The study shows that local capabilities in wind and solar PV technologies are perceived to be important in addition to the degree to which capabilities are sort from outside Kenya and utilized by local actors. This paper attempts to expand this scholarly field. It does so through a qualitative study carried out to solicit stakeholders' perspectives about capabilities[1] and collaboration in RE projects in Kenya and what this means for policy and practice. The study draws insights from technology transfer and technology innovation system (TIS) framework literature to expose stakeholders' understanding about the key processes that enhance local capabilities in the uptake of solar and wind technologies in Kenya. The study contributes to the on-going scholarly discussion about the prospects of green energies revolution in emerging economies. The paper is structured as follows; first is the context that defines the scope of the study. Second is the framework that has informed the study, followed by methodology adopted in the study. Finally is a critical review of functions associated with RE development and deployment in Kenya based on perspectives of stakeholder groups (policy makers, private sector, researchers and NGOs). The study concludes by drawing policy and practice oriented lessons for an expanded discussion about inclusive renewable electrification in Kenya.

1.3. The Kenyan solar and wind landscape

The Kenyan solar PV sector

Utilizing 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., 2014; 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 (Byrne et al., 2014). Lately, the government has shown increasing interest for solar electric energy but despite the tremendous market growth, the diffusion of large-scale (grid-connected) solar plants is relatively limited, and solar energy potential of the country is untapped. 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).

The Kenyan wind energy sector

Wind energy in Kenya has remained untapped. 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. 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.

[1] In this paper, capabilities can be defined as having the capacity (resources, skills/competences and knowledge) to carry out a task. These include technological capabilities (e.g. manufacturing, installing, operation and maintenance) and soft aspects of capability such as the ability to organize a project, planning, financial managements etc. Local capabilities signify domestic (Kenyan) as opposed to global capabilities but can also refer to capabilities at the sub-national (county, village) level.

Kenyan solar and wind energy policy environment

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. Arguably, promotion of renewable technologies is increasingly collaborative and involves multiple actors, both local and international along the manufacturing and deployment value chain. This calls for policies and implementation strategies that provide for mandatory local capabilities building critical for sustainable growth in this sector.

2. Theoretical background

2.1. Technology transfer and local capabilities

There is a wide body of literature that looks into international technology transfer from the perspective of cross boarder flows of hardware (capital goods like machinery and equipment) or software (knowledge skills and capabilities) between suppliers and users among countries (Bell, 2012). However, linear transfer of technology from exporting country to importing country does not guarantee transfer of software. In addition, globalization and commercialization of knowledge have influenced how technologies are developed and diffused, making the local context relevant in the adaptation of requisite pro-poor technologies. Lema et al. (2018) argue that attention should be given to how technological capabilities are acquired. This is because there are complex and multiple user-producer interactions that demand critical thought about how technological and experiential learning occurs and how this contributes to local capabilities. As new technologies are introduced to a new context, the process of adaptation is determined largely by local and organizational arrangements (Sovacool, 2014). This contributes significantly to the development of a local innovation ecosystem that is critical for technological deployment more generally. As mentioned elsewhere, the stakeholder groups (policy makers, private sector, researchers and NGOs) can strategically shape the technological field in which these technologies develop and diffuse. These are referred to as system builders or operators (Ockwell and Byrne, 2015; Lema et. 2015) who advocate for policies that support a functional system.

2.2. The innovation system approaches

The innovation system approaches have been used to interrogate issues of development in emerging economies including Africa (Lundvall and Lema, 2014). The technological innovation system (TIS) for instance is organized around a technology or product of technology or knowledge field (Hekkert et al. 2007; Bergek et al. 2008). A TIS consists on the one hand, a network of actors involved in the process of development and deployment of an emerging technology, and on the other the key components that influence this process. The TIS framework is appropriate for understanding processes of technological change and hence can help explore aspects that enhance or curtail capabilities for successful uptake of renewable technologies (Tigabu, 2017; Jacobsson and Bergek, 2011). The sectoral innovation system on the other hand pays attention to learning, knowledge and capability building in an innovation process (Malerba, 2005). The application of innovation system approaches add value to the traditional technology transfer concept in the interrogation of perspectives about emerging technologies like RE. This is because aligning stakeholders' perspectives to the different relevant concepts may expose underlying factors that should receive attention for policy and practice.

