ELECTRICITY
A review of South Africa’s electricity sector
February 2014
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<tr>
<th>AFD</th>
<th>Agence Francaise de Developpement</th>
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<tr>
<td>AfDB</td>
<td>African Development Bank</td>
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<td>BEE</td>
<td>black economic empowerment</td>
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<td>CBM</td>
<td>coalbed methane</td>
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<td>CCGT</td>
<td>combined-cycle gas turbine</td>
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<td>C&amp;I</td>
<td>control and instrumentation</td>
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<td>CO₂</td>
<td>carbon dioxide</td>
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<td>CSP</td>
<td>concentrated solar plant</td>
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<td>CTF</td>
<td>Clean Technology Fund</td>
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<td>DRC</td>
<td>Democratic Republic of Congo</td>
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<td>DEA</td>
<td>Department of Environmental Affairs</td>
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<td>DMP</td>
<td>demand market participation</td>
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<td>DoE</td>
<td>Department of Energy</td>
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<td>DPE</td>
<td>Department of Public Enterprises</td>
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<tr>
<td>EIA</td>
<td>environmental-impact assessment</td>
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<tr>
<td>EPREV</td>
<td>Emergency Preparedness Review</td>
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<td>FGD</td>
<td>flue gas desulphurisation</td>
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<td>GHS</td>
<td>General Household Survey</td>
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<td>HPA</td>
<td>Hitachi Power Africa</td>
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<td>IAEA</td>
<td>International Atomic Energy Agency</td>
</tr>
<tr>
<td>IEP</td>
<td>Integrated Energy Plan</td>
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<td>IDM</td>
<td>integrated demand management</td>
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<td>IPP</td>
<td>independent power producer</td>
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<td>IRP</td>
<td>Integrated Resources Plan</td>
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<tr>
<td>LHWP</td>
<td>Lesotho Highlands Water Project</td>
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<tr>
<td>LNG</td>
<td>liquefied natural gas</td>
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<tr>
<td>MTRM</td>
<td>Medium-Term Risk Mitigation</td>
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<tr>
<td>MVAr</td>
<td>megavolt-ampere reactive</td>
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<tr>
<td>MW</td>
<td>megawatt</td>
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<td>MYPD</td>
<td>multiyear price determination</td>
</tr>
<tr>
<td>Nersa</td>
<td>National Energy Regulator of South Africa</td>
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<td>NDP</td>
<td>National Development Plan</td>
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<td>OCGT</td>
<td>open-cycle gas turbines</td>
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<tr>
<td>PV</td>
<td>photovoltaic</td>
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<td>REIPPPP</td>
<td>Renewable Energy Independent Power Producer Procurement Programme</td>
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<td>SACRM</td>
<td>South African Coal Roadmap</td>
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<tr>
<td>SAPP</td>
<td>Southern African Power Pool</td>
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<tr>
<td>TDP</td>
<td>transmission development plan</td>
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<td>UCG</td>
<td>underground coal gasification</td>
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<td>Wasa</td>
<td>Wind Atlas for South Africa</td>
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The material contained in this report was compiled by Mariaan Webb and the Research Unit of Creamer Media (Pty) Ltd, based in Johannesburg.

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Cover and table of contents pictures by Creamer Media.
January 2013: Eskom meets with the leaders of its four main coal suppliers to initiate talks on how the mining companies can assist in keeping its coal costs under control, to limit future electricity price increases.

January 2013: Eskom acknowledges that a substantial portion of South Africa's existing electricity transmission system is not currently compliant with the regulatory requirement that the system remain operable even when key equipment on the network fails. The utility sets a target of ensuring 80% compliance by 2017.

January 2013: Global solar power plant developer SunEdison breaks ground at the site of its first project in South Africa – the R1.2-billion, 28 MW Soutpan photovoltaic project, in Limpopo.

February 2013: The Department of Energy announces a new plan to supply electricity to 97% of households by 2025. The country initially aimed to provide access to energy to 92% of formal households by 2014.

February 2013: The National Energy Regulator of South Africa allows Eskom to increase its electricity tariffs by 8% a year between 2013 and 2018 – half of the 16% sought by the utility for its third multiyear price determination period.


March 2013: The Industrial Development Corporation says South African mineral smelters and chemical plants can potentially generate more than 2 000 MW of electricity from hot gases.

April 2013: Eskom agrees with labour and contractors at the strike-prone Medupi coal-fired power station, in Lephalale, Limpopo, to renegotiate the project labour agreement. Earlier in 2013, the site was closed for ten weeks, owing to labour unrest.

April 2013: Eskom approves a new five-year generation strategy, premised on an 80:10:10 principle, which implies average plant availability of 80%, with unplanned outages limited to 10% and scheduled maintenance also set at 10%.

April 2013: South Africa’s national power utility appeals for a domestic coal-pricing regime that is based on an “efficient and transparent cost, with a fair return”, rather than one that migrates towards export parity-price levels.

May 2013: South African Coal Roadmap chairperson Ian Hall declares the securing of coal for Eskom power stations as the number-one priority. He says Eskom needs 60-million tons a year of new mine coal to come on stream in the next few years and 120-million tons before 2020.

May 2013: The 19 projects identified as preferred bidders in the second bid-window of South Africa’s rolling renewable-energy procurement programme reach financial close. The projects, comprising wind, solar and minihydro, collectively represent 1 044 MW of capacity.

May 2013: Eskom CEO Brian Dames calls on countries in sub-Saharan Africa to work together to establish a “super grid” to boost electricity supply in the power-starved region.

June 2013: The Department of Energy makes a fresh call for potential developers of baseload and cogeneration electricity projects to register their projects to aid in the design of procurement processes based on Ministerial determinations published in December 2012.

July 2013: Mining group Exxaro Resources and energy firm GDF SUEZ, of France, unveil plans for a 600 MW coal-fired power station north-west of Lephalale, in Limpopo, where Eskom is building the Medupi power station. The total capacity of the plant could be expanded to 1 200 MW, depending on the availability of water and transmission capacity.

July 2013: Eskom confirms another delay in the Medupi power station, in Limpopo, and sets the second half of 2014 as its new deadline for synchronising the first unit to the grid. The utility previously targeted the end of 2013 as the start-up date for Unit 6 of the power station.

August 2013: Eskom tests market appetite for a new demand-response incentive. The utility issues a request for information to test the potential for large power consumers to reduce their loads during periods of system stress in return for monetary compensation.


September 2013: The Department of Energy formally launches the public-consultation phase for the formulation of an Integrated Energy Plan. The plan is set to be published during the course of 2014.
KEY DEVELOPMENTS

September 2013: Cabinet determines that new coal-fired capacity will be required beyond what Eskom is developing at the Medupi and Kusile sites. Energy Minister Ben Martins is to determine whether the project, widely dubbed Coal Three, will be built by Eskom or by an independent power producer.

September 2013: Eskom issues a request for information for the supply and delivery of conventional or unconventional gas to its Ankerlig power station, near Atlantis, in the Western Cape. The open-cycle gas turbine currently operates using imported diesel. Work is under way on the possible conversion to a closed-cycle gas turbine.

October 2013: Ratings agency Standard & Poor's downgrades Eskom's standalone credit profile and indicates that the South African utility will require additional funding of about R50-billion to close a gap that arose as a result of the National Energy Regulator of South Africa granting it yearly increases of 8% for the third multiyear price determination period, instead of the 16% requested.

October 2013: Cabinet approves the gazetting of regulations for the exploration for and production of shale gas in South Africa's Karoo.

October 2013: The European Union's long-term lending institution, the European Investment Bank, provides R2.8-billion for the construction of the Ka Xu Solar One concentrated solar power (CSP) plant, to be located near Pofadder, in the Northern Cape.

The project is one of the largest CSP investments in the Renewable Energy Independent Power Producer Procurement Programme.

October 2013: Eskom says it is ready to advance its underground coal gasification project at the Majuba power station, in Mpumalanga, to the second phase, which will use a larger gasifier to feed larger amounts of gas into the power station.

November 2013: Energy Minister Ben Martins and a delegation visit subsidiaries and facilities of nuclear group Rosatom in Russia.

November 2013: Eskom contractor Hitachi Power Africa confirms it can meet the utility's revised commissioning programme at the Medupi power station. Eskom pushed back the commissioning of the first unit to the second half of 2014.

November 2013: Eskom places a temporary hold on its energy efficiency rebate programmes, pending a review of the incentives in light of financial constraints.

December 2013: The Department of Energy publishes the updated Integrated Resources Plan 2010-2030 for public comment, in which it materially lowers demand outlook over the 20-year horizon.

December 2013: Brian Dames announces his resignation as Eskom CEO, citing personal reasons. He will depart at the end of March.
Although South Africa has avoided load-shedding since 2008, national power utility Eskom is still walking a tightrope to keep electricity flowing to industry and consumers, while bringing overdue power plants on line and maintaining its current power station fleet.

To deal with the mismatch between supply and demand, Eskom is investing in new generation and transmission capacity, giving mothballed power stations a new lease on life and operating its fleet for longer.

The big capital investments by Eskom has resulted in the utility having had to apply for above-inflation tariff increases, leading to growing anxiety about South Africa’s power price path and its impact on the nation’s competitiveness. Eskom now faces a five-year financial gap of R225-billion, after being granted lower-than-requested tariff increases for the five-year period to 2018.

The Department of Energy (DoE) is also facilitating the introduction of private power to increase generation capacity and diversify the country’s energy mix. The competitive bidding process to procure renewable-energy power is currently the DoE’s most advanced independent power producer programme, with three bidding rounds having delivered 3 900 MW of electricity from 64 projects across the country. Another round of bidding is to follow in 2014.

However, opinion remains divided on what generation technologies the country should pursue. Government’s intention to embark on a big nuclear power programme and its apparent support for shale gas frequently made headlines in 2013. In December, the DoE published an updated version of the Integrated Resources Plan 2010-2030, which proposes a delay of the nuclear power programme, as revised demand projections show that 6 600 MW less capacity than previously envisaged will be required by 2030. The new demand projections suggest that no nuclear baseload capacity is needed until at least 2025 and that alternative options, such as regional hydro or shale gas could be considered, should the cost of nuclear power be too high.

What to look out for in 2014:

- The final Integrated Energy Plan – a coordinated energy plan setting out the provision of all energy sources, not only electricity, up to 2050 – will be published.
- The comment period on the updated Integrated Resources Plan 2010-2030 closes on February 7. A final draft is to be submitted to Cabinet by March 2014.
- Eskom is set to announce the winning bid for the replacement of six steam generators at the Koeberg power station in early 2014.
- The Prieska and Uppington solar park feasibility studies are expected in the first quarter of 2014.
- South Africa plans to issue licences to allow for the exploration for shale gas reserves in the first quarter.
- Eskom’s 100 MW Sere wind farm, in the Western Cape, will deliver its first power to the national grid in the first half of the year and will be in full commercial operation by the end of 2014.
- Construction is set to start on Eskom’s 100 MW concentrated solar plant, in the Northern Cape.
- The fourth bidding round under the Renewable Energy Independent Power Producer Procurement Programme opens in July.
- The first 800 MW unit of the much-delayed Medupi coal-fired power station, in Limpopo, is set to be synchronised to the grid in the second half of the year.
- Electricity from the Kusile power station, in Mpumalanga, will hit the grid in December.
- The Ingula pumped-storage scheme, in the Little Drakensberg mountain range, should become fully operational.
From 1970 to 1990, South Africa built 31 000 MW of new electricity capacity, but power was in oversupply the following decade and little was invested. The supply balance started to shift in the mid-2000s, when the economy expanded at a yearly average of 4.5% – the country’s fastest growth since becoming a democracy in 1994. Goldman Sachs reported recently that South Africa’s gross domestic product jumped by nearly 2.8 times in that period. By 2008, an electricity shortage plunged Africa’s leading economy into the dark, accentuating the underinvestment in this crucial industry.

National power utility Eskom is playing catch-up, investing billions in new generation and transmission capacity, while independent power producers (IPPs) are also being introduced to expand the power supply and diversify the electricity mix.

**Eskom-generated power**

Eskom generates about 95% of the power used in South Africa and about 45% of that used in Africa. The utility – which turned 90 in March 2013 – operates 27 power stations with a nominal capacity of 41 919 MW, comprising 35 650 MW of coal-fired stations, 1 860 MW of nuclear, 2 409 MW of gas-fired and 2 000 MW of hydro and pumped storage stations.

Eskom’s electricity supply network is ageing and, therefore, requires higher levels of planned maintenance work. Almost two-thirds of the power stations are past the midpoint in their expected operating lives.

Maintenance is generally scheduled for the warmer summer months and reduced to a minimum during the winter months when residential demand is high. However, the winter of 2013 was different: For the first time ever, Eskom had to do extensive maintenance work during the coldest months of the year. This was on account of a maintenance backlog owing to disruptions in imports from the Cahora Bassa plant, in Mozambique, and an unplanned outage at the Koeberg station, in the Western Cape.

With a reserve margin that has fallen below the internationally accepted benchmark of 15%, Eskom had to delay planned maintenance on its generation fleet in recent years to meet electricity demand. Outgoing CEO Brian Dames has described this approach as unsustainable. The Integrated Resources Plan 2010...
The return-to-service (RTS) stations were mothballed in 1990 and are being recommissioned owing to the growing demand for electricity. The RTS project for Camden power station ended on March 31, 2010, with the entire station fully commercial.

The peaking stations can generate electricity within a few minutes of startup, making them ideally suited to supply power during peak periods. They also assist in regulating the system voltage and frequency to ensure stability of the national transmission network.

These hydroelectric power stations fall within the Distribution Division, in the Eastern Cape, operating unit and are used to stabilise the distribution network in that area.
Dames steps down as Eskom CEO

Eskom CEO Brian Dames resigned for personal reasons in December 2013 and will depart at the end of March 2014.

Dames has spent 25 years at Eskom and took over from former CEO Jacob Maroga in July 2010, following Maroga’s acrimonious dispute with his board and chairperson at the time Bobby Godsell.

