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“It is a central tenet of energy security that governments control either the actual energy supply or the conditions under which other parties develop these” - Kruyt 2009

“Over the past 20 years South Africa has not made significant investments in the energy sector” – South African Department of Energy (DOE) 2012

“Fundamentally, the ability to bring on adequate investment in future energy infrastructure in the decades ahead will largely determine our level of energy security. In this context, government policy has a role in creating the environment in which the private sector invests, and attracting global capital to Australia’s energy sector. Government policy is a particularly relevant consideration for investors in the electricity generation and gas sectors.” - The Australian National Energy Security Assessment 2011

“Büscher (2009:2) identifies a paucity of analysis of the country's power sector from a critical political economy perspective in the post-apartheid era and that many studies either “display a strong technical quantitative bias and/or lean towards rather simplistic ideas about policy processes and dynamics’.” – Baker 2012

Contents

INTRODUCTION

Energy security is a complex, evolving and context-laden concept. Because the national energy system is complex, a multi-disciplinary approach is needed to analyse its resilience and to address challenges to its integrity. A crisis in energy security is thus difficult to diagnose and remedy, but the importance of informed, decisive and timely action cannot be overstated due to the centrality of the energy system to the development and survival of the modern state. Further, the path dependency of energy system policies and investments make a multidisciplinary approach vital for informative policy research, especially if facing an energy security crisis, as this paper argues South Africa is.

South Africa’s dominant energy security perspective is still steeped in the Apartheid era’s myopic focus on stocks of mineral energy resources, the economy as an energy user and independence from oil imports. However, the challenges facing South Africa’s energy system are far more complex and insidious than this technical, ‘input-output’ approach would suggest. Over the past two decades South Africa has failed to create the conditions for adequate investments in major required energy infrastructure developments. There is a monumental backlog in infrastructure development and a seeming investment paralysis. While there have been some stopgap measures and a few successes, these are the exceptions. There is a failure of these deep issues to be addressed directly through clear policy, and/or definitive legislation and regulation to implement the policy. Even when definitive policy statements have been made at the highest-level, implementation has been problematic and remains problematic. This is evidenced in the shortages in bulk electricity supply, the growing backlog and on-going deterioration of electricity redistribution infrastructure, poor households’ energy insecurity, discontinuities in coal supply, the absence of a credible liquid fuels policy, and comparatively low crude oil stocks. The security of the system has been compromised to the point of crisis. Increasing dysfunction coupled with the continuation of previous approaches to the problem, despite previous failures and without contingency measures, makes the system’s endurance going forward uncertain.

This paper begins by addressing the complexity of the concept of energy security, advocating for a broad conceptualisation of energy security based on the World Energy Council’s tenets of accessibility, availability and acceptability, in supplementation to the Department of Minerals and Energy’s focus on “ensuring that diverse energy resources, in sustainable quantities and at affordable prices, are available to the South African economy in support of economic growth and poverty alleviation, taking into account environment management requirements and interactions among economic sectors” (DME 2007a: 13). Having established a broad framework for the analysis of energy security, the paper turns to the analysis of South Africa’s energy security situation. We argue that South Africa is facing a crisis in energy security, evidenced in the three most important sectors- electricity supply, liquid fuels production and coal supply (for electricity generation and end use). Further, in each sector, the failure in technical security is traced back to the inability of the South African government to “control either the actual energy supply or the conditions under which other parties develop these” which has resulted in an energy crisis where, “over the past 20 years, South Africa has not made significant investments in the energy sector” (Kruyt et al 2009; DOE 2012). The arguments and evidence presented in this paper serve as the starting point of a larger research venture, which seeks to provide a comprehensive history and diagnosis of this crisis and hopes to provide a new perspective on how to address this crisis and mitigate the costs it is yet to incur. As such, this paper concludes with a summary of the main points made and suggestions for future research into South Africa’s energy security situation.

ENERGY SECURITY – PERSPECTIVES, INDICATORS AND DEFINITIONS

Energy security is a complex and evolving concept. As such, any analysis of the energy security challenges facing any country would be limited by the use of only one approach or definition, yet such an analysis may also risk clouding the myriad aspects of energy security in a given context if not guided by at least a working frame and consideration of a number of different approaches and definitions. This paper will focus on energy security as security or resilience of supply, however it will not limit the analysis to a geopolitical or technical approach as such an analysis would disregard important country specific circumstances impacting energy security.

Sovacool and Brown have pointed out that notions of energy security "frequently differ by personal and institutional perspectives, national styles, geology, geography and time" (2010: 80). Official South African statements on energy security remain informed, to a large extent, by an out-dated view that places mineral resources at the centre of energy security concerns and treats 'the economy' as the energy resource user (DME 2007a: 13). This approach obscures many key features and challenges facing the energy system in South Africa and the crisis of supply and use it currently exhibits. Indeed, while absolute supply may currently be constrained, there are significant other issues – of access, especially for poor households, market design, and regulatory systems amongst others - which require further analysis. Our approach, although stemming from a security of supply focus, also draws further on several pieces of work, which contribute to deepening the understanding of energy security beyond static definitions.

Historical narratives and perspectives on energy security

Cherp and Jewell (2011) trace three distinct perspectives on the complex concept of energy security, which they term the 'sovereignty', 'robustness' and 'resilience' perspectives. These perspectives arose in response to different policy problems and agendas and are rooted in different academic disciplines. However, the rapid pace of transformation and increasing complexity of energy systems has rendered these approaches out-dated in their mono-disciplinarity and limited the ability of energy security studies to inform energy policy. These dominant perspectives, occasionally overlapping, continue to inform policy debate. However, Cherp and Jewell provide a compelling argument for the importance of an interdisciplinary approach to energy security "that allows [us] to frame, analyse and conceptualise the seemingly separate energy security issues in an integrated way" (2011: 1). This task is beyond the scope of this paper, but our approach here is informed by the need for multiple analytic and explanatory approaches.

Table 1: Three perspectives on energy security (Cherp & Jewell, 2011: 5)

Perspective	Sovereignty	Robustness	Resilience
Historic roots	War-time oil supplies and the 19708 oil crises	Large accidents, electricity blackouts, concerns about resource scarcity	Liberalization of energy systems
Key risks for energy systems	Intentional actions by malevolent agents	Predictable natural and technical factors	Diverse and partial unpredictable factors
Primary protection mechanisms	Control over energy systems. Institutional arrangements preventing disruptive actions	Upgrading infrastructure and switching to more abundant resources	Increasing the ability to withstand and recover from various disruptions
Parent discipline	Security studies, international relations, political science	Engineering, natural science	Economics, complex system analysis

The above table presents a summary of the three perspectives and the accompanying historical narratives outlined by Cherp and Jewell. The relevance of these perspectives in understanding the energy security literature in South Africa and energy policy is straightforward. South Africa's reliance on crude oil, and energy security measures to address this, revolve around the concerns of the sovereignty perspective and are deeply entrenched in South African literature on energy security and energy policy. This is largely an outcome of the very real security threat that oil embargos, terrorism and war posed to the apartheid government and the instability in international crude oil supply since the 1970s. Concerns with a technical solution to South African energy security challenges revolve around the concerns of the robustness perspective: the mix of electricity generation technologies, energy efficiency, the energy intensity of the economy and energy efficiency, spatial development patterns and transport systems.

Although the concerns of the first two perspectives persist in South African energy security research, the concerns of the resilience perspective, namely *who* makes the large investments, and *which institutional arrangements* will best achieve this, have come to the fore in South Africa over recent years. This has involved re-assessment of, and attempts to alter, the roles of the ministries, government planners, regulatory authorities, state owned enterprises (SOEs), and private sector actors. The involvement of the concentrated and powerful interests that characterise the energy sector in South Africa brings into play the need for political analysis in order to understand the impacts that post-apartheid political dynamics are having on energy security.

Indicators

Cherp and Jewell identify "at *least* three distinct perspectives on energy security", however there are of course many others, including environmental perspectives, which are not explicitly treated in this paper. The outline of Cherp and Jewell's perspectives and application to South Africa's energy security merely provide a conceptual framework within which to locate the dominant approaches to energy security and their distinctive polysemic historical narratives. This is important not only in the illustration of different and often incompatible approaches, but also in terms of the implications such perspectives have for energy security research.

Cherp and Jewell argue that "the key challenges for interdisciplinary energy security studies are drawing the credible boundaries of the field, formulating credible research questions and developing a methodological toolkit acceptable for all three perspectives" (2011:1). This is beyond the scope of this paper, but a few key stances are taken in regard to these challenges. The first is the attempt, throughout the paper, to identify challenges to energy security, which are not limited by, but are mindful of, each perspective. The second is to approach the framing of the problems in a comprehensive manner, depending on important statistics, technical description and qualitative analysis. And finally, the exclusion of composite indicators in the framing of energy security challenges.

This final stance is in response to a comprehensive review of work devising and applying indicators to provide quantitative measures of energy security, undertaken by Kruyt et al (2009). They conclude that capturing a broad notion such as energy security in indicators inevitably leads to simplification. Moreover, while indicators suggest some form of scientific objectivity, their value cannot be interpreted independently from the context. Indeed, one may question whether the indicators make much sense as real metrics, instead of (subjective) relative position or trend. Studying Sovacool and Brown (2010) in tandem with Kruyt et al (2009) leads to the view that there would be very limited, if any, utility in compiling aggregate indicators for South African energy security and that simple indicators are useful only when presented in their explicit context and with an explanation of their relevance to energy security. In this analysis simple indicators will be used in this way where they add value to the analysis. However the overall approach of this paper is a qualitative analysis of energy security in South Africa.

Towards a workable qualitative definition

In South Africa's 2007 *Energy Security Masterplan*, energy security is defined as, "ensuring that diverse energy resources, in sustainable quantities and at affordable prices, are available to the South African economy in support of economic growth and poverty alleviation, taking into account environmental management requirements and interactions among economic sectors" (DME 2007a: 13). This definition places resources at the centre of energy security and the economy as the recipient of energy resource outputs. Although poverty, the environment and affordability are included in this definition, it is primarily concerned with energy resources and energy supply and is rather out-dated in this focus.

