Centre for Competition Law and Economics

Competition as a means to reform the South African electricity sector

Roan Minnie[1]
Centre for Competition Law and Economics, Stellenbosch University

6 February 2018

UNIVERSITEIT STELLENBOSCH UNIVERSITY

Competition as a means to reform the South African electricity sector – a policy research note

Roan Minnie[1]
Centre for Competition Law and Economics, Stellenbosch University

[1]**Research assignment presented in partial fulfilment of the requirements for the degree of Bachelors of Economic and Management Sciences with Honours at the University of Stellenbosch.**
Supervisor: Helanya Fourie

Physical address

CCLE Lab, 6th Floor,
CGW Schumann Building,
Stellenbosch University,
Bosman Street, Stellenbosch,
7600, South Africa

Postal address

Centre for Competition Law and Economics, Department of Economics,
Stellenbosch University,
Private Bag X1, Matieland,
7612, South Africa

Directors

Prof Willem Boshoff (Economics)
e.**wimpie2@sun.ac.za**

Prof Philip Sutherland (Law)
e. **mailto:pjsu@sun.ac.za**

Reception

Mrs Ina Kruger
gmkruger@sun.ac.za

t / f. +27 (0)21 808 2247

Table of Contents

Executive Summary

The rationale for the structure of South Africa's electricity sector is indefensible in the 21st Century. In the past, there were clear economic rationales for having a state owned vertically integrated monopoly in the South African electricity sector. However, technological advances resulted in the interaction among the functional phases of electricity services (generation, transmission and distribution) being reformed. It follows logically that the manner in which this sector is structured, should also be reformed.

The increase in reformation of electricity sectors globally lends further strength to the argument that South Africa's electricity sector should be reformed. The prominence of reformations enables one to collect the components of a standard reformation model by observing the strategies followed in successful reformations. The importance of proper sequencing of the reformation steps and appropriate regulation is especially applicable to the South African case**.** Applying these lessons to a reformation model for South Africa can ensure that it reaps the benefits of successful reformation observed in other cases.

The current market structure has enabled Eskom to prevent any attempts at reformation and to maintain its market power in the sector. Eskom's ability to delay and ultimately derail both the White Paper on Energy and the Electricity Working Group's efforts of reformation in the late 20th Century, a time when South Africa experienced revolutionary changes in its constitution, has led to the utility retaining its market dominance in the sector. In the 21st Century, Eskom continues to halter reformation by refusing to sign power purchase agreements with Renewable Energy Independent Power Producers.

Eskom's continued ability to prohibit the reformation of the South African electricity sector calls for a new paradigm of policy. For the reformation of the South African electricity sector to be successful, a model that calls for the generation phase to be unbundled from the transmission and distribution phase is recommended. Appropriate regulation has to form part of such a model to protect the interests of private sector participant that would eventually lead to competition in the generation phase.

1 Introduction

The electricity sector has various atypical characteristics that has led to it traditionally being structured as a vertically integrated monopoly market structure in the past. However, in recent decades there has been considerable reformation of the electricity sector globally. This paper aims to assess the feasibility of a reformation model that introduces competition in the South African electricity sector.

The paper examines how market failure in electricity sector investment, government's public focus and social objectives, and efficiency and security of supply contributed to the rationale for a state monopoly electricity utility in South Africa. Before looking at the rationale for reforming the market structure in South Africa's electricity sector, one must assess the possibility of alternative market structures in this sector. Therefore, section 2 first looks at the functional decomposition of electricity services and market structure models. It then proceeds to re-examine what was previously the rationales for monopoly, but now as the rationales for reformation in South Africa.

Section 3 follows a case-study approach on electricity sector reformations in Mexico, China, Chile and Brazil. It sets out to discuss the components of a standard reformation model and how countries employed these components to achieve one of six market structure models in the electricity sector. The objective is to extract the important lessons from existing reformations to assist South Africa in developing a reformation model.

The final section discusses the history of electricity sector reformation in South Africa and concludes that the current market structure has enabled Eskom to maintain its market power in the sector. It is therefore crucial that a new reformation model addresses the restructuring of the sector in order to capitalise on the efficiency gains from reformation.

2 Market structures in the electricity sector – a South African perspective

In the past, the global consensus used to be that electricity is most efficiently supplied by a vertically integrated monopoly (McDonald, 2012:60). In recent decades, countries have increasingly reformed their electricity sectors in an effort to address the inefficiencies

accompanying this market structure (Jamasb, 2006:14). In South Africa, electricity is still supplied by Eskom, the state monopoly electricity utility, which supplies approximately 96% of electricity demand (Generation Plant Mix Fact Sheet, 2017). In order to ascertain why there is a need for reform in South Africa's electricity sector, this section will investigate the rationale behind state monopolies in the electricity sector and the market structures characterising an infrastructure industry.

2.1 Reasons for state monopolies in the electricity sector

The rationale for state intervention in any sector is to correct market failure. It is important to determine what market failure is being addressed by governments' intervention in the electricity sector, as it will influence if and how reformation of the sector takes place. Market failure in the electricity sector can be classified into the three categories discussed below.

2.1.1 Electricity sector investment

Many infrastructure industries, such as telecommunications or electricity services, are characterised by technologies that exhibit decreasing costs when operating scale is increased (Bjornstad & Brown, 2004:6). Creating the infrastructural network to exploit decreasing marginal costs and achieve economies of scale, is a capital intensive project (Byrne & Mun, 2003:50). In the past, it was unlikely and in most cases infeasible for more than one competitive entity to achieve this required scale of operation (minimum efficient scale) in a country's electricity sector. This characteristic can explain the reason for the electricity sector being a natural monopoly. However, it does not provide the reasoning for the electricity sector usually consisting of a state owned monopoly.

The reason for increased government intervention can be attributed to two properties of electricity sector investment. The first is the so-called "missing money" problem. Market failure occurs as a result of the competitive electricity price being incapable of sufficiently reflecting the operating and capital investment costs required to attract long term investment in new generating capacity (Haikel, 2011:120). Given the large investments required, governments had to intervene by committing public resources to increase infrastructure coverage (Kessides, 2004:1).

The second property associated with electricity sector investment is the large sunk costs to establish a distribution network. In the short- and medium term, sunk costs cannot be recovered by stopping operation, which makes investment in this sector risky (Kessides, 2004:30). The duplication of these expensive sunk costs deterred risk averse private investors from investing in the electricity sector. In response to this market failure, governments typically intervened by establishing a single utility to generate and distribute electricity (Church, 2017:8).

The failure of the electricity sector to attract suitable and sustainable private investment is exacerbated by the extremely long payback period (Byrne & Mun, 2003:50). For example, in SA in the 1970's it would take fourteen years from approving plans for a new six-unit coal fired station to the completion thereof (Steyn, 2006:15). Two of Eskom's most recent coal-fired generation expansion projects, Medupi (announced in 2007) and Kusile (announced in 2009), are both expected to be completed 13 years after its announcement (Eskom, 2016:4). Hence Eskom has not been able to capitalise on the technological advancements of the last 40 years – a point discussed further in section 2.3.3.

The aforementioned market failures resulted in private investors either decreasing investment in the electricity sector, requiring a significant risk premium, or both (Kessides, 2004:30). In response, government intervention led to the establishment of a state monopoly in the electricity sector of many countries.

2.1.2 Public service focus and social objectives

A second reason for state monopolies in the electricity sector, that is especially applicable to the South African case, is that government has a public commitment and focus with regards to electricity services (McDonald, 2012:67). The 1922 Electricity Act of South Africa gave statutory power to the Electricity Supply Commission (Escom, which would later become Eskom), to supply electricity solely in the interest of the public and forbade the utility to make profits (McDonald, 2012:57). The Act was amended in 1987, with the most prominent difference being that the entity was no longer required to operate without profit (McDonald, 2012:65). The reform attempts and failures of the South African electricity sector will be discussed in detail in section 4.1.

