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Tensions in the transition: The politics of electricity distribution in South Africa

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Abstract

This paper argues that the distribution of electricity represents an important yet neglected aspect of the politics of energy transitions. In recent years, South Africa's electricity sector has seen the introduction of new actors and technologies, including the 'prosumer' (producer–consumer) of electricity and small-scale embedded generation from roof-top solar photovoltaics. We analyse these recent developments in historical context and consider implications for contemporary planning, regulation and ownership of electricity. We find that the reconfiguration of electricity distribution faces significant political and economic challenges that are rooted in the country's socio-economic and racial inequalities and its heavy dependence on coal-fired power. First small-scale embedded generation offers potential opportunities for affordable, decentralised, low-carbon energy, yet disruption to the coal-powered electric grid and the monopoly of South Africa's electricity utility has been minimal to date. Second, small-scale embedded generation creates tensions between equitable and low-carbon energy transitions and threatens critical revenue from the country's wealthy consumers that cross-subsidises electricity services for the poor and other municipal public services. Third, the South African experience queries common assumptions about the democratic potential of decentralised governance. Fourth, South Africa provides insights of global significance into how political institutions have responded to social and technological drivers of change, in a context where planning and regulation have followed rather than led infrastructural developments. While energy policy remains unresponsive or resistant to social and technological change, there remain significant political, economic, technical and regulatory challenges to a just and inclusive energy transition.

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Distributed generation, electricity, small-scale embedded generation, solar photovoltaics, South Africa

Introduction

In recent years, the transformation of the electricity network has become recognised as critical for the low carbon transition. The conventional electricity utility business model based on a centralised system of transmission, generation and distribution is subject to significant challenge from disruptive technologies and the rise of the ‘prosumer’ (producer–consumer) of electricity (Sioshansi, 2014). The term disruptive technologies is used here to refer to innovations which if scaled up would disrupt the basic network architecture of the electricity system (Verbong and Geels, 2010). Such disruption includes the rapid deployment of renewable energy generation, including from wind and solar across the globe; the emergence of distributed electricity generation; smart and flexible power systems such as energy demand response and storage and rapid advances in information and communication technologies (Skillings and Lafford, 2016).

These innovations are proving all the more disruptive as the costs of renewable energy technologies decline and the costs of maintaining a centralised grid increase (Lacey, 2014, Price Waterhouse Coopers [PwC], 2016). Furthermore, there is growing evidence that the costs of integrating renewable energy into the grid are much lower than currently assumed if appropriate and targeted investment in grid flexibility takes place (Skillings and Lafford, 2016). The implications that this has for the regulation, ownership and structure of electricity systems are significant, which as the International Energy Agency (IEA) argues, needs to look ‘beyond the usual and simplistic alternative between “free markets” and “utility regulation” or “decentralised decisions” versus “central planning”...’ (IEA, 2016: 18).

We consider how these global shifts in electricity supply and demand are playing out in South Africa, where the electricity system to date has been controlled by a state-owned, largely coal dependent monopoly utility which owns the transmission grid, is responsible for 95 per cent of generation and 60 per cent of distribution. Municipalities meanwhile are responsible for the other 40 per cent. South Africa’s electricity system has been historically determined by the country’s abundant coal supplies, and complex interactions between its social, political and economic institutions, networked infrastructures and technological capabilities (Baker, 2016). Despite the recent introduction of a small but significant programme for renewable energy from utility-scale, grid-connected independent power producers (IPPs), coal-fired power plants account for approximately 90 per cent of electricity produced. While grid connection rates have increased from only a third of the population to approximately 87 per cent since the end of apartheid in 1994, many low-income households cannot afford to use the grid to which they are connected and 3.2 million households, particularly those in informal settlements, lack access to electricity and other basic services. Forty-three per cent of South Africans are considered ‘energy poor’, meaning that they do not have ‘access to adequate, reliable, safe and environmentally benign energy’ (Sustainable Energy Africa (SEA), 2015).

Within this complex milieu, in recent years, South Africa has witnessed the rapid introduction of rooftop and ground-mounted solar PV by commercial, industrial and high-income residential households.¹ The many thousands of grid-tied distributed installations, each less than 1 MW and typically much smaller, are collectively termed small-scale

embedded generation (SSEG) or distributed generation.² Despite the absence of an appropriate national legal and regulatory framework thus far, SSEG has been installed by commerce, industry and wealthy households, primarily in response to recurrent crises in electricity supply, rising tariffs, and rapidly declining prices for solar PV technology. While the level of electricity generated by SSEG in South Africa is minimal in comparison to overall national capacity, it still offers a window of opportunity to reconfigure systems of electricity generation, distribution and transmission. In this paper, we consider whether this is done in a way that prioritises a ‘just’ and ‘inclusive’ transition (Swilling et al., 2016) and explore the challenges that currently prevent this.

In this paper, we demonstrate the significance of electricity distribution to energy transitions. First, we provide an exploration of the socio-economic and technical challenges that are arising from the interaction between the politics of electricity in South Africa and the introduction of SSEG as a disruptive technology. Second, we examine the potential socio-economic impacts of rooftop solar PV, and the extent to which new opportunities may either redress or reproduce the injustices of the current electricity system. We find that while disruptive technologies offer potential opportunities to develop infrastructure that is more responsive to environmental and social imperatives, they also threaten critical revenue from South Africa’s wealthy consumers that cross-subsidises electricity services for the poor and other essential municipal public services. This has been compounded by the fact that energy policy and planning to date has been unresponsive or resistant to social and technological change. Moreover, there are currently no safeguards to ensure that generation of renewable energy by and for the wealthy does not take place at the cost of service provision to the poor. There are therefore significant political, economic, technical and regulatory challenges to any potential reconfiguration of the country’s electricity infrastructure, and to a just and inclusive energy transition.

