



## Message from the NSTF Executive Director

### What should be shed at Eskom?

**The public is fed-up with the national power utility for loadshedding in ever increasing 'stages'. Should Eskom 'shed' its CEO, its managers, its power plants, or what? If South Africa needs to go beyond stage 8, large blocks (towns and cities) could be dropped off the network. The aim is to prevent this as well as a total power system collapse.**

We frequently hear or read calls for the CEO Andre de Ruyter to be replaced, or even that Eskom must be shut down and rebuilt from scratch. But these are not serious proposals or options. Eskom is not a single office, and it consists of extensive power plant operations and a vast national network for transmission and distribution. If the current highly competent CEO is replaced, we would see that it doesn't make a positive difference to the serious electricity challenges we face as a country. If the CEO should not be fired, who or what should be 'shed' to make Eskom work?

When Tommy Garner, Chair of the Independent Power Producers Association<sup>1</sup>, addressed the [NSTF discussion forum on loadshedding](#) in October last year, he pointed out that Eskom runs an aging fleet of power stations. Most of them are more than 37 years old and need to be refurbished. That means downtime. Since 2008 Eskom has not been able to do the necessary maintenance because it has to fix the airplane of power distribution while flying it. This has remained a challenge and South Africa is tangled up in an ongoing conundrum. While the generation side of Eskom is falling apart before our eyes and darkness descends on us ever more frequently, Eskom has in fact been doing scheduled maintenance to try and catch up. It simply can't do so quickly, while keeping the lights on for 14 to 22 hours per day (which is what loadshedding allows it to do) and trouble-shooting every second of every day.

To complicate an already complex situation, Eskom experienced the systematic dismantling of crucial state owned entities during the tenure of Jacob Zuma as our country's president. Pieces of the plants and the network are also even now sabotaged with such regularity that it would need a highly skilled army to guard it all. And loadshedding provides opportunities for theft of cables and other parts essential to electricity supply. (As I write, the news comes in that a conveyor belt is on fire at the Kriel power plant. The cause is not yet known).

It is clear that other sources of electricity are crucial to give Eskom the chance to fix its failing fleet of power stations. Security and anti-corruption measures are also required on every site, and level, and on a massive scale. However, the most dire need is for skills.

In a media statement on Friday (16 September) Eskom announced its plans to address the ongoing crisis: [Invitation to Electricity Industry Experts: Eskom Crowdsourcing initiative](#)<sup>[08]</sup> - Eskom and said: "Eskom looks forward to collaborating with South African citizens to address the current electricity supply challenges facing the country."

Eskom is preparing a crowdsourcing digital platform for people with the required skills to register their interest in doing 'national service' to assist Eskom. A skills database will be established to help

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<sup>1</sup> **Tommy Garner** presented on ['The perspective of independent power producers'](#). He is Business Development Manager at Earth and Wire, and the Chair of the Independent Power Producers (IPP) Association.

with such recruitment. This is an interesting and long-overdue development as skilled staff have fled Eskom for various reasons over many years. It seems that the utility is now willing to headhunt those people with the necessary skills. There have been many offers of assistance to Eskom from individuals and organisations, but a 'governance mechanism and platform' were needed to allow such people to work directly on the challenges facing Eskom. Such a framework is now in the offing, and the plan is to contract suitable candidates on a fixed term contract basis. The necessary skills include: "mechanical, nuclear, electrical, system and maintenance skills, as well as senior artisans and plant operators for coal and nuclear power stations" among others. They also envisage partnerships with e.g. the [Engineering Council of South Africa](#) (ECSA), which officially registers professionals in engineering according to their qualifications and experience.

This initiative is very welcome, even if it would have been best to stop the brain drain about 15 years ago. Throughout the years, we have heard experienced South African engineers and people with technical skills complain that they cannot find suitable employment in their own country. This has always struck me as a bizarre situation: that the country is crying out for service delivery of all kinds but many people with the critical skills find themselves unemployed. We have also lost great numbers of skilled people to other countries where they are appreciated more, and the rate of the brain drain must have increased over recent years and months as it becomes more difficult to do business in an energy-constrained country with failing state-owned enterprises.

