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Space and Energy Transitions in Sub-Saharan Africa:

Understated Historical Connections

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Abstract
Sub-Saharan Africa is seeing an influx of international interest and investment in energy projects designed to address the energy poverty and climate agendas. Often missing from these energy initiatives is an acknowledgement that bringing about energy transitions will require more than just the creation of efficient energy markets and technological leapfrogging. This article explores how we may begin to examine the spatial dimensions of contemporary energy systems in connection to the organization of social life in sub-Saharan Africa. Drawing on the seminal article by Bridge et al. (2013) on the spatial dimensions of energy transitions, on energy geographies literature and on various strands of social science research about Africa, the article examines the usefulness of a spatial perspective to researching how energy systems in sub-Saharan Africa came to be the way they are today. This historical understanding of energy systems is necessary if we are to make sense of future energy transitions, yet the connections between past, present and future remain understate in current policy interventions.

Keywords
Sub-Saharan Africa, Energy geographies, Space, History, Path-dependency

Highlights

- Energy initiatives in sub-Saharan Africa miss the relevance of spatial embeddedness
- Article examines spatial dimension of energy systems with a historical perspective
- Future initiatives to address spatiality of energy systems in sub-Saharan Africa

1. Introduction

Sub-Saharan Africa is seeing an influx of international interest and investment in energy projects designed to address the energy poverty and climate agendas. A recent survey of fifty-eight initiatives covering various energy subsectors for Africa as a whole showed that investment had grown six-fold between 2003 and 2013, from USD$750million to over USD$4.7billion, respectively (Quitzow et al., 2016). About seventy-nine percent of this investment was directed at sub-Saharan Africa, but even that figure was well below the estimated annual spend of USD$55billion required to meet the target of universal access by 2030 (Africa Progress Panel, 2015). Unsurprisingly, most initiatives focus on how to facilitate the creation of energy markets and attract private sector investment (cf. Quitzow et al., 2016). This approach mirrors attention to the fragmented governance landscape across Africa's energy sector (Bazilian et al., 2014; Cherp et al., 2011; Florini and Dubash, 2011; Florini and Sovacool, 2009). There are particular concerns with the ability of national governments to address, simultaneously, a low-carbon agenda and the needs of the 625 million people who lack access to electricity in sub-Saharan Africa (IEA, 2014). Despite the latest investments, the number of people without access seems to be rising – not decreasing – due to a combination of natural population growth, increase in energy exports, as well as an intensification in demand through urbanization (IEA, 2014). This reinforces the argument of various authors who think that addressing sub-Saharan Africa's energy future will require a joint consideration of Africa's ongoing 'urban revolution' (Parnell and Pieterse, 2014; Silver and Marvin, 2017).

Often missing from these energy initiatives is an acknowledgement that bringing about energy transitions will require more than just the creation of efficient energy markets and technological leapfrogging (cf. Baptista and Plananska, under review). While there are various ways of conceptualizing energy transitions (e.g. Bulkeley et al., 2014; Geels and

Schot, 2007; Shove, 2010), it is now recognized that change in energy systems requires transformations in various ecological and social dimensions that underpin social life, especially in urban areas (Castán Broto, 2017; Goldthau and Sovacool, 2012; Hodson and Marvin, 2010; Urry, 2014). It requires confronting the obduracy of energy infrastructure (Hommels, 2005) and the path-dependencies historically embedded in them (Unruh, 2000). Path-dependencies have to be conceived in material terms and in relation to the various socio-technical arrangements that make up the broader energy system (e.g. technical expertise, resource extraction networks, regulations, finance, political and economic interests, or cultural practices). Finally, it requires addressing the spatial dimensions of energy systems in relation to the organization of social life; or, as Bridge et al. (2013, 331) put it, "developing new ways – and new geographies – of producing, living, and working with energy."

