Eskom's fifth decade

And then there was one

1963 to 1973

ESCOM was mourning the passing of the company's second and third chairmen, Mr AM Jacobs and Dr JT Hattingh, both of whom died in 1963. In that year, ESCOM also said goodbye to the Sabie River power station (Eskom's first permanent power station) after Sabie Undertaking had been incorporated into Witbank Undertaking. But, as Frank Herbert said, "there is no real ending. It's just the place where you stop the story". In 1963, ESCOM continued apace as the organisation set about meeting burgeoning demand.

Ingagane power station ww(near Newcastle in KZN) was commissioned in 1963 and consisted of five 100 MW sets. At this stage, the Rand and Natal systems were not yet linked, and so Ingagane was connected to the Southern Natal system. Work had also begun on the construction of three major power stations: Camden, Grootvlei, and Hendrina. These three stations began commercial service in 1967, 1969, and 1970, respectively. They all used 200 MW sets, which were "technological dinosaurs" (dinosaurs were around about 220 million years ago and lasted for about 160 million years before dying out). The problem with these sets was that they did not make use of the latest power generation technology in reheat cycles and were, thus, costlier to build and less reliable than those that did boast this cutting-edge technology.

Hendrina power station was South Africa's last to use non-reheat generation sets. It had a turbine hall that was 500 m long, and some staff even used bicycles to get around. Hendrina got its coal from the nearby Optimum Colliery, South Africa's first large-scale opencast coal mine.

Quality coal was exported, and a washing plant separated out discarded (lower-grade) coal, which was burnt by Hendrina. Eskom shared in the large profits generated by exporting the coal, which meant that Hendrina's average coal price was kept very low – the cheapest on Eskom's system. However, there was a price to be paid, as the low-grade coal contained abrasive stone that put wear on the mills and the boilers. Improved mining (and generation) techniques eventually sorted out the problem.

The reheat technology was finally used on Arnot power station, which began commercial service in 1971. As a result of this improved technology, steam pressure increased from 10 MPa to 16 MPa, while steam temperature decreased from 538°C to 510°C. The lower temperature meant that less specialised steel was used in the boiler, which led to cost savings and an impressive (for its day) efficiency of 33%. At around the same time, ESCOM also built Grootvlei power station, near Balfour. Grootvlei had to get its water from the already heavily taxed Vaal Dam, and thus, it was the obvious choice for South Africa's first dry-cooling towers – which were used for Units 5 and 6, while Units 1 to 4 used conventional wet-cooling towers.

As is mostly the case for a power utility, the great x factor in making problems go away and dreams come true was technology. For ESCOM, the late 1960s and early 1970s saw the dream of a national grid come to fruition at last.

Transmission technology had advanced sufficiently. Long transmission lines of 275 kV and 400 kV were now viable. ESCOM went to great lengths to plan an interconnected network: the ultimate pool. The massive difference between coal costs in the Cape and the Eastern Transvaal (R2 a ton versus R7 a ton) was a big factor in pushing things forward. In 1969, ESCOM began constructing the network in 300 km stages. By August 1970, the transmission line running from Camden power station (near Ermelo) to Cape Town had been completed. It took a little longer to connect the Natal and Transvaal systems, as the Orange River Project caused shortages of steel and cement. But a 400 kV line linking Camden and Ingagane was completed in October 1971. A 1971 amendment to the Electricity Act gave ESCOM the authority to amalgamate the power resources of two or more undertakings and to supply electricity from one undertaking to another. This paved the way for the establishment of the Central Generating Undertaking (CGU) on 1 January 1972, which enabled ESCOM to operate all its power stations and other power plants as an integrated system. However, it was only in ESCOM's 50th year (1973), after extending the network to the Eastern Cape, that a national grid was finally achieved. All ESCOM's power stations were transferred from the regional undertakings to the CGU (under the expert guidance of Ian McRae).

Pooling meant that ESCOM could benefit from economies of scale, which meant lower electricity prices. The more expensive coastal stations could be used for peak load and emergencies, while the country ran primarily off cheap Highveld coal.

ESCOM could now decommission some older stations, and hence, Brakpan, the VFP's first power station, was closed in 1970. Rosherville, which had also produced compressed air, was decommissioned in 1966 and turned into a central workshop complex. The mines then made their own compressed air. Meanwhile, Simmerpan, which had been the VFP's control centre since 1912, received a revamp in 1968. becomming the control centre for the entire country's grid featuring world-class communications technology. It was also the site for laboratories and workshops for monitoring and maintaining the transmission network.

The national grid brought cost-saving economies of scale into the system, which meant that municipalities were better off abandoning their own baseload power generation and rather looked at buying in bulk from ESCOM. The Johannesburg City Council tried to buck the trend in 1969 when it applied to build its own 1 000 MW power station. In the end, it could not secure permission to do so, and this was the last time a South African municipality applied to build its own baseload station.