The amendment of the Act coincided with the Apartheid government's efforts to ease political tension in the country by electrifying rural areas towards the end of Apartheid. Anticipating the end of Apartheid, Eskom also announced its respective electrification programme to electrify 700 000 new households in 1990 (Eberhard, 2007:236). These efforts were supported and expanded by the new democratically elected government of 1994. A state monopoly market structure was integral in navigating the extremely difficult and unique political environment that South Africa faced at that time. The complementary objectives of Eskom and the government were met and exceeded at an unprecedented pace (McDonald, 2012:1). Figure 1 shows the rapid electrification of the rural population from 26.44% in 1990 to 71.48% in 2014.

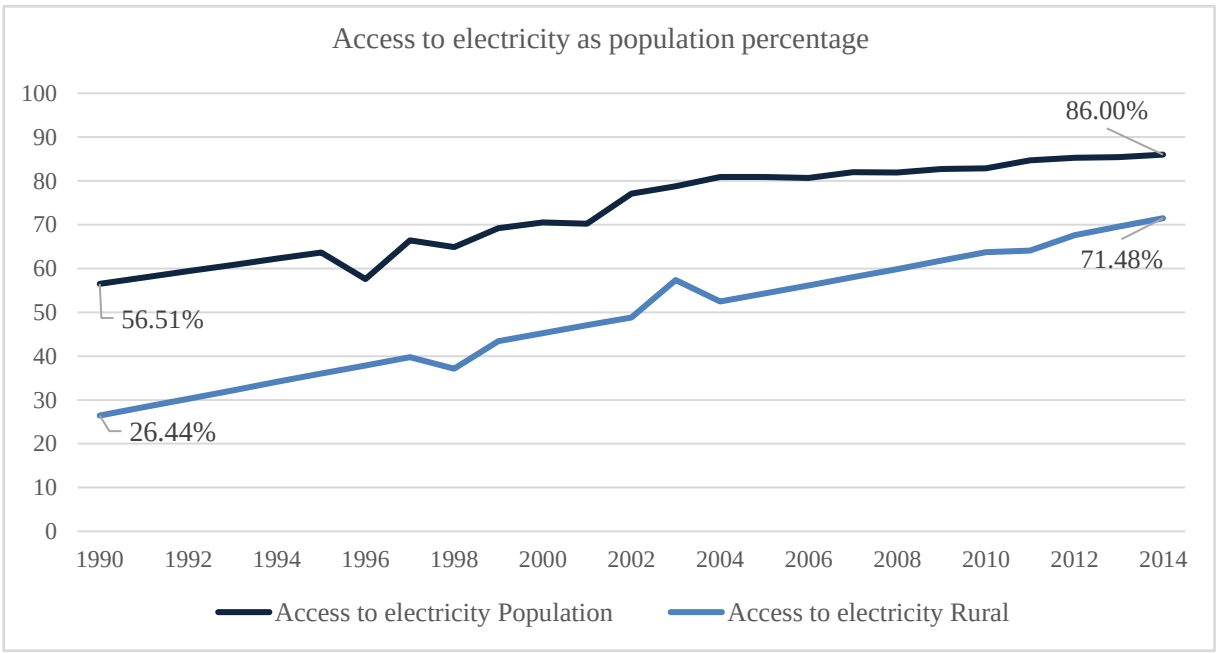

Figure 1: Access to electricity as population percentage in SA. Source: Author's own calculations. Data: World Bank, Sustainable Energy for All (SE4ALL) database from the SE4ALL Global Tracking Framework led jointly by the World Bank, International Energy Agency.

After the end of Apartheid, the state prioritised socio-economic development in all policy decisions. Along with the rural electrification objectives, one of the most important socio-economic goals was employment creation (Winkler, 2006:42). The electricity sector contributes twofold to this goal. Firstly, the sector itself is a reasonable source of employment in the form of coal mining in South Africa and direct employment by Eskom. Secondly, and more importantly, the electricity sector is a key input to almost every other industry in the economy and consequently a key driver of economic growth and development (Eberhard, 2007:215).

State intervention in the sector can therefore be explained by government's goal to ensure that electricity supply in the economy is secure and hence can contribute to economic growth. The question is whether this goal is currently being achieved (examined in full in section 2.3) and whether there is a way that government can achieve this goal outside of a state owned market structure.

2.1.3 Efficiency and security of supply

Lastly, the market for electricity is subjected to very atypical demand and supply conditions, which could also be used as a motivation for a state monopoly. Demand for electricity can be inconsistent and fluctuate widely by hour, day and week (Ljung, 2007:41). Economic efficiency requires generation capacity to be able to meet the maximum demand in this volatile range in order to satisfy consumers' expectations (Steiner, 2000:8). Concurrently, from the supply side, current technology does not allow electricity to be stored once it has been generated (Steiner, 2000:8). This results in the demand for electricity being an instantaneous demand and for it to be met, requires high levels of coordination.

Joskow (2000:16) argues that it is the complementarities between the functional composition of the generation and transmission phase that is the primary source of economies of scale in electricity services. Hence, for electricity services to be efficient, stable and secure, close coordination between service providers (generation phase) and infrastructure facilities (transmission phase) is required to equate demand and supply (Kessides, 2004:48). Some have argued that the current electricity market structure in which governments regulate final prices in a vertically integrated monopoly, is the only way to avoid shortages and high prices (Newbery, 2002a:921). In what follows, the composition of electricity services is explored in more detail.

2.2 Market structures in the electricity sector

The rationales discussed above motivate why the South African electricity sector is currently a vertically integrated monopoly. Before determining if there is a rationale for reforming the electricity sector, one must assess the alternative market structures that form part of this sector. Since electricity services function in three distinct stages (generation, transmission and distribution), it is important to understand how each of these stages fit into the broader value chain. This functional decomposition will aid the discussion of the market structures

present in this sector. Furthermore, how these operational stages interact with one another will be important when possible reformation strategies for South Africa are discussed in section 4.2.

2.2.1 Functional decomposition of electricity services

Electricity generation entails the transformation of one form of energy (e.g. coal, nuclear, hydro, gas, etc.) into electrical energy (Steiner, 2000:8). As discussed in section 2.1.1, in the past electricity services were generally regarded to be a natural monopoly due to the high capital cost associated with achieving economies of scale in the generation phase. Whether this is still the case, is unclear. In many countries, technological advances made it possible to decrease plant size (Kagiannas, Askounis & Psarras, 2004:413), but some countries have yet to experience these advances. Whether South Africa's generation phase is still a natural monopoly will be discussed throughout the rest of the paper.

Electricity transmission concerns the high-voltage transportation of electricity and management of generators in a grid while preventing system breakdown (Steiner, 2000:9). As discussed in section 2.1.3, electricity services have previously been regarded as a natural monopoly due to the high levels of coordination required between the generation and transmission phase to ensure efficiency. Furthermore, transmission networks are seen as the "common carrier" of the electrons generated and make use of large network infrastructure that would be costly to duplicate, as discussed in section 2.1.1. (Byrne & Mun, 2003:54). This further cements the natural monopoly status of this phase.

Similar to transmission, distribution concerns the transportation of electricity (Steiner, 2000:9). The difference between the transmission and distribution network is that the latter is the part of the system that transmits low-voltage electricity to the final customer (Expósito, Gomez-Exposito, Conejo & Canizares, 2016:25). In order to do this, it makes use of a network of wires that will be costly to duplicate and is hence also considered to be a natural monopoly. In contrast to transmission, there is not a high level of coordination required between distribution and generation for efficiency (Steiner, 2000:9). If the intermediary, the transmission phase, achieves efficient coordination with the generation phase, there is practically no need for coordination between distribution and generation.

2.2.2 Market structure models

Following the abovementioned functional decomposition, there are six basic models that reflect the degrees of interaction among the phases in the electricity sector. These models are categorised into four phases, shown in figure 2, reflecting the level of competition in the sector. Phase 1 constitutes a monopoly at all levels, Phase 2 allows competition in generation, Phase 3 allows further competition in distribution while Phase 4 has competition at every vertical level of the electricity supply chain. This subsection will provide a short description of each model's main characteristics. The objective is to introduce these models in order to contextualise the discussion of the case studies to follow in section 3.