Eskom chairperson Zola Tsotsi has praised Dames for his role in stabilising the organisation during a period of acute supply shortages and has described his departure as a “great loss”.

A process has been initiated to find a suitable replacement for Dames.

In response to questions as to whether he felt pressured to resign in light of delays to Eskom’s build programme and other organisational challenges, Dames stressed that it was his own decision and that he was “absolutely not pressurised”.

In January 2014 Eskom chairperson Zola Tsotsi reported that the power utility’s board was pursuing an open process to select a successor to.

In an interview with Engineering News Online, Tsotsi also confirmed that Public Enterprises Minister Malusi Gigaba, who has the prerogative to appoint the CEO, had mandated the board to oversee the selection process, which would be facilitated by executive search agencies. Gigaba would still have the final word on the selection and his spokesperson Mayihlome Tshwete confirmed that a Cabinet endorsement would also be sought.

A board committee, led by Tsotsi and comprising the chairpersons of the various board subcommittees, has been assembled and will select and brief an executive search agency. In-house and external candidates will be considered and Tsotsi has also confirmed that the search agencies will be mandated to propose South African and foreign candidates.

Tsotsi and Gigaba have indicated their preference for a handover period from Dames to the new CEO. However, Tsotsi has acknowledged that the timeframe may not allow for a handover. He has also acknowledged that it might not even be possible to appoint a new CEO by the time Dames is scheduled to leave.

The board has decided that none of its members will take up an executive role, as was the case when Mpho Makwana was executive chairperson, following Maroga’s departure in late 2009 and prior to the appointment of Dames in mid-2010. Therefore, an existing Eskom executive has been earmarked for the position in an acting capacity, should the appointment of a permanent CEO not be possible by April 1, 2014.

Tsotsi and Gigaba have been contemplating the selection process for several months, as it was clear from early 2013 that Dames intended to resign. However, it was also decided that the formal selection process would be initiated only after the resignation announcement, which was eventually made at the group’s interim results presentation on December 5.

Dames first approached Tsotsi, outlining his intention to leave Eskom in February 2013, citing work/life imbalances as the primary consideration. However, Dames had also been unsettled by media reports suggesting that he was to be relieved from his duties – reports that emerged in the immediate aftermath of the African National Congress’ Mangaung elective conference, which took place in late 2012.

“I immediately dissuaded him from even giving me a letter of resignation . . . I actually told him, I don’t want to see it,” Tsotsi has disclosed.

Gigaba and Tsotsi, who dismissed the media reports as speculation, offered assurances as to Dames’ continued value to the organisation. At a weekend meeting, held in early 2013, Dames was requested to stay on as CEO, particularly in light of the problems taking place at the Medupi construction site, which had effectively been shut down.

Dames agreed to continue, but by April, he indicated to Tsotsi his determination to leave. However, he offered to stay on, even beyond his contractual notice period of six months, should that be necessary.

Initially, Dames indicated his desire to depart at the end of 2013, but the board asked him to stay on until at least the middle of 2014. Eventually, it was settled that Dames would stay on until the end of the Eskom’s 2013/14 financial year.

The focus, since December 5, 2013, has turned to the selection process, which is gathering momentum. Applications are open and the executive search agency will also present the board selection committee with a list of suitable candidates to interview. A shortlist will be created and the board committee will conduct the interviews, before delivering a further shortlist of names to Gigaba for his approval.

The board is expected to “run with the process” and the Minister “expects to receive a solid list of candidates from the board”. Any association between Dames’ decision to leave Eskom and Gigaba’s call for “heads to roll”, as a result of delays and cost overruns at the Medupi power station site, have also been dismissed.

assumed the fleet to have an average availability of 86%; however, actual performance has reportedly declined to less than 80%.

To avoid continued stress on the fleet, Eskom has implemented a new five-year generation strategy, premised on an 80:10:10 principle, to ensure its fleet is sustainable for the long term. On average, Eskom is targeting plant availability of 80%, with unplanned outages limited to 10% and scheduled maintenance set at 10%. About 8% of the planned maintenance will be fixed in terms of a schedule, while the other 2% will be short-term maintenance. The 10% planned maintenance is scheduled over a full operating year, with maintenance limited to about 2 000 MW in winter and peaking at about 8 000 MW during summer months.

The lack of spare capacity became evident again in November 2013, when Eskom declared its first electricity emergency since early 2008 because of planned and unplanned maintenance and the delay in the commissioning of the first unit of Medupi. At the time, Eskom had 5 400 MW of its generating capacity out of production for maintenance and, added to that, 5 700 MW of capacity was down, owing to unplanned outages, resulting from the tripping of units, boiler leaks and the inability of certain plants to produce power at full capacity.

Usually, Eskom only takes 4 000 MW of capacity offline during its summer maintenance programme.

Eskom compelled heavy industrial users, particularly power-hungry aluminium smelters and ferrochrome smelters, to reduce their consumption by at least 10% to help secure the system during the power emergency. However, the utility subsequently revoked the emergency declaration three days later, after its key industrial users voiced unhappiness about the call for a prolonged restraint in electricity use. Many big users felt that the measures were unfair, as the supply reduction was not demanded of the entire Eskom customer base, despite the fact that municipalities and households accounting for 30% of the peak demand.

### Generation capacity investments

To reverse the electricity difficulties of recent years, a large-scale investment programme focusing on new power stations and major power lines is under way. The current capacity expansion programme will cost R340-billion, excluding capitalised borrowing costs, and will have added 17 100 MW of generating capacity to the national grid by 2018/19.

When the expansion programme started in 2005, Eskom’s nominal generating capacity was 36 200 MW. By March 2013, Eskom had delivered 6 017 MW of the new generation capacity, which includes the open-cycle gas turbines (OCGTs) at Ankerlig, near Atlantis, and Gourikwa, in Mossel Bay, and the 3 700 MW return-to-service programme.

Eskom’s three largest new build projects are Medupi, Kusile and Ingula. The three projects rank among the world’s largest construction projects. At a combined capital expenditure of about $23-billion, they cost more than the world’s largest mining project – BHP Billiton’s $20-billion Olympic Dam, in Australia – which is about $2-billion short of the $25-billion that is invested in the world’s biggest electricity project – the Three Gorges Dam hydropower plant, in China.

The main challenge facing the capacity expansion programme is remaining on schedule, especially in the current labour environment where unrest is causing project delays. The Medupi power station, for instance, has been delayed to 2014, which Eskom estimates has resulted in a supply shortfall of 700 MW, which has to be managed until the first unit of the plant delivers stable, reliable power. There have also been cost escalations for major projects.

### Eskom’s planned installed capacity expansion plan

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<th>Project</th>
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<tr>
<td></td>
<td>Year to March 2014</td>
</tr>
<tr>
<td>Grootvlei</td>
<td>30</td>
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<tr>
<td>Komati</td>
<td>100</td>
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<tr>
<td>Medupi</td>
<td>1 588</td>
</tr>
<tr>
<td>Kusile</td>
<td>800</td>
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<td>Ingula</td>
<td>1 332</td>
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<td>Sere</td>
<td>100</td>
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<td>Total (MW)</td>
<td>130</td>
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Source: Eskom 2013 financial year results presentation, July 2013
Return-to-service programme

In the early 2000s, Eskom initiated a programme to bring three mothballed power stations back into service, adding 3 700 MW to the power-stressed grid. The programme comprises the refurbishment and return to service of the Camden (1 520 MW), Grootvlei (1 200 MW) and Komati (1 000 MW) plants, which were mothballed during South Africa’s power-surplus years of the late 1980s and 1990s.

Eskom completed the R25.1-billion return-to-service programme in October 2013.

Reviving these power stations has increased the demand for coal from sources in Mpumalanga, which led to a serious deterioration of the province’s road infrastructure. Eskom has implemented a coal-to-rail plan, of which Grootvlei forms part. In collaboration with State-owned Transnet Freight Rail, a 20 km rail line is being built from the Balfour North train station to the Grootvlei power station and is expected to be completed by March 2014.

New baseload capacity

Medupi facts:
- Output: 4 764 MW (world’s fourth-largest power station)
- Location: Lephalale, Limpopo
- Technology: Coal, dry-cooling and flue-gas desulphurisation to remove sulphur dioxide emissions
- Name: Medupi is a Sepedi word, which means rain that soaks parched lands, giving economic relief.

Eskom’s committed baseload capacity investments include the Medupi and Kusile coal-fired projects being built near Lephalale, in Limpopo, and Delmas, in Mpumalanga, respectively.

The Medupi project entails the construction of a 4 764 MW dry-cooled coal-fired plant. The baseload power station – the first to be built in South Africa in more than two decades – will use supercritical technology, which will make it more efficient than older coal-fired stations. The power station is designed to be flue-gas desulphurisation (FGD) ready – a mechanism that controls emissions. Eskom plans to retrofit Medupi with FGD six years after each unit has been commissioned.

Medupi will source its coal from Exxaro’s Grootegeluk colliery, which also supplies the existing Matimba power station.

Medupi is the first of the two megascale coal-fired projects due to come on line, but it has faced numerous delays and several cost increases since construction started in 2007.

The latest delay – announced in July – pushed the synchronisation of Unit 6, the first of six 800 MW units, to mid-2014, from the previous December 2013 deadline. Public Enterprises Minister Malusi Gigaba insisted at the time that the December deadline would not change. The project is three years behind its original schedule. Once Unit 6 is operational, Eskom plans to bring the remaining five units on line in intervals, targeting a fully commissioned plant by 2017.

Eskom expects Kriel compliance resolution by the end of January

State-owned electricity utility Eskom expects to secure a resolution by the end of January with regard to its Kriel power station, in Mpumalanga, operating in breach of its Atmospheric Emission Licence conditions.

Spokesperson Andrew Etzinger told Engineering News in early January that, owing to the progress being made with the “relevant authorities”, the power station had, thus, not been partially shut down, in line with a self-imposed compliance deadline of December 31, 2013.

The utility acknowledged last year that the 3 000 MW power station had been unable to comply with the licence since its introduction in July and indicated that it might be forced to shut up to 2 400 MW of capacity, should it fail to find a remedy.

“We expect final resolution by the end of January,” Etzinger reported.

Towards the end of 2013, the Department of Environmental Affairs (DEA) advised Eskom to apply for a five-year postponement to Kriel’s compliance. However, it stressed that there was no legal provision for the plant to be exempted from the licence conditions.

Eskom placed newspaper advertisements indicating that it planned to apply for a postponement and an exemption from the Minimum Emission Standards as they applied to Kriel.

However, the DEA indicated that, although Section 59 of the National Environmental Management: Air Quality Act provided for exemptions to provisions of the Act, no exemptions could be granted from a provision of Section 22, which related to the Atmospheric Emission Licence.

Eskom indicated that it had found solutions to ensure that the Duvha and Matla power stations, which are also located in Mpumalanga, were compliant with the requirements of the Minimum Emission Standards of the Air Quality Act, but that Kriel could only be made compliant through fabric filter plant retrofits, which were currently scheduled for between 2017 and 2022.

Source: Engineering News, January 2014
Eskom has placed much of the blame for the latest Medupi delay on the shoulders of the contractors, citing issues with the control and instrumentation (C&I) and boiler-welding contracts.

The three work packages of particular concern are:

- the Alstom C&I contract to deliver the central computer system needed to monitor and control the plant – the software has failed factory acceptance tests;
- Hitachi Power Africa (HPA) retested and fixed multiple welds after irregularities had been found with the post-weld heat treatment of the boiler; and
- boiler welds that did not meet Welder Performance Qualification Record specifications had to be replaced.

HPA has lamented the shortage of skills in the local engineering and construction sector, particularly a shortage of experienced A-class welders. Projects, such as Medupi and Kusile, require a technique called mirror welding, which can only be performed by A-class welders.

Nevertheless, it has confirmed that it can meet Eskom’s revised commissioning programme, despite having to replace four separators. The next milestone for Unit 6 will be the execution of the hydro test, which is scheduled for March 2014.

To ensure the project remains on schedule, the Medupi management team has adopted a 24-hour, seven-day presence to oversee the performance of contractors.

Besides technical issues relating to the welding and C&I contract, there is also ongoing labour problems at the strike-prone site. Early in 2013, the site was closed for ten weeks and only reopened after Gigaba personally intervened. A project labour agreement was at the heart of the workers’ unhappiness, as it reportedly had led to inconsistencies in the treatment of workers on the site. Following negotiations between Eskom senior executives, contractors and trade union officials, a new partnership agreement was reached in June 2013.

The cost of the Medupi plant has also risen significantly since 2008, when it was estimated at R87-billion. In June 2012, that figure was revised to R91.2-billion and in July 2013, Eskom said the power station would cost R105-billion, excluding interest during construction, which is estimated at about R30-billion. According to *Engineering News* a large portion of the cost increase relates to owner’s development costs, which increased from R6-billion to R11-billion, as the utility had to allocate urgent resources to deal with delays.

The Department of Public Enterprises (DPE), which manages State-owned utilities, such as Eskom, has vowed to regain some of these expenses through claims against contractors. The penalty clause that enables it to claw back the cost overruns applies to all contractors employed in the construction of its power stations. In November, Eskom served its two main contractors – HPA and Alstom – a bill for cost overruns and to pay the utility for stepping in to manage their contractors. Not only will the contractors be required to fund the correction of their work defects but they will also have to pay for extended labour hours.

**Kusile facts:**

- **Output:** 4 800 MW (the world’s third-largest coal-fired power station)
- **Location:** Emalahleni, Mpumalanga
- **Technology:** Coal, dry-cooling and flue-gas desulphurisation to remove sulphur dioxide emissions, as well as carbon capture and storage ready.
- **Name:** Kusile is a Ndebele and Siswati word meaning good morning, the dawn has come.

The 4 800 MW Kusile power station, adjacent to the existing Kendal power station, has the same technology as Medupi, but with the addition of FGD, which reduces sulphur dioxide emissions. Kusile will be the first power station in South Africa to have the FGD technology installed.