In addition to the significant literature on national level dynamics and policy making in South Africa’s electricity sector (e.g. Baker et al., 2015; Bekker et al., 2008; Eberhard et al., 2014), this paper contributes to the more recent academic studies on the country’s distribution system. These studies include the challenges involved in the implementation of SSEG from rooftop solar PV and growing understandings of politics of electricity distribution in South Africa, as a contested space (Janisch et al., 2012; Korsten, 2015; Mayr et al., 2015; Tshela, 2014; Walwyn, 2015). The paper draws on an extensive desk-based analysis of policy and regulatory documents produced by institutions involved in South Africa’s electricity governance, including national and municipal government, the state-owned utility Eskom and the national energy regulator, as well as reports and publications by advocacy organisations, think tanks, industry and relevant media, including *Business Day*, *Engineering News* and *ESI Africa*. Analysis of secondary sources is combined with insights drawn from the authors’ participation in electricity policy consultations and debates in South Africa, supplemented by 18 semi-structured interviews carried out with members of South African industry, non-governmental organisations and local government in November 2016 and July 2017.

The structure of this paper is as follows. The next section outlines our perspective on the politics and political economy of electricity, including key literatures and theoretical concepts that contribute to emerging thinking on disruptive technologies. The ‘Electricity access in South Africa’ section examines the nature of energy access in South Africa, raising critical considerations for the socio-economic impacts of disruptive technologies. The ‘Eskom in context: A monopoly in crisis’ section focuses on national-level dynamics and structures including the monopoly utility Eskom and key policies and regulations which have determined the structure of the country’s electricity governance. This is followed in ‘The politics

of distribution' section by an examination of the politics of the distribution network, including the role of municipalities and tensions between municipalities and Eskom. The 'Tensions in the transition' section analyses key tensions with regards to the implementation of SSEG, including the absence of a regulatory framework. Conclusions are given in the final section.

A political economy of electricity: From monopoly to disruption

We use the South African case study to advance understandings of how politics matters for energy transitions (Bouzarovski et al., 2017; Lockwood et al., 2017) and to consider questions of power, politics, equity and socio-economic welfare that remain under represented in research on energy transitions to date. Following evolving concepts of the political economy of electricity (Baker and Burton, 2018), we conceive of the electricity sector as a site of 'struggle' over the governance and ownership of generation, distribution and transmission; and the allocation and access to electricity services (Gentle, 2009; MacDonald, 2016). The concept of struggle further relates to the way in which disruptive technologies will reconfigure electricity as a networked infrastructure and how interactions between technological change and established configurations of political, social and economic power should be accounted for.

As a large technological system, electricity is 'site-specific' – embedded in broader political, economic and social forces (Hughes, 1983) – and as a natural monopoly, lends itself towards economies of scale. For this reason, electricity is not easily governed and has proven one of the hardest network industries to reform (Victor and Heller, 2007). As South Africa's case demonstrates, purposeful efforts to adapt electricity infrastructures can be frustrated and/or manipulated by path-dependency, vested interests and the uncertainties of adopting new technologies.

As Eberhard and Godinho (2017) argue, the literature on electricity sector reform has often underplayed the social, political and economic complexities of electricity in favour of a more techno-economic and managerial approach, despite the growing acknowledgement of contextual difference, and national and sub-national factors. Such differences include how the electricity system is shaped by and interacts with differentiated patterns of domestic and industrial consumption; socio-economic inequality and uneven access to services; processes of spatial development; land tenure regulations; municipal level governance and the strong influencing role that vested interests can have in electricity policy and planning.

The long-standing debate on the optimal model of electricity sector reform, particularly in low- and middle-income countries, has generally been reduced to a polarisation between liberalisation and free markets at one end, and state ownership and central planning at the other. Consequently, the literature on electricity sector reform (Sen, 2014; Victor and Heller, 2007) has largely focused on the unbundling of utilities and the 'standard model' of power sector liberalisation (Gratwick and Eberhard, 2008), first promoted by the World Bank and related consultants in the 1980s and 1990s as part of loan conditionalities. The rationale behind this model was that public ownership resulted in poor technical and financial performance and was unable to meet the high levels of investment required by the electricity sector. In the interests of efficiency and cost effectiveness, proponents of this model advocated a move away from a state-owned utility to the unbundling of the utility into separate transmission, generation and distribution companies, including a significant role for wholesale markets and retail competition (Sen, 2014). However, in light of repeated failings of the standard model in low- and middle-income countries, its promotion has been in demise for some time.

The underlying logic of electricity sector liberalisation has been subject to further challenge from rapid technological change and an increase in renewable energy generation, including embedded generation (Sen, 2014). More diverse models are now emerging, including various forms of 'hybrid power markets' in which vertically-integrated, state-owned utilities remain the dominant player and the single buyer of electricity, but IPPs contribute a certain amount of generation capacity. A new challenge for the literature on power sector reform therefore is to engage with the recent evolution of disruptive technologies which will see new generation sources connecting directly to the distribution network rather than the transmission network (Verbong and Geels, 2010), and the impact that this will have on the nature of electricity regulation, given the more decentralised infrastructural configurations that this will require.

