Framing of the nuclear discourse in South Africa: an institutional economics analysis

ABSTRACT

Nuclear energy has gone from the initial uptake in the 1960-1970s to a decline and a promised renaissance. Cost considerations and technology choices frequently dominate decisions about transitions from fossil fuels to nuclear power. Cultural legitimacy is often ignored. Securing cultural legitimacy involves implementing good governance principles, proper framing of the nuclear discourse, and effective public participation. This paper looks at the framing of the nuclear discourse in South Africa after 1994 using the Multi-Level Perspective and Institutional Economics. Rational choice under technocracy and corruption tends to preclude public participation especially in a hierarchical society dominated by one political party. For effective framing of the nuclear discourse good governance must be adhered to; technocracy and modelling must be subjected to societal acceptance; corruption must be eliminated; and Pareto optimality must be sought.

1. INTRODUCTION

"… an energy-mix transition, however, should be done methodically and systematically, taking into consideration possible political, socioeconomic and energy system effects." – Bohlmann et al., 2016: p1.

There has been much debate in South Africa about climate change and the transition to non-polluting technologies like substituting coal by nuclear power and/or renewable sources or increased use of clean coal technologies like carbon capture and storage (CCS) (Geels, 2018; Goodman, 2016). Options like nuclear energy and CCS are socially controversial and require extensive public consultations and approval (Rogge *et al*., 2018; Geels *et al*., 2017). South Africa committed itself to reducing emissions to 34% and 42% below business-as-usual levels by 2020 and 2025 in the Copenhagen Agreement of the United Nations Framework Convention on Climate Change subject to capacity building, financial, and technological assistance from developed countries (SANews, 2009). The UN Emissions Gap Report (2018) expressed uncertainty about the country achieving its targets and that it may need support since the conditions on which the commitments were made were not realised.

Menyah and Wolde-Rufael (2010) argued that South Africa had to reduce energy consumption (sacrificing economic growth), or change from coal to less polluting options to meet its pollution targets. Sacrificing economic growth in South Africa could be detrimental due to high unemployment and low economic growth. A reduction of coal use risks job losses while carbon-intensive production methods risk losses in global competitiveness (Fankhauser *et al*., 2008; White Paper on Energy Policy, 1998; OUTA, 2017).

Replacing a dominant technology encounters resistance from lock-in effects, user practices, and institutional power (Geels, 2018; Geels *et al*., 2016). Geels and Verhees (2011) argued that new technologies also need cultural legitimacy coupled with appropriate framing. Framing of the nuclear discourse has been centred on clean energy, nuclear safety, security of supply, and economic growth (Shim *et al*., 2015). Steady and reliable electricity supplies are essential for economic growth. Base load supply by nuclear power, relatively small fuel quantities used, ease of stockpiling, long times before feedstock replacement, and low waste quantities have been used in support of nuclear technology against fossil fuels and the intermittency of renewable options (Vujić *et al*., 2012). The antinuclear lobby has argued that nuclear waste is extremely dangerous and remains radioactive for many years with no identified safe disposal methods (Thomas, 2010). The other major concerns are the high capital costs of constructing nuclear plants.

This work uses Geels and Verhees's (2011) five dimensions of determining the plausibility and salience of frames. The five dimensions are actor credibility, centrality, empirical fit, experiential commensurability, and macro-cultural resonance. Section 2 presents the literature on transitions from the institutional and multi-level perspective while section 3 presents the method. The results are presented in section 4 and analysed in section 5. A discussion is presented in section 6 and the conclusion is in section 7.

2. LITERATURE

2.1 The institutional settings in facilitating transitions

Institutional economics accepts that economic actors function under bounded rationality due to positive transaction costs and incomplete information which creates uncertainty about the possible outcomes and necessary strategies (Menard and

Shirley, 2014; Richter, 2005). Uncertainty affects choices, levels of investment, and commitments to research and development of products and technologies (Fischer and Sterner, 2012). Institutions are then set up to mediate the uncertainty (Richter, 2005). Despite the good intentions of setting up institutions, North (1992) argued that there is no guarantee that the intervention of institutions will result in efficient outcomes.

According to Geels (2014), institutions depend on the government for establishing property rights, general rules of exchange, tariff protection, and assistance. Greif (2013) stated that rules provide the cognitive, normative, and coordinative foundation for choices. The choices are aligned to cultural aspects like norms, beliefs, and values that are acceptable to society (North, 1992). Menard and Shirley (2014) argued that it is not easy to change these cultural aspects leading to the stickiness of existing institutions and path dependence. Resistance to institutional change is also reinforced by economies of scale, complementarities of products, and network externalities (North, 1992).