3. Methodology

The narrative informing this case study is supported by primary and secondary materials (literature and gray materials). The empirical data is part of a wider research project innovation and renewable

electrification in Kenya (IREK). IREK seeks to provide a better foundation for selecting and deploying available technologies in a way that increases inclusiveness and contributes to poverty reduction. The project uses solar and wind subsectors as case studies. The project provides an opportunity to generate evidence around capabilities and collaboration and consequently use this to lobby for appropriate practice and policy change. The data analysis takes into consideration some insights from innovation systems approaches and international technology transfer literature with respect to building local capabilities.

3.1. Empirical grounding and data collection

The IREK project undertook a survey of stakeholder perceptions, attitudes and knowledge survey in mid-2016 with 91 policy-makers, energy professionals and academics from across the renewable energy sector in Kenya. The survey was focused on current perceptions, attitudes and knowledge of:

- The use and practices of wind and solar technologies in Kenya
- Current policies for Solar PV and Wind energy in Kenya
- Current barriers to diffusion of technologies in these fields

The survey placed a specific emphasis on:

- The type and extent of collaborations (local and international) within the industry that foster and enhance diffusion of solar PV and wind technologies
- The types of capabilities/capacity building that are needed to ensure these technologies can be effectively introduced and utilized in Kenya.

The survey was complemented by other secondary activities that were sources of data namely:

- Analysis of stakeholders' recommendations emanating from two stakeholders' workshops (IREK, 2015; IREK, 2018a).
- Follow-up interviews with selected policy makers and stakeholders. These were conducted in Feb 2017 in Nairobi, Kenya (IREK, 2017).
- Interaction with Kenya's parliamentary committee on Energy, 2018 during IREK's project submission on 15 March (IREK, 2018b).
- Review of relevant energy policies and strategies. The review of these policy instruments was guided by two key research questions;
  - Are energy policies cognizant of capability and collaboration and requisite importance in stimulating inclusive development and diffusion of green/renewable energy technologies?
  - What are the dynamics related to formulation of energy policies that promote capability building and collaboration in a developing country context?

3.2. Data analysis

This analysis focused on the perspectives of Kenya's stakeholder' groups about capabilities and collaboration in solar and wind subsectors. The analysis entailed three steps. First was the tabulation of the survey data based on:

a) Collaborative relationships among stakeholders. One major element of the project is to understand the importance of technology transfer (both physical technology but also skills and capability building) between countries.

b) The use of solar PV and wind technologies in Kenya: The aim was to explore the extent of stakeholder attitudes towards the perceived benefits of the technologies, parameters of technology choice and understandings on which technologies were more appropriate for Kenya.
c) Capabilities solar PV and wind technology deployment in Kenya: The aim was to illicit stakeholder opinion on the extent of capabilities in Kenya to deploy solar PV and wind technologies and in which areas foreign expertise was required.
d) Policies for solar PV and wind technology deployment in Kenya: The aim was to understand stakeholder knowledge on the existence of supportive policies for capability building and the perceived knowledge of policy-maker expertise in Kenya with regards solar PV and wind technologies and their requirements for successful deployment.

Second stage entailed the analysis of data from secondary sources that was used to triangulate findings from the survey data.

The final step entailed interrogation of the emerging perspectives using the theoretical framework adopted for this paper.

4. Findings and discussion

This section documents the results of the data analysis and relevant discussion. The first part summarizes the outcome of the review of key energy policies and strategies. The last part details the perspectives of stakeholders and how these inform policy and practice for promotion of RE local capabilities in Kenya.

4.1. Overview of major energy policies and strategies with respect to capabilities and collaboration in Kenya

As part of this study, major energy policy frameworks in Kenya were reviewed with the aim of highlighting the extent to which they reflect capability building and collaboration, which are needed for widespread diffusion and adoption of renewable energy technologies. The key assessment questions that guided the analysis were: (a) what are the relevant policies, which shape the development of wind and solar PV in Kenya? (b) To what extent do these policies reflect capability building and collaboration?

