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Eskom of South Africa's Death Spiral

Eskom's crisis is not simply one of criminality and corruption. Rather, the organisation is in a storm of storms, where disruptions in one place (the resignation of a power plant manager, or a shortage of coal, or a boiler bursting) produce complex and unpredictable events somewhere else.
"Breaking Eskom's Death Spiral," *Daily Maverick,* 31 October 2019.

In January 2020, South Africa was once again suffering an electrical power crisis as a series of rolling blackouts, termed *load-shedding*, crippled the people and the economy. ftis was the latest in a series of power crises dating back to 2007. ftese chronic shortages were the result of failures on the part of the national electrical power producer, Eskom, and its owner, the South African government. fte costs to the people of South Africa and the South African economy were enormous. fte problem was the simultaneous shrinkage of power supply and power demand. Eskom, in the throes of leadership change, corruption investigations, and potential insolvency, was in the midst of what was described as a *death spiral*. fte people of South Africa wondered when their never- ending power crisis—now in its 13th year—would end.

Eskom

Eskom—the Electricity Supply Commission (ESCOM) or Elektrisiteitsvoorsieningskommissie (EVKOM) in Afrikaans—is the state-owned electrical power utility for South Africa. Eskom is vertically integrated, controlling power production, transmission, and distribution of power produced). fte company is responsible for 90% of South Africa's electricity and is the single largest power producer in all of Africa, producing 40% of all the power on the continent. Eskom is critically important to the country's many energy-intensive industries like mining.

Eskom in 2019 had 45,000 megawatts (MW) of electrical power production capacity. Aligned with South Africa's sizeable natural resource base of coal, the company's power production is predominantly coal-fired (90%) with diesel and natural gas fueling peak-load plants. Nuclear (1,836MW) and hydroelectric power (8,000 MW) made up the balance of capacity. After 20 years of officially supporting the development of renewable energy, the company had one 100MW-capacity wind farm.

Eskom's Evolution

Eskom is a *state-owned enterprise* (SOE) under the control of the South African government. South Africa had a long and storied history with SOEs. First established in the late 19th century as a barrier to British industrial entry, over time they were used to promote domestic economic development, create monopolies to benefit local special interests, and as a shield from the impacts of anti-*Apartheid* politics of foreign enterprises.[1] fte continued use of SOE's over a century effectively eliminated competition in a number of major industries, including telecommunications, air travel, and electricity. In turn, the state itself was largely controlled by the ruling political party, the African National Congress (ANC).

[1] *Apartheid* ("separateness") was a system of institutionalized racial segregation that existed in South Africa and South West Africa (now Namibia) from 1948 until 1994. fte system was based on *baasskap* (white supremacy), which ensured that South Africa was dominated politically, socially, and economically by the nation's white minority. Under apartheid, white citizens were of the highest status, followed by Asians, Coloureds (mixed ethnicity), and black Africans.

Critics of the ANC say it fails to distinguish between its own interests and those of the country. As a revolutionary movement it sees ANC people appointed to run state organs as "deployed cadres" whose prime loyalty is to the party."A liberation movement represents the nation, and if you are the nation then distinctions like party and state can become blurred. There's a tendency to conflate the two."[2]

fte ANC's influence was also formative in its support of South Africa's three key energy pillars: (1) state ownership; (2) coal-fired power generation; and (3) centralized power production. Any proposal or initiative that sought to cross any or all of these pillars, including privatization, unbundling the vertically integrated Eskom, or moving away from South African coal, faced a multitude of opposing stakeholders and a serious uphill battle. ftese pillars had largely defined the three distinct stages of Eskom's and South Africa's power sector development over the past 50 years.

Consolidation and Construction (1950-1993)

fte first stage of South Africa's power development, roughly 1950 to 1993, was characterized by the consolidation of power generation and distribution under Eskom's control. Consolidation under state control was based on growing economies of scale, drivers of utility development globally, and a distrust of private industry accountability. Eskom's vertical integration went even further than from generation to transmission to distribution. Eskom's links extended all the way up the supply chain to South Africa's coal sector, unofficially integrated with electrical power generation.

Eskom responded with major investments in power capacity: large-scale coal-fired power plants, two pumped-storage hydroelectric power plants, and Africa's first nuclear power plant, the Koeberg plant. (Koeberg remains Africa's only nuclear facility even today.) fte objective was to provide cheap and plentiful electrical power to stimulate industrial development, inward capital investment, and jobs. fte result was excess capacity and excess supplies of electricity.

Access Expansion (1994-2006)

South Africa's second stage of electrical development followed the end of apartheid in 1994. Eskom was reorganized and made more accountable for both operating and financing results. It now undertook an effort to expand access to electricity. fte country placed a moratorium on new power plant construction, focusing all capital investment on expanding reach—transmission and distribution. (Eskom also shut down or mothballed a number of older power facilities at this time.) In 1994, only 30% of South Africans had access to electricity; Eskom intended to change that.[3] Although power capacity had been expanded, the state had underinvested in transmission and distribution to large segments of the population—primarily the poor and black South Africans. In an effort to stimulate load growth and economic growth, the company provided discounted electrical tariffs to a variety of industrial and commercial power users, targeting export industries. Power demand grew slowly. fte company continued to suffer from overcapacity and insufficient demand for its installed capacity base.

Energy security for low-income households can help reduce poverty, increase livelihoods and improve living standards.[4]

In 1998, the Department of Minerals and Energy, Eskom's governor, published the *White Paper*. ftis policy document for South Africa's energy future would prove to be influential for years to come. fte White Paper addressed a number of key areas including market structure. It noted that many countries were now moving away from purely monopolistic utility market structures in favor of a variety of market-based competition models (summarized in Exhibit 1).

fte White Paper also sparked debate over whether a competitive electricity market, where the various competitors were driven by profitability and shareholder interests, would be equitable, environmentally sound,

2 "A Ruling Party ftat Is Unshockable: fte African National Congress Stands to Make a Big Profit from a State Contract," *The Economist*, April 15, 2010.

3 A number long quoted by President Zuma, there is substantial debate over its accuracy. A recent fact check of this claim concluded that the percentage in 1994 was likely closer to 50%. ftis is also what the World Bank estimates.

