THE JOURNAL OF THE HELEN SUZMAN FOUNDATION

ISSUE 64 • FEBRUARY 2012

FOCUS

KEEPING THE LIGHTS ON

helen.suzman.foundation

promoting liberal constitutional democracy

Printing:
Fishwicks

Focus is published by The
Helen Suzman Foundation,
Postnet Suite 130
Private Bag X2600
Houghton, 2041
No 2 Sherborne Road
Parktown, 2193

Email: anele@hsf.org.za
Website: www.hsf.org.za

ISSN 1680-9822

The publication of *Focus*
is made possible through
generous funding provided
by the Friedrich Naumann
Foundation for Liberty

CONTENTS

Lenin's definition of communism – soviet power plus the electrification of the whole country – sounds a little whimsical today. The Russians never got communism; but they did get Boris Pasternak's novel on the electrification of the Soviet Union, and the rest of the world got Nigel Osborne's Chamber Opera, also on the electrification of the Soviet Union. Lenin was at least correct in recognising the importance of electricity in the industrial development of the Soviet Union.

Francis Antonie is the Director of the Helen Suzman Foundation. He is a graduate of Wits, Leicester and Exeter Universities. He was awarded the Helen Suzman Chevening Fellowship by the UK Foreign Office in 1994. From 1996 to 2006 he was senior economist at Standard Bank; thereafter he was director of the Graduate School of Public Development and Management at Wits University. He is the founding managing director of Strauss & Co.

This edition of *Focus* reviews the electrification of South Africa, but goes beyond straightforward supply side issues and considers alternative energy sources, sustainability, and the social impact of the energy sector.

Philip Lloyd reviews the historical structure of electricity supply and traces the development from the early 1920s to the present. He is pointed about the supply crisis which led to the blackouts in 2008, and he brings the distribution problem into sharp focus.

Shaun Nel reviews our progress since 'the sovereign electricity shock in the country in 2008'. He is particularly concerned about the regulatory clarity in the industry, and the relationship between public and private sector players. Indeed if one central theme runs through this entire edition of *Focus* it relates to the lack of regulatory clarity and, what Nel refers to as the "strategic and regulatory vacuum which the Independent Power Producers" find themselves in.

David Fig, in assessing the issues around Fracking, draws attention to the problems of consultation and transparency when deciding on the uptake of new technology or development projects. He cautions us that "when citizens are left out of debates confined to government and the business community, the only means of influencing policy is to petition, protest, or litigate, usually after the horse has bolted".

Hilary Joffe's account of the challenges facing South Africa's electricity supply industry takes as a starting point that we have to "keep the lights on". (Even then she does concede that we may have to switch some of the lights off!) She deals persuasively with the perception that Eskom and its Shareholder are averse to competition, but she emphasises the importance of opening up the industry to new players.

The papers by Doug Kuni, and Thomas Garner and Stephanie Kock remind us of just how important it is for political leaders to sketch out their vision for the society and then leave the realisation of that vision to appropriately competent men and women who can ensure service delivery. In this case the visionary is Smuts and the technocrat is HJ van der Bijl, and the year is 1920 - the same year in which Lenin sought to drive the electrification of the Soviet Union.

Doug Kuni identifies a set of three important policy initiatives which government should implement and which entails an immediate revision of the *entire* suite of regulatory documents to ensure that they are concurrent and have congruency.

Thomas Garner and Stephanie Kock stress the importance of certainty (in this case of electricity supply) in an uncertain (economic and regulatory) environment. Their sober assessment is that South Africa has lost a decade of planning in the supply of electricity. Their timely reminder of Van der Bijl's observation – that "the greatest and noblest function of science and engineering is to raise the standard of living of the human being" – should serve to remind us of the moral and social imperatives of service delivery.

Rob Adam and Steve Thomas evaluate the role which nuclear energy should play in our energy mix.

Adam's *five lessons from Fukushima* are an important reminder of the limitations of believing in any one approach to resolving the energy challenges we face. In his call for "a more lateral marketing approach built on the confidence-building participation of ordinary people" there is a resonance with David Fig's concerns about transparency and consultation even though their responses to policy initiatives may differ vastly. Rob Adam's concluding remarks, that "the nuclear industry treats the world like a big science class, exciting a few people, alienating others and paralysing the vast majority with reams of facts" will resonate with many readers.

Steve Thomas examines systematically the costs of nuclear energy. His assessment is a sober one and he reminds us that the Fukushima disaster can only serve to increase the costs of nuclear energy and probably the complexity of a new generation of nuclear designs.

In addition to these challenges, South Africans should be especially on their guard to ensure that the commissioning of nuclear power stations and the tender processes relating to this commissioning is carried out scrupulously. The country simply cannot afford another corruption fiasco similar to that which followed in the wake of the arms deal.

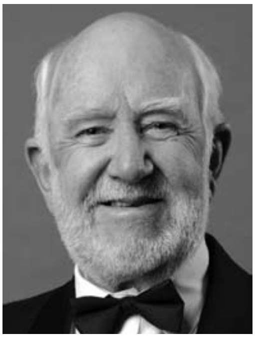
Joe Roussos provides, if not an obituary, then a lament of the solar parks. He neatly points out that the story of the Solar Park demonstrates a worrying lack of coordination within the Department of Energy and between the Department and other players.

Jonas Mosia offers a class perspective on the debate about the energy challenges we face in South Africa. His views are more derived from Lenin than Smuts as he reminds us that the subsidies accorded to business are invariably paid for by poorer consumers.

Mike Roussos ends our discussion by reviewing energy planning and sustainability. His paper could very well have been titled '*Can we keep the lights on without killing the earth?*' Roussos poses nine questions which policy-makers should address when attempting to create a local green economy. These questions in themselves provide a framework for further discussion and debate.

We end with Antoinette Handley's review of Stephan Chan's new book '*Southern Africa: Old Treacheries and New Deceits*'.

Restructuring South Africa's Electricity Supply Industry

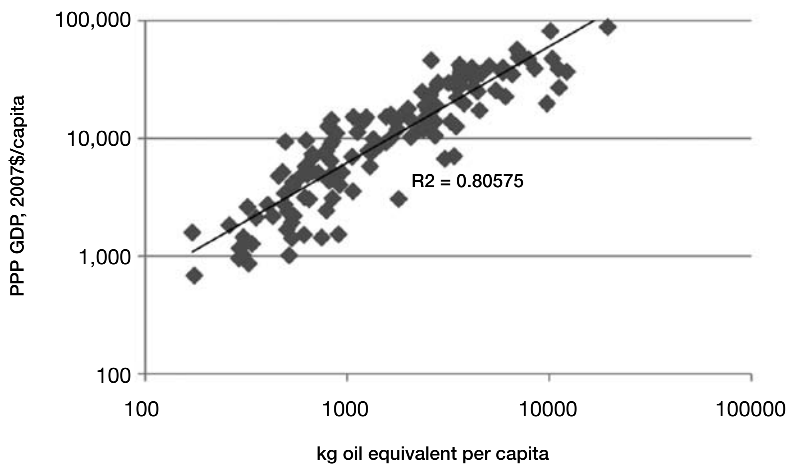


Professor Philip Lloyd is a professor at the Cape Peninsula University of Technology when he is not consulting to the process industries worldwide. A chemical engineer and nuclear physicist by training, he had a career in the mining industry and then in international construction before 'retiring' to academic life.

In recent years, South Africa's electricity supply industry has lurched from fiasco to disaster and back. In January 2012, Eskom held discussions with the Energy Intensive Users Group (EIUG) to persuade them to cut back on their demand for power. The alternative is to revert to rolling blackouts, which will drastically harm an economy already slowed by the lack of energy. How is this possible, in a country which less than a decade ago was seriously considering building a further aluminium smelter at Coega to provide an outlet for excess electricity?

There is a very direct relationship between wealth generation and the consumption of energy. The relationship is used by the International Energy Agency to predict future energy demand, which varies linearly with economic growth. Its predictions have proved astonishingly reliable for the past 20 years, an indication of the strength of the relationship, which is shown in Figure 1.

Figure 1. The relation between energy and wealth creation as measured by GDP for 132 nations



Source: World Bank

The wealthier a country, the more energy it consumes. The observation is also true – if energy supplies are limited, then growth will be constrained. This is precisely the situation in which South Africa now finds herself. Accordingly, we address the changes of the past fifteen years, in an attempt to identify the factors that have contributed to the change from an economy in energy surplus to one which is presently energy constrained, and considers the possible impact of proposals to remove the constraints.

The Historical Structure of Electricity Supply

Electricity supply in South Africa has long been the preserve of Eskom. Eskom was established in 1923 in terms of the Electricity Act (1922), following amalgamation of several private enterprises. It grew regionally in a number of 'undertakings', each with their own generating facilities. Distribution was primarily by municipalities, who bought power from their own local undertaking. The local undertakings constructed comparatively small power stations to service these local markets. The power stations were fuelled by coal, generally delivered by rail. There was comparatively little long-distance transmission of power. As a result many rural areas had no access to electricity.

From the late 1950s through the 1960s, the undertakings were interconnected by high-voltage transmission lines, until a national grid was established. It was thus possible to centralise the operations of the various undertakings. Also, Eskom found it possible to service many rural customers, so a diverse distribution system was established, with municipalities distributing power to the cities and Eskom servicing rural areas as well as transmitting power to the cities, and a few major industries whose demand for power was similar in size to that of a city.

Larger and more economic power stations were constructed close to the coal fields, because it was cheaper to transmit electricity by wire than to rail coal. This trend accelerated in the 1970s, when it was found possible to export high-grade coal very profitably. A by-product of the high-grade material was a low-grade fuel that formed an excellent and low-cost power station feed. The higher revenue generated by the new export business also enabled the coal mining industry to change its mining practice from underground to surface operations, which were much more efficient both in terms of the quantity of coal that could be recovered and the cost of production. Eskom was thus able to purchase large quantities of coal at a low price, both from the collieries producing export coal and from tied collieries that sold raw coal under long-term contract to Eskom.

The higher revenue generated by the new export business also enabled the coal mining industry to change its mining practice from underground to surface operations, which were much more efficient both in terms of the quantity of coal that could be recovered and the cost of production.

This in turn led to the construction on the Highveld of a fleet of large power stations fuelled by cheap coal. Typically these comprised six 600MWe units, each of which had its own boiler, generator and associated facilities, and were known colloquially as 'six-packs'. There were eight such stations, Kriel (1973), Duvha (1975), Matla (1977), Tutuka (1984), Lethabo (1985), Matimba (1986), Kendal (1987) and Majuba (1996) - the year is the start of the first unit.

This was an enormous programme and, as such, it demanded enormous resources. Eskom set up a huge engineering division to manage the construction. The demand for water for cooling was so large that it was necessary to divert rivers from one watershed to another. Because of water supply problems, Matimba was fully dry-cooled and Kendal was indirectly cooled. It was intended that Majuba should be dry cooled and the first three units were constructed accordingly. However, it became apparent, from the experience gained at Matimba that dry-cooling caused a serious and insuperable loss of efficiency, and the three final units at Majuba were conventionally cooled.

The programme had great momentum but, before completion, it became apparent that the growth in demand was slower than had been anticipated. This caused numerous problems, not least of which was the financing of the programme. Sales from the early stations were intended to help to finance the on-going construction. If sales fell below expectation, clearly there would be funding problems. This was exacerbated by civil unrest and attacks upon the primary transformers at the Arnot and Duvha stations which caused power cuts and additional loss of revenue.

As a result, the De Villiers Commission of Enquiry was established in May 1983. It reported in October that year, and recommended that ESCOM be replaced by a two-tier control structure, consisting of a management board and an Electricity Council of 15 members, namely:

- A chairman
- The Chief Executive of the Management Board of Eskom[1]
- The Directors-General of the Departments of Finance, and of Minerals & Energy Affairs
- A nominee of the South African Transport Services
- Up to five independent experts
- One representative each from five major consumer organisations.

One of the first actions of the new Council was to slow down the build programme. The last station to commence construction was Majuba, where ground was broken in 1980. The project was put on hold, and only recommenced in 1992. Soon thereafter the Eskom engineering team was wound down and many of its staff transferred to Majuba to complete the station from site.

In addition many old, grate-fired stations were closed, and some of the more modern but small stations such as Camden and Grootvlei were mothballed (but have since been returned to service).

It was surprising that such excessive capacity was available, because from about 1982, 1920MW of power from the Cahora Bassa dam, which had come into service in 1979, was lost. The civil war in Mozambique led to the line to South Africa being damaged and made maintenance impossible. This had the knock-on effect that the agreement to supply power to Mozambique was abandoned, which further increased the power available in South Africa. The line from Cahora Bassa only returned to full operation in 1998, and at the same time 450MW of power was routed through Swaziland to Mozambique.

In the early 1990s negotiations started to create a Southern African Power Pool (SAPP), an international high-voltage transmission grid which would also provide the benefit of making better use of South Africa's excess capacity. There were already links to Namibia, Botswana and Swaziland. The supply to Botswana was increased, and Botswana agreed to extend a line to Zimbabwe. Construction started in 1993. There were ambitions to extend the grid more widely, and to include the Democratic Republic of the Congo, where there was the possibility of constructing 40 000MW of generating capacity at Inga Falls on the Congo.

This structure was in place when the new South Africa came into being in 1994. Eskom owned and operated about 98% of the generating capacity in the Republic, was fully responsible for all high-voltage transmission, and was responsible for about half the distribution system. It had started to electrify a few black townships, but the majority of its domestic customers were white. There was a significant oversupply of electricity, but Eskom had recently concluded a contract with Alusaf for the provision of power to its Richard's Bay Hillside smelter, which commenced operation in 1995; and another with Mozal to power its Maputo smelter, about half the size of the Hillside smelter. Together these took a sizable fraction of the oversupply, but the terms of the contract were not particularly favourable to Eskom. As there was every appearance of political peace finally coming to the region electricity was becoming an increasing international commodity. The SAPP became a reality in 1995.

The Electrification Programme

The lack of electricity supply to black townships because of apartheid was one of the first issues to be addressed by the new government. Nevertheless, a National Electrification Conference was held in Johannesburg in September 1992, which led to the formation of a National Electrification Forum in 1993. Studies by the Forum revealed that distribution was a mess - many municipalities cross-subsidised services using electricity revenues, failed to collect revenues properly, and failed to maintain infrastructure. There were "too many distributors and many were financially unviable" [McRae2006]. The Forum was wound up in early 1995, when it reported:

- There were two options to resolve the distribution problem. Either the smaller, non-viable municipal undertakings should be taken over by Eskom, or a few Regional Electricity Distributors (REDs) should be established, which would take over distribution from both Eskom and municipalities large and small; and

- A National Electricity Regulator (NER) should be established to regulate the electricity supply industry.

The second recommendation was implemented, and NER was established in terms of the amended Electricity Act of 1995. The first task of NER was to try to resolve which of the options should be followed. Fortunately the Act gave NER teeth, in the form of licences both to generate and to transmit or distribute electricity. Few of the then 420 municipalities distributing electricity seemed capable of meeting electrification goals while setting equitable and low cost tariffs and still remaining financially viable. So they were issued with temporary licences to warn them to address these issues.

… the threat of removal of temporary licences worked in a number of cases, where a lame municipality was about to lose supply because of non-payment, and a nearby, financially-sound municipality came to its rescue.

This was a holding solution, but it did not address the real problem of there being nearly 1000 different tariff structures in place across South Africa. There was even a difference between the price at which Eskom sold electricity to its own distribution network and what it charged municipalities. Nevertheless, the threat of removal of temporary licences worked in a number of cases, where a lame municipality was about to lose supply because of non-payment, and a nearby, financially-sound municipality came to its rescue.

Importantly, however, Eskom and the municipalities took on the task of electrification. In 1991, there were only about 80 000 new connections. At the peak of the programme, there were nearly 450 000 new connections a year. Today, nearly 10 million homes are connected to the grid, and less than 3 million remain to be connected, most of which are in rural areas. Every school and every clinic has power.

The programme has been fostered by the introduction in 2003 of free basic electricity. This had been announced with great fanfare in January 2000 by the Minister of Minerals and Energy, but it took several years to get the necessary legislation and financial arrangements in place. While the programme has been a great political success, it has also caused problems. Many of these were foreseen in studies preceding the Minister's announcement. Worldwide, free energy had been found to be unsustainable in the long run, even in small quantities. Once the user has exhausted his/her allowance, the full tariff applies, which becomes a disincentive to the more widespread use of clean energy. 50kWh per month of free electricity is insufficient to provide more than the most basic services. Identifying those qualifying for the benefit is fraught with problems, while those who have no access to electricity are resentful of the perceived benefit from which they are debarred. It seems likely that in due course the unsustainable nature

The success of the electrification programme has meant that the provision of peak power has become critical, and additional turbine-driven generators have had to be installed at Ankerlig, Gourikwa, Port Rex and Acacia.

of the programme will be appreciated, and the more sustainable alternative of a steeply graded tariff introduced.

The success of the electrification programme has, however, to some extent taken the energy planners by surprise. Today about 6 million households use electricity for cooking. The installed generating capacity is ultimately determined by the peak requirement, and the peak occurs in the early evening as the evening meal is prepared. Utilities cope with fluctuating demand by having large base-load generators that operate continuously at near-optimum efficiency; smaller generators that can follow most of the load changes without so much of an efficiency penalty for sub-optimal performance; and still smaller generators that can be started up and shut down rapidly to cope with peak demands. The peak power is accordingly the most expensive. The success of the electrification programme has meant that the provision of peak power has become critical, and additional turbine-driven generators have had to be installed at Ankerlig, Gourikwa, Port Rex and Acacia.

The 1998 White Paper on Energy

Section 7.1 of the White Paper dealt with the electricity supply industry, the longest section in the White Paper. We will attempt to summarise the key aspects as they relate to the ongoing development of the industry.

Policy Objectives

The White Paper set out two objectives relevant to this discussion:

- To enhance the efficiency and competitiveness of the South African economy by providing low-cost and high quality energy inputs to industrial, mining and other sectors; and
- To achieve environmental sustainability in both the short and long-term usage of our natural resources.

It hoped to achieve the first of these by:

- Giving customers the right to choose their electricity supplier;
- Introducing competition into the industry, especially the generation sector;
- Permitting open, non-discriminatory access to the transmission system; and
- Encouraging private sector participation in the industry.

Interestingly, the White Paper was effectively silent on the question of environmental sustainability.

Clearly, choice of electricity supplier would depend on successful introduction of competition. As this has not yet been achieved, the choice of supplier cannot be considered fruitfully here, but needs to be borne in mind as a longer term objective.

Introducing competition – Generation

The White Paper recognised that the first step towards introducing competition had to be the separation of Eskom's generation and transmission facilities. Both independent power producers and the co-generation of power would be encouraged, and the NER would be charged with establishing tariffs that would reflect "full avoided costs of non-utility generation." Eskom Generation would be established as a company and Eskom's stations would be restructured as separate companies in their own right. However, the White Paper noted that any restructuring was "likely to be delayed for a number of years while the distribution sector restructuring [was] undertaken."

Introducing competition – Transmission

The first steps towards liberalisation of transmission had already been taken – Eskom's transmission licence from the NER had an "open access" condition. Government undertook to "legislate for transmission lines to provide for non-discriminatory open access to uncommitted capacity, transparency of tariffs, and disclosure of cost and pricing information to the National Electricity Regulator."

Introducing competition – Distribution

The White Paper summarised the key problems in the distribution of electricity as follows:

- "There are substantial differences in the financial health of municipal distributors. Four municipalities earn 50 per cent of the total surpluses being earned by all municipal distributors and an additional 18 municipalities earn another 25 per cent of the total surpluses. At the other extreme 289 municipalities earn less than 1 per cent of the total surpluses, and the bottom 25 per cent of municipal distributors loses money on their electricity sales."
- "There is a wide disparity in the prices paid by the various customer segments that cannot be fully explained by the costs associated with serving these segments. For example, mining customers pay anywhere from 9 to 17 cents per kWh in Gauteng, and anywhere from 23 to 32 cents per kWh in Mpumalanga. Price disparities for other customer segments are as wide."

The REDs would establish cost-reflective tariffs for each major customer segment, and the NER would regulate domestic electricity prices in order to rationalise the large variety of tariffs.

The White Paper proposed to resolve these by consolidating the electricity distribution industry into five financially viable independent Regional Electricity Distributors (REDs). The REDs would be owned by Government, and all distribution network assets would pass to them. The REDs would either be companies or statutory corporations.

The pricing complexity would be addressed via the National Electricity Regulator in a number of ways. Cost-reflective tariffs would apply at electricity distributor supply points[2]. The REDs would establish cost-reflective tariffs for each major customer segment, and the NER would regulate domestic electricity prices in order to rationalise the large variety of tariffs.

Matching Supply and Demand

The White Paper noted the difficulties that had been caused by an oversupply. However, it also noted that "Eskom's present generation capacity surplus will be fully utilised by about 2007. ... The next decision on supply-side investments will probably have to be taken by the end of 1999 to ensure that the electricity needs of the next decade are met." In the hopes of obviating future problems, Government would "require the use of integrated resource planning methodologies in evaluating further electricity supply investments."

Implementation of the White Paper

The NER seized upon the opportunity offered by the policy objective to provide low-cost and high quality energy inputs. About the quality it could do little except monitor what Eskom was doing, but pricing was clearly well within its remit. In the early 2000s it took up the fight against inflation, and reduced Eskom's applications for annual tariff increases to significantly below the rate of inflation. At the end of the 20th century, the cost of Eskom power was the lowest in the world; by 2005 it had become even cheaper. With hindsight, this was a disaster. Eskom was unable to finance essential base load expansions; commerce, industry and households had no economic incentive to save energy; and manufacturers lived in a fool's paradise, easily able to compete on world markets because their input costs for energy were so low by world standards.

Loss of the South African supply was an economic disaster, which was exacerbated by the South African refusal to conclude an off take agreement with the intended 3600MW Mmamabula station.

Relatively unrestrained growth in demand and very limited increases in supply had the inevitable consequences – as predicted in the White Paper. The country essentially ran out of adequate power in 2007. When 900MW of generation capacity was lost at the Koeberg nuclear power station, there were widespread blackouts, a clear indication of how tight the supply had become. Moreover, the incident put unaccustomed stress on the transmission system, which experienced a far higher than normal failure rate. Less than a year later, in January 2008, a combination of unusually heavy rains on the Highveld, low coal stocks at the stations, and a heavy maintenance schedule at the power stations caused the entire system to collapse, with enormous economic damage.

It also damaged our relationships with our partners in the SAPP. One of the worst affected was Botswana, which had only 120MW of own generation and imported 500MW from South Africa. Loss of the South African supply was an economic disaster, which was exacerbated by the South African refusal to conclude an off take agreement with the intended 3600MW Mmamabula station. Botswana had hoped that construction would be well advanced by 2008, but the National Energy Regulator of South Africa (NERSA)[3] believed the price sought for electricity was excessive. As a result, not only was South Africa not able to benefit from a possible additional source of supply, but Botswana was denied the opportunity of becoming energy independent.

In 2001, Eskom's name was changed to Eskom Holdings Limited, and it became a wholly-state-owned enterprise administered by the Department of Public Enterprises. This was the first step foreseen in the introduction of competition into the generation and transmission parts of the supply industry.

The change was not an unqualified success. For one thing, the Department was ill-equipped to deal with the challenges of running one of the largest public utilities in the world. The Electricity Council was abandoned – it had provided high-level oversight through some players who had had a lifetime of experience in the industry, and that experience was lost. Board appointments became a political handout, and a number of singularly ill-advised appointments were made, which has led to difficulties in the strategic direction of Eskom at a time when it desperately needed direction. In one tragi-comic incident, the Chairman of the

Board, who had recently been appointed after a life at senior management level in industry, accepted the resignation of the CEO, and the CEO then withdrew his resignation, apparently after political pressure on him. This led to the loss of both officers and the resignation of another board member.

The introduction of competition did not proceed as hoped. In vain the Department called for private enterprise to enter the supply. There was a simple and unrecognised stumbling block – who can possibly compete with the lowest-cost producer in the world? The answer is, of course, no-one. The price of electricity had to rise to levels commensurate with that in the rest of the world before private industry could commit funds towards new generation and expect a reasonable return on investment.

In the interim, there was no decision to proceed with supply-side investment, which the White Paper had said should be made in 1999. The new Eskom board had not worked out how to access the major funding required for such an investment, and government was set on trying to establish public-private ventures which never materialised. The then Department of Minerals and Energy issued numerous warnings that went unheeded. The result was predictable and, as we have seen, disastrous.

In November 2003, environmental issues finally entered the supply question … This set a target of 10 000 GWh (0.8 Mtoe) renewable energy contribution to final energy consumption by 2013, to be produced mainly from biomass, wind, solar and small-scale hydro.

In 2004 the first Retail Electricity Distributor[4] was set up in Cape Town. In September 2005, Cabinet announced that six Metro REDs would be established immediately after the 2006 local government elections, and that all assets and distribution personnel would be transferred from Eskom to the REDs at the end of June 2006. This process was halted. The City of Cape Town threatened to mount a challenge in the Constitutional Court over the compulsory transfer of its assets to RED1. In December 2010, Cabinet decided to close Electricity Distribution Industry Holdings, a company established to manage distribution in the areas which were not serviced by the metropolitan REDs.

In November 2003, environmental issues finally entered the supply question, with the publication of a White Paper on Renewable Energy. This set a target of 10 000 GWh (0.8 Mtoe) renewable energy contribution to final energy consumption by 2013, to be produced mainly from biomass, wind, solar and small-scale hydro.

In 2005, the decision was finally taken to commence construction of the next coal-fired base-load power station, Medupi. Construction started in 2007, and it is expected that the first unit will commence operation in late 2013, over a year behind the original schedule. Delays are attributed in part to the supply of the boilers. The company Hitachi was awarded the contract for the boilers, which controversially coincided with the ANC's Chancellor House organisation taking up 25% of the local subsidiary of Hitachi which is undertaking construction of the boilers.

The construction of a further base-load station, Kusile, started in 2008. The first unit is expected on line in 2014. There is concern about the costs of both these stations, as the investment per installed kW is approximately double the international benchmark.