The first unit of the R118.5-billion Kusile power station is expected to be commissioned in December 2014, with the five subsequent units being completed at six- to eight-month intervals thereafter. Kusile was initially pencilled in for a mid-2013 start, but Eskom delayed the introduction of the plant’s first unit, owing to funding challenges that are currently in hand.

Kusile will obtain most of its coal – 16-million tons a year – from Anglo American’s New Largo operation, in Mpumalanga. However, by December 2013, Eskom and Anglo American had yet to sign a supply contract, owing to a disagreement over revised black economic-empowerment (BEE) requirements imposed by the DPE. Government wants to use Eskom’s procurement muscle to develop new BEE mining companies and has stipulated that the utility source up to 64% of its coal from emerging miners, which are defined as having BEE ownership of 51%. New Largo is owned by Anglo American Inyosi Coal – a BEE company in which Anglo American owns 73% and Inyosi consortium 27%. The black shareholding means the mine meets the country’s mining legislation requirements, but not the DPE’s requirements. Eskom has medium-term contracts in place to supply Kusile until New Largo comes on line in 2017.

**Peaking and renewable projects**

**Ankerlig and Gourikwa stations**

In response to a rapidly deteriorating supply/demand balance, government had to find electricity solutions that could be built in a very short lead time. In 2004, it
was decided that Eskom should build two OCGT power stations in the Western Cape, as these plants could be erected in a much shorter lead time than for instance larger coal or nuclear power stations. Depending on the capacity, OCGTs have lead times of between one and three years, whereas coal and nuclear have lead times of about eight to ten years.

Eskom completed the first phases of the 1 332 MW Ankerlig power station, in Atlantis, Cape Town, and the 740 MW Gourikwa power station, in Mossel Bay, in time for the winter peak demand of 2007.

OCGT plants can burn either natural gas or liquid fuel (kerosene or diesel). Ankerlig and Gourikwa currently use imported diesel as their fuel source, which makes it extremely expensive to run these plants. In 2012/13, the cost of operating the OCGTs more than tripled to about R3.6-billion, as Eskom used the plants for longer periods to meet peak demand and create space for higher levels of planned maintenance. In the first three months of 2013, Eskom ran the OCGTs harder than in any month in the last four years. Average load factors were close to 20%.

It is estimated that Eskom consumes more than 609-million litres of diesel, which accounts for about 8% of its primary energy costs, while these plants provide less than 1% of the country’s electricity supply.

Eskom is working on several schemes to convert Ankerlig and Gourikwa to combined-cycle gas turbine stations, which will help lower its primary energy costs and increase its coastal capacity. The switch from diesel to gas will mean 80 MW could be added to the grid for each gas turbine and the power-unit efficiency will increase from 33% to 50%.

At Ankerlig, for instance, the conversion will enable Eskom to operate five of the plant’s nine turbines on midmerit basis, which is equivalent to 15 hours a day for five days a week. For this, it will require 35-billion cubic feet of gas yearly.

Eskom has issued a request for information for the supply and delivery of conventional or unconventional gas to the Ankerlig station. The utility has signed a memorandum of understanding with gas explorer Sunbird Energy to jointly investigate the feasibility of securing gas for Ankerlig from the Ibhubesi gas project being developed off South Africa’s West Coast. Sunbird says it could supply gas at between $12/GJ and $15/GJ, which is significantly lower than the $22/GJ to $25/GJ that Eskom is paying to operate the plant on diesel.

Eskom is also cooperating with national oil company PetroSA on possibly importing liquefied natural gas (LNG) through a floating terminal offshore of Mossel Bay. Should the LNG project proceed, the imported gas will
be shared between PetroSA's gas-to-liquids refinery and the Gourikwa power plant.

**Ingula pumped-storage scheme**

The 1 332 MW Ingula power station is situated in the Little Drakensberg mountain range, straddling the border of the Free State and KwaZulu-Natal. The R25.9-billion pumped-storage scheme was started in 2004 and is expected to be fully operational in 2014.

Ingula consists of an upper dam (Bedford), in the Free State, and a lower dam (Braamhoek), in KwaZulu-Natal, each with a water capacity of about 22-million cubic metres. The dams are 4.6 km apart and are connected by underground waterways, through an underground powerhouse, housing four 333 MW pump turbines. During times of peak energy consumption, water will be released from the upper reservoir through the pump turbines to the lower reservoir to generate electricity. During low energy-demand periods (generally during the night and over weekends), the pump turbines will be used to pump the water back from the lower dam to the upper dam.

**Eskom suspends construction at all sites following Ingula fatalities**

Eskom suspended work across all its construction sites for several days in November 2013 to assess safety conditions after an accident at its Ingula project, on the border of the Free State and KwaZulu-Natal, left six people dead and several injured.

The accident occurred when an 8 t gantry, or platform, came loose from its anchoring and travelled at speed down a 938 m inclined underground shaft, connecting with a monorail used to transport workers and two other gantries on which employees were standing.

Three of the deceased were employed by Eskom’s primary contractor, CMC, and the other three by CMC subcontractor Whesseo. Contractors across the construction industry were subjected to severe criticism from outgoing Eskom CEO Brian Dames, who said he had long appealed to the engineering and construction firms in Eskom’s employ to improve safety measures and adhere to the utility’s mandated safety requirements.

“I have been ... disappointed by the lack of interest demonstrated by the heads of [construction and engineering] houses, many of whom don’t pitch up at our yearly safety sessions. For the last few years, we have appealed that company leadership take personal accountability for safety in their companies. There have been strides within Eskom, but we have not seen this in those working with us,” he stated.

Source: Engineering News, November 2013

**Sere wind farm and Upington solar plant**

On the renewable-energy front, Eskom is involved in wind energy and solar technologies. The 100 MW Sere wind farm is the coal-heavy utility’s first large-scale renewable-energy project. Eskom already operates a small 3.2 MW experimental wind farm at Klipheuwel, in the Western Cape.

The Sere project involves the development of a wind farm near Koekenaap, in the Western Cape, comprising 46 turbines of 2.3 MW each, a new substation and a 132 kV distribution line. In May 2013, the National Energy Regulator of South Africa (Nersa) granted Eskom a licence for the R2.4-billion project, giving the green light for construction to start. The wind farm will deliver its first power to the national grid in the first half of 2014 and will be in full commercial operation by the end of 2014. It has an expected operating life of 20 years, with average energy production of about 233 000 MWh/y.

Eskom claims that the cost of generating electricity at the Sere wind farm will compare favourably with those achieved by private wind developers in the first two rounds of the DoE’s Renewable Energy Independent Power Producer Procurement Programme (REIPPPP). The Eskom project’s levelised cost will be 77c/kWh, which compares with an average levelised cost of R1.14/kWh for projects in the first bidding round and 89.7c/kWh for the second-window projects. The average cost for private wind projects declined to 65.6c/kWh in the third bidding round.

A group of development finance institutions, including the African Development Bank (AfDB), France’s Agence Francaise de Developpement (AFD), the Clean Technology Fund (CTF) and the World Bank, is funding the project.

Eskom has also started the development of a 100 MW concentrated solar power (CSP) project near Upington, in Northern Cape. The utility has secured an oversized site for the plant, in anticipation of it pursuing a 500 MW to 1 000 MW fleet of solar projects in the coming years.

Eskom is proposing a central-receiver CSP plant, where molten salt is used as a storage and heat-transfer medium. The so-called power tower will be surrounded by an array of heliostats, or mirrors, which continuously reflect sunlight on the tower’s central receiver. A CSP plant is similar to conventional power plants in that steam is used to power a turbine and generator, but the fossil fuel combustion is replaced with solar energy.

Initial estimates indicate that the project will cost about R9-billion, but a more precise capital estimate is expected only after a tender has been concluded. Eskom plans to appoint an engineering, procurement and construction contractor in the second half of 2014. Construction is envisioned to start in 2014, continuing through to the end of 2017, with the commissioning phase continuing into the first half of 2018. Tractebel Engineering is the owner’s engineer on the project.

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**Creamer Media’s Electricity Report – February 2014**

Presented by: PowerTech
DoE plans solar parks in the sun-drenched Northern Cape

The Department of Energy (DoE) is studying the feasibility of developing two solar parks of 1 000 MW each in Prieska and Upington, as part of a larger plan to create a 5 000 MW solar-park corridor in the sun-drenched province.

The studies, which the Central Energy Fund is undertaking, will investigate the best mix of technologies, including concentrated solar power (CSP), photovoltaic (PV) and concentrated PV, thereafter advising on the implementation timeline.

The studies are earmarked for completion in the first quarter of 2014. The environmental-impact assessment for the sites will be completed by the end of the third quarter of 2014.

Eskom is developing its CSP demonstration project, near Upington, with five privately owned CSP projects with a combined capacity of 400 MW – all located in the Northern Cape – have also been approved under the three bidding rounds of the DoE’s Renewable Energy Independent Power Producer Procurement Programme. Nineteen private solar PV projects, with a combined capacity of about 880 MW, are also under consideration in the province.

The Northern Cape’s solar resources are among the best in the world.

Source: GeoModel Solar 2011, through Stellenbosch University

-Upington solar park in the context of direct normal irradiance solar resource in South Africa-
The CSP plant is being funded by the AfDB, AFD, the CTF, the European Investment Bank, Germany’s KfW and the World Bank.

Ensuring adequate coal supplies

While South Africa is aiming to diversify its electricity mix, coal will remain the anchor of its power sector for at least another 20 years.

Most of Eskom’s coal is supplied by “mine-mouth” facilities, with coal transported on conveyors from dedicated mines. These mines were typically established simultaneously with the power stations, and long-term supply contracts, generally on an operating cost-plus basis, were entered into for the original planned life of the power stations. The exception is the Majuba power station, in Mpumalanga, where coal is sourced from elsewhere, owing to geological problems with the colliery.

Eskom buys about half of the coal produced in South Africa every year to run its fleet of coal-fired power stations. In the 2012/13 financial year, the utility bought 126-million tons of coal and burnt 123-million tons.

Eskom’s coal stock days peaked at 49 days at the end of February 2013 – its highest ever, but were reduced by a three-week strike at coal supplier Exxaro in March, which impacted on the Matla, Arnot and Matimba power stations. During the strike, Eskom reduced the capacity from the affected power stations by as much as 1 000 MW to conserve its stockpiles, which impacted on its maintenance schedule.

Eskom’s coal requirements are increasing, owing to power stations being operated at capacity factors higher than envisaged in the long-term contracts, while production from some of the older collieries tied to Eskom is declining.

Over the next 40 years, Eskom needs about four-billion tons of coal to supply its current power stations to the end of their planned operating lives. Half of this is still unsecured. Experts have warned that Eskom is facing a so-called coal supply cliff, which could result in yearly shortfalls of up to 40-million tons after 2018.

It is estimated that between five and ten new mines, costing between R60-billion and R90-billion, will be required to make up the shortfall in demand.

As the reserves of the coal mines tied to Eskom’s power stations in Mpumalanga edge closer to depletion, Eskom will have to consider sourcing the fuel from new mines, with the Waterberg field appearing to be the most feasible supplier. In the National Development Plan, the National Planning Commission recommends actions to open up the Waterberg coalfield to mining, citing security of coal supply for existing power stations.

However, transporting about 100-million tons a year of coal from Limpopo’s Waterberg for power stations

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First Majuba coal train scheduled for May 2016

State-owned power utility Eskom reports that the first coal-loaded train is scheduled to begin operating on the R5.2-billion 68 km railway corridor, which is being built to link the coal mines of Mpumalanga with the Majuba power station, on May 31, 2016. The project is partly being financed with a R3.08-billion World Bank loan, with the balance being financed by Eskom.

The rail line will yield lower life-cycle transportation costs, improve coal-delivery turnaround times and enable Majuba to access more coal sources than is currently the case. It has been designed to transport 14-million tons a year of coal from Shanduka, Middelkraal, Goedgevonden, Vlakvarkfontein, Exxaro and Kuyasa.

Source: Engineering News, September 2013

Eskom’s actual stock days in the 2007/8, 2011/12 and 2012/13 financial years

Source: Eskom state of the power system update, April 2013
in Mpumalanga will inevitably increase the utility’s cost profile.

Head of the South African Coal Roadmap (SACRM), Ian Hall, has identified security of supply to Eskom as the most pressing issue. The SACRM was developed by government, business and technical experts to explore the country’s requirements for domestic energy supply, while ensuring that coal exports remain a source of foreign revenue.

A leading coal analyst says South Africa still has enough coal resources to supply power stations for a long time. The country’s total indicated resource of power station coal amounts to 33.3-billion, from which 17-billion could be extracted as run-of-mine coal. The resource is estimated to support 35 new power stations at 12-million tons a year of coal burn for 40 years each.

However, the country has to improve the investment climate for coal mining projects to secure future supplies for Eskom. The SACRM states that there is an “urgent need to create an environment conducive to mining investment”.

The roadmap also calls for clarity on the contentious issue of declaring coal a strategic resource. Eskom has long wanted coal to be declared a strategic resource, arguing that the cost of producing electricity is unnecessarily exposed to international coal market prices. It wants the price of domestic coal to be based on efficient production costs and a risk-adjusted return.

Opponents to the declaration of coal as a strategic mineral have warned that such a move will not protect Eskom’s coal future and that any effort to regulate prices could undermine investment, curtail production for domestic and export markets and effectively “sterilise” the country’s remaining coal resources. Senior coal analyst Xavier Prevost believes that South Africa should rather limit exports of low-quality coal needed for Eskom to generate power.

Until recently, the quality of coal used by Eskom has been largely unsuitable for exports, but there has been an increase in demand for low-quality coal, particularly from India. Eskom is proposing that it gets offered certain grades of coal first before producers are allowed to export the fuel. It also wants to be consulted prior to the awarding, granting and renewal of exploration and mining licences.

The power producer is concerned that domestic coal prices are trending towards international export prices and that the higher prices will have a significant impact on electricity tariffs, which is already causing much anxiety among electricity consumers.