4 "White Paper on the Energy Policy of the Republic of South Africa," Department of Minerals and Energy, December 1998, p. 10.

and sustainable. Implicit in the discussion was South Africa's preference for independence from outside interests (one of the legacies of the apartheid era) and an electricity market that was accessible by all people of all incomes at very low rates. (ftis was far from the first-time privatization of Eskom and the industry was debated. A 1988 study on privatization was heavily criticized for a similar recommendation.)

Exhibit 1. Possible Benefits of Competition

fte 1998 White Paper listed a number of potential benefits arising from a competition-based electricity market:

- increased opportunities to exploit cheaper and environmentally benign generation options;
- the potential to increase the level of supply security, at a lower cost, through a regionally integrated and diversified supply base;
- the potential for efficiency improvements; and
- the potential for downward pressure on electricity prices.

Source: "White Paper on the Energy Policy of the Republic of South Africa," Department of Minerals and Energy, December 1998, p. 55.

Despite the White Paper's optimism on independent power (*"It is clear that the introduction of Independent Power Producers (IPP) will be allowed in the South African electricity market"*), it postponed action based on the need for further study and the country's priority to continue to expand access. Under an IPP program, private interests would put up their own capital to build power plants, primarily renewable energy technologies of wind and solar, once they were assured of a long-term power contract with Eskom (20 years or longer). Going one step further, the White Paper suggested unbundling Eskom, separating its three functions into separate businesses for increased transparency and accountability. ftis was met immediately with stiff opposition from management (Eskom), labor (power workers, line workers, coal miners, among others), and industry (Eskom suppliers of all kinds including coal suppliers). All current stakeholders would likely lose power, influence, and financial returns from change.

Power Crises and Load-Shedding (2007-2020)

Eskom's third development stage arrived with the power crisis of November 2007. A coal-supply shortage resulting from a union strike initiated power plant shutdowns and outages. fte result was *load-shedding*, the use of rolling blackouts across the country to reduce power consumption. fte periodic blackouts continued for six months. fte state concluded that Eskom needed more generation capacity in order to have a larger reserve base. Eskom committed to new generation and the promotion of independent power production.

Kusile and Madupi. Eskom now undertook the construction of two new power plants, Kusile and Madupi, designed to be two of the largest coal-fired power plants in the world. In order to fund their construction, Eskom borrowed nearly $4 billion from the World Bank. ftis was highly controversial as the post-Apartheid South African regime had intentionally avoided working with international institutions such as the World Bank for many years. And although the money was earmarked for coal-fired power plant construction, the loan carried with it a commitment to pursue market-based power solutions for renewable energy.

Conditions worsened. In 2008, Eskom recorded its first operating loss in years. Under increasing political pressure from load-shedding and financial losses, and in anticipation of the games of the World Cup to be held in South Africa in 2010, Eskom was reorganized. To boost power production, the company returned several retired coal-fired power plants to active service. Acknowledging that many of its current problems resulted from mismanagement, Eskom also embarked on an effort to repair its plants and its reputation.

Eskom's reputation, however, continued to suffer. fte Medupi and Kusile projects were the subject of a series of debates and investigations of corruption between Eskom and its contractors. One of the largest subcontractors was Hitachi Power Africa, a subsidiary of Babcock-Hitachi Europe, which was awarded a 20 billion rand (the South African currency is the *rand*, R, or ZAR) contract for Medupi's steam turbines.[5] It was then revealed that Chancellor House Holdings, the investment arm of the ANC, held a 25% interest in Hitachi Power Africa. fte ANC stood to earn a R1 billion profit on the contract. Eskom's chairman was a member of the ANC's finance committee. Despite public outcry, Eskom refused to resolve the conflict of interest. Hitachi Power Africa denied any wrongdoing, arguing that it had no idea that Chancellor House was related to the ANC. Finally, after four years of delay, Hitachi Power bought back the ownership interest of Chancellor House at an undisclosed price.[6]

[5] "Hitachi and Chancellor House: How the Events Unfolded," Qaanitah Hunter, *Mail & Guardian*, 29 Sep 2015.

[6] In 2014, the U.S. Securities and Exchange Commission charged Hitachi Ltd. with improperly recording payments to Chancellor House on the Eskom contracts under the U.S. Foreign Corrupt Practices Act.

Independent Power Production. The second initiative was the launch of a renewable energy program. fte program called for independent power producers (IPPs), private sector startups to generate electricity, to sign *power purchase agreements* (PPAs) with the country's Renewable Energy Purchasing Agency (REPA). Since no such agency was actually created, Eskom was named as the acting REPA. fte IPPs, once holding a contract to sell the power, could obtain financing for their power projects.

Exhibit 2. What Is An IPP?

A company (consortium) established by a range of shareholders for the purposes of bidding for, constructing, and operating an independent power plant. Typically, the IPP company structure could consist of:

- Black industrialists
- Other South African shareholders
- Community trusts representing the local communities where the projects are located
- Foreign shareholders bringing foreign direct investment (FDI) that improves the country's balance of payments as well as expertise

Source: "Outlining the Renewable Energy Independent Power Producer Procurement Programme, Empowerment Imperative," a presentation made at the Business Opportunities for Women Entrepreneurs in the Renewable Energy Sector, London, August 2014.

Eskom was charged with connecting the IPPs to its electrical grid and paying them a fixed *feed-in tariff*. A feed-in tariff is a structure to promote private investment in renewable energy in which tariffs are set by technology (wind, solar photovoltaic, etc.) to assure covering operating costs and an adequate profit margin. But this creates a problem: the feed-in tariffs often need to be set above existing utility rates. Eskom clearly opposed the program. In an obvious attempt to stifle IPP development, Eskom announced cuts in feed-in tariffs ranging up to 40%. ftis was followed by South African courts declaring the fixed feed-in tariff illegal. fte IPP program foundered.