Actors achieve the gradual changes in institutions through lobbying, forming coalitions, and negotiating terms that favour their needs (Geels and Schot, 2007). Geels (2014) considered that power and politics influence the outcomes of lobbying by the actors with the exercise of power effected by instrumental means. These include using positions of authority, money, and access to the media, and structuring the debate. Technology transitions can result from successful framing of discourses and Geels (2011) proposed a framework for explaining transitions called the Multi-Level Perspective (MLP) which is made up of technological niches, the socio-technical regimes, and the landscape.

Verbong and Geels (2007) stated that niches form the micro-level where innovations and novelties emerge. The socio-technical regimes consists of networks of actors and social groups like firms, institutions such as rules, and material artefacts like the electricity grid and power plants. The landscape forms the macro-level which provides the exogenous environment that influences the niches and socio-technical regimes e.g. recessions and globalization (Smith *et al*., 2010; Kern, 2012). Disturbances in one or more of the MLP levels, e.g. an innovative discovery at the niche level, a policy change at the regime level, or a climate change development at the landscape level, can open up new opportunities for a transition in the system.

Kemp *et al*. (2007) and Geels and Schot (2007) stated that the process of change involves an alignment of processes in the three levels of the MLP. Fouquet and Pearson (2012) and Allen (2012) argued that previous transitions were determined by price incentives, science, path breaking technologies, and economic conditions. Climate change considerations gave many governments incentives to direct transitions from fossil fuels to non-polluting sources like renewables and nuclear energy. Efficient government intervention can be compromised by picking of winners and state capture by big (Geels, 2014). According to Solomon and Krishna (2011) and Turnheim and Geels (2012), outcomes of choosing winners depend on the level of focus on niche developments, consensus about chosen resource options and technologies, and rule changes.

A transition from a dominant fossil fuel to nuclear power has to deal with relative costs of the technologies, the impact on macroeconomic objectives, nuclear fuel preparation, access to the transmission grid, waste disposal, and radiation threats (Huhtala and Remes, 2017; Thomas, 2011 and 2018). Effective engagements on these issues favours societal embedding of new technologies in technological transitions and cultural legitimacy (Geels and Verhees, 2011).

3. METHOD

The five dimensions in Geels and Verhees (2011) were used to analyse the framing of the nuclear discourse in South Africa:

- Actor credibility – the competency of actors supporting a frame
- Empirical fit – how a frame fits real world events
- Centrality – the importance of a frame to affected audiences
- Experiential commensurability – how a frame resonates with real world experiences
- Macro-cultural resonance – the fit between the frame and cultural repertoires

Data was obtained through document analysis from published government policies such as the Integrated Resource/Energy Plans (IRP/IEP), the Presidency and government ministries, Eskom, and other stakeholders making inputs in the nuclear debate. Arguments for building the Koeberg nuclear power plant were used to link the new build to historical nuclear framing in line with Vink *et al*.'s (2013) argument that

policy proposals do not only focus on contemporary societal and political contexts but also link back to historical views on earlier proposals.

4. RESULTS

Several documents proposing the extent and timeframes of nuclear expansion were released by different stakeholders.

Table 1: Nuclear expansion projections

Document	Nuclear projections and timeframes
White Paper on Energy Policy, 1998	Diversification of energy sources encouraged; expansion depended on environmental and economic merits of other options relative to nuclear, political, and public acceptance.
(IEP), 2003	No new nuclear plants to be built before 2020; Pebble Bed Modular Reactor (PBMR) not cost competitive but its research justified for diversification, climate change, and developing a nuclear export industry.
Energy Security Master Plan, 2007	Nuclear energy considered expensive but recommended for inclusion as in the IEP-2003 with nuclear plants to be commissioned in 2017, 2021, and 2025 at 1800 MW, 2600 MW, and 2400 MW respectively.
Nuclear Energy Policy, 2008	Proposed a diversified energy mix to promote industrialisation, reduce greenhouse gas (GHG) emissions, and ensure energy security.
IRP – 2009 by the Department of Energy (DoE)	Nuclear units from 2020 at 1650 MW; then 1650 MW yearly until 2027 except in 2022 for a total of 11550 MW by 2030.