In terms of the Electricity Regulation Act, No. 4 of 2006, NERSA finally approved significant increases in Eskom's tariffs in 2008. It allowed about a 25% increase in the price every year for three years, which has had the effect of raising the cost of power to internationally comparable levels. NERSA also published Renewable Energy Feed-in Tariffs (REFIT) in 2009 which were, with hindsight, quite generous. The question then arose as to who would pay for the difference between the standard tariff and the REFIT? However, no power purchase agreements were concluded in terms of the 2009 REFIT. When the REFITs were revised in 2011, with decreases of as much as 40%, there was considerable distress in some quarters. However, this did not prevent an excess of offers of renewable energy in terms of the bidding resulting from the Integrated Resource Plan of 2010 (IRP2010) as discussed below. There is a lack of clarity about the REFITs – the IRP2010 process involved competitive bidding, but details of the bidding process and whether they include REFITs are unknown.

With regards to access to the grid, Eskom and NERSA have also agreed rules under which any Independent Power Producer (IPP) can be allowed access to the grid in an area serviced by Eskom[5]. The process starts with an application to NERSA. Once this is approved, the IPP applies to Eskom, and Eskom supplies a non-binding cost estimate for the connection. If this is accepted, Eskom will then prepare a budget quote. If the IPP wishes to proceed, a connection, use-of-system agreement and an operating agreement must be signed between the IPP and Eskom before Eskom will allow the IPP to connect to the grid.

The National Energy Act, No. 34 of 2008, put into effect a number of issues from the White Paper on Energy that had thus far not been addressed. In particular, it set the process by which integrated resource planning for energy would be undertaken. We will therefore briefly look at the impact of IRP2010 on the restructuring of the supply industry before looking to the way forward in the light of what has so far occurred.

IRP2010

The process started with the publication of a draft plan in January 2010. After a round of public consultation, a revised draft plan was published for public comment in October 2010. The plan foresaw:

- The continuation of Eskom's committed build programme including the return to service of Grootvlei and Komati power stations, the construction of Medupi (4332 MW) and Kusile (4338 MW) power stations and the Ingula (1332 MW) pumped storage scheme.
- The construction of the Sere 100 MW wind farm.
- Phase 1 of the Renewable Energy power purchase programme in terms of the REFIT1 programme amounting to 1025 MW.
- Phase 1 of the Medium Term Power Purchase programme of 390 MW.
- The Open Cycle Gas Turbine (OCGT) Independent Power Producer (IPP) programme of 1020 MW.
- A nuclear fleet contributing at least 9.6 GW by 2030.
- A wind programme in addition to the REFIT1 wind capacity of a minimum 3.8 GW.
- A solar programme in addition to the REFIT1 solar capacity of a minimum 400 MW.
- A renewable programme from 2020, incorporating all renewable options of an additional 7.2 GW.
- Imported hydro options from the region totalling 3349 MW from 2020 to 2023.
- CCGT capacity, fuelled with imported LNG, totalling 1896 MW from 2019 to 2021.
- Own generation or co-generation options of 1253 MW.
- Up to 5 GW of generic coal-based power generation from 2027 to 2030.

These proposals had arisen from modelling what was needed to achieve the anticipated demand, subject to certain constraints. One of the primary constraints was the carbon emission profile derived from the Department of Environment Affairs' Long-Term Mitigation Scenarios (LTMS). This was the subject of a degree of criticism of the plan, because it was a set of scenarios which, by their very nature, took extreme positions in order to define the range of options within which future plans should be structured. There was also criticism of the continuation of a nuclear component in the Plan, and the lack of assessment of the impact of interruptible sources on the grid. In general, however, there was a high degree of acceptance of the Plan.

The Revised Balanced Scenario that emerged was the subject of final refinement before being approved by Cabinet in March 2011. Nuclear remained in the plan; the renewables programme was brought forward in order to foster local industry; and an emission constraint of 275 million tons of CO_2 per annum was confirmed. The plan called for 1 850 MW of onshore wind, 1 450 MW of solar photovoltaic capacity, 200 MW of concentrated solar power, 75 MW of small hydro capacity, 25 MW of landfill gas and 12.5 MW of biomass and biogas respectively.

The Department of Energy (DoE) solicited renewable energy bids in July 2011. There were complaints about the conditions attached to the bids, but it is difficult to tell how justified these complaints were as the conditions have not been published. Nevertheless, 53 bids were made, worth a total of R70-billion and represented 2 100 megawatts of electricity, 50% from wind, 48% from solar and 2% from hydro sources.

In November 2011, the DoE announced acceptance of 28 bids with a total 1 416 MW being selected as preferred bidders. These comprised solar photovoltaics (631.53 MW), concentrated solar power (150 MW) and wind (633.99 MW)[6]. The preferred bidders are required to meet financial closure by 30th June 2012 and to commence construction shortly after that. A second bid window will close in March 2012 and will be followed by three subsequent rounds. A separate procurement process for small renewable energy IPP projects, involving a total capacity of 100 MW, will start in early 2012.

Cogeneration, nuclear power and renewable energy will all feature strongly in South Africa's energy future. Prices will probably rise modestly from now onwards, but the generation side of the industry will look very different in 20 years time.

As this article was being completed, the Department of Energy announced that, during the 2012 session of Parliament, it intended to put forward legislation to create an Independent System and Market Operator. This would take over the transmission and distribution of electricity from Eskom, and would enter into purchase agreements with generators and supply agreements with municipalities in terms of which a rationalised tariff structure would prevail. A draft bill was published for comment in May 2011. It is understood that there was considerable opposition to the Department's proposals, so the intended structure is not clear at present.

The Way Forward

As we have seen, the restructuring of the generation aspects of the electricity supply industry is well advanced. Cogeneration, nuclear power and renewable energy will all feature strongly in South Africa's energy future. Prices will probably rise modestly from now onwards, but the generation side of the industry will look very different in 20 years time.

Most of the aspects required to free up the transmission aspects of the industry are in place. There is a debate regarding the precise position of a single network operator, and how it should evolve out of Eskom, but in principle the way forward is clear, although the financial implications are still somewhat hazy. Clarity can only come through implementation, and that will occur as more IPPs enter the supply chain.

Distribution remains chaotic. There are areas of reasonable performance: Eskom and the major metropoles are generally meeting standards, although there are some major questions about Johannesburg's City Power. There remain many areas where reform is critical to the maintenance of supply. It is disconcerting that a nation that can accomplish electrification at the rate which we have achieved still cannot resolve the distribution equation satisfactorily. However, it seems entirely possible that the funds that have been devoted to electrification over the past 15 years could soon be diverted to resolving the difficulties of the distribution side of the industry.

A question which has not been addressed is that of our relations with our neighbours. The catastrophe of early 2008 has clearly damaged our relationships with them. The SAPP is administered out of Harare, and it is not clear to what extent the national dysfunction of Zimbabwe is affecting its performance. Nevertheless, ambitions in Namibia, Botswana and Mozambique will undoubtedly enhance the supply industry of the region over the next 20 years, and we can learn from Europe's experience, that the introduction of renewable energy is fostered by extensive interconnection. As government gains confidence and competence in governing, it is to be hoped that statesmanship will be enhanced and the Power Pool will become a stronger feature in the supply.

NOTES

1 The organisation was known as Escom/Evkom until 1984 when the name was formally changed to Eskom.
2 At the time Eskom levied a transmission surcharge of up to 3%, although the actual costs of long-distance transmission were significantly higher. Also the basis for the surcharge varied from customer to customer.
3 The National Electricity Regulator became the National Energy Regulator (NERSA) in terms of the National Energy Regulator Act, 2004. Its mandate is to undertake the functions of the Gas Regulator, the Petroleum Pipelines Regulatory Authority and the National Electricity Regulator.
4 The name was changed from 'Regional' to 'Retail' when the decision was taken to organise the major metropolitan areas as distribution areas and have a national agency catering for distribution for all areas not serviced by the metropolitan areas. See http://www.dpe.gov.za/state-4_eskom (accessed Jan.2012)
5 http://www.eskom.co.za/c/article/150/independent-power-prodicers-ipp/ Accessed January 2012
6 http://www.energy.gov.za/files/media/pr/2011/MediaStatement_IPP_07Dec2011.pdf Accessed December 20111

REFRENCES

Conradie, S.R. & Messerschmidt, L.J.M. 2000 A Symphony of Power. The Eskom Story. Johannesburg, Chris Van Rensburg Publications.
Department of Energy. 2010 Integrated resource plan for electricity (Rev 2). Department, Pretoria
Department of Energy. 2011 Integrated resource plan for electricity 2010-2030 Final Report. Department, Pretoria
Department of Energy. 2011 Independent System and Market Operator Establishment Bill: Request to submit written comments. Government Gazette No.34289 13 May 2011, Government Printer, Pretoria
Department of Minerals and Energy. 1998 White Paper on the Energy Policy of the Republic of South Africa. Department, Pretoria
Department of Minerals and Energy. 2001 Electricity Distribution Industry Restructuring Blueprint Report. Department, Pretoria
Department of Minerals and Energy. 2003 White Paper on Renewable Energy. Department, Pretoria
Energy Research Centre. 2007 Long Term Mitigation Scenarios: Technical Summary, Department of Environment Affairs and Tourism, Pretoria, October 2007
Eskom Conversion Act, Act No.13 of 2001, Government Gazette No.22545, 3 August 2001.
Kaiser, H.T. & de Waal, P. 1977 The Alusaf Aluminium Smelter at Richards Bay. J SA Institute of Mining and Metallurgy, 77, pp247 – 253
Lang, J. 1995 Power Base: Coal Mining in the Life of South Africa. Jonathan Ball, Johannesburg, ISBN 1 86842 028 0
Marquard, A., Bekker, B., Eberhard, A. and Gaunt, T. 2007 South Africa's Electrification Programme: An overview and assessment. Working Paper, Graduate School of Business, University of Cape Town
McRae, I. 2006 The Test of Leadership - 50 years in the electricity supply industry of South Africa. First edition, EE Publishers, Johannesburg, ISBN 0-620-35793-2
National Energy Act, Act No.34 of 2008, Government Gazette No.31638, 24 November 2008
NERSA 2011 Consultation Paper: Review of Renewable Energy Feed-In Tariffs, Regulator, Pretoria.
Power 80 – Escom: The Story of Power. Thomson Publications, Randburg, 1980
Raynham, E.F. 2004 Apollo – Cahora Bassa: Enigma and Diversions. EE Publishers, Johannesburg, ISBN 0 620 32261 6

Transforming the Energy Supply Industry

With the spectre of a return to the devastating, rolling load-shedding seen in 2008 across South Africa, it is a fortuitous time to revisit the progress made towards the transformation and liberalisation of the electricity sector in South Africa. What progress, if any, has been made in light of the sobering electricity shortage in the country and its impact on the growth of the economy?

Shaun Nel is a founding Director in BDO Consulting Services (previously Gobodo Systems Consulting) and previously a Director at Ernst & Young. Shaun has extensive experience in Organisational Effectiveness, Energy and Climate Change strategy and Policy both in South Africa and internationally, across public and private sectors. For the last five years Shaun has been involved in addressing the Energy crisis in South Africa and working with large industrial companies and Government to address both Generation and Demand Side issues.

Eskom is responsible for the generation of approximately 95% of electricity consumed in South Africa; the remainder is made up by imports, municipal generation and Independent Power Producers (IPPs). Eskom is the exclusive transmission licensee and is responsible for all transmitted electricity. The responsibility for distribution is shared between Eskom, the municipalities and a number of other licensed distributors. Eskom is the vertically integrated (Generation, Transmission and Distribution) South African electricity public utility and electricity generation monopoly, established in 1923 as the Electricity Supply Commission (ESCOM) by the government of South Africa in terms of the Electricity Act (1922). Eskom is the largest producer of electricity in Africa. It is among the top seven utilities in the world in terms of generation capacity, and among the top nine utilities in terms of revenue.

It is clear that Eskom is the lifeblood of economic growth in South Africa and any transformation or transition from the current monopolistic market to a free market system is likely to be both complex and risky. At a fundamental level the purpose for transformation would be simply to provide a reliable and a cost effective energy supply. While the debate rages as to the appropriate structure such a transformation might lead to, experience has shown that effective structures are more a product of the socio-political and economic environment, than specific models of success. Transformation in South Africa, however, is too often seen through a normative economic lens, but the ongoing electricity supply shortage provides an opportunity to assess the transformative effects of the crisis on the Electricity Supply Industry through the supply-demand perspective.

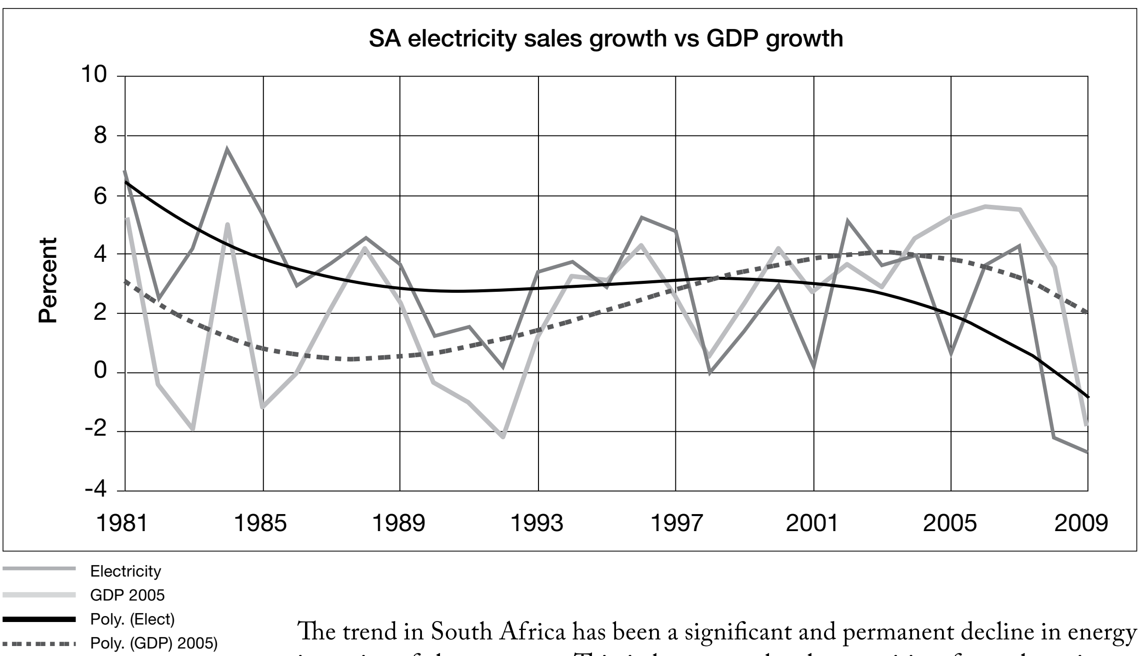
The publication of the Department of Energy's Integrated Resource Plan (IRP) in May 2011 provides the clearest insight into the shifts made in the demand side and illuminates some of the changes and opportunities in the shifting supply side environment. The importance of private sector players in the form of IPPs in meeting South Africa's future electricity demand is highlighted in both Eskom's revenue application for the second Multi-Year Price Determination (MYPD2) and in the IRP. The IRP recognises the important capacity contribution that IPPs can make both within the renewable and non-renewable generation sectors. More specifically, the Medium-Term Risk Mitigation Plan (MTRM Plan), which forms an integral part of the IRP in addressing the anticipated electricity supply shortfall in the immediate medium term (2011 to 2016), places substantial emphasis on renewable, co-generation, own generation and IPP projects to mitigate the risks of extensive load shedding as a mechanism of last resort during the ongoing energy shortage.

The Changing Profile of Electricity Demand

South Africa is a developing country with significant heavy industry and extractive industry components to the economy. This places it high in international rankings of energy intensity. Energy intensity refers to the ratio of aggregate energy use to Gross Domestic Product (GDP)[1]. In determining the future national demand, one of the crucial parameters in the IRP is determining the energy intensity ratio, which coupled with forecast economic growth, provides a forecast for the expected energy demand. This ratio provides a significant insight into the structure of the economy as well as the energy demand profiles of sectors of the economy. Changes in this ratio are influenced by changes in the structure of the economy as well as by changes in sectorial energy demands.

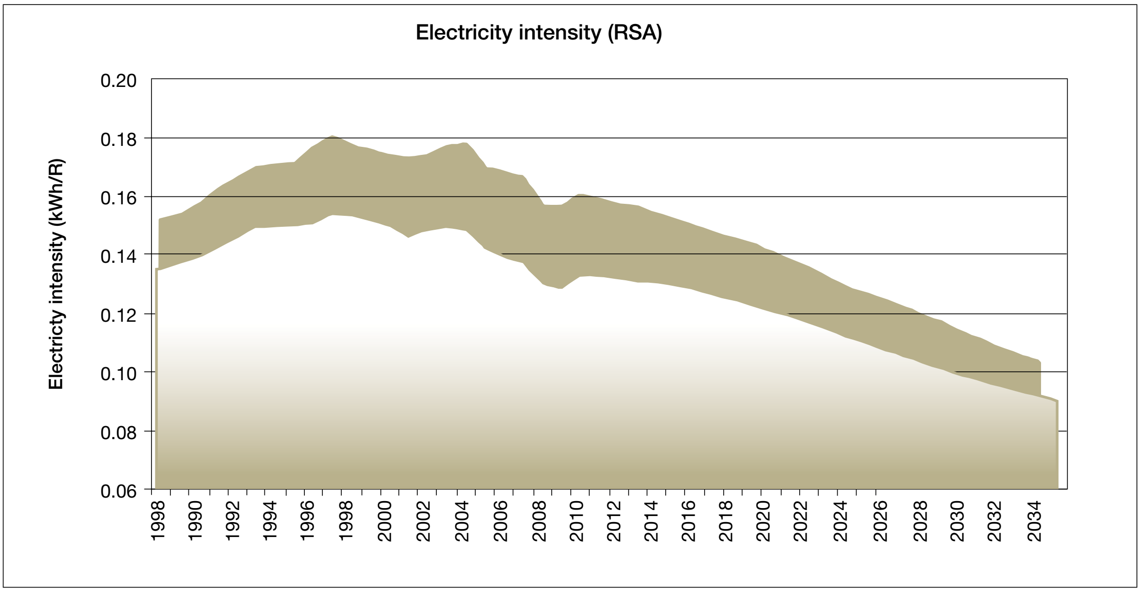
Globally, energy intensity is decreasing steadily, with the amount of energy used per unit of GDP declining by an average of 1.6% per annum from 1990 to 2008[2]. The South African energy intensity data is more remarkable. The relationship between GDP growth and energy consumption is illustrated in the figure below:

Figure 1: Relationship between Energy Sales and GDP[3]



The trend in South Africa has been a significant and permanent decline in energy intensity of the economy. This is borne out by the transition from the primary (energy intense) to the tertiary sector (less energy intense).

Figure 2: Energy Intensity of South Africa historical and forecast (Eskom)

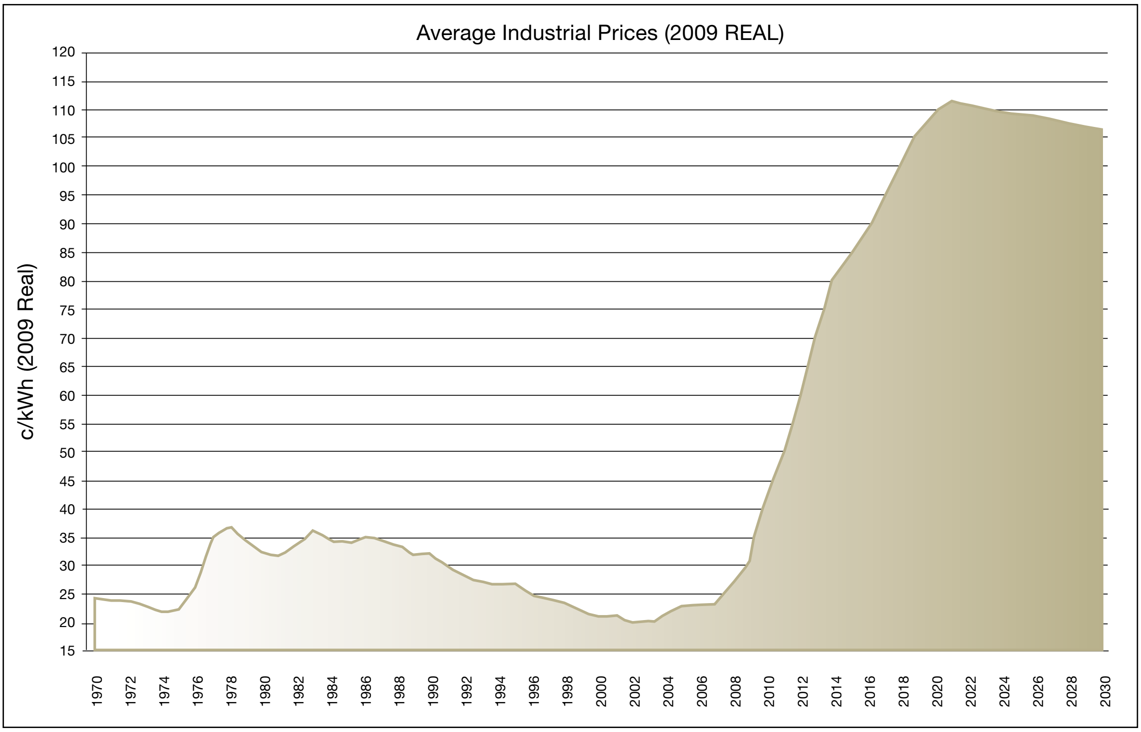


These trends illustrate the transformation of the South African economy from the energy intense primary sectors to the less intense sectors, and provide additional benefits like:

- Delaying the investment required to build new capacity for the production of usable energy, such as power stations or refineries;
- Reducing of the carbon intensity of the economy, with an associated reduction in any additional burden of carbon pricing on society, and significant benefits for the mitigation of climate change;
- Improving air quality and reduced water usage, with benefits for health, biodiversity and climate change adaptation efforts;
- Enhancing economic competitiveness for industry, as a result of enhanced production methods and reduced exposure to fuel price volatility and rising energy prices;
- Lowering carbon intensity for national exports, with benefits for access to environmentally sensitive market segments and retailers; and
- Improving power generation and transmission system efficiencies, resulting in reduced fuel input requirements and atmospheric emissions, as well as lowered water usage.

The fracture in the relationship between energy demand and GDP growth not only reflects the shift in the South African economy, it is also a consequence of the steep increases in electricity pricing seen since 2008. The figure below represents the Real (2009) Average Industrial Tariff:

Figure 3: Real (2009) Average Industrial Prices (Historical and Forecast)[4]



While the increases in prices provide a market-based signal to private generators to invest, it is potentially a double-edged sword. The rising prices create incentives for private generators to invest in generation assets, but it also creates incentives for large industrial users to invest in their own generation, and seek opportunities for transforming waste into energy through processes like co-generation.

Dangers of Demand Reduction

Economic efficiency is best served if prices reflect the cost of supply. This principle is also an objective of the South African Electricity Pricing Policy, but needs to be considered in light of other policy objectives to assist the poor through the subsidisation of electricity. Electricity prices are complex and contain many cost components, but in essence it consists of variable costs (the cost of the energy consumed), fixed costs (the cost of the network and metering infrastructure to deliver the energy) and the levies and taxes imposed.

The electrification and rural subsidy of 4.53c/kWh (in 2011) is an explicit subsidy shown transparently on the tariff schedules of the large energy users[5]. Additionally the introduction of inclining block tariffs, in the domestic sector, is causing a significant revenue loss and this is being reclaimed by additional increases to energy rates in industrial tariffs. This hidden subsidy started at 4.6% in 2010 and grew to 7.2% with the 2011 increases. A further 4% is expected in April 2012, so that the total subsidy to the poor will grow to 19% of industrial electricity tariffs. This is clearly not sustainable in an era where energy intensive industries are at risk of becoming uncompetitive, given the NERSA approved average electricity price increases and the possibility of further above inflation increases in the next Multi-Year Pricing Determination.

These pressures increase the likelihood of the large users investing in private generation. The national risk is, however, that due to the fact that about two thirds of electricity sales in South Africa are to industrial users, and only about one sixth to domestic users, the subsidies recovered from industrial users are significant and, on average, result in a price reduction of six times the level of the subsidy at the domestic end. The move towards private generation, therefore, would threaten these subsidies and make electricity unaffordable for other sectors of the economy.

Supply Side Perspective

The majority of all power generation projects throughout Africa have been financed by the public sector, supported by developmental loans. However, influenced by reforms across the globe and in response to insufficient public funds for new generation as well as decades of poor performance by state-run utilities, many African countries began to consider a new model for their electricity generation systems. Most of these countries, including South Africa, adopted plans to either unbundle their power systems and introduce private or have private power producers participate in the market, and thus create competition and foster private investment. IPPs were considered a quick and relatively easy solution to persistent supply constraints and provide investment into infrastructure without incurring additional fiscal burdens. While not universally successful, there are some useful insights that can be gained from specific research carried out on a range of IPP projects and market reforms in different markets. This research is summarised in a World Bank[6] study on variations to the standard "single buyer model" and in an energy policy paper published by Katharine Nawaal Gratwick and Professor Anton Eberhard (Graduate School of Business, University of Cape Town)[7].

Most of these countries, including South Africa, adopted plans to either unbundle their power systems and introduce private or have private power producers participate in the market, and thus create competition and foster private investment.

The South African Government has already engaged in a series of far-reaching interventions in the electricity sector since mid-1998. First, it adopted the White Paper on Energy in 1998 which provided, among other things, for the restructuring of the electricity sector and the introduction of the Independent Power Producers (IPPs) in the electricity generation sector.

The second key policy intervention was the commercialisation of Eskom in 2001; Eskom was expected to be self-sufficient. The adoption of the Electricity Pricing Policy (EPP) in 2008 was meant to ensure that Eskom recovered all its costs incurred in the generation, transmission and distribution of electricity through tariffs. This intervention has had a significant impact on tariffs and subsequently the demand profile.