In light of this myopia, the World Energy Council's (WEC) 3 A's are outlined in addition to and in an extension of this definition. These 3 A's conceptualise energy security in terms of the *Accessibility* of modern, affordable energy for all; *Availability* in terms of continuity of supply and quality and reliability of service; and *Acceptability* in terms of social and environmental goals. We draw on the WEC definition as it encompasses many of the facets of energy security that a straight security of supply analysis fails to include. The 3 A's are defined further as follows (WEC 2007:14):

- *Accessibility* means that a minimum level of commercial energy services (in the form of electricity, stationary uses, and transport) is available at prices that are both affordable (low enough to meet the needs of the poor) and sustainable (prices reflecting the full marginal costs of energy production, transmission, and distribution to support the financial ability of suppliers to maintain and develop these energy services).
- *Availability* relates to the long-term continuity of supply as well as to the short-term quality of service. Energy shortages can disrupt economic development, so a well-diversified portfolio of domestic or imported (or regionally) traded fuels and energy services is required. (*Energy for Tomorrow's World - Acting Now*, World Energy Council Statement, 2000, London.) Keeping all energy options open is the key.

- *Acceptability* addresses public attitudes and the environment, covering many issues: deforestation, land degradation or soil acidification at the regional level; indoor or local pollution such as that from the burning of traditional biomass fuels, or because of poor quality coal briquettes or charcoal production; greenhouse gas emissions and climate change on a global scale; nuclear security, safety, waste management, and proliferation; and the possible negative impact of the large dams or large-scale modern biomass developments. Clean technologies and their transfer to developing countries is the key.

This analysis of energy security will be implicitly underpinned by the WEC's 3 A's. These challenge areas provide the heart of this analysis and are as follows; shortages in bulk electricity supply, the growing backlog and on-going deterioration of electricity redistribution infrastructure, poor households' energy insecurity, discontinuities in coal supply, absent liquid fuels policy, and comparatively low crude oil stocks. In the analysis of these areas, we argue that there are serious and unresolved impediments to the provision of modern, affordable energy for all, that there are costly short-term disruptions in supply and that going forward, this indicates that long-term continuity in supply is not secure. We maintain that the current challenges identified are not acceptable given the socio-economic inequality facing the country, the need for economic growth for socio-economic development and the environmentally harmful energy intensity of South Africa's economy. These challenges to energy security indicate a crisis in supply and a prospective crisis in the functioning of the energy system going forward.

An Energy Crisis?

The challenges to energy security identified in this paper are in fact disrupting supply of electricity, liquid fuels and energy resources to the economy and to the citizens of South Africa. Further, these challenges are undermining efforts to extend safe and reliable energy sources to those who do not have them and impairing the prospects for mitigating the prospective energy intensity of the economy. These challenges are not simply threats to energy security but indicate an energy security crisis, where the complex energy system is failing to maintain its functionality. The underlying causes of this dysfunction are yet to be addressed, and they need to be addressed with great urgency in order to avoid a potential collapse of the current energy system.

THE CURRENT ENERGY CRISIS IN SOUTH AFRICA

> *According to the South African Department of Energy, 'Over the past 20 years South Africa has not made significant investments in the energy sector' - DOE 2012: Revised Strategic Plan 2011/12 - 2015/16.*

Over the past two decades South Africa has failed to create the conditions for adequate investments in major required energy infrastructure investments. For commercial and industrial users, the situation has moved from one of general over-capacity and low priced reliable supply to under-capacity and unreliable supply of coal, electricity and liquid fuels, with coal and electricity prices rising significantly. Households have meanwhile experienced a significant improvement in grid electricity connections until about 5 years ago, but the increase in electricity prices and deterioration of the electricity re-distributor retail networks is compromising gains made. New connection rates have fallen to a level where they are not keeping up with household formation and, as a result, the number of households not connected to the grid is increasing.

There is a significant backlog in infrastructure development and a seeming investment paralysis, perpetuating insecurity of supply and increasing uncertainty in the security of the energy system moving forward. These are indicators of an energy security crisis the South African energy system is deteriorating and decisions need to be made and implemented immediately if the system is to be resuscitated.

Electricity

The electricity supply crisis is perhaps the most obvious of South Africa’s current energy security crises, with emergencies in supply being declared in 2008 and once again in early 2014.

Electricity accounts for some 28% of final energy consumption with about 95% being produced from coal in local power stations and the remainder from nuclear at Koeberg, from diesel in Open Cycle Gas Turbines (OCGT) which are (meant to be) used for peak-supply, and imported electricity, mainly from the Cahora Bassa hydropower plant in Mozambique.

Ninety-five per cent of electricity is supplied from local generation and although there are opportunities for substantial imports, in the medium term it is likely that South Africa will rely on local generation for most of its electricity supply. The capacity and performance of the domestic generation sub-sector is, and will continue to be, a determining factor of South African electricity supply security.

Chronic shortage of bulk electricity and tripling of real electricity price

Low-cost electricity generation was central to South Africa's economic and industrial development from at least the 1960s onwards (Marquard, 2006). Since 2005, escalating challenges with a shortfall in generation capacity, reliability problems with supply on the national grid, and rapidly increasing and unpredictable costs have been the most important visible issue in the electricity supply sector.

Scheduled completion dates for new baseload generation capacity being constructed (Medupi and Kusile power stations) to alleviate the shortage have been repeatedly reviewed, and when the first units of this new generation capacity comes on stream there will probably[1] still be a shortage. It will also take some time for reserve margins to recover to adequate levels; they will possibly not do so until 2017-2020 according to the IRP2010 Update (DOE 2013b). Since 2007 national grid electricity prices have doubled in real terms in unpredictable and often unexpected increments; prices are expected to rise further. It appears that the era of low-priced electricity is over.

Electricity consumption growth has remained relatively flat or decreased for six years since 2007 – a development unprecedented in the history of the South African electricity sector (Eberhard, 2012). There are signs of significant suppressed demand and a negative impact on economic production and investment.

The tripling in the real price of electricity by the time adequate capacity is brought on line by 2017-2020 raises questions about the future growth of demand and the macroeconomic impacts of steep price increases. Economic analysis undertaken by Cameron and Roussouw (2012) showed that the MYPD 3 price increases could reduce GDP growth by 0.73% and employment by 1% by 2018. They also warn that as a result of year after year of running the national electricity generation fleet at over-capacity and deferring maintenance, the fleet is showing signs of being overstressed. This compounds the low reserve margin risk through lower unit reliabilities and hence higher probabilities of unplanned outages. According to Eskom's 2013 Annual Report, unplanned capability loss factor (UCLF) increased from 7.97% to 12.12% in 2013 (Eskom 2013b).

Evolution of the reserve margin from 40% to a chronic zero

South Africa had considerable spare electricity generation capacity in the mid 1990s with a reserve margin of some 40% (Steyn 2006). Electricity demand continued to grow steadily at around 3.5% p.a., with some yearly variations, continuing the long-term trend. There was no significant unexpected surge in demand. However, as demand grew, no new capacity was added. As a result, by 2003 the reserve margin[2] had deteriorated to a point where the supply/demand balance was very tight. A situation was created where the bulk electricity supply system became increasingly stressed, and where there was a growing unacceptable risk that 'withdrawal' of system components, such as the unplanned outage of power stations or transmission lines, could result in having to shed load to maintain system integrity. It is important to note that such 'withdrawal' of system components is normal – all system components have finite reliabilities and thus occasionally need to be withdrawn from service. To achieve acceptable reliability, systems are designed with excess capacity and components to cater for such withdrawals. Well-planned and managed systems thus have a considerable capacity to tolerate unplanned outages (failures) of major system components such as large power stations or trunk transmission lines.

[1] Forecasts of the future have to take into account 'normal' and exceptional conditions. Here, 'probably' refers to a situation where the overall world economy continues to grow, as does the South African economy, albeit slowed down by energy shortages.

[2] There are various ways of calculating the reserve margin with varying results. There are different opinions on what prudent or acceptable reserve margin should be. Whether a reserve margin is prudent depends on the overall system, the elements of the system and their condition and performance, and varies from system to system and time to time. If a system is stressed it is likely that individual elements will become less reliable and more likely to experience unplanned outages. For example, when a system is stressed individual power stations are run 'harder' and maintenance is deferred, making them more likely to suffer failures. The DOE Energy Security Master Plan - Electricity 2007- 2025 (DOE, 2007 p 30) states that a 19% reserve margin is prudent for the South African system in that it would balance the inefficiency of investments in over-capacity with the costs of load shedding in the case of under-capacity. Duncan and Adams (2006 p5) report that: 'Eskom has recently stated that a reserve margin of 15% to 25% is the desirable range required to meet Eskom's obligation to supply (OTS).'

In large electricity networks 'reserve' is not a luxury, it is a necessity. In other words, acceptable management of the system as a whole has not only failed when load shedding occurs, it has already failed when the reserve margin decreases to the point where the potential impact of system events that would normally be tolerable, such as unplanned outages, expose the system to catastrophic failure, or where load shedding would be made necessary. Thus the South African system became inadequate in 2003, not in 2005 when load shedding began

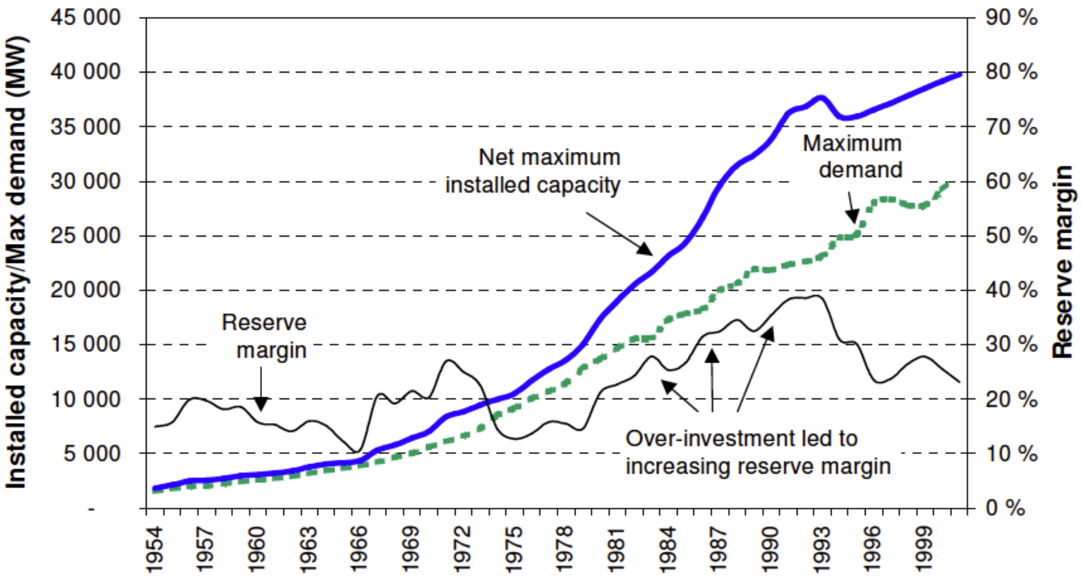

Figure 1 – Growth in maximum demand and capacity at Eskom. (Cited in Newbery and Eberhard 2007, Source Eskom Annual Reports 1980-2002, Eskom statistical yearbooks 1985-1996.)