IRP – 2010 by the DoE	Nuclear units from 2023 at 1600 MW; then yearly at 1600 MW until 2029 except 2027 for a total of 9600 MW.
The National Development Plan (NDP), 2011 by the National Planning Commission (NPC)	Called for the investigation of the cost, desirability, and timing of the nuclear expansion and full cycle.
IRP – 2013 from the NPC	Nuclear units from 2025, 2035, or no nuclear before 2050 depending on scenarios and electricity demand.
2013, 2015, and 2016 DoE Ministerial determinations	9600 MW nuclear as in IRP-2010. DoE as procurer in 2013 and 2015 but changed to Eskom in 2016.
IRP – 2016 by the DoE	Least cost scenario with nuclear from 2037 and a total of 20385 MW by 2050.
IRP-2016 by CSIR	No additional nuclear in the Least Cost and Decarbonised scenarios up to 2050; renewable sources dominate.
IRP-2017 by ESKOM	No nuclear before 2030 unless carbon budgets and renewable constraints apply at the same time. Only the Forced Nuclear scenario includes nuclear from 2030.
IRP – 2018 by the DoE	The least cost scenario has no nuclear expansion.

Presidents and government ministers expressed commitment to nuclear expansion. Government officials framed the nuclear discourse from security of energy supply, contribution to economic growth, nuclear safety and climate change moderation. Statements in favour of nuclear expansion were made in:

- President Mbeki – SONA, 2007
- President Zuma – SONA, 2014; 2015; 2016

- Minister Phumzile Mlambo-Ngcuka – Department of Minerals and Energy (DME) budget speech, 2004
- Minister Alec Erwin – Department of Public Enterprises budget speech, 2007
- Minister Buyelwa Sonjica – DME budget speech, 2007; 2008
- Minister Dipuo Peters – DME budget speech, 2009 and DoE budget speech, 2010 to 2013.
- Minister Tina Joemat-Pettersson – DoE budget speech 2014 and 2016

Several organisations rejected nuclear power expansion or called for it to be deferred to later years. These included organisations like the CSIR, Earthlife Africa, Southern African Faith Communities Environmental Institute, and groundWork (in submissions to the DoE-IRP/IEP–2016 process). Other organisations like the Coalition Against Nuclear Energy (CANE, 2007), the Thyspunt Alliance (Fin24.com, 2017), the Save Bantamsklip Association (IOL, 2009), and the Koeberg Alert Alliance (https://koebergalert.org/) rejected nuclear expansion or location of plants due to safety concerns and environmental impact.

Actors like the Nuclear Industry Association of South Africa and the South African Nuclear Energy Association supported nuclear expansion (DoE-IRP/IEP-2016 submissions) citing employment opportunities, economic growth, and security of energy supply.

5. ANALYSIS OF RESULTS

5.1 ACTOR CREDIBILITY

(a) Lack of originality – Koeberg arguments rehashed

Firstly, reducing the need to transmit electricity over long distances or to build coal plants in areas with no collieries was offered as justification for the nuclear build. However, South Africa obtains electricity from Mozambique and plans to receive more from the Democratic Republic of the Congo (Engineering News, 2017; IRP-2010). This indicated that distance as cited in the 2008 Nuclear Energy Policy and the IRP-2010 is not prohibitive in sourcing electricity despite the recognised transmission losses.

Secondly, decision makers expected nuclear costs to decrease due to learning-by-doing but this has not materialised. With new technologies and safety concerns,

nuclear power costs escalated and did not fall due to learning effects (Thomas, 2012). The World Nuclear Association (WNO, 2017) estimated the overnight capital costs of new pressurized water reactors (PWR) at $1441 per kWe in 1998, escalating to $4100 in 2015. Even the Koeberg capital costs escalated from R500 million in 1974 to R1.75 billion in 1978, measured in 1978 prices (Christie, 1984). Evidence of high and unaffordable nuclear costs in South Africa comes from Eskom abandoning the 2007-2008 nuclear tenders (Thomas, 2010); the PBMR discontinued in 2010 (Thomas, 2011); Ministers of Finance stating that nuclear was unaffordable (The Citizen, 2017).

Thirdly, the aim of reducing water consumption in the inland regions was less convincing since Eskom developed the dry cooling technology that reduced water consumption in coal plants by 90% compared to wet cooling, yet failed to retrofit existing coal plants with this technology (Eskom, 2016).

Fourthly, using nuclear energy to conserve coal for Sasol use and exports was also flawed since Sasol used and still uses dedicated high grade coal mines like Bosjesspruit and Sigma. South Africa also developed the technology to use lower grade coal in power plants and the possibility of using discard coal increased the available coal stock for Eskom power plants (Lloyd, 2000; DoE, 2001).