In 2011 the Cabinet approved the draft legislation for the establishment of an Independent System and Market Operator (ISMO) Bill. The ISMO is expected to plan for generation expansion, procure independent power, enter into power purchasing agreements and manage the electricity transmission assets. These are the functions currently performed by Eskom. ISMO is meant to facilitate the introduction of private players in the electricity generation sector through the establishment of a non-conflicted buyer and dispatcher of power.

The decision to establish the ISMO is based on the assumption that there would be an upsurge in the investment by IPPs in the electricity generation sector post the publication of the IRP2010. However, Government made the same assumption after the adoption of Energy White Paper in 1998, which provided for the introduction of IPPs and committed almost 30% of new generation to IPPs. This assumption that IPPs would invest in the sector and the fact that the requisite investment in generation was not made neither by Eskom nor the Government, resulted initially in decreasing tariffs. However, the country now struggles with a significant energy shortfall and steeply rising costs to meet the current generation build programme.

The reality is that IPPs did not invest in the electricity generation sector because they did not find the price of electricity appealing. However, the increasing electricity tariffs now make increasingly more commercial sense – witnessed by large users looking to develop "own generation" options and external investors who are drawn to a market where they can compete with Eskom on the marginal cost of new generation.

> *The Single Buyer Model was introduced as an initial step in power sector reform, starting in the United States … a similar model was adopted in the developing world, but with the main objective of attracting new private sector investment in generation, primarily where countries faced serious energy shortages.*

In light of these changes, some of the pertinent aspects of the World Bank's empirical study of the deployment of various forms of the Single Buyer Model (of which the ISMO Bill is an example) around the world in the last 15 years provides some useful background and insights. The Single Buyer Model was introduced as an initial step in power sector reform, starting in the United States, with the objective of increasing competition at the wholesale level and promoting co-generation opportunities. Following this, a similar model was adopted in the developing world, but with the main objective of attracting new private sector investment in generation, primarily where countries faced serious energy shortages. The Single Buyer Model allowed many developing countries to achieve remarkable success in attracting private capital into distressed power sectors, and thereby help relieve power shortages and support economic growth. Despite these early successes, the model did, however, fall short of expectations in many respects. It created a series of unanticipated problems, including high tariffs and stranded investments. There were also concerns around a lack of transparency and accountability, which in some cases exacerbated the problem of corruption. Moreover, because of the inflexibility of the contractual arrangements put in place, the model served to impede rather than promote competition and the advancement of power sector reforms.

The Emergence of a New Hybrid Model

Not surprisingly, the conclusions and recommendations emanating from the World Bank Report are fairly well aligned with similar analysis conducted in South Africa, at the University of Cape Town for developing markets. Both World Bank and University of Cape Town research acknowledge the way in which developing countries follow the lead of more industrialised countries in changing their power sectors to unbundle the electricity industries and introduce competition and private sector participation. They further noted that this often resulted in the prescriptive application of a so-called "standard market model" and theoretical framework, but that after an extended period, the new industry model was not fully established in most developing countries. Rather than seeing the establishment of a classic single buyer model, it appears that in many markets a hybrid market model has emerged. Under this hybrid model large, state-owned utilities have retained significant, if not dominant, market share, but co-exist with IPPs that invest and operate on the back of long term contracts.

This hybrid model is characterised by several forms of IPPs:

- Non-utility generation for own-use on site;
- Non-utility generation for own-use across the transmission network;
- Non-utility generation for sale to the single buyer; and
- Non-utility generation bilateral trading (willing buyer-willing seller model).

The regulatory and normative response to liberalisation of the generation in South Africa focuses purely on non-utility generation for sale to the single buyer. The ISMO Bill and the draft New Generation Regulations do not address the other forms of non-Eskom generation.

This lack of regulatory clarity and the co-existence of public and the private sector players understandably gives rise to new planning, procurement and contracting challenges, which if not specifically addressed, will frustrate further investment in new power generation capacity. Indeed, there is already significant evidence that investment in much needed new capacity is lagging and that these delays are in part due to the new challenges of these hybrid markets neither being recognised nor being tackled explicitly.

The strategic and regulatory vacuum the IPPs find themselves in undermines the principle of fair and equitable treatment of all generation sources and hamper investment as private players perceive they are competing unfairly with the incumbent state-owned utility that effectively retains the upper hand. However, positive interaction between Eskom, NERSA, the Department of Energy and IPPs will hopefully address the range of unintentional but inequitable policies, rules and tariffs which discriminate against private power producers gaining access to the transmission and distribution infrastructures. The question facing South Africa's regulators and policy-makers, however, is will the regulatory processes be overtaken by the pressures on the demand side for reliable and inexpensive energy?

NOTES

1 http://www.un.org/esa/sustdev/natlinfo/indicators/isdms2001/isd-ms2001economicB.htm
2 http://www.wec-indicators.enerdata.eu/
3 Eskom System Operator IRP Demand Forecast Report IRP 2010
4 IRP 2010, Frost & Sullivan Affordable Price Path Study, Energy Intensive User Group Analysis
5 http://www.eskom.co.za/content/Tariff%20Book%202010_11~1.pdf
6 Beatriz Arizu, Defne Gencer and Luiz Maurer "Centralized Purchasing Arrangements: International Practices and Lessons earned on Variations to the Single Buyer Model", World Bank (2006).
7 Gratwick, K.N., Eberhard, A. "Demise of the standard model for power sector reform and the emergence of hybrid power markets. Energy Policy (2008), doi:10.1016/j.enpol.2008.07.021"

Fracking and the Democratic Deficit in South Africa

David Fig is a researcher on environmental policy questions with a background in international political economy. He specialises in matters of energy, governance, biodiversity, food security, and corporate behaviour. He is currently a research associate of the Environmental Evaluation Unit at the University of Cape Town.

Despite having one of the world's most liberal constitutions, South Africans still have no transparent and participatory mechanisms for deciding democratically on the uptake of new technologies or development projects, even those which impact on millions of lives and livelihoods. There are limited opportunities for intervention in very circumscribed public participation processes, which are often derisory in the sharing of any sovereignty with citizens in the name of producing better public policy. When citizens are left out of debates confined to government and the business community, the only means of influencing policy is to petition, protest, or litigate, usually after the horse has bolted.

Examples of this abound, especially in relation to controversial technologies. Government took little trouble to consult the public on questions of building the now-defunct pebble bed modular reactor; of allowing aluminium smelters to consume massive amounts of our once-cheap electricity; or of the introduction of genetic modification of our food crops. The mining industry has almost free reign in operating in fragile buffer areas of World Heritage Sites or in the face of opposition from local communities. Adjudication of these kinds of conflicts is usually via government fiat, not through any fair, transparent democratic consultation process.

In terms of environmental and health impacts, there has been a steady watering down of public participation, seen as a brake on development. The protocols associated with environmental impact assessments have been streamlined, often resulting in too little time for sufficient public consultation. Often government resorts – as did its predecessor regime – to the publication of opportunities for public comment in the *Government Gazette*, allowing only a 30-day response time. No efforts have been made nor have any resources been set aside to facilitate or promote effective public participation. The National Environmental Advisory Forum, which was a consultative body of civil society representatives established under the National Environmental Management Act No. 107 of 1998, was subsequently abolished in later amendments to the Act.

Fracking, a shorthand term for hydraulic fracturing, is the latest example of a new technology that will be introduced without any public debate. This will happen immediately that one of the oil companies receives an exploration right from the oil and gas regulator, the Petroleum Agency of South Africa, which simultaneously has the role of promoting the oil and gas industry. Applicants for this exploration right have to lodge an Environmental Management Plan, and when this is published, the public, in the form of registered interested and affected parties, are given a short time in which to comment.

The threat of litigation around the imperfections of this process, and around the absolute lack of any impartial scientific investigation into the technology and its impacts, resulted in the Minister of Mineral Resources, Susan Shabangu, declaring a moratorium on the issuing of exploration licences. Further development is frozen until the moratorium is lifted, possibly as early as February 2012. The Minister created a task team to undertake research into fracking to enable a decision on the lifting of the moratorium. Certain government officials were included, but others excluded, with no representation from agriculture, water, environment, energy, tourism and health.

Without transparency, suspicions are mounting that the task team is obliged to consult the very oil companies who seek licences to frack. Litigation is under way to put pressure on the Minister to reveal the membership, qualifications, terms of reference, minutes, research undertaken, and experts consulted by members of the task team. Water and Environmental Affairs Minister Edna Molewa has stated in Parliament that the water legislation needs to be made more robust in order to "ensure adequate control" to prevent contamination from fracking[1].

Further conflicts may have to be resolved in the courts of the land, since there is no other social space in which these can be fairly adjudicated.

Fracking – What, Who and Where?

Within the last decade, the technology has emerged for the extraction of shale gas, or methane, from deep under the earth. Although research and exploration remains to be done, estimates have been made that South Africa could be a rich source of shale gas. Its extraction requires drilling deep into the earth for between 4 and 6km, through underground freshwater supplies. When the drilling reaches the level where the gas is found, it changes direction from vertical to horizontal. Enormous quantities of water, combined with sand and a cocktail of toxic chemicals, are pumped at high pressure into the rocks. The injection of sand particles causes the rocks to fracture and release the gas. This is captured and piped back to the surface by means of the same equipment. This process is known as hydraulic fracturing, or fracking for short.

A number of companies have lined up to explore shale gas locally, and have been granted permission by the regulator, the Petroleum Agency of South Africa, to undertake preliminary technical studies in different parts of the country. Four bids cover a total area of 228 000 km^2, which amounts to almost one-fifth of the territorial surface of South Africa. Three bids are for parts of the Karoo, while the fourth covers an enormous area including most of the Free State, parts of the Northern and Eastern Cape, and a strip of KwaZulu-Natal adjacent to the Drakensberg.

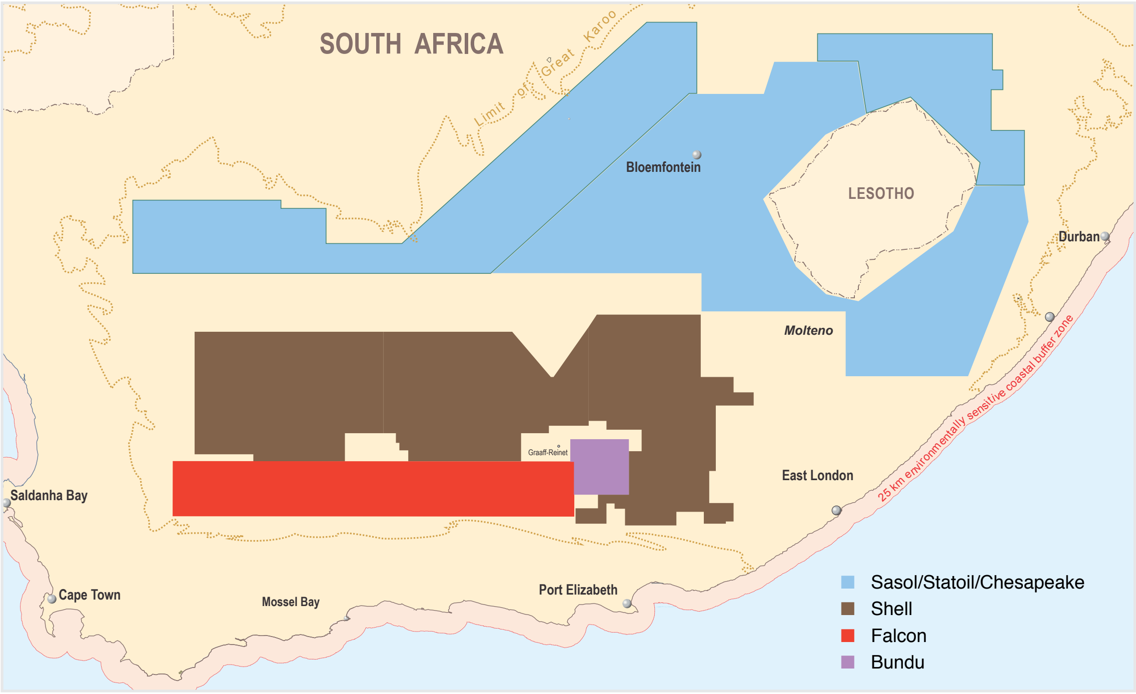
TABLE Applicants for exclusive exploration rights for shale gas in South Africa, 2011

Company	Nationality	Area of exploration	Surface area granted (km^2)
Royal Dutch Shell	UK/Netherlands	Karoo (W & E Cape)	90 000
Bundu	Australia	Karoo (E Cape)	3 100
Falcon	US	Karoo (E Cape)	30 350
Sasol – Statoil – Chesapeake*	SA – Norway – US	Free State, E Cape and KZN	105 000

Sources: Petroleum Agency of South Africa, www.pasa.co.za (downloaded 11 October 2011); Falcon, www.falconoilandgas.com (downloaded 11 January 2012, equivalent to 7.5 million acres); Challenger, www.challengerenergy.com.au/projects/south-africa-project/cranemere (downloaded 11 October 2010).

*Sasol and associates announced in late November 2011 that they would no longer pursue their right to explore, leaving their territory open to another applicant[2].

Areas for which fracking exploration licences were applied 2011



Source: Petroleum Agency of South Africa

Under the Mineral and Petroleum Resources Development Act 28 of 2002, the regulator first allocates a technical co-operation permit. This gives the applicant a year in which to conduct desk-top studies on the feasibility of extracting the shale gas, and an exclusive right to apply for an exploration right. If successful, the applicant can undertake exploration for three years, renewable for another six years. During that time, if the deposits of gas are found to be economically viable, the company can apply for an exclusive production right lasting 30 years, which is also renewable.

The oil companies have argued that the technology is safe, proven and reliable and that the shale gas is plentiful … They claim that the energy from shale oil is more climate-friendly than coal, and that therefore its production would make a contribution to reducing carbon emissions.

The regulator does not hold open hearings in granting these rights. The only way in which the public can intervene is when the company applies for an exploration right. To do so, the company must hire consultants to produce an Environmental Management Report (EMR). It needs to release the EMR to those registered as interested and affected parties, hold public meetings, and allow time for the public to make comments on the report. Since the exploration rights are often, in South African practice, converted almost automatically to production rights, this is one of the very few occasions in which the public has any voice in the process.

Fracking is a controversial new technology, for which almost no research has been undertaken in South Africa. In order for companies to find out how large the resource is, and whether it is worth exploiting, fracking has to be undertaken during the exploration phase. Therefore giving permission to explore, in effect means that

mediaclubsouthafrica

Water pumps are a common sight in the often flat and dry landscape

government would be allowing fracking to take place immediately. It is unlikely that the effects of fracking would ever be reversed once it has started taking place.

Things have moved at such a speed that many of the large questions about water contamination, waste management, climate change, employment and social impacts have not even begun to be discussed. Instead of the government creating a space for the transparent public policy discussion about whether the technology is appropriate for South Africa's development needs, it has been left to obscure administrative processes in which the public has had no say.

The oil companies have argued that the technology is safe, proven and reliable and that the shale gas is plentiful (485 trillion cubic feet, although estimates have to be confirmed). They claim that the energy from shale oil is more climate-friendly than coal, and that therefore its production would make a contribution to reducing carbon emissions. Shell, in particular, has offered assurances that the huge amount of water needed for fracking would not be drawn from the Karoo. It has also undertaken to consult communities and to reveal in confidence the list of toxic chemicals it will be using to a small committee drawn from selected interested parties. The oil companies say the finds of shale gas will be a 'game changer', allowing South Africa to become more self-sufficient in energy sources.

The government sees the mining of shale gas as a way of substituting for imported fuels, providing South Africa with increased energy security. The recent policy process, the Integrated Resource Plan 2010 (IRP2010), does not take shale gas into account, but nevertheless allows for combined-cycle natural gas turbines to play a part in the country's future energy mix, at 2.6 per cent of the total by 2030[3].

In many of the fracking areas of the United States, such as the Marcellus Shale area of Pennsylvania, water is plentiful. Not so in the shale fields of the Karoo, one of South Africa's most arid areas.

The National Planning Commission has stated in its recently published report that "shale gas has the potential to contribute a very large proportion of South Africa's energy needs … South Africa will seek to develop these resources provided the overall environmental costs and benefits will outweigh the costs and benefits associated with South Africa's dependence on coal [and] nuclear."[4]. This enthusiasm is not the product of any intense debate on fracking within the NPC, and pre-empts any scientific examination of the issue. Commissioners were certainly not made aware when they took the decision that fracking would commence as soon as the exploration right was granted.

Dangers and Challenges

In examining the costs and benefits of fracking, a number of dangers and challenges have come to light.

Water

In many of the fracking areas of the United States, such as the Marcellus Shale area of Pennsylvania, water is plentiful. Not so in the shale fields of the Karoo, one of South Africa's most arid areas. Life in the Karoo depends on access to groundwater from underground aquifers or chambers containing fresh water which is replenished by the infrequent rains. The Karoo is characterised by its extensive sheep, ostrich and, increasingly, game farming, with steel wind pumps drawing up the groundwater for animal and human consumption. Surface dams or reservoirs provide the rest of the area's water requirements, but these can be unreliable. (For example, in recent years the dams in the Beaufort West area dried up, causing a water crisis in the town. Travellers passing through it were asked to donate bottled water to help alleviate the problem.)

Most of South Africa's surface fresh water (98%) has already been allocated to existing users. This raises the question of how the fracking industry will source the millions of litres it will need to undertake its operations. It has been calculated that 20-25 million litres may be needed to frack a single well. This would require transportation of water by at least 1 667 trucks per well and possibly the building of expensive pipelines and desalination plants. Shell and other companies have failed to announce from where this large quantity of water will be drawn. Shell has, however, undertaken not to draw it from the Karoo, but some hydrologists have recommended that it be sourced from the already overstretched Gariep (formerly Orange) catchment.

Around 30 per cent of the water used in the process will be unrecoverable and will remain underground. This subtracts it from the water that might be recycled.

The use of toxic chemicals in the drilling process has also raised questions about whether any damage to the drill casing will release toxic fracking liquid into underground freshwater sources and contaminate them.

The use of toxic chemicals in the drilling process has also raised questions about whether any damage to the drill casing will release toxic fracking liquid into underground freshwater sources and contaminate them. These kinds of accidents are not common in the United States, but nevertheless there have been records of at least eight instances of large-scale pollution resulting from drilling and fracking. Such instances are increasingly coming to light in new studies being undertaken by the US Environmental Protection Agency (EPA). For example, a three-year research paper found that test wells proved that fracking had caused contamination of groundwater and high methane levels at Pavilion, Wyoming[5].

There is no specific law regulating the use or protection of underground water, and certainly no law specifically pertaining to the use of fracking as a technology.

Waste Management

As we have seen, fracking entails the pumping of toxic chemicals at high pressure, along with water and sand, into underground shale rock formations. Although forming only 1 per cent of the mix, the toxic chemicals used vary between wells depending on their geology. Most of the fracking liquid returns to the surface after use, and has to be disposed of without causing harm to the environment. On site there need to be lined ponds or tanks to receive the toxic sludge initially. Questions arise about how this is handled and what arrangements are made for the final disposal of the waste. In the US, home to about a million wells, 25 per cent of wells transgress the rules of safe management, and the regulatory agencies find this very difficult to enforce[6].

The management of hazardous waste in South Africa falls under provincial jurisdiction. The Eastern Cape is likely to be the site of most of the fracking, and remains South Africa's 'poorest, least resourced and most administratively weak province'[7]. Capacity to deal with the extensive management of hazardous waste arising from the fracking industry does not yet exist, and will have to be funded and planned into the system. Most municipalities in the province are not even coping with the management of ordinary household and industrial waste, both in terms of budgets and the necessary human capital.

Aside from liquid and solid wastes, there will be enormous dust pollution arising from the large-scale transportation of water, sand and chemicals on mostly gravel surfaced roads.

Climate

Shale gas is a fossil fuel and its combustion contributes to global warming. Although carbon dioxide emissions are less than coal or conventional gas, we need to remember that methane is a greenhouse gas far more deadly for our climate than carbon dioxide. Recent research from Cornell University shows that shale gas has a larger greenhouse gas footprint than coal, 20 per cent more, rising to 40 per cent more over 20 years[8]. Other studies in the US have shown that up to 8 per cent of the mined methane is directly released into the atmosphere during the fracking process.

During the exploration phase, which would last up to nine years, very few jobs (about 100) will be created on site. Running the wells and doing the drilling requires a small number of very skilled operatives.

The oil industry nevertheless claims that fracking is less harmful to the environment than coal mining. It advocates that while shale gas is indeed a fossil fuel, it is a sensible 'transition' fuel to use while South Africa tries to move toward more climate friendly energy options. What it does not calculate is that the requirement for the government to invest in infrastructure for the industry (improved roads, waste disposal, and regulatory functions) will take investment away from support for the emerging renewable energy industry.

South Africa recently hosted the 17th annual UN climate conference in Durban, making commitments to a plan to lower greenhouse emissions and to develop a greener economy. Support for a shale gas industry would compromise such commitments.

Livelihoods

If the industry is introduced, will this not lead to an expansion of employment and of the local economy?

During the exploration phase, which would last up to nine years, very few jobs (about 100) will be created on site. Running the wells and doing the drilling requires a small number of very skilled operatives. The oil companies admit that they do not do the fracking themselves, but outsource these functions to experienced subcontractors. This implies that the tenders will be awarded to foreign companies, which will use their own labour, and not be in a position to draw from unskilled Karoo residents. Figures from the US indicate that over 400 wells can be managed by 66 employees.

Jobs will expand in the areas of truck driving, security, road construction, service provision and so on. However it should be remembered that each well can only be fracked around 18 times, and that the drilling will move from place to place as wells are closed. This means that there is a cycle of local 'boom and bust' as the fracking moves to new areas.

With the increased risks of water contamination and severe air pollution, the fate of local agriculture is at stake. In the Eastern Cape, agriculture provides over 70 000 jobs in the commercial sector, and livelihoods for many thousands of emerging farmers. Julienne du Toit, a Karoo-based journalist, feels that farming and fracking will not be compatible. In her view, farmers will not be able to continue under conditions of air and water contamination. The Karoo would lose its reputation for clean air, soil and farm produce. Those trying to sell up would experience difficulty in finding willing buyers, and property prices would plummet. Many farm workers would be displaced, adding to the epidemic of unemployment[9].

With the anticipated air and water pollution, niche industries like astronomy, palaeontology and ecotourism will also be adversely affected in the Karoo. South Africa's bid to host the Square Kilometre Array of new-generation telescopes might be compromised.

Opposition Builds

Propelled by the applications for exploration rights, a new opposition movement quickly arose during 2011. It includes a number of campaigns, principal of which is the Treasure the Karoo Action Group (TKAG), which has placed resources in public outreach, research, and legal interventions. It has gained an extensive following through the use of traditional and social media, and its membership consists of residents of both the Karoo and the large cities. It has made links with other sympathetic campaigns and NGOs, but remains the main civil society organisation speaking out against fracking. Public meetings have attracted a great deal of interest, and have seen interventions opposing fracking from personalities such as entrepreneur Johann Rupert and swimmer Lewis Pugh. Marches in Cape Town have been well attended, and the movement has generated a plethora of posters, t-shirts, leaflets and considerable media attention[10].

TKAG lawyer Dr Luke Havemann stated that 'unfortunately any report that the task team may eventually produce will be tainted by their failure to play open cards'.

TKAG has a back-up team of legal and communications professionals. The legal team was able to put together a comprehensive response document to the Environmental Management Report issued by Shell. The team also challenged claims in advertisements placed in the country's major newspapers by Shell in April 2011 by appealing to the Advertising Standards Authority (ASA). The Authority ruled in July that the claims were 'unsubstantiated and misleading' and ordered Shell to withdraw the advertisements[11].

The legal team also initiated litigation under the Promotion of Access to Information Act to challenge Minister Shabangu, who had failed to reveal information about the government task team which she had established to research fracking. TKAG lawyer Dr Luke Havemann stated that 'unfortunately any report that the task team may eventually produce will be tainted by their failure to play open cards'[12]. The North Gauteng High Court ordered the Minister to respond to TKAG's request for information by 31 January[13].

Opposition has also developed within commercial agriculture. Dougie Stern has his farm in the Murraysburg district, in the area that Shell plans to frack. Along with fellow-farmer Lukie Strydom, Dougie was sponsored by BKB (a former farmers' co-operative which markets wool and livestock) to investigate fracking in the United States. The two of them returned as convinced opponents, and have been mobilising other members of the farming community. Stern is an office bearer of Agri-Eastern Cape and has been organising anti-fracking resolutions to be passed at local and Agri-SA conferences. He rejects the claim that shale gas could be a bridging fuel and feels that government should speed up its support for renewables rather than letting oil and gas companies further exploit fossil fuels[14].

The Southern Cape Land Committee has been working to sensitise farm workers to the likely impacts of fracking. Organisers Amos Dyasi and Nettly Maarman report that farm workers have opposed fracking because most of the jobs will not go to local people, and because fracking could destroy existing jobs on farms[15]. Other NGOs have taken an interest in providing greater support for public participation. For example, the Wildlife and Environment Society of South Africa, in conjunction with the Centre for Environmental Rights, has conducted public workshops on fracking in 17 Karoo communities.[16]

Poverty and Social Inequity

The Karoo, and the Eastern Cape in general, demonstrates all the contradictions of South Africa with its legacies of segregation, social inequality, and racial privilege/dispossession. On the one hand, fracking may give rise to alliance formation across the social divides, where common resistence to the violation of the Karoo's sense of place and traditional livelihoods might occur. This would require that those in the Karoo who oppose fracking learn to form political partnerships that defy traditional loyalties. Is it possible for campaigners to learn new ways, to learn how to coalesce in a united campaign despite past divisions?

This situation could potentially divide the communities further, with oil companies taking advantage of the situation to claim that opposition to fracking means depriving people of livelihoods, opportunities and resources.

On the other hand, fracking may serve to deepen social and racial divisions. It might be argued that most of the opposition to fracking is being articulated by the privileged 'white' community, which has traditionally not shown a great interest in the advancement of others. The demand that this opposition places on solidarity from the black community may not be one which has been earned through past trust. This situation could potentially divide the communities further, with oil companies taking advantage of the situation to claim that opposition to fracking means depriving people of livelihoods, opportunities and resources.