South Africa now drafted a new energy master plan, the *Integrated Resource Plan of 2010* (IRP). fte new plan embraced the need to move away from coal-fired power generation and make preliminary steps towards a more competitive power market. fte IRP set an explicit goal for renewable energy to be 26% of South Africa's installed power capacity by 2030. To facilitate the transition to renewable energy, the IRP created the Renewable Energy Independent Power Producer Procurement Programme (REIPPP), a renewal of the IPP program described above. fte IPP envisioned a mix of renewable energy sources (wind, solar, biomass, small hydro, etc.) to be based on a series of competitive auctions (rounds) for government contracts. Winning bids were to be awarded power contracts with the state assuring them of power sales if they constructed the renewable energy facilities. Although a number of IPP bidding rounds were completed and PPA agreements signed, the reduced tariffs offered by Eskom, combined with a number of refusals to honor PPA connection contracts, resulted in a low level of renewable development.

South Africa was shaken by yet another power crisis in November 2014 as a result of a series of unfortunate events. First, a coal storage silo at the Majuba power plant collapsed, forcing its shutdown. fte loss of that 4,000MW baseload plant stressed the entire utility's productive capacity, as a continuing drought had already reduced available hydroelectric power. Shifting load to the company's diesel-fueled *peaker plants* (power plants used for daily peak-period demands), added to a countrywide diesel shortage. Power curtailment deepened when Eskom took several plants offline for maintenance. fte power shortage caused large-scale mining and industrial cutbacks, slowing South Africa's entire economy.

The Nuclear Solution and the Guptas. South African President Jacob Zuma now pursued a nuclear solution, one involving Russian President Vladimir Putin and a powerful South African business family, the Guptas. Zuma's administration entered into a partnership for the construction of up to 9,600 gigawatts of new nuclear power. fte plants would be based on Russian technology and the first on the African continent. Plans, however, came to a sudden halt when South Africa's minister of finance publicly refused to sign the agreement, arguing that such large-scale construction projects should go through a competitive bid process. It was also rumored that President Zuma's own son and family business associates—the Gupta family—would personally benefit from the project.[7]

fte Guptas were a powerful South African family that owned a network of businesses, including computers, media, and mining. President Zuma's relationship with the Guptas was described in the press as *state capture*, a form of corruption in which private interests influence the state's decision-making processes for their own benefit. fte Guptas' close ties to the Zuma administration were already under scrutiny, given a series of coal

[7] "How Two South African Women Stopped Zuma and Putin's $76 Billion Russian Nuclear Deal," Lynsey Chutel, *Quartz Africa*, April 24, 2018.

supply contracts with Eskom totaling nearly R12 billion. fte Guptas had acquired uranium mining interests in preparation for the nuclear program. Although the nuclear power program was eventually scuttled, the time and resources involved in its exploration proved costly to Eskom.

In early 2018, Eskom requested a 19.9% increase in electricity tariffs from the National Energy Regulator of South Africa (Nersa). Nersa approved an increase of only 5.2%, accusing Eskom of continuing failures in efficiency, forecasting, cost control, and overstaffing (arguing that Eskom had 6,000 too many employees on its payroll). Nersa noted that Eskom's continued rate increases and lack of reliability were driving more and more South Africans off the grid.

fte Current Crisis (2019/2020)

> *The initial focus of the board appointed in January 2018 was to root out financial mismanagement, malfeasance, and maladministration, the elimination of which is critical to restore transparent and effective governance. The ongoing internal and external enquiries and investigations into state capture also negatively impacted on Eskom's reputation.*
>
> Director's Report, Eskom, Annual Financial Statements, 2019, p. 3.

In February 2019, Eskom announced it would have to begin load-shedding once again and would require a R20 billion cash injection from the government in order to continue to operate. In August, its CEO resigned. Newly appointed from outside the company, he had found leading the bureaucratic and politically charged organization, immersed in patronage, impossible. Eskom's power generation continued to fail. fte Medupi plant was operating at 59% capacity, Kusile at 19% (when they should have been operating at rates of 65% or better). Attempts to bring in consultants from outside the country to aid in fixing the multitude of problems was met with widespread opposition from within Eskom, a variety of labor unions, and even Parliament.

At the center of the debate was who was to blame for the power plant problems. One former Eskom CEO, Matshela Koko, argued that the issues were design and construction issues, and were not Eskom's fault. He blamed the designers and builders and believed they should pay all costs of fixing the power plants.[8]

> *"The first point we need to tell the public is that Medupi and Kusile (power stations) were badly designed and badly constructed and are not performing at optimum levels," [ministers were told] ahead of the country's state of the nation address in parliament.*[9]

Not everyone agreed that the power plant problems were defects. One former Eskom director noted, *"First, they do not know that in mega projects like those, defects are to be expected, but they are frustrated that there is load-shedding and they do not know why, so they look for every excuse, they then overplay the defects at Medupi and Kusile. They have overplayed the lie of Medupi and Kusile."* Others believed the problems were more fundamental, that the problems were in the competence of Eskom itself. Again, Eskom's former director disagreed. *"Eskom does not have a problem of skills shortages. There are just too many experienced engineers at Eskom. Eskom has a serious skills problem right at the top, the executive and the board. It's like taking a civilian and making him an army commander."*[10]

As illustrated in Exhibit 3, Eskom's financial condition had been deteriorating for 15 years. fte company had incurred rising operating costs from a variety of sectors including unionized labor and escalating coal costs. Eskom also suffered from an unwillingness of many customers to pay at all (electricity theft was a problem) or to pay on time, common utility challenges in many developing countries.