With some exceptions (e.g. IEA, 2016; Scott and Seth, 2013), much of the literature on the technical and regulatory implications of the emergence of disruptive technologies has been focussed on high-income contexts, such as the US, the European Union (EU) (Costello, 2015; Eid et al., 2014) and China (PwC, 2016). Similarly, recent academic literature on the reconfiguration of electricity distribution networks, a subset of the vast socio-technical transitions literature, has paid more attention to high-income countries. Countries such as Germany and the UK for instance, have witnessed the 're-regulation' of liberalised electricity markets (Becker et al., 2015; Lehtonen and Nye, 2009) through the introduction of renewable energy feed-in tariffs and low-carbon obligations. Yet, as Bolton and Foxon (2015: 538) argue, there is relatively 'little understanding of the social and institutional dimension' of the distribution network and 'appropriate governance strategies for their transformation'. In parallel to the technology, this literature is still evolving, and so by looking at the case of South Africa we add geographical nuance to a fast-evolving terrain.

For some government and civil society activists in the global North, guiding low-carbon energy transitions has meant bringing ownership of the distribution network back under some form of state, public or cooperative control (Rocholl and Bolton, 2016). This is often accompanied by an implicit assumption that small-scale and distributed generation will automatically result in social and democratic co-benefits e.g. Mouat (2016) and Dodge (2013). However, while South Africa's electricity sector features the level of public ownership envisioned by some activists who have sought to 're-municipalise' the electric grid in the privatised energy sectors of Europe (Moss et al., 2015), its case clearly demonstrates that public ownership does not necessarily imply democratic participation or equality of access. In this sense, debates on ownership of networked infrastructure typically go beyond the legal and material to include issues of distributional justice, environmental sustainability, democratic participation and procedural parity (Cumbers, 2012).

Finally, this research contributes to emerging debates over what the role, nature and ownership of 'the utility' will and should be (MacDonald, 2016) and how the electricity sector in the low-carbon transition could be regulated (Costello and Hemphill, 2014), not least because of the significant role anticipated of it in achieving decarbonisation targets (IEA, 2016; Sen, 2014). Such thinking includes contemporary concepts of the 'utility death spiral' (Costello and Hemphill, 2014; Janisch et al., 2012), a situation which arises when a utility increases its electricity tariffs, thereby creating incentives for retail customers to invest in self-generation for some or all of their electricity supply. This in turn hits utility revenues, creates pressure for further tariff increases and a cycle of grid defection and rising tariffs ensues. Such a spiral results in a decline in the utility's sales and consequently its ability to generate sufficient revenue to cover its fixed costs. In the case of South Africa, both Eskom and municipalities remain vulnerable to declining revenues and as such both have resisted the introduction of SSEG (Korsten, 2015). As we explore, the politics of embedded

generation often plays out in technical debates over the determination of tariffs and the value that solar PV provides to the grid, to utilities, to different electricity users and to society at large.

With this in mind, we now consider the evolution of electricity access in South Africa, particularly since the end of apartheid in 1994.

Electricity access in South Africa

Access to electricity in South Africa, as with access to other basic services such as housing, education and water is paralleled by high levels of poverty and socio-economic inequality. Under apartheid, industry, commerce and nearly all white households including remote farms, enjoyed secure and reliable electricity connections, while few black townships and informal settlements had access. Until 1994, approximately one-third of the population was connected to the grid. During the transition to democracy, access to affordable electricity became 'a basic need and basic right' with high political and cultural significance (Mayr et al., 2015) and was central to the post-apartheid government's Reconstruction and Development Programme (RDP). Consequently, low-income households have typically aspired to a grid connection rather than off-grid alternatives such as solar home systems and solar water heaters (Wlokas, 2011).

Following the transition to democracy, the national electrification programme under the RDP saw a dramatic rise in domestic connection rates, assisted by surplus generation capacity and low electricity prices, which saw 87 per cent of households connected to the grid by 2012 (SEA, 2015). Yet access to electricity is not reflected in electrification rates alone, given that many households cannot afford to use the electricity to which they are connected, despite the provision of a basic allocation of free electricity.³ Millions of low-income houses are multiple fuel users, prioritising other energy sources such as paraffin, wood and coal over electricity which leads to related problems such as air pollution, respiratory illness and shack fires (Tait, 2016). By early 2000s, progress in the national electrification programme had started to slow for various reasons, including the cost of additional infrastructure required to connect sparsely populated rural areas (Bekker et al., 2008: 3132).

South Africa faces a large and rapidly growing urban population. As a legacy of apartheid era planning, South African cities are highly segregated and of low-density, which presents significant financial and infrastructural challenges for electricity distribution. Sixty five per cent of the country's 52 million people live in urban areas, a figure anticipated to rise to 70 per cent by 2030 (Wolpe and Reddy, 2015: 5). Forty per cent of the urban population live in the country's eight metropolitan municipalities, which consume 36 per cent of national electricity consumption (SEA, 2015: 21).

One measure to address electricity access and affordability is the state's free basic electricity (FBE) allowance, introduced in 2004 with the aim to provide 'electricity to all' through the provision of 50 KWh per month of free electricity to low-income households.⁴ Such an amount is deemed sufficient for basic lighting, media access and water heating but critics charge it is insufficient for basic household needs, including as a result of the deterioration of infrastructure and service standards (MacDonald, 2009).

Meanwhile, illegal electricity connections in townships and informal settlements have increased since the country's electricity tariffs started to rise (de Vos, 2016). Illegal connections, for which households often pay a middleman to bypass the municipality's or Eskom's metres, have resulted in electrocutions from live wires and contributed to unplanned power outages. Eskom estimates that electricity theft is costing the country R20 billion (\$1.4 billion) a year (ESI-Africa, 2016). While such theft has typically been associated

with low-income residents (von Schnitzler, 2008), recent evidence suggests that much of this theft is organised and increasingly carried out by or on behalf of higher income consumers or businesses (News24Wire, 2016b). In addition to illegal connections Eskom also refers to a 'culture of non-payment' including in Soweto, Sandton and Midrand. Subsequent disconnections carried out by Eskom or municipalities have affected millions of low-income households (Clarke and Yelland, 2016).