Already there are attempts to form a pro-fracking forum across the Karoo, bankrolled in part by beneficiaries of black economic empowerment legislation such as former dominee, UDF activist and Western Cape politician Chris Nissen, who has connections with Graaff-Reinet. Forum co-ordinator Vuyisa Jantjies has been active in lobbying PASA to grant 5% of the revenues from fracking to communities, and a further 5% to Petrosa, the state-owned petroleum corporation[17].

Final Questions

How do we as South Africans decide on the most appropriate energy future for our needs? We have not created democratic spaces for decision making on the adoption of new, controversial technologies. We do not have robust regulatory or administrative institutions which could guarantee both the public interest and our rights to clean energy, a safe and healthy environment, and decent livelihoods.

The fracking controversy has shown up this deficit in our democracy. Will we be able to resolve these issues through administrative procedures and litigation? Instead we need a more institutionalised space to house a broad, lively, transparent national debate that should occur independently of vested corporate interests.

Meanwhile, the question of trust looms large. Will citizens rely on government to defend the public interest? This seems unlikely, when government is making decisions to favour the technology in the absence of real scientific enquiry. Can we trust the multinational oil companies? Shell's record in Nigeria has illustrated its complicity in the violation of human rights and it has already been caught transgressing our advertising standards. If we are serious about the creation of 'green' jobs in a low-carbon economy, why is there such a strong continued state interest in inviting large new investment in fossil fuels?

Will the Minister lift the moratorium in February 2012, thus enabling fracking to go ahead? Or will she take a leaf out of the books of France, Quebec, British Columbia, New York State, New Jersey and New South Wales, which have refused to allow fracking for the present? While the scientific jury remains out, will we take serious risks with the Karoo?

NOTES

1 Donwald Pressley, 'Fracking may test water law', Business Report, 21 December 2011
2 Siseko Njobeni, 'Sasol decides against Karoo exploration', Business Day, 1 December 2011
3 South Africa, Department of Energy, Integrated resource plan for electricity 2010-2030: final report. Pretoria: Department of Energy, 25 March 2011, table 4, p. 14
4 South Africa, National Planning Commission, National Development Plan: Vision for 2030, Pretoria: The Presidency, 11 November 2011, p. 143
5 Kirk Johnson, 'EPA links tainted water in Wyoming to hydraulic fracturing for natural gas', New York Times, 8 December 2011
6 Prof Daniel Vermeulen, Presentation to the Geological Society, Origins Centre, Johannesburg, 23 November 2011
7 Greg Ruiters ed. 2011, The fate of the Eastern Cape, Scottsville: UKZN Press, p.8
8 Howarth R W et al. 2011 'Methane and greenhouse gas footprint of natural gas from shale formations', Climatic Change 106: 679-690
9 Interview, Cradock, 17 October 2011
10 Interview with TKAG co-ordinator Jonathan Deal and researcher Jeannie le Roux, Cape Town, 7 November 2011
11 The Media Online, 'Shell fracking ad unsubstantiated and misleading', 7 July 2011, www.themediaonline.co.za, downloaded 2 December 2011
12 Cape Times, 5 August 2011
13 Leila Samodien, 'Minister ordered to provide fracking affidavits', The Star, 10 January 2012
14 Interview, Rietpoort farm, Murraysburg, 18 October 2011
15 Interview, 20 October 2011
16 See report at http://wessa.org.za/news/10/74/Environmental-Rights-Workshops-Held-Across-The-Karoo-To-Promote-Participation-In-The-Karoo-Basin-Shale-Gas-Exploration-Applications.htm, downloaded 7 February 2012.
17 Interview, Graaff-Reinet, 19 October 2011

Challenges for South Africa's Electricity Supply Industry

Hilary Joffe was educated at the University of the Witwatersrand and Oxford University. She is spokesperson for Eskom Holdings Limited, where she has been since 2010, after a long career in journalism. She was previously senior associate editor at Business Day.

The power crisis of early 2008 was an experience most South Africans are not likely to forget soon. The experience, and its lessons, must loom large in any discussion of the electricity supply industry and its challenges.

The months of rolling blackouts were a powerful reminder of the importance of keeping the lights on. Though much has changed since 2008, South Africa's power system remains constrained and will be for some years, until Eskom's large new power stations, Medupi and Kusile, deliver the capacity needed to relieve the shortage of supply. Keeping the lights on is therefore, arguably, the most immediate and pressing challenge for South Africa's electricity supply industry now and for the next few years. It is also key to the longer term prospects for the economy. A secure supply of electricity, at a cost which South Africa can afford, is essential if the economy is to sustain faster rates of investment and economic growth as well as to provide access to electricity for all[1].

At the same time, an industry which has been dominated by coal-fired power and by a single player – Eskom – must make the transition to more diverse sources of supply, and more diverse players. Diversifying the energy mix is important if the industry is to address the challenges of climate change. Bringing in new players will bring in new funding, technology and skills. But those transitions will take time and will have to be carefully managed.

Perhaps the biggest challenge then for the industry, and for the policymakers shaping it, will be that of finding the right balance between these imperatives – a secure supply of electricity now and in the future, a 'cleaner' and more sustainable supply, and all at a cost which is affordable for the country and pitched at a level which can attract the necessary investment in infrastructure.

And if keeping the lights on must be a priority, so too must switching lights off. Energy efficiency is one of the key issues that will shape the environment for the electricity supply industry and the capacity it will be required to deliver in decades to come.

Keeping the Lights On

The power crisis in 2008 was long in the making, and was the result of policy and regulatory uncertainty over the previous decade as much as of shortcomings in the management of the system[2].

Government policy in the late 1990s and into the early 2000s was that the electricity supply industry should be opened up to competition and that Eskom, therefore, should build no new power stations. However, the policy and regulatory frameworks were not put in place for private sector participation. Nor, crucially, were electricity tariffs at levels which could have given private investors the returns they needed to make investment in the sector attractive. It was recognised that

South Africa was going to need massive new investment in generating capacity to meet growth in demand. However, by the time the government retreated from privatisation and, in late 2004, gave Eskom the mandate to build, it was too late to bring big new baseload power stations on to the grid fast enough to prevent a shortfall in generating capacity.

The result was that by 2007, after a period of strong economic growth, the margin between supply and demand had fallen to levels which made the power system extremely vulnerable. The shortage of capacity, volatile operating performance, low coal stockpiles and unusually wet weather made it increasingly difficult to meet demand. Eskom resorted to national rotational 'load shedding" from late in 2007 to protect the power system from a total blackout, and a national emergency was declared on 25 January 2008. Load shedding continued until the end of March 2008, while Eskom initiated a recovery plan, with the support of government and business.

Eskom has become adroit at managing a 'tight' power system, and is recognised by its international peers for this – especially given that other developing countries with inadequate supply, such as China and India, have had blackouts.

Economic recession helped initially to provide the space for recovery, and Eskom has since 2008 made significant progress towards stabilising the power system. It has rebuilt coal stockpiles, added some new capacity to the grid and put a Demand Side Management programme which has achieved savings in electricity usage. It has also brought some capacity from Independent Power Producers (IPPs) in to the grid[3].

Keeping the lights on has been a priority for Eskom since 2008, one which is included in its shareholder compact with government, since 2008. But until large new increments of supply are added to the grid once Eskom's large new coal-fired power stations, Medupi and Kusile, start to come online, keeping the lights on cannot be taken for granted. Eskom has become adroit at managing a 'tight' power system, and is recognised by its international peers for this – especially given that other developing countries with inadequate supply, such as China and India, have had blackouts[4]. A pre-requisite has been very close co-ordination and alignment between the System Operator and Eskom's Generation division. Also, increasingly, Eskom has relied on the strong relationships which it has built up, particularly since 2008, with its large mining and industrial customers.

The issue which has come to the fore, increasingly, is maintenance. Eskom's power stations require an ever-increasing amount of routine maintenance, because most of them are in their mid-life, and because they have been run hard over the past few years to compensate for the shortage of capacity. However, doing that planned maintenance requires that units be taken out of service for shorter or longer periods of time, and in a situation of constrained supply, there often has not been the space to take units off, while also meeting demand, and keeping some capacity in reserve to cater for any unplanned events. In effect, in recent years, Eskom has kept the lights on in part by deferring non-essential or non-priority maintenance, with the System Operator and the Generation division working closely together to juggle requirements.

This is clearly not a sustainable strategy, and Eskom has made it a priority since 2011 to comply with its own maintenance schedule and address the backlog which has built up. That requires running at higher levels of risk, with less in reserve to protect the system. And it means making more use of costly diesel-fired generating capacity[5], as well as of options such as paying large customers to switch off.

It envisages that dependence on coal would fall from 90% to 65% by 2030, while renewables increase their share of the mix from 0% to 9% and nuclear's share from 5% to 23%, and it sees the private sector coming in to build 30% of the new capacity.

Lower demand would do much to reduce risk to the system, which is why Eskom has intensified its energy efficiency campaigns and, together with government, is calling for a 10% saving in electricity usage. One of the lessons of 2008 is that keeping the lights on is not a challenge that can be addressed by Eskom alone. Many of the measures required to curb demand and boost supply depend on support from government, whether in the form of policy or regulatory interventions, or in approvals from the government, in its role as Eskom's shareholder. At the same time, reducing demand and making it more predictable requires support from customers. Political support and alignment are therefore essential to keeping the lights on, as are relationships with customers and other stakeholders.

Beyond Kusile

If keeping the lights on in the short to medium term is one challenge, doing so in the longer term is another. South Africa left it too late once before to start building the new power infrastructure it was going to need. There is, hopefully, more determination this time, on the part of government and the industry, not to let that happen again.

The government's Integrated Resource Plan 2010 to 2030 (IRP), which was promulgated in May 2011[6], puts a framework in place for the first time that sets out the scale and mix of the new electricity capacity required over the next two decades. The plan would more than double the capacity of the system, and change the energy mix, and the mix of players, dramatically. It envisages that dependence on coal would fall from 90% to 65% by 2030, while renewables increase their share of the mix from 0% to 9% and nuclear's share from 5% to 23%, and it sees the private sector coming in to build 30% of the new capacity.

The IRP attempts to balance South Africa's various imperatives, for security of supply, affordability, economic growth and cutting its carbon footprint. It provides some certainty on what choices are being made and what the path will be for the industry in future, in terms of who will build and what will be built. It also gives an indication of where the electricity price should be to cover the cost of the investment in new capacity – which could be more than double the level at which electricity is priced currently.[7]

The issue now is implementation. Beyond Kusile - which should be completed in 2018 - there are no new committed build projects. That poses the risk that if decisions on new capacity in terms of the IRP are not taken soon, South Africa could again leave it too late to build. The IRP plans, for example, for substantial nuclear capacity to start coming on to the grid by 2023, and given the long lead times for nuclear build programmes, decisions will be required during 2012/2013.

Decisions on implementation are needed to clarify the eventual shape of South Africa's electricity supply industry, and so attract new investors. Achieving the objectives of the IRP, then, depends on early and clear decisions being taken on implementation of the plan and on ensuring that related areas of policy – such as tariff regulation – are aligned with the plan. It will depend too on a viable funding model. Putting a funding plan in place to ensure that Eskom's current new build programme could be completed has required extensive support from government, in the form of equity and guarantees, as well as tariff increases. Costing the IRP, and putting models in place to finance the public sector part of it in particular, will be key to its implementation.

Opening up the Industry to New Players

Implementing the IRP should, finally, start to bring in the new industry players on a significant scale, in line with what, at least in theory, has been government policy for some time. Even though Eskom was given the mandate to build new power stations in 2004, the government did not entirely retreat from its late 1990s intent to bring the private sector into electricity generation. The intention was that IPPs should build 30% of South Africa's new generation capacity. However, this received little attention until the 2008 power crisis.

… Eskom has, increasingly, sought to sign up whatever non-Eskom generating capacity is available, from independent producers such as Sasol, as well as from those municipalities which had retained some generating capacity of their own.

There is a perception that Eskom (and its shareholder) are averse to competition, and there may well have been an element of truth to that in the past. At the time when there was a surplus of power, there was certainly little incentive for Eskom to court competitors to its own under-utilised fleet. But even once it was clear that South Africa was going to need significant new investment in generation, price was a sticking point.

But if Eskom ever was averse to competition, the tightness of the power system has changed that, and Eskom has, increasingly, sought to sign up whatever non-Eskom generating capacity is available, from independent producers such as Sasol, as well as from those municipalities which had retained some generating capacity of their own.

However, Eskom is empowered only to sign short or medium contracts with private or municipal producers. Anything beyond that must be within the framework of the IRP and is subject to decisions by government. A first step to stimulating investment in new, non-Eskom generation has been taken with the Department of Energy's procurement of a first tranche of renewable energy from new independent producers. Eskom's role will be to connect the producers to the national grid and to buy the power from them, at rates which have been agreed by the Department but which the regulator will allow Eskom to pass through in the electricity tariff[8]

The big increments of new independent power still lie in the future. However, there has been a concern in policy circles that IPPs could prove reluctant to invest in South Africa because of Eskom's dominant position in generation combined with its control of the System Operator and the transmission network. As the System Operator, so the argument goes, Eskom would seek to dispatch its own power stations before those of independent producers.

At present, it is hard to see that happening, given how constrained is the supply of electricity and how keen the System Operator would be to draw on any extra megawatts private producers could offer. However, IPPs will have to commit to long term investment decisions, so the question of how the industry will be structured in the long term, in a future in which electricity could be in ample supply, is pertinent. The Department of Energy has acted on its concerns about Eskom and IPPs with the introduction of an Independent System and Market Operator (ISMO) Bill, which will ultimately unbundle the System Operator and the buying office from Eskom and house them in a new state-owned entity, which will also take over Eskom's large mining and industrial customers.

For the country, the issue is how to open up the industry to new players, who can bring new funding, technology and skills, and set new benchmarks for industry performance – but in a way that supports security of electricity supply.

Any change would have to be carefully timed and managed to mitigate the risks. There are legal and financial issues too which will have to be clarified. Eskom, meanwhile, has set up a single buying office, which will buy from IPPs, as a first step towards the ISMO and is engaging with the government on the details and the sequencing of the proposed industry reform.

For investors and potential investors in the electricity supply industry, Eskom included, clarity and certainty about policy and regulation will be key to long term investment decisions. For the country, the issue is how to open up the industry to new players, who can bring new funding, technology and skills, and set new benchmarks for industry performance - but in a way that supports security of electricity supply.

Cleaner, Greener Power

The IRP, as we've seen, also provides the framework for the industry to diversify its energy mix in order to meet South Africa's objective to reduce its carbon footprint. The IRP sets ambitious targets for non-emitting new renewables and nuclear capacity, which together make up almost two thirds of the new capacity which the IRP sees being built by 2030.

In addition to the programme which the Department of Energy has launched to bring in substantial new investment from private renewable energy producers, Eskom has embarked on its own renewable energy projects, in wind and solar power, and aspires to do more. Eskom, which is Africa's only nuclear operator[9], has also made it clear it would like to be part of the major nuclear new build programme which the IRP envisages. There is also substantial potential for more 'green' power in the Southern African region, given the resources of natural gas and hydro power in countries such as Zambia, Mozambique, DRC and Namibia. South Africa and its neighbours would benefit from the expansion of the regional grid, in terms of both security of supply and of lower carbon emissions.

However, while bringing in non-emitting renewable or nuclear power plants must clearly be a significant part of a strategy to reduce the electricity industry's carbon footprint over time, it cannot be the only part of such a strategy.

Coal is likely to remain the dominant source of electricity for South Africa for the foreseeable future. Crucially, it is cheaper than any of the alternatives currently, and South Africa does not have the resources of natural gas or water which are used to provide baseload power in other countries. However, much can be done to reduce the carbon footprint of the coal fleet, new and existing. Significantly, the new power stations which Eskom is building will be much more efficient than the old ones, using technology which will significantly reduce their carbon emissions per unit of energy produced.[10] They will also be more efficient in terms of water usage - and especially for a water-scarce country like South Africa, addressing climate change is importantly also about adaptation to the impact of climate change in areas such as water.

Again, however, climate change is just one of the issues for the electricity supply industry to address and it is a question of balancing this with considerations of affordability and security of supply.

Switching Some of the Lights Off

One of the quickest and most effective ways for the industry to reduce carbon emissions would simply be to reduce demand for electricity. Energy efficiency must therefore be an important component of any strategy to address climate change. More immediately, however, it is, as we've seen, crucial to enable a reliable supply of electricity in the next few years while supply is constrained.

South Africa is an unusually energy intensive country and there clearly is scope to reduce electricity usage without compromising economic growth prospects. Indeed, sustained energy efficiency could contribute to better growth prospects, especially if it means that South Africa could afford to build less new capacity, or at least build it more slowly, in years to come. In that sense, the outlook for the electricity supply industry is as much about what South Africa will demand as about the industry's ability to supply.

NOTES

1 The United Nations Secretary General has announced a goal of providing energy access for all by 2030 and South Africa has supported that. Access to electricity in South Africa has increased from nder 25% in the early 1990s, when the electrification programme began, to over 75%, but that still leaves more than 3 million households which do not yet have access.

2 For an analysis of the 2008 crisis from inside Eskom, see Chettiar, M, K. Lakmeeharan and R.G. Koch "A Review of the January 2008 Electricity Crisis in South Africa: A Problem a Decade in the Making." Paper P001 presented at Cigre 2009, Sixth Southern Africa Regional Conference Paris: Cigre http://www.cigre.org. Also see Joffe, H.

3 Coal stocks have been rebuilt from 12 days on average in 2008 to over 40 days; approximately 2500 MW of new capacity has been commissioned since 2008; and almost 1000 of capacity from independent power producers (municipal and private) was signed up on short to medium term contracts during 2011/2012. The Demand Side Management programme achieved savings of 2 700 MW.

4 See Loni Prinsloo "SA grid not bad, for a third world state" Sunday Times Business Times 22 January 2012

5 The cost of power generated by these plants depends on the price of diesel but in early 2012 is more than 10 times the cost of coal-fired power generation

6 Republic of South Africa INTEGRATED RESOURCE PLAN FOR ELECTRICITY 2010-2030 Government Gazette No.34263, 6 May 2011

7 The Integrated Resource Plan estimates the cost per unit of electricity under the scenario it has chosen, in 2010 terms, at up to 112 cents per kilowatt hour. The National Energy Regulator (Nersa) approved average tariff for electricity in the 2011/2012 financial year is 53 cents, rising to 62 cents in 2012/13.

8 Though the renewable energy is much more expensive than coal-fired or nuclear power, it will remain only a small part of the mix for some time to come and therefore has little impact on the blended price which Eskom charges for electricity.

9 Eskom's 25 year old Koeberg power station accounts for about 6% of its total capacity,

10 Relative emissions (CO_2 per MWh (megawatt hour) sent out) are highest in Eskom's older, return to service power stations (Camden, Grootvlei and Komati) at over 1.2 tons CO_2 per MWh sent out. The average for the existing Eskom fleet in the last financial year was 1.04 tons CO_2 per MWh sent out. By contrast, Medupi and Kusile will emit only 0.75 to 0.78 ton per MWh sent out.

Doug Kuni the MD of the South African Independent Power Producers Association (SAIPPA) and an Independent Power consultant to major corporations. He is an Honours Engineering Graduate of London University (UK) and undertook postgraduate studies in Germany (Aachen). He has a 27 year career in the electrical power sector. He headed up the Generation Engineering Division of Eskom for 5 years, completing the Majuba Power Station and also worked for Eskom Enterprises, as Business Development Manager. After leaving Eskom, he joined a Hong Kong based company, as Chief Corporate Officer, acquiring supply chain assets in China. After his return to South Africa he headed up IPSA Group operations as General Manager South Africa and completed the Newcastle Cogeneration project.

Roadmap to a thriving Electricity Supply Industry in SA

I am stymied as to what more can be done to tell the Government what a "power pickle" we are in. Simply put: without a stable and thriving electrical power sector in South Africa there will be very little of the precious economic growth we need to prosper.

The electricity sector in South Africa has its beginnings in the old Victoria Falls Power Company Ltd which supplied the Witwatersrand and reef gold mines. It originally consisted of 4 power stations with an interconnected grid – a system design later adopted by America and United Kingdom. The original Electricity Supply Commission (Escom) creation was the genius of H J Van der Bijl whom Jan Smuts summoned back to South Africa in 1920, to put the country on a path to industrialisation. Having seen what was happening in the United States where he worked for the American Telephone and Telegraph Company (AT&T), Van der Bijl realised that abundant, inexpensive electricity would be key to that objective and set about putting Escom in place.

The other pillar required for industrialisation was steel, which would be the feedstock for the downstream manufacturing sector. The formation of Escom, Iscor and the IDC-all of which had Van der Bijl as their first chairman-set South Africa on a path of industrialisation to the point where we are today, or rather in 2007 – when the first power brownouts since the 1970s occurred. It is predicted that we will be in a power shortage situation for the next six to ten years.

Alice Jacob's book: *South African Heritage – a Biography of HJ Van der Bijl* (Caxton 1948) is highly recommended reading. It would be instructive to be acquainted with the quality of person who put it all together. I talk here of the technical genius and depth of understanding this individual had, to be allocated such a complex task and then going about accomplishing it. I speak not of the politics of the era or of its subsequent evolution in South Africa which the present government inherited, but what was started by Van der Bijl and, despite vastly different politics, we now have to build upon it for our survival.

South Africa has reached a cross-roads in the saga of electricity and only time will tell - if this country can today find another Van der Bijl to restructure our power sector for the new Millennium.

Supply - Power Generation (Gx)

We now know how the Government reacted in 1997 to a warning from Eskom that we would be short of power in 2007 if it did not start immediately planning for new capacity. In power generation, for large fossil stations, 10 years is considered 'short term' for planning purposes. Eskom's inability to convince its political principals to approve new expansion led to contracts only being awarded in 2006.

In January 2007 the lights went out and 12 months later the mining industry was shut down for two weeks. The damage to this country's economy cannot be measured – the direct consequences of 2008 were conservatively estimated that South Africa lost about R150bn in Gross Domestic Product (GDP) output in one year, the equivalent of a Medupi power station– but the opportunity costs are impossible to measure. Former President Mbeki apologised to the nation for this.

With that famous apology has come a program of new build, ridden with delays and cost overruns, the likes of which this country has never seen. For how long will the Treasury be able to come to Eskom's rescue?

When will South Africa have adequate Gx capacity again? Left only to public efforts, we could face power shortages for the next six to ten years, depending on how the global economy recovers. That also assumes that the existing capacity will perform at its current level – any deterioration means more shortages. So why would an Anglo, Xstrata or Exxaro start looking at their own power plants for their operations, if we (yes, a partner of 49 million) can save sufficient electricity so that 'we all have enough for our needs'?

> *Without the stabilisation of the base-load and mid-merit capacity in this country, we will remain in a power crisis.*

We are already late on planning further base-load capacity. If you look at the Integrated Resource Plan 2010 (IRP 2010) we see no indication of the next coal base-load planning, or the nuclear fleet. Without the stabilisation of the base-load and mid-merit capacity in this country, we will remain in a power crisis.

With regards to renewable energy and interconnected power systems, it is very important to know that all renewable energy sources which are non-dispatchable need conventional power supply support on the grid. This means that more capacity from conventional sources needs to be installed to keep the grid stable. Only "Renewable Energy with storage" ameliorates capacity constraints on the system.

From a power supply perspective, the first peg in the ground for a Roadmap is:

- *To fix the Gx problems in the public sector - fast;*
- *To allow Private Gx into the market so that the power shortfalls can be made up. With constraints on public funds, private investors can alleviate the funding problems and complement Eskom's shortfall; and*
- *To address the Policy and Regulatory environment.*

Consumption - The Power Distribution Industry (Dx)

If a business cannot deliver its product to the end consumer and collect its money then the entire chain beaks down. This sounds simple enough!

In 2011, Electricity Distribution Industry (EDI) Holdings was shut down after Government's efforts, for 9 years, to restructure the distribution industry had failed. It consumed about R300m per annum and in the end produced nothing of value. Its unintended consequences will come back to haunt us.

The effect of setting up the EDI resulted in the municipalities ceasing further investment in their networks, because the assets were going to be transferred into a new entity. Refurbishment, backbone strengthening and maintenance suffered as a result, leaving the country with a current backlog of about R55bn, required for the municipalities to re-instate their assets to required operating standards.

This crucial "end of the chain" investment needs to be expedited and executed to preserve the integrity of the system. What happens now without EDI Holdings? Where will the funding come from? And how long will it take to make up the backlog?

The second peg on the Roadmap is thus:

- *Put the municipalities under pressure to re-instate their assets – anything less will result in system decay beyond recovery;*
- *Put legislation in place to absorb unviable municipalities into larger ones to ensure viability;*
- *Regulate tariffs to be within affordable levels to avoid delinquency – otherwise electricity theft will just escalate; and*
- *Search for off-grid solutions where possible – grid electricity is expensive. Dovetail the Department of Energy and Treasury renewable energy program with off-grid approach for remote communities.*

The objectives of the industry were spelt out: affordability, efficiency and competition. The current state of affairs is far from meeting these objectives.

The Rules of the Industry - The Regulatory Environment

It has been said of the South African electricity sector in recent times that there are "too many fingers in the pie" resulting in an inability to make or implement sound decisions. An electrical system is instantaneously connected from the point of supply to the point of consumption – if any link breaks down, the system breaks down. Thus the rules of the industry must ensure that all sectors work seamlessly to achieve that objective. There is also a need for institutionalisation of that competence. The objectives of the industry were spelt out: affordability, efficiency and competition. The current state of affairs is far from meeting these objectives.

My analogy is that of an "orchestra" without a "conductor":

- Department of Public Enterprises (DPE): shareholder representative of Government in Eskom.
- Department of Energy (DoE): mandated for policy and ensuring security of supply, also produces the IRP.
- Department of Finance: through the Treasury - providing Eskom guarantees for new build, R350bn approved guarantees.
- Department of Water and Environmental Affairs: published the Long Term Mitigation Scenarios (LTMS) which were incorporated into the IRP2010 to reduce carbon footprint.
- Eskom: the incumbent monopoly utility owning the majority Gx, all the Transmission and System Operations (Tx) and owns parts of Dx not owned by municipalities.
- The National Energy Regulator of South Africa (NERSA): responsible for price regulation and licensing of electricity activities.