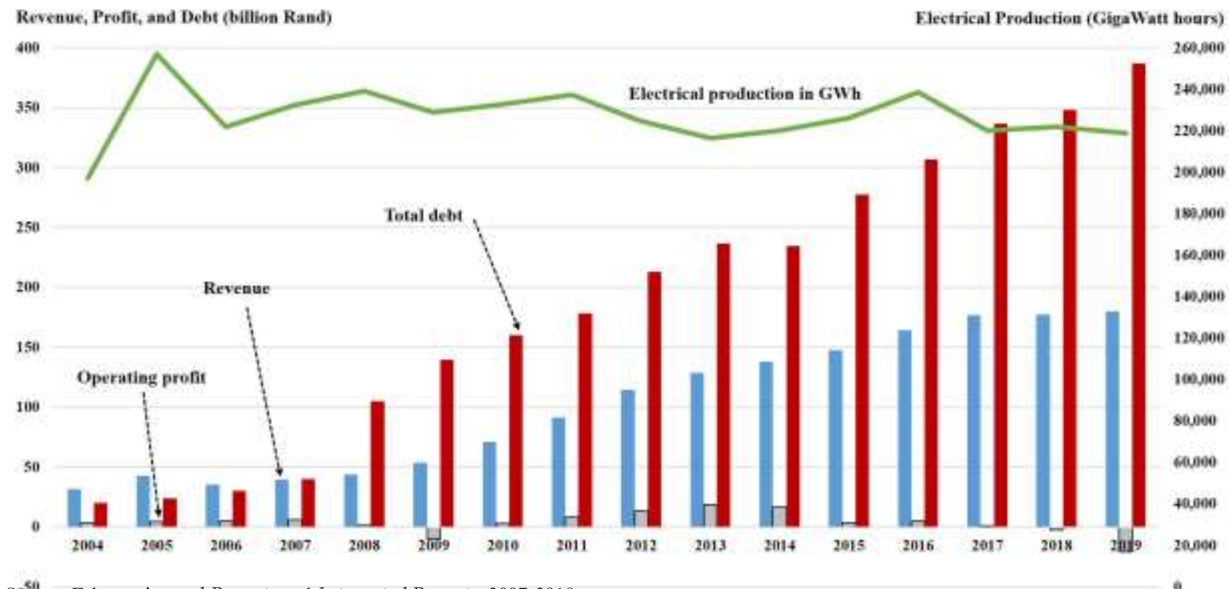
fte expansion of investment in new capacity in 2008 required massive amounts of new debt. At the same time, corporate revenues grew at a much slower pace, peaking in 2017. Profitability, never great, peaked in 2013. In 2015, the company was downgraded by Standard & Poors to a speculative grade credit standing, citing its rising indebtedness and risks in governance and execution. Now, in 2019, it suffered its first operating loss since

[8] Matshela Koko was CEO of Eskom from 2016 to 2018. He resigned in 2018 after being implicated in awarding contracts to a company linked to his stepdaughter.

[9] "Eskom Seeks External Assistance to Address Energy Woes," Smart Energy.com, February 13, 2019.

[10] "Is Debt-Ridden Eskom Too Broken to be Fixed?" Lerato Diale, *Sunday Independent*, February 24, 2019.

Exhibit 3. Eskom's Financials and Production, 2004-2019



Source: Eskom, *Annual Reports* and *Integrated Reports*, 2007-2019.

2009, a record loss of R20.7 billion. Eskom's CEO, newly appointed from outside the organization in 2018 in the hope of a managerial renewal, now resigned.

> *This week, outgoing Eskom CEO Phakamani Hadebe informed a group of journalists, gathered to witness the spectacular train wreck that was Eskom's financial results, that the utility was "facing a death spiral."*[11]

Also illustrated in Exhibit 3 is the fact that Eskom's production of electrical power had changed little over the past 15 years, peaking in 2005. Company revenues had continued to grow through persistent electrical tariff rate increases. In something of a vicious cycle—popularly referred to as a *death spiral*– -each fall in revenue resulted in higher electrical tariffs, in turn leading to a further decline in power sales.

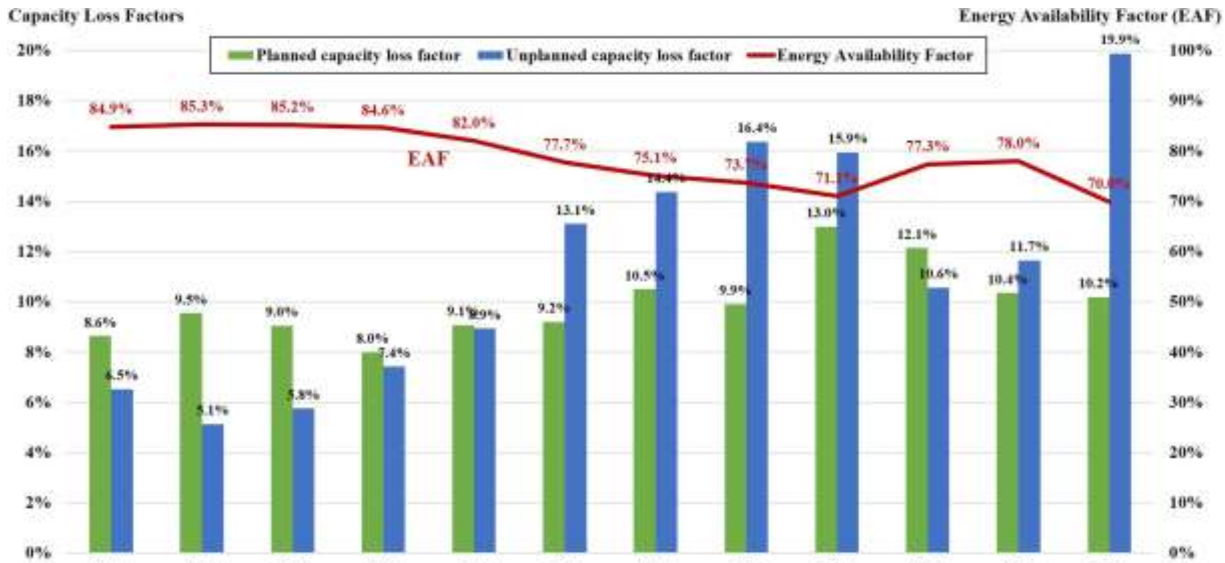
Accusations of mismanagement increased. Despite having a portfolio of power plants that could theoretically meet all current power demands, outages and lack of plant availability caused power shortages. fte power plants were there, they just didn't work reliably. Exhibit 4 tracks Eskom's power plant availability over the 2008-2019 period. fte percentage of the time power plant capacity is technically available is the *Energy Availability Factor* (EAF)—actual power plant availability plus energy losses "not under the control of plant management and internal non-engineering constraints."