Finally, rising consumer tariffs have contributed to incentives for wealthier residential and commercial consumers to establish their own source of solar PV generation, thereby reducing revenues of either Eskom or the municipal distributor. In the following section, we summarise the political, economic and regulatory context out of which this distributed generation has emerged, including an entrenched and complex crisis within the utility Eskom, failed attempts at sector reform and the evolving dynamics of electricity planning.

Eskom in context: A monopoly in crisis

Returning to concepts of the political economy of electricity introduced in the 'A political economy of electricity: From monopoly to disruption' section, South Africa's electricity sector has long been the site of intense political, economic and social struggle. At the heart of this struggle sits Eskom, described by Gentle (2009: 51) as an 'index' of the changing character of the political configurations of South African accumulation. Eskom's coal-fired power plants, currently generating 85 per cent of the country's electricity, are largely concentrated in the north-east and connected other parts of the country via Eskom's high-voltage transmission grid. Eskom is responsible for 60 per cent of distribution, which is consumed by one third of South Africa's customers. The remaining two-thirds are supplied by municipalities, Eskom's largest customer category, accounting for just over 40 per cent of total Eskom sales of which 80 per cent goes to 12 municipalities, including the eight 'metros' discussed below.

Historically speaking South Africa's electricity has been generated from low cost, low-grade coal for cheap and abundant supply, which has historically served an export-oriented mining and minerals industry, as part of a system commonly referred to as the minerals-energy complex (Fine and Rustonjee, 1996). However, a series of complex developments in recent decades have seen notable shifts in this system. Firstly, an economic slowdown and associated decline in the contribution that mining and minerals beneficiation make to South Africa's gross domestic product (GDP) has resulted in reduced industrial electricity demand. Despite this, heavy industry is still the country's largest electricity consumer with 31 energy intensive users accounting for 44 per cent of consumption (Energy-Intensive Users Group (EIUG), 2017). Further changes include increased energy efficiency; the introduction of national commitments to reduce carbon emissions in 2009; the introduction in 2011 of a programme for the procurement of utility-scale renewable electricity⁵ by IPPs which now constitutes approximately 2.9 per cent of the country's system load in 2016 (Calitz et al., 2017); and the increasing cost competitiveness of this renewable electricity compared with that generated by Eskom's new build coal. Formerly one of the world's cheapest generators of electricity until early 2000s, Eskom's average electricity prices increased by approximately 200 per cent between 2008 and 2016,⁶ and current tariff decisions are now the subject of legal review (Baker and Burton, 2018).

Eskom is now mired in a financial, political and technical crisis and front and centre of a national scandal on state capture and corruption (Bhorat et al., 2017). The causes of this crisis, which include decades of mismanagement, are long-standing and complex, while its effects include periodic load-shedding since 2006 and unsustainably high levels of debt

despite various government guarantees and a 2010 World Bank loan (Baker et al., 2015). They have been further exacerbated by the downgrading of Eskom's investment rating to junk status by the 'big three' credit ratings agencies, in reflection of the country's own negative investment rating. Eskom's financial situation is precarious, but given its lack of transparency, is hard to determine precisely. The migration of customers away from Eskom's grid through the introduction of SSEG merely adds to the causes of its instability as well as the financial sustainability of municipalities, discussed below.

Meanwhile since 2015 until the change in president at the start of 2018, Eskom undertook desperate action to retain its monopoly strong hold and the paradigm of large-scale, centralised and state-owned supply (Bhorat et al., 2017). Firstly it blocked the progress of country's procurement programme for renewable energy from IPPs by refusing to approve power purchase agreements for 37 projects, in an act which defied the utility's obligations under national policy. Secondly, with the support of the Presidency it pursued plans for a 9600 MW state-driven nuclear fleet.

While Eskom largely evaded the global trends of power sector reform discussed in 'A political economy of electricity: From monopoly to disruption' section, there are deep and historical ideological differences in South Africa between those advocating for state control of the electricity sector and those for market reform. As we now discuss, this has been reflected in energy policy making since the end of apartheid.

In 1998, the White Paper on Energy Policy put forward the unbundling of South Africa's electricity sector into separate transmission, distribution and generation companies. The White Paper was followed by a cabinet memorandum in 2001 announcing that 30 per cent of electricity generation, including renewable energy, would come from IPPs, in turn followed by a cabinet ruling that Eskom no longer be allowed to build new electricity generation (Eberhard, 2007). The 2001 Eskom Conversion Act converted the utility from a statutory body to a public company and required that it pay tax and dividends for the first time. Eskom's stakeholder-based electricity council was replaced by a board of directors and the government, represented by the Minister of Public Enterprises, became Eskom's sole shareholder. But while the utility was formally converted to Eskom Holdings Ltd in 2002 (Bekker et al., 2008: 3129), key aspects of the 1998 White Paper were never implemented and remain highly contested. Not least, a separate transmission utility has never been established and the Independent Systems and Market Operator bill that was to have done this has been continually postponed. Significantly, between 1998 and 2003, no new generation was built.

This failed privatisation process contributed to the delay in the construction of new generation capacity. Faced with falling reserve margins and an imminent electricity crisis, a 2003 cabinet memorandum put together by the Department of Public Enterprises approved that Eskom should be re-allowed to construct more power plants but that 30 per cent of new generation should be built by IPPs. However in the absence of a regulatory framework, it was not until the introduction of the renewable energy procurement programme in 2011 that generation from IPPs actually took place. Meanwhile, Eskom initiated a new build programme in 2005, to date heavily delayed and subject to substantial cost overruns, which includes the construction of two coal-fired power plants, Medupi and Kusile, at 4800 MW each (Le Cordeur, 2017).