When the DoE's Independent System and Market Operator (ISMO) draft first appeared two years ago it disappeared into limbo for about a year, when Barbara Hogan was Minister of DPE. But when Malusi Gigaba was appointed, the draft started being circulated again.

A public process run by NERSA on behalf of the DoE resulted in public hearings. But at a public gathering Minister Malusi Gigaba announced that there will be no structural changes to Eskom and no mention was made of the ISMO Bill despite the public comments passed on the draft

The Electricity Regulation second Amendment was issued on 19 December 2011 and the closing date for comment was 25 January 2012. Essentially the public was given 3 weeks to comment on the country's Primary Electricity Act – ERA 2006. This was later extended to 17 February 2012. We have also been told that there are further amendments in the pipeline to other regulations and the ISMO draft.The proposed amendments to the ERA 2006 all point in the direction of "overregulation", making Independent Power Producers (IPPs) participation more onerous and difficult.

How are Independent Power Producers (IPPs) expected to conclude contracts with anyone within such an uncertain regulatory environment?

The third and final Peg on the Roadmap is therefore:

- *The Government should put in place a Permanent Electricity Commission (PEC) that includes professionals to rationalise the regulatory process and bring sanity to the industry. This Commission should be drawn from international ranks who are experienced in regulatory affairs and industry restructuring where the models are working. This will include IPPs. There should be one "conductor" of the "orchestra" appointed and mandated;*
- *An immediate revision of the entire suite of regulatory documents must be addressed to ensure they are coherent and have the congruency that will facilitate IPPs participation; and*
- *The PEC must be tasked with producing future IRP's and advising on Government policy.*

As one of the pillars of the economy, it is imperative that we preserve and expand the electricity infrastructure of this country to meet its economic needs. Without this pillar being kept in good shape, we will descend into economic decay.

Nuclear Energy: The Lessons from Fukushima

Dr Rob Adam
was appointed Group Executive: Nuclear Localisation at the Aveng Group from 1 February 2012. Prior to joining Aveng, he was Chief Executive Officer of the South African Nuclear Energy Corporation (Necsa) for 6 years. Dr Adam holds the title of Extraordinary Professor of Physics at both the University of Pretoria and the University of South Africa. He also serves on the Council of the Academy of Sciences of South Africa and chairs the steering Committee for South African bid to host the Square Kilometre Array Radio Telescope. Before joining Necsa, he was Director-General of the Department of Science and Technology, a position he held for 7 years.

The year 2011 was an eventful one on the energy front, both regionally and globally. Regionally, announcements were made regarding a huge gas discovery in Mozambican waters and an equally significant oil find in Namibian waters, and South Africa approved a massive new power generation build that will see a trillion rand being invested over the next twenty years. Globally, the resurgent nuclear industry suffered a blow as a result of the damage inflicted on the Fukushima Daiichi reactors as a result of a massive tsunami produced by an earthquake off the coast of Japan.

This article is an attempt to contextualise Fukushima in a portfolio of risks that the modern world faces in its complex task of balancing developmental, environmental and social considerations. The lessons we draw from Fukushima tell us as much about ourselves as they do about objective dangers.

Nuclear Energy in South Africa's Energy Mix

The Integrated Resource Plan (IRP) for Electricity Generation was approved by Cabinet in March 2011 and gazetted in May 2011. This plan optimises a range of criteria, such as economic growth requirements, carbon emission commitments, local environmental impact, cost, and geographic availability of different generation options (coal, gas, hydro, wind etc) and sets a blueprint for a generational mix in a new power build over the next twenty years. The IRP involved substantial public consultation and expert input, and established a benchmark for South African public policy documents in that it sets a quantitative framework using a scientific methodology to produce an optimal scenario by balancing a complex set of criteria. The optimal breakdown of the new build generation mix was determined to be: 42% renewables, 23% nuclear, 15% gas, 15% coal and 6% hydroelectric.

There is no global "right answer" to the question of what is the best electricity generation mix. Each country must find its own best fit, depending on its location, resources and circumstances. South Africa and Australia have large coal deposits, and have traditionally depended on them for their electricity generation. California has plenty of sunshine, and in Britain the ocean tides are exploitable. In Chile, in the 1990s the Minister responsible for Energy was fired because of a drought! He had not diversified sufficiently away from hydro, and there were blackouts in Santiago. Because of the very compact nature of nuclear fuel – a hundred tons of it is equal to ten million tons of coal – transport factors do not inhibit the location of nuclear power plants. Nuclear power is therefore often a favoured option in those countries without indigenous energy resources. South Korea and Japan fall into this category. However, nuclear power requires an abundance of technically skilled people and sophisticated regulatory systems, putting it beyond the immediate reach of many countries.

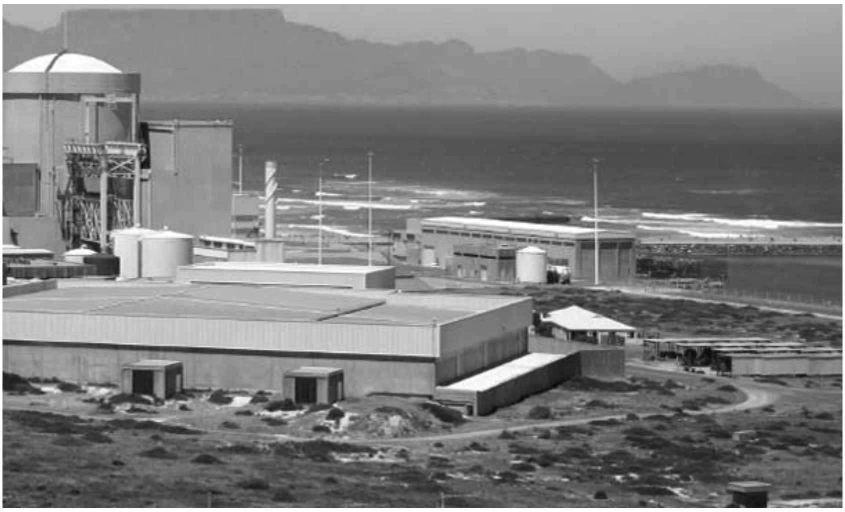
Regional electricity grids and continental gas pipelines are an increasingly important development. Given the fluid nature of both gas and electrical current, regional markets are easy to establish. Spot markets and longer term supply agreements provide more choice but can also seduce a country into dependency. Germany can close nuclear power stations because it can import gas from Eastern Europe and nuclear power from France. But, just as easily, Russia can turn the gas taps off to a politically non-compliant Ukraine. However, many countries do not have the option of tapping into power imported from their region. South Korea is an obvious example, where a hostile northern neighbour prevents access to the Chinese grid. South Africa's neighbours are less economically developed than we are, putting us in an isolated position with respect to power generation too. The rule of thumb has traditionally been that it is safe for a country to import power up to a level equal to its reserve margin, meaning that it is buffered against the caprices of its neighbours. In regions (e.g. the European Union) where countries have decided to cooperate in a tightly coupled way, this precaution is often forgotten: one can imagine an energy supply crisis akin to the current European financial crisis arising because of knock-on effects in such a system.

The rule of thumb has traditionally been that it is safe for a country to import power up to a level equal to its reserve margin, meaning that it is buffered against the caprices of its neighbours.

When we examine the historical fatalities associated with the various generation technologies the following statistics emerge: according to an International Energy Agency study (2002): for every 10 billion kWh of energy generated, there were 33 coal deaths (many of these due to pollution), 55 hydro deaths (mainly due to catastrophic dam failures in China), 1.6 natural gas deaths and 1.2 nuclear deaths. From a pollution perspective, it is interesting to note that the equivalent of half the uranium mined each year (25 000 tons) goes into the atmosphere as a result of electricity related coal combustion!

The South African Cabinet decided on a relatively high percentage of nuclear power in the future generation mix at a very difficult time for the global nuclear industry. The tsunami that damaged the Fukushima plants occurred on 11 March 2011, and Cabinet approved IRP2010 on 16 March. This took some courage, given decisions by Germany, Italy and Switzerland at this time. But it was correct to stick to the plan. Even if climate change considerations are neglected, certain regions in South Africa, particularly the Western Cape and the Eastern Cape, do not have other sensible baseload options. In the months following, stress testing of Eskom's Koeberg nuclear power station indicated a high level of preparedness for a Fukushima-type disaster, with greater redundancy of independent power supplies and a higher elevation above the high water mark than was the case at Fukushima. Moreover, the fault off the Cape coast is a shear fault rather than a subduction fault, and therefore cannot produce the size of wave that engulfed the coast of north eastern Japan last year. Geomorphological evidence going back centuries corroborates this.

As a result, South Africa intends to build the power equivalent of five or six Koebergs over the next twenty years. This is good from a climate change mitigation perspective, and it is also good from the point of view of expanding the technology base of our country. We are being overtaken in the region as a powerhouse of primary industry. Namibia and Botswana have mining industries that are rising rather than declining. Mozambique has massive gas deposits. Zambia and Kenya have rapidly growing agricultural sectors. South Africa's contribution must be in



Koeberg

knowledge and in technology. Investing in nuclear power is a positive step towards embracing this future.

Nuclear Power and Climate Change

According to the Intergovernmental Panel on Climate Change (IPCC), an average global temperature rise of more than 3°C will trigger runaway impacts, mostly negative, in all regions of the world. Large numbers of species will face extinction and new pathogens will abound. Geographic climate shifts-more rapid than we can adapt to from a planning and funding perspective-will affect the whole world. In our region, the Western Cape will become as arid as Namaqualand and the West Coast. Storms will increase in severity, with massive associated infrastructure damage, human misery and financial loss. The world therefore faces a huge mitigation challenge to keep carbon dioxide levels from rising above 500 parts per million. This can only be done by burning less oil, coal and gas and by capturing the carbon dioxide that results from burning these fossil fuels.

The world therefore faces a huge mitigation challenge to keep carbon dioxide levels from rising above 500 parts per million. This can only be done by burning less oil, coal and gas and by capturing the carbon dioxide that results from burning these fossil fuels.

The IPCC has estimated that nuclear power has the largest and lowest cost greenhouse gas reduction effect in electricity generation. If the 104 nuclear power plants in the United States were replaced by coal fired plants, this would be equivalent, from a carbon dioxide generation perspective, to doubling the number of vehicles on American roads. If the nuclear plants were replaced by gas, this would be the same as increasing the number of cars by 60%.

Why then has the United Nations system of decision making organs (the various COPs, etc) not embraced nuclear power generation as the preferred option? The answer, of course, is politics. There is no natural multilateral block of countries in the United Nations that could become a nuclear lobby. JUSCANZ (Japan, US, Canada, Australia, New Zealand) has stood together on other issues, but its members differ decidedly on nuclear power. Both the European Union and the developing world coalition G77 suffer from a similar lack of coherence on this matter. It is also highly unlikely, given the potential dual use (civilian and military) of nuclear technology that a dedicated nuclear power lobby would be allowed to emerge in global multilateral structures. The idea of the United States and Iran (both civil nuclear advocates) sitting on such a body together is too far-fetched to contemplate.

Five Lessons Fukushima Has Taught Us

On the international stage cracks began to appear several years ago in environmental movements regarding nuclear issues. The determining factor was climate change. Many key leaders of the global environmental movement (James Lovelock, Patrick Moore who co-founded Greenpeace International and Stewart Brand, to name but three) have come out strongly in favour of nuclear power as the single greatest potential contributor towards the mitigation of climate change.

However, the recent "black swan" event of earthquake followed by tsunami in Japan has caused the pendulum of public opinion to reverse once more. But what are the facts here? Over 27 000 people were crushed to death or drowned in the disaster. Although radionuclides were indeed released significantly above regulated levels into the environment, not a single nuclear death has been reported. The World Health Organisation (WHO) has labelled the mental health impact of Chernobyl as "the largest public health problem created by the accident" and partially attributes this damaging psychological impact to a lack of accurate information. These problems manifest as negative self-assessments of health, belief in a shortened life expectancy, lack of initiative, and dependency on assistance from the state. These symptoms, experienced most acutely by the 350 000 evacuees, will doubtless play out in Japan too.

"We must establish technically, and explain convincingly, that nuclear events are both increasingly low in probability and increasingly low in consequence. That will be true and must be presented believably".

In this context, the following lessons emerge:

1. *Do Not Promise that there will Never be another Incident*

It is over optimistic-even foolish-to assert that another incident will never occur. For example, if an asteroid 10 kilometres in diameter were to strike near any structure built by humans, there would be nothing left of this structure afterwards. Such incidents have indeed happened to planet earth. In massive disasters, however, everything is affected, and we need to compare the nuclear component of the damage with all the other damage, not lift it out and consider it in its own right. As Jon Ritch, Director- General of the World Nuclear Association has said: "We must establish technically, and explain convincingly, that nuclear events are both increasingly low in probability and increasingly low in consequence. That will be true and must be presented believably".

2. *Nuclear Power is Safe*

At Fukushima three operating reactors and one reactor shut down early in 2011-all between 30 and 40 years old-were subject to the worst earthquake in Japan's history, followed by a devastating tsunami, which flooded the backup diesel generators at the reactors. There was widespread devastation throughout the Fukushima area. Highly precautionary evacuation policies and safety standards in Japan make it extremely likely that not a single radiation fatality will result from this major (category 7) nuclear incident. This needs to be placed in the context of the two hundred odd annual fatalities on South Africa's mines and the thousand or so who die in taxi accidents each year. In any rational analysis, where costs and benefits are soberly considered, the verdict would have to be that nuclear power is safe.

3. The Need for Redundant Independent Cooling Systems

Electricity is needed after the shutdown of a reactor to power cooling systems to deal with the heat generated by the slower decay of fission products that were produced before the nuclear reaction was stopped. Approximately 1% of the power in a nuclear reactor comes from this source. In the case of the 784MW Fukushima Daiichi-4 reactor, this amounts to about 8MW, equivalent to the power from two large wind turbines operating at full power.

Recent in vitro studies indicate that DNA strands damaged by radiation are repaired in the cellular environment, unless damaged a second time before the repair is complete. This implies that high doses of radiation are indeed harmful, but low doses are dealt with as part of "normal housekeeping" by the human body.

The huge earthquake knocked out the grid power supply to the reactors at Fukushima Daichi, which were also automatically shut down, whereupon the backup diesel generators kicked in. An hour later the 14 metre high tsunami flooded the generators. Batteries were then brought in. The batteries lasted a few hours. There was no cooling after this until grid power was re-established to pump sea water into reactor cores and spent fuel ponds. During this period some fuel melted and radioactivity was released.

The lesson here is that all reactors need multiple independent backup cooling systems. The International Atomic Energy Agency is establishing best practice in this regard.

4. Weak Public Understanding of Nuclear Technology

Radiation is part of our natural environment and we have evolved in its presence. All of us are exposed to natural radioactivity every minute, mostly from rocks and soil. Our radiation exposure goes up 10% when we sleep next to another human. The contribution the entire global nuclear industry makes to our annual dose is about 1%, and medical procedures, such as X-rays, contribute about 14%. Usually the annual radiation dose limit for a nuclear worker is set at a level 20 times higher than for a member of the public. But in the Iranian town of Ramsar, natural radioactivity as a result of radon gas brought to the surface by hot springs is at least 10 times the level permitted globally for nuclear workers. Ramsar has been populated since time immemorial. Epidemiological studies have been conducted. No adverse effects have been found. Recent in vitro studies indicate that DNA strands damaged by radiation are repaired in the cellular environment, unless damaged a second time before the repair is complete. This implies that high doses of radiation are indeed harmful, but low doses are dealt with as part of "normal housekeeping" by the human body.

Fukushima has taught us that this correct understanding of the effects of radiation is not held by the public at large. In fact, a staggering feature of the disaster in Japan was that the nuclear incident, which killed nobody, has been given significantly more coverage by global media than the tragedy of 27 000 people who lost their lives in the earthquake and the tsunami. How could this happen? The engine of publicity works by feeding on public preconceptions and deeply held fears and desires, however far-fetched these might be. If someone gets attacked by a shark while bathing at Fish Hoek, the waters will be empty of people for days thereafter. But if there was a fatal car accident nearby, this would not deter a single one of these people from driving home. The fear of being killed and eaten is a very deep and primeval one and we will not be dissuaded from it by arguments based on probability. Ionising radiation is an otherworldly thing for us humans. We were not even aware of it until just over a hundred years ago, because none of our five senses can detect it. In the public view, radiation is not natural but emanates from spooky labs and unnatural man made industries. There has also been a wrong conflation of nuclear weapons and nuclear power in the public consciousness.

5. The Nuclear Industry is a Bad Communicator

The nuclear industry is its own worst enemy in that it apologises for everything, thereby appearing to take the blame. The wider public respond to how you present yourself as much as what you actually say. We need to observe how other high technology industries, for example aviation, deal with serious incidents. Our endless backpedalling results in an 'over-the-top' syndrome. We impose unnecessary conditions on ourselves, in the hope that we will be deemed responsible, not understanding that progress is not always about logic and reason. Giving concessions to pathological opponents is much like giving beer to alcoholics – however much is never enough. And then when we apply for a licence to bury casks of spent fuel 800 metres underground, who can be blamed for ridiculing us when we tell them that these casks are more or less harmless?

The nuclear industry treats the world like a big science class, exciting a few people, alienating others and paralysing the vast majority with reams of facts. A more lateral marketing approach built on the confidence-building participation of ordinary people the public can identify with is more likely to yield results

One of the saddest stories of Fukushima involves a combination of poor understanding and poor communication. The police, acting on instructions to evacuate everyone within a 20 kilometre radius of Fukushima, removed a large number of people from a hospital for the elderly. Their judgment was that removing these patients from life support and putting them on buses was less risky than leaving them to face the radiation plume which was yet to arrive. As a result, 45 of them died. Another sad story involves the suicide of a cabbage farmer whose entire crop was embargoed because it was contaminated above the absurdly low limits imposed by the nuclear safety regulator. He would have had to eat his entire crop himself to have been even mildly at risk from radioactive contamination.

The nuclear industry treats the world like a big science class, exciting a few people, alienating others and paralysing the vast majority with reams of facts. A more lateral marketing approach built on the confidence-building participation of ordinary people the public can identify with is more likely to yield results than aiming for the mirage of public understanding. Public confidence we can certainly achieve over time, public understanding possibly not.

Where To from Here?

Fukushima has been a shocking reality check for all of us. What we need to understand, however, is that progress will always involve balancing risks. If we do not continue to invest in the nuclear renaissance, we will not meet our climate change mitigation targets. Simply, looked at objectively, nuclear power is safe when compared with other options. But as a species we have become afraid of it for a range of reasons I have tried to elaborate on in this article. Some years ago when I was at Chernobyl I was struck by how nature has taken over again in the exclusion zone. There is an abundance of wildlife that has not existed there for over a hundred years. Four decontamination workers were attacked by a wolf a few weeks before our arrival! The deeply disconcerting truth is that low levels of radiation (25 years after the accident) without the presence of humans provide more advantageous conditions for survival for most species than does "normal" human activity.

South Africa should continue on its IRP trajectory. A solid investment in nuclear and renewables shows our commitment to our international obligations, and provides the platform for the technological development of South Africa. It will also free up our gas and coal reserves so that we can use them via our cutting edge gas to liquid and coal to liquid technologies to produce petrol and diesel, thereby reducing our dependence on foreign oil imports.

Professor Steve Thomas is Director of Research at the Business School, University of Greenwich in London. He has been a research in the field of energy policy for 35 years, specialising particularly in economics and policy for nuclear power and on liberalisation of electricity markets.

The Economics of Nuclear Energy

While few people now believe that nuclear power would provide 'power too cheap to meter', there is still a common perception that nuclear power is a cheap source of electricity. The fact that nuclear power has not come to dominate electricity generation is seen as being due to a combination of public opposition and dealing with the safety issues raised by accidents such as those at Three Mile Island (1978), Chernobyl (1986) and Fukushima (2011). The reality is that nuclear power has seldom been the cheapest option for new power stations. Worse, the real cost of any normal successful technology goes down over time due to the effect of intuitively sensible factors such as 'learning-by-doing', economies of scale and general technical progress. For nuclear power, these factors do not seem to have worked and for its entire commercial history, the real cost of nuclear power has only ever gone upwards. The Fukushima disaster can only give a further twist to this upward spiral. This paper examines the determinants of the cost of a kilowatt hour (kWh) of nuclear electricity; what the latest designs of nuclear power plant can offer; how new nuclear plants might be financed; and what issues will determine whether South Africa can successfully launch a new nuclear programme.

What Determines the Cost of Nuclear Power?[1]

Carrying out a detailed cost estimate for the cost of a kWh of nuclear electricity is a major exercise requiring the estimation of a large number of variables many of which are not easy to forecast. However, it is relatively easy to get an approximate idea of the cost of nuclear power because the costs are expected to be dominated by the 'fixed' costs associated with the construction of the plant. As a rule of thumb, it can be assumed that these fixed costs account for about two thirds of the cost of a kWh of nuclear electricity. So, to determine whether nuclear power is competitive, we can concentrate on the variables that determine these fixed costs. The variables can be divided into three: the major determinants of the cost of a kWh (they set the fixed costs); less important determinants; and those that have little impact.

Major Determinants

- **The construction cost:** As nuclear power plants are supplied by an international market, this is usually estimated in dollars and to allow fair comparison between different size plants the cost is usually quoted in dollars per kilowatt of installed capacity ($/kW). To avoid distortions because the cost of borrowing will vary according to the specifics of the plant, the cost is quoted, where possible as if the plant was built 'overnight' with no cost of borrowing.

- **The cost of capital:** If the company borrows half the money from the market at, say, a real rate of interest (net of inflation) of 8% and finances the rest from its own resources at, say 12%, the average cost of capital is 10%.

- **The plant load factor:** Because the cost of nuclear power is dominated by the upfront costs, which have to be paid whether or not the plant is operating, it makes sense to run a nuclear plant at its maximum level for as long as possible so that these fixed costs can be spread out over as many kWh as possible. The annual load factor is calculated as the number of kWh it produces, as a percentage of the power it would have produced, if it had operated at full power uninterrupted for the entire year.

Less Important Determinants

- **Site-specific costs:** A relatively small proportion of the cost of a nuclear power plant is covered by the major items of factory produced equipment. The main costs are incurred at the site and include installation, pouring of concrete. There is therefore significant scope for costs of the same design of reactor to vary from site to site. A highly skilled site labour force is required and if this is not available locally, extra costs will be incurred. Other factors include: the cost of building the transmission links needed to connect the station to the national grid; the local geology and seismology; and the method of cooling.

A highly skilled site labour force is required and if this is not available locally, extra costs will be incurred. Other factors include: the cost of building the transmission links needed to connect the station to the national grid; the local geology and seismology; and the method of cooling.

- **Non-fuel operating cost:** The cost of operating the plant, including maintenance, repair and staffing is relatively low, typically 20% of the total cost, but not negligible. These costs are not completely fixed – if the plant is permanently closed, they are no longer incurred – but they are relatively fixed while the plant is in service. Some nuclear plants that have required a large amount of maintenance and repairs have been closed because these costs were prohibitive.

- **Cost of fuel:** Unlike power plants using coal or gas, the cost of fuel is low, typically 5% including the cost of raw uranium, the cost of turning it into fuel and the cost of disposal after it has been used.

Those with Little Impact

- **Decommissioning cost:** The cost of decommissioning a nuclear plant, cleaning up the site and disposing of the radioactive materials (excluding the fuel) – the structure of the plant will become increasingly radioactive over its life – is of the same order of magnitude as the construction cost, but in a normal project appraisal, costs and benefits arising long into the future have much less weight than earlier costs.

- **Insurance cost:** By international treaty or national law, the liability in the event of an accident of a company owning a nuclear plant is capped at a level far below the potential damage cost. The sum varies from country to country, but, typically, a utility would only be liable for damages up to $200m, with any other costs borne by the country (taxpayers). The company selling the nuclear plant cannot be held responsible for any damages resulting from an accident.

The Public Perspective

The costs described above are as perceived by the company which will own and operate the plant. However, from a societal point of view, the perspective is different because taxpayers ultimately must bear the risks. Some costs, such as insurance costs, are potentially huge: costs from Chernobyl and Fukushima are likely to run into hundreds of billions of dollars. Without the guarantee that accident costs would fall on the taxpayer, it is unlikely that many, if any nuclear plants would have been built. Costs far into the future are 'discounted' away in conventional accounting.[1] In typical project appraisal processes, the value of future liabilities is calculated as the sum of money that would be needed if it was invested today and earned interest till the money was needed-the discounted value. Over a short period of time, this is intuitively sensible. If you have a liability of $100 to be paid in a year and you can earn 3% real interest, a sum of $97 invested today would grow sufficiently to pay the required cost. However, over longer periods, this causes some alarming results. If we assume decommissioning costs $1bn and is expected to be carried out 100 years after the start-up of the plant and money can be invested to earn 3% interest, a sum of only $50m is needed. If the period is 150 years- the timescale planned for the UK's nuclear power plants- the sum required today is only $12m. Similar considerations apply to the disposal of spent fuel.

We have to assume we can forecast accurately what the cost of a process will be that has not been done yet (spent fuel disposal) or not yet done on a commercial scale (decommissioning) 100 or more years in the future.

These are not liabilities like repaying a lender. A future generation will have no option but to try to decommission the plants and dispose of the spent fuel. Over such a long period, the assumptions behind the conventional accounting method are hard to justify. We have to assume we can forecast accurately what the cost of a process will be that has not been done yet (spent fuel disposal) or not yet done on a commercial scale (decommissioning) 100 or more years in the future. We then have to assume that we can invest a sum of money in investments with negligible risk of failure at an assured rate of interest over 100 years. The current financial crisis should have alerted everyone that such assumptions are implausible. If the funding method fails or delivers much less money than is needed, a future generation will not only have to carry out these hazardous tasks but it will have to fund them from their own resources.