(b) Prestige, Status, Power

Prestige and status have been advanced as reasons for pursuing nuclear power in South Africa starting from sanctions-busting building of nuclear bombs to being the only country in Africa that operates a nuclear power plant (COP 17, 2011; Fig, 2005 and 2010). Scientists had a vested interest in nuclear research as a research niche area and had exclusive knowledge of the field that was not available to the general public or even the political heads. Their influence has persisted as they were absorbed into public and private companies following the dismantling of the nuclear programme in the 1990s (Fig, 2010). They were largely responsible for the resuscitation of the nuclear programme in South Africa in the 1990s through the PBMR research (Auf der Hyde and Thomas, 2002).

Further evidence of prestige came from issuing of tenders for untested generation III+ nuclear reactors in 2007-2008 by Eskom instead of the proven PWR, a dominant nuclear technology throughout the world and also used at Koeberg. The desire to

develop a nuclear industrial park also served as evidence of prestige in a country that has no competitive advantage in developing or exporting nuclear technology. Competitive attributes such as learning-by-doing, technical progress, and economies of mass production do not exist in the South African nuclear establishment, yet the country aspires to be a global leader in nuclear technology (Thomas, 2012 and 2018).

(c) Flawed security of energy supply argument

Security of energy supply arguments in building Koeberg was flawed since the plant was built when there was excess supply of electricity (van Heusden, 2009), hence the mothballing of three coal power stations. The electricity supply constraints from 2008 cited as reasons for the new build resulted from policy problems such as the moratorium on Eskom building new plants in order to allow the penetration of independent power producers, maintenance problems, Eskom's poor financial position, failure to capitalise Eskom coal plants, delays in commissioning new coal plants like Medupi, and mismanagement and corruption at Eskom (Eberhard, 2007; Fin24.com, 2018a). Maintenance of existing power plants was inadequate as energy availability factors dropped from 89.30% in 2002 to 84.85% in 2008 and then to a lowly 71.07% in 2016 (Eskom Annual Reports, 2002-2017).

(d) Lack of coordination of nuclear programmes

Transition theory recommends setting up think-tanks referred to as transition arenas (Kemp and Rotmans, (2004). The National Planning Commission operates along the lines of such arenas. While the NPC, the NDP, and the constitution proposed a review of the nuclear build programme and public participation, the Electricity Regulation Act of 2006 permits the Minister of Energy in consultation with the National Energy Regulator of South Africa (NERSA) to determine new generation capacity and the generation mix (Section 34 of the Electricity Regulation Act, 2006). This section 34 was used in deciding the unilateral decisions in the Ministerial determinations that included 9600 MW of nuclear power in the new build. Unilateral stakeholder decisions were taken by Eskom earlier when refusing the government's call for Eskom to take a higher stake in the PBMR and buying locally enriched uranium fuel for Koeberg (Fig, 2009 and 2010).

The NPC (2018) recommended small, modular projects in electricity generation while the government stuck to mega projects as proposed in the IRP-2010. After advocating for the adoption and implementation of the IRP-2010, the Minister of Energy, David Mahlobo, changed his preferences to small, modular reactors (Fin24.com, 2017). The 2008 Nuclear Energy Policy designated Eskom as the owner and procurer of the nuclear build but the Ministerial determinations of 2013 and 2016 assigned this to the DoE and Eskom respectively. There was also no clear indication of nuclear build funding. The approach by the ministers violated the transition management requirements about clear and comprehensive visions, long-term plans, regular evaluations of the transition, and control.

(e) Corruption at the highest levels of decision-making

It emerged in court cases, inquiries and reports that leaders in government and Eskom were involved in corrupt activities related to electricity generation and nuclear expansion (Public Protector's State of Capture Report, 2016; PMG, 2018; the Zondo Commission, 2018; Gupta Leaks - http://www.gupta-leaks.com/category/eskom/). In addition to the corruption findings, the main stakeholders in nuclear decisions were found to have circumvented mandatory procedures. Secret intergovernmental agreements about nuclear procurement were entered into in violation of the prescribed gazetting procedures (EE Publishers, 2014).

(f) Understating radiation exposure

Nuclear technology is framed as a safe option in comparison to fossil fuels. This view understates the long-term radiation effects of nuclear use. Hundreds of workers suffered illnesses from radiation exposure at Koeberg and Pelindaba but such incidents of radiation exposure were suppressed by the nuclear establishment (PMG, 2007). Exposure of these incidents raised issues of trustworthiness of the nuclear establishment.

5.2 EMPIRICAL FIT AND EXPERIENTIAL COMMENSURABILITY

The electricity blackouts experienced nationally from 2008 until 2014 gave credence to the security of supply frame. Economic activity slowed down due to these blackouts and many jobs were lost. These job losses gave substance to the economic growth frame that adequate electricity supply is critical for economic growth. Eskom and

government officials stressed the fact that there were no meltdown accidents or major radiation leaks in Koeberg since the reactors were commissioned in 1984 and 1985.