By 2003, no firm plans[3] to add significant additional generation capacity had been made, despite the fact that the system was now being operated with an imprudent reserve margin. Demand continued to grow and the reserve margin, and hence system reliability, deteriorated further. Appropriate action was not taken i.e. neither adequate demand-side measures to decrease the load on the system nor appropriate increments to supply capacity were made. Duly, at the end of 2005, a combination of inadequate reserve margin, insufficient reliability, a stressed system and system element failures (that should have been tolerable) resulted in system demand exceeding system supply in the Western Cape. Load was deliberately interrupted to maintain system stability, and the Western Cape experienced serious blackouts. This was repeated in early 2006 (Newberry & Eberhard 2007, updated 2008) and by early 2007 the situation had worsened with rolling national load shedding implemented to maintain national electricity grid system integrity. Load shedding was necessary again in late 2007. The system was further stressed in 2008, and even more serious load shedding was necessary to maintain system stability (Newberry & Eberhard 2007, updated 2008). In addition to rolling load shedding, supplies were cut to a number of large customers such as mines and minerals beneficiation plants.

There has been a chronic electricity supply shortage since the initial 2005 load shedding, necessitating the limiting of supply to large customers to maintain adequate reserve and a period of national load shedding. The reserve is so small[4] that the system remains stressed, and short-term increases in demand, for example caused by cold weather, or short-term supply problems, such as coal availability to one or two power stations, events that a system with adequate reserve margin would withstand, pose frequent threats to system security. Progress in expansions to the system has been delayed so that resolution of the generation shortage is unlikely to be resolved for some years to come. Depending on the resolution of

[3] It is most important to define what we mean by "firm plans". A firm plan would be decision to build, plus decision by adequate financiers to invest in the project. Alternatively, "firm plans" would not consist in mention of a large investment in a planning process such as the National Integrated Resource Plans, or the Integrated Resource Plans which are covered in this paper.

[4] The definition of 'reserve margin' has become somewhat academic by now because the system is in a continual situation of having to either run plants beyond prudent maintenance schedules and/or cut power to large customers and/or not provide power to new developments merely to keep demand lower than what can be supplied. i.e. there is a chronic energy shortage. Thus we have chosen the notion of a 'Zero Reserve Margin' until the situation can be re-established to a situation where cutting power and denying power to new investments is no longer required.

problems with the construction of new plants and growth in demand, electricity shortages and/or inadequate reserve margin is foreseeable until the end of the decade (DOE 2013b).

Explaining the electricity supply crisis

According to both the 1998 White Paper on Energy Policy and the foremost electricity planning resources at the end of the 1990s, namely the Eskom Sales Forecasts and the Eskom Integrated Strategic Electricity Plans (ISEP's), unless additional capacity was added to the national system, supply would exceed demand around 2007. Accordingly, if the capacity was to be large "six-pack" baseload coal stations, investment decisions for the construction of additional generation capacity would have to be made by 2000 and construction would need to begin in 2001 if the system's integrity was to be maintained. The last batch of these six-packs had taken on average nine years to construct (Steyn, 2006).

However, these investment decisions needed to be made in the context of profound changes in the roles of the main players, signalled by the 1998 White Paper. Specifically, the White Paper directed fundamental changes in Eskom's duties, including; the unbundling of Eskom, the selling off 30% of electricity generation, and the gradual privatisation of the electricity generation sector by directing that all new generation capacity be built by the private sector. Further, in April 2001 Cabinet explicitly mandated that: *"Eskom [would] not [be] allowed to invest in new generation in the domestic market… to ensure meaningful participation of the private sector in electricity in the medium term*" (DME Cabinet Memorandum April 2001, quoted in Newbery & Eberhard, 2008). This not only changed the roles of previous players but also necessitated the inclusion of new players, the immediate creation of a market that did not yet exist and the creation and maintenance of market conditions that would facilitate the functioning of such a market. Instead of Eskom issuing tenders for construction of plants, conditions would need to be created for the private sector to invest in these plants. A central feature of these conditions would be power purchase agreements (PPAs) with Independent Power Producers (IPPs). The power purchased would be fed into the national grid which was owned and run by Eskom and the operation of the IPP would need to be integrated into the operation of the national bulk power system, owned and run by Eskom. Thus Eskom would need to be integrally involved in the new arrangements.

This was a profound and fundamental departure from the status quo. The policy effectively removed the mandate for securing investment in new generation capacity from Eskom and gave it to the Department of Minerals and Energy (DME), who would need to secure investments in generation capacity from private sector Independent Power Producers (IPPs). However, owing to Eskom's integral role, this would still require Eskom performing an active function in providing access to detailed information (that only it held) necessary for the IPP contracting process and the operational aspects of integration of this new capacity onto the national grid. South Africa had no previous experience of creating the conditions for these kinds of investments. The department now responsible for this, the DME, simply did not have the ability to contract the IPPs on its own, nor did it have the institutional and/or political clout to require its sister-ministry the DPE to hold Eskom to account to do this. The DME also did not develop the necessary legal and regulatory framework identified by the Cabinet decision of 2001 as necessary for implementation of the policy.

In July 2004, a public alert on potential load shedding by the immediate former Chairperson of the NERSA NIRP Advisory and Review Committee was carried in the national business press (Business Day, 29 July 2004). Yet no IPPs were contracted and Eskom was still prohibited from investing in any new builds. Given lead times of around 9 years for a large-scale plant, by 2004 it was already too late to prevent a extremely tight supply-demand balance. Given this situation, Cabinet finally reversed its decision to exclude Eskom from investing in the new-build programme in October 2004 and Eskom was mandated with leading the next phase of creating new generation capacity. However, unless demand did not materialise as expected it was clearly too late for Eskom investments to stave off the upcoming supply crunch. The best Eskom would be able to do was decrease the extent of the upcoming protracted period of electricity shortages by building new capacity as fast as it could. The investment decision to build the 4,800MW Medupi was made by Eskom in 2005. NERSA granted a license in 2006. Eskom had not commenced a new build programme of this scale since the 1980's and, having been excluded from new builds since, had no reason to have retained the capability and skills to implement this kind of project, potentially increasing the already long lead time of 9 years in power plant construction.

Although load-shedding would only start the following year, the stage was set for it, and if the required new build and return to service plants failed to be delivered by the unrealistic dates stipulated in the NIRP, only an unexpected decline in demand growth or a most exceptional record for unplanned outages would obviate the need for load shedding. In other words, barring unexpected and exceptional circumstances, load shedding was inevitable and the generation shortage would be protracted. This system failure had been inevitable for some time and load shedding was not a matter of 'if' but 'when' and 'for how long'. As clearly stated in Eskom's brief response to the 2008 NERSA report;

> *Eskom identified the need to build additional generation and transmission capacity some time ago and this need for additional capacity was reflected in its Integrated Strategic Electricity Plan (ISEP). ISEP was shared with various stakeholders at the time through discussions. Government policy at the time was to encourage the introduction of independent power producers and Eskom therefore did not get approval to proceed with building new capacity.*
> *…Eskom received the mandate to build power stations only in 2004 and since then Eskom has been building new capacity as fast as possible.*
> *The capacity shortages were foreseen. …*
> *The report by NERSA does not adequately deal with the decline in the reserve margin which is the major contributing factor to load shedding. The impact of the low reserve margin is to increase the risk of any unforeseen events resulting in load shedding. Problems (such as wet coal) that would previously have had little or no impact on supply due to adequate reserves now result in major consequences for customers (Eskom quoted in NERSA 2008, p 41).*

The decline in the reserve margin was not the result of an unexpected surge in demand or unforeseen technical problems. The explanation for this decline and the crisis facing the electricity system lies more in policy and regulatory issues, especially those relating to the failure of the DME to contract IPPs which led to the late start in the build programme and which continues to undermine electricity supply as no baseload IPPs have yet been contracted.

Explaining the failure of contracting IPPs

Economic policies related to privatisation, nationalisation, the role of state-owned enterprises (SOEs) and state and private capital have been hotly contested within and between the ANC and its alliance partners for decades. These issues were far from resolved with the publication of the electricity market liberalisation policy in the 1998 Energy Policy White Paper, and remain unresolved even today.

In developing the IPP policy over a period of five years leading up to the 1998 White Paper, fundamental opposition to the IPP policy had been voiced by key stakeholders: in the tripartite alliance, in government and in Eskom executive management. Even after the policy had been announced, leaders in both alliance and Eskom structures still openly voiced opposition. The introduction of IPPs was and still is seen by key parties as a form of privatisation. Privatisation is a polarizing issue in and between political parties, within the tripartite alliance, within the ANC and between and within government ministries and departments. Whether the IPP policy is privatisation or not is a moot point: what is important is that key stakeholders viewed it as privatisation and insisted unequivocally that they opposed privatisation as a matter of principle.

Given the scale of the existing assets involved in electricity generation, and the size of the required new investments, policy statements involving the sale of 30% of Eskom generation assets to the private sector and allocating new investments to the private sector could not be expected to be viewed as a mere sector strategy or policy. They were statements involving implementation of a fundamental national economic policy. That Eskom would resist, or at least not lend voluntary active support to the implementation of IPPs is also quite obvious, given that the policy was a direct action to limit its market power, and its power in general. What was probably not quite as obvious to the technocrats outside Eskom who were motivating for IPPs was the degree to which information and expertise that only Eskom could muster would be required to implement the policy.