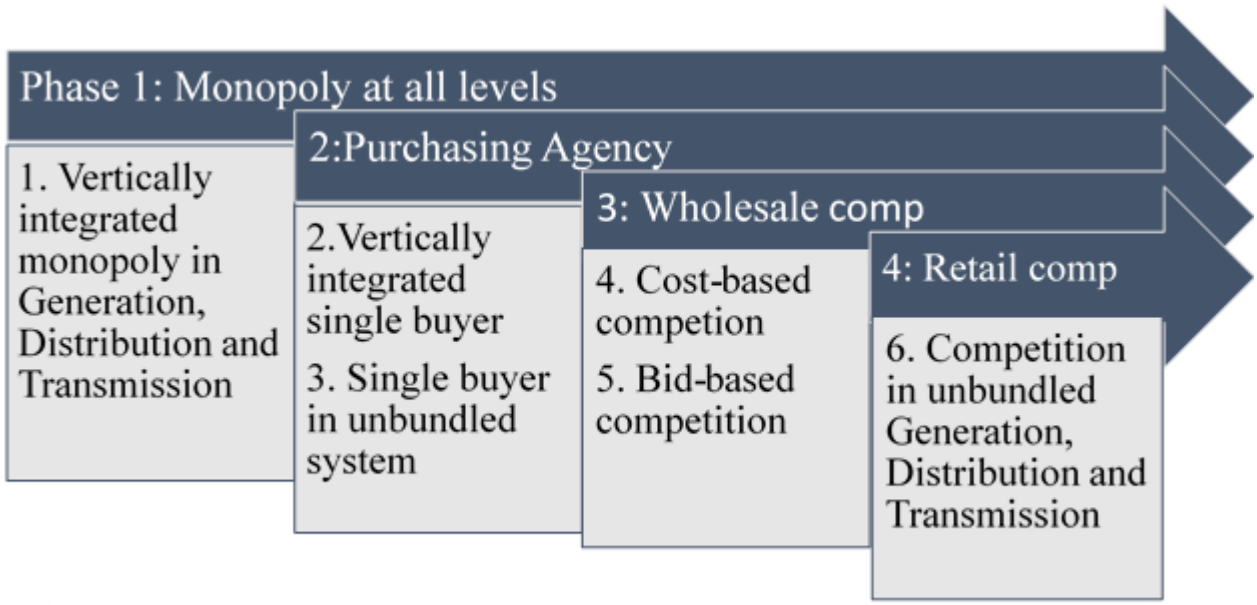

Figure 2: Market structures models categorised into competition phases.

Until the recent surge in electricity sector reformation, most countries' electricity sector comprised of a vertically integrated monopoly for reasons discussed in section 2.1. In this model, all three stages of electricity services are owned by national, state or municipal governments (Ljung, 2007:42). OECD statistics compiled a dataset containing 35 countries that measure product market regulation in the electricity industry on a scale of 0 to 6 (Conway & Nicoletti, 2006:29). According to this dataset, in 1975 all 35 countries were fully vertically integrated, hence obtaining an index score of 6 at this time (OECD Statistics). For every period, the score at the start was subtracted from the score at the end, therefore a positive value indicates vertical separation or unbundling in that period. Figure 3 shows how this score changed in 3 periods. Nineteen countries experienced a form of separation or unbundling during the 1990 – 2000 period, while the United Kingdom and Chile started in the preceding period already. By 2013, South Africa was one of only 3 out of the 35 countries in the dataset whose electricity sector still comprised of a vertically integrated monopoly. It is now widely accepted that this market structure is no longer the best suited to network utilities as the electricity sector is not necessarily a natural monopoly anymore (Kessides, 2004:36).

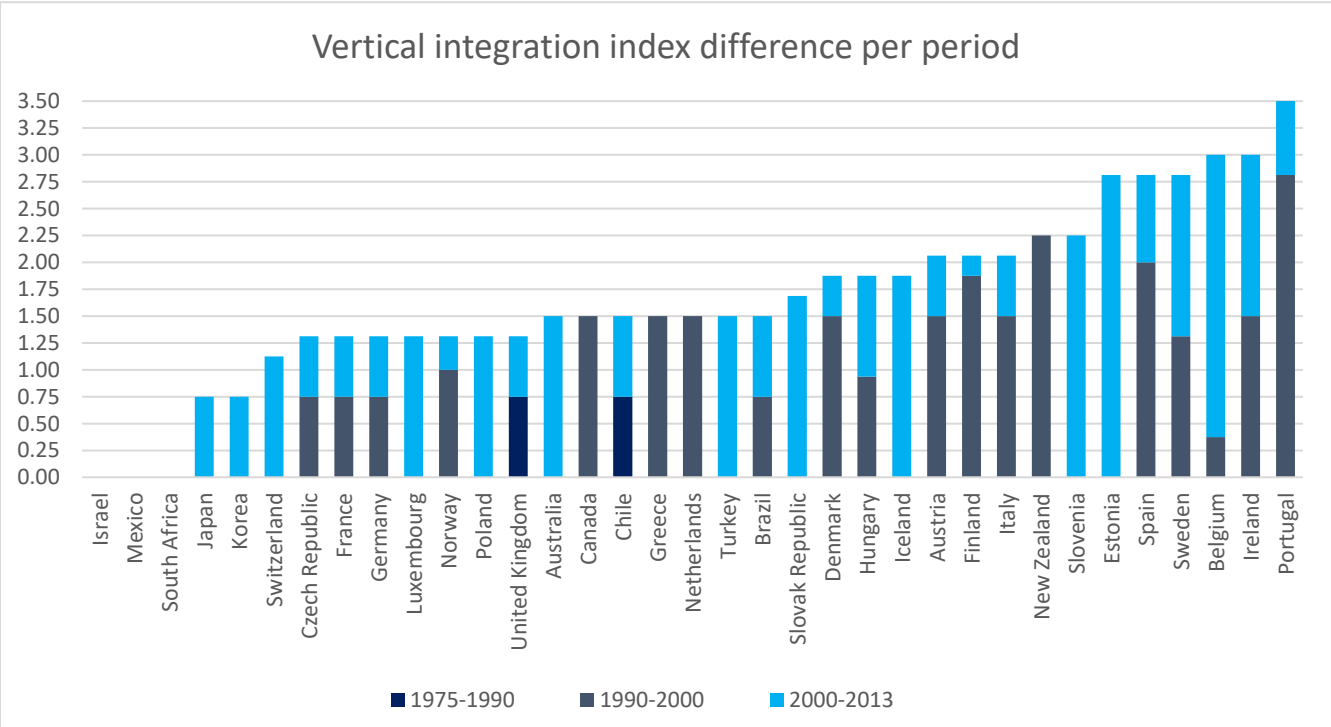

Figure 3: The difference in vertical integration index of 35 countries per period. Source: Author's own calculations. Data: OECD statistics http://stats.oecd.org/

One manner to reform the electricity sector is to introduce private sector investment. In the vertically integrated single buyer model, a vertically integrated state monopoly utility buys electricity from private independent electricity producers (Ljung, 2007:42). The next step is the single buyer in an unbundled system model, where the three stages of electricity services have been unbundled. In this model, the transmission stage is usually kept as a natural network monopoly, while the generation and distribution phases are split into regional companies (Ljung, 2007:43).

The next two models build on the abovementioned unbundled electricity sector and allow a multi-buyer and multi-seller competitive market. The cost-based wholesale competition model introduces competition at the wholesale electricity market level through negotiated contracts and the spot market. Electricity generating companies compete for contracts based on their capacity and asking prices incorporate fixed and variable costs (Ljung, 2007:43). In the bid-based wholesale competition model, the generating companies must provide supply schedules that contain the amount of electricity they are able to provide at different prices. This model depends on market forces in pure competition to determine prices (Ljung, 2007:43).

The final model is the retail competition model where the transmission network is reformed into a “common carrier” that transports electricity from the generation phase to the consumers at a regulated fee (Ljung, 2007:44).