This article explores how we may begin to examine the spatial dimensions of contemporary energy systems in connection to the organization of social life in sub-Saharan Africa. It examines the usefulness of a spatial perspective to researching how energy systems in sub-Saharan Africa came to be the way they are today. This historical understanding of energy systems is necessary if we are to make sense of future energy transitions (Mahoney, 2000; Unruh, 2000), yet the connections between past, present and future remain understate in current policy interventions. To this purpose, the next section introduces a brief overview of most recent energy geographies literature and their arguments for a spatial perspective on energy systems. Using the six spatial dimensions outlined by the seminal work of Bridge et al. (2013), the following section explores how each dimension elicits specific investigations in the historical development of energy systems in sub-Saharan Africa. In particular, this section engages the energy geographies literature with other strands of social science literature on Africa. The article concludes with a reflection on how a spatial perspective could improve future energy initiatives for sub-Saharan Africa.

2. Space, path-dependency and energy transitions in sub-Saharan Africa

The relationship between energy and the way we organize social life is inherently spatial, yet the spatial dimension remains largely understated in the aforementioned energy initiatives for sub-Saharan Africa. In their seminal article on geographies of energy transition, Bridge et al. (2013, 331) outline how a transition to a low-carbon energy system is "fundamentally a *geographical process* that involves reconfiguring spatial patterns of economic and social activity" (italics in the original). They highlight three reasons why this is the case. Firstly, energy systems are embedded in space. This is notably the case of its physical infrastructure, but other components are also spatially distributed and often unevenly so. For example, there is a spatial concentration of engineers and technical staff with the knowledge of designing, managing or maintaining an electric grid in urban areas as compared to rural areas. This affects the prospects of implementation of energy transitions. Secondly, the spatiality of energy systems produces uneven patterns of economic and social life (Calvert, 2016; Castán Broto, 2017). Along similar lines, Huber (2015, 328) highlights that energy "underpins the basic aspects of social life – food, mobility, consumption, and the geographies of home and work." The differential availability of electricity, oil or charcoal to power these will significantly affect what kinds of economic activities (e.g. industry, services, farming) or social practices (e.g. using refrigerators, watching TV, powering mobile phones, building design standards) happen in different places. This has consequences not only for what kind of transition will take place, but also implies that different places will undergo a different process of transition over time. Finally, this unevenness can be found not just within one country, but also across countries (more on this spatial 'scale' below) (Pasqualetti, 2011). As Bridge et al. (2013) allude to, differential access to oil, alongside variable economic power to acquire it and off-set environmental costs, had much to do with the ability of the global North to support its economic development since the 19th century and participate actively in (and shape) globalization (Smil, 2000). Sub-Saharan Africa has participated in this geopolitical order largely as a site for resource extraction (cf. Cooper, 2002; Ferguson, 2006). This places the sub-continent in distinctive spatial and political economy relationships with regards to energy systems. Energy projects that fail to acknowledge how various locales insert themselves into that geopolitical order can fall short of understanding the key drivers (or obstacles) to desired processes of energy transitions in sub-Saharan Africa.

Moreover, Bridge et al. (2013) point out that the temporal dimension of the transition (i.e. how it will unfold into the future) tends to command most analytic attention. Instead, they argue, we need to map out "changes in the spatial organisation of the energy system and economic activity more widely" (Bridge et al., 2013, 332). The authors propose we pay attention to six spatial dimensions that can better elucidate energy transitions as a geographical process: location; landscape; territoriality; spatial differentiation and uneven development; scaling; and spatial embeddedness and path dependency. While Bridge et al. (2013) make various references to the historical dimensions through which these spatial dimensions can be examined, a more explicit treatment of path-dependency, technological lock-ins and inertia can provide a fuller understanding of contemporary energy systems in sub-Saharan Africa.

Understood as a socio-technical system (Hughes, 1983), an established energy system developed as a result of the coevolution of ecological, social, and technological systems over time and across space (Castán Broto, 2017). The choice of technology and design of an energy system is greatly influenced by initial conditions and events that lead to its adoption (Goldthau and Sovacool, 2012; Hughes, [1987] 2012; Mahoney, 2000). This would entail, for instance, issues around availability of fuels or production and distribution technology; contingent events leading to support for specific solutions (involving financiers, government policies, or others); and which individual costs individual users were willing to accept to participate in the system. Over time, as the system matured, it became reinforced by feedback loops that reinforced the connections between the system and other aspects of social life (e.g. distribution networks, the transport system, economic interests, governance apparatus). This is what is usually referred to as 'technological lock-in' (Unruh, 2000). The more intricate and complex the system, the greater its inertia to change (Goldthau and Sovacool, 2012). As we shall see below, such path-dependencies and inertia can be observed in the spatial embeddedness of energy systems.