Eskom divisional executive Kannan Lakmeeharan has stressed that the utility is not seeking to limit exports, but to make sure that domestic needs are met at a reasonable price.

Eskom’s primary energy costs have risen sharply in recent years and is currently the single-largest component of its overall costs. In the 2013 financial year, Eskom’s primary energy costs surged by 36% to 28.1c/kWh, with coal accounting for 53% of the increase. The cost of the coal that Eskom burnt in the year rose by 24%.

The Nersa-approved tariff increase for the third multiyear price determination (MYPD3), which covers the five-year period to March 31, 2018, allows for coal-related increases of 10%. Eskom requested R355-billion to cover its primary energy costs over the MYPD3 period, but was granted R293-billion.

**Eskom to buy one-billion tons of coal from emerging miners**

In December 2012, Public Enterprises Minister Malusi Gigaba initiated Eskom’s strategy of integrating emerging miners into its supply base to take development and transformation to a new level.

The strategy defines emerging miners as those with a 50%-plus-one-share black ownership. Using the Department of Mineral Resources’ black economic-empowerment (BEE) definition of 26% black ownership, there are currently 33 BEE coal mines in South Africa. If measured using the 51% definition, the number is negligible.

Currently, emerging miners in general – comprising junior mining companies not owned by black and majority black-owned juniors – account for 17% of Eskom’s total spend of R28-billion a year.

Eskom is aiming to procure “no less than a billion tons-plus” of coal from emerging black coal miners in the next 40 years. Currently, eight mines supply about 60% of the country’s output.

The new BEE requirements have caused Eskom to bump heads with Anglo American, which is to supply its Kusile power plant, in Mpumalanga, from the New Largo mine.

**Eskom’s carbon footprint**

Owing to South Africa’s dependence on coal for electricity and liquid fuels, the country ranks as the world’s twelfth-largest carbon dioxide (CO2) emitter. Eskom is the biggest producer of carbon emissions in South Africa.

Generally, the CO2 emissions are related to the age of the power station, with the older return-to-service plants having the lowest efficiencies and the highest relative emissions – more than 1.2 t of CO2 per MWh sent out. The Matimba power station currently has the lowest relative emissions of 0.89 t of CO2 per MWh sent out, but it will be surpassed by the new Medupi and Kusile power stations, which are based on subcritical technology, making them more efficient. Kusile’s CO2 emissions will...
be 0.78 t per MWh sent out and Medupi’s will be 0.75 t per MWh sent out.

The FGD technology that the utility is installing at Kusile and that it plans to install at Medupi is very water intensive and will, for instance, triple Medupi’s water usage when the station is retrofitted.

The utility has applied for the postponement of and exemption from the minimum emissions standards for its coal and liquid fuel-fired power stations. It argues that full compliance with the national emissions standards at all its power stations will place major demands on South African water resources and produce higher waste volumes, with a small incremental benefit to the environment.

To reduce greenhouse-gas emissions from its power stations, Eskom is exploring the feasibility of burning biomass alongside coal at some of its power stations. Eskom estimates its biomass co firing initiative has the potential to displace about 10% of its yearly coal consumption with ‘torrefied’ wood pellets.

Biomass is considered a ‘carbon-neutral’ fuel because the CO₂ released during the burning of the fuel is recaptured from the atmosphere when new plants are grown. However, there are additional greenhouse-gas emissions generated in the processing and transportation of the biomass material.

Engineering News reports that Eskom is specifically interested in refined pellets, as the fuel is more coal-like in its characteristics when compared with untreated biomass, which typically cannot be stored outside in the coal yard because of a tendency to absorb moisture and leach organic compounds. There is also a significant threat of self-ignition.

Electricity tariffs

For the past 30 years, electricity prices in South Africa were among the lowest in the world, but the trend took a turn when Eskom had to embark on a large-scale capacity expansion programme to bring supply back in line with demand.

Eskom’s electricity price is regulated through an MYPD. The first MYPD started on April 1, 2006, to March 31, 2009, and was followed by a second MYPD from April 1, 2009, to March 30, 2012. During the second MYPD, referred to as MYPD2, two interim applications were made to correct the differences between the MYPD estimates and the actual costs and revenues. This resulted in the delay of the second MYPD by one year. MYPD2 was, therefore, implemented on April 1, 2010, and ended on March 31, 2013. MYPD3 started on April 1, 2013, and covers a five-year period to March 31, 2018.

In February, Nersa ruled that Eskom be allowed to increase its tariffs by an average of 8% a year over the MYPD3 period. This is less than the 16% average increase requested and translates into allowable revenue of R863-billion over the next five years, compared with the nearly R1.1-trillion sought.

The regulator allowed Eskom to raise its average selling price from 61c/kWh to 65.51c/kWh from April 1, 2013. The prices will rise to 70.75c/kWh in 2014/15, to 76.41c/kWh in 2015/16, to 82.53c/kWh in 2016/17 and to 89.13c/kWh by the end of the MYPD3 in 2017/18.

Nersa has stipulated that poor residential consumers be protected from the increases, which means that other customers have to subsidise them. For instance, increases to Homelight 20A customers, who use up to 350 kWh a month, have been limited to 5.6%. Increases for Homelight 20A customers, who consume more than 350 kWh, have also been limited to 7.6%. Tariffs for higher-consuming residential customers have been increased by the 8% average. However, tariffs for Eskom’s direct large industrial and mining customers increased by 9.6% from April 1, 2013.

Urban local authority tariffs rose by 7.1% and rural local authority tariffs increased by 12% from July 1, 2013.

Eskom’s application for a tariff increase was heavily criticised during public hearings in early 2013, especially as power prices had trebled between 2007 and 2012. The manufacturing industry, in particular, voiced concern at the electricity tariffs imposed by municipalities, which rely on this as a major source of revenue to fund other municipal functions. In terms of the Municipal Systems Act, municipalities are allowed to add a surcharge for commercial and industrial customers.

Manufacturing companies complained that their competitiveness were being eroded by the above-inflation electricity price hikes.

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Source: Adapted from Eskom
The Department of Trade and Industry is conducting a study of the impact of the steep electricity price increases on the manufacturing sector. It intends to use the outcomes of the study as a basis for dialogue with the industry on possible incentives.

Labour movements have also criticised the above-inflation tariff increases, which they say threaten job security, while civil society has questioned Eskom’s cost base and its over-reliance on coal, particularly in light of sharp increases in primary energy costs in recent years.

The General Household Survey, which Statistics South Africa published in November 2013, has found that, nationally, about 50% of households spent less than 5% of their income on electricity, while about 24% spent between 5% and 10%, 16.8% spent between 10% and 20%, and 8.8% of households spent 20% or more. In Gauteng, 11.4% of households spent more than 20% of their income on electricity.

Eskom’s financial performance

The above-inflation tariff increases have helped Eskom to substantially improve its financial performance in recent years, with the utility reporting a surplus for the fourth consecutive year in the 2013 financial year.

Eskom showed a profit after tax of R5.23-billion in the year ended March 31, 2013, with most of the profit earned in the first part of the 12-month period, which covers the winter months when tariffs for large customers are higher and maintenance costs are lower.

Revenue for the year increased to R128.8-billion, from R114.8-billion in the previous financial year, with a decline in electricity sales offsetting an increase in tariffs.

To fund its current capital expansion programme, Eskom needs R300-billion for the period from 2010 to 2017. By the end of March 2013, it had raised R203-billion from a range of sources, including bond markets, export credit agencies, development finance institutions and a shareholder loan. It had secured 83% by mid-July 2013.

Capital raising relies on the organisation’s credit rating, which is linked to South Africa’s sovereign rating.

Owing to the national energy regulator granting it a lower-than-requested yearly tariff increase of 8% for the next five years, Eskom estimates that it will suffer a revenue shortfall of R225-billion. Outgoing CEO Brian Dames has said that he cannot discount the possibility that Eskom could request a reopening of the MYPD3.

To deal with the financial gap, the utility is undertaking a “systematic” review, while implementing a R30-billion cost-savings plan to which it committed in its MYPD3 application.

The State-owned utility is also planning to raise R50-billion more debt than initially expected to complete its current build programme. This means its overall debt position may rise to R450-billion in the coming years.

The group has a strategy of raising long-term debt and 56% of its current debt has a payback period of more than ten years, with a debt maturity profile extending to 2042.

New finance chief for Eskom

Tsholofelo Molefe became the new FD of Eskom in December 2013, taking over from Caroline Henry, who acted in the position since the resignation of former FD Paul O’Flaherty.

O’Flaherty stepped down in July after serving as FD for three-and-a-half years. He joined Eskom before it had a funding plan in place for its large-scale capital programme. Since then, nearly 83% of the R300-billion funding plan for 2010 to 2017 has been secured.

Source: Engineering News, July and December 2013

Demand-focused initiatives

With long lead times to construct new capacity to help South Africa alleviate constraints on the electricity system, interventions to curb power demand are regarded as important measures in balancing supply and demand.

There are essentially two types of interventions in place at State-owned power utility Eskom for lowering electricity usage: The demand response interventions, whereby the system operator can request consumers to reduce consumption during times of power system constraint, usually in return for compensation; and integrated demand management (IDM) interventions, which are geared towards demand reduction through a range of energy efficiency incentive programmes.

Demand response is not a permanent reduction in electricity usage and is only used “as and when needed”, whereas energy efficiency occurs through the installation of long-lasting technologies.

Demand market participation

The demand market participation (DMP) programme is a demand response intervention that was launched in 2004 and targets industrial and municipal customers. A relatively small number of customers (about 20) with high consumption levels, are signed up for the DMP programme. Currently, the DMP programme can achieve 700 MW of load reduction. Eskom is aiming to increase this to 920 MW by the onset of the 2014 winter and to 1 200 MW by the winter of 2015.

Nersa has granted Eskom funding of R1.87-billion over the next two years to fund the DMP programme.
Eskom has investigated the possibility of extending the programme to smaller industrial, commercial and agricultural customers and launched a pilot demand response aggregation programme in 2012 to sign up at least 500 MW of potential savings. The utility has, however, not seen a significant uptake – most probably owing to the level of incentive offered – and as such, the pilot programme will not become a permanent one.

**Power buy-backs**

Power buy-backs are a contentious issue and one that Eskom, does not favour. In 2012, the utility aggressively used power buy-back agreements with certain of its large industrial customers – most notably ferrochrome smelters – to create additional space on the power system. The agreements usually lasted for 30 days and entailed customers reducing their baseload demand, which Eskom repurchased at a negotiated rate, reportedly up to R75c/kWh. The utility has spent about R2.9-billion on buying back electricity.

Eskom has included R8.9-billion into its tariff application for the MYPD3 period for power buy-backs. However, Nersa has refused to allow funding for the programme, which Eskom official Thembani Bukula has described as “inefficient” and “counter productive”.

Should Eskom, therefore, use the power buy-back programme, it will have to pay for it from its profit. Eskom spokesperson Andrew Etzinger has said the utility does not plan on entering into any more buy-back agreements and that they are regarded as a last resort.

**Energy efficiency incentives**

Eskom has introduced a range of incentives for the residential, industrial and commercial sectors to facilitate the switch to energy efficient technologies. These include the residential mass roll-out, the standard offer, standard product and performance contracting programmes, as well as the Esco model.

The residential mass roll-out was the largest contributor to demand savings in the 2013 financial year. The programme is based on a free bulk roll-out of a “basket” of technologies, focusing on replacing inefficient lighting and implementing energy-saving technologies and load control devices in the residential sector. It was started in the 2011/12 financial year to complement the compact fluorescent light project, which has facilitated the installation of about 60-million lamps on an exchange basis.

For businesses, Eskom designed the standard offer and standard product programmes to financially reward companies for achieving energy savings. Since their inception in October 2011, about 245 projects have been registered for the standard offer, realising demand savings of 118 MW and energy savings of 478.6 GWh. More than 4 800 projects have been registered for the standard product programme, which started in January 2012, realising demand savings of 122.7 MW and energy savings of 555 GWh.

The Esco model uses energy service companies to submit proposals to Eskom on potential savings at customer premises. Under the performance contracting programme, the utility buys bulk verified energy savings across multiple sites and technologies by contracting a single project developer. The minimum project size under this programme is substantially larger than the average demand-side management project submissions – it has to be more than 30 GWh of savings over a three-year sustainability period.

However, in light of financial constraints, Eskom placed a temporary hold on all its energy efficiency rebate programmes in late 2013, pending a review of the incentive programmes. The Eskom board is to deliberate on a new list of programmes in February 2014.

Eskom was left with a shortfall of R7.9-billion for its IDM programmes, after Nersa had only granted the utility funding of R5.18-billion for energy efficiency incentives in the MYPD3 period, compared with the R13.09-billion sought.

The lower-than-applied for funding meant that Eskom could not sustain its aggressive programme at the same levels. Eskom has indicated that it is in discussions with government on alternative funding models.

With verified savings of about 3 600 MW since inception, the IDM programmes have established capacity (so-called negawatts) equivalent to that of an average power station. Without those savings, Etzinger says, South Africa would have been in daily load-shedding since 2008.

In the MYPD2 period, Eskom spent R5.4-billion on IDM interventions and achieved savings of 1 200 MW over the three-year period. For the 2013/14 financial year, Eskom is aiming to achieve savings of 379 MW through energy efficiency interventions and is targeting 240 MW in the next financial year.

**Solar water heaters**

While Eskom is a key contributor to the Department of Energy- (DoE-) funded solar water heater (SWH) programme, it is not affected by the Eskom rebate review and is continuing.

The SWH programme used to be supported by a rebate scheme, with incentives for customers to convert to solar technology. The rebate expired at the end of 2012.
and is currently funded by the taxpayer, instead of the electricity consumer. The DoE has allocated R4.7-billion to accelerate the project, which aims to install one-million geysers by the end of the 2014/15 financial year. So far, about 370 000 SWHs have been installed.

The SHW programme stipulates local content of 70%.

