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Powering sub-Saharan Africa's urban revolution: An energy transitions approach

Jonathan Silver and Simon Marvin

Abstract

This paper develops a geographic understanding of urban energy transitions in sub-Saharan African towns and cities. In doing so this paper seeks to critically reflect on the value and limits of urban transitions analysis as a framework for understanding energy networks beyond the largely integrated systems across the Global North. We explore how these potentials and deficits can be addressed by examining promising developments across a series of debates in urban studies that can help sensitise this approach to energyscapes in the African context. By reviewing urban transitions analysis through these debates the paper offers four important contributions to expand existing ways of understanding energy transition. These include the particular urbanisation dynamics of African towns and cities, the need to locate the urban across energy regimes, the agencies of various intermediaries and urban actors and the contested politics inherent in the governing of energy networks. In the conclusion we reflect on the specific directions that have emerged from the paper in relation to our contributions, offering a geographically informed framework that allows us to better examine the challenges and specificities of transition across these rapidly growing urban regions.

Introduction

This paper develops a critical response to how we might undertake analysis of urban energy transitions in sub-Saharan African towns and cities. In doing so the paper seeks to reflect upon the analytical value and limits of urban transitions analysis in understanding how Africa's 'urban revolution' (Parnell and Pieterse, 2014) is being powered. We explore how these potentials and deficits can be addressed by examining promising debates across urban studies and how they can help sensitise urban transitions analysis to the geographies of urban energy in Africa.

It is important to think about urban energy transitions in Africa through an urban studies lens for two key reasons. First, the importance of energy in the rapid urbanisation of Africa. There are two dimensions to this engagement – the relations between energy and the development agenda in which urban regions are associated with very low rates of connection to formalised energy infrastructure and the reliance on informal provision that this engenders – together with the critical importance of energy in supporting wider urban-economic growth imperatives. These challenges, tensions and competing priorities

are often most keenly experienced in urban regions. Second, the issue of how urban governance interrelates with the various (and multi-scaled) geographies of the energy system split into generation, transmission and distribution with complex ownerships from privatised (sometime liberalised) to state control (Graham and Marvin, 2001). The central issue here is to what extent is it possible for urban governance actors to develop energy-related priorities and interventions when they are often not part of the formalised, socio-political organisation of the wider energy system. Additionally, these energy geographies prompt the need to consider how urban governance actors seek to position the multiple spaces of the energy system to implement socially and environmentally just forms of experimentation and transformation.

We address these issues through a critical engagement with urban transitions analysis in which we seek to identify the potential value of the approach to the African urban context by identifying its limitations but then constructively seeking to expand and reformulate the approach, building on recent work that has brought together the multi-level perspective and urban governance. We then use insights drawn from across urban studies to suggest four contributions to an expanded urban transitions analysis that is sensitive to the geographic context of urban Africa. First, we draw on debates in postcolonial urban studies to suggest ways to account for wider urbanisation trends and particularly the critical role of informal energy networks, heterogeneous configurations and unintegrated systems in meeting energy requirements. Here, we argue for the need for urban transitions analysis to engage with a fragmented, dispersed and often unregulated set of infrastructures outside the formal system of (urban) energy governance. Second, we mobilise debates over geography and scale within urban transitions analysis to argue for the need to deal with the specificity of how towns and cities relate to the management of energy transition. This is generated through the institutional context in which many municipalities lack both the formal capacity and the resources to choose to become active in energy planning, implementation and technology development. Third, we bring attention via debates on urban (infrastructure) governance in the Global South to the critical role of wider social interests – publics, the urban poor, civil societies, social movements and local communities – and what sorts of agency can be developed amongst these urban intermediaries in relation to energy transition. Finally, we use urban political ecology to draw focus on how power, politics and existing urban inequalities shape the way in which urban energy transition is envisioned, contested, circulates and is materialised by a range of urban actors.