2.3 The need for reform in the South African electricity sector

Given that there are alternative market structures possible in the electricity sector as described in the models above, this section considers whether there is a need for reformation in South Africa’s electricity sector. Jamasb, Mota, Newbery and Pollitt (2004) provide push and pull factors as the drivers of electricity sector reform. The authors describe the pull factors as being the observed benefits of successful reformations in other electricity sectors and this will form the core of the discussion in section 3. Push factors constitute shortcomings in the domestic market that drive the need for reformation. This subsection investigates the push factors for reformation in South Africa’s electricity sector by re-visiting the rationales given for state monopolies in section 2.1. Specifically, this section evaluates

the merits of these rationales within the current context of South Africa's political, economic and labour market landscape.

2.3.1 Electricity sector investment

Recent technological advances dramatically changed the structure of economies of scale in electricity generation (Kagiannas, Askounis and Psarras, 2004: 413). It is now possible to achieve economies of scale with much smaller technology which reduced the payback period of investment (Steiner, 2000:11). For example, the development of the combined-cycle gas turbine eliminated the need for large, centralised generation plants. Furthermore, the turbines can be completed within 2 years - much faster than coal or nuclear plants that take 5 to 10 years (Kessides, 2004:138) or even longer as observed in South Africa. Despite the fact that this technology can also be used in countries with low natural gas resources (such as South Africa), Eskom's total generation capacity only consists of 5% gas. Figure 4 shows that the technology mix of Eskom's total installed generation capacity of 47 140 megawatt consists of 84% coal fired power stations to meet the demand for electricity.

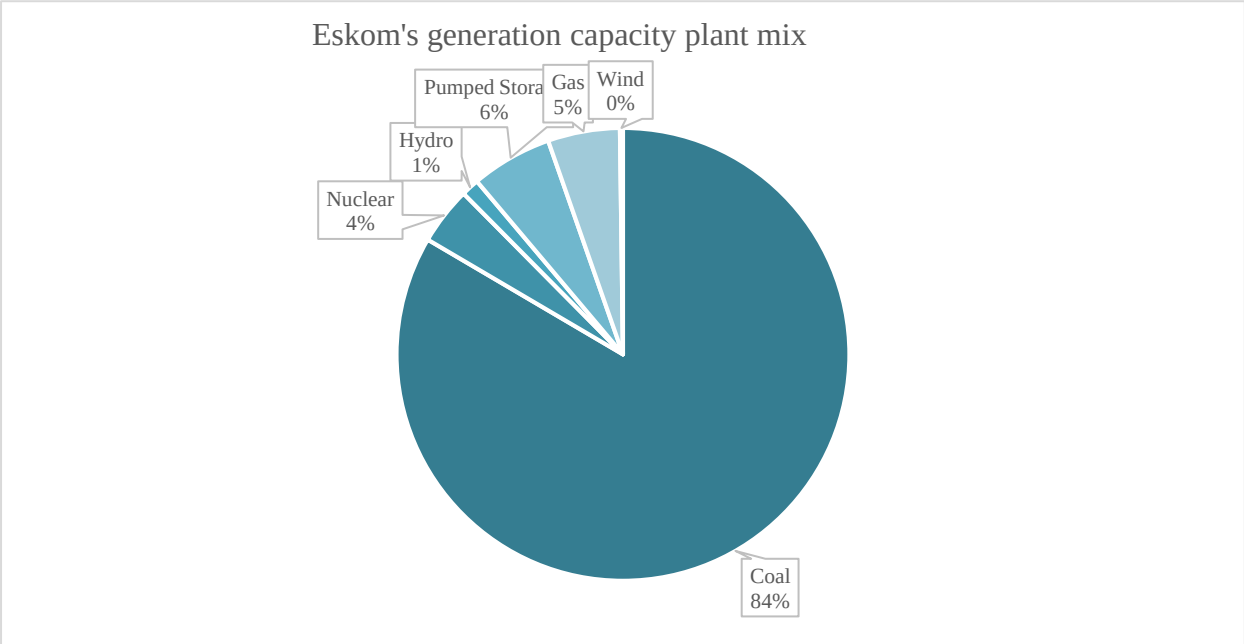

Figure 4: Eskom's generation capacity technology mix in 2017. Source: Author's own calculations. Data: http://www.eskom.co.za/AboutElectricity/FactsFigures/Documents/GX0001GenPlantMixRev19.pdf

Electricity services in many developing countries are under increasing pressure to equate demand and supply. Utilities are running out of spare capacity leading to an increase in the incidence of electricity blackouts (Kessides, 2004: 137). The current structure of the sector

is not suited to attract the significant long-term investment that is needed to counteract the decline in generation capacity (Kessides, 2004: 137). In the 1980's already, Eskom's financing plans did not reflect a risk premium as its monopoly status resulted in financial risks being shifted onto its customers through increased tariffs, irrespective of the utility's economic performance (Steyn, 2006:36). Regardless of over-investment in generating capacity during this time using financing that shifted the risk to the public in the pursuit of exploiting new technologies and economies of scale, real prices in the long run were largely unaffected (Steyn, 2006:50).

Joskow (2012:577) views state ownership as a form of vertical integration that can be analysed in the principal agent theory framework. This framework may help to explain Eskom's decision-making described in the preceding paragraph. The principal (the state) owns the electricity utility but this ownership is separated from the agent (Eskom) that manages the utility. The principal requires the agent to have investment plans that strive for efficiency while still reflecting risks. The agent, protected by the current market structure in which it enjoys monopoly status, need not bear the risks of its investment plans and thus shifts it to the consumer. The problem of mismatched incentives is known as moral hazard. The state tries to effectively and accurately regulate the decisions and actions of the agent in an attempt to address this principal agent problem and, as a result, incurs agency costs (Steyn, 2006:6).

2.3.2 Public service focus and social objectives

One of the biggest successes of South Africa's electricity sector is the rapid electrification of rural areas that was discussed in section 2.1.2 and there is an argument to be made that the vertically integrated structure of the sector played a key role. If reformation in South Africa is to take place, the strategy will have to clearly outline how this public focus will be preserved in a reformed electricity sector. This will be discussed further in section 4.1 and 4.2 which deals with reform policy options for South Africa.

Once again it can be argued that there exists a principal agent problem in the South African electricity sector. The vertically integrated market structure is supposed to be the key tool that enables the principal to oversee that the agent prioritises its social policy objectives. However, recently, Eskom has been under a cloud of speculation about corruption and accusations about state capture. Existing literature have gone as far as stating that South

Africa is experiencing a silent coup with a symbiotic relationship between a constitutional and shadow state (Bhorat, Buthelezi, Chipkin, Duma, Mondi, Peter & Swilling, 2017:2). This suggests that the principal agent relationship is now even more complex. Subsequently, the principal can be divided into a "constitutional principal" and a "shadow principal". The former is already incurring expensive agency costs to address the moral hazard that arises from a mismatch of incentives between them and the agent. Bhorat et al. (2017:3) argues that the latter is using the state-owned entity as a primary vehicle for self-enrichment through state capture. Eberhard and Godinho (2017:24) conclude that reforming the electricity sector will make "capture" of this fundamental input to all economic activity and social development more difficult.

After achieving its social policy goals discussed in section 2.1.2, the South African government is once again in the position to utilise the electricity industry to achieve a new set of social policy objectives. Recently the pressure on government to accelerate black economic empowerment has been accumulating. Electricity sector reformation where assets are divested in a competitive electricity market instead of just a private monopoly could be a big step towards achieving these social policy objectives (Eberhard, 2007:230).

2.3.3 Efficiency and security of supply

Byrne and Mun (2003:52) describe "an almost universal justification" of electricity sector reformation as the efficiency ideology. They regard this ideology universal as a result of the wide ranging multilateral institutions advocating for reformation in developing countries in order to benefit from the improved economic performance, lower prices and greater choices for consumers accompanying successful reformation (Byrne & Mun, 2003:53).

In recent years, Eskom has been unable to guarantee the security of electricity supply in South Africa. So much so that NERSA (the National Energy Regulator of South Africa) approved a regulatory licence requirement in 2010, The National Code of Practice for Emergency Load Reduction, or commonly referred to as load shedding after the electricity outages experienced in 2008 (Eskom, 2015:59). These electricity outages in 2007/8 and 2014/15 had a crippling effect on the economy that has yet to be fully captured by statistics. In a World Bank Enterprise survey conducted in 2007, firms reported that electrical outages resulted in a loss of 0.7% of annual sales (World Bank Open Data).