fte *energy availability factor* (EAF) is not to be confused with a *capacity factor*. EAF is a measure of availability subject to a variety of planned and unplanned system outages. Capacity factors simply measure what percentage of technical capacity is actually used over a period of time. EAF is calculated as the sum of losses resulting from *planned* (PCLF) and *unplanned* (UCLF) capacity loss factors from a theoretical 100% availability.[12]

Energy Availability Factor = 1 – (Planned Capacity Loss Factor + Unplanned Capacity Loss Factor)

All utilities experience planned and unplanned capacity losses. *Planned* losses, primarily from scheduled plant maintenance, are common and average about 8% to 9% in most industrialized countries. *Unplanned*, such as the failure of a boiler or steam turbine unexpectedly, was what all utilities hoped to keep at near 0%. As illustrated in Exhibit 4, Eskom's energy availability had steadily declined from 2010 to 2016, as planned and unplanned losses rose year after year. (When Eskom's EAF fell to 77% in 2013, it was the first time availability had fallen into the 70s since 1994.) New management and new efforts to improve operations resulted in improvements in

Exhibit 4. Eskom's Technical Reliability Factors, 2008-2019



Source: Eskom, *Annual Reports* and *Integrated Reports*, 2010-2019. fte *Energy Availability Factor* (EAF) is calculated as the sum of *Planned Capacity Loss Factor* (PCLF) + *Unplanned Capacity Loss Factor* (UCLF) from 100% availability. Eskom's EAF averaged 88.3% for the 1994-2007 period.

EAF in 2017 and 2018, only to have it plummet once again in 2019. fte EAF reached a record low in 2019 of 70.0%, leading once again, to load-shedding.

One example of Eskom's continuing troubles is seen in the replacement of a steam boiler at the Koeberg nuclear plant in 2015. Eskom had contracted with Areva, a French multinational with extensive experience in nuclear power, to replace steam generators. A number of competing domestic suppliers took the agreement to court, where the Supreme Court of Appeal declared the contract unlawful, delaying replacement for a year.

fte Four D's of Disruption

Eskom was now facing the same disruptive forces that electrical utilities all over the world were facing, the 4Ds. fte 4*Ds*—*decarbonization*, *decentralization*, *digitalization*, and *democratization*—were disassembling and reconfiguring the traditional vertically integrated utility.[13]

Decarbonization. ftis is the transition from hydrocarbon-based fuels—primarily coal, oil, and natural gas—to renewable fuels. Renewable technologies have matured rapidly, so much so, that in many cases wind and solar are considered cost-competitive for new builds of electrical generation capacity. ftis also includes *electrification*, the move away from fossil fuels (primarily oil and natural gas) for transportation and heating to electricity. Many South Africans were calling for Eskom to move away from coal.

Decentralization. ftis is the disassembling of the vertically integrated electrical utility. fte current system utilizes a highly centralized power source (supply) that transmits electrical energy, sometimes at great distance, to consumers of electrical power (demand). A decentralized system would be composed of many smaller generators of power, *micro-grids*, located near where power is consumed. Even in an unorganized state, consumers leaving the grid undermines the sustainability of the utility, something Eskom was now experiencing. Some distributed energy developments also alter the roles of consumer and producer, as distributed energy allows consumers to be producers over different parts of the day.

[13] See "fte Future of Electricity: New Technologies Transforming the Grid Edge," World Economic Forum in collaboration with Bain & Company, March 2017; and "Top 10 Trends in 2018 Driving the Utility Industry Toward a Decarbonized, Distributed, Digital, and Democratized Future," Zarko Sumic, Nicole Foust, Ethan Louis Cohen, Keith Harrison, Gartner, April 4, 2018, for further detail.

Digitalization. Digital technologies allow real-time communication, integration, and data collection services throughout the electrical value chain. Electrical power generation, power dispatching, and transmission activities (situational awareness) throughout the electrical grid will allow more efficient power production and distribution—supply side improvements. So-called *smart systems*, in which consumers can monitor and potentially reallocate their power demands on a real-time basis, allow consumers to reduce costs and their demands on the electrical grid. Reduced demand was now contributing to the death spiral.

Democratization. Although the previous 3Ds capture the complexity of social choices on environmental sustainability and technological change, some argue that there is an even more fundamental driver of disruption in utility systems: *democratization*. ftis is the ability of energy consumers to have access and choice; that is, access to electricity, which a large part of the world still does not have, and the option to choose how and when they access and utilize that power. More and more South Africans every day were beginning to make a choice to leave the Eskom grid.

Eskom in South Africa faced these challenges in its own unique way, as did any utility anywhere in the world. But most importantly, these were principally popular forces, and how and when they occurred was largely not in the hands of Eskom or the South African government.

An Energy Plan for South Africa

South Africa, a signatory to the Paris Agreement on Climate Change, was still as dependent on coal-fired power in 2020 as it was in 1999. fte government had released yet another new energy plan, the Integrated Resource Plan of 2019. fte plan laid out a detailed assessment and series of actions in order for Eskom and South Africa to reach the country's overall economic development plan for 2030. If all went according to plan, coal would provide 59% of South Africa's energy in 2030, a major drop from its current 90%.

fte plan recommended nine decisions to "minimize the risk of both load-shedding and use of diesel peaking plants in the near future."[14]

1. Undertake power purchase programme to acquire capacity;
2. Undertake technical and regulatory work to extend the life of the Koeberg nuclear plant 20 years;
3. Support Eskom to comply with minimum emissions standards;
4. Consolidate into a single team the various initiatives for a transition to a coherent energy policy;
5. Retain current annual build limits on renewables until the finalisation of the just transition plan;
6. South Africa should not sterilise the development of its coal resources for purposes of power generation, but instead all new coal power projects must be based on high-efficiency, low-emission technologies and other cleaner coal technologies;
7. Support the development of gas infrastructure and convert all diesel-fired power plants to gas;
8. Commence preparations for a nuclear build programme to the extent of 2,500MW at a pace and scale that the country can afford because it is a no-regret option in the long term; and
9. Participate in strategic power projects to enable cross-border regional energy trading.