Eskom plans to procure 1000 MW from independent power producers. This is another welcome announcement, small though the contribution may be in the context of a system that has to provide 40 000 to 50 000 MW for the national power grid.

The [National Science and Technology Forum](#) (NSTF) hosted a discussion forum on '[Loadshedding and power cuts – what is really going on?](#)' from 25-26 October 2021. It was hosted under the auspices of [proSET](#), a sector of the NSTF representing professional bodies, of which ECSA and various voluntary associations are members. Here follow some important information and insights from that event:

### **Stability**

A centralised control is needed to keep the power system stable. This was explained in a presentation, '[Why load shedding is necessary](#)', by **Mr Gav Hurford**, National Control Manager: System Operator, Transmission, Eskom.

In general, bulk electricity cannot be stored. It must be generated at *exactly* the same time it is consumed. The System Operator manages the supply/demand balance at every second.

There is very hierarchical control of the high voltage power system, with instructions moving top down from national control (765-132 kV) to regional control (132-66 kV) and finally local control (66-11 kV), such as municipalities. Hurford says: "There is no 'big red button' in the National Control Centre (NCC) that we hit to start loadshedding. It's a lot more systematic than that."

### **National Control Centre and the supply/demand balance of 50Hz**

The System Operator is part of the NCC and the NCC is responsible for the overall wellbeing and real-time operation of the entire power system. In general, this means:

- **Controlling the power system to maintain stability.**
- **Overseeing the safety of people and plants.**
- **Dispatching available generators to meet demand or reducing demand to match the available generation (e.g. loadshedding).** If there's too much demand and not enough power generation, the whole system starts to slow down, i.e. the frequency starts to drop. This puts the network in jeopardy. Typically the network should run at 50Hz or close to it. Hurford says that this supply/demand balance of 50Hz relates to the generators' mechanical capabilities. South Africa's large coal-fired generators must remain running at or close to 50Hz.
- **Managing maintenance outages of the vast transmission network.** The South African network is interconnected from Cape Town up to the Democratic Republic of Congo, and from Namibia across to Maputo. These all run at the same frequency of 50Hz. The bigger the grid, the more stable it tends to be. However, it also means the countries are "locked in and share the same fate," says Hurford. South Africa's Eskom operates the largest system. According to

the 2019/2020 [Southern African Power Pool](#) (SAPP) statistics, the maximum demand was 38 897 MW. Next highest was Zambia with 2 237 MW. It's clear that South Africa won't receive a lot of help from its neighbours. South Africa's NCC operates parts of the network in Swaziland and parts of the network in Mozambique. Hurford says there are plans to make the NCC a separate entity outside of Eskom.

### Eskom's generation responsibilities

The following shows Eskom's generation responsibilities as of August 2021. It also shows the extent of the current power mix in South Africa.

Generation responsibilities (August 2021)		
Type	Number	Nominal capacity
Coal-fired	15 stations	39 498 MW
Gas/liquid fuel turbine	4 stations	2 409 MW
Hydroelectric	6 stations	661 MW
Pumped storage	3 stations	2 724 MW
Nuclear	1 station	1 854 MW
Wind energy	1 station	100 MW
Dispatchable IPP	2 stations	1 005 MW
Wind IPP	29 stations	2 821 MW
Solar PV IPP	44 stations	2 212 MW
CSP IPP	6 stations	500 MW
Small Hydro IPP	3 stations	18 MW
Landfill IPP	3 stations	8 MW
Biomass IPP	0 stations	0 MW
<b>Total Eskom</b>	<b>30 stations</b>	<b>47 246 MW</b>
<b>Renewable (IPP &amp; Eskom)</b>	<b>86 stations</b>	<b>5 659 MW</b>

- The brown rows show what is owned by Eskom.
- The green shows the two Independent Power Producers (IPP) and these are open cycle gas turbines (OCGT) which burn diesel.
- The grey shows renewables that have been added to the power grid since 2015 (about 5600 MW). The bulk of these are wind generation, solar PV (photo voltaic, like solar panels) and CSP (concentrated solar power).

Source: ['Why load shedding is necessary'](#)

Hurford says that South Africa already has significant amounts of renewable energy (RE) on the grid. Typically, during the week there is a contribution of 12% and there have been contributions of over 20%.