Furthermore, technological advances, like the combined-cycle gas turbines, reduced the need for high levels of coordination between generation and transmission in order to achieve efficiency that was regarded the rationale for vertically integrated monopolies, explained in section 2.1.3 (Kessides, 2004:135). This means that a vertically integrated market structure in the South African electricity sector can no longer be justified by a claim of efficiency or security of supply.

If the vertically integrated market structure has become redundant, then the extensive agency monitoring costs of regulating electricity prices in this market structure have also become redundant (Joskow, 2000:8) and more importantly, the market structure has become economically inefficient. Zhang, Parker and Kirkpatrick (2008:163) argue that reformation is expected to increase the economic efficiency of the sector by eliminating the burden on taxpayer support and exposing it to the discipline of the free market.

This does not, however, come without a warning: if reformation is successful it can improve efficiency and lower prices, but unsuccessful regulation and competition can undermine the benefits of reform (Jamasb, 2006:15). The challenge lies in developing a reformation model that preserves the economic efficiencies associated with the current market structure while addressing the problems that drive the need for reformation in the first place.

3 Lessons from electricity sector reformations

The objective of this paper is to ultimately assess if introducing competition in the South African electricity sector can help solve the principal agent problem and address inefficiencies discussed in section 2. The discussion below will investigate the different ways in which competition can be introduced in this sector by drawing from the experiences of countries that have managed to reform their electricity sector. However, it is difficult to compare and transfer experiences due to a range of difference across countries. These difference include, but are not limited to the rationale for reformation; heterogeneity in electricity sectors regarding size, structure and resource use; and differences in institutional, political and economic systems (Jamasb, 2006:15).

Therefore, this section will focus on the key strategies and lessons from the experiences of countries by categorising their reformation models into three phases portraying the level of competition in the sector. Before doing so, the components of a standard reformation model will provide the framework for discussing the different strategies that are available.

3.1 Components of a Standard Reformation model

It is important to draw a distinction between the market structure models discussed in section 2.2.2 and a reformation model for the electricity sector. A reformation model is the strategic plan consisting of multiple facets that is followed to achieve a specific market structure. Seeing that reformation of electricity sectors have become more prominent in recent decades, one can deduce the components of a standard reformation model by observing the strategies followed in successful reformations. Existing literature agree about the key components in a standard reformation model, but are not in consensus about the sequence in which these components need to be performed. Therefore, this subsection looks at the three main elements of a standard reformation model in an arbitrary ordering. The appropriate sequencing of a possible reformation model for South Africa is discussed in section 4.2.

One of the main elements of reformation in the electricity sector requires the restructuring of the industry (Zhang, Parker & Kirkpatrick, 2008:161). Restructuring entails that the vertically integrated functional components, discussed in section 2.2.1, be separated or unbundled (Nepal & Jamasb, 2015:18). Unbundling generation, transmission and distribution enables further reformation in the phases that do not constitute a natural monopoly. Joskow (2006:4) argues that vertical separation also prevents the cross-subsidisation between competitive and regulated businesses as well as the possibility of competitive discrimination, e.g. denying access to networks.

A standard reformation model also requires either a new independent regulatory entity or the expansion of the mandate of an incumbent independent regulatory entity (Victor & Heller, 2007:6). A new regulatory framework is a crucial part of the reformation process, regardless of the market structure that the sector is being reformed to. The rationale for an extensive regulatory framework is twofold. Firstly, ex ante sector specific regulation is needed where market failure exists and an electricity phase constitutes a natural monopoly. Ex ante

regulation facilitates proper conduct in the sector through incentive based regulation that defines market entry, network charges and access (Nepal & Jamasb, 2015:18). For example, if the transmission phase cannot be privatised, it is the role of the independent regulator to establish the rules with regards to access to the transmission grid (Jamasb, 2006:17). Secondly, ex post competition policy must ensure that the reformed market structure does not facilitate anticompetitive practices such as abuse of market power (Bacon & Besant-Jones, 2002:4).

A final important component of a standard reformation model is that it accounts for private sector participants in the electricity sector (Nepal & Jamasb, 2015:18). Bacon and Besant-Jones (2006:17) argue that the private investors and operators are likely to supply finances and expertise to address the inefficiencies in the sector in accordance with their profit motive. Joskow (2006:4) further argues that allowing private participation can rid the sector of government's political agendas, such as revenue collection by the state outside of the tax system.

The standard reformation model is not however a panacea to reform the electricity sector. It is important that the components should be integrated into the reformation model in such a manner and sequence so that it best suits the individual needs, institutions and economic environment of the involved electricity sector. The following subsection will investigate how selected economies incorporated these components in unique reformation models.

3.2 Reformation models and lessons

In reforming the electricity sector, varying degrees of competition can be achieved in the market. From this point of view, Hunt and Shuttleworth (1997) divided reformation into four phases portraying the level of competition present in the sector after reformation has been completed. The convention of calling it phases could be interpreted as something that all reformation models should pass through to ultimately reach Phase 4. This is not necessarily the case. As will be clear in the subsequent discussion, the appropriate reformation model and ultimate market structure model depends on the respective country's electricity sector. This section will follow the framework of Hunt and Shuttleworth (1997) by categorising the market structure models discussed in section 2.2.2 into the four phases as illustrated by

figure 2. Table 1 gives a summary of how the elements in a standard reformation model is utilised in each phase.

Table 1: Summary of possible reformation models

Phase	Market structure	Degree of Restructuring	Degree of Regulation	Private Sector participation
Purchasing agency	Vertically integrated single buyer	Generation, distribution and transmission vertically integrated	Regulation required to prohibit abuse of power by single buyer	IPP's generate electricity and sell to single buyer
	Single buyer in an unbundled system	Generation unbundled from distribution and transmission	Regulation required in natural monopoly phases	Generation phase privatised
Wholesale competition	Cost- or Bid-based wholesale competition	Generation and Distribution unbundled from Transmission	Regulatory institutions required to oversee Transmission network and competitive wholesale electricity market	Private participation in Generation and Distribution with open access to Transmission network
Retail competition	Retail competition	Generation, Distribution and Transmission unbundled	Normal sector-specific regulation	Private participation in all stages of electricity services

3.2.1 Purchasing agency

The Purchasing Agency reformation phase emphasises the private participation component of the standard reformation model. In order to achieve this reformation phase, the reformation strategy must entail either 1) regulation to allow independent power producers

(IPP's) to generate electricity in the market or 2) restructuring of the sector to unbundle generation from transmission and distribution in order to allow private sector involvement.

In this phase a single buyer can purchase electricity from a range of IPP's, hence stimulating competition in the generation phase (Hunt & Shuttleworth, 1997). Subsequently, the vertically integrated single buyer and single buyer in an unbundled system models are categorised into this phase. Bacon and Besant-Jones (2002:8) call the Purchasing agency phase the "toe in the water" approach in introducing competition in the sector.

Mexico altered the law regulating their electricity sector in 1992 to allow private sector participation, hence reforming to the vertically integrated single buyer model (Carreón-Rodriguez, Jiménez & Rosellón, 2007:192). IPP's, owned and operated by private companies, generated electricity and sold it to the state owned electricity enterprise under power purchase agreements (PPA). Despite the IPP's not altering the market structure significantly (the sector still comprised a vertically integrated monopoly), it did have a dramatic effect on the technologies used in the sector seeing that many IPP projects were funded by foreign investors (Carreón-Rodriguez *et al.,* 2007:195). The lesson to learn from Mexico's reformation to a vertically integrated single buyer is that this structure is considered to be a temporary solution to the problem of underinvestment and declining ability to meet growing demand (Carreón-Rodriguez *et al.,* 2007:214).