The next section examines why it is important to address urban energy transition in the African context in both societal and research terms exploring the multiple challenges facing towns and cities in developing, operating, maintaining and upscaling necessary infrastructure configurations. It reviews the connections between urbanisation and energy transitions in sub-Saharan Africa and how energy is a central issue for amongst others, pro-poor developmental agendas, sustainability concerns and economic growth strategies. We find that the connections between urban governance in its various forms and the energy sector are uneven and often weakly connected in institutional and policy terms. The third section provides an overview of urban transitions analysis and especially the recent work to understand energy systems as geographically constituted and in turn

relationally produced across specific urban conditions, illustrating both the potentials and limits of this approach. The fourth section outlines a number of debates across urban studies and current work on energy transition across (and beyond) urban Africa to address the need to better integrate geographical knowledges within urban transitions analysis highlighted in the previous section. Here we offer four contributions to how this can be expanded. The conclusion reflects upon these four contributions and how they reshape our approach to research- ing and analysing energy transitions.

Powering Africa's urbanisation

Despite sub-Saharan Africa having the lowest urbanisation levels of all global regions, rapid urban growth on the continent is expected to see over 700 million urban dwellers by 2030 (UN-Habitat, 2010) and 1.2 billion by 2050 (UN-DESA, 2009). Such significant expansion of towns and cities is shaping what Parnell and Pieterse (2014) term 'Africa's Urban Revolution'— a dramatic rendering of the complex, shifting geographies of the continent. This rapid urbanisation will account for nearly all population growth in Africa over the coming decades, creating multiple infrastructural imperatives for governments, cities and communities alike. Balancing the necessities of economic growth, sustainability, the plethora of national policy objectives and the needs of the 40% to 60% of urban dwellers living in poverty (Toulmin, 2009) we suggest that urban infrastructures will be at the cen- tre of development efforts (Khennas, 2012). As such it is clear that these socio-technical systems will be placed under a series of grow- ing everyday pressures, together with playing a central role in mediating the multiple and open futures of this 'urban revolution'.

One of the most important infrastructures supporting this second wave of urbanisation is the provision of energy services to power the burgeoning towns and cities of the continent (Madlener and Sunak, 2011). Energy networks, are vital to sustaining the every- day urban life of sub-Saharan Africa through a series of flows that provide elec- tricity, charcoal, firewood, gas and so forth to homes, businesses and the public sector. Energy is pivotal to the urban transition. As the recent UN-Habitat (2014: 41) 'State of African Cities' report makes clear, 'The growth of Africa's energy sector is a prerequisite for sustained expansion in all others'. Yet here exists a conundrum, as McDonald (2009: xv) argues, 'Africa is the most under- supplied region in the world when it comes to electricity, but its economies are utterly dependent on it'. In 2012 the UN declared the 'International Year for Sustainable Energy' highlighting global concern for achieving a series of energy policy initiatives and placing energy at the centre of debates about the delivery of the Millennium Development Goals (UN-Energy, 2005) and the subse- quent, post-2015 Sustainable Development Goals.

A focus on energy across these debates reinforces how it becomes a prerequisite mediating all manner of development indica- tors within and beyond Africa from poverty through to heath, education, gender equality and civic participation (Brew-Hammond, 2010).

As numerous policy publications make explicit (Infrastructure Consortium for Africa, 2009; UN-Habitat, 2014) the investment deficit for infrastructure including energy is significant, estimated at US\$360 billion for Nigeria alone (Simone, 2010b) producing widespread breakdown and disruption (Khennas, 2012; Silver, 2015) and curtailing basic rights in accessing technologies and essential services (UN-Habitat, 2014). In Malawi, Burundi and Liberia less than 10% of the population are able to access modern electricity networks (Intergenerational Energy Agency (IEA), 2014). But attention is increasingly being directed on new investment such as the Grand Inga Dams project in western Democratic Republic of Congo that aims to generate 40,000 MW of power or ESKOM's (2012) ambitious 'Electrification Roadmap For South Africa, Africa and Developing Countries', which aims to connect 500 million people to networked energy services in over 50 countries across the continent. ESKOM, the South African parastatal shows the geopolitical aspirations of South Africa in the energy arena of the continent and the new markets that seem likely to open (McDonald, 2009). This is reflected in the increasing amounts of international capital investment and attention across both low carbon and traditional energy sectors (Power et al., 2016). At a national scale countries such as Ghana are broadening their ambitions from electrification to engage with wider issues of carbon reduction, climate change mitigation and renewable energy (Ghana Energy Commission, 2011).

