

Exploring the opportunities for an accelerated phase-out of coal-fired power plants in South Africa

Delivered by: The Carbon Trust, Energy Systems Research Group (ESRG) of the University of Cape Town, Presidential Climate Commission (PCC)

Beneficiary: PCC

Country: South Africa

Summary

South Africa faces a critical juncture in its energy transition. With 40,000 MW of coal-fired power capacity, coal accounts for approximately 70% of the country's electricity generation. Most of this capacity is concentrated in 13 coal-fired power plants (CFPPs) owned and operated by Eskom, a state-owned, vertically integrated utility.

In response to tightening Minimum Emission Standards (MES) and South Africa's climate commitments, a technical assistance project funded by the Coal Asset Transition Accelerator (CATA) was launched. The project aimed to explore how best to accelerate the retirement of CFPPs to improve air quality standards and meet South Africa's climate targets, while ensuring a Just Energy Transition - one that is fair, inclusive, and economically viable for all stakeholders across the coal value chain.

1.Scope

2.Design

3.Deploy

Approach

The project focused on two core activities:

1. Fleet Prioritisation and Portfolio Planning

A multi-criteria analysis was conducted to rank and prioritise CFPPs for retirement. This considered:

- > Energy security including replacement capacity, regional dependence and grid stability
- > Cost and economic impact including capital and operating costs of each plant, cost of retrofitting vs. decommissioning, and economic impact on local communities, including job losses
- > Environmental performance including emissions intensity, impact on water resources and proximity to populations
- > Just Transition considerations, including social and employment impacts, including workforce size and skill levels, and availability of employment/retraining programmes.

2. Techno-Economic Modelling

A modelling exercise compared three scenarios to identify the most cost-effective and climate-aligned pathway:

- > Reference Scenario: Continued operation of non-compliant plants
- > 2030 Closure Scenario: Early retirement of all plants that fail to meet MES by 2030
- > 2030 Retrofit Scenario: Retrofitting plants to comply with MES

REFERENCE

Eskom's Emission Reduction Plan (ERP) - CFPPs run till their technical life

2030 CLOSURE*

All non-MES-compliant CFPPs (excl. Medupi) close from 2030

2030 RETROFIT**

Eskom ERP with additional retrofits and closures to meet MES compliance by 2030

Key findings

> Accelerated renewable energy (RE) deployment is critical

To meet climate targets and improve air quality, South Africa should scale up renewable energy deployment to 6 GW per year. This approach is the most cost-effective and delivers:

- > Significant reductions in CO₂ emissions, with the potential for millions of tonnes of avoided emissions annually
- > Improved air quality with significant reductions in SO_x, NO_x, and PM emissions
- > Enhanced energy system resilience with improved energy access and a reduced need for load shedding
- > Installed capacity would have to make up 175 GW from 2021 to 2050 in the 2030 Closure scenario

⊗ Retrofitting is costly and inefficient

Retrofitting CFPPs to meet MES is economically unviable, with estimated costs of ZAR 30–50 billion per plant. This option is more expensive and less effective than early retirement with a ramp up of the deployment of renewable energy.

⊗ Complying with air quality standards is critical

Full compliance with minimum emissions standards (MES) at all plants scheduled to operate beyond 2030 could prevent 2,300 deaths and economic costs of R43 billion/year, starting from 2025. That amounts to preventing 34,400 deaths and R620 bn in costs on a cumulative basis until the CFPP's end-of-life. However, requiring the application of the best available control technology at all plants instead of the current MES would avoid 57,000 deaths from air pollution (95% confidence interval: 34,800 – 86,500) and economic costs of R1,000bn (USD 68.0 bn; 95% confidence interval: R610 – 1,500bn) compared to the Eskom plan by 2030. These costs will likely be borne by communities already marginalised and disadvantaged, perpetuating the cycle of poverty, inequality, and unemployment as people will not be able to work due to illness or premature deaths of breadwinners and heads of households.