Key policies and strategies that were analyzed are: Sessional Paper No. 4 of 2004 on Energy, Draft National Energy & Petroleum Policy (2015), The Energy Act (2006), Energy Bill (2015), LCPDP (2011 & 2013), Solar Photovoltaic Systems Regulations (2012), Feed in Tariff (FiT) of 2012 and the National Climate Change Response Strategy of 2010.

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. 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.

4.2. Perspectives of stakeholder groups about collaboration and capabilities in solar and wind sub sectors in Kenya

4.2.1. Perspectives about technical and managerial capabilities

This study was motivated by an underlying hypothesis that promoting certain industries enables a country to create and strengthen its value addition activities in the relevant subject area; in this case in the ability to design, build and operate solar PV and wind projects. The survey and follow-up interview questions were designed to elicit perspectives about how renewable electrification efforts in Kenya contribute to raising different forms of technical and managerial capabilities in Kenya. Majority of the stakeholders noted that promotion of renewable technologies increases significantly the ability for local technical and managerial capabilities to be built (figure 1). This is likely to be associated with learning arising from interactions or collaborations within and outside projects.

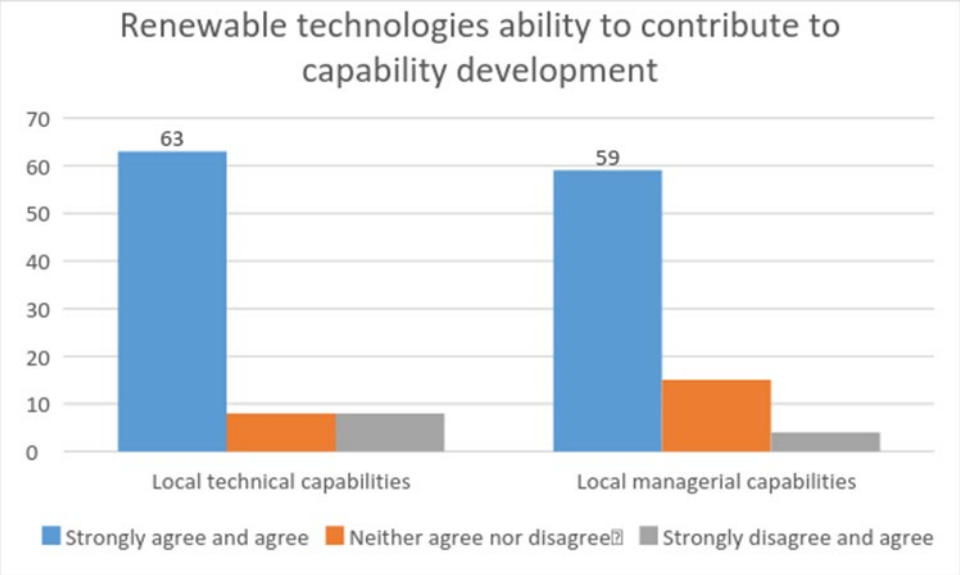

Figure 1: Respondents understanding of renewable technologies contribution to development of technical and managerial capacity (n=79)

However, majority of the stakeholders argued that mechanisms for knowledge generation and diffusion associated with different forms of capabilities in both sub sectors are currently weak. This calls for strategies to strengthen the linkages between knowledge supplies and users in a way that promote learning and consequently local capabilities.

Respondents were asked to identify areas where capabilities are strong or lacking in the wind and solar PV technology sectors in Kenya. They were required to select from i) equipment manufacturing, ii) project development, iii) construction and installation, iv) operations and maintenance, and v) training. The study

shows that equipment-manufacturing capability is significantly low in both subsectors (fig 2). Respondents argued that this might be the main reason why local projects rely heavily on foreign firms for acquisition and supply of energy generating equipment. The international transfer of technology is arguably an indication of top down transfer flow of knowledge. This is attributed to the infancy stage of Kenya's local manufacturing sector (Lema et al. 2018). Capability in operations and maintenance was a bit more developed particularly in solar subsector, which may denote opportunity for local capability deployment at the lower level of technology manufacturing and deployment chain.