What these, and the plethora of initiatives, projects, financing and emerging institutional arrangements show is that energy has, over the last few decades become an important concern to multi-scalar governance actors and the development aspirations of the continent (Kebede et al., 2010; Sokona et al., 2012). And urban contexts are becoming increasingly important sites in these processes as these global goals around energy are being translated at multiple scales and across geographically stretched networks. With the lowest global rate of urban electrification located in sub-Saharan Africa at 68.8% (IEA, 2014), together with the fastest rates of urbanisation, significant urban service provision demands and high rates of poverty (UN-Habitat, 2014) the need for urban studies to engage with the specificities of this urban (energy) transition on the continent are pressing.

Yet there are important differences in the ways that the urban energy demands, infrastructure development and future network plans across sub-Saharan Africa are (re)shaped by the region's distinct and multiple geographies. These are, of course, also very different to the development of modern urban energy services in the Global North (Rutherford and Coutard, 2014). The rising numbers of urban poor form the central demographic in the rapid growth of African cities, estimated at over 100 million in the next decade alone (Parnell and Walawege, 2011). These populations demand access, electrification and affordable service provision from across the formal and informal infrastructure conditions that make up energy networks in the low income neighbourhoods that constitute significant parts of many cities. These demands from the urban poor sit alongside a growing middle class, implicated in intensifying usage, requiring increased generation to facilitate emerging consumption patterns (Karekezi and Majoro, 2002; Silver, 2015). As Rutherford and Coutard (2014: 1356) helpfully suggest, 'Urban energy transition in the South thus clearly means something very different from the North, combining issues

around governance, access to finance, trade and supply chains with everyday concerns of, amongst other things, very low basic household incomes, availability of cooking fuel and indoor air pollution’.

There are also global imperatives and issues that apply in sub-Saharan Africa as elsewhere that will shape a series of differentiated transition pathways (Bulkeley et al., 2010). For instance the need to reduce green- house gas emissions globally is also predicating new ways to understand Africa’s urban energy transition as a low carbon transition. As Bridge et al. (2013: 331) comment, ‘Ensuring the availability and accessibility of energy services in a carbon-constrained world will require developing new ways – and new geographies – of producing, living, and work- ing with energy’. We suggest that the urban energy transitions that respond to these global–local energy dynamics and imperatives generate a series of strategic pressures on how innovation across infrastructure space is organised that require more detailed attention.

Urban transitions analysis

There is emerging but convincing evidence then that urban governance actors are under pressure to strategically respond to the regional energy geographies outlined above through developing managed, systemic change in the socio-technical organisation of key aspects of their energy networks (Swilling and Annecke, 2012). In this section we will examine how urban transitions anal- ysis, developed predominantly through work across Global North cities can help us to understand the role of energy transitions (Bulkeley et al., 2010).

Urban transition analysis has emerged from a constructive and critical engagement between the multi-level perspective and debates focusing on governance within urban studies. The multi-level perspective on transitions provides a framework for understanding how infrastructure systems are organised, (temporarily) stabilised and how technological change can be incremental through to radically transformative. (Geels, 2002; Geels and Schot, 2007; Smith et al., 2005; Verbong and Geels, 2010). In doing so it seeks to understand the institutional and technological conditions through which a socio-technical regime can be reshaped through internal pressures, wider socio- technical landscape pressures, and through the development of protected niches. While the multi-level perspective approach is useful in understanding the distributed nature of technological transitions our critical concern is that institutions, social interests and knowledge are often assumed to be ‘out there’. Place is implicit within the division of landscape, regime and niche. Only within the niche is the notion of place more explicit as some sort of bounded, experimental and local context while the landscape and regime are assumed to be global, international or national scale in nature. Spatial scale frequently remains implicit or underdeveloped in the multi-level perspective. The consequence of this is that we are often unclear about where transitions take place and, given the mutual shaping of system and social context, the spaces and places where transitions take place (Bridge et al., 2013; Bulkeley et al., 2010; Hodson and Marvin, 2010, 2012). There is a developing body of work that addresses the urban and regional geographies of transition and questions of scale and space (Hodson and Marvin, 2010; Bulkeley et al., 2010;

Coenen and Truffer, 2012; Coenen et al., 2012; Geels, 2010; Raven et al., 2012a; Rohracher and Spath, 2014; Spath and Rohracher, 2010, 2014; Truffer and Coenen, 2012). We are particularly interested in the two critical insights this work offers in thinking about a richer and more geographically informed conception of urban transitions analysis.