⊗ **2030 Closure scenario was the optimal scenario**

Decommissioning non-compliant CFPPs by 2030 and replacing them with renewables:

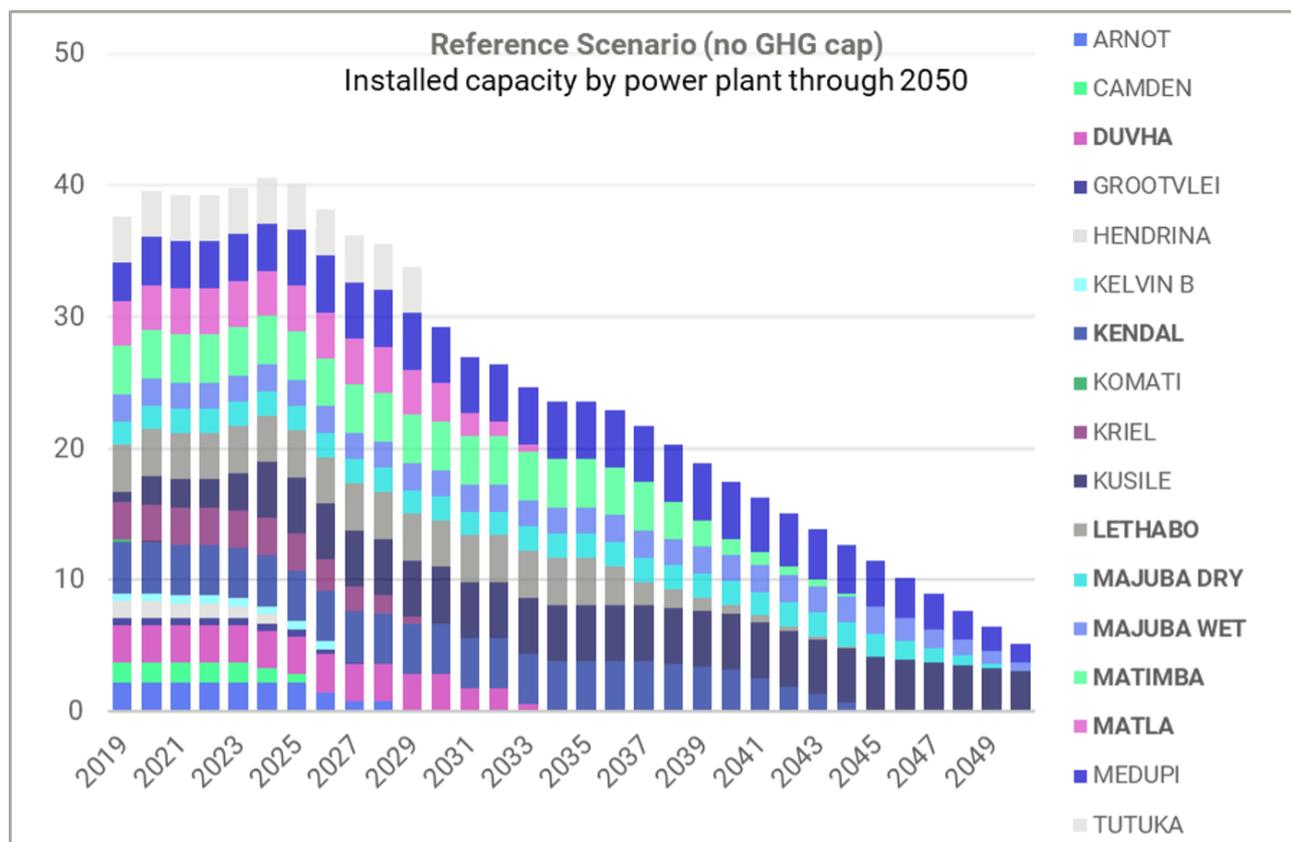
- > Has lower direct costs and risks than retrofitting
 - > Retrofitting 8 power stations would cost about R300bn total
 - > Each power station requires a refit cost of R30 – 50bn per station (R300bn total)
 - > The 2025 deadline for complying with air quality standards is unachievable as it takes 7 – 10 years to build gas converter plants
 - > Non-compliance risks withdrawal of Eskom’s operating license, DFFE not granting further legal indulgences, or not meeting specific loan agreement conditions.
 - > Example from Eskom Sustainability Report: Tutuka power station (2023): The decision to retrofit requires funding of approximately R340 billion and would affect the operating licence of 16,000MW immediately and a further 10,000MW post-2025 leading to further load shedding.
- > Avoids long-term lock-in of polluting infrastructure
- > Supports a faster transition to a low-carbon energy system
 - > The ‘2030 Closure scenario shows a very high peak of wind, PV, and gas additions in 2031, which reach 8.4GW, 13.2 GW, and 19.6 GW respectively
 - > The ‘2030 Retrofit’ scenario sees a more moderate peak of new build in 2031 (2.5, 6.5, and 7.7 GW of wind, PV, and gas respectively)
 - > The ‘9Gt cap’ has the effect of reducing new-build gas and raising the build of wind and some PV – while still high (peak new wind reaches 9.2 GW in 2033), the overall rate of the new build is smoother than the above two cases.