Fuel is also an important issue. It is unlikely that the price of uranium, which probably represents less than 1% of the cost of a kWh of nuclear electricity, will go up to a level at which it would have a significant impact on overall nuclear economics. However, if the price of uranium were to go up, say, 5-fold, this would imply the need to mine poor quality ore. Mining uranium produces large quantities of hazardous (radioactive) waste, which must be carefully dealt with if it is not to contaminate water sources and cause serious health issues. The poorer the quality of ore, the more waste will be produced to get each kilogram of uranium.

The Latest Designs of Nuclear Plants

Nuclear power plants are usually categorised according to the coolant used-the fluid that takes the heat from the reactor core to the turbine generator where the electricity is generated-and by the moderator - the material that is used to maximise the chances that when an atom splits, the particle emitted causes another fission. More than 90% of reactors installed worldwide use water as coolant and moderator, either as a Pressurised Water Reactor (PWR) or a Boiling Water Reactor (BWR). The two reactors at Koeberg are of the PWR type. The Pebble Bed Modular Reactor (PBMR) that South Africa tried to develop from 1998-2010 would have used helium gas as coolant and graphite as moderator.

Nuclear designers attempted to meet this challenge by producing a new generation of nuclear power plant designs, still using water as coolant and moderator, which offered improved safety and economics. These became known as Generation III+ designs …

After the Chernobyl disaster, a combination of poor economics and public concern meant that nuclear power plant ordering reached a low ebb. For example, in Europe and North America, no nuclear orders were placed in the 1990s. Nuclear designers attempted to meet this challenge by producing a new generation of nuclear power plant designs, still using water as coolant and moderator, which offered improved safety and economics. These became known as *Generation III+ designs*[2] and optimism in the nuclear industry about their attractiveness was so high that it claimed a 'Nuclear Renaissance' would occur. Under this, countries such as USA, UK, Germany and Italy, which seemed to have turned away from nuclear power, would start ordering large numbers of reactors.[3]

The two designs with the best commercial prospects and which are closest to deployment are the French European Pressurised Water Reactor (EPR) supplied by Areva and the AP1000, a PWR supplied by the Toshiba-owned company, Westinghouse.

The first government to be convinced by their merits was the US which, in 2002, launched its Nuclear 2010 programme, under which it was expected that one or more of these designs would be in service by 2010. It summarised the expected advantages of the *Generation III+ designs* as follows[4]:

> 'New Generation III+ designs have the advantage of combining technology familiar to operators of current plants with vastly improved safety features and significant simplification is expected to result in lower and more predictable construction and operating costs.'

The nuclear industry predicted that these designs could be built for an overnight cost of $1000/kW so that a typical reactor with a capacity of 1,000,000kW (1000MW) would cost $1bn. The promises for these designs have proved well wide of the mark and the latest cost estimates are about 5-6 times this level. Only eight reactors using *Generation III+ designs* have been ordered and six of these are in China and have only started construction in the past couple of years so there is little to be learnt from these.

Construction of the two plants in the West, both EPRs, one in Finland and one in France, has gone badly wrong. Both are now forecast to take at least five years longer to build than the 4-5 years expected and their final cost is at least double the forecast level. Far from being simpler, these are now seen as more complex than their predecessors and this has contributed to the problems of controlling construction cost and time.[5] It seems likely that two orders for AP1000s will go ahead in the USA, the first plants ordered under the US Nuclear 2010 programme. These are unlikely to enter service before 2017-18, more than seven years later than originally envisaged.

Finance

One of the main hurdles for any nuclear project has been to convince financiers to lend the money to nuclear projects. The record of nuclear plants being built-to time and cost-and operating reliably is poor and recent experience in France and Finland has reinforced this poor reputation. In the past, these economic risks did not matter to financiers in most markets because in a monopoly electricity market, consumers usually pay whatever costs are incurred, so the risk falls on consumers not the financiers. However, electricity markets have increasingly been opened to competition and, in a market, expensive producers go bankrupt and the banks that lent them money lose it. Even where monopoly remains, consumers are increasingly unwilling to sign a 'blank cheque' to power plant developers and when a nuclear project goes wrong, the company that owns the plant may be forced to take the hit potentially bankrupting it and jeopardising the banks' loans to it.

Even where monopoly remains, consumers are increasingly unwilling to sign a 'blank cheque' to power plant developers and when a nuclear project goes wrong, the company that owns the plant may be forced to take the hit potentially bankrupting it and jeopardising the banks' loans to it.

Where nuclear projects are going ahead in the West, invariably there is high confidence that consumers will meet whatever costs are incurred. One alternative to passing the risk to consumers is for the government of the vendor to offer sovereign loan guarantees. This means that if the project goes wrong and the utility building the plant cannot repay the loan, taxpayers would repay the banks. However, this option has disadvantages, especially to the utility's consumers. If the utility is bankrupted, taxpayers from the vendor's home country will step in to repay the bank, but the consumers of the utility will still have to bail out a bankrupt utility.

Prospects for Nuclear Power in South Africa

Since 1998, the South African government and Eskom have pursued nuclear power with enthusiasm, but no success. From 1998-2010, there was a programme to try to bring the PBMR design to commerciality. This attempt failed, costing around R10bn, mostly of South African public money.[6] By 2006, Eskom was beginning to look at alternative options to the failing PBMR programme and in January 2008, it launched a tender calling for 3200-3600MW of new capacity from Areva NP and Toshiba/Westinghouse for 3200-3600MW of capacity.[7] In 2007, Eskom was expecting bids of about $2500/kW.[8] It was reported that the bids were actually in the order US$6000/kW[9] and in November 2008, Areva was reported to have won the contest.[10] However, in December 2008, Eskom cancelled the tender citing 'the magnitude of the investment.'[11] *Engineering News* reported that the issue was the credit rating of Eskom[12]:

"... ratings agency Standard & Poor's said on Thursday that South Africa's National Treasury needed to extend "unconditional, timely guarantees" across all Eskom's debt stock if it hoped to sustain the utility's current BBB+ investment-grade credit rating. The National Treasury was still to announce the details of the package. The Eskom board had, as a result, decided to terminate the commercial procurement process to select the preferred bidder for the construction of the Nuclear-1 project."

Far from being deterred by this experience, Eskom has cast its net wider to include earlier generation designs, on the assumption they would be cheaper. This is expected to bring in reactors from China and Korea. Ironically, the design offered by China, the CPR1000, is effectively an updated version of the design built at Koeberg in the 1980s. This design dates back to the late 1960s. The Korean design is a little newer and is based on a US design from the 1990s. It is expected a formal call for tenders will be launched in 2012 for 9600MW of capacity. The government is expecting bids of about $4000/kW.[13] It is hard to understand why the government assumes the cost this time will be only two thirds of the level from four years ago, and how it will be possible to finance 9600MW when it proved impossible to finance 3600MW then.

Conclusions

Nuclear power is an expensive way to generate electricity and even after more than 50 years of commercial development, there is no sign that costs are going to stop increasing. In addition, it is an economically highly risky option because of the poor record of plants being built-to time and cost-and operating as reliably as forecast. The Fukushima disaster serves to underline the problems the nuclear industry was already facing. A new generation of nuclear designs appears close to failure because it is failing to deliver the promises made for it: that they would be safer and because they were simpler, they would be cheaper and easier to build than their predecessors. The Fukushima disaster can only serve to increase their costs and probably their complexity and delay further the time they are commercially available to order.

If it is going to be feasible for new nuclear plants to be financed, it will only be if electricity consumers bear these economic risks, as has always been the case in the past. This economic risk is in addition to the financial risks that the public has always had to bear. These risks arise from the possibility of a catastrophic nuclear accident and the need to dispose of the spent fuel and other radioactive waste and decommission the reactor returning the site to a state where it can be released for unrestricted use.

For South Africa, the latest attempt to place orders for new nuclear plants is not likely to be any more successful than previous attempts. This will waste some public money, but the bigger problem is that for several more years, the government and Eskom will continue to act on the basis that nuclear power can meet its electricity objectives. The options that are capable of meeting these objectives will continue to be neglected.

NOTES

1 For a more detailed review of nuclear economics, see S Thomas (2010) 'The Economics of Nuclear Power: An Update' Heinrich-Böll-Stiftung, Berlin. Also available in Russian and Chinese http://www.boell.de/downloads/ecology/Thomas_economics.pdf

2 There are no clear definitions of the different design generations, but Generation 1 designs include the prototype and demonstration plants of the 1960s, Generation 2 designs include the majority of plants in service now and were ordered in the 1970s and early 1980s. Generation III plants, of which there were relatively few were designed after Three Mile Island and installed from the late 1980s onwards. All Generation III and III+ designs are PWRs or BWRs. A fourth generation of plants has been posited which does not use water as coolant and moderator but these are decades from commercial deployment. It was hoped the PBMR could have been developed into a Generation IV design.

3 For a review of the latest status of the world nuclear market, see M Schneider, A Froggatt & S Thomas (2011) 'Nuclear Power in a Post-Fukushima World' Worldwatch Institute, Washington, 85pp.

4 US Department of Energy (2003) 'DOE Seeks Public-Private Partnerships To Demonstrate "One-Step Licensing" of New U.S. Nuclear Power Plants' Press Release November 21, 2003. http://nuclear.gov/home/11-21-03.html

5 For a review of the problems incurred at these two sites, see François Roussely, Future of the French Civilian Nuclear Industry (Paris:16 June 2010), translated by the Institute for Energy and Environmental Research, Takoma Park, Maryland, http://www.psr.org/nuclearbailout/resources/roussely-report-france-nuclear-epr.pdf

6 For a review of the PBMR programme, see S D Thomas (2011) 'The Pebble Bed Modular Reactor: An obituary' Energy Policy, vol 39, 5, 2431-2440.

7 Nucleonics Week 'French consortium to submit bids to build two EPRs in South Africa' Jan 24, 2008, p 5.

8 Nucleonics W eek, "Cabinet Mulls Policy as Eskom Launches Consultation on New Plant", June 7, 2007.

9 Nucleonics Week 'Big cost hikes make vendors wary of releasing reactor cost estimates' Sept 14, 2008.

10 Nucleonics Week 'Eskom to build initial reactors, but long-term plan to be curtailed' Nov 20, 2008.

11 Nucleonics Week 'Eskom cancels tender for initial reactors' Dec 11, 2008, p 1.

12 Engineering News, "Eskom Terminates Nuclear 1 Procurement Process, but SA Still Committed to Nuclear", December 5, 2008

13 Nuclear Intelligence Weekly 'Back to nuclear with aim of 9.6 GW' October 31, 2011, p 6.

W(h)ither the Solar Park?

Joe Roussos was an intern at the Helen Suzman Foundation. He holds a Bachelor's degree in Mathematics, Physics and Philosophy, and an Honours in Physics from Wits University. He is currently pursuing a Master's in theoretical physics at Cambridge.

The tale of the Solar Park is a useful one to illustrate the function and dysfunction of the South African energy supply industry. When it was publicly announced in 2010, the project attracted much international media and investor attention, and was heralded as a move which could push South Africa to the cutting edge of solar energy technology. Now, a year and a half later, the project has foundered and it appears that progress is unlikely.

This story, like so many involving state-owned enterprises in South Africa, is one of a lack of coordination between the various government and non-government players in the industry. The aim of this paper is to outline the project and its initial promise, and then to attempt a partial diagnosis of the current state of affairs.

Development and Announcement

In October 2009 a Memorandum of Understanding was signed between the Department of Energy (DoE) and the Clinton Climate Initiative (CCI), a subsidiary of the William J Clinton Foundation. The aim was to investigate the possibility of developing a large-scale "Solar Park" in South Africa. The CCI's pre-feasibility study, produced in April 2010, explains the concept as follows:

> "A Solar Park is a concentrated zone of solar development that includes thousands of megawatts (MW) of generation capacity. One or more parcels of land in close proximity are designated and pre-permitted as a Solar Park. Individual solar plants developed by multiple power producers are constructed on the land in a clustered fashion and on a predictable timeline, sharing common transmission and infrastructure."[1]

The Solar Park is a government project, with infrastructure and services constructed and provided by the government - but the power generation itself rests in the hands of so-called Independent Power Producers (IPPs). These are private companies which own and operate power plants independently of Eskom. They connect to the national electricity grid and sell the electricity they produce to a division of Eskom. It then becomes part of the electricity supply consumers access every day. The CCI's study proposed an area west of Upington in the Northern Cape as ideal for the Park. Not only is it relatively flat and sunny, but the government owns land there and the site has access to water (from the Gariep River) and to the electricity grid. The site has an incredibly high level (2800 kWh/sq m p.a.) of Direct Normal Irradiance[2], an index used to measure solar power production potential, beating many of the best sites currently under development worldwide.

The Solar Park was planned to contain a mix of solar technologies. In the Clinton document the majority is envisaged as being Concentrated Solar Power (CSP), a type of power plant which uses an array of mirrors to focus sunlight onto a central receiver, sitting atop a tower. The heat from this sunlight heats water to drive a generator, which generates electricity. CSP is a relatively new technology which is undergoing rapid commercialisation, and has the potential to achieve lower costs and higher energy efficiencies than the more mainstream "solar panels". One of the benefits of CSP is that it can utilise heat-storage to provide power even when the sun is not shining.

The Park would also include photovoltaic panels (PV), as well as a modification of this technology called concentrated photovoltaics (CPV) which uses various optical devices such as lenses to concentrate a large amount of sunlight onto a small area of high efficiency PV cells. Photovoltaic technologies convert sunlight directly into electricity, without the intermediate steps of heating water to create steam to drive a generator. These panels are either fixed or tilt/rotate to follow the movement of the sun. These technologies have seen wider implementation, with the largest plant currently in operation being the Perovo I-V plant[3] in the Ukraine, which produces 100 MW.

The idea behind developing a large park containing many smaller plants is that the infrastructure and development costs are shared. Therefore operating costs are far less than in a scenario where plants are geographically distributed, as economies of scale apply to purchasing and manufacturing of components. A central Solar Park Authority would be created to build and operate the site, providing serviced sites for private investors to install their solar plants. The large-scale infrastructural costs (building roads, supplying the site with water, plugging it into the grid) are borne by this body or the grid utility, thus bringing down the costs which individual investors face. It also allows for the central management of the critical environmental aspects of building a power station. The environmental impact assessment and associated impact-management costs would be investigated in the feasibility study for the Park as a whole, removing this significant cost to the investor and reducing the time required to reach the commercial operation date. A large park also concentrates the associated industries (providing, for instance, the materials needed to build the solar panels).

Downsides to this model are that it fails to capitalise on one of the popular selling points of solar power technologies — that being that they are modular and can therefore be built close to the demand (providing there is suitable space and sun). In addition, the Northern Cape site's distance from the major demand centres in Gauteng and Cape Town means that there will be inevitable "transmission losses" associated with long-distance power lines. The concentration of this much solar generation capacity in one location also amplifies the most basic problem preventing solar power becoming a core part of our power supply: the sun doesn't always shine. Distributing solar plants allows one to distribute the risk of an interruption in generation due to cloud cover or sandstorms.

The CCI study estimated that the Solar Park would cost a total of around R150 billion, with the original estimate for government spending on infrastructure estimated to be 10% of that. The electricity grid would have to be modified and expanded to deal with a new power production centre in the Northern Cape, where there is currently no production, with these costs borne by Eskom. The report concludes that "solar power can be deployed in South Africa in large quantities over the next decade at costs that become competitive with coal-fired power…" The initial timeline sketched a scenario in which stakeholder negotiations would occur in 2011, with the first plants ready to come online in 2012/13. As we shall see, on-the-ground progress has in no way met this optimistic forecast.

Upington and Beyond

In late 2010, the DoE announced the project publicly and convened an investor conference in Upington in October. This is when the Solar Park first captured the public imagination. It was announced as a 5 000 MW development, which would make it the single largest solar park in the world, and make South Africa a leading producer of solar power[4]. The announcement also immediately generated confusion about how this 5 000 MW fitted into other long-term plans for bolstering South Africa's 35 000 MW total generating capacity. The conference attracted 400 people, including investors from the United States, India and China. Despite this initial frisson, the content of the conference was relatively unexciting, as very little actionable information was released to the public[5]. The CCI presentation was largely about the technology to be used, with some estimations of the size of the demand the project would generate for component materials. It announced that 12 000 construction jobs would be created, with a further 3 000 ongoing jobs in the operation and maintenance of the Park. The first indication of a lifetime was given as 8 years, with the implication that the period in mind was 2012-2020.

Presentations were also made by the Department of Energy (DoE), the Development Bank of South Africa (DBSA), Eskom and others, but the majority of them contained little beyond high level discussions of frameworks of how various pieces of the project might unfold. The DBSA discussed its approach to funding projects of this sort. The DoE's Deputy Director-General's presentation mostly outlined the other work the DoE was doing, with a focus on the Integrated Resources Plan (IRP).

The Eskom presentation hinted at the first signs of trouble - raising issues which the still-to-be-conducted feasibility study would need to address. In particular Eskom outlined the grid capacity constraints in the area. In order to evacuate as (relatively) little as 150MW from the area, Eskom stated that it would need to strengthen the local distribution system - work which could complete at the earliest in 2012. By 2014 they could build a new transformer, allowing 170 MW to be evacuated. Further capacity evacuation would require strengthening the longer range transmission system. By earliest 2016, Eskom stated, they could build two new power lines, allowing for the evacuation of up to 900 MW. By 2017 at the earliest they might have another two lines up, allowing for 1 100 MW to be evacuated.

In response to questions at the conference, Eskom representatives indicated that the 756 kV lines could potentially be installed as early as 2015/16, allowing these larger amounts to be evacuated, but the costs for this would need to form part of the feasibility study.

In order to move significantly beyond the 1 100 MW level, Eskom estimated that significant investment would be required in new, higher voltage (765 kV) transmission lines and potentially in High Voltage Direct Current lines.

While not actively contradicting the predictions of the CCI, this information was certainly at odds with early CCI timelines to have the first 1 000 MW coming on stream in 2015/16. In response to questions at the conference, Eskom representatives indicated that the 756 kV lines could potentially be installed as early as 2015/16, allowing these larger amounts to be evacuated, but the costs for this would need to form part of the feasibility study. Despite these issues, the event was declared a success by the DoE, and in November the Minister announced[6] that the feasibility study had begun. In the 15 months since this speech, no report on such a study has been released.

Lack of Coordination

As early as the announcement of the conference, industry analysts pointed to various gaps in coordination which were likely to prove problematic[7]. To begin with, no mention of the Solar Park project was made in the first draft of the Integrated Resource Plan (IRP1), which is intended as a twenty year plan for South Africa's energy production. IRP1 allocated only 600MW of future capacity to solar, 12% of the announced Solar Park goal. When it emerged that the project's origin was in a 2009 agreement with the CCI, it began to look as if this project was not part of the long-term planning processes operating within the DoE. The second and final draft of the IRP does have a solar allowance theoretically large enough to encompass the full Solar Park capacity goal (it allocated 8 400 MW to PV and 1000 MW to CSP), but no specific mention of the Park is made and the timeline for building this new capacity is clearly independent of that envisaged by the Solar Park process.

The Solar Park also did not fit well into the (then) extant framework for the allocation of contracts for building power stations to private companies. This regulatory framework was developed by the National Energy Regulator of South Africa (NERSA), which is responsible for, amongst other things, the regulation of prices consumers pay for electricity. This system was conceived in 2009 and, while under development, was publicly discussed throughout the time period when the Solar Park was being conceptualised. The system was a feed-in tariff, under which power producers using any of a range of renewable energy technologies sell the electricity they generate for a fixed price, calculated to cover the costs of any technology and provide a reasonable level of profit. This renewable energy feed-in tariff (REFIT) would form the basis of bankable power purchase agreements between the state and the IPPs. As the South African grid is owned by Eskom, this framework forces Eskom to act as a single-buyer and redistributor, namely, to pay the REFIT price to the IPPs and to resell their electricity to the public.[8] The REFIT price was to be calculated in a manner which took into account all long term build plans, in order to cover their costs. The Solar Park was never an explicit part of this process, despite advertising a total capacity which would have significant impact on the REFIT process.

Door Closed on the Solar Park for at Least Two Years

In late 2011 the DoE abandoned the REFIT process and in November opened the first window of bidding for a tender to produce 3725MW of renewable energy by 2016. In this first round, over 700 MW of the solar power capacity quota was allocated, with around 150 MW of it planned for the Northern Cape. This was done without reference to the Solar Park, and did not make use of its site. As Eskom explained at the Upington conference, the area has limited grid capacity, and this allocation exhausted that capacity. Considering that a second round of allocations in terms of the IRP are due soon, it seems unlikely that the required two years of upgrading work on the grid will go towards the Solar Park. If doubt still remained, the recent allocation made it clear that the IRP solar production quotas are independent of any considerations of the Solar Park.

The Solar Park project now seems, in retrospect, to have been doomed to fail. Despite the central role given to it in government presentations[9], its development process did not and does not fit well with the large-scale plans governing the development of this industry over the next twenty years. What the story of the Solar Park demonstrates is a worrying lack of coordination - within the DoE and between the DoE and the other players which must be a part of any major change to how we produce power, Eskom and NERSA.

NOTES

1 Solar Park Pre-feasibility Study For South Africa ver. 2, Clinton Climate Initiative (unreleased), 2010.

2 DNI measures the amount of solar radiation received per unit area, and converts it to potential power produced per unit area. DNI is used to predict the output of technologies like Concentrated Solar Power, which track the sun's movement in order to maximise energy collection. The 2800 kWh/sq m should be compared to the sites of Spanish CSP plants, which average between 2000 and 2200 kWh/sq m. It is higher even than sites in North Africa proposed for solar development. See http://www.greenbusinessguide.co.za/northern-cape-solar-resources-among-the-best-in-the-world.

3 See http://www.pvresources.com/PVPowerPlants/Top50.aspx for the largest solar PV developments as of 2011.

4 There were many reports of this. See, for example, http://cleantechnica.com/2010/10/26/worlds-largest-solar-park-to-be-in-south-africa/

5 See http://www.engineeringnews.co.za/article/solar-park-conference-draws-interest-but-more-clarity-sought-2010-10-29

6 http://www.polity.org.za/article/sa-peters-address-by-the-minister-of-energy-at-the-launch-of-the-turning-on-science-improving-access-to-energy-in-sub-saharan-africa-somerset-west-09112010-2010-11-09

7 For example, see the beginning of http://www.boell.org.za/downloads/Trollip_FINAL.pdf

8 See www.nersa.org.za for details.

9 As recently as at COP17 the DoE was highlighting the Solar Park as a flagship project. See http://www.energy.gov.za/cop%2017/DoE%20Programme%20Presentation%20V2%20FlagShipProjects%20.pdf

Energy Intensive Users: South Africa's energy needs

Thomas Garner is an employee at Exxaro Resources and is the founder member and Chairman of the South African Independent Power Producers Association. Thomas holds a degree in Mechanical Engineering from the University of Pretoria (1992) and a Masters in Business Administration from the University of Stellenbosch Business School (2003). Thomas has vast experience in the mining industry and is currently responsible for the formation of a clean energy independent power producer on behalf of Exxaro Resources, a black owned mining and minerals company, listed on the Johannesburg Stock Exchange.

Stephanie Kock holds a Masters Degree in Zoology from the University of Pretoria (1999). She has also completed courses in strategic management, carbon management and others. Stephanie has vast experience in environmental management, specifically strategic environmental planning. She has been involved in the setting up of a cleaner energy company on behalf of Exxaro Resources and is currently managing the environmental and stakeholder processes on major infrastructure projects in Mozambique and Swaziland.

"At the height of his career as a scientist I called him back to South Africa where, as Prime Minister after the first World War, I wanted him back as scientific and technical adviser to the Government, and ultimately to head a public utility corporation for generating electrical power on a nation-wide non-profit basis. To this appeal he responded and in due course became chairman of ESCOM, the Electricity Supply Commission, which is today supplying South African industry and other users with probably as cheap power as is to be found anywhere in the world".[1]

It is December 1948, and these words are from Jan Smuts, twice Prime Minister of the Union of South Africa, in his foreword to the book *"South African Heritage"*, a biography of HJ van der Bijl by his long-time assistant Alice Jacobs.

Why is this quote relevant in an era when South Africa is facing challenges of energy security, a low carbon future, energy hungry industry, and an increase in unemployment and poverty that could be the spark in the proverbial powder keg?

South Africa's Energy Mix

Since the rolling blackouts of 2008, South Africa's energy mix has not changed much, and negligible capacity has been added. Therefore, I will refer to the energy mix as presented to industry in 2007 during a discussion regarding the Energy Conservation Scheme that was planned.[2]

29% of South Africa's energy is provided by electricity. Installed capacity is around 39GW, of which 80% is coal fired. Eskom imports about 1.5GW from Cahora Basa Hydroelectric Dam in Mozambique. The largest 138 customers consume 40% of the available electricity. The largest 40 000 customers consume about 75% of electricity, while 8 million customers consume about 25% of electricity.[3]

Eskom Plant Statistics

In 1999 the reserve margin was 27%, and by 2007 it had decreased to 5%. The power stations had to produce much more by 2007, with the load factor increasing from 61% in 1999 to 74% in 2007. During the same period, plant unavailability doubled from 2.4% to 5%.[4]

Eskom has to force energy intensive users to cut back on electricity demand. This has a negative effect on output, GDP, the tax base, job creation and industry's ability to plan for expansion.

It is difficult to analyse the reserve margin from 2008 to 2012, as Eskom is under severe pressure to keep the lights on and is cutting back supply to industry to ensure this. Eskom is using a combination of the Demand Market Participation Programme, utilising its peaking gas turbines at an extremely high cost of around R4.50/kWh, and its interruptible contracts with some large energy intensive users to balance the supply and demand and avert the need for load shedding. In January 2012 it came close to rolling blackouts, with Eskom losing the supply from Cahora Basa for a period of time. The forecast operating reserve margin for the evening peak period was minus 2400MW. To ensure a safe operating reserve margin, Eskom has to force energy intensive users to cut back on electricity demand. This has a negative effect on output, GDP, the tax base, job creation and industry's ability to plan for expansion. The country's reserve margin is thus largely managed by managing the quantity of un-served energy, with a massive impact on the economy.