There is a risk that a vertically integrated monopolist may give preference to bids from its own generation phase above the PPA's of IPP's (Newbery, 2002b:28). To solve the problem of possible discriminatory practices by the vertically integrated monopoly, the reformation model can include restructuring of the sector to unbundle generation from transmission and distribution. China's electricity sector reformation in 2002 addressed exactly this problem and comprised of unbundling generation to achieve a single buyer market structure (Andrews-Speed, 2012:166). Generation assets were redistributed to five competitive companies, each not holding more that 20% of generating capacity. The sector faced several challenges following the implementation of the reformation strategy. It needed to ensure that there was an adequate supply of coal to meet the increasing demand and solve the problem of creating competition among provinces (Yi-Chong, 2004:202). Erdogdu (2010:32) note that China, being the second largest electricity industry in the world, still needs to overcome these challenges while reforming to a competitive market. Despite these

problems, reformation in China is regarded as a success that engendered improvement in financial and technical performance while stimulating investment in new capacity (Andrews-Speed, 2012:170-171).

3.2.2 Wholesale competition

In the Wholesale competition reformation phase, private participation is increased by unbundling distribution, in addition to the unbundling of generation as under the Purchasing agency model. Competitive distribution companies then purchase electricity from generators and service customers via an open access central transmission grid (Hunt & Shuttleworth, 1997). As discussed in section 2.2.2, Wholesale competition can take place on a cost-based or bid-based basis. It is not within the scope of this paper to discuss the technicalities regarding the distinction between the two forms, but what is important is that in this reformation phase, competition takes place in two stages of electricity services, i.e. generation and distribution.

Chile is accredited for being the first country to reform its electricity sector in 1982 (Newbery, 2002b:11). Initially a competitive wholesale market was created by dividing two state owned integrated companies into five separate generation and eight separate distribution companies (Newbery, 2002b:11). The electricity sector encountered problems as a result of the transmission phase not being unbundled from the generation phase and consequently being controlled by the largest private company (Erdogdu, 2010:13). This resulted in further reformation in 1991 when the companies were privatised (Newbery, 2002b:11). Regardless of the initial problems, reformation of Chile's electricity sector is regarded as highly successful, with literature citing large efficiency gains (Kessides, 2012:3). The important lesson from the Chilean reformation model is the careful consideration of the sequence of reformation steps. The model first introduced regulation to protect potential investors, after which restructuring occurred in order to give enterprises experience before privatisation (Kessides, 2004:110). The importance of adequate regulation to prevent market power abuse is also highlighted by the Chilean case.

Brazil also reformed its electricity sector to a wholesale competition market structure in 1995 by privatising the generation and distribution phases (Erdogdu, 2010:16). Kessides (2012:3) argue that the Brazilian reformation model was not adequately planned and sees the privatisation of distribution before an independent regulator was established, as a flaw in the

model. The electricity sector was further plagued by a drought that depleted the sector's ability to generate hydropower that constitutes the biggest proportion (±95%) of their generation capacity (Ljung, 2007:80). Brazil reformed the sector once more, moving towards an untraditional single buyer model where a Market Administrator pools the demand and generators bid to supply the aggregate demand (Ljung: 2007:80). The lesson to learn is once again that the "correct" reformation model and ultimate market structure model depends on the characteristics of the electricity sector involved. The Brazilian case also highlights the importance of adequate planning and the sequence of reformation steps.

3.2.3 Retail competition

The final reformation phase constitutes retail competition in a completely unbundled electricity sector. To achieve full retail competition is logistically complicated and expensive (Bacon & Besant-Jones, 2006:11). Existing literature notes the decline in reformation to retail competition as a result of the mixed performance by the small number of countries that reformed to this market structure model (Erdogdu, 2010:28). Ljung (2007:159-162) shows that from a sample of 122 developing countries, none have a retail competition market structure model in their electricity sector. Gratwick and Eberhard (2008:3975) reiterates this point by noting that the adoption of retail competition has been neglible.

Bacon and Besant-Jones (2006:11) and Ljung (2007:72) state that the lesson to learn from the failure of California and other electricity sectors that implemented retail competition is that retail competition is not a viable option for developing countries.

As emphasised throughout this section, there is no standard reformation model with clear steps and sequence that can be followed to reform an electricity sector. The reformation models discussed in this section (summarised in table 1 above) and the lessons from the failures and successes will aid the exploration of an appropriate reformation model for the South African electricity sector in the following section.

4 Reforming South Africa's electricity sector

So far, this paper has described the rationale for why South Africa's electricity sector was established as a state owned vertically integrated monopoly, and the effect that this may

have had on the functioning of the sector. It has illustrated that South Africa undoubtedly stands to gain from reforming the sector, and has shown that there are six typical market structure models that can be used to provide a framework for thinking about reformation. The discussion of the experiences of other countries and how they have used the components of a standard reformation model to achieve improved electricity outcomes, presents South Africa with a few lessons.

The discussion so far has set the tone for exploring the reformation attempts and failures in the South African electricity sector before ultimately developing a reformation model that introduces competition in the sector.

4.1 Reformation attempts and failures

This section will follow Winkler (2006) by discussing the history of South Africa's electricity sector reformation by looking at the pre-democracy, post-democracy and post-2000 periods respectively. Remarkably, each period can be characterised by major policy initiatives that affected the sector in ways that can still be observed today.

4.1.1 Pre-democracy electricity policy in South Africa

Under the Apartheid regime in South Africa, electricity policies were predominantly aimed at providing services to the minority white population (Winkler, 2006:6). As mentioned in section 2.1.2, the 1987 Electricity Act of South Africa gave statutory power to Eskom to supply electricity. The Act was amended in 1992 and did no longer require the utility to operate without profit (McDonald, 2012:65). The Act defined the functions and structure of the first electricity regulatory entity in South Africa, the Electricity Control Board (ECB) (Winkler, 2006:6).

The major policy initiative that characterises this period is the start of the rapid electrification near the dawn of democracy (recall that this was one of the rationales for a vertically integrated state monopoly in the electricity sector of South Africa, discussed in section 2.1.2). Eskom announced in 1991 that it aimed to electrify 700 000 new households in the following six years (Eberhard, 2007:236).

4.1.2 Electricity reformation in a young democracy

When South Africa gained democracy in 1994, the aim of electricity policies shifted towards addressing the needs of the previously disadvantaged and strengthening the institutions governing electricity supply.

Endorsing Eskom's electrification initiative, the newly elected democratic government implemented the National Electrification Programme during 1994 (Winkler, 2006:7). The remarkable success achieved by these initiatives and the key role of the vertically integrated monopoly market structure have been discussed in section 2.1.2. Section 2.3.2 proceeded by stating that if reformation of South Africa's electricity sector is to take place, a clear strategy for preserving this public focus will be required. Developments in South Africa's reformation attempts in 2001 will shed more light on this subject.

The Electricity Act was amended once more during 1994/95 giving statutory authority to the National Energy Regulator (NER) that replaced the ECB (Erdogdu, 2010:34). The NER regulated all aspects of electricity services, licensing and prices in South Africa (Kessides, Bogetic & Maurer, 2007:75). Eberhard (2007:242) notes that the NER developed into a respected independent regulatory entity, but still faced challenges with a lack of sufficient capacity to regulate Eskom.

A remarkable development in electricity sector reformation in the young democratic South Africa was the White Paper on Energy that was published at the end of 1998 (Kessides *et al.*, 2007:72). The paper was on par with the international energy agenda (Winkler, 2006:8), enjoyed extensive inputs from numerous sources and was a comprehensive document covering all facets of the energy sector (Kessides *et al.*, 2007:72). Eberhard (2007:242) argues that through the paper, government publicly confirmed its belief that Eskom needed to be restructured and how important they regarded the role of an independent regulator – both key components of a standard reformation model discussed in section 3.1. Existing literature recognises the White paper as a paradigm shift in electricity policy in South Africa. Unfortunately, opposition to the paper and the recommendations came in the form of labour unions and Eskom (even though supporting reformation in principle, in practice Eskom resists proposals that it should divest a share of its generation assets) (Eberhard, 2007:247). As a result, the recommendations contained in the White Paper were never implemented.