⊗ **Just Transition costs must be weighed against inaction**

While transitioning away from coal requires upfront investment in social support, retraining, and economic diversification, the costs of inaction – including health impacts, environmental degradation, and stranded assets – are significantly higher.

Methodology detail and Key takeaways

Reference Scenario



The Reference Scenario maps the installed capacity by power plant through to 2050, with no cap of GHG emissions, in accordance with the decommissioning timeline of Eskom's Emission Reduction Plan (ERP) 2022.

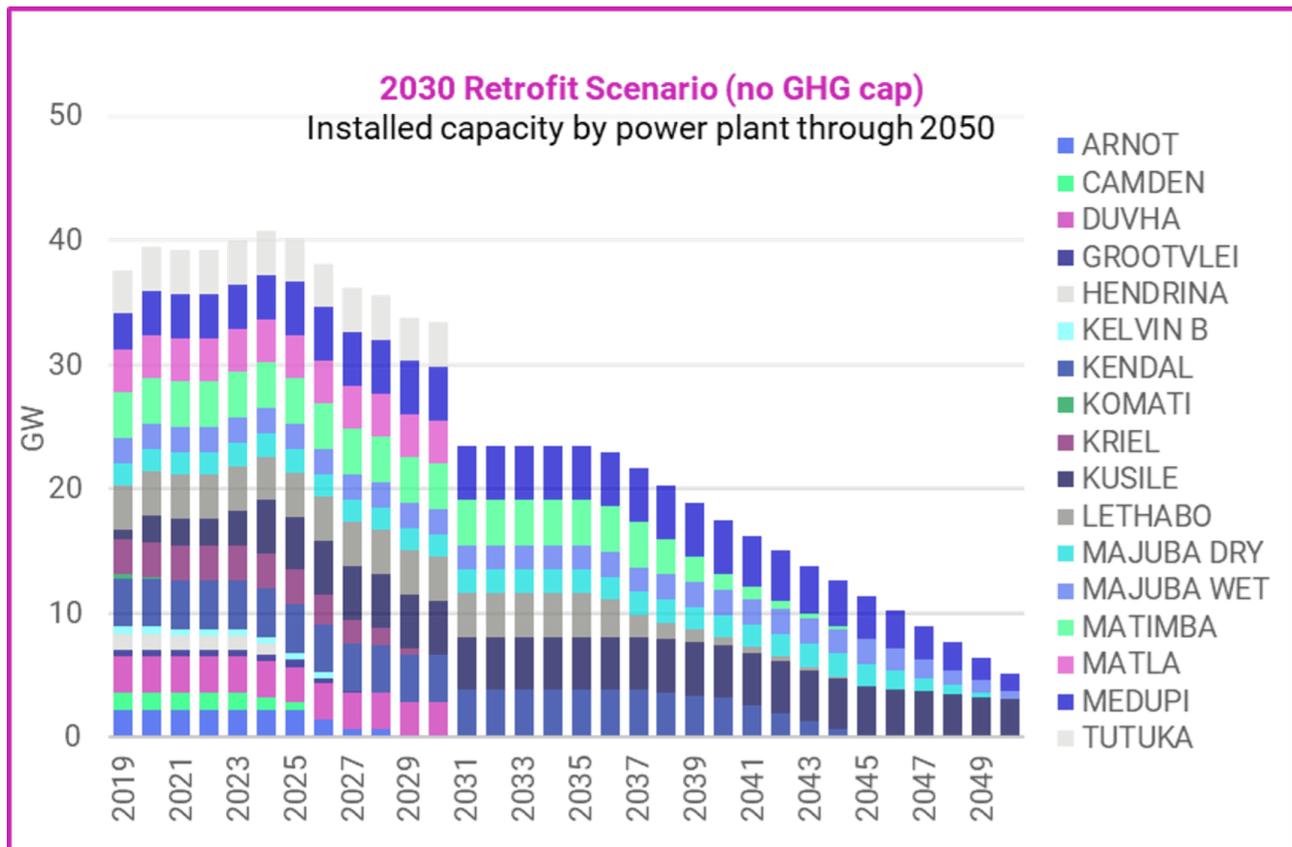
Assumptions

- ⊗ Plants are decommissioned at their end of life. The reference CFPP retirement schedule assumes over 15 GW of coal-fired capacity remains in 2040 and over 5 GW in 2050
- ⊗ Currently there are no plans to retrofit plants with AQ abatement technology except for two of the newer plants.

Key Takeaways

- ⊗ The Reference Scenario shows 26% reduction (10.4 GW) in coal capacity by 2030, 41% (16.2 GW) by 2035 and 87% (34.4 GW) by 2050, relative to 2023 levels.
- ⊗ MES compliance cannot be achieved as limited abatement retrofits are planned in this scenario, with no projects to deal with SO_x emissions.
- ⊗ Matla, Duvha, Lethabo, Matimba, Kendal, and Majuba CFPPs would be operating without compliance (SO_x) beyond 2030 under this scenario.

2030 Retrofit Scenario



The 2030 Retrofit scenario analyses the decommissioning schedule, as per Eskom's ERP 2022, with retrofits of the non-MES compliant plants with technologies to reduce air pollution and comply with the MES.