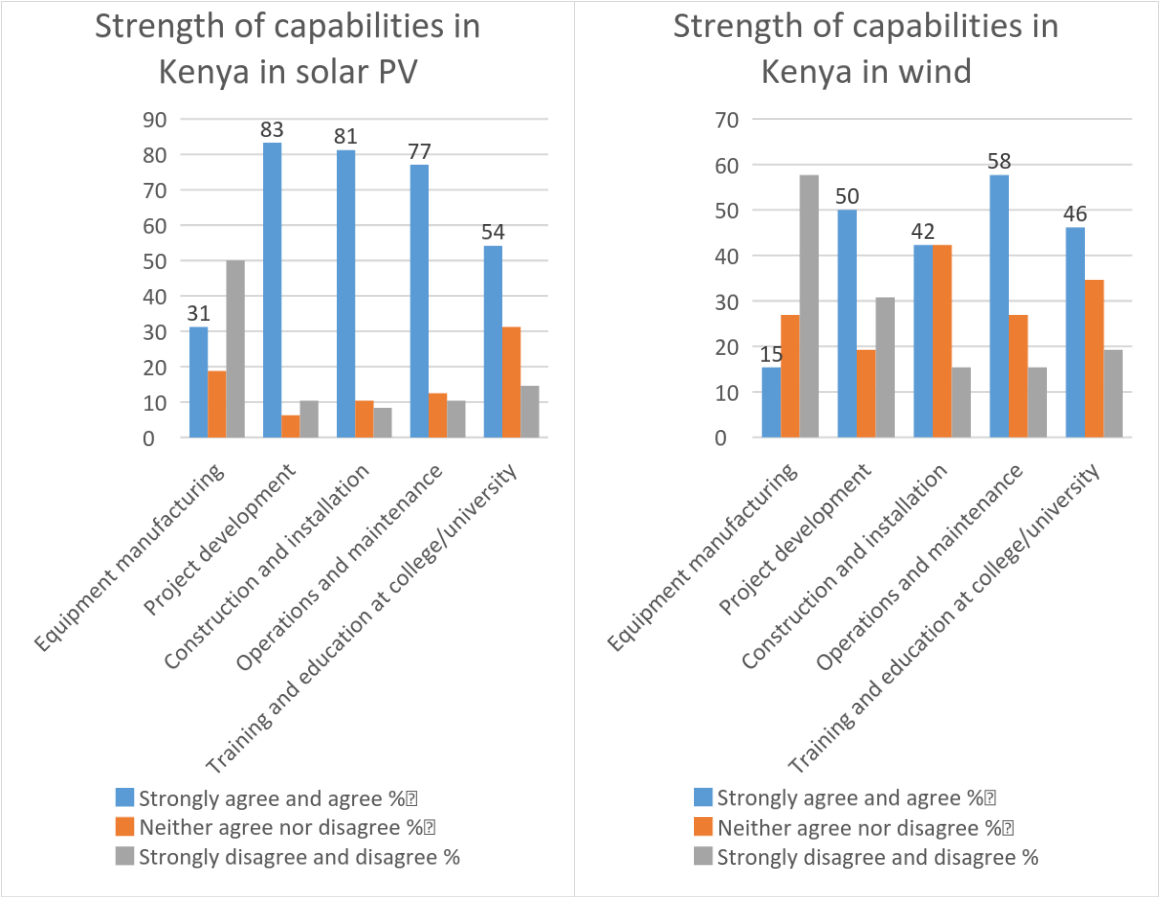

Figure 2: Respondents understanding of Kenyan capability strengths in wind and solar (%)

The respondents further noted that lack of local training and education in these subsectors has confounded the weak local capabilities situation. Arguably, training and education at college level may contribute to basic knowledge but this may not guarantee attainment of practical knowledge that is relevant for sustained local capability. Majority of the respondents identified the importance of capacity for managing networking including international relationships to enhance successful technology transfer. This is non-technical skill that need to be built at the local level. Lema et al. (2018) contend that both manufacturing and deployment chains of solar PV and wind turbines promote interactive learning that is ignored in informing requisite policy and practice. Local universities and colleges have a role to promote capabilities at both the manufacturing and deployment chains through appropriate education and training. However, combining or integrating practical knowledge in the formal technical training is an issue for policy and requires critical thought.