### Grid Code and maintaining the 50Hz supply/demand balance

The South African power industry is governed by the Grid Code, a National Energy Regulator of South Africa (NERSA) suite of documents. It lays out what licensees (participants in the power system) can and can't do, what is expected of them technically, and what to do to maintain the stability of the power system. It includes what to do in a power crisis.

The frequency of the power system needs to stay within 49Hz and 50.1Hz. In that range, generators should operate continuously. Grid Code Level 1 restrictions occur when the frequency drops by 0.5Hz (49Hz-48.5Hz). A large generator only tolerates this for about 80 minutes *over its lifetime* of 30 years.

Automatic tripping starts at Level 2 (48.5Hz-48Hz). Here the lifetime tolerance is about 10 minutes, operating for one minute in this range. Each consequent level shows a 0.5Hz drop with automatic tripping after a very short time.

Below 47.5 Hz it becomes chaotic, says Hurford. Generators will then automatically trip off to protect themselves and there will be a cascading situation. As more generators trip off, there is less capacity available to supply the demand and the frequency drops even further. This results in the tripping of every generator connected to the power system and a national blackout. (Note that there are other causes for large and national blackouts beyond lack of generation capacity, including faults on the transmission system.)

To maintain the supply/demand balance, Eskom uses a range of options.

- **During normal system operations:** The base load power and self-dispatched generation comes from nuclear, coal, IPPs, and Eskom's RE.
- **As demand increases within normal system operations:** Eskom uses more RE. There are also various products. Examples include specific customers switching off their plant or part of a plant, as well as contractual agreements where Eskom can interrupt demand. The benefit of these products is rapid response. (It's quite a slow process to ramp up a large coal fire station – about 8 MW per minute – for example.)
- **At highest peak during normal system operations:** There is a country response with calls to reduce load, i.e. the 'power alert'. Hurford says that the public does respond and the impact can be significant. "We can get about 275 MW response if we haven't shed for a while," he says.
- **System Emergency:** This is declared in terms of the National Code of Practice (NRS048-9). It's a document adopted by industry and approved by NERSA. It sets out a systematic way of load shedding, from the System Operator declaring a system emergency to load shedding stages and further. The third edition is currently being developed. The guiding principle of NRS048-9 is that all participants be treated equitably. This does involve ensuring essential services meet criteria, like hospitals having back-up generators. NRS048-9 allows for very specific circumstances – if something critical is happening – where power is not interrupted.
- **After System Emergency:** There is large customer and international load curtailment, scheduled loadshedding (stages 1-8), and unscheduled loadshedding. Load curtailment means load reduction from customers who can reduce demand on instruction. Load shedding is load reduction from disconnecting the load at selected points on the transmission and distribution network.
- **Beyond stage 8 load shedding:** Hurford says there are contingency plans if South Africa needs to go beyond stage 8, such as large blocks (towns and cities) dropped off the network plus more. The aim is to prevent a total power system collapse.

### Impact of national blackouts

Planned and unplanned load shedding is part of the solution to avoid a national blackout. So far, South Africa has not had a full national blackout. However, there have been a number around the world. Hurford says the one in March 2019 in Venezuela drew many parallels with South Africa. They have a similar system and the cause was poor maintenance. Venezuela was down for around five months.

The impact in Venezuela included: looting, running out of water, the inability to process sewerage, people dying at hospital (no electricity for essential equipment), business interruption, the inability to keep food fresh, and much more. There was an impact on almost every single part of daily life.

There are other considerations with a national blackout. Hurford says the telecommunications backbone would fail in about eight hours. Another example is the impact on available liquid fuel. While it's used to power so much, it also needs powered storage. Just moving around the country would become severely limited.

South Africa's system design includes contingency plans and capabilities to deal with a blackout. There are Black Start capabilities to restart the power grid.

### Understanding our emergency reserves

Emergency reserves provide a limited amount of energy and are only available for a short duration. There is also an ongoing need to replenish emergency reserves. The cycles become clearer when looking at pumped storage and open cycle gas turbines (OCGTs).