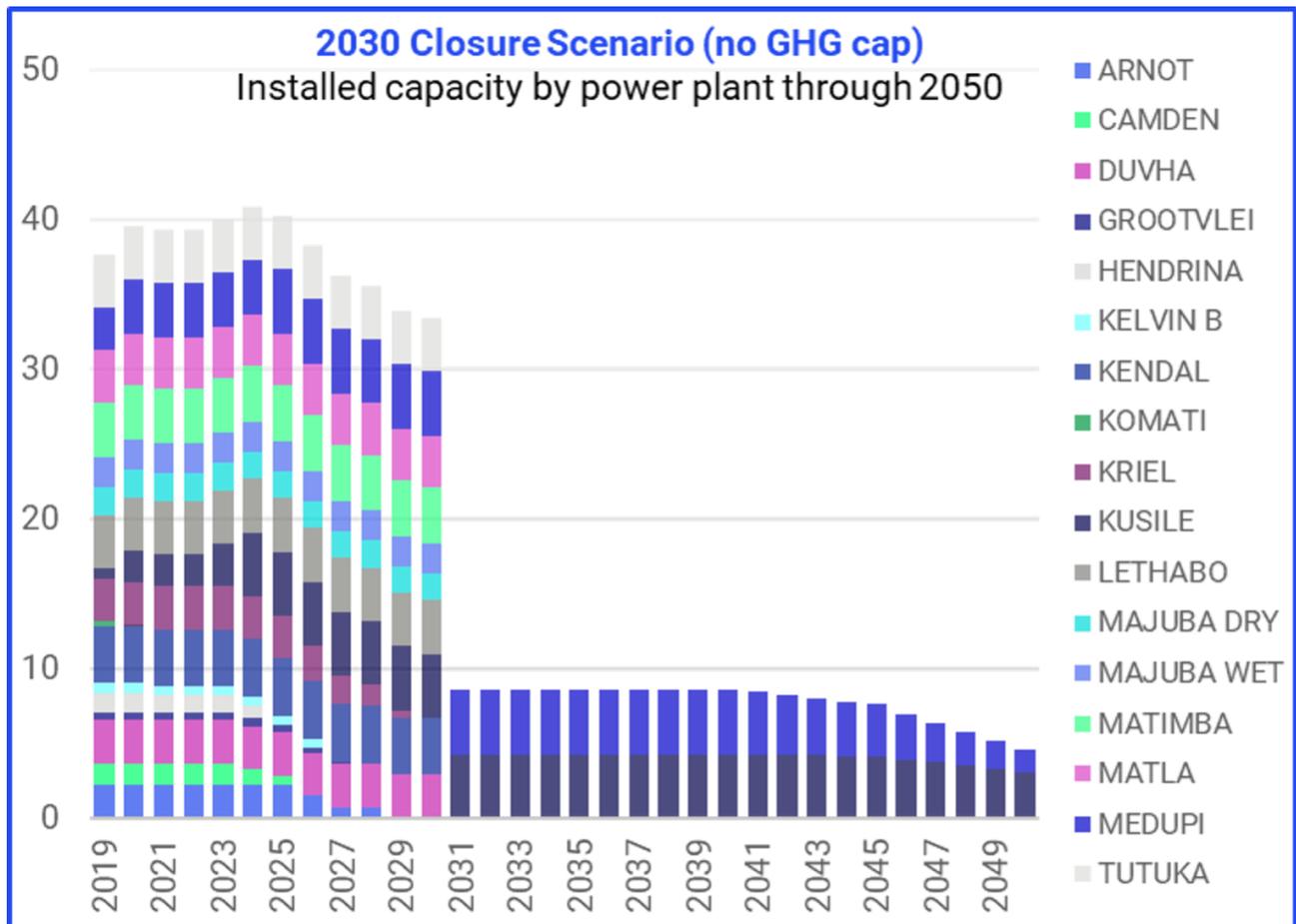
Assumptions

- ⊗ Arnot, Camden, Duvha, Grootvlei, Hendrina, Matla, Tutuka, and Kriel CFPPs are assumed to be decommissioned in line with current plans (IRP2019; draft IRP2023; and Eskom plans), so no retrofits were modelled for these plants.
- ⊗ This scenario includes technologies to reduce Particulate Matter (PM) and NO_x (nitrogen oxides), but not technologies to reduce SO₂ emissions due to high costs.

Key takeaways

- ⊗ Decommissioning CFPPs does not accelerate notably compared to the Reference scenario
- ⊗ Retrofitting non-MES compliant plants comes at a high cost. It would cost ZAR 30-50 billion per plant to retrofit AQ technologies to comply with the MES requirements.
- ⊗ We note that while the retrofit is being implemented, a plant may need to be taken offline for at least 6 months (some estimate it could take 12 months or more). This decrease in installed capacity could prolong system operation challenges, a risk mitigated by building more infrastructure for renewable energy.
- ⊗ In addition, the cost of continued operation and maintenance of these plants is significant, and continued SO₂ emissions mean that the health costs are not decreased by this intervention.

2030 Closure Scenario



The 2030 Closure scenario assumes that non-compliant plants would be granted MES exemptions until 2030, at which time, all non-compliant plants must be closed. This scenario offers significant cost savings and health benefits. The 2030 Closure scenario supports a faster transition to a low-carbon electricity system, requiring repowering and replacement generation capacity to be supplied by renewable energy sources.