The study has also exposed the complexity around technology transfer and local capability building. The expected knowledge transfer from international or foreign firms should be complemented with requisite training to enhance uptake of renewable technologies.

4.2.2. Factors that should guide development and deployment of renewables in Kenya

The stakeholders were on the opinion that local and international collaborations are critical for guidance of the search in renewables' development and diffusion. The government and private sector were the two key collaborations cited (Fig 3). The nature of collaborations prioritized include training and capacity building, joint implementation of projects and research & development (R&D).

Figure 3: Most important collaborations as perceived by survey respondents

Stakeholders further noted that a number of factors should dictate strategic collaborations as well as guidance of the search for appropriate technologies.

- Origin of technology and parameters for influencing selection.

Europe was the preferred origin of solar and wind technologies, with quality of technology; and operation and maintenance as main parameters to influence selection.

- Specific demand side aspects that are important in guidance of search.

Enhancing accessibility (financing options; spares) and acceptance by consumers is critical for legitimization of the technologies. Selection and use of renewables should also be based on the extent to which they increase inclusiveness. Job creation, access to energy and opportunities for micro-businesses are key factors that were attributed to increased inclusiveness in the deployment of solar and wind technologies.

- Types and size of projects.

In solar, mini grids and home systems were recommended because of their potential to reach a large off grid population especially in the rural areas. In the case of wind, large scale grid connected projects and to a lesser extent mini grids were preferred.

- The capacity of policy makers to assess and make decision about promotion of solar and wind technologies.

The stakeholders' views about what is critical in the guidance of the search for renewable technologies suggest important factors for policy and practice. They acknowledge the important role of two actors, the government and private sector in providing a direction for the manufacturing and deployment of solar and wind technologies in Kenya. These two actors have been credited for their role in creating conducive regulatory and policy environment and for undertaking dynamic system building processes (Jacobsson and Bergek, 2011; Bergek et al. 2008).

Depending on nature of interactions, different actors in the value chain stimulate learning through the functions they undertake. This provides an opportunity for local capability building (Lema et al. 2018).

4.2.3. Creation of legitimacy through articulation of stakeholders' demand

Stakeholders' perception about benefits of renewable electrification to a large extent determines appropriate creation of legitimacy and acceptance of solar and wind technologies. Stakeholders identified economic growth and job creation as major benefits for engaging in renewables (Fig. 4). These should be major outcomes of enhanced energy access and micro-business opportunities, which exemplify inclusiveness of disadvantaged members of the society.