First, urban transitions analysis requires an appreciation of ‘multi-level governance’ and the politics of scale in understanding attempts to shape transitions in particular urban contexts. Key to this is the development of a framework that permits us to analyse the entangled relations and interactions of governance at the different scales that inform potential energy transitions. This is particularly significant in a period of accelerating globalisation, shifting political- economic connections, networks, markets and flows of investment and where the changing role of the state concerning infra- structure and issues of multi-level governance raise a series of issues about how we might understand or know the urban and its spatial relations to regions, the local, national and supranational. Critically, this requires, ‘an appreciation of the complex geometry of power and the political and cultural struggles through which societies assume their regional shape’ (MacLeod and Jones, 2001: 670). A focus on the ‘endogenous’ city and region and ‘creating the conditions’ for transitions often ignores what drives urban-regional economies of infra- structure and in doing so underplays the differential economic, ecological and political positions of places and the wider role of the nation-state in devolving responsibility (but not power and resources) for technology and innovation strategies (Ward and Jonas, 2004). Critically questioning these relations between scales allows us to conceive of urban regions not merely as sites for receiving national or international transition initiatives but also potentially as contexts for the development of more purposive urban transitions that may address local rather than national priorities (Bridge et al., 2013; Bulkeley et al., 2010; Hodson and Marvin, 2010).

Second, urban governance actors are then clearly constructed in an unfolding and structured set of social, political and

economic relations. Importantly new technology and innovation is both a product of, and produces political pressures for, institutional change. Seeing the urban as merely responding to these imperatives ignores specific relations informing urban contexts and attempts to shape infrastructure space through multi-scalar governance. This highlights the importance of seeing urban infrastructure in relation to technological transitions not only through the lens of ‘endogenous’ institutional inter-relationships, but also in terms of the influence of and relations with the nation-state and global institutions. Urban governance can actively and strategically work both internally and externally in developing the resources, networks and relationships to actively shape energy transitions. Considering how the capacity to act is organised in constituting and realising these shifts in energy production, distribution and operation in such a fragmented context is therefore an important issue. Understanding the dynamics of how such spaces of intervention are created and maintained is therefore fundamental for understanding the various attempts to develop and translate visions of an energy transition into the future of cities (Bulkeley

et al., 2010; Coenen and Truffer, 2012; Geels, 2010; Hodson and Marvin, 2010; Raven et al., 2012b; Rohracher and Spath, 2014, Spath and Rohracher, 2010, 2014).

Critically then work on urban transitions analysis has started to provide a conceptual outline through which different urban contexts mediate variable capacity to envision and enact transitions. Key to this is understanding the ways in which urban contexts are differentially positioned within a wider multi-level governance context that both enables and constrains the development of urban energy transitions and how local capacity to act is constituted in the context of Global South and in particular contextual specificities of cities of sub-Saharan Africa.

Africa's urban energy transition

Work on energy transitions across the towns and cities of Africa are increasingly present across urban studies (Gebreegziabher et al., 2012), particularly in South Africa (Jaglin, 2013; Swilling, 2013) and including engagement with neighbourhood transitions (Bulkeley et al., 2014; Mdluli and Vogel, 2010). However, these remain relatively limited compared with the focus on either household and national-scale transition dynamics, meaning there are still too few accounts that have interrogated energy transition at an explicitly urban scale. Building on this failure to engage with the urban dimension of energy transition is the assumption that towns and cities in the region have little capacity to shape transitions compared with other intermediaries such as national governments. We would challenge such assertions as outlined above, arguing that the energy regime intersects in a range of ways with urban innovation, technology development and public pressure, all of which require more sustained scrutiny.

Developing research and associated debates across urban studies can provide an important way to help urban transitions analysis address the series of emergent dynamics and imperatives across sub-Saharan African towns and cities. These understandings of urban futures suggest very different trajectories from the urban (modernisation) experiences of the Global North (Robinson, 2002, 2006). This is a particularly important point in considering the changing nature of infrastructure space and notions of transition across these urban contexts (Swilling and Annecke, 2012). Importantly, such work prompts us to examine how we might contribute to an expanded urban transitions analysis by paying close attention to how these regional energy/urban geographies might challenge and reshape this approach to better address the particular and geographically located infrastructure conditions of urban Africa (Swilling, 2011).