South Africa had shown that a national grid was the best way to utilise power resources for the benefit of the entire country. The next step would obviously be to connect the entire region. This is yet to happen in any meaningful sense, but back in 1964, the South African Parliament recognised the opportunity of regional power integration. The Electricity Act was amended to authorise ESCOM to supply electricity in bulk to "adjoining territories". So it was that, in 1967, Lesotho received ESCOM power via an 88 kV line from Ladybrand in the Free State. The border town of Ressano Garcia in Mozambique received ESCOM power in 1969, and in 1972, a 275 kV line, supplying 20 MW, began sending electricity to the capital, Lourenço Marques (now Maputo). Swaziland began receiving ESCOM power in 1973.

Plans were also afoot to send power in the other direction. In the 1960s, the Portuguese and South African governments began plans to dam the mighty Zambezi River in the north of Mozambique.

The ideal spot for this was a narrow gorge known as Cabora Bassa (later changed to Cahora Bassa after the Komati accord had been signed), situated in Tete Province. It was reckoned that Cabora Bassa could produce as much as 4 000 MW, and in 1969, the South African and Portuguese governments signed a contract which gave the go-ahead for the damming of the Zambezi River and locked South Africa into buying 680 MW in 1975 and 1 500 MW by 1980 at a rate of 0.3 c per kWh. It was slow progress negotiating with the Portuguese, and the civil war in Mozambique meant this was always going to be a tricky project. However, things were progressing rather more smoothly with a local hydroelectric project. In 1966, excavations began on the Hendrik Verwoerd Hydro Station (now known as Gariep). Five years later (1971), the station started feeding power into the grid. On completion, Hendrik Verwoerd would add 360 MW to the grid and provide the country with useful back-up in the event of emergencies and peak demand.

Unfortunately, South Africa is not well suited to the development of hydroelectric power, and when it comes to finding alternatives to coal, nuclear provides better potential. In the early 1960s, the government had already approved an atomic energy research and development programme, and this received a boost when a research reactor, known as Safari and supplied by the US, was installed at Pelindaba. Scientists and engineers were sent overseas for training, and research continued under the auspices of the Atomic Energy Board (AEB).

In 1966, ESCOM purchased the farm Duynefontein, 30 km outside of Cape Town, as a possible site for a nuclear power station. In 1972, the decision was made to construct Koeberg nuclear power station at that site.

By that stage, the country was facing an oil embargo from the Arab states, and the government was understandably fearful of running out of energy. There was also the matter of nuclear weapons. No one is sure whether South Africa's nuclear energy programme was driven by the government's desire to equip itself with an atomic bomb – but in any event, in the same year that ESCOM decided to build Koeberg, the government initiated a nuclear weapons programme. Happily; South Africa dismantled its nuclear weapons in the 1990s, and Koeberg continues to supply the country with 1 840 MW of energy.

Meanwhile, the 1960s saw high levels of growth for the South African economy and a steep increase in the demand for power. In 1970, sales rose by 10.7%, the highest surge since 1955. In 1971, ESCOM needed R175 million for its expansion programme, but there was a world shortage of capital, interest rates were high, and South Africa's reputation as a racist state meant increasing isolation from capital markets. All the hard work ESCOM was putting into bringing down the cost of power was being eroded by the high cost of borrowing. The solution was the 1971 Electricity Amendment Act, which allowed ESCOM to raise capital from its own revenue. ESCOM duly set up a Capital Development Fund (CDF) and began to do just that. The CDF meant that tariffs could be used to build up capital and, thus, protect consumers from large increases in the future.

In the next edition...

It is the rise of the "six-pack" power station, growing political turmoil, and ESCOM comes under attack from the public.

Did you know!?