While Africa (and especially Sub-Saharan Africa) is usually deemed energy poor – conceptualized as having limited access to modern energy services such as electricity – Africans have not been *energy-less*, nor have they been *without* energy systems. They have satisfied their energy needs with other forms of energy (usually deemed 'traditional'), often mixing different fuels to 'power' their livelihoods. From an historical point of view, the study of such energy systems in the post-colonial moment cannot be disentangled from the diverse colonial experiences of different countries and even various locations within those countries. There are ongoing debates about the nature of the colonial enterprise led by different European powers (Chabal, 2002; Cooper, 2002; Cooper and Stoler, 1997), but these have seldom addressed the issue of energy. Conversely, current energy initiatives rarely take into account the colonial and post-colonial path-dependencies and historical contingencies of the energy systems they seek to transform (cf. Quitzow et al., 2016). This article seeks to make this spatial-temporal relationship more explicit in how we begin to understand contemporary energy systems in sub-Saharan Africa. To do so, the next section takes each of the six dimensions in turn and teases out context-specific historical aspects for sub-Saharan Africa that are worth paying attention to.

3. Spatial dimensions and the historical development of energy systems in sub-Saharan Africa

3.1. Location: Context-specific energy patterns

The first spatial dimension identified by Bridge et al. (2013) concerns *location*, conceived in both absolute and relational terms. This means specifying the kinds of energy produced, distributed and consumed in various locales and by whom; investigating how these energy patterns and networks have evolved over time and in relation to a locale's specific context; specifying how different locales relate to each other (or not) around the globe; and exploring how such relational interactions affect the socio-technical dimensions of the energy system.

Detailed and accurate descriptions of energy systems in various sub-Saharan countries are few and far between, usually single-country (or even single-city) (Chikowero, 2007; Christie, 1984; Isaacman and Isaacman, 2013; Manafa, 1979; Olukoju, 2003; Phillip, 2005; Wilson, 1967). Such historical analyses face a shortage of reliable historical data, with some authors suggesting indirect forms of measurement (Coquery-Vidrovitch, 2003). Njoh (2016) recently reviewed electricity supply trends during the colonial period drawing on the United Nations Energy Statistics Yearbook, which was first published in 1952 with a review of world energy supplies for selected years between 1929 and 1950 (United Nations, 1952, s.d.). While the country-aggregate data is helpful, it is of limited value to understanding the energy systems of different locales on the ground, especially as they relate to a diversity of 'traditional' or 'modern' fuels. Yet, analyses of energy transitions must begin with a grounded knowledge of energy systems in the very locales where they will unfold. Learning about energy systems in historical perspective will require piecing that puzzle through a combination of archival sources and oral histories, where possible.

3.2. Landscape: Socio-technical investigation of colonial energy systems

The second spatial dimension Bridge et al. (2013) refer to is the energy *landscape*. This refers to the "constellation of activities and socio-technical linkages associated with energy capture, conversion, distribution and consumption" (Bridge et al., 2013, 335). In their view, 'landscapes' can be described for their material features, their symbolic (representational) power or the multifaceted cultural processes that originated them. Similarly, Castán Broto's (2017) has recently expanded on the idea of the 'energy landscape' as representing the spatial organization of energy systems produced by the co-constitution of social life, space and energy systems and practices (Crang and Thrift, 2000). For her, energy landscapes are not static or pre-determined; they have local expressions that are context-specific and historically contingent (Castán Broto, 2017). Both approaches identify not just the material components of an energy system (e.g. physical infrastructure, technological artifacts), but also the various actors with their diverse roles, cultures and practices (e.g. engineers, financiers, state regulators, users), who jointly co-produce every energy system.