We now examine work on the diverse geographies across urban Africa to generate four contributions into how such an expanded urban transitions analysis can be deployed. These contributions are based on the distinct forms of urbanisation being generated, the place of the 'urban' in understanding energy transitions in the region, the actors involved in innovation and the contested and political nature of energy systems across urban contexts. Bringing these concerns together would help urban transition analysis to better address how towns and cities beyond the Global North shape and are shaped by system

innovation, new technologies, shifting networked relations and broader political-economic transformations.

Specificity of African urbanisation

We draw attention to the particular forms of urbanisation across urban Africa that challenge how energy networks are conceived, the notion of a energy transition in these contexts and the imperatives of addressing intersections of poverty, informality and broader urban transformation. Infrastructure has tended to be understood through the dichotomy of formality and informality (Varley, 2013) yet new approaches are shifting our understandings to consider alternative forms of infra-structure that are heterogenous and hybrid, consisting of standard hardware, improvised technologies (Silver, 2014) and people themselves (Simone, 2004a). This work draws attention to what Furlong (2014: 139) terms the, ‘coexistence among sociotechnical systems, as opposed to the universality of a single dominant infrastructure network’ alongside the everyday practices that (re)make infra-structure space across various socio-material configurations (McFarlane, 2009; Silver, 2014; Simone, 2004a). This growing body of literature explores these particular urbanisation dynamics covering multiple scales from the everyday through to the broader urban and regional geographies of sub-Saharan Africa (Myers, 2003; Pieterse, 2008, 2010a, 2010b; Simone, 2004a, 2004b, 2010a; Swilling, 2011). Taken together this work illustrates some of the important urban conditions and dynamics for urban transition analysis to engage with.

These include the historically ‘splintered urbanism’ of towns and cities both during and after the colonial era (Graham and Marvin, 2001; Swilling, 2011) including those of sub-Saharan Africa and that, unlike the Global North, reveal the historically produced and ongoing fragmented and divided nature of urban (energy) systems in Global South contexts that have favoured colonial and later post-colonial elites (Bakker, 2003; Furlong, 2014; Jaglin, 2008; Odendaal, 2011; Silver, 2015). These historical forms of uneven urban infrastructure provision shape distinct geographies in which the rise of the ‘infrastructural ideal’ (Graham and Marvin, 2001) offers only a partial narrative of how colonial and post-colonial logics of control, segregation, exploitation and various forms of development mediate unfolding energy transitions. They ask us to take seriously the overlapping spatial legacies of colonial, post-colonial (and, of course, in South Africa, apartheid) urban energy governance and the logics of specific colonial–capitalist relations that have structured the fabric of infrastructure space across towns and cities. These histories have produced spatial configurations of racialised, gendered and class inequality in accessing basic urban resource provision (Demissie, 2007; Myers, 2006) and continue into the variegated experiences of structural adjustment and neoliberalism.

Related to these historical dynamics are the associated conditions of informality and multiple, heterogeneous urban systems that operate across these infrastructure spaces in the absence of a universal, state-operated infrastructure (Pieterse, 2008; UN-Habitat, 2014). These energy geographies prompt the need to recast how urban conditions are

understood in urban transitions analysis. We can draw on some themes here including the (overlapping) roles of both formal and informal energy systems in the operation and circulation of energy resources, high levels of energy poverty, reliance on fuels such as charcoal or firewood, together with ongoing struggles over land, tenure and broader service provision. These forms of urbanisation challenge and stretch Global North-anchored understandings of what constitutes an urban energy network. As such we would suggest that these differentiated forms of urbanisation generate variegated energy geographies across towns and cities that challenge whether any ‘modernisation’ incorporating ‘linear’ transition to modern energy services is possible or even desired. This is particularly relevant for the large and growing number of informal urban settlements across much of sub-Saharan Africa which often remain unelectrified. As Sokona et al. (2012: 5) argue, ‘The low levels and lack of access to modern energy services for productive activities has also impacted negatively on development and entrenched poverty in the continent’. Further issues related to these informal urban spaces include issues about recognition of land (often a precursor to formal electricity connections), the high concentrations of poverty in these areas (in sustaining flows of electricity), high levels of density making interventions difficult to plan, high levels of unauthorised connections and a series of health and safety issues including widespread ‘shack-fires’.