South Africa's electricity policy has focussed largely on supply rather than demand. Under apartheid, electricity policy and planning was highly secretive, had no formal departmental mandate and was largely carried out by Eskom. Following the transition to democracy the 2006 Electricity Regulation Act allocated responsibility for electricity planning to what is now the Department of Energy (DoE), set up in 2009, and established the necessary powers for the DoE to conduct an open integrated resource planning process, though given

the DoE's limited technical capacity the task of electricity planning has mostly been carried out by Eskom's System Operator (Baker et al., 2015). The Act however has been criticised for containing a 'municipal void', given that it largely focussed on Eskom and gave limited consideration to municipal distributors (Jones, 2012).

Recent gains towards transparency, participation and accountable planning in electricity following the first Integrated Resource Plan (IRP) for electricity launched in 2011 have been undermined, including by the stalling of the latest version of the plan and attempts by the Presidency to push through a highly controversial nuclear procurement programme (Winkler, 2017). Under the 2006 Electricity Regulation Act, before an electricity generation project can be approved, it must align with the technological allocations set by the IRP in order for the National Energy Regulator of South Africa (NERSA) to be able to grant the project a licence. The first version of the IRP, approved in 2011 included an allocation for 17.8 GW of renewable energy which if built would deliver nine per cent of electricity supply by 2030. However, distributed generation was not included in the modelling and was merely flagged as an area for further research and analysis. The subsequent draft update released in 2013 estimated that embedded generation could reach 22.5GW by 2030 and suggested that incentivising its implementation could result in greater benefits than ignoring or resisting it. Yet this draft was stalled on the basis that it questioned the need for a national nuclear programme (Baker, 2016).

The latest draft of the IRP, eventually released in November 2016 for public comment, proposes a generation mix to 2050 and allows for up to 17,600 MW for solar PV. While this is an increase on previous drafts, it has been criticised by renewable energy groups such as the South African Photovoltaic Industry Association for its failure to make *specific* provision for SSEG and to recognise the impact of disruptive technologies; for using outdated cost assumptions for wind and solar PV; and unjustified constraints on how much renewable energy generation can be built in any one year (Baker and Burton, 2018). The plan also proposes 20,000 MW of nuclear to be built by 2037. This draft has also been stalled, following confirmations that the new IRP will only be updated in the last quarter of the current fiscal year, ending March 2018.

As this section has established, the entrenched nature of South Africa's electricity policy and planning has long been heavily dominated by the interests of large-scale, state-owned, centralised supply, in which municipal interests have had little representation. Furthermore, limited provision has been made for the rapid emergence of disruptive technologies which poses a significant challenge to any reconfiguration of the country's electricity generation, transmission and distribution system. With this in mind, the following section examines the politics of electricity distribution and the role of municipalities within this.

The politics of distribution

Municipalities are responsible for just over 40 per cent of electricity distribution in South Africa, purchasing electricity in bulk from Eskom at wholesale prices which they then mark up and sell on to the end user. Of 257⁷ metropolitan, district and local municipalities (Statistics South Africa, 2015a: 1), approximately 174 municipalities have been licensed by NERSA to serve as electricity distributors, a role which includes maintaining infrastructure, providing new connections, and setting minimum service level standards and pricing and subsidy levels for poor consumers (South African Local Government Association (SALGA), 2014). Municipalities use revenue from electricity sales to cross-subsidise the provision of other basic services.⁸ Mid- to high-income consumers are a particularly

important source of this revenue, which also cross-subsidises electricity and/or new connections for low-income households (Janisch et al., 2012: 3).

As a result of the spatial legacy of apartheid, South Africa's municipalities differ widely on numerous counts. These include population size and density, levels of income, financial, human and institutional resources, level of service provision and associated cost structures (Grant, 2015). They further differ significantly in terms of type of electricity consumer (i.e. domestic, commercial and industrial) and levels of electricity consumption (Yelland, 2015). Many of the best performing and most affluent municipalities are located in the Western Cape Province and Gauteng, while the worst performing with the highest rates of poverty are in Eastern Cape Province or the former 'Bantustans', territories set aside for black South Africans under the 1913 Land Act. These socio-economic inequalities are enmeshed with political ones and following Butler (2016), while 'the metropolitan municipalities... are powerful sites of power and patronage, and present priceless opportunities to demonstrate a capacity to govern', poorer municipalities have high levels of poverty and unemployment, poor rates of service provision and fragmented governance structures.

South Africa's institutions of municipal governance are also institutions of electricity distribution meaning that in the case of urban municipalities in particular, 'electricity revenue and city financial survival' are closely linked (Janisch et al., 2012: 1). Given that national government grants are insufficient for South Africa's municipalities to meet their developmental and redistributive mandate, municipalities are forced to operate on a cost recovery basis, not only from the sales of electricity and water but also property rates and investment from the private sector (Wolpe and Reddy, 2016: 19). Approximately 30 per cent of total municipal income was earned from sales of electricity during the 2013/2014 financial year, while electricity purchases made up to 22.1 per cent of total operating expenditure (Statistics South Africa, 2015a). Grid defection via SSEG coupled with Eskom's tariff hikes therefore pose a threat to such a model.