Pumped storage schemes involve water stored in an upper reservoir and then released to drive turbines that generate electricity. The water ends up in a lower reservoir. At night, excess energy allows the water to be pumped back up. It's a 168-hour cycle so reserve power is not easily restored. Hurford says that pumped storage is about 75% efficient but offers the only viable means of storing large amounts of energy. South Africa has three pump storage stations.

South Africa has 20 OCGTs and Eskom owns 14. These cost about 10 times more than coal to run, using almost 1900 litres of diesel per minute per generator. The cost is excessive. Beyond that, it's not even possible to move diesel fast enough to these generators.

Between pumped storage, OCGTs, and gas turbines, Eskom is able to dispatch almost 6000 MW, making up the majority of the emergency reserves.

### **Managing a constrained power system**

“We’ve had to manage the power system very differently from the traditional way,” says Hurford. “Obviously we need to do maintenance on generators but we can’t shut them all down. We are forced to do maintenance as and when we can.”

Managing the systems involves Eskom teams doing scenario planning, looking at installed generation capacity, plant unavailability, the demand forecast, planned outages for maintenance, and potential unplanned outages. Eskom works with three scenarios at any given time. Even with this planning, the system is volatile and unreliable. It “makes giving the country certainty absolutely impossible,” says Hurford.

However, the system is continuously monitored and, where there is enough time, Eskom gives the country as much warning as possible. Note that Eskom is fully mandated to do whatever is required to get the power system stable, even if there’s no time to give a warning. Hurford says he knows there’s anger around load shedding and consumers have a right to be angry. He also hopes that understanding the situation in more detail will ease the frustration.

### **System adequacy with a diversified energy mix**

South Africa’s power system is in crisis with urgent action needed to ensure system adequacy while simultaneously creating a cleaner and more diversified long-term energy mix. So said **Dr Jarrad Wright** when he presented on [‘What happened? Load shedding in South Africa and how to fix it’](#). He was, until recently, at the [Council for Scientific and Industrial Research](#) (CSIR) and is now at the National Renewable Energy Laboratory (NREL) in the USA.

Wright says there is a worrying trend of a continuous increase in loadshedding. There has also been a shift from equal levels of planned maintenance and unplanned outages in 2017 to more unplanned outages at higher levels as the years progress. This means there’s limited space to do planned outages and maintenance. He says, “There is still a lot that needs to come into play until we get an adequate power system over the next 2-3 years.”

To reduce load shedding and increase power generation, his recommendations include enabling regulations and institutional capacity for customer response at scale (power self-supply) to all customer segments. Wright says South Africa also needs to accelerate the augmented Department of Mineral Resources and Energy (DMRE) Risk Mitigation Power Procurement Programme. All things need to be done in parallel including implementing the Integrated Resource Plan (IRP) 2019 now. This is so there is sufficient time for lengthy procurement processes, technology specific lead times, and so on.

Statement by DMRE: Mineral Resources and Energy on pricing of projects under the Risk Mitigation Independent Power Producer Procurement Programme (RMIPPPP), on 14 Dec 2021: [Mineral Resources and Energy on pricing of projects under the Risk Mitigation Independent Power Producer Procurement Programme \(RMIPPPP\) | South African Government \(www.gov.za\)](#) The Risk Mitigation Independent Power Producer Procurement Programme (RMIPPPP)’s main objective of the bid window is to help close the immediate supply gap indicated in the Integrated Resource Plan (IRP2019) and reduce the extensive utilisation of expensive diesel-based peaking electrical generators in the medium to long-term. The 11 Preferred Bidder projects, totalling 1 995.76 MW, offer a combination of technologies and facilities at the same or different geographical locations across South Africa.

### **The case for Renewables**

**Prof Frik Van Niekerk** noted that we have a growing population and a growing energy need. At the same time, there is an unreliable energy supply and the burden of the climate crisis. The current renewable energy (RE) use is too low and he says our future planning is insufficient. Van Niekerk presented on [‘A compelling case for fast tracking variable renewable energy in South Africa and the region’](#). He is from the [Unit for Energy and Technology Systems, Faculty of Engineering, North West University](#).

Van Niekerk says that we need a strategy to accelerate the green energy trajectory. He recommends deregulating and deploying RE of which there is an abundance in South Africa and Africa, ensuring a fair energy transition, and recognising the lowered cost of RE and storage technologies.