Locating the urban context

Second, the location of the ‘urban’ in energy transition across these towns and cities is a pressing concern in considering how we develop analytical vocabularies (Hodson and Marvin, 2010). This is particularly important in considering the institutional limitations across urban authorities in fostering systemic innovation (Agbemabiese et al., 2012). There is important work concerned with how household-scale transitions are taking place (Kowsari and Zerriffi, 2011) and particularly focused on how poverty mediates energy usage/transition (Keddebe et al., 2010; Visagie, 2008). For instance, Karekezi et al. (2008) show that in Kenya, despite urban dwellers requiring access to electricity for modern energy services, a range of off-grid fuel sources and technologies form a key part of everyday energy usage and experience in cities such as Nairobi. These everyday household experiences of energy services are established through poverty and inequality but also the informal conditions of many urban spaces. Van der Horst and Hovorka (2008) challenge how energy transition approaches understand household energy usage through empirical research in Maun, Botswana. By revealing variegated household energy use patterns the authors challenge notions of linear pathways to modern fuel consumption and the range of structural and everyday factors that shape household energy decisions and assumptions about energy transition, suggesting, ‘multiple energy sources are employed in complex ways, each for specific purposes, such that modern fuel uptake largely complements fuelwood rather than leading to its abandonment’ (Horst and Hovorka, 2008: 3342). This work on household-level transition pathways must be incorporated into research on sub-Saharan Africa’s urban energy transition and, importantly, there are examples that link to broader understandings about the urban scale and associated

political economies of energy. These include Baptista's (2016) examination of everyday practices of prepaid electricity in Maputo.

At the national scale these energy transitions are also comparatively interrogated across a number of different countries revealing the diversity of experiences in multiple geographical contexts (Baker et al., 2014; Khennas, 2012; Krupa and Burch, 2011). They offer a moment of caution in seeking to make generalisations across the many urban worlds of sub-Saharan Africa. These studies also reflect the perceived importance of national governments, often at the expense of considerations focused on an urban energy regime in unfolding transition pathways. This focus on the national scale often extends to the constituent regional dynamics and offers important overviews of shared energy geographies across the continent (Brew-Hammond, 2010). This research seeks to consider the key drivers, actors, dynamics and outcomes of energy transitions across the continent that are of course useful in placing and understanding urban conditions even if they often locate the energy regime beyond the boundaries of towns and cities.

Constituting urban capacity

Third, we contend it is crucial to expand the understanding in urban transition analysis of wider social interests involved in technological innovation in urban Africa and the deployment, maintenance and operation of heterogeneous energy systems. In particular we argue that the agency of 'slum dwellers' and associated social movements and civic organisations in informal settlements. As Silver (2014) suggests infrastructure space in cities such as Accra have long been associated with incremental and ongoing interventions by urban dwellers seeking to transform conditions of energy poverty and wider socio-environmental inequality. And this incremental upgrading has long been important to broader debates within the academy and policy worlds concerned development and urban planning in the Global South (Hasan and Chetan, 1986; Satterthwaite and Mitlin, 2013; Turner, 1972).

These urban, neighbourhood or even household-scale transitions, often termed niches in the socio-technical literatures (Geels, 2002) illustrate the need to better consider the role of social movements and civic society in experimentation, innovation and technological upscaling. As Ferguson (2006) so usefully elucidates, this 'civil society' cannot simply be grounded within the context of the 'local'. As groups such as Slum Dwellers International (McFarlane, 2009; Satterthwaite and Mitlin, 2013) show, these urban poor movements are intrinsically linked to trans-national networks of solidarity, financing and the co-production of knowledges around delivering essential urban service provision. Further attention should of course be paid to the emergence of what commentators term 'the rising Africa middle class' (Melber, 2013; Ravallion, 2010; Visagie and Posel, 2013). Whilst this is a contested term the growth of suburban developments (Mabin et al., 2013) and new housing geographies (Grant, 2009; Mercer, 2014) together with new consumption habits and technology usage predicate a series of niches from which innovations are being generated and reshaping the socio-technical landscapes of energy

across these towns and cities. Our brief outlining of these actors offers some important intermediaries beyond the focus on the elite within urban transitions analysis.