**Independent power producers**

Until recently, public coffers essentially funded all South Africa’s electricity generation projects, but in 2003, Cabinet decided that 30% of all new power generation would be derived from IPPs. The country is introducing private power in the form of baseload capacity, renewable-energy projects, waste energy projects and cogeneration plants.

**Renewable-energy power**

South Africa has a high level of renewable-energy potential, especially in solar and wind energy technologies, given its excellent solar resource and fair to reasonable wind resource.

South Africa first explored the option of renewable-energy feed-in tariffs before choosing instead to pursue a criteria-based competitive-bidding process. These criteria include the consideration of the creation of a local industry, job creation, BEE and technology transfer.

The REIPPPP encourages private-sector investment in wind, solar, PV, CSP, biomass and small hydro technologies. The DoE initially said it would procure 3 725 MW of renewable power in five different rounds and allocated 1 850 MW to onshore wind, 200 MW to CSP, 1 450 MW to solar PV, 12.5 MW to biomass, 12.5 MW to biogas, 25 MW to landfill gas, 75 MW to small hydro and 100 MW to small projects. In late 2012, the DoE determined that a further 3 200 MW of renewable generation capacity was to be procured by 2020 under the REIPPPP, in addition to the 3 725 MW already sought.

So far, the DoE has held three bidding rounds and has committed to procure 3 916 MW of electricity from IPPs, with most of the investments in wind projects, followed by solar PV and CSP projects.

Under bid window one, the DoE entered into 28 agreements on November 5, 2012, and under bid window two, it entered into 19 agreements on May 9, 2013. With regard to the most recent bidding round – bid window three – the DoE had received 93 bids by the submission deadline of August 19, 2013, with a collective capacity of 6 023 MW, although the available megawatts for allocation under this round was only 1 473 MW.

In November, the DoE announced that 17 projects, with a combined capacity of 1 456 MW, had reached preferred bidder status under the third bid window. Seven onshore wind, six solar PV, two CSP, one landfill gas project and one biomass project were selected. The winning bidders are expected to sign project agreements with the DoE by July 30, 2014, after which developers will have about one month to finalise all documentation and foreign currency hedging before project roll-out begins.

Should all 17 projects of bid window three reach financial closure, the number of renewable-energy projects across South Africa will increase to 64, with a combined installed capacity of 3 933 MW. So far, 47 projects from the two earlier bid windows have moved through the financial-close threshold and are at various stages of development. Some projects have already started producing electricity.

The fourth bidding round is expected to start in July 2014 and will be finalised a year later.

The pricing has significantly improved during the first three bidding rounds, with solar PV bidders
## Renewable Energy Independent Power Producer Programme projects (REIPPPP)

<table>
<thead>
<tr>
<th>Project</th>
<th>Capacity (MW)</th>
<th>Location</th>
<th>REIPPPP window</th>
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<tbody>
<tr>
<td><strong>Solar photovoltaic (PV)</strong></td>
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<tr>
<td>Konkoonsies Solar</td>
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<td>Lesedi Power Company</td>
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Source: Compiled from Department of Energy documents

## REIPPPP – continued

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<th>Location</th>
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## Wind

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<td>Hopefield wind farm</td>
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<td>Jeffreys Bay</td>
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<td>Amakhala Emoyeni</td>
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<td>Gouda wind project</td>
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<td>Loeriesfontein 2 wind farm</td>
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<tr>
<td><strong>Total wind</strong></td>
<td>1 983.5</td>
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</table>

Source: Compiled from Department of Energy documents
particular competitive. The average PV price fell from R2.75/kWh in bid window one to 88c/kWh in the third round. The price of onshore wind projects declined from R1.14/kWh in round one to 89c/kWh in round two and to 66c/kWh in the third round. CSP prices fell from R2.68/kWh in the first window to R1.46/kWh. The third bidding round made it possible for CSP generators to receive a 270% premium on that base price, if they were able to dispatch power during South Africa five peak-demand hours.

The landfill gas project of the third round came in with a price of 83.7c/kWh and the biomass project had a bid price of R1.24/kWh. All prices are fully indexed, using April 2011 as the base year.

In light of the competitive responses received during the third bidding round, the DoE has indicated that it may appoint further preferred bidders. This will require a reallocation of capacity set aside for onshore wind and solar PV for future REIPPPP submission windows, as the allocation for round three had been restricted to 1 473 MW.

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The South African Photovoltaic Industry Association believes there is potential to appoint further solar PV bidders collectively representing up to 500 MW of capacity. It argues that many of the other unsuccessful bids in the round were also highly competitive and that it will be in the country’s interest to name more preferred bidders.

The DoE intends to make an announcement on a potentially extended list of preferred bidders early in 2014. The roll-out of the REIPPPP has attracted significant local and international interest in renewable-energy projects and has resulted in the Department of Environmental Affairs (DEA) receiving numerous environmental-impact assessment (EIA) applications for projects scattered across the country.

Acting on behalf of the DEA, the Council for Scientific and Industrial Research approached the Centre for Renewable and Sustainable Energy Studies to produce a geographical information systems layer containing all the renewable-energy EIA applications submitted to the DEA before December 2012.

<table>
<thead>
<tr>
<th>REIPPPP – continued</th>
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<tbody>
<tr>
<td><strong>Project</strong></td>
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<td><strong>Concentrated solar power (CSP)</strong></td>
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<td>Khi Solar One</td>
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<td>KaXu Solar One</td>
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<td>Bokpoort CSP project</td>
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<td>Xina CSP South Africa</td>
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<td>Karoshoek Consortium</td>
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<td>Stortemelk Hydro (Pty) Ltd</td>
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<td>Neusberg hydro electric project</td>
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<td><strong>Total small hydro</strong></td>
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<tr>
<td><strong>Landfill gas</strong></td>
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<td>Johannesburg landfill gas-to-electricity</td>
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<td><strong>Biomass</strong></td>
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Source: Compiled from Department of Energy documents.

South Africa releases high-resolution wind resource map

The Department of Energy (DoE) published a large-scale high-resolution wind resource map, in July 2013 generated from the Wind Atlas for South Africa (Wasa) project for the research, development and planning of wind farms.

The map aims to improve the knowledge and quality of resource assessment methods and tools during the planning and development of wind farms and off-grid electrification, while enabling local institutions to undertake wind resource measurements.

The map’s incorporated information, such as ground surface terrain effects, will save time and costs during the planning process, as it will accurately determine the local wind climate, identify high-yielding wind development zones and the potential yield of the wind energy resources, as well as estimate available wind energy and capacity.

The wind resource map currently covers the Western Cape and parts of the Eastern Cape and Northern Cape; however, following the completion of the second phase of the Wasa project, it will also encompass KwaZulu-Natal, the remaining parts of the Eastern Cape and parts of the Free State.

“The wind resource map will be a very useful instrument in government’s further planning of the efficient use of the country’s wind resources. Also, we expect this new data to serve as an all-important tool in enabling developers to fast-track their own efforts in developing wind farm projects,” says Energy Minister Ben Martins.

The map will feed into the DoE’s Renewable Energy Independent Power Producer Procurement Programme, which requires independent power producers to comply with environmental, agricultural and social criteria.


The South African Photovoltaic Industry Association believes there is potential to appoint further solar PV bidders collectively representing up to 500 MW of capacity. It argues that many of the other unsuccessful bids in the round were also highly competitive and that it will be in the country’s interest to name more preferred bidders.

The DoE intends to make an announcement on a potentially extended list of preferred bidders early in 2014. The roll-out of the REIPPPP has attracted significant local and international interest in renewable-energy projects and has resulted in the Department of Environmental Affairs (DEA) receiving numerous environmental-impact assessment (EIA) applications for projects scattered across the country.

Acting on behalf of the DEA, the Council for Scientific and Industrial Research approached the Centre for Renewable and Sustainable Energy Studies to produce a geographical information systems layer containing all the renewable-energy EIA applications submitted to the DEA before December 2012.
Source: This map was developed using DEA Geographic Information System digital data, but its secondary product has not been verified by the DEA.
South Africa and Morocco are leading the African charge into renewables, as they are the only countries on the continent so far to have introduced large IPP procurement programmes. South Africa is ranked the twelfth most attractive investment for renewable energy, with the programme having attracted more than R150-billion in investment. The renewables industry could contribute 42%, or 17 800 MW, of South Africa’s new generation capacity by 2030.

**Small-scale renewables**

Through the small projects IPP programme, the DoE is aiming to procure 100 MW of electricity from developers of onshore wind, solar PV, biomass, biogas or landfill gas technologies, which have projects ranging in size from 1 MW to 5 MW. The programme will cater, in particular, for biomass technologies that can provide opportunities for rural development.

In August, the DoE formally invited bids for the small-scale renewable-energy projects.

**Baseload, midmerit and cogeneration projects**

Besides the electricity that government is acquiring from private developers of renewable-energy projects, it is also aiming to sign up 7 761 MW of private baseload capacity.

Two Ministerial determinations, published in late 2012, opened the way for bidding programmes for baseload projects and the so-called Medium-Term Risk Mitigation (MTRM) programme. Under the baseload determination, the DoE is seeking to procure 2 500 MW of coal-fired generation capacity; 2 652 MW of baseload or midmerit gas power, some of which will probably be imported; and 2 609 MW of hydroelectric power imports.

The DoE aims to procure 800 MW of near-term cogeneration capacity and 474 MW from natural gas projects under the MTRM determination. The cogeneration capacity could arise from biomass, industrial waste and combined heat and power sources.

The DoE requires the IPP capacity to be introduced into the electricity system by March 2019, which will be in advance of any new Eskom capacity to follow the introduction of the Medupi, Kusile and Ingula power projects that are meant to be completed by 2018.

A Parliamentary Portfolio Committee on Energy heard in July 2013 that South Africa could produce as much as 3 500 MW of power through the cogeneration of electricity from waste heat fuels. However, concerns were raised about the absence of incentives.

Some of the larger cogeneration projects under development or consideration include sugar producer Tongaat Hulett’s proposed 80 MW plant, to be built at its Amatikulu sugar mill, in KwaZulu-Natal; industrial group Scaw Metals’ planned 68 MW plant, in Germiston, in Gauteng; and forest products group Mondi’s 47 MW steam turbine, at its Richards Bay mill, in KwaZulu-Natal.

Smaller projects, such as a cogeneration plant at York Timbers’ Sabie plant, in Mpumalanga, generating between 12.5 MW and 25 MW, and a 4.9 MW operation at Anglo American Platinum’s Waterfall smelter, in the North West, are also on the cards. In March, SA Calcium Carbide opened its 8 MW cogeneration plant at its Newcastle facility, in KwaZulu-Natal, converting waste gas produced during the carbide production process into electricity. The R115-million project was supported by the Industrial Development Corporation.

In June, the DoE issued a request for registration and information to help in the design of procurement processes for baseload and cogeneration electricity facilities. In a similar market appraisal in 2012, potential IPPs registered projects with a combined capacity of 60 300 MW.

**Peaker projects**

The DoE is pursuing a project to introduce new peaking power from two OCGTs being developed in KwaZulu-Natal and the Eastern Cape. The R9.7-billion power projects will have a combined nameplate capacity of 1 005 MW.

The 670 MW Avon facility being built in KwaZulu-Natal will comprise four units, while the 335 MW Dedisa plant, in the Eastern Cape, will incorporate two units. Each facility will also have on-site fuel and water storage for a continuous 45-hours of full-load operations.

The DoE has awarded the build, own and operate package to a consortium comprising international energy group GFD SUEZ (38%); Legend Power Solutions (27%), of South Africa; Mitsui (25%), of Japan; and The Peaker Trust (10%), representing BEE and community interests. The peaker projects have been subjected to several delays, with the DoE having initially selected an AES-led consortium as the preferred bidder, before terminating talks in April 2008.

The turnkey engineering, procurement and construction contractors are Ansaldo Energia and Fata, of Italy. Investec acts as the coordinating mandated lead arranger and sole documentation bank providing senior debt facilities in a syndicate of six financial institutions.

In June, the consortium signed 15-year power purchase agreements with Eskom. Construction started on the two projects in August. Commercial operation is expected at Dedisa in 2015 and at Avon in 2016.
South Africa’s electricity requirements are outlined in the Integrated Resources Plan (IRP), which defines the country’s long-term electricity needs and identifies the generating capacity, technologies and costs associated with meeting that demand.

The current version of the IRP was promulgated in 2011 and covers the period from 2010 to 2030. It is known as the policy-adjusted IRP or IRP2010 and has evolved since its initial draft to bring forward the introduction of renewable energy and accelerate planned new coal builds.

In addition to all existing and committed power plants, including 10 000 MW of new coal capacity approved prior to the IRP2010, the final plan includes 6 300 MW of new coal-fired electricity, 9 600 MW of nuclear, 17 800 MW of renewable energy and 8 900 MW of other sources.

By 2030, South Africa should have an installed capacity of 89 500 MW, of which 45.9% will be sourced from coal, 12.7% from nuclear, 21% from renewable energy and the balance from other sources such as gas, pumped storage and hydropower.

The IRP was the subject of a review in 2013, with demand assumptions identified as one of the main issues.

In December 2013, the Department of Energy (DoE) published an updated version of the IRP2010. The document, which is going through a public-comment period before a final draft is submitted to Cabinet in March, materially lowers the projected demand outlook over the 20-year horizon. The update anticipates that 6 600 MW less capacity will be required by 2030, which could allow government to delay its decision on a new nuclear build programme.

A demand projection of between 345 TWh and 416 TWh by 2030 is made, which is considerably lower than the 454 TWh anticipated in the current version. From a peak demand perspective, this means a reduction from 67 800 MW to 61 200 MW (on the upper end of the range), with the consequence that less capacity of at least 6 600 MW is required.

The update still uses the National Development Plan’s (NDP’s) aspirational economic growth target of 5.4%, against which the economy is currently underperforming. Should the economy’s recovery towards such growth levels fail to materialise, though, the update’s demand projections could be reduced even further.