Certainty in an Uncertain Environment

Industry requires some degree of certainty in the uncertain trading environment that exists globally today. The effects of the credit crunch of 2008 as well as the uncertainty about the Euro crisis, adds to an environment where business would rather look after its balance sheet and especially its cash reserves, than make investments to expand its business. If insecurity like the availability of something as basic as reliable electricity is added to the existing uncertainty, it becomes fatal for new investments and therefore economic expansion.

The Electricity Supply Industry 1920 to 1996

After Dr. van der Bijl responded to Jan Smuts' call, he formed ESCOM, ISCOR and the IDC and was almost single handedly responsible for leading the industrialisation of South Africa. Van der Bijl could only achieve this because Jan Smuts as a leader had the vision, knew who had the relevant competency and drive, appointed him, empowered him and stepped aside to ensure that he could carry out the job efficiently and effectively.

ESCOM (later named Eskom) was formed as a non-profit company owned by the state but managed on sound business principles. It played a key role in the electrification and industrialisation of South Africa. Eskom has been the largest player in the South African electricity supply industry since its inception in the 1920s.

By the mid 1950s Eskom was in the process of building three power stations at any one time. Between 1980 and 2000 a total of ten power stations were built and commissioned, including seven coal fired power stations, one nuclear power station and two pump storage stations. The total capacity added during this twenty year period was 30 100 MWe. During this period, a core body of knowledge, skills and experience was built up in the country. Eskom was known globally for its large scale power stations, excellent skills base and efficient operations.

By the mid 1980s international sanctions started to be effective and South Africa's economy began to falter. By 1988/89 the reserve margin was more than 15%. Eskom was looking for more customers and started various programmes to expand its customer base. This included the Agrelek programme which encouraged farmers to farm with electricity. And the 'Electricity for all' programme focused on electrification for that part of the population that did not have access to electricity. The largest new customer was, however, the Bay Side Aluminium Smelter built in Richards Bay during the early 1990s. Electricity was sold to them at a special tariff for a period of 15 years, after which the tariff would return to a normal industrial tariff. The Aluminium Industry recognised the opportunity, and the Hillside Smelter followed in the mid 1990s, and the Mozal Smelter followed in the late 1990s/early 2000s.

With the demise of apartheid in 1994, the government focused its efforts on normalising society through various programmes, including Black Economic Empowerment (BEE), Employment Equity (EE) and the Reconstruction and Development Programme (RDP). The latter included the expansion of the 'Electricity for all' programme. International sanctions ended and the South African economy started to grow steadily.

By 1996, Eskom envisaged that the South African electricity supply industry would migrate towards a competitive market arrangement. The leadership at Eskom was ahead of its time and implemented what was called an "experimental wholesale power pool", modelled on the United Kingdom's wholesale market. Eskom wanted to be ready for this move by experimenting with the system in a less abrasive environment than real competition[5]. The internal Eskom Power Pool was implemented on 1 January 1996, with trading rules based on the United Kingdom market. The demand side was represented by an hourly load forecast. The wholesale model market could have been a suitable starting point when introducing non-Eskom generation into the mix, but events subsequently overtook the exercise.[6]

The good work that was undertaken to separate the different businesses in Eskom was undone, and the experimental power pool eroded to become a centrally planned generator scheduling tool as a result of the re-integration exercise.

Different Agendas

By 2004 the planned move to a wholesale-market model in South Africa was abandoned, and Eskom was re-integrated to become one entity again. The good work that was undertaken to separate the different businesses in Eskom was undone, and the experimental power pool eroded to become a centrally planned generator scheduling tool as a result of the re-integration exercise.[7]

This all happened against the backdrop of the Energy White Paper of 1998. The White Paper stated that, to ensure success of the electricity supply industry as a whole, government should consider various developments namely:

- Giving customers the right to choose their electricity supplier;
- Introducing competition into the industry, especially the generation sector;
- Permitting open, non-discriminatory access to the transmission system; and
- Encouraging private sector participation in the industry.

This intent is now prescribed by the Electricity Regulation Act No. 4 of 2006. It is thus clear from Government that there is intent for policy design support of a wholesale market with multiple providers of electricity.[8]

It seems that during the period 1996 to 2007 Eskom and Government were working against each other, which led to the lost decade.

The Lost Decade

A decade was lost where Eskom did not have a mandate from Government to build more power stations. During this period no alternatives were put into place by Government, the policy and regulatory environment had not yet been developed, and the uncertainty of this environment led to no significant investments by Independent Power Producers (IPPs). Eskom tested the market with its Multi-Site Coal-Base Load Programme, but this led to nothing but wasted efforts from IPPs. Eskom launched the Pilot National Co-generation Programme in 2007. IPPs and industry players could develop co-generation projects of about 3000 MW and could have the capacity commissioned by 2010/2011. The process was very trying and nothing has come of it. Independent Power South Africa (IPSA) took a bold step and built a small co-generation plant in Newcastle. Eskom ensured that, even during the rolling blackouts of early 2008, it did not buy electricity from this plant. It was clear that Eskom was intent on keeping private players out of the electricity supply industry, but at the same time government was not successful in creating an environment independent from Eskom to bring in private players.

It is an irony that one of the core values of the founder of Eskom was seemingly ignored by Eskom during this lost decade. The fundamental principle of Van der Bijl's life was "the greatest and noblest function of science and engineering is to raise the standard of living of the human being"[9]. It seems that the leadership during this stage was not interested in raising the standard of living of human beings.

Reality Setting in

The far reaching effects of the 2008 rolling blackouts made Government take notice of the reality of Eskom protecting its own market space. President Zuma's Government formed the Department of Energy (DoE), unbundling it from the Department of Minerals and Energy. Energy policy was now the DoE's responsibility. Eskom now reported to the Department of Public Enterprises, and some independence was created. During this period, industry associations like the South African Independent Power Producers Association, the South African Wind Energy Association, the South African Solar Thermal and Electricity Association and the South African Photovoltaic Industry Association were formed. All role players became engaged to ensure that the electricity supply industry has a future.

Long Awaited Breakthroughs

The DoE, in alliance with industry and Eskom in 2010, introduced the Integrated Resource Plan (IRP). This bold plan, which balances the supply industry with various demand forecasts, included about 19GW of renewable energy in a 20 year electricity plan. The IRP has been accepted by all role players, although not without criticism from various sectors. The biggest questions are the affordability of electricity and the ever relevant debate regarding renewable energy versus base-load electricity. However, the IRP was a breakthrough in terms of creating certainty and establishing a task team-comprising Government, the National Energy Regulator of South Africa (NERSA), industry and Eskom- that has one goal national interest.

This led to the next step, namely, the Independent Power Producer Procurement Programme. The DoE, in close cooperation with National Treasury coupled with a healthy debate with industry and NERSA, designed for the procurement of 3725 MW of renewable electricity. The process was not without controversy, but it is clear from the outcome of the first procurement window that Government is sticking to its action plan. The programme should ensure a large, world-class renewable energy sector in South Africa. It should also lead to further black economic empowerment, the empowerment of local communities, job creation, skills development and an expanded manufacturing sector.

The Current Reality

The current reality is that South Africa has lost a decade of planning for new electricity infrastructure. During the same period industry lost the opportunity to plan vital expansions of their businesses in a global arena, where China and India's growth demands massive volumes of minerals that South Africa could supply if the infrastructure and electricity were in place.

The Eskom build programme is behind schedule. The first renewable energy from the Independent Power Producer Procurement Programme will only come on line by mid 2012. At the same time, the co-generation opportunities in South Africa are not being developed. Taking into account that it is the cheapest electricity that could be supplied from new power stations, that it is carbon neutral and that it is perfectly related to demand from energy intensive users, it is definitely not a feather in South Africa's cap that it has not been developed.

The policy and regulatory environment is not in place yet, and various parts of existing and new legislation are not yet aligned.

The Future

The electricity supply industry in South Africa is beyond its darkest hour. With good leadership at all levels of Government and industry at large, the electricity supply industry can play a vital role in creating the platform for economic growth, job creation and poverty alleviation.

The focus should be on ensuring the success of the Independent Power Producer Procurement Programme and on finalising outstanding legislation. Furthermore, it is imperative to unbundle Eskom into a generation company on the one hand and a transmission and distribution company on the other. It could still be state-owned but should be managed in such a way to ensure that there is no conflict of interest and that IPPs can enter the field without fear of an uneven playing field.

Conclusion

The South African electricity supply industry needs leaders of the mettle of Jan Smuts and Hendrik van der Bijl.

To ensure that South Africa is successful, we will need political leaders who have a vision, who know who has the relevant competency, who empower that competence, and who steps aside to ensure that the player are able to execute the job efficiently and effectively.

On the other hand, in an environment lacking clear leadership combined with a culture where incompetence is rewarded and where political meddling is part of everyday life, engineers and technocrats cannot be successful in realising the founder of Eskom's fundamental principle, namely "the greatest and noblest function of science and engineering is to raise the standard of living of the human being".

NOTES

1 Jacobs, A. (1948). South African Heritage. Pietermaritzburg: Shuter & Shooter.
2 Lakmeeharan, K. and Visagie, C. (2008). Setting the Scene for the Power Conservation Programme Debate. October 23.
3 Ibid.
4 Ibid.
5 Kruger, F. (2010). The South African Wholesale Market for Electricity: Requirements for Renewable Energy Uptake. The Sustainable Energy Resource Handbook: The Essential Guide, 1:31-38.
6 Ibid.
7 Ibid.
8 Ibid.
9 Jacobs, A. (1948). South African Heritage. Pietermaritzburg: Shuter & Shooter.

Should Energy Intensive Users have such a large say in Energy Discourse?

Jonas Mosia joined the COSATU Policy Department as Industrial Policy Coordinator in 2007. He develops policies and advises COSATU leadership and its affiliates on trade, industry, energy and related issues. He has occupied various leadership positions in the trade union movement since 1992 and has worked for the National Education, Health and Allied Workers Union (NEHAWU), as both a Regional/Branch Organiser and Provincial Education Secretary. He represents organised labour on Trade and Industry Chamber of NEDLAC and its various subcommittees.

In 2011 the South African government adopted an Integrated Resource Plan (IRP). The IRP is aimed at providing guidance in relation to investment in the electricity sector in the next 20 years, i.e. between 2010 and 2030. The total new generation capacity less decommissioning in the IRP amounts to about 41340 MW which will be sourced from coal, nuclear, imported hydro, Closed Cycle Gas Turbine (CCGT), Peak Open Cycle Gas Turbine (POCGT), wind, Concentrated Solar Panel (CSP) and Solar Photo Voltaic (Solar PV). These technologies will contribute in the energy mix as follows:

Technology	Proportion	Share of new capacity in %
Coal	6300MW	15%
Nuclear	9600MW	23%
Hydro (Import)	2600MW	6%
Gas: CCGT	2400MW	5%
Peak: OCGT	3900MW	9%
Renewables	17800MW	42%
Wind	8400MW	
CSP	1000MW	
Solar PV	8400MW	

Adapted from IRP2010 Document

South Africa's main sources of electricity so far have been coal and nuclear. Currently coal constitutes 90% of the country's source of electricity and nuclear 5%. The IRP aims at reducing the share of coal in South Africa's electricity generation from 90% to 65.5% whilst increasing the nuclear share from 5% to 20% by 2030. The renewable sources of electricity will contribute 9% of electricity generation by 2030. This means that the share of coal would have decreased by 27.2% and that of nuclear increased by a massive 300% by 2030. Initially, the IRP was proposing 11400MW for renewable sources of electricity. This was ultimately increased to 17800MW after consultations.

The current total installed generation capacity in the country is about 44000 MW. So government has decided to double installed generation capacity through the IRP.

Is there a Need for Such a Massive Investment?

Government's main objective through various policy interventions is the creation of decent jobs. South Africa has one of the highest unemployment rates which have not fallen below 20% in the past 20 years or so[1]. This means those who are working have a responsibility to take care of the millions who are unemployed.

It is in this context that government has adopted policies like the Industrial Policy Action Plan (IPAP) and the New Growth Path (NGP). The NGP aims at creating 5 million new jobs by 2020. In order to create the productive capacity in the country, and therefore reverse the challenge of de-industrialisation, there is a need to invest in the energy sector.

Not surprisingly, therefore, the main reason given for this massive investment in the electricity sector is to ensure security for the supply of electricity. 'Investors need certainty in the security of supply' is a common refrain. Surely, this sounds quite reasonable. The country needs investment in the economy, particularly in relation to the manufacturing sector which is the engine of growth.

The South African economy is still dependent on the upstream energy-and-capital intensive sub-sectors whose products are directly exported with few forward linkages with the domestic economy.

However, does the country need this massive investment to achieve the noble objective of creating jobs in the economy? If we all agree that, indeed, the country needs this huge investment, then the next questions are whether the energy mix is optimal? Who will foot the bill for this investment? Which sectors of the economy need this massive investment?

Electricity Consumption by Sector in South Africa

On aggregate the business sector (primary, secondary and tertiary) consumes 69.9% of the electricity compared to a mere 17.2% by residential consumers[2]. These figures can be broken down further as follows:

- Industrial sector: 37.7%
- Mining: 15%
- Commercial sector: 12.6%
- Agricultural sector: 2.6%
- Transport sector: 2.6%
- Domestic sector: 17.2%
- General: 12.3%

The manufacturing sector accounts for about 15% of national output and consumes close to 40% of electricity in the country. This sector is currently dominated by petrochemicals and basic iron and steel industries. The South African economy is still dependent on the upstream energy-and-capital intensive sub-sectors whose products are directly exported with few forward linkages with the domestic economy. These sub-sectors are basic chemicals, other chemicals and man-made fibres, basic iron and steel, basic non-ferrous metals, paper and paper products and coke and refined petroleum products.

The Beneficiaries of the Investment

The upstream, energy-and-capital intensive sub-sectors are the ones that stand to benefit massively out of more than double the new generation capacity being created. This should not be surprising because out of 16 members of the IRP technical task team members, about 40% of them came from the Energy Intensive Users Group (EIUG), namely, Xstrata, Anglo American, Exxaro, SASOL, BHP Billiton and Chamber of Mines[3]. The EIUG consumes about 44% of the electricity sales in South Africa[4].

While Eskom's System Operator did modelling work for the IRP, it would be difficult to understand how the EIUG, which served on the technical task team, did not bring its weight to bear on the final document.

While the major concern is security for the supply of electricity, it does happen that at times supply may exceed demand. In that eventuality, some of the power stations will have to be mothballed, as happened with Eskom's power stations in the 1980s. Unfortunately, returning those power stations back to service does not come about cheaply, money is needed for de-mothballing. The question is who would foot the bill for de-mothballing those power stations? As it happened when Eskom returned the power stations it had mothballed back to service, the electricity tariffs would have to be increased massively.

Business was opposed to this approach and argued for an opportunity for customers to utilise new additional suppliers of power. They argue that this would create a strong incentive for investment in additional and efficient power generation.

One of the cheapest ways of making electricity available for the economy is to use electricity efficiently. In the midst of the 2008 electricity crisis, government tried to introduce a protocol for new electricity connections. In terms of the draft protocol, a New Electricity Connections Protocol (NECP), new applications of more than 100kVA but less than 1MVA would be scheduled if the customers adopted energy efficiency technologies. Applications of more than 1MVA but less than 20MVA would be scheduled if the applicants committed to energy efficiency and energy savings in terms of Energy Conservation Scheme (ECS).[5]

Business was opposed to this approach and argued for an opportunity for customers to utilise new additional suppliers of power. They argue that this would create a strong incentive for investment in additional and efficient power generation. The protocol did not see the light of the day ultimately.

Now government is introducing an Independent System and Market Operator (ISMO) to ensure more private sector involvement in the electricity sector. The introduction of private sector players in the electricity sector will inevitably result in higher prices of electricity, and the poor are the ones to suffer in this regard. Higher electricity prices will cause more strain in other sectors of the economy, thus jeopardising any job creation prospects.

Government had to be convinced about the need to increase the share of renewable sources of electricity in the IRP. Ultimately the renewable sources of electricity, which are critical in the fight against climate change which is putting the lives of ordinary people in the main at greater risk, were increased in the IRP from 11400MW to 17800MW.

There seems to be mistrust about the renewable sources of electricity because they "can not provide the base-load energy". Again, those who need base-load energy are energy intensive users and certainly not residential consumers. Whilst the share of coal in electricity generation, which provides base-load energy, would be decreased by 27.2% in 2030, this decrease would be compensated by a massive increase in nuclear energy. This increase in nuclear energy is defended by the base-load energy argument.

The nuclear energy industry is both capital and skills intensive. As a country, we do not have nuclear skills base. The Koeberg nuclear plant was built by a French nuclear company Areva (previously known as Framatome)[6]. Therefore, the nuclear plants will be built by foreign nuclear companies, with foreign skilled workers. Not only that, but most of the inputs will be imported and thus little benefits will be derived by local manufacturers.

This commitment to invest massively in nuclear power will require trillions of rand. At the same time financial markets do not have the appetite for the risk associated with nuclear investments; and the World Bank, which has granted Eskom the loan for coal-fired power stations and renewables, is currently not funding new nuclear projects.

The reality is that the nuclear industry cannot be viable without massive financial support from the government. The Department of Energy acknowledged this fact in the Energy White Paper: *"Despite its small contribution, the nuclear industry has been the recipient of a major portion of DME's budget…"* In 2010 government was forced to close down the Pebble Bed Modular Reactor (PBMR) because its costs had escalated dramatically, and at the time of its closure, government had already spent about R9 billion.

Whilst we are told that a major nuclear accident is unlikely except in cases of human errors, natural disasters or terror attacks, three major nuclear related disasters have occurred in just about thirty years, viz., Three Mile Island, Chernobyl and now Fukushima.

Nuclear energy is characterised by a problem of dangerous long term radioactive waste with onerous requirements for safe custody over a period of some thousand years. Whilst we are told that a major nuclear accident is unlikely except in cases of human errors, natural disasters or terror attacks, three major nuclear related disasters have occurred in just about thirty years, viz., Three Mile Island, Chernobyl and now Fukushima. In financial terms, nuclear incidents can be so devastating that the cost of full insurance would be so high to make nuclear energy more expensive than fossil fuels.

Japan's Fukushima disaster has shown that nuclear power is a viable source for cheap energy only if it is insured. Governments that use nuclear energy are torn between the benefit of low-cost electricity and the risk of a nuclear catastrophe, which could total trillions of dollars. Nuclear risks, be it damage to power plants or the liability risks resulting from radiation accidents, are covered by the state.

Climate concerns are said to be the force behind the resurgence of nuclear energy as part of the energy mix. The Copenhagen Accord requires of developing countries to submit proposed Nationally Appropriate Mitigation Actions (NAMAs) showing their plans to reduce their Green House Gases (GHG) emissions through specified projects. Accordingly, nuclear energy is touted as a solution to the challenges of climate change, and developing countries are advised to have nuclear energy policy to meet the commitments of the Copenhagen Accord.

But nuclear energy is not as clean as its supporters want us to believe. If the full life-cycle of nuclear energy is taken into account, uranium mining up to electricity generation, there is carbon dioxide generated and released into the atmosphere.

The Poor Pay the Price for Energy Intensive Users

Thus far, government has not clarified where the resources to fund the IRP would come from. The main source of revenue for the electricity sector is electricity tariffs. Already South Africa has seen steep electricity tariff increases since 2008. The National Energy Regulator of South Africa (NERSA) allowed Eskom a 27.5% tariff increase for 2008/09. In 2009 Eskom applied for an interim price increase of 34% to cover its main operational costs.

In 2010 NERSA awarded Eskom an average tariff increase of 25.5% each year, until 2012/13. This trend of steep electricity hikes will result in many of the poor not being able to afford electricity at all, and they will turn to more dangerous sources of heat and light, such as paraffin and gas. At the same time media reports indicated that Eskom continued to charge energy intensive users an average electricity price of between 9c/kWh and 17c/kWh.[7] The massive investment in the electricity sector will continue to benefit EIUG through these low electricity prices for them.

Conclusion

The EIUG continues to influence the policy direction in the electricity sector. While the IRP shows an increase in the share of renewable sources of electricity, it is, however, still too small when compared to fossil fuel and nuclear proportions in the plan. The argument always given is that the renewable sources of electricity cannot provide base-load energy and cannot be relied on for security of supply. The question, then, that should be asked is: who needs base-load power? Surely it is not the residential customers but big electricity guzzlers who pay very little for the electricity prices.

NOTES

1 In terms of Quarterly Labour Force Survey, the official unemployment rate stood at 25% in the 3rd quarter of 2011

2 Information sourced from Electricity Pricing Policy: 2008

3 Information sourced from Institute for Democracy in Africa (IDASA) presentation to NEDLAC labour constituency on IRP: 2010

4 See EIUG website: http://www.eiug.org.za/about/

5 Department of Energy (2008) Draft criteria to be applied to screen applicants for electricity-intensive industrial and commercial processes

6 Mosia, J. 2011. Is Nuclear Power a Solution to SA's Electricity Crisis? The Shopsteward. No. 3 Volume 20. June/July, pp 25-26

7 See Davie, K. 2009. Eskom's Crazy Plan. http://mg.co.za/article/2009-10-17-eskoms-crazy-plan.

Energy Planning and Sustainability

The Integrated Resource Plan for Electricity 2010-2030 (IRP2011) is a 20 year plan that looks at the projected demand for electricity and uses certain assumptions to derive a plan to meet this demand.

Mike Roussos
is a renewable energy developer who also consults to many businesses on energy issues and other general management issues. He has run a variety of companies in the past, in industries ranging from mining to information technology to legal insurance to retail. He has also assisted Government in setting up and running a range of new initiatives at local and provincial level.

It is an attempt to anticipate the need for electricity, and set up a cost-effective, reliable and hopefully sustainable way to supply us with this electricity. 'Sustainability' refers to the need to take into account the impact of various ways of generating this electricity: its impact on our environment, on our health, and on our planets ability to cope with all the Green House Gas (GHG) we are spewing into the atmosphere.

Such a plan must re-examine: How we use electricity how much we use and what we use it for. These are all questions about the energy-intensity of the ways we grow our economy in order to meet all our needs. They are critical questions, but they cannot be addressed in the context of an IRP for electricity. They are part of the broader question of how South Africa uses- all types of-energy. The broader Energy Resource Plan that this IRP should be a part of, has yet to be finalised by government (it's apparently 'in-process' at the moment) and as such, a number of these key issues are left open-ended in this IRP.

This article will examine how this IRP was formulated, how reliable its predictions are, to what extent it addressed the sustainability issues and what "trade-offs" it made on the way and why.

Any discussion of new ways of meeting electricity demand must take into account the reliability of the technology being used to generate such electricity, as this will definitely impact on Eskom's ability to guarantee security of supply (its ability to 'keep the lights on'). This article will also comment on some of the debates about renewable technologies and their reliability sometimes referred to as their 'maturity'.

The question of cost is critical to the final decisions made about what to build, how to build it and how to pay for it. This article will also make some comments about the ability to finance the development plans being made in the IRP and raise some questions about the way forward.

The IRP Process

Formulating a 20 year plan is a very imprecise exercise, which is subject to many assumptions that have to be made about key variables; assumptions about how much the economy will grow and the impact this will have on electricity demand. The list of key assumptions is very long and contentious, and includes the electricity intensity of future economic growth (will we build more electricity guzzlers like

This is why there is so much controversy around who has access to the process; who has the opportunity to influence the process; and who is chosen as an expert to assist the Department of Energy (DoE) in its determinations.

the Aluminium smelters or more factories that require comparatively little electricity to function), the price elasticity of demand for electricity (how sensitive electricity consumption is to changes in the price of electricity), and how much electricity can we save using Demand Side Management (DSM) measures (how much can we rely on efforts to introduce energy-saving measures, to bring down the overall usage of electricity?).

Many of the inputs into the IRP process are subject to interpretation and introduce opportunities for interest groups to push the decision in a direction that suits their constituency. This is why there is so much controversy around who has access to the process; who has the opportunity to influence the process; and who is chosen as an expert to assist the Department of Energy (DoE) in its determinations.

The DoE ran a far more consultative process than had ever happened before. Many of their critics have pointed out that this happened in fits and starts, depending on how much pressure was being exerted on them: but whatever the reason, they started setting the framework for a much more consultative process. The consultation process began with a debate around the assumptions and moved onto a set of scenarios that were examined as part of the process that led up to the decision about the final mix of technologies - and the timing of their introduction. This then led up to the plan that was presented to the Cabinet for their approval.

After a lot of pressure, this Cabinet Plan was presented to the public for discussion and comment. This resulted in many criticisms and many suggested changes. Public commitments were made regarding revisions of the scenarios, particularly of the pricing, and regarding consultations that would take place after these changes had been made.

Once the revisions were made by the DoE, the new recommendations were taken straight to the Cabinet and final approval was given. It only became public once it had already been approved and the finished product was then published. This raised a lot of questions about the legitimacy of the process and of the value of consultations when there is no commitment to take account of the results of such consultations.

An examination of the recommendations may help to clarify some of the problems that arise from such a process.

The building of scenarios is done using a piece of software that allows one to model various technology options over a predefined period, to determine the most cost-effective mix. In this case the mix included the traditional fossil fuel options (coal, gas, diesel), the newer renewable options (wind, biomass/gas, solar PV & CSP, hydro) and nuclear. This was modelled over a 20 year period. The model allows one to stipulate costs for each technology over the entire period, that is, you can stipulate that the cost will rise, drop or stay constant - over the period. The initial set of scenarios included fixed costs for the renewable technologies. It was assumed that they would stay constant over the period -apart from inflation which is excluded from the model. This is contrary to the experience of massive and on-going cost reductions as these renewable technologies achieve higher levels of penetration. It also set the costs for nuclear at levels that were far below those that emerged from various actual tenders or construction projects over the past few years.