Representatives of both 'pro' and 'anti' factions were retained in key Cabinet positions. There was strong representation of both factions in the tri-partite alliance, in the Government Executive and in structures down to the relevant national departments and through to executive managers in State Owned Enterprises (SOEs). This coincided with the resistance that could naturally be expected in Eskom to its market dominance being dismantled. What the 'anti' IPPs had on their side was that the implementation of the policy would require their active cooperation, and access to information and expertise only available inside Eskom at that stage. The 'anti IPPs' did not have to actively oppose implementation but just 'sit on their hands' while other 'anti' IPPs sat on structures from the most senior alliance leadership and Cabinet levels down. In other words, it was safe, and often strategic, to 'do nothing'. The regulatory framework to ensure the participation of IPPs, also a DME responsibility was outstanding. Eskom reported to the DPE, not the DME.

These complicated relationships, between the DOE, DPE, Eskom Board and Eskom executive, proved to be an additional compounding difficulty in implementation. Energy policy was a DME responsibility but Eskom reported to the DPE. Electricity policy that involved disturbing powerful incumbent interests was made in the DME, but relied on active support of Eskom, which reported to DPE for implementation. Senior Eskom managers, the Eskom Executive and, if necessary, Eskom governance structures, including the Board and the Shareholder, needed to play an active supporting role in identifying, engaging and contracting IPPs. There is little evidence that an active role at the level required was ever played.

Muller observed that; "[i]n energy, the main achievement of independent regulation has been to move from a situation in which one party (Eskom) could be held responsible for ensuring the capacity and integrity of our bulk power system, to one where no one is responsible" (2006). However, this is disputable. While the Cabinet decision of 2001 gave effect to the fundamental policy change by explicitly prohibiting Eskom from investing in new generation capacity in the domestic market, this was in order to implement a DME policy that then, logically, became responsible for procuring this generation capacity from IPPs. There can be no other interpretation than that this was the main point of the policy and the Cabinet decision, i.e. that the DME was responsible. That it did not have the necessary in-house capacity to implement the policy, and that it did not develop the necessary legislation to compel Eskom to play along, does not absolve it from this responsibility.

It would take the DME five years to develop and promulgate the required legislation to provide the framework for successfully contracting IPPs, namely the Electricity Regulation Act (Act No. 4 2006), and a further five years to promulgate successful regulations under the Act to implement IPP procurement. The first IPP PPAs were procured in the Renewable Energy Independent Power Producer Procurement Programme (REIPPPP) in 2013. However, no baseload IPPs have yet been successfully procured.

The IPP legislative and regulatory framework

In 2006 the first element of the new legislative framework, namely the Electricity Regulation Act (Act No. 4 2006), was put into place. Load shedding had already started when the Electricity Regulation Act was promulgated, and some of the powers it gives to the minister appear to have the features of emergency legal powers. Given the frustration government must have experienced in its failure to enlist Eskom to assist with procuring IPPs, and the serious situation the shortage of electricity was causing, these emergency legal powers are understandable. Importantly, these legal powers bring Eskom under explicit government control. These included the powers granted to the DME Minister, with regards to new generation capacity, to;

> *(1) (a) determine that new generation capacity is needed to ensure the continued uninterrupted supply of electricity;*
> *(b) determine the types of energy sources from which electricity must be generated, and the percentages of electricity that must be generated from such sources;*
> *(c) determine that electricity thus produced may only be sold to the persons or in the manner set out in such notice;*
> *(d) determine that electricity thus produced must be purchased by the persons set out …*
> *(2)(a) undertake such management and development activities, including entering into contracts, as may be necessary to organise tenders and to facilitate the tendering process for the development, construction, commissioning and operation of such new electricity generation capacity; …*
> *(4) In exercising the powers under this section the Minister is not bound by the State Tender Board Act, 1968 (Act 86 of 1968).*

In August 2009 DME promulgated the *Electricity Regulations on New Generation Capacity* under the new Act. However, on-going efforts to secure an IPP contract were unsuccessful, demonstrating the difficulties faced by government even with the new powers given under the Act.

In May 2011, using the powers under the Act, but with more experience of the challenges in securing necessary cooperation, the Department of Energy (Energy and Minerals being split apart under the Zuma administration) promulgated a new set of regulations, also titled *Electricity Regulations on New Generation Capacity*. These regulations contained the following key provisions:

> *4. Planning for new generation capacity*
> *(1) The integrated resource plan shall;*
> *(a) be developed by the Minister after consultation with the Regulator; and*
> *(b) be published in the Government Gazette by the Minister.*
> *(2) The system operator, the NTC and the Regulator shall timeously provide such assistance as the Minister may require for purposes of developing and monitoring the implementation of an integrated resource plan...*
> *6. Ministerial determinations*
> *(1) The Minister may, in consultation with the Regulator, make a determination in terms of section 34 of the Act.*
> *(2) A determination under section 34(1) shall include a determination as to whether the new generation capacity shall be established by Eskom, another organ of state or an IPP.*
> *(3) If the determination referred to in sub-regulation (2) requires that the new generation capacity be established by an IPP, the Minister shall also determine the identity of the buyer or, where applicable, the procurer and the buyer. …*
> *(5) A determination contemplated in this Regulation is binding on the buyer and the procurer.*

Clearly, government's patience in relying on ‘voluntary’ cooperation had worn out. Now, so long as the generation technology was contained in an Integrated Resource Plan, these regulations gave the minister all the necessary powers and access to Eskom’s expertise and knowledge of the system, required to enter into successful negotiation with an IPP and secure a contract.

The Renewable Energy IPP Procurement Programme (REIPPPP) - using the new IPP legislative and regulatory framework

The first demonstration of the powerful use of the new regulations under the Act was the procurement of IPPs for renewable energy. By 2011, many efforts to establish IPPs had been unsuccessful, as had efforts to implement renewable energy feed-in to the grid. In this case, the National Electricity Regulator, not DME/DOE, had put in most of the frustrated effort, although DME/DOE had also made some efforts, promulgating an IRP in December 2009 which required Eskom to develop a 100MW wind electricity generation plant facility and a 100MW CSP plant, to no avail (DME 2009). In March 2011, DOE published the 2010 *Integrated Resource Plan for Electricity 2010-2030*, which contained more than 18GW of renewable energy. With the Electricity Regulation Act (No. 4 of 2006) and the Electricity Regulations on new Generation Capacity to back it up, this was a watershed in electricity planning in South Africa.

On the 3rd August 2011, in the form of a Ministerial Determination under the Electricity Regulations on New Generation Capacity, the DOE issued a Request for Proposals for the supply of 3,725 MW of renewable energy to the national grid, with a bid submission date set for November 2011. South Africa was hosting the UNFCCC Conference of the Parties 17 (COP17) in December 2011, and in that month 28 successful projects totalling 1,416 MW were selected. By the end of 2013, 64 IPP projects for a total of 3,882 MW of renewable energy with foreign direct investment worth R150Bn[5] had been secured under the REIPPPP, with 34 of these including signed PPAs (DOE 2013d). This includes 1,983 MW of Wind, 1,499 MW of PV and 400 MW of CSP.

After the years of struggle to contract IPPs this was a remarkable success. The REIPPPP operates on a bidding process where prospective IPPs offer projects that are assessed on price and a variety of socio-economic indicators. Purely assessed on price, the REIPPPP has been very successful. The latest bidding round which closed in 2013 achieved a simple average of R0.74 for 787 MW of wind IPPs, which is R0.31 less[6] than the average cost expected from Eskom's coal-fired baseload Medupi plan currently under construction (SAWEA 2013). However, we have yet to see whether or not the success of the REIPPPP will be followed by a similar success in non-renewable IPPs where Eskom still wields monopoly power with powerful energy intensive users and coal mines to lobby in their corner.

The Independent Market and System Operator (ISMO)

In addition to, and complementary to, the IPP regulatory framework, Cabinet had decided in 2001 that "a separate state-owned transmission company would be established [...] to ensure non-discriminatory and open access to the transmission lines" (Van Der Heijden 2013). About nine years later, with no *separate*[7] state-owned transmission company yet established, in his 2010 State of the Nation address the President stated: "[w]e will establish an independent system operator, separate from Eskom Holdings" (South Africa 2010). Yet twelve years after the 2001 Cabinet decision, and after much effort, the Independent Market and System Operator (ISMO) Bill was withdrawn from the National Assembly of Parliament after a most extraordinary process, having been passed earlier by the Parliamentary Portfolio Committee on

[5] There are a number of statements regarding the value of the projects. This figure of R150Bn is from the speech by the Energy Minister on the 4 November 2013 (DOE 2013d).

[6] Although such a direct cost comparison of kWh-to-kWh for such different kinds of generation asset needs to be aware of important differences depending on the system context of deployment, in the South African context while wind generation capacity compared with total is still significantly below 20% the comparison is valid. See H. Holttinen, et al. (2009) and applied in Trollip & Marquard (2011).

[7] Among the dearth of public policy analysis supporting the non-implementation of this policy is a lack of a comprehensive assessment of the various tenable options available to achieve this "separateness". Such an analysis needs to go far beyond micro-economic arguments involving efficiency of wholesale electricity markets and uncertainty in large investments.

Energy. The shadow minister of energy was reported (Business Report 15 November 2013) as saying that "[o]n Wednesday the ISMO Bill was moved below the line on Parliament's order paper, effectively preventing it from being passed this year" (it had been scheduled to be debated and voted on in the National Assembly on that Wednesday afternoon). He also said that, "Eskom [had] resisted this move for over a decade and the DA suspects there [had] been ministerial interference in the processes of Parliament, in order to avoid Eskom relinquishing control of the grid".