In the South African context, the IRP is not an energy plan, but rather an electricity plan and a subset of the Integrated Energy Plan (IEP). Faced with the power crisis in 2008, government fast-tracked the publication of an IRP and promulgated the plan in May 2011, despite not having first finalised an IEP, which is a requirement of the National Energy Act of 2008.

The IEP refers to an over-arching coordinated energy plan and sets out the provision of all energy sources, not only electricity, up to 2050. The IEP will incorporate the DoE’s new Liquid Fuels Master Plan, the Gas Infrastructure Plan and the IRP, besides others.

In July 2013, Cabinet endorsed a draft IEP report ahead of a public consultation period, which started in September. The draft report contains a base case, providing a snapshot of a business-as-usual scenario,

### Generation capacity 2010 to 2030

<table>
<thead>
<tr>
<th></th>
<th>Total capacity</th>
<th>Capacity added (incl. committed)</th>
<th>New capacity (uncommitted)</th>
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<tr>
<td></td>
<td>MW</td>
<td>%</td>
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<td>45.9</td>
<td>16 383</td>
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<td>2 370</td>
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<tr>
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<td>1 332</td>
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<tr>
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<tr>
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<td><strong>Total</strong></td>
<td><strong>89 532</strong></td>
<td><strong>56 539</strong></td>
<td><strong>42 539</strong></td>
</tr>
</tbody>
</table>

Source: IRP2010, May 2011

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Creamer Media’s Electricity Report – February 2014  
Presented by: Powertech
IRP debate heats up

Much of the initial commentary on the draft update of the Integrated Resource Plan (IRP) has focused on the potential delay, downscaling or even abandonment of South Africa’s proposed new nuclear build programme. However, more comprehensive responses are beginning to surface on the 20-year electricity blueprint as the February 7 comment deadline approaches.

As was expected, the proposed revisions to the nuclear build programme, together with the suggested $6 500/kW price cap for any new nuclear capacity, continues to receive significant attention.

The update itself describes the nuclear decision as being “particularly volatile”, owing to shifts in underlying assumptions, not least being the lowered demand assumptions. The document ventures that demand will be in the 345 TWh to 416 TWh range by 2030, as opposed to the 454 TWh expected in the current plant. “From a peak demand perspective this means a reduction from 67 800 MW to 61 200 MW (on the upper end of the range), with the consequence that at least 6 600 MW less capacity is required.”

However, University of Cape Town Energy and Development Research Centre director and National Planning Commission member professor Anton Eberhard highlights that even this moderated demand assumption remains “aspirational”, having been aligned to the National Development Plan’s expectation of average yearly growth of 5.4%. In reality, South Africa’s economy is growing far slower, while electricity demand has declined to 2006 levels.

Energy Intensive User Group (EIUG) chairperson Mike Rossouw believes the final IRP requires a “more realistic return-to-growth profile” than what is contained in the update and a commitment to regular updates of the demand assumptions.

Similarly, Frost & Sullivan consulting manager for energy and environment Johan Muller argues that the demand uncertainties underline the importance of revising and amending the IRP every two years. “The key will be to avoid a situation where there is an oversupply of generation and resultant debt that cannot be serviced,” Muller adds.

South African Wind Energy Association (Sawea) CEO Johan van den Berg, meanwhile, says the latest modelling appears to be more robust and nuanced. Nevertheless, he questions whether it fully grasps the changes that have taken place in the electricity environment, or whether the “old order” is still assumed in assumptions. “We need to fine-tune our IRP modelling assumptions,” Van den Berg avers.

Nuclear Industry Association of South Africa (Niasa) Knox Msebenzi takes a slightly different tack. He argues that demand has been artificially suppressed through measures placed on large power consumers and that demand will “bounce back” once economic growth recovers.

“The long-term outlook remains that of sustained demand growth,” Msebenzi asserts, while acknowledging that electricity price increases have led to increasing energy efficiency and decreasing energy intensity. “Eskom has, thus, reached the point where it can no longer increase prices at will, as it will be punished by decreasing demand.”

Msebenzi is also critical of the update’s proposal that long-term commitments be eschewed in favour of building only the minimum generation capacity required. Such an aversion to long-term commitments will “preclude new nuclear construction” and South Africa will turn to shorter lead-time technologies, which Niasa argues could well have a higher levelised cost of electricity (LCOE) than nuclear. This, in turn, could result in the price of electricity increasing “unnecessarily”, while stifling economic growth.

By contrast, the EIUG’s Rossouw sees the update’s preference for “decisions of least regret” as a “big positive”, while again underlining that a “realistic demand forecast is critical”.

Nuclear Debate

Rossouw is also supportive of the suggested $6 500/kW capital-cost cap for any new nuclear capacity, while Eberhard says the update contains a “sensible decision tree around nuclear”.

“Essentially, it says if electricity demand is lower and nuclear prices are higher, then we don’t need nuclear. [But] whether decisions take this rational path remains to seen,” Eberhard comments, while noting that the capital costs associated with the new nuclear plant being planned for Hinkley Point, in the UK, are around $7 900/kW.

The revised base case in the IRP draft update continues to include nuclear. However, it proposes only 6 660 MW of nuclear capacity (including Koeberg) by 2030, instead of the 11 400 MW expected under the current IRP. Total nuclear capacity in 2050 ranges from 0 MW to 30 400 MW.

Muller believes the proposal to delay and scale back nuclear, as well as to set a capital-cost cap is a sound one, particularly in light of the current project management issues at Medupi and Kusile, as well as the possibility that shale gas could be a “potential game changer if managed correctly”. Muller adds that the impact of other types of gas should also not be discounted.

However, Niasa’s Msebenzi believes the cap places too much emphasis on the overnight costs of nuclear, while failing to take account of nuclear LCOE being more sensitive to the yearly percentage weighted average cost of capital (WACC). “It is clear that the proposed cap on the overnight cost for...”
nuclear is largely meaningless and should, for all the power sources, rather be replaced by a cap on the LCOE, which will be determined by the combined effects of WACC, overnight costs, external costs and system costs,” he argues.

Several other assumptions included in the update, Msebenzi adds, “drastically overestimate” the LCOE of nuclear and “drastically underestimate” the LCOEs of coal, solar photovoltaic (PV) and wind.

“Therefore, nuclear capacity was suppressed or even absent in most of the scenarios of the IRP. However, once one corrects these flaws, nuclear easily outperforms all its competitors. Therefore, nuclear should neither be scaled down nor be delayed,” he avers.

Unambitious on Gas
Gas appears to be a material beneficiary of the revisions made in the IRP update, with a target of 3 550 MW set for closed-cycle gas turbines, up from 2 370 MW in the current plan.

Frost & Sullivan’s Muller, however, describes it as an “unambitious target that could be higher”, but a higher target depend on a system-wide solution. “Finding a stable supply of gas, whether in the form of shale gas, or whether from Mozambique, will be vital for this target to be met.”

He adds that the gas market is in “a chicken-and-egg situation regarding investment”, since the market and infrastructure are currently geared towards a coal-based system, with few major investors willing to make the leap of transition to a gas-based system.

Gigajoule Group CEO Johan de Vos is even more strident, arguing that the IRP fails to fully recognise the economic, environmental, construction and operational benefits of natural gas. “At present natural gas power stations are being constructed at between $0.8- and $1.3-million per installed megawatt, depending on technology. This is substantially cheaper than coal or nuclear power stations. Typical construction times of two years make it even more competitive, if the interest during construction is accounted for.”

De Vos describes the recent discoveries in the Rovuma basin, of northern Mozambique, as “truly remarkable”, with proven reserves of about 170-trillion cubic feet. “Studies for a pipeline from these discoveries to the south indicate that it is feasible and economical to flow around 400-million gigajoule a year, supplying around 5 000 MW to the regional grid. For such a pipeline, the estimated investment would be about $5-billion, with a three-year construction period.”

He argues that any revised IRP should be committing to buying at least 5 000 MW of gas power, which would provide the “catalyst” for the development of a pipeline from the massive reserves in the Rovuma basin. The project, he adds, could be pursued with firm and clear pricing and a rand-denominated transportation tariff.

Rossouw believes a detailed study is required to strengthen the potential for gas, while Eberhard proposes that the plan comprise a mix of offshore sources and liquefied natural gas imports in the near term, which could be supplemented by shale gas as the reserves are proved.

Renewables rethink?
There are also mixed reactions to the update’s proposed changes to the renewables mix, with its greater emphasis on solar, both PV and concentrated solar power, and less emphasis on wind.

“This did come as a surprise, since wind is a very viable energy option,” Muller says, while acknowledging that solar is starting to make more sense as capital costs fall.

“My view is that the best technology should be picked for the circumstances, which will typically hold that a combination of wind and solar will be used,” he adds, arguing that government should rather pose an open question and let the market decide the technology.

Eberhard adds that the issues need further interrogation, adding that he suspects the assumed learning curves for solar may have been a “little too aggressive”.

Sawea’s Van den Berg says the modelling underpinning the new IRP disregards some of the major changes that have taken place in the domestic renewable-energy sector over the past few years, particularly the success of independent power producers (IPPs) in delivering projects. “The modelling proceeds implicitly as if all energy plants will be built on the country’s balance sheet. The enormous risk and opportunity costs of Eskom building are disregarded for modelling purposes,” he says.

Van den Berg adds that, at an average of 74 c/kWh in the third renewables bidding round, wind is now almost 30% below the likely cost of electricity to be supplied by Medupi. “This tells us that, all other things being equal, the more wind power we install, the more money we save.”

Coal Consensus?
One area of emerging consensus from the update, though, surrounds the issue of the performance of the Eskom fleet and a proposal that a procurement programme be pursued for fluidised-bed-combustion coal generation instead of the so-called Coal 3 mega-project.

“Going for a number of smaller coal IPPs, preferably with off-the-shelf designs, is clearly less risky than another mega Eskom coal plant,” Eberhard asserts.

Muller adds that, if put to the private sector, ways will be found to ensure South Africa’s coal resources are put to efficient and cost effective use. “Again, rather than prescribing the technology types, it would be interesting to see what would happen if government said to the private sector: “We have need of X amount of megawatts, here are the available resources, let us know what you propose.”

There is less agreement, though, on whether there is indeed potential to extend the life of the Eskom fleet.

Rossouw cautions that such a move will depend on whether exemption is given to the retrofitting of flue-gas desulfurisation at the plants, while Eberhard adds that adequate coal sources will have to be secured.

Muller says much hinges on the specifics that emerge from a cost-benefit analysis that will need to be undertaken at each power station. “In general, Eskom is not in the position to mothball any power stations at the moment, so the questions on whether to extend the lifetime of the fleet is a moot point: the power stations (subject to safety standards) must be run until new power generation plants come online.”

The Department of Energy, which published the draft update on November 25, aims to promulgate a final updated IRP during March 2014.
and several test cases, which are premised on a set of core assumptions relating to matters such as project discount rates, population, demand growth and energy prices. The draft report has been guided by policies, such as the NDP and the New Growth Path, as well as other strategies and commitments, including transport policy, water resources infrastructure plans and the climate change policy.

The final IEP is expected to be published during the course of 2014.

Planning for future baseload

The IRP2010 makes provision for a third coal power station after the Medupi and Kusile power plants currently under construction in Limpopo and Mpumalanga respectively, and for 9 600 MW of new nuclear capacity.

In August 2013, Cabinet gave its approval to proceed with another large-scale coal-fired plant. However, it did not prescribe which entity – Eskom or an independent power producer (IPP) – should build the new power station, which has been widely dubbed ‘Coal 3’. In terms of the law, Energy Minister Ben Martins is to determine who will build and operate the new coal-fired plant.

At the time, Eskom welcomed the Cabinet endorsement and said it provided the utility with the required time to make adequate preparations for the development.

However, the updated version of the IRP favours a model whereby ‘Coal 3’ is pursued as a procurement programme for several plants, rather than a mega-scale facility such as the new Medupi and Kusile coal-fired plants under construction in Limpopo and Mpumalanga respectively. The update argues that a programme should be launched for between 1 000 MW and 1 500 MW of fluidised bed combustion coal plants, based on discard coal.

On nuclear, the updated IRP calls for a delay in building new nuclear capacity, stating that it will not be needed until after 2025, owing to revised demand projections. The updated document suggests that the country should not prematurely commit to a technology that may become redundant if electricity demand expectations do not materialise. Under low demand growth conditions, the update does not foresee a need for nuclear baseload until after 2035.

The current version of the IRP indicates 11 400 MW of capacity (including the Koeberg station, in the Western Cape), with the first 1 600 MW of the larger 9 600 MW fleet being integrated from 2023. However, the base case outlined in the update, envisages 6 660 MW by 2030, with the first capacity being introduced in 2025.

Questions have been raised about the affordability of the nuclear programme and whether it was sensible to invest in large generating plants ahead of smaller, more modular solutions that could be more responsive to changes in demand-growth patterns. The updated IRP document highlights the uncertainty about nuclear-build costs, noting that these range from $3 800/kW to $7 000/kW, while the update makes the assumption of $5 800/kW overnight costs, in 2012 dollar terms.

Cabinet has already confirmed that Eskom, which operates the Koeberg nuclear plant, will be the owner-operator of the future nuclear fleet, although a strategic equity partner may be introduced.

Eskom is responsible for the environmental-impact assessments across the various nuclear sites, which currently include Thyspunt, in the Eastern Cape, and Bantamsklip and Duynefontein, both in the Western Cape. There is strong community opposition across all the proposed sites, with antinuclear lobby groups opposing the construction of any new nuclear facilities.

Prior to the publication of the updated IRP document, the DoE had stressed that the nuclear programme would not be dislodged by public opposition. Government has stressed on numerous occasions that nuclear power is needed to help the country meet its commitment to lowering its carbon footprint, while ensuring sufficient baseload capacity to support economic growth.

Companies that have expressed an interest in bidding for South Africa’s nuclear energy plan include Westinghouse, from the US; Russia’s Rosatom; Areva, of France; and South Korea’s Korea Electric Power Corporation.