On the other hand the Fukushima (2011) and the Chernobyl (1986) incidents countered the nuclear safety arguments. The antinuclear lobby expressed concern about possible electricity tariff increases following nuclear expansion. Tariffs have been increasing tremendously even without the nuclear build.

Table 2: Electricity price increases in South Africa (Eskom, 2019)

Year	Price adjustment		Year	Price adjustment
2004	2.50		2011/12	25.80
2005	4.10		2012/13	16.00
2006/7	5.10		2013/14	8.00
2007/8	5.90		2014/15	8.00
2008/9 April	14.12		2015/16	12.69
2008/9 July	34.20		2016/17	9.40
2009/10	31.30		2017/18	2.20
2010/11	24.80		2018/19	5.23

The lack of a clear funding strategy for nuclear expansion compounded their scepticism about the affordability of nuclear energy and access to electricity for South Africans who could be disconnected from the grid due to non-payment. The price and income elasticities of electricity demand have been reported by Inglesi-Lotz (2011):

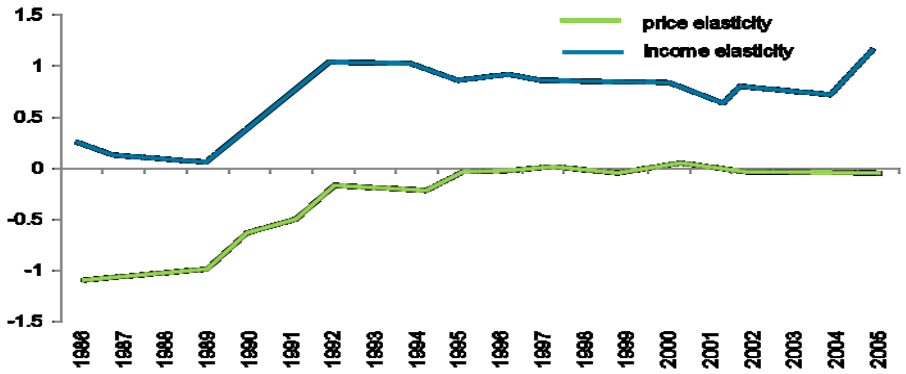

Figure 1: Price and income elasticity of electricity demand in South Africa (Inglesi-Lotz, 2011)

The findings by Inglesi-Lotz (2011) were that electricity demand was not affected by price changes when the real prices of electricity were low but a sectoral study by Blignaut *et al*. (2015) for the period 2008-2012 revealed that when the drastic price increases took effect from 2008, electricity demand became elastic. These results indicated that further price increases could lead to reduced consumption which might reduce output. Combined with reports of investors pulling out of South Africa due to high electricity prices, job losses, and low economic growth (PMG, 2012), the possible damage from increased electricity prices following nuclear expansion could be detrimental.

Justifying nuclear expansion on the basis of climate change involves scientific measurements and explanations, and is therefore an abstract concept that does not resonate well with the public (Vink *et al*., 2013). The IRP/IEP process is a highly technical process for the general public to understand. Laitner *et al*. (2003), and Trutnevyte *et al*. (2014) argued that quantitative modelling has several limitations including exclusion of behavioural aspects in pursuit of least cost options and new market potential distortions. These limitations were shown by Eskom's exclusion of public participation in the ISEP process and rejection of forecasts that contradicted Eskom projections. Government and Eskom commitment to climate change abatement is questionable when considering additional coal generation at Medupi, Kusile, and that independent power producers are allowed coal generation.

5.3 CENTRALITY AND MACRO-CULTURAL RESONANCE

Fine and Rustomjee (1996) and McDonald (2009) positioned electricity supply at the core of South Africa's economic growth together with minerals extraction and processing in their Minerals-Energy Complex (the MEC). The argument was that South Africa developed as a result of the abundant cheap electricity resulting in energy intensive production.