> *The DOE provided an overview of the process which included the points that:*
> *Independent Power Producers (IPPs) had not been forthcoming in significant volumes due to:*
> *· Perceptions of conflict of interests in vertically integrated Eskom*
> *· Perceptions that government was not serious about reforming the industry*
> *· Perceptions about long-term viability of present electricity supply industry (ESI) structure*
> *· Lack of clear policy specifically aimed at IPPs*
> *· Lack of enabling legal/ regulatory framework to facilitate IPPs. (PMG 2013a)*
> *The committee made further comments, including:*
> *…what came up strongly in the public hearings was that there needed to be a long-term vision for the electricity industry and its end state. More concrete work was needed in formulating relevant policy by the DoE to reach agreement on what the ultimate objectives in the energy industry were. DoE needed to revisit some of the issues which had failed in the past and re-cast a new framework. The Minister should therefore address the restructuring of the electricity sector as a matter of urgency, which included policy renewal, legislation, programmes and a road map. It was suggested that DoE should hold another energy summit to address some of these issues.*
> *(PMG 2013a).*

The Cost of the Electricity Crisis

These struggles are costing South Africa dear. Figure 2 presents a rough estimate of cumulative losses if electricity growth resumes at previous levels when additional capacity begins to come on stream in 2015, but does not 'bounce back'[8] because of the period of shortage. Although there are many possible and plausible future scenarios, in the one shown, over the next fifteen or so years South Africa will have forfeited some 600 TWh of electricity production with a (conservatively[9]) estimated value of some R540Bn. This might at first sight seem a very, very large amount. As a reality check consider: annual electricity production is some 230TWh. If this is valued at R0.90 per kWh, its value is R207Bn. If electricity consumption had not been constrained by lack of supply it is quite conceivable that the long term trend would have led to consumption in 2013 being 260TWh, i.e. more than 10% less, with a value of R20.7Bn. Losses began in 2008 and extending this 10% loss into the future quickly leads to losses of multiple hundreds of billions of Rands.

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[8] It is quite plausible that it will not bounce back, given that prices will be some 2 to 3 times higher in real terms than before the shortages began.

[9] A real (ZAR 2013) utility revenue price of R0.90 which is lower than the lowest price in Figure 11 – Comparative real average revenue price path following each step to the Base Case in the IRP2010 Update (DOE 2013 b: 21)

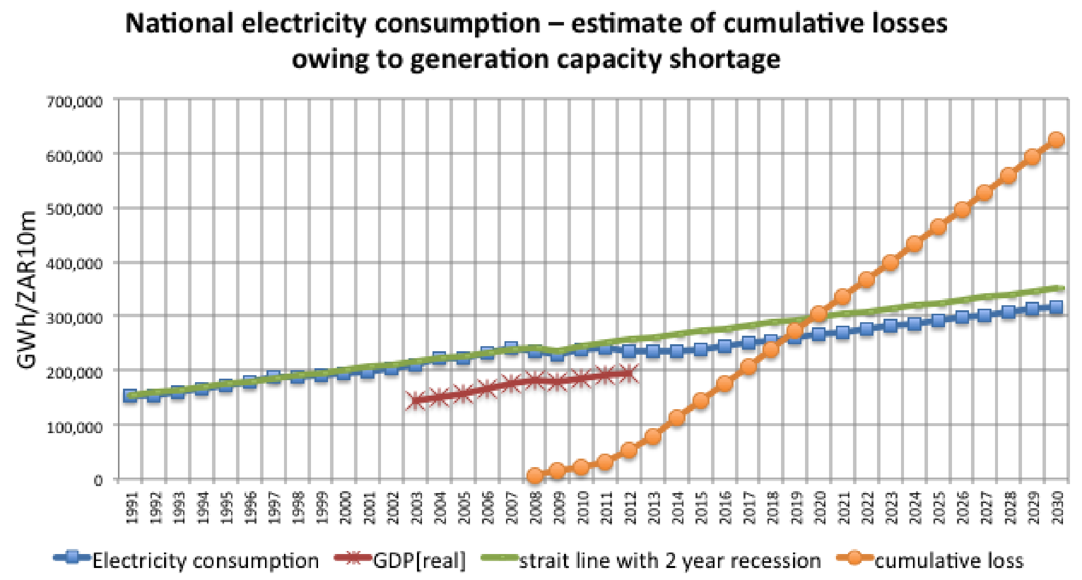

Figure 2 – Cumulative losses of electricity production owing to generation capacity shortages from 2008-2015/2017 (Stats SA)

What is also of concern to energy security for South Africa is that the success in the REIPP procurement mechanisms might not necessarily apply to procuring baseload. The REIPPPP has been a remarkable success; but it does not present a substantial threat to Eskom's market power. The 64 approved IPP projects of 3,882 MW of renewable energy will contribute some 3% of energy supplied to the grid. If all the renewable energy in the IRP2010-3030 is implemented, it will be less than 10% of total electricity energy fed into the grid by 2030 (DOE 2011a). Baseload IPPs, however, will present a direct and substantial threat to Eskom's market power, even if quite small to start with. Once proven successful, a new baseload procurement process based on the REIPPPP could be an even more significant threat.

Nonetheless, given the success of the REIPPPP it can be argued that government is now fully empowered to implement whatever IPPs it wants to – the new legislative and regulatory framework has demonstrated this. While achieving success in the REIPPPP, this undermines much of the argument put forward for the ISMO.

While there has been remarkable success in the REIPPPP programme, baseload procurement includes many other complications, especially those to do with the politics of implementation, and the struggles playing out between powerful incumbents, new entrants and government and, most importantly, tight linkages with very large coal and transport infrastructure investments. These issues around baseload procurement have not been fully thrashed out and given the history to date it indicates a crisis in South African energy security.

Electricity Re-distributors

Similar to the electricity generation sub-sector, government attempted to implement a policy to fundamentally re-structure the re-distributor sub-sector which on-sells electricity from the national grid to retail customers. The intention was to meld some 180 local authority electricity re-distributors and Eskom Distribution into six Regional Electricity Distributors (REDs). After extensive efforts over some ten years to implement this policy it was finally abandoned in 2010. In the interim the failed re-structuring created an environment of extreme uncertainty in the sub-sector that exacerbated already problematic local government administration (South African Auditor General 2013) in South Africa. From some technical perspectives based mainly in electricity market analysis the REDs policy could have solved some local authority electricity distributor issues - it was the political dimension involving local authorities that was not successfully addressed. Local government electricity re-distributor problems that the REDs policy was meant to address have not been solved, and have in fact worsened, and the REDs re-structuring process, abandoned at the end of 2010, has not been replaced by anything.

Table 2 – Local government electricity distributors financial viability under threat - Net surpluses on electricity sales *(South African National Treasury 2013)*

R million	2006/07	2007/08	2008/09	2009/10	2010/11	2011/12	2012/13
					Medium-term estimates		
Category A (Metros)	2 888	3 211	3 350	2 454	2 945	2 166	1 151
Category B (Locals)	1 487	1 473	1 251	795	608	-331	-1 282
Secondary cities	815	618	577	341	339	-87	-785
Large towns	310	406	374	151	214	-92	-285
Small towns	304	372	253	252	37	-80	-205
Mostly rural	58	77	46	50	17	-72	-7
Category C (Districts)	-21	-28	-48	-25	4	-4	-7
TOTAL	**5 840**	**6 129**	**5 803**	**4 018**	**4 165**	**1 500**	**-1 421**

Many local government electricity distributors are not covering costs. Local government electricity distribution has historically been run at a profit with the surplus used to fund the general rates account. However, since 2006 the aggregate surplus of around R5.8bn for distributors nationally has turned to a loss of R1.4Bn and many local government electricity distributors are not covering costs. Re-distributors in the aggregate have recently moved into the financial red and the doubling and soon tripling of the bulk electricity price presents them with huge revenue challenges. This impacts customers' energy security, but in the medium to longer term presents a risk to the whole sector, including (potentially) a new ISMO, because bankrupt re-distributors, which account for 60% of bulk sales, will challenge entire sector finances. The National Energy Regulator of South Africa (NERSA) has already warned that municipal electricity prices are reaching a 'tipping point' beyond which many businesses will find them unaffordable and have to close shop.

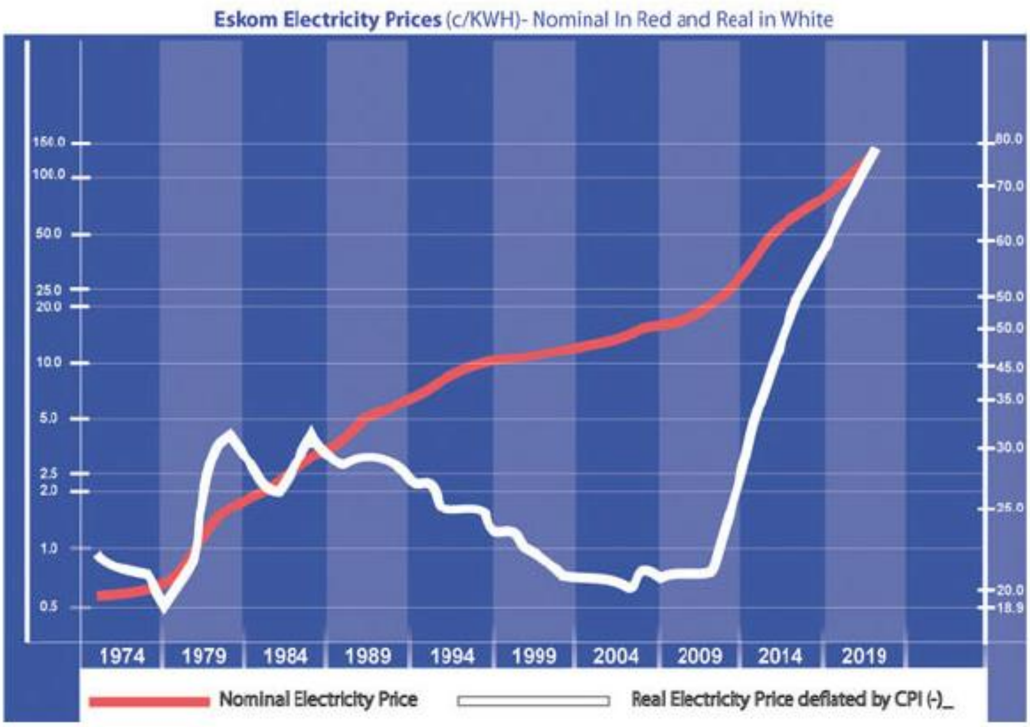

Figure 3 Past and future electricity prices (Source Moneyweb 25 November 2013)

Local blackouts have become commonplace. Failures of local distribution networks are related in some aspects to general service delivery problems being experienced by local authorities. These are caused by financial maladministration associated with severe skills shortages in managerial, administrative and technical areas and corruption at the political levels (Auditor General 2013). It is estimated (Kuni 2013: 15) that there is a maintenance backlog of R50Bn on these networks and the situation is worsening (DOE 2013a). Poor maintenance will increase costs and complexity delayed maintenance, with a feedback effect- the system is becoming unstable.