Generally speaking, urban municipalities within Gauteng and the Western Cape are more dependent on electricity as a source of revenue than peri-urban and rural ones (Statistics South Africa, 2015b). However, some of the smaller municipalities still earn nearly half of their total income from electricity sales, including uMhlathuze, Umtshezi, KwaDukuza in KwaZulu-Natal, Langeberg in the Western Cape and Tlokwe in the North West Province (Grant, 2015). There are eight metropolitan municipalities in South Africa which have exclusive municipal and legislative authority in their areas: City of Tshwane, City of Johannesburg, Ekurhuleni, eThekweni, Manguang, Buffalo City, Nelson Mandela Bay and City of Cape Town. These 'metros' constitute the country's largest cities with over 500,000 inhabitants and represent 'intense nodes of activity and energy consumption', accounting for 60 per cent of total economic activity, 42 per cent of the national population and generating 39 per cent of national energy-related carbon emissions (Wolpe and Reddy, 2016: 9).

High-income consumers have been particularly affected by municipal level tariff increases not least due to the 'inclining block tariff' (IBT) (Cape Town Electricity Services, 2015). Under the IBT, the more an electricity customer consumes the more they pay, a structure which parallels the country's tax system under which high earners pay the majority of the country's taxes (de Vos, 2016). Consequently, high-income consumers have been the most affected by increasing electricity tariffs and are therefore the most likely to seek alternatives. Indeed the valuable cross-subsidy that the IBT provides, both for energy services to the poor and other essential municipal activities is declining and may challenge the revenue base of South African municipalities (Mayr et al., 2015: 11), relating to discussions of the 'utility death spiral' discussed in the 'A political economy of electricity: From monopoly to disruption' section.

The nature of tariff setting within and between Eskom and municipalities is not straightforward or transparent. Firstly, NERSA is mandated to approve licenses for electricity generation, distribution and transmission and set the tariffs at which electricity is sold. These include tariffs at which Eskom sells electricity to individual end users and in bulk supply to municipalities, as well as the tariffs that municipalities charge to end users. In recent years, tariff setting has brought Eskom into conflict with NERSA, which has refused to approve the significant tariff increases requested by the utility. Establishing a tariff at which SSEG will be bought by Eskom and municipalities is central to establishing how the costs and benefits of SSEG are accounted for and distributed. But the national regulation for doing so is still catching up as discussed in the 'Tensions in the transition' section.

Secondly, while 'municipalities were able to supply data on total electricity bought from Eskom and total municipal sales broken down by tariff' (SEA, 2015: 18), electricity tariff categories and user categories differ across municipalities so it is hard to compare. Indeed, according to NERSA, mark-ups range from 20 per cent to 150 per cent (Bukula, 2013). Significantly, the surplus generated from electricity distribution has declined substantially over the last decade (National Treasury, 2013; Peters, 2015): as Eskom's tariffs have increased faster than inflation, it has become harder for municipalities to pass on the costs to the consumer, which has reduced the income available both for core functions of the electricity department and other city functions (Janisch et al., 2012; Wolpe and Reddy, 2015). Despite the fact that NERSA restricts the extent to which municipalities can pass the increased costs imposed by Eskom on to their customers, NERSA nonetheless approved an increase in municipal tariffs by 7.64 per cent with effect from 1 July 2016 (News24wire, 2016a). The unpredictability of Eskom's tariffs hikes has also made it difficult for municipalities to be able to plan their expenditure.

Failed attempts to reform South Africa's electricity supply industry after the end of apartheid, discussed in the 'Eskom in context: A monopoly in crisis' section, were paralleled by failed attempts to restructure the electricity distribution industry. Under apartheid, municipalities distributed electricity to historically white areas and Eskom to the black townships and rural homelands. Post-apartheid restructuring to tackle the racial segregation of local governance structures reduced the number of electricity distributors significantly. A subsequent process initiated in 2003 was to have integrated Eskom's electricity distribution business with the country's municipal distributors in order to create six regional electricity distributors (REDs). Such a move, it has been argued, was a further attempt to de-racialise the electricity industry by facilitating a redistribution of political power and technical and financial capacity from the wealthier metropolitan municipal distributors to poorer electricity distributors (Gaunt, 2008: 3450). It was also anticipated that the restructuring would address the inconsistency of tariffs which still exists between different municipal distributors and Eskom, the absence of income-generating industrial customers in many small black municipalities, and the backlog of infrastructure refurbishment and maintenance in many municipalities, which remains an on-going challenge (de Beer, 2016). However the restructuring process failed and was eventually shelved in 2010 (SALGA, 2014), in part due to resistance by many municipalities who feared that the formation of REDs would threaten the revenue they generate from on-selling bulk electricity to end users (Eberhard, 2007: 5311). Such resistance has continued and now poses a key challenge to the introduction of SSEG.

Though both Eskom and municipalities are responsible for electricity distribution, there are long-standing tensions and little coordination between them and a dual system therefore exists (Swilling, 2014). Despite the fact that Eskom controls 60 per cent of electricity distribution, under the post-apartheid constitution, 'electricity reticulation' is listed as a local

government responsibility (National Treasury, 2008: 109). Such legislation lies at the heart of tensions between these two institutions, firstly because of Eskom's apparent objection to municipalities using electricity tariffs for cross-subsidy (Swilling, 2014) and secondly due to the debt owed to Eskom by many municipalities. According to Eskom total municipal arrears stood at R6 billion at end March 2016, of which the majority is held by 20 municipalities alone (Eskom, 2016: 41). Under the 2006 Electricity Regulation Act and the supply agreement with municipalities, Eskom is entitled to disconnect the supply of electricity to municipalities that have defaulted and has recently done so (Engineering News, 2016). The advent of SSEG therefore adds a further dimension to these tensions over who controls and benefits from the country's electricity distribution system.