Attention to the 'energy landscape' in fundamental to understanding the lineage of contemporary energy systems in sub-Saharan Africa, yet we know little about it. Historical studies of technology as a 'tool of empire' examine the role of guns, steamboats, quinine and various forces of communication and transportation, but make no mention to energy systems (Headrick, 1981, 2010). More recently, Hausman et al. (2008) conducted a detailed study of the history of corporate and financial endeavors leading global electrification between 1878 and 2007. Their work traces the various phases of expansion of electrification through the circulation of ideas, knowledge, technology and capital, involving a range of individuals, companies, imperial administrators, and banking institutions. In their nearly-500 page book, fewer that a dozen pages are dedicated to broad statements about Africa and specific African countries. This is not a criticism of the superb work conducted by the authors, but instead a reflection of the dearth of data highlighted before.

Accounts of colonial 'energy landscapes' will need to delve into studies similar to those that examined Africa as the laboratory for European medicine, urban planning, and anthropological or government practices (e.g. Demissie, 2012; Njoh, 2008; Tilley, 2011). Such research would highlight how flows of energy-related ideas, expertise and capital between colonies and metropoles came to shape what energy systems are in existence nowadays. Accounts of post-colonial 'energy landscapes' are equally needed. One theme that requires further study is a socio-technical analysis of attempts at liberalization of the energy sector in Africa. This can add detail to more economic and policy-oriented studies (Bhagavan, 1999; Turkson and Wohlgemuth, 2001).

At any rate, these various strands of research should aim to produce accounts not just of modern energy systems (e.g. electricity), but also of energy systems based on 'traditional' fuels such as charcoal. Charcoal remains dominant in the fuel mix of most African households, even in urban and wealthier areas (Brew-Hammond and Kemausuor, 2009; Sokona et al., 2012). It is common, in policy circles, to think about the eradication of energy poverty through a linear process of climbing up the 'energy ladder' from traditional to modern energy sources and services (Hosier and Dowd, 1987; Leach, 1992). More often than not, such thinking is rooted in a technocratic and economic understanding of technology substitution. A more detailed understanding of the 'energy landscape' that encompasses various fuels and the socio-technical dimensions of these will be better equipped to conceptualize effective energy transitions.

3.3. Territoriality: Energy politics in sub-Saharan Africa

The third spatial dimension outlined by Bridge et al. (2013) relates to the notion of *territoriality*, more specifically the spatial organization and exercise of power over the energy system. The authors draw on a longstanding debate in geography about the importance of territory and territoriality to the formation (and imagination) of the state, its borders and identity (cf. Agnew, 1994; Agnew and Corbridge, 2002; Elden, 2007, 2010; Painter, 2010; Sassen, 2000). Applied to energy debates, the authors remind us that energy infrastructures have played a significant role in processes of nation-building, modernization and development, as well as in the making of modern citizens (Bridge et al., 2013, 336). Energy has also played a key role in imaginations of sovereignty, or what Huber (2015, 330) calls the "modern geopolitical imagination of a world of independent states – conceptualized as individual actors – vying over scarce resources." Understanding how energy systems are territorialized, Bridge et al. (2013, 336) claim, "draws attention to the different scales and arenas of political action that govern energy systems."

There is no shortage of studies in the social sciences about the relevance of energy, especially oil, to the politics of many African states (e.g. Anderson and Browne, 2011; Oliveira, 2015; Reed, 2009; Watts, 2004). Studies of electrification in various African countries draw together the relevance of this form of energy to state formation, subject-making and cultural practices (e.g. Chikowero, 2007; Christie, 1984; Winther, 2008). However, joint attention to the spatial and political dimension of energy systems in sub-

Saharan Africa is only recently gathering interest (e.g. McEwan, 2017; Power et al., 2016). One such area where research is expanding is the study of the politics of urbanization in African petro-states (e.g. Buire, 2014). Yet, the latest energy initiatives implemented in sub-Saharan Africa rarely draw on the wealth of information about the politics of energy in the respective countries. Instead, many initiatives adopt a technocratic tone to their interventions, dealing with politics as a blank slate (cf. Baptista and Plananska, under review). There is significant scope for continuing developing these various lines of research having in mind future energy policies that are more attuned to the specificity of the local contexts they are inserted in.