Contested urban transitions

Finally, the contestations and politics over infrastructure development, service provision, operation, maintenance and repair all critically shape urban energy transitions. Most usefully, Lawhon and Murphy (2012) have offered important ways to grasp the contested and political nature of urban transition processes. This could provide a way of how UTA that can explicitly centre how power, politics and inequalities across the city come to shape the ways in which transition is planned, operationalised and unfold.. Here Lawhon and Murphy (2012: 372) suggest, ‘how political ecology can improve it through a deeper consideration of the role of knowledge, diversity, power, geography, and non-material circumstances in shaping transition dynamics’. This useful provocation seeks to build on transitions research and debates in urban studies that explicitly politicise infrastructures (McFarlane and Rutherford, 2008) including work on politics and contestations over these urban systems in African towns and cities (Gandy, 2006; Loftus, 2006, 2012; Myers, 2003; Silver, 2015) that have emerged specifically from the UPE literatures and we would suggest have a key role to play in developing urban transition analysis to account for the politics of energy transitions across the region. Specifically, this work would help to interrogate the contested natures of urban energy regimes, paying attention to the ongoing production (and circulation) of inequalities and injustice through and across energy systems together with sites and processes that produce divergent visions of future energy transition and moments of tension and conflict. These have perhaps been most visible in urban studies through accounts of the struggles over metering installations and wider service delivery tensions between the urban poor, municipalities and utility providers in South Africa (McDonald, 2009; Ruiters, 2007).

Conclusion

Given the scope and scale of the challenges and pressures involved in powering Africa’s urban revolution (Parnell and Pieterse, 2014) there is a both a societal and research need to develop explanations that understand both the limits and opportunities for urban governance in shaping sustainable and socially just energy futures. Urban transitions analysis provides an important way to think about the pressures, institutional contexts and forms of experimentation involved in understanding these emerging energy geographies.

Our review has offered four contributions that need to be addressed within urban transition analysis to expand its ability to account for urban African energyscapes. First, we argued for the need to address the relations and tensions across formal and informal practices of energy production, distribution and consumption as part of the urban futures of Africa. This means recognising that large parts of the energy systems sit outside a conventional understanding of transition and standardised integrated and modernist notions of infrastructure configuration. Consequently further work needs to be undertaken in enlarging the range, methods and ways of analysing the informal and its relations with the formal networks through notions of hybridity and heterogeneity, everyday interactions

with the energy system and the incremental nature of urbanism across urban space. Second, we showed the need to recognise the limits of urban government and governance in terms of the capacity and knowledge to understand and reshape urban energy systems. This means looking more widely at which organisations are active in intervening in the energy systems and how they may produce differing visions of transitions and the ways that these urban governance actors are assembled across multiple scales and through multiple relations. Third, we outlined the need to develop an understanding of what forms of intermediary capacity can be created in different urban contexts, particularly the role of energy users in informal settlement contexts. Critical to this is an understanding of the role of international organisations – NGOs, development agencies, universities – who may be active in constituting visions and capacities for externally imposed energy

transitions. Here, further work is required to incorporate the everyday experiences of infrastructure and the capacity of social movements, civic organisations and neighbourhood groups to transform energy conditions. Finally, we argued for a better understanding of contested and multiple transition pathways being opened in this complex institutional context. In particular we wish to draw attention to the need to explore the politicised relations between different social, ecological and economic outcomes of particular transitions pathways. Further work needs to centre the importance of politics in the shaping of networked systems and the ways that such dynamics reinforce and reflect current and future power relations.

Although we are not suggesting that these contributions provide easy answers they do at least provide a means for locating urban transition analysis within a series of particular geographical and political-economic contexts where urbanisation patterns, municipal capacities, regime dynamics, politics and power relations all shape the potentials and limits of transforming infrastructure space across Africa's towns and cities. Through this expansion of urban transition analysis to better account for these geographical processes we would be better equipped as researchers to examine what sort of transitions can be developed at an urban scale and importantly to understand what sort of social interests are included (or excluded) in the urban governance of energy transition.

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