The government intends to use the nuclear build programme to develop a domestic nuclear industry, create opportunities for South African industry in the nuclear supply chain and possibly access the global nuclear export markets. Rosatom has estimated that the South African nuclear energy programme could create 15 000 additional jobs in the construction, service and operation of the new units, as well as several thousand jobs in related industries. Areva has cautioned, however, that full localisation of the nuclear plant build programme will be impossible, as an audit of local engineering companies has revealed that only about 10% of the firms qualify for a nuclear build. In France, only about 65% of the nuclear programme is fully localised.

The broader nuclear programme also includes the replacement of six steam generators at the 1 800 MW Koeberg to extend the unit’s life span by at least another decade. Eskom plans to announce the winning bid for the refit, which could cost between R1-billion and R10-billion, in early 2014. Areva, Mitsubishi Heavy Industries and WorleyParsons Resources and Energy are among the companies that have responded to the tender. The new generators will be installed in 2018.

* See Appendix 1 for more on the updated IRP document.
Nuclear: Infrastructure and safety review

South Africa has delayed its nuclear programme to accommodate a voluntary peer review by the International Atomic Energy Agency (IAEA) of the country’s preparedness to safely add new capacity, given that 30 years have lapsed since it last constructed a new nuclear power station. The agency undertook an Integrated Nuclear Infrastructure review mission to South Africa in early 2013, following an internal self-assessment report, completed by nuclear stakeholders in 2012.

The IAEA review focused on 19 topics – safeguards, management, electrical grid, nuclear safety, national position, radiation protection, regulatory framework, legislative framework, funding and financing, human resources development, security and physical protection, site and supporting facilities, environmental protection, stakeholder involvement, industrial involvement, emergency planning, nuclear fuel cycle, radioactive waste and procurement.

The IAEA has reportedly expressed some concern that the National Nuclear Regulator reports to Parliament through the Department of Energy. The international agency feels that a conflict-of-interest situation could arise.

Further, a safety reassessment performed at the current nuclear facilities has identified the need for certain improvements to the plants and regulatory framework. Energy Minister Ben Martins reported in September that the country was undertaking a self-assessment process to address matters related to the emergency preparedness as outlined in the IAEA Emergency Preparedness Review (EPREV) guidelines. South Africa will have a full IAEA EPREV conducted in 2014.

Sources: Engineering News and the Department of Energy

Unconventional and conventional gas

Unconventional gas refers to natural gas that is trapped in deep underground rocks, which is difficult to reach such as shale rock or coal beds. Unconventional gas includes shale gas, coalbed methane and underground coal gasification.

Conventional gasfields are usually situated in easier-to-reach layers of rock.

Globally, natural gas is becoming ever more important for energy production and in South Africa, plans are afoot to increase the role of gas in the country’s energy mix. Currently, gas accounts for only 3% of South Africa’s energy mix, but it is projected to increase to 11% by 2030.

The main future sources include known conventional gas reserves in South Africa and neighbouring countries, such as Mozambique and Namibia; unconventional sources, such as shale gas in the Karoo region of South Africa; or coal-bed methane (CBM) in Botswana, South Africa and Zimbabwe, and liquefied natural gas (LNG) imports.

Despite severe criticism from environmentalists, the government is puntting shale gas as a lower carbon fuel source for electricity and liquid fuels production. Top government officials have on several occasions described shale gas as a game changer for the South African economy, but opinion is divided over whether the benefits of shale gas can outweigh potential environmental and social impacts associated with the extraction of the gas.

A year after lifting a ban on the drilling process known as hydraulic fracturing, or fracking, Cabinet approved the gazetting of regulations in October 2013 for the exploration of shale gas in South Africa. The Karoo basin is estimated to have the world’s eighth-largest technically recoverable shale gas resource at 390-trillion cubic feet. The draft regulations require drilling companies to meet American Petroleum Institute standards governing the type of equipment used and the disclosure of chemicals.

<table>
<thead>
<tr>
<th>Rank</th>
<th>Country</th>
<th>Shale gas (trillion cubic feet)</th>
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<tbody>
<tr>
<td>1</td>
<td>China</td>
<td>1 115</td>
</tr>
<tr>
<td>2</td>
<td>Argentina</td>
<td>802</td>
</tr>
<tr>
<td>3</td>
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<tr>
<td></td>
<td>World total</td>
<td>7 299</td>
</tr>
</tbody>
</table>

Source: US Energy Information Administration (June 2013)

While proponents of shale gas tout the potential economic benefits of developing the resource, opponents, such as Treasure the Karoo Action Group and AfriForum, emphasise the environmental risk associated with extracting the gas. The main concern centres on water, considering that water is particularly scarce in the Karoo, the name of which is derived from the Khoisan word meaning “land of thirst”.

Fracking requires large supplies of water and there is a risk of water contamination from fracking fluids and materials brought to the surface by returning fluids.

Fracking proponents have urged government to award exploration licences as a matter of urgency to, at least, ascertain the commercial and economic viability of shale gas in the Karoo basin. Even those experts who consider themselves to hold neutral ground in the fracking debate, such as Rhodes University economics professor Gavin Keeton and University of the Free State Faculty of Natural and Agricultural Sciences associate professor Gideon Steyl, have stressed the need to drill exploratory wells to better inform stakeholders about the potential costs and benefits of developing a shale gas industry.
What is hydraulic fracturing?

Hydraulic fracturing, or fracking, is a technique involving a vertical well that is drilled to a depth of between 2 000 m and 6 000 m, after which the drilling bore turns to drill horizontally for a few thousands metres.

Water, sand and other fluids are injected at very high pressure into the rock formation, creating tiny fissures, allowing for the natural gas to flow. The fluids injected into the rock consist of 99% water and sand, and about 1% chemical additives.

About 20-million litres of water and thousands of litres of chemicals are required for one frack per well. The chemicals can range from benign to highly toxic.

If a well is 2 500 m from the surface to the hydraulic fracturing location, it equates to:
- more than 11 Carlton Centres – Africa’s tallest skyscraper – stacked end-to-end;
- more than 22 Victoria Falls – the world’s largest waterfall – stacked end-to-end; and
- more than 24 rugby fields from goal line to goal line.

Since the promulgation of the IRP2010, there have been several new gas finds and developments in the gas market on the domestic, regional and international fronts. These have required a change in how the IRP considers gas options. The updated document includes a ‘big gas’ scenario to consider the potential regional and local gas developments. It recommends that gas options be pursued and that shale gas exploration be accelerated.

According to Mineral Resources Minister Susan Shabangu, the country plans to issue licences permitting shale gas exploration in the first quarter of 2014.

The move to pursue South Africa’s shale gas potential follows a shale boom in the US, which is transforming that country into a budding energy exporter. However, it diverges from policy in France and the Netherlands, where fracking has been restricted or banned.

Besides shale gas, the NDP also calls for exploratory drilling to identify economically recoverable coal seam reserves. CBM is attracting considerable attention in Botswana and South Africa. Petroleum Agency South Africa estimates South Africa’s resource of CBM at about ten-trillion cubic feet.

Underground coal gasification (UCG) also holds promise as a future source of energy for South Africa. The UCG process unlocks the energy potential of deep coal that would otherwise go unmined by converting the coal into gas while it is still underground, or in situ.

Eskom has been involved in researching and developing UCG at its Majuba power station, in Mpumalanga, for the past six years. The utility has successfully run a small-scale pilot plant for two years, cofiring Majuba with gas and coal, and is advancing to a larger project. During the second phase, it will use a larger gasifier to feed more gas into the power station. It will still be co-fired with coal, but when the project reaches the third phase, Eskom will use only gas.

Other groups involved in UCG projects include coal mining firms Anglo American Thermal Coal and Exxaro Resources, as well as former Sasol executives Johan Brand and Elphus Monkoe, who are planning a UGC project in Theunissen, in the Free State. Brand and Monkoe’s venture will supply coal gas to a 50 MW IPP plant.

While plans are advancing on the domestic unconventional gas-to-electricity front, government is engaging with the authorities in neighbouring Mozambique and Namibia to assess the potential of importing additional natural gas for use in power generation.

There have been calls for South Africa to embrace Mozambique’s gas reserves and suggestions that these discoveries should wipe the nuclear option off the table, considering the relatively quick power project implementation rates that gas offers. However, the large gas discoveries off northern Mozambique are more than 2 000 km from Gauteng, which will make a pipeline from source to demand an expensive option. Building an LNG import terminal will cost less than a pipeline over rough terrain and will provide more flexibility, as capacity can be increased as power demand increases.

Sasol inaugurates SA’s largest gas-fired plant

Sasol inaugurated its 140 MW gas-fired power plant – South Africa’s largest power plant using gas engines – at its Sasolburg site, in the Free State, in July 2013. The investment is also the largest single investment in gas engine technology in Africa.

Commissioned in December 2012, the project was completed three months ahead of schedule. The main supply of natural gas for the plant comes from Mozambique.

Sasol and its Mozambican partner, the country’s State-owned power utility, Electricidade de Moçambique, approved an investment in a similar power generation facility in Ressano Garcia, Mozambique. The project aims to start electricity generation in the second quarter of 2014.
ELECTRICITY TRANSMISSION

Key transmission projects

Source: Eskom, March 2013
The transmission network forms an integral part of the country’s electricity infrastructure, delivering power to major customers and load centres, from where it gets distributed to end-users.

Eskom is the licensed transmission network service provider and thus the sole transmitter of electricity through its high-voltage transmission network. Parliament is contemplating options to restructure the sector and is considering the possibility of transferring the transmission assets from Eskom by incorporating them into the yet-to-be-established Independent System and Market Operator or establishing a Transmission System Operator.

As Eskom invests in new generation capacity and the Department of Energy (DoE) advances its programmes to introduce independent power producers (IPPs) to the grid, the utility also has to expand its transmission network. In 2013, Eskom had 154 substations and 29,297 km of transmission lines.

In its current ten-year transmission development plan (TDP) for 2013 to 2022, which was published in October 2012, Eskom outlined a R149-billion investment plan to increase its grid capacity. The utility earmarked R121-billion for projects designed to improve the reliability of the network, R25-billion for programmes aimed at integrating new power generation projects and about R3-billion for customer-related projects.

The organisation plans to add 12,700 km of new transmission lines to the existing network by 2022, of which more than 8,600 km will be in the form of new 400 kV capacity and the balance comprising 3,700 km of 765 kV lines and 400 km of 275 kV lines.

Eskom will also introduce an additional 83,500 MVA of transformer capacity, 2,600 megavolt-ampere reactive (MVAr) of capacitive support and 9,200 MVAr of reactor capacity.

Besides the R149-billion allocated for upgrades and expansions, Eskom expects to spend R12.2-billion on refurbishment projects and R2.3-billion on capital spares. It has a budget of R4.7-billion for the acquisition of servitudes and the completion of environmental-impact assessments.

The TDP – the fourth to be published by Eskom Transmission – is based on the Integrated Resources Plan, which covers the period from 2010 to 2030.

One of the main challenges for private power projects is their integration into the transmission network. Eskom published an updated Generation Connection Capacity Assessment, in October 2013, to show developers the potential capacity available on its transmission network by 2016. The results of the study indicate that the grid has the capacity to connect high levels of renewable-energy generation capacity, provided that the projects are spread around the country. The report provides the available capacity that can be connected at each main transmission system substation and at area level, while maintaining N-1 Grid Code reliability.

The N-1 Grid Code is a National Energy Regulator of South Africa requirement that the system remain operable even when key equipment on the network fails. A substantial portion of the existing electricity transmission system is currently not compliant with the stipulation, but the utility is working towards 80% of its network meeting that requirement by 2017, and achieving full compliance by 2022.

In terms of area limits, the Generation Connection Capacity Assessment report states that the Limpopo and the North West can connect a combined 10 GW of new generation capacity, KwaZulu-Natal can connect 17 GW and the Cape area (Northern, Southern and Western) will be stable for 15 GW of new capacity. Many of the wind and solar projects that IPPs are proposing under the DoE’s Renewable Energy Independent Power Producer Procurement Programme are located in the Western, Eastern and Northern Cape.
ELECTRICITY DISTRIBUTION

In South Africa, the responsibility for distributing electricity to end-users is shared between Eskom and municipalities, which means that tariff structures vary and different areas are served by different service providers.

Eskom supplies the majority of electricity to the agriculture sector and industries, such as mining and transport, while municipalities are the main distributors to domestic and commercial customers. Government funding has enabled Eskom to provide electricity for poorer households, particularly in rural areas.

Government’s initial plan was to establish six regional electricity distributors to take over the assets and functions of Eskom and municipal distributors, and established EDI Holdings to set up the regional electricity distributors, or Reds. The plan was abandoned in December 2010 and no alternative was provided.

The uncertainty created during the policy hiatus has resulted in serious underinvestment in maintenance and refurbishment of distribution infrastructure. Maintenance and refurbishment backlogs are estimated to exceed R35-billion and are growing at about R2.5-billion a year. The average age of the existing network is about 50 years.

To address the shortcomings in the distribution network, the National Development Plan (NDP) – a policy blueprint for eliminating poverty and reducing inequality in South Africa by 2030 – proposed a plan to fix the electricity distribution industry.

Anton Eberhard, an energy expert from the University of Cape Town and a commissioner in the 26-member National Planning Commission, which produced the NDP, believes that 80% of the distribution problem could be fixed with 20% of the effort. The NDP’s proposal is focusing on the 12 largest municipalities, which account for about 80% of the electricity distributed by local government. It recommends that these municipalities’ electricity-distribution businesses be ringfenced, which would lead to their maintenance and refurbishment backlogs being resolved. Municipal funding formulas mean cross subsidisation of other municipal functions is common.

It also highlights investment in human and physical capital in the 12 largest municipal distributors as a high priority. Municipalities let their apprenticeship and bursary schemes collapse during the time of policy uncertainty, while senior engineers have retired or are nearing retirement age.

Once the problems of large cities have been fixed, the focus should shift to other smaller towns. The NDP suggests that Eskom, or larger cities or towns, take over electricity distribution functions on a voluntary basis from smaller, poorly performing municipalities.