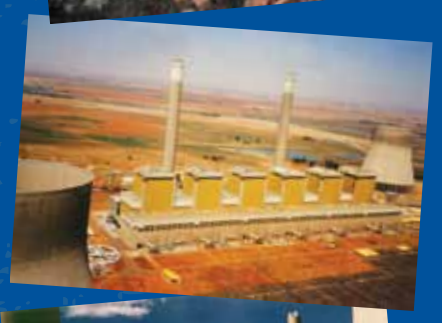
1. In 1964, the Electricity Act was amended so that ESCOM could supply "adjoining territories" (neighbouring countries).
2. In 1966, South Africa introduced its first dry-cooling towers at Grootvlei power.
3. In 1969, ESCOM appointed Marie Talitha Potgieter, the first female pupil electrical engineer, at the Umgeni Test Department (Natal Undertaking).
4. ESCOM's Medical Aid Society was inaugurated in 1971.
5. The national grid was completed in 1973 and boasted 25 000 km of power lines.
6. In October 1969, electricity generated at the power stations of Mpumalanga flowed into the Western Cape Undertaking system. This was an important step in the establishment of a national grid.
7. Work on the Cabora Bassa hydroelectric power scheme began in October 1969, and supplies started flowing in late 1976.
8. ESCOM's 1968 Annual Report makes the case for transmitting electricity from coal-rich areas (that is, Mpumalanga) by means of high-voltage transmission lines, rather than transporting coal by rail to distant power stations.
9. ESCOM's capital expenditure in 1970 was R163.9 million, R98.2 million of which was spent on new power stations and power station extensions. In 2012, annual capital expenditure was around R19 billion.
10. There were 92 students on ESCOM bursaries in 1970. Currently, Eskom has almost 6 000 learners on bursaries.
11. In 1972, electricity sales to the mining industry comprised 35% of ESCOM's total sales; in 2012, mining accounted for only 14.5% of total sales.
12. It was Jan H Smith (ESCOM Chairman from 1980-1985) who, as a system planner at ESCOM, in the 1960s named major substations after ancient Greek gods.

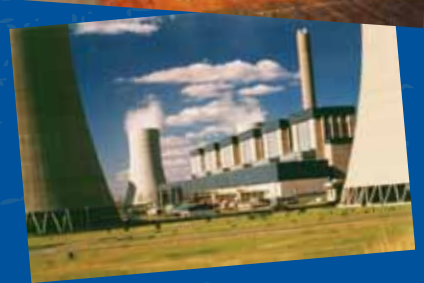
Eskom's sixth decade

Demand for electricity soars

1973 to 1983

To an ESCOM planner in the 1960s and 1970s, the idea that South Africa could end up with too much power capacity must have seemed laughable. Putting aside the post-World War II boom, the 1970s saw the biggest growth in electricity consumption in South Africa's history. In 1973, demand grew by 12% and by 13% the following year. The average annual growth for ESCOM's sixth decade was almost 9%.





Growing international pressure towards South Africa's apartheid government seemed only to harden its resolve. In spite of growing isolation, there was still strong global demand for South Africa's gold, minerals, iron ore, steel, and coal. What South Africa lacked were oil and gas. Thus it was that ESCOM relied so heavily on coal and, particularly, low-grade coal (or "black-painted" rock as some power station operators called it).

So the 1970s saw ever bigger coal-fired power stations popping up in the Mpumalanga veld. Arnot had begun commercial service in 1971, and it was becoming apparent that its 350 MW sets (massive for the time) would be too small for future stations. With an annual growth in power demand of 9%, ESCOM would need to double capacity every eight years, which translated to a further 10 000 MW by 1980.

Kriel was the first of the "six-packs" (so-called because of their six tall, and very prominent, boiler houses) and featured new "once-through" technology, where steam "bypasses the turbine while the boiler is warmed up or when the turbine is shut down".

From the start, there were challenges in getting the most out of Kriel, which was once ESCOM's biggest power station. The boilers were susceptible to slagging, and new mill foundations had to be built when the heavy milling machinery created dangerous vibrations. On completion, in 1979, Kriel consisted of six sets of 500 MW each and was one of the largest coal-fired power stations in the southern hemisphere, as well as being of the world's first to receive its coal from a fully mechanised coal mine.

Meanwhile, Duvha, like Kriel, was a "six-pack" power station, with separate housing for its turbine generators. Unlike Kriel, the boilers were of a conventional design and used natural circulation and not once-through. Kriel began commercial operation in 1979 and, on completion (in 1983), boasted six sets of 500 MW each. It was distinctive for its boiler house superstructure – constructed from concrete in order to reduce lead time and capital costs amid a world shortage of steel.

Duvha Power Station was the third and final "six-pack" and was built near Witbank in Mpumalanga. It, too, used a "once-through" boiler technology, but instead of six 500 MW sets, it consisted of six 600 MW sets.

The boilers proved more reliable than Kriel's, but there were still challenges, particularly of an environmental nature. The precipitators on Duvha's first three units did not reduce emissions to acceptable levels, and the pollution problem was only solved in 1984 when the offending units were retrofitted with pulse-jet fabric filter plants – a world first. Another first for Duvha came in the form of a man by the name of Mr Ehud Matya – ESCOM's first black power station manager – but that is a story for a later edition.

Ehud Matya

In the 1970s, ESCOM's environmental challenges paled into insignificance compared to the crisis that it faced on 5 December 1975. An interconnected transmission system, while preferable, had its risks, and faults could spread to the entire country. This is exactly what happened on that particular day, when a relay malfunctioned at the Hydra substation near De Aar. Much of the country went without power for 24 hours, and ESCOM had to rethink its transmission system. In 1976, ESCOM addressed the problem by building two gas turbine stations, one near Cape Town and the other near East London. The year 1976 saw the completion of Hendrina power station and Gariep (then Hendrik Verwoerd) hydropower station (Arnot had been completed the previous year).