With reformation gaining momentum in South Africa in the late 1990's, the NER sought legislation from government to establish a committee (Electricity Working Group) that would later propose that distribution be rationalised into six Regional Electricity Distributors (RED's) (Eberhard, 2007:243). This proposal was approved by Cabinet in 1999. However, once again opposition came in the form of local governments (municipalities) not wanting to lose influence and revenue from electricity undertakings (Kessides *et al.*, 2007:74). On paper, the first RED was established in 2005 (Kessides *et al.*, 2007:72), but the restructuring process was formally abandoned in 2010 (Baker, 2012:81).

Eskom's ability to delay and ultimately derail two viable reformation models in a time when South Africa experienced revolutionary changes in its constitution, has led to the utility retaining its market dominance in the sector (Eberhard, 2007:250). These developments had a significant impact on possible reformation in the 21st century.

4.1.3 Electricity reformation in South Africa since 2000

In the early 2000's the National Energy Regulatory Act of 2004 replaced the NER with the National Energy Regulator of South Africa (NERSA). The key difference between the two regulators is that the new regulatory entity's mandate now included the functions of the Gas Regulator (Kessides *et al.*, 2007:75).

In 2001, the corporatisation of Eskom according to the Eskom Conversion Act, coincided with two reformation developments that significantly impacted the generation capacity of the electricity sector. Firstly, government placed a moratorium on Eskom's projects in an attempt to create a competitive market and secondly, there were delays in contracting with IPP's (Montmasson-Clair & Ryan, 2014:58). Unsurprisingly private investment did not materialise due to uncertainty in the regulatory environment in the sector as a result of the failed reformation attempts in the past. The moratorium ended in 2004, but the sector lost four crucial years of generation capacity expansion (Montmasson-Clair & Ryan, 2014:58). This undoubtedly contributed to South Africa's electricity supply problems during 2007/8 and 2014/15.

One of the most important aspects of the corporatisation of Eskom, that can easily be overlooked, is that since corporatisation, Eskom pays taxes and no longer subsidises the electrification programme. This gave rise to government establishing a separate National

Electrification Fund that is funded by National Treasury that ensures the security of the programme started in 1994 (Eberhard, 2007:239). This addresses one of the pressing issues discussed throughout this paper: the retention of government's public focus if the electricity sector should be reformed. Eberhard (2007:240) states that policies and regulatory instruments have been put in place to ensure the continuation of the National Electrification Programme, regardless of the market structure in the sector.

The latest reformation initiative undertaken in South Africa's electricity sector is the Renewable Energy Independent Power Producer (REIPP) programme launched in August 2011 (Montasson-Clair & Ryan, 2014a:1). This reformation model aimed to achieve a vertically integrated single buyer market structure model discussed in section 3.2.1 and addressed all three rationales for reformation discussed in section 2.3. In terms of investment, in less than two and a half years, approved projects of the REIPP represents investment of R150 billion; in terms of public focus, the REIPP aims to create 400 000 sustainable employment opportunities through supporting black economic empowerment initiatives; and in terms of economic efficiency, the REIPP aims to reduce costs of electricity by making use of competitive technologies (Montasson-Clair & Ryan, 2014a). Eberhard, Leigland and Kolker (2014) praise the success of the REIPP and state that it successfully attracted private sector investment and expertise to the South African electricity sector.

Despite the successes of the REIPP program, a warning by Eberhard *et al.* (2014) now read almost like a doom prophesy: the authors recommended that an independent institution and market operator will be needed to ensure the sustainability of this successful reformation of the electricity sector. The authors were concerned that if the programme did not involve the appropriate level of independence, that Eskom will engage in discriminatory practices against the IPP's. These concerns have indeed been born out over time (Roberts, 2017:6). Eskom states in its 2017 integrated report (Eskom, 2017:34-49) that it will continue to communicate with NERSA and the Department of Energy to "manage the risks of the IPP programme and mitigate any unintended negative operational and financial impacts on Eskom". Subsequently, Eskom has not signed any PPA's since September 2016. In the light of the lessons learnt from Mexico and China's reformation discussed in section 3.2, this outcome should not be surprising. Eskom's continued ability to prohibit the reformation of the South African electricity sector calls for a new paradigm of policy in South Africa.

4.2 A new reformation model for South Africa

Considering that the current vertically integrated monopoly market structure enabled Eskom to successfully derail three major reformation attempts in the last three decades, it is evident that restructuring of the sector is the most important aspect of a new reformation model for South Africa. The lessons learnt from reformations in Chile and Brazil and the failed attempts in South Africa highlight the importance of the proper sequencing of a reformation model. Therefore, this paper recommends that the restructuring and regulation steps of the reformation model be carried out concurrently and ahead of privatisation. The remainder of this section will develop a strategy for each of the three components of a standard reformation model by discussing them in this proposed sequence.

4.2.1 Regulation

Under the Electricity Regulation Act of 2006, NERSA has the power to review the long-term contracts of Eskom (Das Nair, Montmasson-Clair & Ryan, 2014:8). It is thus unclear why the regulator did not review the recent REIPP contracts. At the same time, the Department of Energy and National Treasury seized control of the REIPP programme from NERSA to lend a greater level of ministerial power to the procurement of electricity projects (Baker, 2012:103). Newbery and Eberhard (2008:53) argue that NERSA has uncertainty regarding its responsibilities, faces asymmetric information and has a lack of expertise. Apart from addressing these problems, the mandate of the independent regulator will also need to be expanded to incorporate appropriate sector specific regulation of the new unbundled phases in the sector. Strengthening the regulatory institutions will be crucial to the success of a new reformation model for South Africa.

4.2.2 Restructuring

Hedden (2015:2) argues that renewable energy is changing the electricity sector landscape in South Africa and if policies do not respond in a coordinated manner, the benefits will only accrue to a minority that can afford it. Considering the success that recent REIPP's achieved in the two and a half years that the programme was implemented, the biggest efficiency gains from a new reformation model is expected to come from unbundling generation. This would entail vertically separating Eskom by unbundling generation from transmission and defining regulations for third party access to transmission (Kessides, 2004:147). Kessides

et al. (2007:81) state that the electricity sector in South Africa is large enough to benefit from active competition among generation companies. This would engender lower operating costs, the closing of inefficient plants and better pricing (Kessides *et al.,* 2007:81).

In other countries, less ambitious reformations of generation achieved notable efficiency gains conditional on the appropriate accompanying reformation of the distribution phase (Newbery, 2002b:45). To achieve this in South Africa, the implementation of the proposed RED's make sense from an efficiency viewpoint. The initial plan aimed to achieve economies of scale by correcting the failure of small fragmented municipal distributors (Kessides *et al.,* 2007:77). Newbery and Eberhard (2008:79) recommend that the six proposed RED's be anchored in Eskom's distribution regions in order to limit the regulatory disruptions and to exploit Eskom's existing network systems and management capabilities. The large RED's will make coordination between the transmission and distribution phase more efficient and can simplify the task of the regulator to oversee this facet of the sector.

The arguments in favour of unbundling generation and reforming distribution to regional companies are strong. However, the likely effects of reformation of transmission is more ambiguous. If the transmission grid consists of a mature network that does not require significant expansion and that contributes only a small proportion to the final price, there is not a strong case to privatise the transmission phase (Kessides, 2004:157). Newbery (2002b:40) notes that there is no problem in delaying the reformation of transmission to several years after that of generation and distribution and that it could even have advantages.

4.2.3 Private sector participation

It is only once the appropriate regulation has been put in place and restructuring has been completed, that privatisation in the electricity sector should be considered (Newbery, 2002b:38). In order to have effective competition in the electricity sector, the unbundled generation assets need to be privatised (Newbery & Eberhard, 2008:77) and generation expansion projects should become open to private investors. If investors observe a commitment to a new reformation model that fosters regulatory institutions that protect them against default, it is likely that the observed investment of the REIPP programme can be exceeded. For South Africa competition seems to be the only means to successfully reform the electricity sector.

5 Conclusion

This paper set out by clearly defining that government intervention was required to ensure electricity sector investment, maintain government's public focus, and encourage economic efficiency in the South African electricity sector. This defined the rationale for establishing a state owned vertically integrated monopoly, Eskom. However, the possibility of reformation became evident in a discussion of six market structure models in the electricity sector. The arguments presented for the need for reformation showed undoubtedly that South Africa stands to gain from reforming the sector.

