Energy Research & Social Science xxx (xxxx) xxx–xxx

Contents lists available at ScienceDirect

Energy Research & Social Science

journal homepage: www.elsevier.com/locate/erss

Original research article

Institutional influence on power sector investments: A case study of on- and off-grid energy in Kenya and Tanzania

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ARTICLE INFO

Keywords:
Multi-level perspective (MLP)
On- and off-grid energy resources
Regime transition

ABSTRACT

With the recent decline of renewable energy technology costs—most notably solar photovoltaics —off-grid energy systems are becoming increasingly attractive alternatives to grid extension for advancing rural electrification in Africa. However, there are institutional challenges to wider adoption of off-grid solutions. Combining a multi-level perspective with project funding data from the Kenyan and Tanzanian energy sectors, we assess the extent to which these new off-grid technologies have been incorporated into the existing energy regimes in both countries. Using a qualitative assessment of academic literature and official documents, and a quantitative assessment of energy investments, we find that although international development agencies have provided financial support for niche, off-grid companies, both global donors and the regime electricity sector operators in Kenya and Tanzania continue to favor on-grid and grid extension activities. While landscape influences on both countries are similar, we find that differences within the institutional regimes result in different development pathways for off-grid niches. In Kenya, unbundling and privatization efforts have attracted private investment in both on- and off-grid projects. Tanzania has more relaxed regulations for off-grid power producers, and a clearer regulatory framework for allowing off-grid operators to impose cost-reflective tariffs, which creates a supportive environment for niche innovation.

1. Introduction

Electrification rates in Sub-Saharan Africa lag behind other parts of the world, with 59% of the population still lacking access to electricity relative to the global rate of 14% in 2017 [1]. The share of individuals without electricity access in Sub-Saharan Africa is also disproportionately rural, with more than 80% of those lacking electricity living in rural areas [1]. Serving these rural populations is difficult as traditional utility-managed grid extension projects are expensive relative to the small amount of revenue that they generate. This is in part because of the distance between remote communities and the location of existing power generation facilities, which are situated to serve larger population centers [2–6].

With the cost of off-grid and renewable energy technologies falling dramatically in the past decade, investors have increasingly been looking to use off-grid generation to provide electricity to rural communities. Off-grid electricity startups are aggressively expanding into first-access communities, many in Sub-Saharan Africa, selling over 20 million branded solar lighting products worldwide [7]. Funding for this sector includes over $100 million in venture capital from the UK, US, and India [8]. The drastic increase in the size and awareness of this market, in conjunction with mobile-enabled pay-as-you-go financing schemes that align with existing sociocultural systems, have raised questions about whether it is possible for off-grid technologies to overtake more traditional and centralized on-grid-based forms of electricity generation in rural areas [9].

While interest in off-grid energy technologies continues to grow across the region, evidence suggests a relationship between the institutional structure of each nation's electricity sector and the adoption and integration of these technologies for electrification [10,11]. Until relatively recently, electricity sectors in Sub-Saharan Africa have been dominated by state-controlled and vertically integrated utilities. With the global push for privatization in the electricity sector in the 1990s—along with reforms required by multilateral organizations as a condition for project funding—many countries, including Kenya, allowed for some private sector participation. This participation can vary

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https://doi.org/10.1016/j.erss.2018.04.011
Received 1 July 2017; Received in revised form 3 April 2018; Accepted 5 April 2018

from simply allowing independent power producers (IPPs) to exist to a more full unbundling of generation, transmission, and distribution systems, as was the case in Ghana, Nigeria, and Uganda [12,13].

However, other countries, including Tanzania, have chosen to maintain state-owned, vertically integrated electricity utilities with limited private participation. Centrally controlling the numerous components of energy provision can inhibit market participation by smaller actors such as IPPs or microgrid operators. Such actors can be denied or given limited access to the existing grid and often face less transparent contracting and governance, which in turn can increase risk and deter private investment [9,13]. Furthermore, the existence of state-controlled energy companies and utilities allows politicians to further their own policy agendas and take credit for electricity services and associated economic benefits [10,14], whereas dispersed ownership and the resulting market competition may weaken the political benefits and threaten the consumer base of state-controlled utilities [15].

Previous studies have found mixed results as to whether electricity sector privatization is linked to improved electricity service and expanded access in rural areas [16]. In this paper, we seek to examine further how the history of the Kenyan and Tanzanian electricity sectors, funding flows, and policies related to new off-grid energy technologies create a supportive environment for technological development and deployment. As alluded to, off-grid technologies exist in a unique space with potential political pros and cons: they can compete with centralized generation in expanding electricity access to underserved communities, but do not necessarily rely on access to government controlled resources, and could therefore challenge existing institutional structures. It therefore is of interest to further explore how off-grid generation is either being supported or hindered by the institutions involved in the energy sector.