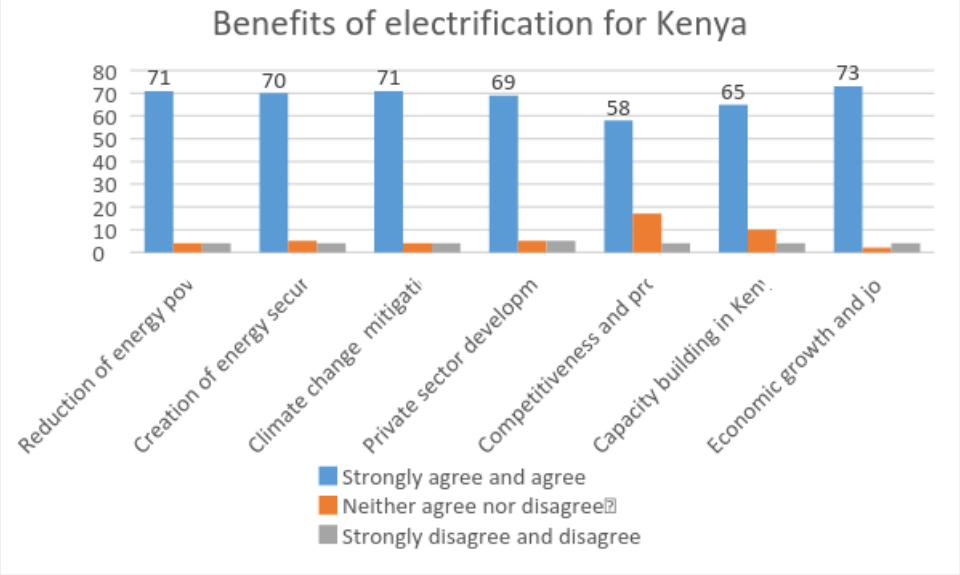

Figure 4: Respondents' evaluation of the perceived benefits of electrification with renewable energy in Kenya (n=79)

Majority of the respondents agreed that they are in a position to enhance legitimization of RE technologies through different avenues that include advocacy, publications, publicizing of research results and exposure of best practices. This form of advocacy helps balance between interest of the suppliers of technology (international firms, private sector and researchers) and demand side (consumers and communities).

4.2.4. The role of resources in deployment of solar and wind technologies.

Perspectives of stakeholders about resources revolved around financial, technical and human resource. At the level of collaboration, donors and private sector were identified as critical to implementation of projects through financial support, support for R &D as well as provision of network infrastructure. Review of major energy policy instruments shows that, the government identifies human resource as important in deployment of renewables in Kenya. A conversation with Kenyan policy makers involved in the drafting of the Energy bill established that commitment of resources (mainly technical and financial) for building local content and requisite local capabilities is paramount for the government (IREK, 2018b). They noted that private sector involved in collaborative projects must commit to do this to ensure sustainability of local projects. One way to ensure this is implemented is by embedding capabilities in the projects agreements/contracts but this must be provided for in the government policies and strategies.

5. Conclusion

The main aim of this paper is to advance knowledge about stakeholders' perspectives about capabilities building and collaboration in RE projects in Kenya and what this means for policy and practice. The study attempted to situate these perspectives within the dynamic national and local system building processes. The findings show that, stakeholders consider solar and wind technologies as opportunities for building local capabilities through their deployment in Kenya. In addition, they offer an opportunity to promote inclusivity through job creation and micro business entrepreneurship among rural community. Policy makers' recognition of documentation of case studies as one way to generate evidence that could inform development of policies and strategies at the county levels was acknowledged. The stakeholders identified different functional and sectoral aspects that are critical for efficient and inclusive deployment of solar and wind technologies in Kenya.

5.1. Learning and capabilities build up

Perspectives of stakeholders exposed capabilities building activities that enhance both technical and practical knowledge with significant learning occurring as stakeholders interact. This process is spurred by mainly government and private sector actors. Data revealed that, the Kenyan government has been supportive of conducive tax regimes for importation of solar and wind equipment. Introduction of favorable policy regimes and tax incentives generates demand for these products (Jacobsson and Bergek, 2011).

5.2. The role of policy makers in RE technologies guidance of search

Stakeholders' perspectives exposed dynamic activities that are perceived to have an influence on the attitude of actors and positive outlook about solar and wind technologies (Hekkert et al. 2007; Bergek et al. 2008). The origin and parameters of selection; types and sizes of projects are critical factors that should not be overlooked in the manufacturing and deployment chains. This is one way to enhance legitimization of solar and wind technologies in Kenya. These findings are supported by similar studies (Hansen et al. 2018; Lema et al. 2018). The capacity of policy makers to assess and make decision about promotion of solar and wind technologies was found to be important. However, review of major policy instruments suggests that energy policy designers have minimal or lack knowledge about dynamics that shape innovation and diffusion of new technologies, such as solar PV and wind turbines. This study and other studies (for example Lema et al. 2018) suggest that adapting of these technologies into new settings is determined by the degree of interactive learning among key actors and their capabilities. This calls for increased

opportunities for policy makers' capacity building which were found to be insufficient. Indeed the government should play a major role in guidance of the search through creation of policies and regulations that take into cognizance the above mentioned factors.