3.4. Spatial differentiation and uneven development: Convergence and divergence

Another spatial dimension highlighted by Bridge et al. (2013) focuses on the spatial variation in energy systems. Spatial variation is implicit in the three dimensions examined so far, so the authors use this additional dimension to underscore how low-carbon energy transitions have the potential to create new winners and losers across space. Yet, such spatial variation is the hallmark of energy systems across sub-Saharan Africa since colonial times. It is now widely established that electricity, water, sanitation and other networked infrastructures were used by colonial powers to differentiate the spaces of settlers from those of indigenous peoples, in Africa as elsewhere (Baptista, 2015; Chikowero, 2007; Gandy, 2006; Kooy and Bakker, 2008; McFarlane, 2008; Phillip, 2005). In postcolonial contexts, spatial segregation through energy infrastructure seems to continue along class, ethnic, and political lines (cf. McDonald, 2009). Moreover, rates of access to electricity vary substantially between urban and rural environments (although this is also varies across countries) in sub-Saharan Africa. According to estimates by the World Bank for 2012, urban areas had, on average, a rate of connection of nearly 72% against a little over 15% in rural areas (The World Bank, 2016). Energy initiatives are thoroughly focused on narrowing this gap and many of their initiatives do focus on rural Africa (Quitzow et al., 2016). Yet, the initiatives tend to adopt what Bridge et al. (2013, 337) call the "implicit assumptions about spatial convergence" – i.e. that energy transitions will have the power to flatten the spatial unevenness of energy systems. In contrast, the work of Silver and Marvin (2017) highlights how urban transitions are infiltrated by contestation over infrastructure and service provision. Given the historical patterns embedded in contemporary energy systems and other economic assumptions about the roll-out of efficient electricity markets (e.g. cost-recovery), there is a certain dose of wishful thinking (if not utopia) in the goals of universal access to modern energy services by 2030. Attention to how spatial differentiation and uneven development have been produced over time and became embedded in the materiality of energy systems has the potential to temper some of that optimism, as well as to show potential avenues for effective action.

3.5. Scaling: The importance and specificities of the urban scale

Bridge et al. (2013, 338) use the notion of 'scaling' (instead of 'scale') to denote the active production of "the [geographical] scale at which energy systems are organized and governed (…) as a product of economic and political decisions." Through this spatial dimension, they seek to highlight how energy policy is pervaded by specific assumptions about how things are done. For example, they note that energy policy is crafted usually at the national scale, by national governments, involving oligopolies that control centralized energy systems, which are in turn largely organized as on-grid systems. The authors argue that, "As an analytical lens, scaling can illuminate significant questions about who is affected, who has the capacity for action, and where the boundaries of responsibility lie" (Bridge et al., 2013, 338).

The latest energy initiatives implemented in sub-Saharan Africa take for granted the national scale as the locus of action. Their default assumption is that action towards a low-carbon, pro-poor energy transition is to be devised at the national level, through national governments, conceived as unitary entities. The prevalence of this 'territorial trap' (Agnew, 1994) is long known to shape international relations, and climate change policy is no stranger to it. However, there is increasing evidence that city governments are taking the lead with experimenting various pathways into energy transitions (Bulkeley et al., 2011; Castán Broto and Bulkeley, 2013). Rutherford and Jaglin (2015) suggest that thinking of the urban scale is not only relevant but necessary to engage in successful energy transitions. They also contend that more than thinking along the scalar dimension, the 'urban' should also be conceptualized as a set of actors and of sites and spaces engaged in the production, distribution and consumption of energy (Rutherford and Jaglin, 2015).

