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Reflections on load-shedding and potential GDP

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Abstract

This economic note investigates the slowdown in South African growth since the global financial crisis. It finds that domestic growth (both actual and potential) has been on a declining trend largely due to structural constraints, which over the last two years have been exacerbated by load-shedding. SARB models estimate the impact of load-shedding at between -0.7 and -3.2 percentage points, while other institutions' estimated impacts range between -0.4 and -4.2 percentage points. In our view, load-shedding will likely continue for longer as Eskom embarks on major repairs, new capital investment and maintenance projects. To prevent further growth slippage, it is crucial that there is efficient implementation of energy reforms as well as private sector participation and investment.

1. Introduction

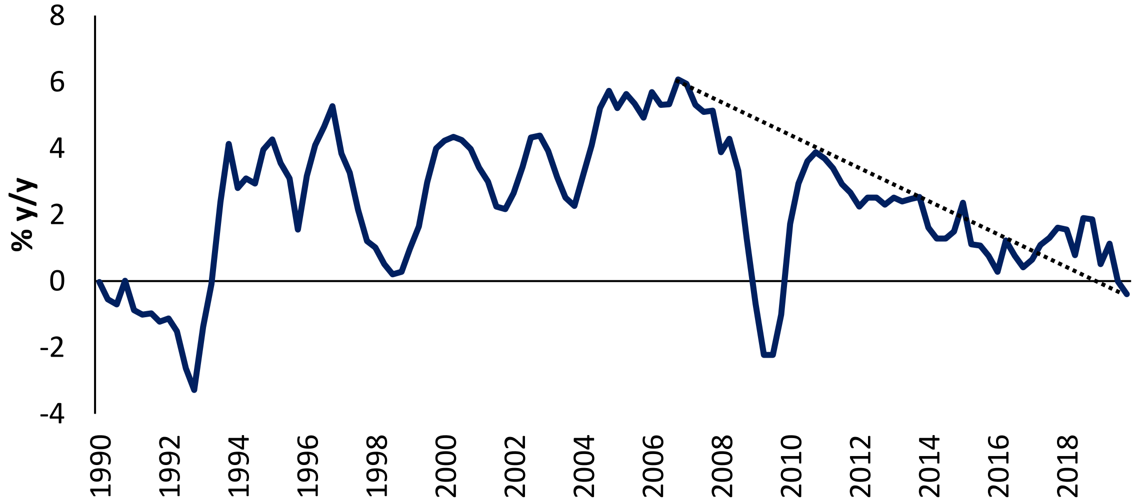
South Africa's domestic growth was declining long before the onset of the COVID-19 pandemic in 2020. Quarterly growth (on a year-on-year basis) peaked at around 6% prior to the global financial crisis (GFC) but fell below 0% at the end of 2019 (Figure 1). Such a prolonged growth decline is not cyclical but structural in nature and cannot be remedied with stimulatory demand policies. Moreover, structural growth (used interchangeably here with sustainable or potential growth) now risks being worsened by load-shedding.

The aim of this note is to briefly summarise South Africa's post-1994 growth and to demonstrate that growth has been on a declining trend for the past 15 years and that the slowdown is structural (largely productivity-related) in nature. Load-shedding is likely to slow potential growth even further over the near term. However, recently announced energy reforms should prompt increased private and public investment in electricity generation, thereby raising potential growth over the medium to long(er) term.

2. Domestic growth was slowing even before load-shedding

Following the democratic elections in 1994 and the reopening of global markets, South Africa's gross domestic product (GDP) growth accelerated from an average of 2.2% in the 1980s to an average of 2.7% per annum (p.a.) over the 1994–2000 period. It accelerated even further to 3.6% p.a. in the first decade of the new millennium on the back of policy reforms and higher commodity prices.