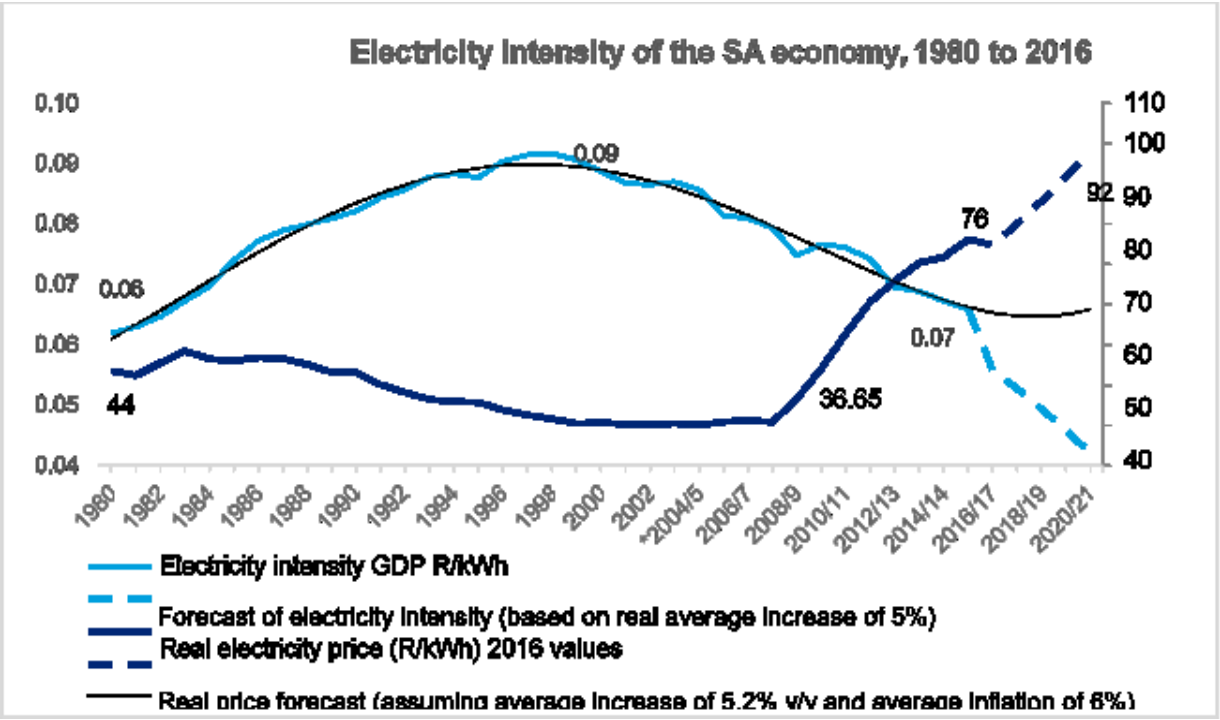

Figure 2: Electricity intensity and real electricity prices (Deloitte, 2017)

As real electricity prices increased, electricity intensity of the economy decreased and there was a structural shift away from the energy-intensive primary sectors like mining.

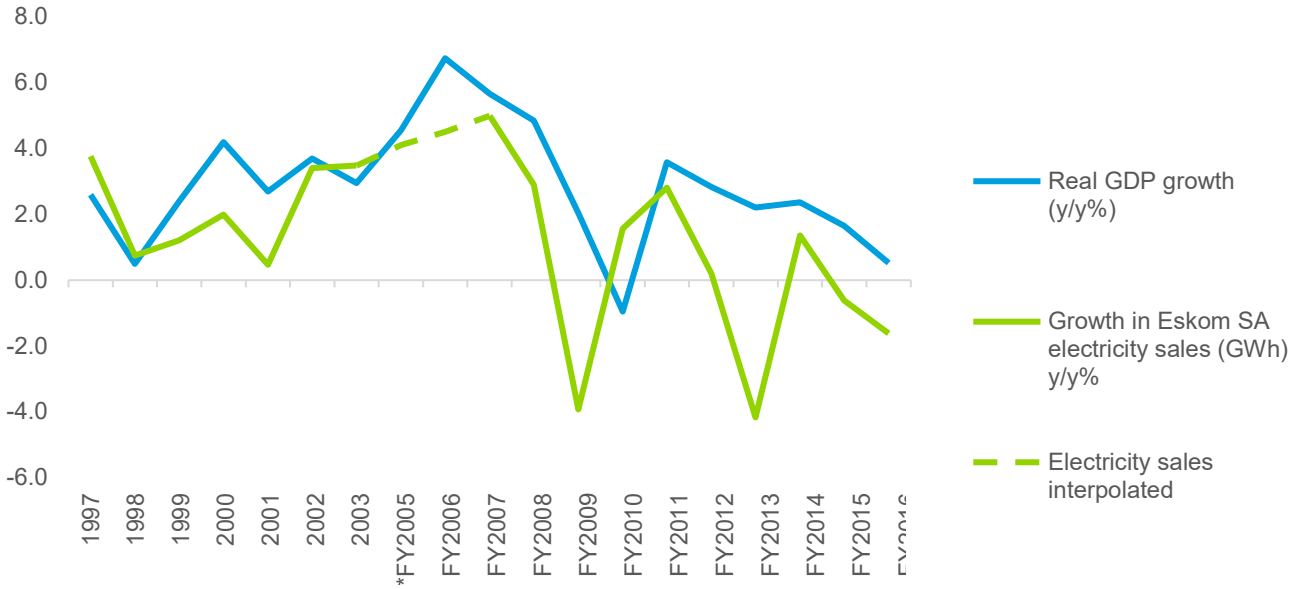

Figure 3: Electricity sales from Eskom and real GDP growth in South Africa (Deloitte, 2017)