This study exposes the sectoral, functional and structural aspects of a national system of innovation that should be supported through policy for enhanced manufacturing and deployment of renewables. These aspects largely define policy and practice in emerging economies like Kenya. For instance, one structural aspect relates to reluctance by the government to consider alternative energy pathways. The non-renewable energy still occupies a dominant technology niche that is being challenged through proposal to consider renewable energy as an alternative but potential temporary niche. This is an area that requires further research in order to inform the growing literature in sustainability innovation policy.

6. Recommendations for policy and practice

The study is part of IREK project that is particularly interested in understanding two things:

- The type and extent of collaborations (local and international) within the industry that foster and enhance diffusion of solar PV and wind technologies.
- The types of capabilities/capacity building that are needed to ensure these technologies can be effectively introduced and utilized in Kenya.

The study has therefore provided useful information that can inform policy and practice.

6.1. Recommendations on collaborations

The Government of Kenya is seen as a strategic partner nationally in renewable electrification efforts. This places it in a strong position to utilize this perception – and not just its legal standing – as a means to capitalize on its efforts of promoting renewable energy technologies in Kenya. A key area of collaboration identified by respondents throughout the survey was training and capacity building, both at the level of policy makers and at the level of project design, implementation and operations. However, there was an acknowledgement that training opportunities were limited, especially in Kenya. This suggests the need for further investigation and analysis of training gaps and potentially the appropriateness of existing training collaborations that are in existence. It also indicates that private sector and researchers should focus more attention on investigating the gaps and how they can contribute to filling these and hence – in a broader perspective – contribute to making the solar and wind innovation systems in Kenya more effective and efficient.

The reliance on foreign technology and expertise, particularly in the area of equipment manufacturing, from a collaboration perspective, this highlights potential for foreign firms to enter this market particularly European firms, which were preferred above others in both sub-sectors. During a stakeholders workshop held to validate the study's findings, there was a consensus that academic researchers especially within Kenyan universities can benefit from this study by informing how they engage in collaborative efforts (IREK 2018a). The policy makers (the parliamentary committee on energy) were also on the opinion that the findings of this study are timely and relevant in charting Kenya's rural electrification efforts (IREK 2018b).

6.2. Recommendations on capability/ capacity building

The study shows that Kenya does not have good equipment manufacturing capabilities. This suggests that Government should proactively work to boost production capability of local actors for both wind and solar technologies. It also suggests the importance of building a strong local innovation system that nurtures

production capacity in the area of solar and wind energy in Kenya. The country would benefit tremendously if it aims at building local manufacturing capability since this may reduce the cost of solar and wind technologies, which in turn make them affordable to poor households.

The stakeholders put emphasis on existing capabilities in operations and maintenance field, especially in the wind sub-sector and a corresponding perception that Kenya did not have to rely on foreign firms for operations and maintenance expertise. This raises a conundrum for policy makers. Should the focus of attention be on building industrial manufacturing base and trying to become the source of solar PV or wind original equipment manufacturers whose products are then exported? Or, should the attention be on increasing access to energy, thereby reducing energy poverty and working towards national climate change targets? The former fits with the focus on longer term job creation and economic growth that was emphasized by so many of the survey respondents. However, so too does a focus on ensuring 100% access to electricity (whether grid connected or otherwise) – at least in the short and medium term until the country has been fully electrified through jobs building renewable power plants and maintaining them. A key question that requires more research by academics and more consideration by policy makers is whether focusing on increasing access to energy utilizing foreign technology creates transferable skills and opportunities for employment and viable operations and maintenance businesses beyond the wind and solar PV sub-sectors.

With regards training needs in the solar and wind sub-sectors, the results raise a key need for more assessment of the current situation to be conducted. This requires action not just by the Government of Kenya but also firms and other actors involved in solar PV and wind projects in Kenya to ensure that they have adequately trained staff. More research on the level of in-house training that takes place within firms and organizations involved in this field would provide interesting additional context here as to would a review of county level vocational training efforts, particularly in counties that have large or large numbers of renewable energy projects. Universities and other parts of the education system should likewise investigate more in what specific training may be useful to develop at Kenyan universities and in other parts of the educational system such as e.g. vocational training. All these issues relate to lack of clarity on factors that motivate the policy makers to prioritize capability building.

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