ESCOM itself was not a capitalist enterprise, and in the 1970s, many South Africans began to see it as inefficient, especially when the price of electricity started to rise. The problem was that ESCOM had to finance most of its own growth. At the same time, ESCOM feared that if it did not expand, the country would run out of power. In 1977, consumers were paying 166% more for electricity than in 1971.

Unsurprisingly, the move to Megawatt Park in 1977 was not greeted favourably by the public, who saw it as an example of ESCOM's wasteful expenditure. The upshot of all this was that, in 1977, the Minister of Economic Affairs asked the Board of Trade and Industries to investigate the supply of electricity in South Africa.

ESCOM cooperated with the board to seek the best solution for the utility and for the South African economy. In the end, ESCOM did away with the Central General Undertaking (CGU) and modernised its accounting system. Although the Capital Development Fund (CDF) and ESCOM's insistence on large reserve plant margins came under attack, they were ultimately defended by the government, which shouldered some of the blame for the sharp price increases. ESCOM defended its spending on expansion by arguing that, without it, South Africa would have faced not only an oil shortage crisis, but an electricity shortage crisis, too. In 1979, Jan H Smith, ESCOM's General Manager at the time, lambasted the Board of Trade and Industry for their use of the word "profit". Then, as now, the term is a potentially misleading one, given that ESCOM's profits do not enrich private investors, but are used to expand South Africa's electricity system.

In 1980, the Chairman of ESCOM, Reinhardt Straszacker, retired, and it was the same Jan H Smith who grasped the baton. Smith, who raised tortoises as pets because he admired their tenacity, was known for being a "man in a hurry". He was nicknamed "Mr Kilowatt-hour", a reference to his ability to reduce complex planning issues to the effect they would have on the cost of a kilowatt-hour of electricity.

Unfortunately for ESCOM, although Smith was famous for being a top-class planner, he overestimated South Africa's future electricity needs. He was not helped by the fact that there were delays in the building of Koeberg, and the power from Cahora Bassa (then called Cabora Bassa) was so unreliable as to be arguably worse than no supply at all. With sanctions starting to bite, it was feared that ESCOM would be unable to complete Koeberg at all, and so certain planning schools of thought discounted nuclear power from the equation. The upshot was that ESCOM urgently began building more power stations in anticipation of continued high growth in demand. The early 1980s saw construction begin on Lethabo, Matimba, and Kendal power stations. This would add almost 12 000 MW to the system and create a problem that seemed almost unthinkable at the time: what to do with masses of excess electricity.

In the next edition ...

ESCOM's annus horribilis; the winds of change; and ESCOM enters a new era.

Did you know!?

1. ESCOM moved its head office to Megawatt Park in 1977.
2. Kriel Power Station (completed in 1979) was one of the first coal-fired power stations in the world to receive its coal from a fully mechanised coal mine.
3. Matla Power Station (completed in 1983) was built with a concrete boiler house superstructure, a rare innovation. This helped reduce the construction lead time during a time of international steel shortages.
4. The Drakensburg Pumped-storage Scheme (commissioned in 1981) was constructed entirely underground.
5. Between 1950 and 1980, ESCOM increased its share of the electricity market in Southern African from 71% to over 93%.
6. Between 1930 and 1980, the annual percentage growth in the demand for ESCOM's electricity exceeded South Africa's growth rate in every single year, but for one. The 1980 Annual Report put this phenomenon down to "increasing industrialisation".
7. From 1973 to 1982, ESCOM averaged an annualised growth in electricity of almost 9%.
8. The boilers for Kriel Power Station (first commercial service: 1976) – at 60 m high, with a furnace cross section of 20 m by 15 m, and containing 9 000 t of steel – were by far ESCOM's biggest at the time.
9. The chimney of Matla Power Station (first unit commissioned in 1979) had to be demolished when it was discovered that a supervisor had been stealing the reinforcing rods and selling them as scrap (Symphony p. 222).
10. Duvha Power Station (first unit completed in 1980) boasted the largest opencast colliery and the largest free-standing concrete structures (chimneys) in the Southern Hemisphere.
11. Jan H Smith, Chairman of ESCOM from 1980 to 1985, raised tortoises as pets because he admired their tenacity. Unlike his pets, he was known for "always being in a hurry".
12. In the early 1980s, the production of one unit of electricity used up about two and a half litres of water. Twenty years later, average water usage was less than half that amount.
13. In 1976, in an attempt to empower black artisans, ESCOM created the Artisan Recognition and Training Scheme. This allowed black artisan assistants to be trained up to artisan level.

Jan H Smith