Figure 3 shows that electricity consumption and real GDP have varied in tandem for most of the time in line with the correlations in Menyah and Wolde-Rufael (2010). As

a source of electricity, nuclear energy is therefore central to the economic development of South Africa.

The strength of the centrality frame is reduced by possible sacrifices in production and employment as incumbent technologies are replaced. The fact that nuclear expansion is usually funded by subsidies and loans which burden the taxpayer and the possibility of passing the costs of nuclear build onto electricity consumers, thus crowding out public and private investments reduce the strength of the economic growth frame (Thomas, 2012). The government acts as guarantor for Eskom loans but its current account debt has reached 5% of its GDP and sub-investment grade credit ratings (Fin24.com, 2018). Eskom has been downgraded to junk status (Fin24.com, 2019). The implication of these ratings is that it will be more costly for the government and Eskom to secure loans to fund the new build, thus reinforcing the concerns of the antinuclear lobby about bankrupting the country through nuclear expansion.

The exclusion of public participation in nuclear planning as shown through the IRP/IEP processes undermined the macro-cultural resonance frame since the constitution prescribes public involvement. The stipulated biennial reviews of the IEP/IRP programmes were not enforced and outdated projections were used in the nuclear build (groundWork *et al*., 2017).

6. Discussion

6.1 Different stakeholder motivations and strategies

The 1994 democratic process presented a landscape disturbance and forced the government and Eskom to review their policies at the socio-technical regime level. The dominance of Eskom and experts effectively reversed the hierarchical structure of the electricity sector (Eskom annual report, 2007; Marquard, 2006). This lack of hierarchical conformity resulted in a lack of coordination of activities in the electricity sector with Eskom making unilateral decisions.

The democratic process and globalisation threatened Eskom with regime destabilising factors like shrinking markets, competent new entrants, and loss of political or cultural legitimacy in the incumbent coal technology (Turnheim and Geels, 2012). In constructing large nuclear plants Eskom was adopting reorientation and recreation strategies designed to deflect government interference and remain dominant (OUTA,

2017). The dominance would also be reinforced by scale economies, power relations, infrastructure that was already in place, established user practices, established markets and networks, competencies and learning economies, and other institutional arrangements that were not available to new entrants (North, 1992; Geels, 2011).

The state and Eskom did not engage in coordinated planning until the IRP-2010 process. Institutional coherence posits that firms must engage with other actors to secure finance and input resources, to ensure compliance with employment regulations, and to be competitive in markets (Hall and Gingerich, 2009). The government and Eskom would have derived mutual benefit from institutional coherence but Eskom laboured under the threat of unbundling and restructuring of state-owned entities proposed in the government's Growth, Employment and Redistribution Strategy.

The post-1994 government sought to continue the stability in the political, economic, and social regime through stable supplies of electricity but regulate and downsize Eskom. Retaining a regulated Eskom allowed the government outlets for Black Economic Empowerment capital in a manner similar to the assimilation of Afrikaner capital into the South African apartheid economy (Eberhard, 2001; Clark, 1987). A regulated Eskom was also critical for other socio-economic objectives like universal access to affordable electricity and facilitating foreign direct investment (Eberhard, 2001). Corporatizing Eskom and selling of non-core assets was also likely to generate more tax revenue for the state's benefit.

Differing views on cost issues also affected planning in the electricity sector. The modelling approach used in the IRP processes is often criticised for focusing on technology and cost issues that may be risky or lack societal approval (van Sluisveld *et al*., 2017). Public good considerations of a clean environment can deter the private sector from engaging in climate change moderation at the time when huge investments are required (Turnheim and Geels, 2012). Engaging the private sector also affects social acceptance and political feasibility of the considered options.

Trade union Cosatu also rejected the proposed nuclear build (Cosatu, 2015; Fin24.com, 2018b) arguing that the nuclear build involved high costs, it fails to create jobs, has upstream environmental problems, and South Africa lacks domestic skills needed in the nuclear sector in addition to the possible job losses in the coal sector

(Cosatu, 2015). Geels *et al*. (2017) stated that for a low-carbon transition, losers such as the coal sector employees should be compensated but the South African government and Eskom did not address this issue.