The NDP further calls for more governmental support to strengthen the fight against electricity theft and for smarter management of electricity grids through smart meters.

Electricity theft

Electricity theft, through illegal connections and meter tampering is becoming an increasing problem in South Africa, costing the economy about R4.4-billion a year. In 2012/13, Eskom’s total energy losses were 9.08%, of which nontechnical losses, particularly theft, accounted for between 1.78% and 2.85%.

Households in townships and informal settlements are among the worst offenders, accounting for the biggest segment of customers who do not pay for electricity although businesses account for the most losses in terms of value. About 60% of total energy theft volumes in South Africa take place in the industrial, commercial and agriculture sectors.

Eskom GM for energy trading Maboe Maphaka explains in an article published in BDLive that businesses keep their consumption lower by tampering with meters. In the past three years, charges have been laid against 60 businesses, which normally result in a settlement and compensation for the stolen electricity.

Eskom’s Operation Khanyisa campaign seeks to curb electricity theft and related energy losses. So far, it has recovered more than R243-million in revenue since its launch in 2010. This includes more than R200-million recovered from the large power user sector and more than R43-million in tamper fines issued between 2010 and 2013.

Since the launch of the campaign, 112 arrests and 60 convictions have been made. These convictions include the first successful prosecution of two electricity theft suspects on racketeering charges, who received a combined sentence of 111 years. In 2013, five farmers appeared in the Jan Kempsdorp Magistrates Court, in the Northern Cape, on charges of fraud relating to electricity theft. Various arrests were also made in Limpopo, including two teachers, for the sale of illegal prepaid electricity vouchers. Thus far, more than 100 customers in the province who were found to have bought these illegal vouchers were also disconnected. Tamper fines of up to R5 000 were imposed for reconnection.

Besides electricity theft, Eskom is also facing network equipment theft, generally referred to as conductor or copper theft. This involves theft of overhead lines,
underground cables, airdac and bundle conductors, earthing equipment, transformers and pylon support lattices.

During 2012/13, losses owing to conductor theft totalled R50.5-million and involved 5 187 incidents.

## Electrification

South Africa initially aimed to provide access to energy to 92% of formal households by 2014, but with connection rates slowing to about half of that a decade ago, the country had to reset its universal access goal. The Department of Energy (DoE) has announced a new household electrification strategy, which is targeting access to 97% of households by 2025.

DoE deputy director-general of energy for programmes Dr Wolsey Barnard explained in an article published in *Engineering News* in February 2013 that the country could not continue with the electrification of 200 000 to 220 000 households a year, as this covered only the number of households built each year, owing to natural growth and, hence, did not effectively reduce the electrification backlog.

The DoE has identified the rural areas in the Eastern Cape, KwaZulu-Natal and Limpopo, and the many informal settlements surrounding the country’s major cities as being in need of electrification the most.

According to the General Household Survey (GHS), which Statistics South Africa published in November 2013, the percentage of households with access to electricity increased from 77.1% in 2002, to 85.3% in 2012. However, 1.45-million, or 11% of households still do not have access to electricity, while another 3.6%, or 578 005 households, access electricity informally, or illegally.

The GHS found that rural households remain more likely than urban households to be without electricity. In rural areas, 33.5% of households in formal areas and 17.3% of households in tribal areas do not have access to mains electricity.

The highest percentage of households connected to the main grid are in the Northern Cape and Free State, with 91.9% and 91.5% of households connected respectively. The survey shows that 98.2% of households with access to electricity use it for lighting and 84.5% used electricity for cooking.

### Nongrid electrification programme

As households in rural areas are typically sparsely settled, which makes the extension of grid networks to connect those areas economically unviable in the short to medium term, nongrid electrification has been identified as an alternative.

The programme is designed to temporarily give deep rural communities access to limited electricity until grid connections are possible. Solar home systems, comprising a photovoltaic (PV) panel, a charge controller, wiring and outlets for small appliances, a battery and four energy efficient compact fluorescent lights, are being given to households as part of the nongrid electrification programme.

Of the 12.8-million households that are electrified in South Africa, about 52 000, mostly in rural areas, are being supplied by basic PV solar power. The solar system allows for the use of a black and white television for four hours; four hours of quality lighting; the use of a portable radio for ten hours and the charging of cellphones. It does not cater for thermal energy needs such as cooking, heating, ironing and refrigeration.
Eskom, which is a founding member of the now 12-member Southern African Power Pool (SAPP), has indicated that it is keen to increase its role in generation and transmission projects on the rest of the continent. The South African utility is active as an operator of power generation systems in Senegal, Mauritania and Mali and the generation system in Uganda, but its future priority areas will be in the Southern African Development Community (SADC).

Outgoing Eskom CEO Brian Dames is advocating establishing a “super grid” to boost electricity supply in the power-starved sub-Saharan Africa region.

Realising the need to cooperate on a regional level on electricity-related matters, SADC countries joined forces in 1995 to form the SAPP. In 2013, the power pool had an available capacity of 51 702 MW against a demand of 53 833 MW inclusive of peak demand, suppressed demand and reserves. In 2012, a total capacity equivalent to 1 099 MW was commissioned as follows: Angola (340 MW), the Democratic Republic of Congo (DRC) (120 MW), Namibia (92 MW), Mozambique (107 MW), Tanzania (100 MW), South Africa (303 MW) and Zambia (37 MW).

Regional plans will result in the commissioning of 17 000 MW of new generation capacity between 2013 and 2016, of which 3% will be renewable energy from wind and solar sources.

African heads of State have endorsed a pipeline of 15 priority energy projects, with a combined investment value of $40.5-billion, to foster economic growth. The projects include nine hydroelectricity generation developments, four transmission corridors and two energy pipelines.

The transmission projects include the North-South Power Transmission Corridor from Egypt to South Africa, with branches into Eastern and Southern Africa; the Central Transmission Corridor, from Angola to South Africa, with branch lines into Central and West Africa; a North African Transmission Corridor from Egypt to Morocco, with links through Libya, Tunisia and Algeria; and the West African Power Transmission Corridor, linking Ghana to Nigeria, with branches to Guinea, Guinea Bissau, Gambia, Sierra Leone, Liberia and Côte d’Ivoire.

The nine hydroelectric projects include the Great Millennium Renaissance Dam, in Ethiopia; the Mphanda-Nkuwa project, in Mozambique; the Inga hydro projects, in the DRC; the hydropower component of the Lesotho Highlands Water Project Phase 2; the Sambanganalou project, on the Gambia river; the Kaleta 2, in Guinea; the Batoka Gorge project, on the Zambia-Zimbabwe border; the Ruzizi 3 project, in Rwanda; and the Rusumo Falls development, being pursued by Tanzania, Rwanda and Burundi.

The two pipelines listed are the Uganda–Kenya petroleum products pipeline and the Nigeria–Algeria gas pipeline.

**Inga project**

It has been a long-held continental dream to build the world’s largest hydroelectric scheme in the DRC, with the mighty Congo river estimated to have hydropower potential of about 40 000 MW.

The hydropower scheme has had several false starts, often as a direct result of political uncertainties in the DRC that erode the confidence of any would-be investors. However, owing to a treaty signed between the governments of South Africa and the DRC, the project might finally get off the ground.

Inga 3, which is the first stage of the much larger Grand Inga scheme, will produce 4 800 MW of electricity and will be completed in two phases. The first phase - the Inga 3 low-head project – will have a capacity of 1 800 MW and will not require the damming of the Congo river. The second phase – the Inga 3 high-head project – will add an additional 3 000 MW and includes construction of the Grand Inga dam. Five other hydropower plants will then be built on the same dam, eventually raising the scheme’s cumulative capacity to 40 000 MW.

South Africa, through Eskom, has committed to taking an initial 15% equity position in the first 4 800 MW phase of the project and will also support efforts to secure funding for the scheme.

Eskom has further agreed to buy an initial 2 500 MW of the electricity from the first phase, with the 2 300 MW balance to flow to the DRC, and has agreed to buy a minimum of 30% of any future phases, targeting an eventual offtake of about 11 000 MW.

South African Energy Minister Ben Martins has been quoted by *Engineering News* as saying that higher levels of stability in the DRC, together with growing energy demand and support for crossborder projects, bode well for the power scheme. The 2013 Budget allocated a substantial amount to the project. However, with multiple countries involved, energy-market observers have pointed out that it might be some time before the project is realised.

**Lesotho Highlands Water Project**

The governments of South Africa and South Africa have committed to building a pumped-storage scheme, with...
an installed capacity of 1 200 MW, as part of the second phase of the Lesotho Highlands Water Project (LHWP).

The bulk of the electricity will be transmitted to South Africa, with only about 200 MW to feed into the Lesotho power grid. The hydropower component of the project is expected to be operational in 2018.

The first phase of the LHWP already generates 72 MW of hydropower at the Muela power station.
Appendix 1: Extract from the Updated Integrated Resources Plan

Since the promulgation of the Integrated Resources (IRP) 2010-2030 in 2011, there have been several developments in the domestic and regional energy sector and the electricity demand outlook has changed markedly from that expected in 2010.

IRP2010 update – conclusions

1. The update and additional analysis provide valuable insights to support decisions over the next two to three years. In particular the following is strongly recommended:
   
   1.1 The nuclear decision can possibly be delayed. The revised demand projections suggest that no new nuclear baseload capacity is required until after 2025 and that there are alternative options, such as regional hydro, that can fulfill the requirement and allow further exploration of the shale gas potential before prematurely committing to a technology that may be redundant if the electricity demand expectations do not materialise (especially in the face of widespread embedded photovoltaic generation);
   
   1.2. Procurement for a new set of fluidised bed combustion coal generators should be launched for a total of 1 000 MW to 1 500 MW capacity (as a preferable implementation of the ‘Coal 3’ programme). It is recommended that these should be based on discard coal;
   
   1.3. Regional hydro projects in Mozambique and Zambia are realised including the infrastructure developments that may have positive spillovers in unleashing other potential in the region. Additionally, regional coal options are attractive due to the emissions not accruing to South Africa, and in cases where the pricing is competitive with South African options, would be preferred;
   
   1.4. Regional and domestic gas options are pursued and shale exploration stepped up;
   
   1.5. Additional analysis on the potential of extending the life of Eskom’s existing fleet should be undertaken, to firm up on the costs involved, weighing up against the environmental impacts (specifically the departments of Water Affairs and Environmental Affairs should agree on the appropriate way forward to deal with the impacts of flue gas desulphurisation on water resources in Mpumalanga). Alternatives to extending the life of the plant would be to build new coal-fired generation, which is more efficient and with lower emission rates, or non-emitting alternatives under more aggressive climate mitigation objectives.
   
   1.6. Continue with the current renewable bid programme with additional annual rounds (of 1 000 MW PV capacity; 1 000 MW wind capacity and 200 MW concentrated solar plant capacity), with the potential for small hydro and land-fill gas at competitive rates;
   
   1.7. A standard offer approach is developed by the Department of Energy in which an agency similar to Eskom’s Single Buyer Office purchases energy from embedded generators at a set price (with a self-correcting mechanism based on uptake) so as to render municipalities indifferent between their Eskom supply and embedded generators and thus support small-scale distributed generation;
   
   1.8. Formalise funding for energy efficiency demand-side management programmes and secure the appropriate mandate for the national entity to facilitate these programmes (possibly with targets on electricity intensity of the economy).

2. Many of the options considered for future generating capacity would involve contracts that may be dollar denominated. The current thinking against dollar-denominated contracting needs to be adjusted as it would jeopardise the feasibility of these options. In particular it forces developers into a shorter-term contacting paradigm in order to hedge their currency exposure and it limits the interest from potential developers. In particular development of gas options would be greatly prejudiced unless the current aversion to dollar-denominated contracts is dropped.

3. The assessment of the transmission impact of the update indicates that five possible transmission power corridors will be required to enable key generation scenarios. The main difference between these scenarios is the physical amount of transmission infrastructure within these corridors and their timing. The transmission impact assessment has been based on the reasonable spatial location of the future generation taking into account current knowledge and information. Therefore, there is still opportunity to consider better generation location strategies in the longer term. One generation strategy that can provide advantages in terms of reducing the network integration costs and minimising system losses is to consider a large distributed generation network with more appropriately sized units. These would be smaller sized plants that can be integrated into the distribution networks utilising their infrastructure and reducing the loading of the transmission grid. Initially this can be achieved with PV but later extended, with the associated transport infrastructure, to gas and even coal plants located near large loads or major load centres.

4. Considering the changes in consumption patterns and technology costs over the past three years it is imperative that the IRP should be updated on a regular basis (possibly even annually), while flexibility in decisions should be the priority to favour decisions of least regret. This would suggest that commitments to long range large-scale investment decisions should be avoided.

5. There are short-term constraints in the electricity supply industry until 2016. There are, however, few options available to alleviate the situation in this time period, except increased energy efficiency and demand-side responses, and improved utilisation of existing generation resources (improving Eskom’s fleet performance and incentivising production from existing non-Eskom generation). These options should be strengthened.

Source: Updated Integrated Resources Plan, November 2013

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O’Flaherty leaves Eskom, acting officials appointed while replacement sought (July 10, 2013).

Eskom may need to raise R50bn more debt than initially forecast (July 11, 2013).

High-resolution wind resource map released for public use (July 31, 2013).

DoE moves to improve visibility of nuclear costs ahead of big decision (August 9, 2013).

Eskom may need to raise R50bn more debt than initially forecast (July 11, 2013).

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Eskom, Sunbird sign MoU for possible gas supply to Ankerlig (January 6, 2014).

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Eskom’s reserve supply put to the test (November 25, 2013).


Nersa slaps down Eskom’s R8bn plea (March 28, 2013).

Medupi weighs as Eskom triggers emergency (November 19, 2013).

Eskom looking to buy billion tons coal from emerging black miners (December 10, 2012).

Declaring coal a strategic resource would not benefit South Africa’s economy – analyst (March 15, 2013).

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Electricity 2014: A review of South Africa’s electricity sector

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