The urban dimension of energy transitions requires special attention in sub-Saharan Africa. Energy has been placed squarely at the center of emergence of modern societies in the 'global North' due to its role in facilitating industrialization (and mass production) and consequent urbanization (and mass consumption). However, urbanization in Africa has proceeded without substantive industrialization (Fox, 2012; Potts, 2009). Colonial urban centers developed and operated as sites for the coordination of the extractive activity of European powers (Coquery-Vidrovitch, [1993] 2005; Freund, 2007; King, 1990). In the post-colonial period, many governments adopted a generally anti-urban, or pro-rural, approach to economic development, which has been emphasized by the 'urban bias thesis' (Lipton, 1977). The missing link between industrialization and urbanization then shifts attention to other processes as drivers of urbanization: internal population growth, circular migration, improvements in health care and disease control, food security, or informality (Fox, 2012; Parnell and Pieterse, 2014). In a recent article, Silver and Marvin (2017) noted that the specificity of African urbanization and its relationship was critical to our understanding of future energy systems. They share the view expressed here that it is necessary to place energy transitions in their specific (urban) context and to include a wider range of interests with capacity to act (not just national governments) (ibid.). These various dimensions must be taken into account when considering the territorial dimension of contemporary energy systems in sub-Saharan Africa.

3.6. Spatial embeddedness and path-dependency: Culture and materiality of energy consumption

The last spatial dimension that Bridge et al. (2013) deploy is the spatial embeddedness and path dependency (or lock-ins) of energy systems. They remind us that energy systems are more than just technological artifacts; energy systems are embedded in cultures of energy consumption, built into various aspects of our settlements (e.g. housing or transport, whether in the countryside or the most populous city), and the sunk cost of infrastructure capital investment. Attempts at effecting an energy transition will thus require not just a technological switch, but also a shift in those other geographical dimensions. However, these various forms of spatial embeddedness show great inertia to change (Hommels, 2005; Unruh, 2000).

In the same way as recent energy initiatives avoid engaging with local politics, they also tend to gloss over issues around the spatiality of energy consumption, cultural dimensions of energy or the materiality of energy systems (Barry, 2013; Shove and Walker, 2014; Strauss et al., 2013). Once again, the social sciences have much to offer energy policies seeking to engage with those various dimensions in sub-Saharan African contexts. Three examples should suffice to illustrate the point. Winther's (2008) ethnographic study of electrification in Zanzibar offers a compelling view of how electrification intersects with various social relations (including gender, age, political affiliations, and even certain spiritual cosmologies). She ties her investigation to the importance of electricity in establishing spaces (and imaginaries) of development and modernization in the island. Mavhunga (2013) traces the flows between rural and urban areas in Mozambique that underpin an energy system dominated by charcoal consumption. His work shows the spatial embeddedness of charcoal in various socio-economic relations in a country that is rich in hydropower resources but where its population remains energy poor. Finally, Baptista (2016, Forthcoming) looks at how historical patterns of nationalist politics, urbanization and segregation have shaped practices of prepaid electricity consumption in contemporary Maputo, Mozambique. She argues that the desire for accessing modern livelihoods powered by electricity seemingly lead Mozambicans to adopt prepayment technology without significant contestation to the inherent problems of self-disconnection. In sum, attention to the various dimensions of the spatial embeddedness of energy systems and their interaction with context-specific issues of culture and materiality are of essence to understand how energy systems in sub-Saharan Africa came to be the way they are today.

4. Conclusion and policy implications

This article sought to begin to tease out the spatial dimension of contemporary energy systems in sub-Saharan Africa by drawing attention to how these came about in historical and context-specific terms. It pieced together a wide range of literatures from the social sciences to characterize the six spatial dimensions advanced by Bridge et al. (2013) for the analysis of energy transitions. The article made the case that we need to know a lot more about various dimensions of contemporary energy systems: how urban energy systems were formed, operated, governed, contested and transformed; what kinds of energy systems powered colonial urban settlements and the localized colonial enterprises; how various modes of colonial statecraft harnessed energy to power social life, and the global connections across different places and spaces; how people conceptualized, used and related to various forms of energy and energy services, and the social practices (and livelihoods) these enabled. Ultimately, we need to establish more substantive accounts of how urban environments and energy systems have co-evolved, mutually shaping each other. These historical accounts should provide insights into the mechanisms and practices that underlie the path-dependencies that shape contemporary energy systems. These insights are of the utmost importance if we are to devise energy policies and interventions that are attuned to the realities of social life in sub-Saharan Africa.

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