Nowhere are the issues in the electricity re-distribution sector clearer than for those in the 'second economy' who generally have poor access to electricity through the grid, despite huge improvements since the 1980s. If they do have access, most cannot afford enough electricity despite the 'lifeline tariff'. These consumers are energy poor and depend on expensive fuel alternatives that come with severe negative health and safety costs. Thus, although there have been significant improvements in providing electricity grid connections to poor households, many of these households still typically experience energy poverty which is worsened by the disruptions to electricity supplies and high prices. This will be expanded upon in the next section on poor households' energy security before energy resources are addressed in those that follow.

Poor Households' Electricity Insecurity

Until improvements beginning in the mid-1980's most residents in the 'second-economy' generally had poor access to energy services, either by virtue of not being connected to the electricity grid and/or because adequate energy services were unaffordable. At the beginning of the 1970's only about one third of South African households were connected to grid electricity. These consumers generally had little or no access to safe/convenient fuels, and inconvenient, expensive unsafe fuels were often obtained at relative high expense and in addition to being inadequate to provide sufficient light, heat and cooking services had severe health and safety impacts. The negative impacts include compromised nutrition, respiratory disease, paraffin poisoning and shack fires. These households typically experienced energy poverty associated with significant associated hardship compounding other poverty effects.

Beginning in the mid-1980's electricity grid connections were progressively extended from 'whites' in the 'first economy' to all urban residents so that today most urban residents are connected to the electricity grid. A 'lifeline' tariff has been introduced and many poor households have access to between 25-60kWh of 'Free Basic Electricity' (FBE) a month.

Table 3– Households without grid electricity (Source National Treasury, 2012)

Municipal type	2001	2011	% Reduction
Metros	19%	11%	8%
Secondary cities	22%	12%	10%
Large towns	31%	15%	15%
Small towns	34%	17%	17%
Rural municipalities	52%	25%	27%
National Total	30%	15%	15%

Although mid-high income residents that were not classified 'white' in the apartheid era now have access to affordable electricity, many rural households are still not connected. Census figures record that around 85% of all households use electricity for lighting, indicating that they have a connection. However, around 15-20% still use paraffin and wood for cooking – fuels associated with high relative financial costs in the context of these households budgets and poor performance and significant negative health and safety impacts. *Access* using the WEC 3As definition includes affordability, and although households might have a connection, they often find enough electricity to meet basic needs unaffordable, and lack access to alternatives such as LPG.

The initial success of the mass extension of grid connections to households in South Africa begun in the 1980s has tailed off with connection rates of over 400,000 per year decreasing in the last few years to between 150,000 and 200,000 a year. In 2011 there were still a reported 3,388,156 unconnected households (DOE, 2011b). Tait and Winkler report that 'the Bureau of Market Research (BMR, 2007) says that the number of households in South Africa is likely to grow from approximately 12.9 million in 2006 to nearly 17 million in 2020', which is an average of some 285,000 households per year. If current trends continue new connections will not even keep with household formation, let alone fill the backlog. Combined with huge tariff increases, increasingly unreliable electricity supplies, inappropriate metering solutions and apparent difficulties in extending usage of LPG, it appears that energy security for poor households, which is already poor, is set to deteriorate further.

Thus, although until some five years ago there were significant improvements in providing electricity grid connections to poor households, many of these households still typically experience energy poverty and the trends indicate deterioration. The energy security fortunes of poor households are directly linked to re-distributor performance but their situation is exacerbated by the inability of these households to afford the price increases.

Coal

Of the some 250Mt of coal used locally or exported annually, 44% is used for electricity generation, 28% exported, 18% used for making liquid fuels from coal (CTL) and 10% is used directly. Of the 10% used directly, 65% is used by industry, 23% by households and 12% by commerce (DOE 2009)[10].

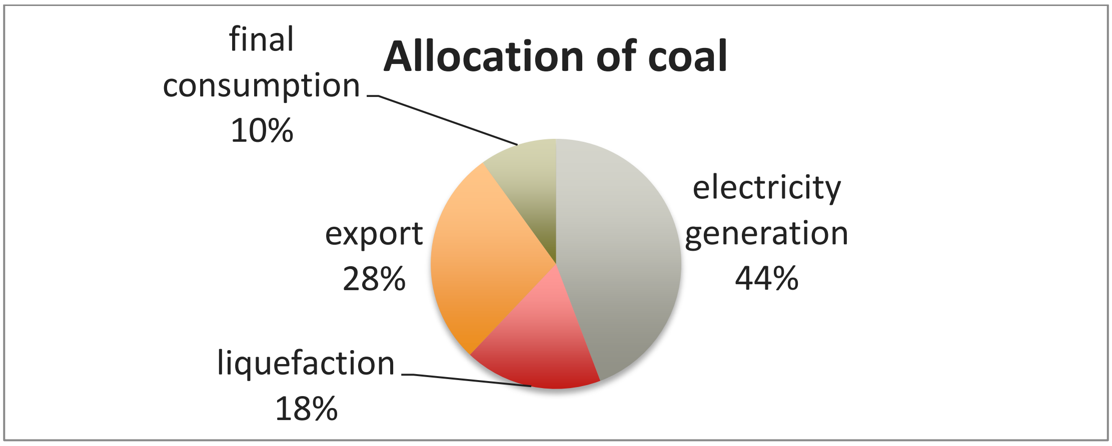

Figure 4 – Allocation of coal production (DOE 2009)

The South African coal industry itself estimates South Africa's recoverable coal reserves at approximately 49,000Mt, giving the country the world's sixth-largest coal reserve (SACRM 2013). At a production rate of some 250Mt/year this equates to a reserve to production [R/P] ratio of 200. Purely from a reserves perspective, South Africa likely has adequate resources for the medium to long term. It should be noted, however, that reserves and resource data has not been updated for several

[10] These are 2006 statistics, the latest official statistics covering all energy sub-sectors.

years, and the most recent study, by the Council for Geoscience, has not and will not be released publicly. There is thus some question about the precise reserves remaining, and more importantly, their location, in the Central Basin, or the Ellisras Basin in the Waterberg.

Because there are probably adequate domestic coal reserves which can be mined at low cost, coal energy security, and so electricity energy security, in the short and medium term at least[11], 'simply' [12] involves the reliable and efficient mining of these reserves, the production of appropriate coal grades and transport to market. As this involves some 250Mt per annum this is a major industrial undertaking requiring long term planning, large investments and effective cooperation of a number of parties. While it is technically feasible for the industry to ensure adequate supply, shifting economic incentives and policy and governance uncertainties are threatening domestic supply.

The rapid ramp up since the 1970s of coal exports and coal for electricity generation has relied on arrangements where many of the collieries supplying the low-grade 'electricity-coal' are dual-product and also produce higher-grade coal for the export market. Serving these two different markets from dual product mines enables significantly lower costs for each grade, facilitating very low coal costs for domestic power production, and competitive prices and attractive profits for export coal.

The integration of low-grade electricity-coal and high-grade export coal markets and the associated electricity generation system has been the foundation underlying one of the most productive and cost-competitive coal and electricity sectors in the world. The complementary relationship between coal for exports and coal for Eskom hinged historically on the large quantity of low-grade coal made available to Eskom and the higher value exports out of Richards Bay Coal Terminal. State-owned Eskom built the power stations and signed long-term coal-supply contracts with private sector mine owners. An additional linkage was investment by the private sector and the state-owned railways' operation of a special purpose high-volume rail link to the privately owned Richards Bay Coal Terminal (RBCT), the largest of its kind in the world.

Development of this integrated system was based on coordinating large, long-term investments by privately-owned and public entities, including: private sector coal mines; large private and public sector energy-intensive electricity consumers and re-distributors; state-owned Eskom; state-owned railways; and a privately owned export terminal.

To envision and achieve this coordination often involved very assertive action by the state. In addition to its mega-projects, the state regulated domestic coal prices and controlled private sector coal exports in order to achieve low domestic coal prices, increase extraction and utilisation rates, and encourage the coordination of electricity-coal and export-coal markets (Marquard 2006: 75-78). This integrated coal-production and marketing system is a core component of Fine & Rustimjee's (1996) minerals-energy complex. Driven by centralised apartheid state planning, the coal/electricity/energy-intensive industrial sector was expanded rapidly from the early 1970s, increasing five-fold in size by 1990.

Due to the relationship between export-coal and coal for electricity generation, coal exports also expanded rapidly from the 1970s, which had large economic benefits mainly in the form of job creation and significant foreign exchange earnings. The South African economy relies heavily on coal and energy-intensive exports for significant foreign exchange earnings, and to create jobs. In 2011, primary mineral export sales were R282bn, making up 38% of total merchandise exports. Coal and

[11] In the medium to longer term the GHG emissions of the South African energy system could become of major importance to energy security and this could impact on coal and energy security. This is a most important issue and is dealt with in section xxx. This section deals with less complex (although currently problematic) issues of energy security and conventional coal supply: mining, transport and coal markets.

[12] We say 'simply' because the system used to be able to achieve this and there are no natural resource or technology challenges. Given effective coordination, there are also no financial barriers because the techno-economics of the coal/electricity/industrial system are very favourable.

platinum group metals (PGMs) contribute significantly to this – coal sales alone accounted for R87bn in total, contributing R50bn to exports in 2011 (CoM Facts and figures 2012). In 2011, coal mining accounted for 81,000 jobs (CoM 2012).

Deterioration in coal supply reliability and a structural increase in coal costs

Coal supply to power stations has seen a significant shift away from a complex but highly effective arrangement. Supplies from large-scale, tied collieries, often multi-product, on long-term contacts either delivered by conveyor belt from mine-mouth power stations or transported by rail, have been falling away. The benefits of the synergies achieved in production and marketing of higher-grade export and lower grade, lower cost electricity-coal have also been falling away. These are being replaced by a less coordinated arrangement of supplies on short-term contracts which do not take advantage of the low costs achievable from synergies with exports or large scale mining, and are often transported by road. Analysis of the 2007/2008 load shedding provided the first official reports on performance problems related to the fundamental structural changes in the coal supply system.