One of the earliest and most important goals of South African energy policy after the fall of apartheid was access to electricity. Eskom now claimed that 84% of the population had access. Unfortunately, that power was neither reliable (load-shedding continued) nor affordable (new rate increases were forthcoming). Load-shedding was deepening. South Africa and Eskom seemed to be no closer to a sustainable and secure energy future that was envisioned in the 1998 White Paper. Eskom's COO, back on the job after years away, stated it fairly bluntly:

> *Eskom is captured. That's all. It's hard to find the right words. Since returning, I've realised that greed is an untreatable disease. I'm now working with the Special Investigative Unit. The capture runs right through the entire organisation, not just the leadership. It also doesn't help when you work with unethical contractors and suppliers. It's a cancer, and you have to cut it out.*[15]

[14] *Integrated Resource Plan of 2019*, South Africa Department of Energy, October 2019, pp. 49-54.
[15] "fte Load Shedding Crisis Should Overshadow ANC's Birthday Celebrations," Rebecca Davis, *Daily Maverick*, 10 January 2020.

Appendix 1. Eskom's Electrical Power Plant Generation Base

Fossil-fueled power stations

Power plant	Province	Type	Commissioned	Capacity (MW)	Status
Acacia Power Station	Western Cape	Gas turbine	1976	171	Operational
Ankerlig Power Station	Western Cape	Gas turbine	2007	1,338	Operational
Arnot Power Station	Mpumalanga	Coal fired	1971-1975	2,352	Operational
Camden Power Station	Mpumalanga	Coal fired	1967-1969; 2005-08	1,561	Operational
Duvha Power Station	Mpumalanga	Coal fired	1980-1984	3,600	Operational
Gourikwa Power Station	Western Cape	Gas turbine	2007	746	Operational
Grootvlei Power Station	Mpumalanga	Coal fired	1969-1977; 2008-11	1,180	Operational
Hendrina Power Station	Mpumalanga	Coal fired	1970-1976	1,893	Operational
Kendal Power Station	Mpumalanga	Coal fired	1988-1992	4,116	Operational
Komati Power Station	Mpumalanga	Coal fired	1961-1966; 2009-13	990	Operational
Kriel Power Station	Mpumalanga	Coal fired	1976-1979	3,000	Operational
Kusile Power Station	Mpumalanga	Coal fired	2017 – 2021	4,800	Under construction
Lethabo Power Station	Free State	Coal fired	1985-1990	3,708	Operational
Majuba Power Station	Mpumalanga	Coal fired	1996 – 2001	4,110	Operational
Matimba Power Station	Limpopo	Coal fired	1987-1991	3,990	Operational
Matla Power Station	Mpumalanga	Coal fired	1979-1983	3,600	Operational
Medupi Power Station	Limpopo	Coal fired	2015 – 2019	1,588	1st Unit Operational
Port Rex Power Station	Eastern Cape	Gas turbine	1976	171	Operational
Tutuka Power Station	Mpumalanga	Coal fired	1985-1990	3,654	Operational
				46,568	

Renewable and nuclear power stations

Power plant	Province	Type	Commissioned	Capacity (MW)	Status
Colley Wobbles Power Station	Eastern Cape	Hydroelectric		42	Operational
Drakensberg Pumped Storage	Free State	Hydroelectric	1981	1,000	Operational
Gariep Power Station	Free State-Eastern Cape	Hydroelectric	1971	360	Operational
Ingula Pumped Storage Scheme	KwaZulu-Natal	Hydroelectric	2017	1,332	Operational
Koeberg Power Station	Western Cape	Nuclear	1984	1,860	Operational
Ncora Power Station	Eastern Cape	Hydroelectric		2	Operational
Palmiet Pumped Storage Scheme	Western Cape	Hydroelectric	1988	400	Operational
Sere Wind Farm	Western Cape	Wind	1/1/2015 (Oct 2013)	100	Operational
Vanderkloof Power Station	Northern Cape	Hydroelectric	1977	240	Operational
				5,336	

Source: Eskom.

Appendix 2. Power Plant Capacity Planning by Fuel Type

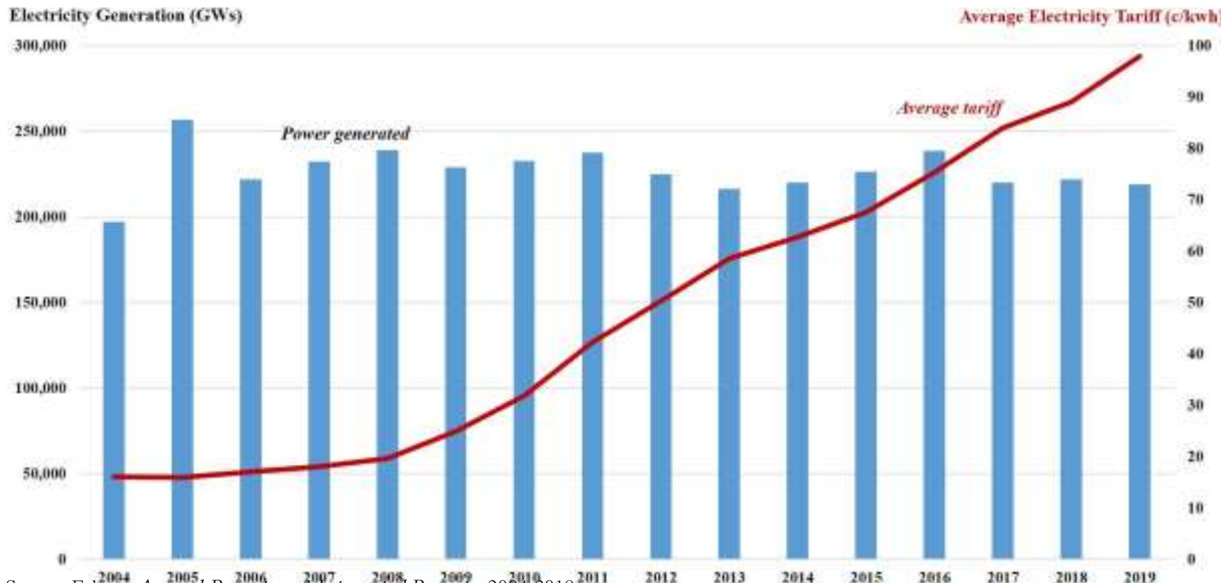
	Coal	Coal (Decommissioning)	Nuclear	Hydro	Storage	PV	Wind	CSP	Gas & Diesel	Other (Distributed Generation, CoGen, Biomass, Landfill)
Current Base	37 149		1 860	2 100	2 912	1 474	1 980	300	3 830	499
2019	2 155	-2373					244	300		Allocation to the extent of the short term capacity and energy gap.
2020	1 433	-557				114	300			
2021	1 433	-1403				300	818			
2022	711	-844			513	400 1000	1600			
2023	750	-555				1000	1600			500
2024			1860				1600		1000	500
2025						1000	1600			500
2026		-1219					1600			500
2027	750	-847					1 600		2000	500
2028		-475				1000	1 600			500
2029		-1694			1575	1000	1 600			500
2030		-1050		2 500		1 000	1 600			500
TOTAL INSTALLED CAPACITY by 2030 (MW)	33364		1860	4600	5000	8288	17742	600	6380	
% Total Installed Capacity (% of MW)	43		2.36	5.84	6.35	10.52	22.53	0.76	8.1	
% Annual Energy Contribution (% of MWh)	58.8		4.5	8.4	1.2*	6.3	17.8	0.6	1.3	