To organize our analysis of these off-grid generation technologies, we use a multi-level perspective (MLP) socio-technical framework to examine the institutions in both the Kenyan and Tanzanian electricity sectors, in conjunction with a quantitative analysis of investment and development aid transaction data for on-grid and off-grid energy projects in both countries. Investment in energy projects reveals the priorities and constraints of different actors across on- and off-grid technologies. Kenya and Tanzania provide interesting case studies as they are regional neighbors with similar external pressures from the socio-technological landscape and some of the most robust off-grid electricity niche markets in the world, but varied internal regime level institutions and priorities. While such case studies cannot determine causation, we intend to illustrate more fully the interactions between state policies, investment in off-grid technologies, and expansion of electricity access. Currently, both countries have relatively low electrification rates, with Kenya ahead of Tanzania in rural electrification (13% compared 4%) [17]. In addition, a 2015 study in Kenya found that over half of rural households with unmet electricity needs were within 200 m of existing grid connection point [18]. This suggests that it is not just distance from the grid, but also the interaction of institutions and policies that is important in determining the rates at which these counties are able transition to universal electricity access. Our analysis thus contributes to the discussion of the varying paths and enabling factors by which electricity is being and might be brought to underserved rural communities.

In Section 2, we define the on- and off-grid energy technologies included in our analysis, outline the MLP framework, and characterize the qualitative and quantitative data used in our analysis. In Section 3, we provide an overview of the shared socio-technical landscape that affects both the Kenyan and Tanzanian power sectors. Sections 4 and 5 focus on the context of the Kenyan and Tanzanian power sectors, respectively. Finally, in Section 6 we discuss the differences in the interactions between the different levels of the MLP framework within the Kenyan and Tanzanian energy regimes, the limitations of our current work, and some of our broad conclusions.

2. Theory and methods

2.1. Distinction between off- and on-grid technology

In this work, we distinguish between off-grid and on-grid technology to understand the relevant actors and investments into the energy sector. We use a broad definition of off-grid products that comprises any energy resources or system that is not connected to the national grid. This definition includes a wide scope of technologies, ranging from solar lanterns and solar home systems, which have generation capacities ranging from watts to tens of kilowatts and that generate, store, and use the electricity produced by a single off-the-shelf appliance, up to microgrids, which can include hundreds or thousands of kilowatts of electricity generation capacity with a distribution network serving dozens to hundreds of customers. The important distinction we draw is that these systems are still separate from larger national grids. Although many off-grid technologies make use of distributed and renewable energy resources, like solar and wind, they can also utilize more traditional technologies like small-scale hydropower or diesel generators. Currently East Africa is home to some of the largest off-grid energy technology markets in the world, with a particular focus on solar photovoltaics (PV) [7].

The on-grid projects we consider in our analysis vary from grid-connected power plant construction projects (both renewable and fossil-fuel combustion), power plant maintenance funding, transmission and distribution line construction and maintenance, and other grid extension projects as part of rural electrification programs. The emphasis of these projects is improving reliability or service of the existing electric grid, or extending it to include previously unserved customers, rather than increasing electricity consumption without grid access. On-grid initiatives can also include either distributed or utility-scale renewable energy projects if they are connected to the main grid.

2.2. The multi-level perspective

The multi-level perspective (MLP) is a conceptual framework for analyzing socio-technical transitions, including transitions associated with energy technologies [19,20] and especially for renewable energy or emerging ‘green’ technologies [21–23]. The MLP considers three levels: the exogenous socio-technical landscape, the regime, and niche innovators. Although these levels are not ontological, they do provide an analytical framework to examine the interacting institutions [24].

At the broadest level is the socio-technical landscape, which includes institutions, norms, and other environmental factors that exist outside the regime. The sociotechnical landscape exhibits the highest degree of institutionalization of the three levels, and as such, generally undergoes slow transitions over time [24]. This level also includes things like demographics, climate change, and global technology prices [25]. Baker et al. also categorize ‘international factors,’ like World Bank financing, as part of the landscape in their examination of renewable energy transitions in South Africa [26]. Here, we adopt a similar categorization for international development agencies, which play a substantial role in the electricity sectors of both of our case study countries.

Regimes lie between the socio-technical landscape and niches, and like the landscape also exhibit a high degree of institutionalization. These regimes, as described by Rip and Kemp, are “the rule set or grammar embedded in a complex of engineering practices, production process technologies, product characteristics, skills and procedures, ways of handling relevant artefacts and persons, ways of defining problems; all of them embedded in institutions and infrastructures” [27]. Although rules exist at this level, many have criticized the MLP approach for making these regimes seem monolithic when in fact the rules and institutions embedded in the regime can be and often are contradictory. Care should be taken to ensure that descriptions of these regimes reflect internal conflicts and tensions [28,29]. For decades, the