While the aggregate availability of coal supplies has not yet been a problem for the electricity sector or coal for the industrial sector, some of the causes of the 2008 electricity load shedding were related to fundamental changes in the integrated 'electricity-coal', 'export coal' and electricity generation system established in the 1970s and rapidly scaled up over the following thirty years. The 2008 NERSA *Inquiry into the National Electricity Supply Shortage and Load Shedding*, states that, 'unexpected low stock levels in December contributed largely to the load losses experienced in the inquiry period' (NERSA, 2008). These low stock levels were a result of older long-term coal supply contracts coming to an end and short-term contracts being entered into between Eskom and coal miners. Furthermore, these new contracts relied more on road transport and were supplying coal at significantly higher prices, despite the unreliability of these contractors. The NERSA inquiry found that in the three month period from 2 November 2007 to January 2008, 28.9 million tons of coal were received at Eskom power stations of which 78% was delivered by tied collieries, 19% was transported by road and 3% was transported by rail (NERSA 2008). It stated that '[r]oad haulage of coal to meet the requirements of power stations is not suitable to supplement the contracted coal that is available from tied collieries' (NERSA 2008). Furthermore, the unreliability of short-term contracts was underlined by the finding that deliveries from short-term contracted mines stopped during the holiday season.

It would be a mistake to attribute the degraded performance of the coal supply system in terms of reliability and cost to poor performance of any single element in the system; rather, the cause is the breakdown in coordination of the many interconnected system elements. These do not only affect immediate operational performance, but also impact on medium to long-term strategies and associated large-scale long-term investments. The structure of the system is changing fundamentally, resulting in higher costs and lower reliability. Improving the performance of individual elements is unlikely to solve the underlying structural problem.

The highly integrated and interlinked system of joint planning to implement a joint vision, long term commitment, implementation and operation of the coal-supply and electricity generation system is unravelling, simultaneously putting an end to security of coal supplies, low-cost coal for power generation, low cost electricity and growth in the South African coal sector. This has profound implications for energy security and the economy.

Coal exports have stagnated over the past decade[13], largely due to logistical constraints on the Transnet heavy haul coal line, including capacity constraints and derailments.

Property rights and investment

There is a fundamental issue related to property rights or security of tenure potentially impacting on energy security in South Africa. Despite government assurances, private sector investors perceive high risks associated with their ownership of mineral rights, ranging from nationalisation through to the state declaring coal a strategic mineral under the Minerals and Petroleum Resources Development Amendment Bill and limiting the rights of miners to export product. There is considerable uncertainty as to what will happen when existing prospecting rights expire from 2015 (SACRM, 2013). The coal mining industry as a whole will require investments of up to R90 billion in new mines, R30 billion for expansion of export infrastructure, and further infrastructure development in South Africa to transport coal to power stations. The SACRM publication states that 'Unless South Africa is prepared to pay far higher returns for new coal projects than has been the case in the past, the mining companies, and in particular the diversified global mining companies, cannot logically be expected to supply the capital' (SACRM 2013: 6). The South African Coal Roadmap foresees a potential shortage in coal supplies to existing power stations by as early as 2015, 'a dire probability given that South Africa's energy system will continue to depend on coal well into this century' (SACRM, 2013).

Merely achieving adequate investments in mines to supply sufficient coal for existing and under-construction power stations appears to present a major challenge. If the synergies between local and export coal markets and multi-product mines cannot be re-established, South Africa will unnecessarily be locked into much higher cost coal for electricity production, for no reason other than lack of coordination. While coal combustion needs to be curtailed to mitigation GHG emissions it is economically inefficient to achieve this end through policy implementation failures and planning and implementation inefficiencies.

Exports could also decline further. The record of developments in the sector lead to an inescapable conclusion that the necessary level of mutual understanding, trust and cooperation between private sector investors, government, Eskom and Transnet required to achieve efficient and effective long-term investments and coordinate the domestic electricity generation coal and export coal markets has become problematic. This is exacerbated by export demand for lower grades of coal that previously would only have been suitable for the local electricity coal market, the entry of small-scale BEE and junior miners on short-term contracts, and a shift to road transport.

The long-term, well-planned, low cost, coordinated and secure large scale production and transport of dual-product coal to domestic power generation (by conveyor belt and rail) and to export markets is unravelling and being replaced by unplanned, high-cost, short term uncoordinated, *ad-hoc,* insecure supply from mines, often by unsuitable road-transport; the system is not optimised for the necessary multi-product production required to achieve very low costs or secure supply of coal for electricity generation.

[13] Very recent reports indicate that exports are recovering with 70.1Mt in 2013 (Business Report, 22 January). However, the central argument re coal energy security, namely difficulties in the set of arrangements required between a number of parties, has also recently surfaced, with Transnet offering to build a separate terminal to the RBCT to cater to "Junior Miners" who claim they are being discriminated against by RBCT. From a systems perspective, the concern remains that the synergies between electricity-coal and export coal markets are being lost and with this low coal costs. (Business Day Live 30 October 2013, Financial Mail 7 November 2013)

Liquid Fuels

Liquid fuels account for the largest share, at 34%, of final energy consumption in South Africa (DOE 2009). South Africa has minimal crude oil resources and thus imports most of the crude oil needed for liquid fuels production in South African refineries, which supply some two-thirds of liquid fuels needs with the remaining third manufactured from coal (CTL) and a small and decreasing proportion manufactured from natural gas (GTL). Demand began to exceed domestic liquid fuels manufacturing (crude refining and CTL) capacity some years ago. According to the liquid fuels industry, local refineries have been running at maximum capacity and increasing demand has been met by imports. This has decreased the security of liquid fuels supply to the South African economy and consumers and undermines energy security in the entire system. This situation has evolved over the last 20 or so years through poor governance of the sector and is further exacerbated by low strategic crude oil stocks.

Liquid Fuels Production

The 1994 South African government inherited a highly regulated petroleum/liquid fuels sector. All aspects of the system were controlled through often opaque agreements between industry participants and non-transparent regulation, ranging from quota control of product imports through to price control. This system was effective at every stage of supply – refinery gate, wholesale and retail – and was developed and operated in the context of the United Nations crude oil embargo against the Apartheid regime (Trollip 1995).

The democratically- elected government of 1994 decided to make fundamental changes to these arrangements. In the words of the 1998 White Paper on Energy: “the government believes that competitive market forces should determine prices. Retail price regulation, import control and Government support for the Service Station Rationalisation Plan will be simultaneously removed. Government is committed to promoting a climate that would be conducive to reasonable profits and sustained investment in the liquid fuels industry”.

A phased process of de-regulation was mapped out in the White Paper of 1998. However, like the electricity sector, liberalisation of the petroleum sector has met severe challenges and failed. Uncertainties during the attempted implementation of the fundamentally new policy direction, and a subsequent policy vacuum, have prevented necessary investments and development and have led to a severely stressed supply system.

As with the electricity generation shortages from 2005 until the present, the liquid fuels supply system exhibited the first signs of serious and indubitable deterioration in 2005. In 2005 the sector experienced ‘stock outs’ at many locations throughout the country including shortages of aviation fuel that delayed flights, diesel for agriculture and fuel for motorists (Moerane 2006). According to the Moerane Investigating Team to the Minister of Minerals and Energy, “these events exposed underlying structural and regulatory weaknesses in the sector” (Moerane, 2006).

According to a BP release titled *2007 Who will invest in our fuel infrastructure and why should they?,* South African refineries “are operating at full capacity; [the] road and rail transport systems for carrying fuel are stretched to the limit; […] pipelines are too expensive and too few and [the] roads are crumbling under the weight of increased loads. … The truth is that [South Africa is] now at a point at which any unplanned break in the supply chain (i.e. refinery breakdowns, pipeline interruption, shortage of rail tank-cars) will create shortages”. The report also stated that existing infrastructure “is unable to support the requirements for increased imports in the short term and will need to be upgraded” (BP, 2007).

Since then, there have been shortages and disruptions in supply and South Africa has had to significantly increase imports of refined product (Energy Global 2011; Oil Review Africa 2013).

A Failure in Governance

Similar to the electricity sector since 1998, stable policy for the liquid fuels sector was agreed to by all in an inclusive process, but in practice its (non)-implementation has led to a level of policy and regulatory uncertainty that has caused severe under-investment in the sector. As a consequence the liquid fuels supply system, in all links of the chain, is overstressed and failing under pressure. Apart from the long-delayed commissioning of a new multi-product pipeline that was scheduled for completion in 2010 and partially completed in January 2013, government has not taken substantial action. The 40-year-old refineries have not had the required investment to keep up with demand. According to the DOE, "our refineries are experiencing reduced production levels which is a threat to liquid fuels security of supply" (SAPIA 2012).

In 2007, the Department of Minerals and Energy (DME 2007) published the *Energy Security Master Plan – Liquid fuels* which states as a priority that South Africa develop the ability to construct "properly thought-out" energy plans, as well as a tool for evaluating proposed energy policies. However, by 2013, eight years after the initial serious shortages were experienced, and six years after the announcement of the urgent priority to develop a 'properly though out plan' this plan is still outstanding. DOE reported to Parliament (SA News, SA Government News Service) in September 2013 that it was "also looking at finalising the liquid fuels infrastructure roadmap in order to improve energy security". At the same time, the department acknowledged that it was challenged by the task of compiling energy data and statistics on specific sectors, and stated its intention to improve its ability in this regard.

Year after year, the DOE has made statements in annual reports and reports to Parliament about the liquid fuels crisis and what needs to be done urgently to address it. However, by 2013, the DOE has not produced a policy or plan to update the out-dated and unimplemented 1998 policy. Neither have any actual commitments been made to invest at the scale required to effectively address the situation. Of possibly even greater concern is the fact that the basic statistics required to development such a plan are still not available, including the 'real status' of refinery production capacities.

Given the level of policy uncertainty and statements of large planned prospective state-investments in the sector, such as PetroSA's Mthombo refinery, it is hardly surprising that private sector incumbents have been unwilling to invest in the system. This, in turn, only serves to increase its unreliability. Thus, a crisis in governance in the liquid fuels sector has led to a growing fissure in the liquid fuels system, which neither government nor the private sector has been able to or inclined to fill. The liquid fuels system and the energy system that it forms an integral part of are thus increasingly insecure in terms of short-term supply shortages and long term supply deterioration. This increasing insecurity is further exacerbated by low strategic crude oil stock, underlining the systemic insecurity of the liquid fuels system.