### **Obstacles to RE**

Van Niekerk looks at what is holding us back from more RE. He says that IRP2019 still has too much coal in the energy mix and the idea of 'new coal' should be avoided. IRP2019 isn't ambitious enough and there's insufficient attention to storage. Deregulation is needed, as well as a more distributed small-scale generation rather than just a centralised system. He emphasises more urgency around RE, including prioritising it within the highest offices of government.

He doesn't believe the problem to be technological but rather around political considerations. These include Eskom debt liability, labour politics, gate keeping, and procurement issues. Garner agrees with him.

Garner explains that when new technology gets to the point of lower costs, this drives more demand in the RE sector. (RE costs are now up to 45 times cheaper over the last 10 years while coal, nuclear and carbon capture are not reducing in cost.)

With more demand in the sector comes more production investment and more supply – which in turn drives lower costs. This feedback loop continues, with more infrastructure investment and more government support. This then drives better capability and more public acceptance. It also drives less demand of older technology.

Garner says that this was happening in 2010 when government added RE into the energy mix. There was also investment in the IPP office, and the Renewable Energy and Energy Efficiency Partnership (REEEP) programmes were very successful.

However, in 2014, these positive causal feedback loops came to a halt. As part of state capture and the Gupta family intervening in Eskom, government supported the fossil fuel industry, says Garner. Agreements for REEEP weren't signed and the programme started to fall over. There was less infrastructure investment and less government support in RE. Garner says this also led to IRP2019 including a large coal component even though it doesn't make any sense.

All of this has resulted in a stop-and-start process.

Garner says South Africa needs between 3-5 times our current generation capacity with variable renewable energy (VRE) and between 35-90 hrs of battery storage. We can then go to a complete VRE system.

Hurford does note that, when planning power grids, we need to keep in mind the 'one in 10 year' event where there is no wind or sun to maintain stability of the network.

Garner recommends updating IRP2019, especially regarding battery storage, prioritising investment in grid infrastructure, and government pushing through the unbundling of Eskom and supporting RE and IPP, among other things. He also sees deregulation as a significant driver.

Getting back to Tommy Garner's words:

Let's apply our minds about solutions:

- Optimal system: 3 to 5 times more solar and wind than the current system, e.g. for RSA 120 to 200GW of solar and wind;
- 35 to 90 hours of battery storage;
- IRP 2019 was a good start to create a pathway for this;
- IRP 2019 needs to be updated;
- Investment in grid infrastructure needs to be prioritised;
- Government needs to show commitment to push through with the unbundling of Eskom, support RE and IPP's through REIPPPP but also through enabling private PPA's;
- 100MW cap for generation license a step in the right direction;
- NERSA should optimise its processes for registration and licensing;

- NERSA and municipalities should allow excess energy from C&I installations (commercial solar) to be fed back into the grid.

**Conclusion: What should be shed?**

South Africa's electricity supply (or lack of -) is a national emergency, even if it is not declared as such. It is against this background that I want to plead with Eskom and our country's people to stop (shed) the following scourges:

- Sabotage
- Corruption
- Theft
- Strikes
- Brain drain
- Red tape around IPPs; and:
- Politics

**Sources and further reading:**

- [Media Statements - Eskom](#)
- [Mineral Resources and Energy on pricing of projects under the Risk Mitigation Independent Power Producer Procurement Programme \(RMIPPPP\) | South African Government \(www.gov.za\)](#)
- [LoadsheddingMediaRelease.pdf \(nstf.org.za\)](#)
- [It could get worse, warns Eskom \(msn.com\)](#)
- <https://www.eskom.co.za/invitation-to-electricity-industry-experts-eskom-crowdsourcing-initiative%ef%bf%bc/>
- [Loadshedding and power cuts – what is really going on? – NSTF](#)
- [A-Just-Transition-Framework-for-South-Africa-2022.pdf \(imgix.net\)](#)
- [Just Transition Framework \(climatecommission.org.za\)](#)

***The opinions expressed above are those of the Executive Director, Ms Jansie Niehaus, and do not necessarily reflect the views of the [Executive Committee](#) or [members](#) of the NSTF.***