Long term planning inevitably impacts on the interests of different stakeholders within the economy. An obvious example is that of coal. We have a lot of coal in this country and many people rely on the coal industry for their livelihoods–for jobs or profits. When international concern about GHG emissions led to plans to remove coal from the list of options that should be included over the next 20 years, the lobby groups swung into action. Some of them, like the trade unions who are concerned about the jobs of their members, engage openly in debates about the future growth of the economy and how this will affect the coal workers and what alternative jobs could become available within green industries. They use their support base and their access to the ruling party to ensure their views are taken seriously. On the other hand business owners intervene in other ways. They have access to money and the influence to assert their views in the process. They send various experts, who work for them, to participate in working groups that formulate the options and influence the decisions. They demand opportunities to brief the Cabinet to ensure it is aware of the consequences of making various decisions and they also have the resources to draw up extensive and persuasive presentations on the consequences of various choices.

The problems arise when this happens behind closed doors, when experts are seconded from business groupings with a clear interest in the outcome - without counterbalancing experts from the other side, when unreasonable access is given to those with the resources or the political clout to demand it.

This is all part of the normal process of democratic engagement and debate – as long as it is transparent and open to challenge by other interest groups. The problems arise when this happens behind closed doors, when experts are seconded from business groupings with a clear interest in the outcome - without counterbalancing experts from the other side, when unreasonable access is given to those with the resources or the political clout to demand it.

The IRP process can be challenged on the basis of many of those pitfalls, and needs to be carefully examined so that the next IRP corrects those defects.

IRP2010 Recommendations – The First Set of Scenarios

Cost and reliability tend to dominate as the key criteria in such a process. This ignores the contribution that different technology mixes will make to the devastation being wrought by global warming. Such externalities must increasingly become the most important consideration in such decisions. We need to understand what impact our choices will have on the survival of the planet. These choices have to be made in the context of what we can afford; in the context of the need to grow the economy to fight unemployment, poverty, hunger and disease. Global warming cannot be fought in one country. The danger is that this is used as an excuse for us to do as little as the worst of our neighbours.

At Copenhagen our President committed South Africa to various target reductions in GHG emissions, with some conditions attached. The targets derive from the Long Term Mitigation Scenarios (LTMS) done for the Cabinet, which projected various growth paths and the impact of each type of growth on GHG emissions. These projected the following figures for GHG emissions under the Growth without Restriction (GWR) scenario - bearing in mind the Electricity sector is responsible for about 50% of total emissions.

Copenhagen Agreement

	GWR	Elec. Contribution	Reduction agreement
2020 target	720 Mt	360 Mt	34% down to : 238 Mt
2025 target	880 Mt	440 Mt	42% down to : 255 Mt

When the IRP scenarios were run, these targets disappeared from the documentation and other targets were substituted. Initially a 275 Mt target by 2020 was utilised, which was later changed to 275 Mt by 2025. This represents a very different reduction from the 'business as usual' (or GWR) scenario. 275 Mt by 2020 is a 24% reduction; down from the 34% reduction South Africa committed to. 275 Mt by 2025 means that we do not reduce emissions below 'business as usual' at all for the whole period from 2010 (when the commitment was made) up to 2025. We then try and achieve a 38% reduction from then on; down from the 42% reduction. This change was never justified and the documentation made it sound as if this target will enable South Africa to meet the targets committed to in Copenhagen.

This inevitably pushed the total costs up as a large proportion of the existing 'polluting' plant was not being used – and new 'clean' plant was being built to bring down the emissions. This was, to a large extent, due to governments' refusal to review the decision to build Medupi and Kusile.

One of the emission-reduction scenarios removed many of the new coal plants and replaced them with 11GW of wind and 9.6GW of nuclear. This was done to meet a lower emissions target than was possible with the GWR or 'business as usual' technology mix (with coal comprising the vast majority of generating plant). This scenario dropped emissions to 275 Mt by 2018 and kept it there from then on. In the 'base case' it was 286 Mt in 2018 and went up to a high of 381 Mt by 2030. The total capital cost rose by 9% above the capital cost of the base case to R860.5bn.

A more 'extreme' emission-reduction scenario was then explored. This introduced much more wind (17GW) and introduced it two years earlier (by 2015). This pushed the emissions down to 220 Mt by 2020 (better than the target of 238 Mt) and kept it there for the whole period. The capital costs rocketed to R1250bn – a 58.3% increase above the base-case. This was used to demonstrate the impossibility of such 'radical' emission targets and was used to justify a shift to the conservative targets introduced in the final IRP plan (275 Mt by 2025).

This conclusion ignored the fact that the earlier introduction of wind 'stranded' many of the existing coal assets – thus creating an absurdly high reserve margin (the percentage of unused generating capacity). It rose to 72% due to the un-utilised coal plant. This inevitably pushed the total costs up as a large proportion of the existing 'polluting' plant was not being used – and new 'clean' plant was being built to bring down the emissions. This was, to a large extent, due to governments' refusal to review the decision to build Medupi and Kusile.

This result was also due to using incorrect costs for the renewable technologies. The costs used ignored the yearly drop in price for these new technologies, as installations increased around the world. Some of these errors were corrected after the public consultations, including correcting the low price of nuclear in the early scenarios. This also impacted on the result above.

The first round of scenarios included DSM targets that were very conservative: even Eskom had estimated that around 3 times that level could comfortably be achieved. DSM refers to measures like replacing incandescent light bulbs with compact fluorescent bulbs; replacing electric geysers with solar ones etc. The Enhanced DSM scenario increased this target by a low increase of 45%. The analysis dismissed this option as too risky as it was difficult to achieve, and the benefits were too small. The emission levels of this scenario were not very good - 302 Mt in 2020, 332 Mt in 2025, and 376 Mt in 2030. But it did manage to drop the capital cost to slightly below that of the base-case (–1.62%). The IRP plan dismissed it as an unrealistic option.

An analysis of this scenario reveals that it included more coal than any other scenario – just a tiny bit less than the base case – and no wind or solar. This is what led to the high emissions in this scenario: hardly a fair test!

An analysis of this scenario reveals that it included more coal than any other scenario – just a tiny bit less than the base case – and no wind or solar. This is what led to the high emissions in this scenario: hardly a fair test!

The Second Round of Scenarios – After the Consultations

The nuclear costs in the model were increased by 40% to take account of criticisms of the first round of models. Although this is a big correction, it is arguably still far too small. This was convincingly argued in the submission made by Greenpeace to the IRP consultation process: they quoted the costs of a number of new nuclear installations around the world -using estimates from rating agencies Standard & Poor's and Moody's, they put this cost at around $7500 / kW – which is more than double the figure used in the first round of scenarios. The cost of de-commissioning the nuclear plants - a cost that has been, very conservatively, estimated by the International Energy Agency (IEA) to be R 2700 / kW of existing plant) has not been taken into account at all. This would add at least 10% to the original costs used by the IRP.

Notwithstanding these problems, when a least cost analysis was run using the new costs (increased for nuclear and reduced over time for solar), this generated some interesting results. With the emission target set at 275 Mt by 2025 - the model recommended not including any nuclear, including very little coal, 15.8GW of wind, 8.8GW of solar PV and 8.75GW of solar CSP. The capital cost of this scenario was lower than most of the first round scenarios (except the base case and the Enhanced DSM ones).

Despite this, in the final 'adopted' IRP, the DoE and their expert panel decided to ignore this result and 'force in' 9.6GW of nuclear as a 'safe' and 'reliable' option. They excluded most of the solar CSP plant (they dropped it to 1GW by 2030 – from 8.75GW). They dropped wind from 15.8GW to 8.4GW and kept the target emissions at the high level of 275 Mt by 2025. They announced that this would result in 275 Mt being achieved by 2025 – but did not publish a year-by-year emissions column in the "Policy-adjusted IRP" table detailing their chosen scenario (which introduced doubts about their claims).

IRP Decisions

Nuclear	9.6 GW
CSP Solar	1.0 GW
Solar PV	8.4 GW
Wind	8.4 GW
Coal	16.383 GW (including Medupi & Kusile)
Emission target	275 Mt by 2025 – kept at that level until 2030

This was in line with the approach adopted by the DoE throughout the consultation process – where nuclear was treated as non-negotiable – as something that had been decided by Cabinet and was not open to question or reasoned discussion. This approach does not inspire confidence and raises all sorts of questions about the motives underpinning such a decision.

How reliable is Renewable Energy – can it ever replace Coal or Nuclear as a Base-load Resource?

Can the shortcomings of intermittent sunshine and inadequate wind be dealt with by a grid operator? These are not new problems, but they are often exaggerated as we have very little experience of managing a grid with significant quantities of such plant.

Renewable energy results in intermittent generation, as it is reliant on the sun shining and on the wind blowing: it only works when those 'resources' are available.

The grid is run by the 'system operator' – whose job it is to ensure that the projected demand is met by the grid, every hour of every day. This obviously creates some anxiety for those whose job it is to 'keep the lights on'. They tend to be conservative when faced with having to choose between relying on the resources they have always used and whose peculiarities they know and feel comfortable with, versus changing to new 'unknown' technologies. This will not change unless and until we build up a different experience base in this country.

Can the shortcomings of intermittent sunshine and inadequate wind be dealt with by a grid operator? These are not new problems, but they are often exaggerated as we have very little experience of managing a grid with significant quantities of such plant. In the first place, they pose little problem when the grid includes a small percentage of such intermittent plant, and we can draw on international experience to determine at what levels this can become a real issue. This will not be a problem for us for some years to come (Eskom has estimated this level to be at around 15-20% of total grid capacity).

Once a comprehensive wind map has been compiled for the entire country, it becomes possible to guide the installation of 'wind farms' to maximise the overall yield from all such sites. This uses the basic principle that once we know when, where, at what speed and at what height above the ground the wind blows, we can plan a wind grid that will give us a defined resource at a very high level of reliability – whenever we need it. Let me give an example: Once we have the wind map and have built our wind farms accordingly, we will be able to guarantee that of the 10GW of wind farms that we have strategically placed around the country, to maximise the overall availability of the entire wind-plant establishment – AT ANY TIME we will be able to rely on (for example) 6GW being available to the grid.

This is a relatively simple exercise that takes into account the wind map and depends on having built the wind farms in the correct locations, with the turbines at the correct heights, and then doing a statistical analysis to determine the percentage we can rely on – at any time of the night or day – with a high degree of accuracy.

What about solar? The sun does not shine at night and it is very difficult to determine how much sun-energy we can rely on at any point in time during a specific day of the year. Clouds may blow over and ruin our forecasts; freak rainstorms (or sandstorms) can wreak havoc with our attempts to predict how much power we can generate at any point in time.

This is less of a problem if the quantity of solar power on the grid is relatively small – and again we can rely on international experience to guide us regarding the 'hurdle percentage' of solar on the grid.

Base-load is a term used by system operators to describe generators that can be relied upon to carry the bulk of the load on the grid – day after day. The term refers to the fact that once these generators are on, they tend to run reliably, until we run out of fuel or until they suffer from an unexpected and infrequent breakdown. The above discussion explained how wind can become part of the base-load of a grid – even if only to a limited extent (i.e. less than the built capacity of the total wind-plant).

The situation is different for solar CSP plants as these are thermal plants i.e. they do not generate electricity directly but collect the suns heat and then use this (as a substitute for coal) to heat water to run a generator – that then generates electricity.

What about Solar? The only way it can really become part of the base-load category would be if it could be stored efficiently and cost-effectively. This is not possible (at this point in time) for PV plant – batteries are far too expensive to be a practical option for PV power stations. The situation is different for solar CSP plants as these are thermal plants i.e. they do not generate electricity directly but collect the suns heat and then use this (as a substitute for coal) to heat water to run a generator – that then generates electricity. Fortunately heat can be stored much more cost effectively and more efficiently than trying to store electricity. CSP solar – with enough storage – can therefore be described as 'base-load' plant. The only problem with this is the high cost of the electricity generated by such a plant, at this point in time.

The dispatch-ability (how quickly it can be switched on when needed) of generating plant is also of concern to a system operator. This is critical in allowing them to deal with fluctuations in the expected demand that occur suddenly and unexpectedly.

A nuclear power station is very reliable once it is switched on and running (barring any spanners being thrown into the works – or any tidal waves, earthquakes …) but nuclear power stations take a long time to get up and running and are thus of little use in dealing with demand spikes (even if we had a few spare ones lying around). Coal-fired power stations are also very reliable once they are up and running – but they take – depending on the size – at least half a day to get up and running from scratch – and are thus of little use in dealing with short term fluctuations. Wind energy is not really dispatchable, except that there may be some excess capacity available from the aggregated total we calculated as a portion of the total plant built around the county. But this needs further examination and study. Solar PV is not dispatchable as it cannot be stored cost-effectively. It is only available when the sun is shining.

Solar CSP can be stored and although the current overall cost is high, this technology represents our best hope of achieving a long-term solution to our need for sustainable clean energy that is available whenever we need it.

Certain kinds of gas or diesel powered turbines can be started up in only a few minutes. They burn fossil fuels and can be very expensive to run (especially the diesel OCGT ones). They are very useful when the demand changes unexpectedly and the system operator has to do something quickly to stop 'black-outs' or grid crashes. Gas turbines emit less GHG's than coal during their combustion process, but cannot be considered 'clean energy'. Recent studies; using the fact that methane is a vastly more potent GHG than CO_2; and the fact that gas pipelines historically leak a demonstrable amount of methane into the atmosphere; argue that using gas may even be more problematic to global warming than the use of coal.

Unless this installed base increases rapidly in the coming years, this technology may be relegated to the sidelines – even though it is probably our best chance of creating a base-load (and dispatchable) technology within the Renewable arena.

The reliability of solar (PV and CSP) and Wind technologies are not really in question. These are all stable technologies. Exponential increase in installations is leading to more experience and ongoing improvements to the technologies being used. Wind turbines have been built all over the world and the experience underpinning this technology is large and stable. CSP solar that utilises a 'trough-based' configuration has a large installed base and is accepted by most banks as 'tried and tested' technology.

The tower-based CSP plants are more efficient as they allow for higher temperatures to be generated. This also helps enormously when the heat they generate is stored for use when the sun is not shining. Sadly this technology does not have a very high installed base and is still regarded by many banks as a relatively risky technology. Unless this installed base increases rapidly in the coming years, this technology may be relegated to the sidelines – even though it is probably our best chance of creating a base-load (and dispatchable) technology within the Renewable arena.

What about Cost? Isn't Renewable Energy very Expensive?

Eskom claims that its average cost, incurred in producing electricity, is around 56 cents per kWh. Most of us pay a lot more than that, as we get our electricity via the Municipalities, who treat electricity as an additional way of extracting money from us.

This is not an accurate cost to use for comparison with renewable electricity. It includes all the old plant that was built many years ago and has been completely 'written off' in Eskom's books. Our comparison should be with the costs of running a grid with 'new-coal' plant – like Medupi. This cost would include the cost of writing off the capital it cost to build this new plant. I have calculated the cost of electricity from such a plant as being around R1.14 per kWh of the electricity it produces over a 30 year life of such a power station. Currently the government (via Eskom) is offering to pay IPP's 80 cents per kWh for biogas electricity, 84 cents per kWh for landfill gas electricity, R1.07 for biomass electricity, R1.03 per kWh for hydro electricity, R1.15 for wind electricity and R2.85 per kWh for solar (PV and CSP) electricity (these prices were calculated over the 20 year life of the contracts they stipulated in the tender). This shows that some of the renewable energy sources are much cheaper than new coal – but they are not available in very large quantities.

Wind costs around the same as the cost of the 'new-coal' electricity – but solar is a lot more expensive.

This cost would mean that if we install large quantities of solar on the grid today – it would cost a lot more to buy electricity from the grid. Solar electricity is dropping in cost year by year – as more and more of it gets installed, but right now it is relatively expensive. How do we bring down these costs? Every government that has embarked on this path (India, Brazil, China etc) has stressed that they want to participate in the international economies of scale with the decreasing costs. At the same time they have launched a drive to create a local industry to build a big proportion of the plant in their own countries, as this is what will really bring the costs down in their countries.

No-one will build a local factory to produce PV (or CSP) plant unless they are convinced that there is a future for the renewable energy market in this country. Market confidence regarding the future prospect and size of such a market, is a critical component of any anticipated renewable industry in South Africa.

Conclusion

This process has raised many questions that need to be addressed if we are to introduce a sustainable energy mix that contributes appropriately to our attempts to create a local green economy:

- Does it make sense to use a growth forecast that is arguably excessive in order to 'lower the risk' of building too little plant?

- Can we afford to casually dismiss options that allow us to build less new plant by reducing our energy consumption via higher DSM targets – as they are 'too risky'?

- Faced with a history of incompetence in the promotion of such DSM options by the bodies responsible for introducing them on a large scale – can we afford to allow such incompetence to force us to dismiss such 'cost-effective low-hanging fruit' as 'too risky'?

- Can we afford to opt for a nuclear path - despite its being excluded by the very same 'least-cost' model that was previously used to demonstrate that nuclear was a better option than any of the renewable options (now that a more realistic cost for nuclear has been put into the same model and the model excludes nuclear – we override the model and force nuclear in?)

- Can we afford to allow questions to be raised about the integrity of our process when we keep finding new reasons to promote the option that costs the most, thus creating the greatest opportunity for tender manipulation, despite world-wide concern about its continued implementation in the light of the Fukushima disaster?

- Can we afford to allow the introduction of renewable energy to happen in such a haphazard manner – with insufficient regard for the need to control:
  - The sustainability of such options in the long term (relating to critical issues about the possibility of storing the renewable energy)? and;
  - The localisation aspects of the roll-out relating to both the technology used and the skills required to producing and maintaining such technology locally?

- Can we afford to chuck out our previous commitments regarding GHG reductions on the basis of such a flawed process thus condemning us to higher levels of emissions?

- Can we afford to allow profit to overrule sanity in our struggle to preserve what is left of our chances of preventing global warming – here and internationally?

- Can we afford to keep making decisions on the basis of 'piecemeal' data – of relatively short-term thinking – of insubstantial plans regarding the financing of such options?

We need to learn the lessons from the mistakes that were made in this process - to ensure that the next round of IRP planning results in the development of a comprehensive long-term plan that encompasses both the manufacturing and the generation side of things. This can only happen if a comprehensive assessment is made of the two processes – with open and honest debate underpinning some real long-term planning.

This is not an academic or a financial exercise: success in this area will make a significant contribution to our struggle to find an alternative development path that also encompasses a sustainable energy path.

Antoinette Handley
is Associate Professor in the department of Political Science at the University of Toronto. South African born, her research interests on state-business relations in Africa take her back regularly to the sub-continent. She is the recipient of numerous scholarships and research grants including the Rhodes (1993), Fulbright (1998, 1999) and a SSHRC (2007). She is a research fellow at the Helen Suzman Foundation.

REVIEW ARTICLE

Southern Africa: Old Treacheries and New Deceits

In his latest book, Stephen Chan has set himself a very particular task: "to write an intelligent book for the nonspecialist reader who has a newspaper and television knowledge of Southern Africa built around a small number of political leaders"[1]. His focus here is on Zimbabwe, South Africa and the relationship between them over the last 20 years. His aim is "to show how, in a linked and intimate region, lives and political decisions weave in and out of one another"[2] and in this he succeeds admirably, painting vivid portraits of four central figures: Thabo Mbeki, Robert Mugabe, Jacob Zuma and Morgan Tsvangirai. Ultimately however, the central strength of the book is also its weakness - namely the extent to which the account focuses, first and foremost, on the interpersonal dynamics between a small number of key figures.

Chan is Professor of International Relations at the SOAS, University of London. The author of some twenty-eight books, he was honoured last year with an OBE and the International Studies Association named him an "Eminent Scholar in Global Development." His work is thus taken seriously by academics but, unlike many of his colleagues, he is also intensely interested in - and skilled at - addressing popular audiences.

It should come as no surprise, therefore, that the portraits he paints of his four lead characters are nuanced, perceptive and more three-dimensional than those found in popular media accounts. They are also not unsympathetic. He argues that Mbeki, for example, "did not fail by simple lack of effort in his 'quiet diplomacy' with Robert Mugabe," and that Mugabe, for his part, "did not become a tyrant because of a love of tyranny, but lost himself in the contradictions of his convictions"[3]. There are many such careful and balanced observations, often conveyed with a journalist's eye for the telling detail and a canny sense of the reader's need for a coherent, character-driven story-line. Throughout, Chan makes excellent use of the wealth of new bibliographic material that has become available in the last decade, and of his own extensive network of contacts and his experiences in the region. He evidently has access to high quality gossip; he plausibly argues, for example, that in the 2009 elections, Mugabe had actually been preparing to step down and was busily exploring a range of exit options. Mugabe was however "persuaded" not to step aside by the generals who stood to lose so much financially from a change of regime[4].

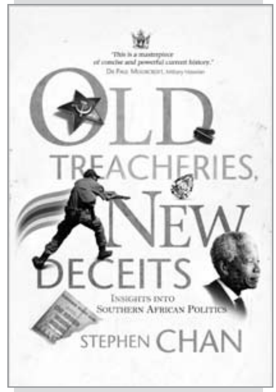
The general implication of Chan's book however is that personal loyalties and betrayals ought to be regarded as the key drivers in the recent histories of South Africa and Zimbabwe and of the interactions between these two countries – and here he may be doing too little to challenge the worldview of his intended audience. For example, the arc of his story about the rise of Jacob Zuma to the South African presidency will already be familiar to a well-informed, newspaper-reading audience, told as it is principally as an account of a highly personalised struggle for power between Mbeki and Zuma. Very little time and attention are devoted in this volume to the structural and institutional factors that facilitated the rise of Zuma and the fall of Mbeki. This type of analysis reflects rather than challenges the prevailing tendency to portray the ANC's recent politics as driven purely by personal struggles for power.

Chan makes much of the affinity between Mbeki and Mugabe, driven by similarities in their sensibilities and outlooks: they are both veterans of the liberation struggles in their respective countries. But both figures have recently been challenged by younger, less intellectually-inclined men (Tsvangirai and Zuma). Both Mbeki and Mugabe are clever, learned, and sophisticated; and both are inclined towards a set of Afro-centric thinkers and ideas. Accordingly, both react viscerally - and often in ways that are tragically misdirected - against the perceived racism of some of their fellow citizens and international interlocutors.

A key part of Chan's analysis then is rightly concerned with the kinds of ideas that have engaged Mbeki. Chan presents a canny reading of Mbeki's intellectual trajectory and how this might have influenced his policy inclinations. He elucidates how a set of ideas found in early negritude, anti-imperialist and pan African writings[5] served as a powerful motivator of Mbeki's policies on NEPAD and the African Renaissance – but also informed his reaction to the discourse that Mugabe deploys and is embedded in. While not an uncritical observer, Chan is clearly sympathetic to the nationalist struggles across the continent and, refreshingly, does not entertain the more facile and often racist constructions of Mbeki's involvement in Zimbabwe

Chan is not quite so impressive on Mbeki's AIDS denialism – but this is not central to the story he is telling so one might easily forgive him that[6]. However, it is useful to contrast Chan's overall approach to Mbeki's thinking and decision making with the approach adopted by Anthony Butler in his 2005 *African Affairs* article. In this article, Butler seeks to explain South Africa's AIDS policy under Mbeki and explicitly eschews psychoanalytic accounts of Mbeki as the key explanatory variable for these policies. Instead, Butler delivers a sober, coherent and convincing analysis of the competing paradigms within which the debate and decision making about HIV/AIDS was conducted, the responses of the ANC, the Department of Health and the broader health community to these – and why one paradigm triumphed.

Make no mistake, Chan's account is vivid and highly readable and we may learn a great deal from it. For example, Chan gives a credible and balanced account of Mbeki's international diplomacy, the full extent of which many South Africans are unfamiliar with. In addition, towards the end of his book, Chan makes a thoughtful set of observations that challenge an overly romantic view of democracy (at least of democracy as expressed in a strict, first-past-the-post rendering of election results). He argues instead the pragmatic importance of ensuring that all parties that enjoy a significant constituency have significant representation: "there is something to



SOUTHERN AFRICA: OLD TREACHERIES AND NEW DECEITS: Stephen Chan
Yale University Press, 2011
ISBN: 9781868424375

be said," he reminds us, "for a form of government in which all parties competing for power are delicately given a place"[7]. South Africans who are overly critical of the compromise Government of National Unity (GNU) that Mbeki negotiated in Zimbabwe in 2009 and of its failings, might bear in mind that it resembled in important ways not only our very own GNU in South Africa in 1994, but also the carve-up of votes between the ANC and IFP respectively in that same year in the province of KwaZulu-Natal, both of which sets of arrangements arguably facilitated our "miraculous" transition and may well have saved a good number of lives.

Chan is shrewd and perceptive too in his observation that, ultimately it is Mbeki rather than the much lionised Mandela who dominates post-apartheid South Africa - after all, Mbeki's policies were pursued not only under his own presidency but under Mandela's too. And despite projecting himself as the "anti-Mbeki," in crucial policy areas Zuma's government has yet to diverge sharply from the overall policy direction laid down by Mbeki.

Having said all of that, Chan's account would have benefited from a more systematic engagement with the broader theoretical literature on the region. South African policy after all, goes well beyond the whims and proclivities of a single man, however ambitious he may be. And the same can be said for Zimbabwe's tragic trajectory. In this telling however, one might be forgiven for concluding that Southern Africa's regional politics is little more than the churning of personal rivalries and ever shifting loyalties – and this is a conclusion that Chan himself would reject, I have no doubt.

NOTES
1 pxii
2 pxii
3 pxii
4 p267
5 p71, 75, 79
6 p129
7 p219

helen.suzman.foundation
promoting liberal constitutional democracy

SUPPORT LIBERAL DEMOCRACY

Dear Reader,

As a member of the Helen Suzman Foundation's mailing list, you currently receive all publications and invitations to Roundtable discussions and symposia.

I invite you to become a Friend of the Foundation. The subscription is R1000, which is excellent value for a tax deductible donation.

Your help will enable us to continue the vital work of the Foundation in supporting liberal constitutional democracy.

Payment can be made by EFT or cheque, and email (or fax) your personal details to kate@hsf.org.za (011 482 2872).

To those of our readers who have already contributed, thank you for your continued support.

Our banking details are:
Helen Suzman Foundation
Nedbank Branch code: 195 805
Account Number : 1958 496006
Swift Code: NEDSZAJJ

With kind regards

Francis Antonie
Director
Helen Suzman Foundation

PERSONAL DETAILS Required

Name ....

Email address .... Contact Number ....

Postal address ....

....