Crude oil stocks

The strategic crude stock held by South Africa decreased dramatically towards the end of apartheid as the imperative for long-term stocks was removed with the lifting of the UN crude oil embargo in October 1993. Today, on average, each refinery holds crude oil stocks that equate to about 10 days of refinery operation at maximum capacity. In addition, there are 10 million barrels of crude oil kept by the Strategic Fuel Fund as strategic stocks, which would cover one month of imports at 20bn bbl/year (DOE 2012f).

In 2013, DOE published a draft *Strategic Stocks Policy and Implementation Plan*. However, there are large inadequately motivated differences between stock levels recommended in the Draft Policy and previous levels according to the Energy White Paper. The only reason given is that holding higher levels would be too costly. No supporting analysis is provided in the Draft Policy, and there is no analysis of the likelihood of disruption, the impacts of disruptions and no cost/benefit analysis is presented. The Draft Policy appears to contradict the 2007 *Energy Security Masterplan – Liquid Fuels,* with no explanation given. This is worrying for South Africa's energy security situation, and indicates a lack of adequate policy analysis, misaligned policy and underinvestment – in this case in strategic stocks – of a resource that could cripple the economy if an external disruption cut crude supply for a longer than a month.

The kind of strategic planning, government regulation and investment, and private sector buy-in required to build up strategic stock reserves over a longer period, as has been done in developing countries or developed countries such as those in the EU (90 days), is not evident. This is worrying given the other areas of the system in crisis, and it is likely that if a cost/benefit and risks analysis were undertaken, larger strategic stocks would be necessary to achieve reasonably justified levels of security of the energy system.

While current actual delivery of liquid fuels to market is adequate, the warnings from all quarters on under-investment are a cause of concern for the future of liquid fuels production in South Africa. This is especially worrying given the increasing dependence on crude oil imports as a high level of dependence on imported crude oil opens South Africa up to shocks caused by external disruptions which can put huge stress on the whole energy system, undermining economic growth, social stability and development. Given the large prevalence of energy insecurity at the household level, and lack of resources to deal with additional pressures, the load on the poor in such circumstances is of considerable concern.

CONCLUSION

South Africa has experienced a significant deterioration of its energy security situation over the past ten years. While there have been recent successes, these are the exception and not substantial in the context of the challenges being faced. South Africa's energy future still looks insecure despite Eskom's new build projects and the success of the REIPPPP. Key sectors of the energy system are in crisis, evidenced by the protracted electricity generation capacity shortage, the South African Coal Roadmap alert of potential coal shortages by 2015 and the huge backlog in transport and re-distributor infrastructure investments and/or maintenance identified in a number of government publications and that the key findings of the Moerane investigation into liquid fuels shortages in 2005 have yet to be substantially addressed. The Liquid Fuels Roadmap is yet to be published despite repeated official statements of the seriousness of the problem in liquid fuels and promises of delivery of the roadmap. South Africa's energy generation sector remains dependent on the success of baseload IPPs under construction and IPPs are yet to be identified. Despite the more than 10-year failure to contract baseload IPPs in the past, there is no contingency plan for failure of the current IPP process. Eskom retains its market power and continues there are reports that it continues to block the ISMO bill and may continue to make the contracting of IPPs difficult, even with the DOE minister's new emergency-style 'Determination' powers under the Electricity Regulation Act (No. 4 of 2006). Unless government manages to generate the necessary consensus between key members in government and other stakeholders in the energy system on an agreed vision, and/or create the necessary regulatory power to command support when consensus is lacking, the investment necessary to resuscitate the energy system is unlikely.

Implementation has been highly problematic, with the exception of the REIPPP. Thus, the focus in energy security analysis/implementation in South Africa has been misguided in taking on a "strong technical quantitative bias or leaning towards rather simplistic ideas about policy process and dynamics" (Baker 2012). If government is to fundamentally change the roles of major investment actors in a sub-sector or industry, it will first require development of a vision (which is plainly absent), followed by a realistic assessment of what is required to create the necessary conditions for investment. This would include an overarching economic policy with support from key players. The Eskom failed re-structuring has shown just how serious the consequences can be when forging ahead while key partners are voicing opposition. Whether or not a necessary new vision is generated, with adequate support, after the failed implementation of policy in the electricity generation, electricity re-distribution and liquid fuels sectors is at the crux of South Africa's energy security challenge for the future. Also, a coal policy, which has been absent, will need to compliment the policies in the other sub-sectors. Further, multi-disciplinary research[14] into South Africa's energy security situation is urgently needed to inform policy making going forward if the underlying causes of the crisis are to be addressed and the medium to long term risks mitigated.

[14] A number of research areas are included in Appendix 1 on page 37

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APPENDIX

RISK	IMPACT	MITIGATION
Policy analysis risks		
Official explanation of 10 year chronic electricity generation shortage from 2005 – 2014/15 that has had severe economic consequences does not identify and analyse key underlying causes and issues.	The underlying causes persist, exposing the sector to further problems.	Conduct an independent investigation, possibly a Judicial Commission, to investigate the 10 year electricity generation shortages.
Sub-sector policies are moved into implementation phase without realistic and comprehensive assessment of conditions required for success nor consequences of failure.	Sub-sector policy implementation fails with severe consequences	Comprehensive policy analysis including implementability, consequences of non-implementation and contingencies
Sub-sector plans based on limited basis: e.g. focus on market economics without adequately taking into account political economy and relevant implementation issues.	Sub-sector policy implementation fails with severe consequences	Take into account relevant economic interests and political conditions
Inadequate alignment of sector policies with other sectors and general political and economic policy e.g. linking electricity policy to coal and transport sectors (for coal supply for electricity generation) and to industrial and socio economic policies, for electricity sector to serve electricity users and economic production	Sector policy out of line with other sectors: e.g. new Eskom coal supply arrangements don't optimally take advantage of synergies with export market or coal mining in general	Adequately involve all sectors in policy development. Ensure that policies are properly analysed for alignment
Inadequate vision and coherent systemic policy for highly complex sector	Addressing individual elements of complex system ineffective	Establish coherent vision and related policies
Policies and implementation plans for crucial issues, for example Strategic Fuel Stocks, are circulated for comment and then often announced/promulgated for implementation, without the necessary analysis or supporting information to assess their viability	Polices plans with unknown potential impacts. Un-implementable policies. Severe unintended consequences	
Political risks		
Effective party rule with lines between party/Alliance and state blurred, especially in context of deep divisions in Alliance: Cascading political appointments through from alliance, ruling party, Cabinet, government departments and SOE's.	Resistance at all levels to policies that are strongly contested at alliance/ruling party level. Absence of necessary support (passive resistance) to implementation	Realistically assess policies for vulnerability to resistance in implementation at SOE, individual department level.
Sector policies are formulated that do not have necessary level of alignment, or support, from higher-level policies.	Sector policy fails	Comprehensive policy analysis including assessment of alignment with and support of higher-level policies.
In time of "elite transition" powerful new political elites not adequately served	Political resistance to implementation of policies until these adequately serve new economic/political interests	Ensure policies effectively address interests appropriately to the political power of the interests.
Policy process		
Policies announced by key interested actors (e.g. Mthombo by PetroSA) without supporting sector policy.	Undermines effective policymaking process. Creates high levels of investment uncertainty in the sector	Establish clear policy parameters especially for SOEs Clarify SOE boundaries of responsibility and accountability
Implementation governance risks		
Core executive does not hold executive (line ministers) to account for implementation of Cabinet policy.	Failed policy implementation if there is resistance to Cabinet policy in a line ministry or its line departments including (especially) SOEs	Core executive holds ministers to account for implementing Cabinet policy
SOE governance opacity, ineffectiveness combined with necessity of SOE active support of policy implementation.	Resistance at all levels to policies that are strongly contested at alliance/ruling party level.	Realistically assess policies for vulnerability to resistance in implementation at SOE, individual department level.
Inadequate technical knowledge in core executive or access to trusted adequate technical knowledge to assess relevant implementation details of policies (e.g. inadequate functionality in core executive to spot that IPP policy would need to succeed very quickly unless there were to be severe consequences and delay in acting when IPP policy failed.	Unrealistic policy or failure to know that action is necessary when policy fails	Establish adequate technical capacity or access to trusted adequate capacity. Ensure that relevant technical issues are effectively communicated to core executive.
Inadequate technical knowledge in line department or access to trusted adequate technical knowledge to	Unrealistic policy or failure to know that action is necessary when policy	Establish adequate technical capacity or access to trusted adequate

assess relevant implementation details of policies	fails	capacity
That department strategic plans are not aligned e.g. DPE 2011-2015 Strategic plan does not include consideration of what Eskom will HAVE to do for success for DME 2011-2015 Strategic Plan	Items that are required for success in one department but action by another department are not provided for, with consequent failure	Ensure adequate alignment through interdepartmental processes AND proper thorough policy analysis
Sub-sector technical risks		
Demand projections not sufficiently transparent and/or unduly influenced by interested parties	Plans unnecessarily either aim at under-or over capacity, or planning process fails to warn of crises	Transparent demand panning with competent independent oversight
Lack of flexibility in demand projections / demand not updated frequently	Plans unnecessarily either aim at under-or over capacity, or planning process fails to warn of crises	Frequent demand projections
Inflexible build plans	Inefficient investments that don't take account of implementation realities and don't benefit from innovations and creative solutions to meeting demand	Build plans take implementation realities into account
Risks related to non-delivery of core government policies		
Energy poverty persists in a large number of households.	Suffering large costs to health services. Reduced/stalled socio-economic development. Social instability.	(It is necessary that the core energy system be secure in order to address poverty, but this in itself is not sufficient) So, in addition to mitigation measures for the core, energy poverty has to be elevated to an appropriate political priority. Policy analysis is required to identify why current policies are not improving energy poverty.
GHG emissions targets not met because renewable energy component of IRP not implemented. A degradation in the overall electricity system could lead to renewable energy being de-prioritised	International relations issues Global climate change not sufficiently mitigated	(Implement other measures to prevent failures in core system) Ensure that other failures in core sector do not impact on renewable energy IPP implementation.
Performance risks		
SOEs such as Transnet have basic functional performance problems that impact on energy security, such as performance of the Richards Bay coal line	Coal exports necessary to maintain synergy between local electricity coal and export markets cannot be achieved	Adequately skilled and resourced management at SOE's. Employment in key roles based on necessary competence.
Vicious spiral leading to serious financial viability problems of electricity generation sector	Instability in electricity sector with potentially far reaching economic and social consequences	(all of the above)