Installed Capacity
Committed / Already Contracted Capacity
Capacity Decommissioned
New Additional Capacity
Extension of Koeberg Plant Design Life
Includes Distributed Generation Capacity for own use

- 2030 Coal Installed Capacity is less capacity decommissioned between years 2020 and 2030
- Koeberg power station rated / installed capacity will revert to 1926 MW (original design capacity) following design life extension work.
- [illegible] ities in circumstances in which the facility is operated solely to supply electricity to an end-use customer within the same property with the facility
- Short term capacity gap is estimated at 2000 MW

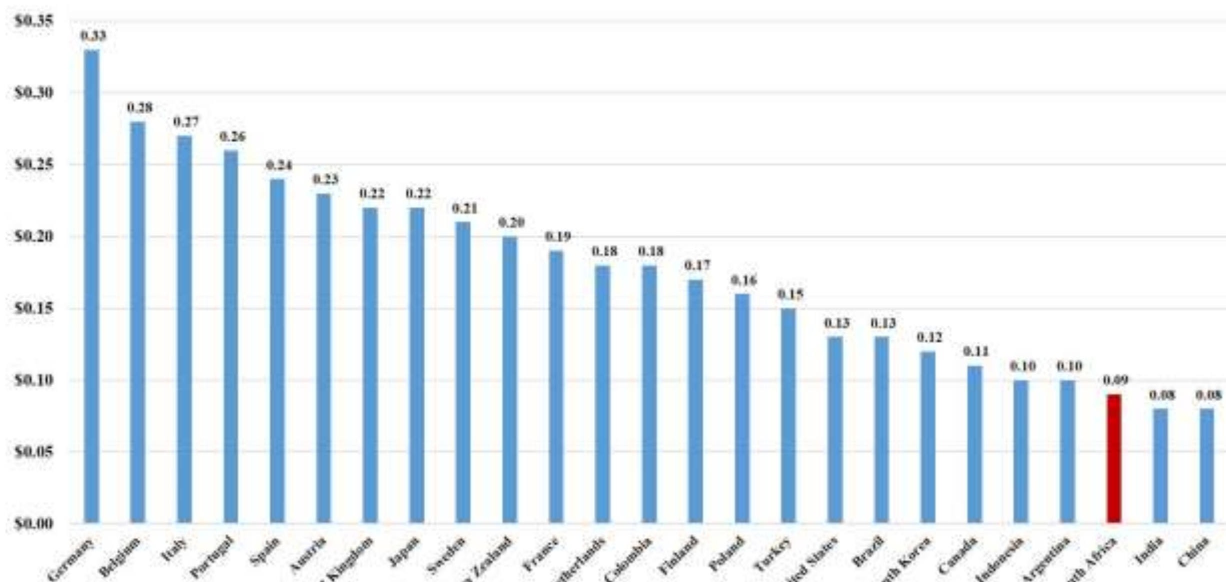
Source: *Integrated Resource Plan 2019*, Table 5, p. 42.

Appendix 3. Eskom's Power Generation and Tariffs, 2004-2019



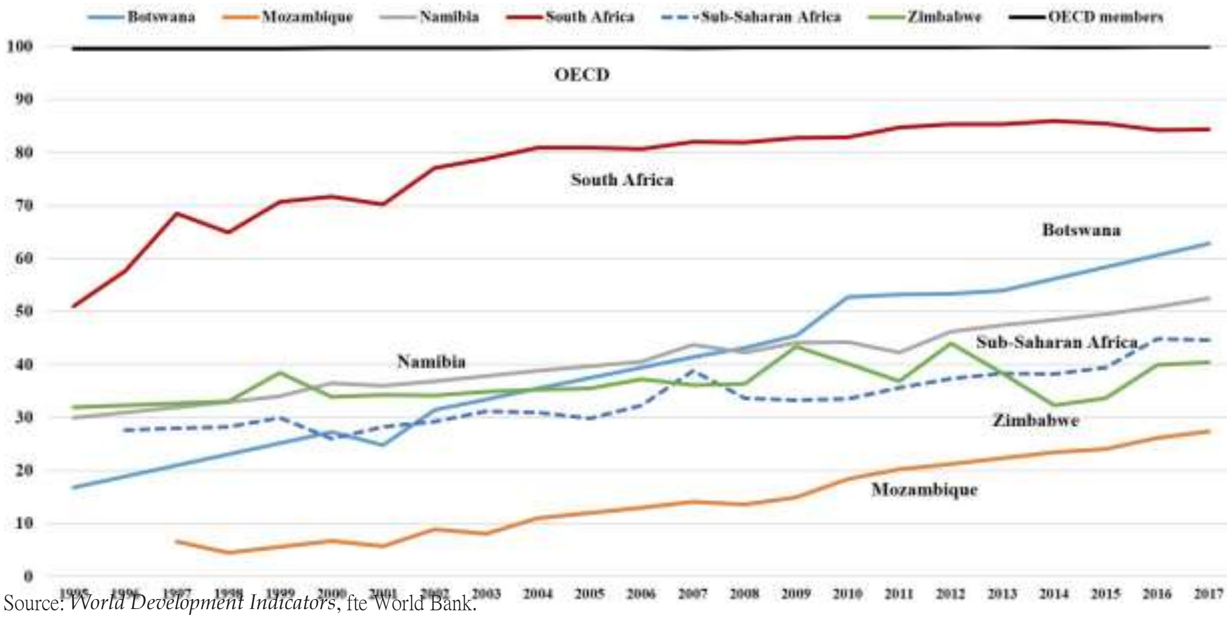
Source: Eskom, *Annual Reports* and *Integrated Reports*, 2004-2019.