The politics of distribution are also complicated by the fact that in some cases Eskom distributes directly to customers within the licensed municipal distributors though an accurate picture is difficult to acquire due to lack of publicly available distribution data (SEA, 2015: 17). In either case, customers have no choice over who they are supplied by and both Eskom and municipalities effectively operate as 'geographic monopolies' (Yelland, 2015). As we now discuss in the 'Tensions in the transition' section, with the rise of SSEG, the distribution network is up for further contestation that goes beyond Eskom and municipalities, including regulatory and legal uncertainty over the right to generate electricity.

Tensions in the transition

As the technology costs of solar PV continue to decline, South Africa's electricity rates go up and Eskom's crisis escalates, the installation of grid-tied SSEG has become an increasingly attractive option for businesses and high-income residential household customers. Recent years have seen the rapid adoption of SSEG in South Africa (Mayr et al., 2015) with estimated installations of over 200 MW by September 2016 (Spencer, 2016), compared to just 35 MW in early 2015 (de Vos, 2016). However, these developments have been taking place in the absence of an appropriate regulatory framework coupled with concern and/or resistance from municipalities and Eskom, whose revenue is threatened by grid defection.

The installation of SSEG has proceeded apace and a small number of cities, including Cape Town and Nelson Mandela Bay, have introduced systems for 'net metering' which means that generators of SSEG are remunerated for the energy that they generate to the municipal grid (Green Cape, 2016, Spencer, 2016). In Cape Town, 18 commercial customers and 42 homes are now generating their own electricity from rooftop solar PV and feeding excess electricity into the city's grid (Cloete, 2016). However, while this may be seen as a positive step in terms of the introduction of renewable energy technologies, in socio-economic terms it will reduce revenue for the city. Walwyn (2015: 2) discusses an anticipated decrease 'of between 17 per cent and 25 per cent in electricity revenue collection from the residential sector alone and significant additional potential losses driven by similar dynamics in the commercial sector'.

Meanwhile there is still lack of regulatory clarity over the ability of municipalities and Eskom to buy and sell power generated by SSEG, particularly that which is greater than 100 kW (Janisch et al., 2012), in addition to legislative and revenue limits (Wolpe and Reddy, 2016: 17) and technical challenges. The *Standard Conditions for Embedded Generation within Municipal Boundaries*, produced by NERSA in 2011 suggested that embedded generators of up to 100 kW who registered with municipalities should be allowed to sell power to municipalities. However, these standards lacked clarity with regards to the connection to Eskom's grid and because they were launched without due public consultation, could only be

considered guidelines. The 100 kW limit was also criticised by stakeholders for being too small for most proposed SSEGs (NERSA, 2015: 18).

Subsequently in February 2015, NERSA launched a stakeholder consultation process for regulatory rules on SSEG for projects of up to 1 MW, which was to have been completed by the end of May 2015 (NERSA, 2015). However the DoE stalled on completing the drafting of these licensing regulations, stating that they could not be approved until the 2006 Electricity Regulation Act (discussed in the 'Eskom in context: A monopoly in crisis' section) had been amended in order to adequately reflect the language on privately-owned generation. It took until December 2016 for this to happen, after which the DoE published in the Government Gazette a 'draft licensing exemption and registration notice' for public comment. If approved this document would remove the requirement for SSEG below 1 MW to obtain licensing from NERSA in order to feed into the distribution network. While this draft is seen as a potentially positive step in removing regulatory hurdles to SSEG, the fact that it is capped at 1 MW is still seen as a restriction (Williams et al., 2016). At the time of writing it was still in draft form.

Beyond an effective regulatory framework, the tariff structure is also a critical consideration. Current electricity tariff structures in South Africa do not reflect the fixed and retail-related costs involved in managing, maintaining and operating the grid. Therefore as SSEG is installed, it will result in a loss of revenue to the distributor (be that Eskom or the municipality). This invokes arguments of the free-rider effect, 'where households with PV systems do not pay fully for their share of the system's fixed costs, shifting the burden to households without PV systems' (IEA, 2013: 218). As the example of various US states demonstrates, utilities argue that distributed generators should be charged to access the grid that utilities are paying to maintain (Hess, 2015). Such a scenario raises further questions over how a fair contribution to grid availability and operation costs should be allocated.

Finally, South Africa's distribution network both at the municipal and Eskom level, is largely unprepared for the introduction of SSEG, which will introduce a significant level of technical complexity into a system that thus far has primarily operated on the basis of a one way flow of electricity. Given the design of the distribution network and the maintenance backlog discussed above, there are limits to how much self-generation it will be able to absorb, while installations, many of which are unregistered (SAMSET, 2014:2) are being carried out with limited or no planning which may mean that latecomers to the installation of SSEG may not be able to connect to the grid (de Vos, 2016). The seasonal variability of renewable energy will add a further challenge to this, given that consumers use more electricity in winter when there is less solar PV generation capacity available. Moreover the generation output of solar PV is at its greatest in the middle of the day which does not match up with energy demand, which peaks during the morning and evening. As Jones (2012) explains, 'net metered PV generation takes place at times when it is relatively cheaper to purchase energy from Eskom, and consumption takes place when it is relatively more expensive to purchase electricity from Eskom'. How such challenges are managed will be critical to the long-term social and economic sustainability of SSEG.

Conclusion

As we have argued, the distribution of electricity represents an important yet neglected aspect of the politics of low carbon energy transitions. The conventional model of electricity supply and demand is subject to significant change as part of a global technological and infrastructural transformation in the way in which electricity is generated, transmitted and distributed. Consequently, fossil-fuel dependent, centralised electricity utilities, of which

South Africa's Eskom is just one example, are under challenge. Not only does this offer new opportunities for both consumers and producers of energy but in some countries, particularly in the global North, has also resulted in new regulatory models, including demand response markets (Mouat, 2016; PwC, 2016).