Assumptions

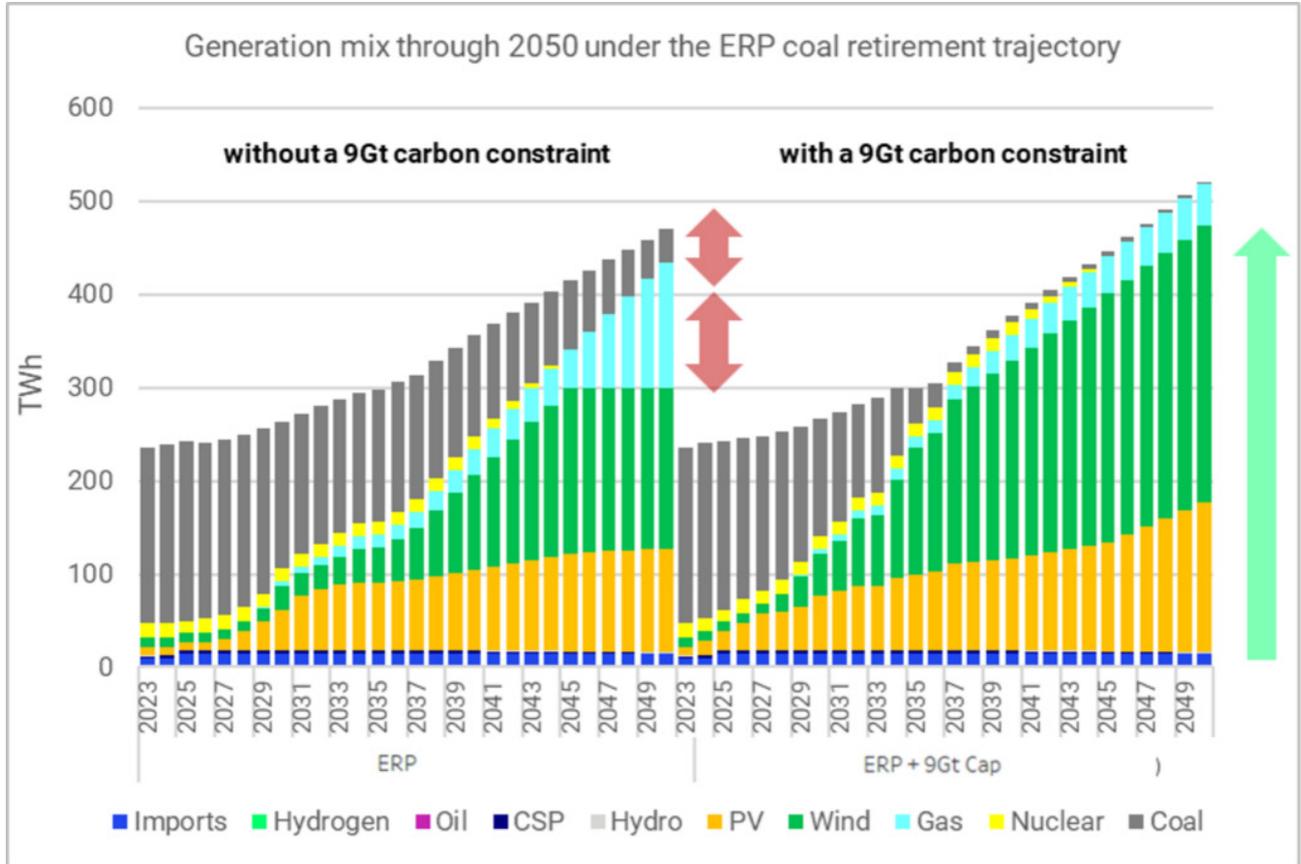
- ⊕ Except for Medupi and Kusile, retrofit costs are not included in this scenario.

Key takeaways

Overall fleet operation and maintenance costs and adverse health impacts and costs would also be avoided. However, shutting down a plant without replacement capacity cannot be supported and significant new capacity (RE) must be brought online. Additionally, the costs of urgently implementing a Just Energy Transition must be weighed against the cost of doing nothing or implementing the 2030 Retrofit Scenario.

Sensitivity analysis – 9Gt Carbon Budget

The project also modelled a scenario for meeting South Africa’s NDC (i.e. implementing a 9Gt carbon cap, with no additional retrofit/closure action for MES) as sensitivity analysis on the Reference scenario.



The results showed that the carbon cap drives the pace and scale of the closure of coal-fired power plants post-2030. Wind and solar penetration in particular need to substantially increase regardless of the remaining coal capacity operating.

This scenario would smooth new capacity additions and could support reducing pollutants and GHG emissions. While investment needs are higher than Eskom’s ERP, most of the new investment in generation capacity does not depend on Eskom or deepen its indebtedness.