Appendix 4. Global Electricity Prices, 2018 **(US dollars/kilowatt hour)**



Source: Statistica.com. https://www.statista.com/statistics/263492/electricity-prices-in-selected-countries/.

Appendix 5. Percentage of Population with Access to Electricity



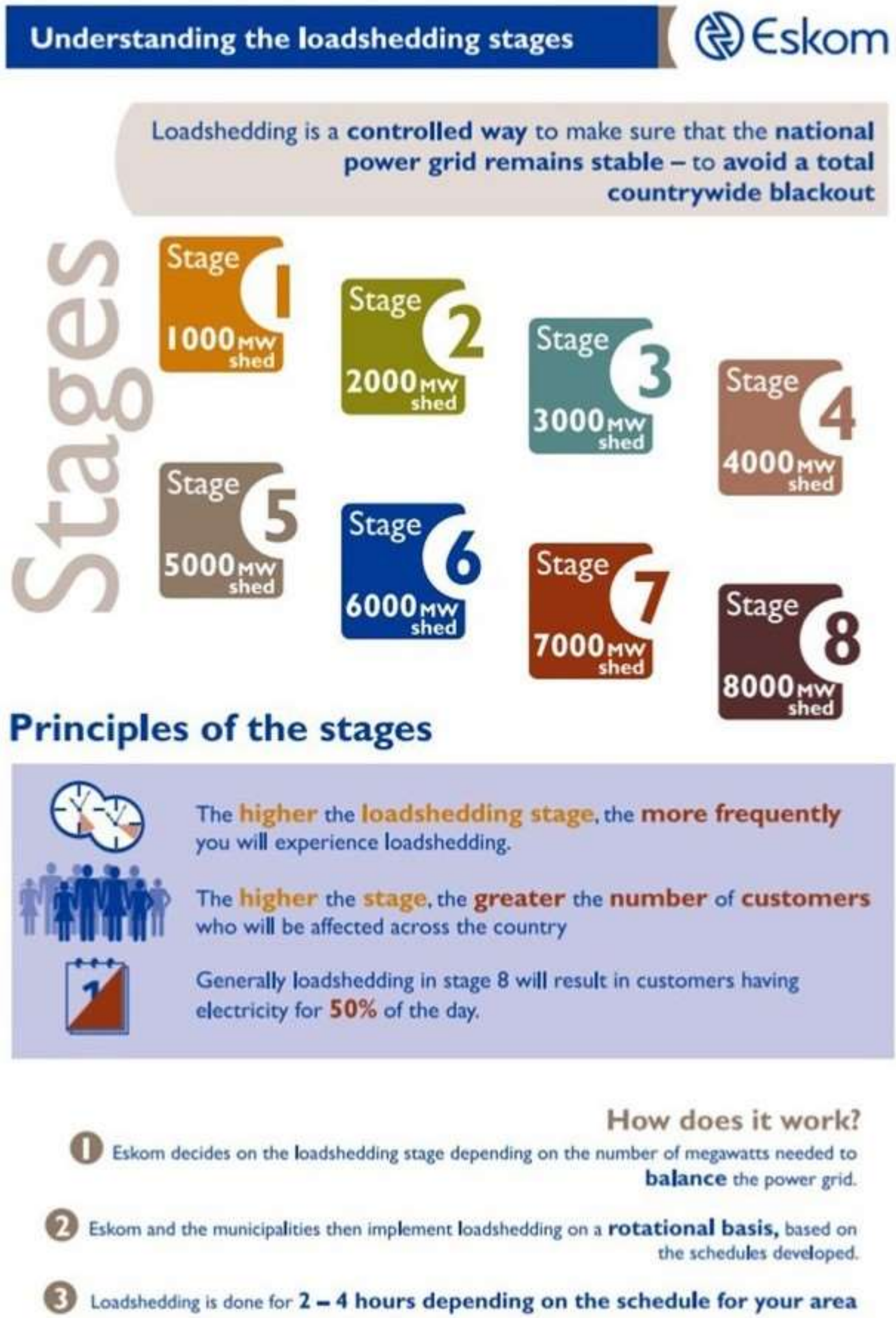
Source: *World Development Indicators*, fte World Bank.

Appendix 6. Stages of Load-Shedding and What ftey Mean for the End User

		Typical Impact		
Stage	Energy Removed from Grid	Customers Disconnected	Disconnect Duration	Percentage of users without power
Stage 1	1000 MW	2 to 4 hours	6 hours over 4 days	6%
Stage 2	2000 MW	2 to 4 hours	12 hours over 4 days	13%
Stage 3	3000 MW	2 to 4 hours	18 hours over 4 days	19%
Stage 4	4000 MW	2 to 4 hours	24 hours over 4 days	25%
Stage 5	5000 MW	2 to 4 hours	30 hours over 4 days	31%
Stage 6	6000 MW	2 to 4 hours	36 hours over 4 days	37%
Stage 7	7000 MW	2 to 4 hours	42 hours over 4 days	44%
Stage 8	8000 MW	2 to 4 hours	48 hours over 4 days	50%

Source: Eskom.

Appendix 7. Load-Shedding Stages Described by Eskom.



Source: Eskom.