Embedded generation offers a potential challenge to the historical structures of South Africa's electricity sector as well as a potential opportunity to provide affordable, low-carbon alternatives to a crisis ridden, largely coal-fired electricity grid with ever rising tariffs. Yet, thus far the ability of these technological developments to disrupt Eskom's current monopoly stronghold – as well as blockages at the municipal level – have been minimal. Moreover, response from the sphere of South Africa's energy policy and planning has thus far been one of either resistance or inertia. While the introduction of distributed generation has implications for the affordability of electricity, safeguards are not yet in place to ensure that the generation of renewable energy by and for the wealthy does not take place at the cost of service provision to the poor. With this in mind, we offer the following four conclusions.

Firstly, there are significant political and economic challenges to any potential reconfiguration of South Africa's electricity sector. These challenges include: the significant resistance posed by Eskom and its entrenched and long-standing monopoly control over the country's transmission, generation and 60 per cent of distribution; the structural legacy resulting from the failure of reform in both the electricity supply and distribution industries in the aftermath of apartheid; the fact that Eskom and municipalities stand to lose revenue from the introduction of SSEG which therefore removes incentives to facilitate it; the stalling of the IRP and the absence of an electricity planning document which affords the necessary priority to municipal distributors and specific provision for embedded generation; and finally the absence of regulatory clarity over the introduction of SSEG. Deep seated tensions between Eskom and municipalities over who has the right to distribute electricity further contribute to the complexity.

Secondly, the loss of cross subsidy for both Eskom and municipalities from high-end customers who have started to install solar PV systems has led to what Mayr et al. (2015: 11) identify as a challenge for any just transition, and a tension between establishing a low-carbon energy supply at the same time as ensuring affordable electricity and other basic services for low-income households. The installation of SSEG has largely benefitted wealthier consumers while low-income households and those who do not own property are unable to buy themselves out of an increasingly unreliable and expensive electricity supply. This, in addition to the implications for the financial sustainability of Eskom as the monopoly utility and municipalities who may ultimately be left with low-income consumers and non-payers. The interdependence between the sale and distribution of electricity and the wider system of public administration within municipalities and Eskom therefore presents a challenge to systemic change. While South Africa may be some way off from the so-called 'utility death spiral' (Killeen, 2016) which is arguably being experienced currently by some of Europe's large utilities (Lacey, 2014), other factors as discussed in the 'Eskom in context: A monopoly in crisis' section are also at play which are contributing to the crisis within Eskom and that of some municipalities. This begs the question as to what the alternative methods should be of generating the revenue that has been lost from electricity payments.

Thirdly, the case of South Africa demonstrates that the growth of distributed technologies will require new players and institutions as well as a far greater scope for integrated energy planning at a local and municipal level. This in turn points to a much bigger role for local government in the low carbon transition particularly, if it is to ensure greater democratic control. Furthermore, given that distributed generation involves much more complex

and interactive energy flows of energy than a centralised model, not only does the requirement for grid flexibility increase, but also the challenges for planning, regulation and ownership. Furthermore, at the municipal level, the introduction of SSEG may result in the diversion of critical revenue from high-income consumers and consequently the ability of some municipalities to provide basic services, including electricity. This undermines assumptions of inclusiveness and participation often associated with decentralised provision.

Finally, the South African experience provides insights into how political institutions have responded to social and technological drivers of change. In South Africa incentives to install SSEG have not derived from government policy or regulations, but instead from high-income consumers responding to a national electricity crisis, rising tariffs, declining costs of solar PV technologies, and reduced public trust in the grid to provide reliable and affordable supply. For some, distributed generation therefore represents an increasingly attractive investment with which regulation has not kept pace. The South African experience offers a poignant contrast with that of high-income countries such as Germany and the UK where the introduction of distributed generation has been encouraged by strong regulation and subsidies. Further comparative research in this area is needed as the rapid evolution of disruptive technologies continues to reconfigure long-standing institutions and structures of electricity governance.

Author's note

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Notes

1. Defined as households that consume more than 700 kWh per month.
2. While small-scale embedded generation can also refer to off-grid installations, for instance in rural areas, here we focus on installations by consumers connected to the national grid, which are potentially more disruptive. South Africa's national energy regulator describes an embedded generator as 'an entity that operates one or more units that is connected to the Distribution System.'

Alternatively, a legal entity that desires to connect one or more units to the Distribution System', and distributed generation as 'the installation and operation of electric power generation units connected directly to the distribution network or connected to the network on the customer site of the meter' (NERSA, 2015: 4).

3. According to the DoE, 3.2 million households lack access to electricity, of which 75 per cent are supplied by Eskom and 25 by municipalities (DoE, 2013).
4. Currently set at a monthly income of R2300 (National Treasury, 2013).
5. Roof top solar PV is excluded from this programme which sets a minimum of 1 MW for projects under the small programme and of 5 MW under the main programme.
6. Calculated from Eskom's figures: www.eskom.co.za/CustomerCare/TariffsAndCharges/Pages/Tariff_History.aspx
7. The number of municipalities was reduced from 278 to 257 in 2016 and their boundaries redrawn, the most significant boundary change since 2000 (National Treasury, 2016).
8. Guidelines and regulations on how revenue from electricity tariffs should be spent are outlined in the Municipal Systems Act and the Municipal Fiscal Powers and Functions Act (see Peters, 2015 and NERSA, 2016).

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