The experiences of other countries and how they used the components of a standard reformation model to achieve either one of the six market structures, presents South Africa with a few lessons. The importance of proper sequencing of the reformation steps and appropriate regulation is especially applicable to the South African case. The lessons from South Africa's attempted reformation models reiterate this.

Eskom's continued ability to prohibit the reformation of the South African electricity sector calls for a new paradigm of policy. Recent allegations of state capture amplify the call for a new reformation model that strengthens regulation and restructures the sector. The key recommendation in this paper is to separate generation from the other phases of electricity services in South Africa to allow private sector participation and hence competition in this phase. Introducing competition is not one option of a range of possibilities to reform the electricity sector, but it seems very likely that it is the only means to successfully reform the South African electricity sector.

6 Reference list

Andrews-Speed, P., 2012. *The governance of energy in China: Transition to a low-carbon economy*. Springer.

Bacon, R.W. and Besant-Jones, J., 2002. Global Electric Power Reform, Privatization and Liberalization of the Electric Power Industry in Developing Countries.

Baker, L.H., 2012. Power Shifts? The political economy of socio-technical transitions in South Africa's electricity sector (Doctoral dissertation, University of East Anglia).

Bhorat, H., Buthelezi, M., Chipkin, I., Duma, S., Mondi, L., Peter, C. and Swilling, M., 2017. Betrayal of the Promise: How South Africa is Being Stolen. *State Capacity Research Project*.

Bjornstad, D.J. and Brown, M.A., 2004. A market failures framework for defining the government's role in energy efficiency. *Joint Institute for Energy and Environment. Report Number: JIEE*, *2*.

Byrne, J. and Mun, Y.M., 2003. Rethinking reform in the electricity sector: Power liberalisation or energy transformation. Electricity reform: Social and environmental challenges, pp.48-76.

Carreón-Rodriguez, V.G., Jiménez, A. and Rosellón, J., 2007. The Mexican electricity sector. Cambridge University Press.

Church, J., 2017. Defining the Public Interest in Regulatory Decisions: The Case for Economic Efficiency.

Conway, P. and Nicoletti, G. 2006. Product Market Regulation in the Non-Manufacturing Sectors of OECD Countries: Measurement and Highlights. *OECD Economics Department Working Papers*, No. 530, OECD Publishing, Paris.

Das Nair, R., Montmasson-Clair, G. and Ryan, G., 2014. Regulatory Entities Capacity Building Project Review of Regulators Orientation and Performance: Review of Regulation in the Electricity Supply Industry. *University of Johannesburg and Trade and Industrial Policy Strategies, Johannesburg and Pretoria*.

Eberhard, A. and Godinho, C., 2017. *Eskom inquiry reference book*.

Eberhard, A., 2007. The Political Economy of Power Sector Reform in South Africa. Cambridge University Press.

Eberhard, A., Leigland, J. and Kolker, J., 2014. *South Africa's Renewable Energy IPP Procurement Program*. World Bank Publications.

Erdogdu, E., 2010. *Electricity Market Reform: Lessons for developing countries* (No. 27317). University Library of Munich, Germany.

Eskom. 2015. *2015 Integrated Report*. South Africa.

Eskom. 2016. *2016 Integrated Report*. South Africa.

Eskom. 2017. *2017 Integrated Report*. South Africa.

Expósito, A.G., Gomez-Exposito, A., Conejo, A.J. and Canizares, C. eds., 2016. *Electric energy systems: analysis and operation*. CRC Press.

Generation Plant Mix Fact Sheet. 2017. [Online]. Available: http://www.eskom.co.za/AboutElectricity/FactsFigures/Documents/GX0001GenPlantMixRev19.pdf [2017, July 22].

Gratwick, K.N. and Eberhard, A., 2008. Demise of the standard model for power sector reform and the emergence of hybrid power markets. *Energy Policy*, *36*(10), pp.3948-3960.

Haikel, K.M., 2011. A Game theoretic model for generation capacity adequacy: Comparison between investment incentive mechanisms in electricity markets. *The Energy Journal*, pp.117-157.

Hedden, S., 2015. Gridlocked: A long-term look at South Africa's electricity sector. *Institute for Security Studies Papers*, *2015*(15), p.24.

Hunt, S. and Shuttleworth, G., 1997. Introduction: economic and technological principles in designing power markets. *Competition and Choice in Electricity. John Wiley & Sons Ltd., West Sussex, England*, pp.1-10.

Jamasb, T., 2006. Between the state and market: Electricity sector reform in developing countries. Utilities Policy, 14(1), pp.14-30.

Jamasb, T., Mota, R., Newbery, D., & Pollitt, M., 2004. Electricity sector reform in developing countries: A survey of empirical evidence on determinants and performance. Cambridge Working Papers in Economics, CWPE 0439. Department of Applied Economics, Cambridge.

Joskow, P.L., 2000. Deregulating and regulatory reform in the US electric power sector.

Joskow, P.L., 2006. Introduction to electricity sector liberalization: lessons learned from cross-country studies. *Electricity market reform: an international perspective*, *1*, pp.1-32.

Joskow, P.L., 2012. Vertical integration. *The Antitrust Bulletin*, *57*(3), pp.545-586.

Kagiannas, A.G., Askounis, D.T. and Psarras, J., 2004. Power generation planning: a survey from monopoly to competition. International journal of electrical power & energy systems, 26(6), pp.413-421.

Kessides, I., Bogetic, Z. and Maurer, L., 2007. *Current and forthcoming issues in the South African electricity sector* (No. 4197). The World Bank.

Kessides, I.N., 2004. Reforming infrastructure: Privatization, regulation, and competition. World Bank Publications.

Kessides, I.N., 2012. Electricity reforms: what some countries did right and others can do better. World Bank Publications.

Ljung, P., 2007. Energy sector reform: strategies for growth, equity and sustainability. Sida.

McDonald, D.A. ed., 2012. *Electric capitalism: Recolonising Africa on the power grid*. Routledge.

Montmasson-Clair, G. and Ryan, G., 2014. Repositioning Electricity Planning at the Core: An Evaluation of South Africa's Integrated Resource Plan.

Montmasson-Clair, G. and Ryan, G., 2014a. Commissioning Renewable Energy: A Review of South Africa's Regulatory and Procurement Experience. *Journal of Economics and Financial Sciences, 7, Special issue*.

Nepal, R. and Jamasb, T., 2015. Caught between theory and practice: Government, market, and regulatory failure in electricity sector reforms. *Economic Analysis and Policy*, *46*, pp.16-24.

Newbery, D. and Eberhard, A., 2008. South African Network Infrastructure Review: Electricity. *University of Cape Town: Cambridge, Cape Town, South Africa*.

Newbery, D.M., 2002a. Problems of liberalising the electricity industry. European Economic Review, 46(4), pp.919-927.

Newbery, D.M., 2002b. *Issues and Options for Restructuring Electricity Supply Industries* (No. 0210). Faculty of Economics, University of Cambridge.

OECD Statistics. [Online]. Available: http://stats.oecd.org/ [2017, July 23].

Roberts, S., 2017. Barriers to Entry and Implications for Competition Policy.

Steiner, F., 2000. Regulation, industry structure, and performance in the electricity supply industry.

Steyn, G., 2006. Investment and Uncertainty: Historical experience with power sector investment in South Africa and its implications for current challenges. Cell, 83, p.379.

Victor, D., and Heller, T.C., 2007. The Political Economy of Power Sector Reform. Cambridge University Press.

Winkler, H., 2006. Energy policies for sustainable development in South Africa: Options for the future.

World Bank Open Data. [Online]. Available: data.worldbank.org [2017, July 26].

Yi-Chong, X., 2004. *Electricity Reform in China, India and Russia*. Edward Elgar Publishing.

Zhang, Y.F., Parker, D. and Kirkpatrick, C., 2008. Electricity sector reform in developing countries: an econometric assessment of the effects of privatization, competition and regulation. Journal of Regulatory Economics, 33(2), pp.159-178.