The lack of policy coordination meant that the government and Eskom could not present to the public a comprehensive unified strategy on nuclear expansion. The framing discourse then suffered from such divergence of views and strategies based on differing motivation.

6.2 Expert advice and technocracy

The Thabo Mbeki administration was highly technocratic (The Economist, 2005). Issues of global climate change amelioration and African renaissance featured prominently in their policies. Top-down planning from the technicians who modelled the scenarios and the executive in government was implemented with no public consultations. Gaymer *et al*. (2014) and Butler *et al*. (2015) acknowledged that top-down processes benefit from state resources to offer nationally inclusive strategies. On the other hand they argued that government strategies are based on political and economic considerations which may decouple from public interests and face opposition from other stakeholders.

Experts modelled scenarios made complex by issues like climate change and the policy context (Spruijt *et al*., 2014). Pel (2016) warned against the capture of innovation attempts by situated actors through downplaying or emphasising some elements of an innovation e.g. putting limits on renewable capacity in order to promote nuclear energy in the IRP-2016. Recommended methods of reducing failures of experts such as bias towards existing policies include engaging in dialogues with other experts and encouraging public participation (Spruijt *et al*., 2014). The Mbeki administration relied on expert advice and excluded remedial public participation in advancing nuclear expansion.

6.3 From technocracy to corruption

Corruption and state capture became the driving forces of electricity sector decisions under the Zuma administration as evident from the court cases and other revelations. Rogge *et al*. (2018) stated that strategic policy intelligence, vertical and horizontal policy coordination, and accountability mechanisms must be in place to avoid capture

by powerful stakeholders. Lack of policy coordination, weak regulatory bodies, and corruption led to the capture of Eskom by outside forces. Eskom's financial rating fell drastically to junk status thus making nuclear procurement more difficult (Fin24.com, 2018c).

Many state institutions like parliament were undermined or their powers usurped by the Zuma government and Eskom. It was suggested by Kemp *et al*. (2007) that there should be regular reviews and adaptations of the chosen transition option to reduce lock-in effects but no finalised IRP was produced from 2010 to 2018.

Lambsdorff and Teksoz (2002) stated that corrupt activities are often linked to legal transactions to hide the true intentions of corruption. The legally developed IRP-2010 was used to advance nuclear expansion that involved secret deals with Russian nuclear vendors. Coupling corrupt intentions to legal transactions is considered to reduce transaction costs of corruption emanating from searching for corrupt associates, retaining the partners, and enforcing compliance in corrupt deals. The transaction costs of finding corrupt associates are reduced by family ties, group membership, and political ties (Lambsdorff and Tesoz, 2002). Political party affiliation and other ties were used to plunder Eskom. The government preferred large nuclear plants as stated in the IRP-2010 instead of modular smaller plants recommended in the 2007 Ministerial determination in line with the view that large projects are susceptible to corruption due to the complex nature of the procurement process and difficulties in monitoring every step in the process (Locatelli *et al*., 2017).

7. Conclusion

South Africa and Eskom adopted an elitist and exclusionary approach to the nuclear discourse that did not effectively include public participation. Reducing the nuclear discourse to parliamentary documents gazetted with minimal debates, secret intergovernmental agreements, and lack of effective oversight by regulatory bodies constrained the nuclear discourse. The main stakeholders in government and Eskom suffered credibility losses following political infighting within the ruling party, policy discords, and revelations of corruption. Electricity recovery to excess capacity following national blackouts from 2008 to 2014, the commissioning of new coal plants, and significant reduction in electricity demand during the same period deflated the centrality frame of the nuclear discourse.

Cultural legitimacy to obtain societal acceptance should be made one of the priorities of nuclear planning in addition to cost considerations and technological choices used in the IRPs. This cultural legitimacy must be sought to turn nuclear opponents while losers such as workers at coal plants that will be decommissioned as a result of nuclear expansion should be compensated in monetary terms or through the creation of alternative jobs and skilling. Schumpeterian principles of creative destruction involving stopping support to coal technology and the ultimate decommissioning of coal plants while the nuclear new build is implemented should be considered if nuclear technology obtains societal acceptance.

With countries like Germany phasing out nuclear power and the negative experiences such as the Fukushima incident, framing of the nuclear discourse needs to be open to public scrutiny and accountability should be ensured. The public should be capacitated to make informed decisions without being coerced through political conformity.

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