Figure 1: Real GDP growth (1990–2019)

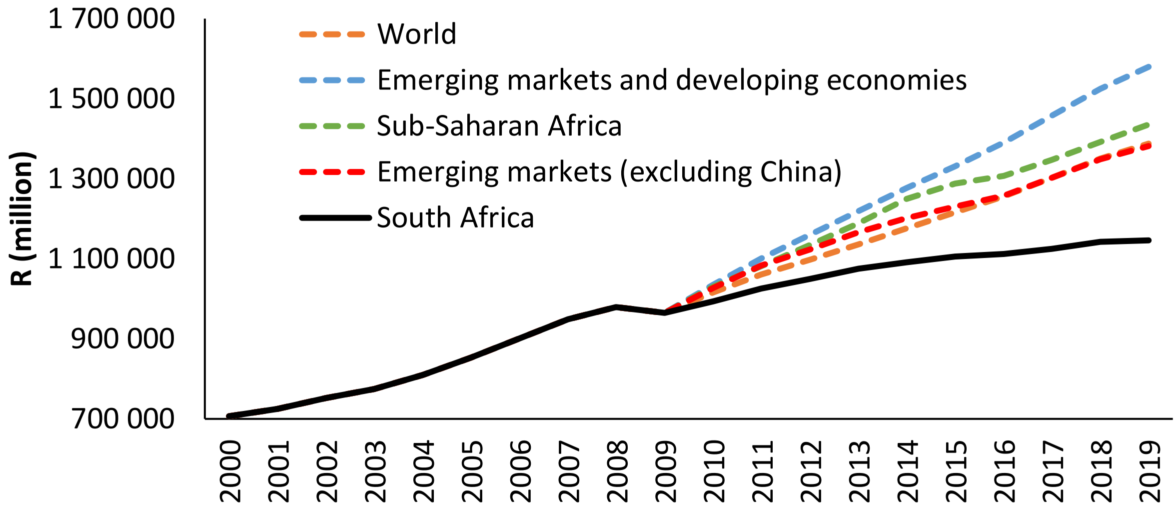


Source: Statistics South Africa (Stats SA)

But after the GFC, the growth picture changed dramatically. Even though growth temporarily recovered after the sharp decline during the GFC, it has been on a declining trend since it peaked at just below 6% in the final quarter of 2006 (Figure 1). Whereas growth averaged 3.6% p.a. over 2000–2009, it declined to 1.75% p.a. over the 2010–2019 period and decelerated even further to only 1.0% p.a. over the 2015–2019 period. South Africa's disappointing economic performance in the post-GFC period can be attributed to negative productivity shocks, exacerbated by corruption and misgovernment.

Moreover, domestic growth tracked global growth quite effectively before the GFC but diverged sharply thereafter. This suggests that most of the post-GFC growth slowdown can be attributed to domestic factors (rather than external factors). A similar picture emerges when South Africa is compared to other aggregate groups such as emerging markets and sub-Saharan Africa. In fact, if domestic growth had matched that of the world, emerging markets or sub-Saharan Africa after the GFC, South Africa's real GDP would have been significantly higher relative to its current level (see Figure 2).

Figure 2: South Africa's real GDP growth scenarios



Source: SARB, IMF and Stats SA

3. The growth slowdown is due to structural factors

Such a relentless growth slowdown over a period spanning more than 10 years (even when excluding the COVID pandemic years) cannot be explained by cyclical factors. It should rather be attributed to supply-side factors that in a broader macroeconomic context can be explained by the production function, which measures potential growth. The production function depicts the level of potential output commensurate with the quantities of productive factors (such as labour and capital), and how efficiently (productively) these factors are combined in the production process, while inflation is at target. To estimate potential GDP, the SARB uses a semi-structural multivariate filter that can be adjusted to account for temporary supply shocks (such as drought, load-shedding, strikes and floods) (Botha, Ruch and Steinbach 2018).

When analysing the production factors, it is well known that the domestic economy is characterised by an abundant labour supply – but, critically for production, there exists a shortage of skilled labour (Foko 2015; Daniels 2007). Although investment and capital stock growth have slowed since the GFC, the bulk of the decline in potential growth relates to negative productivity shocks.[1]

The South African literature has over the years highlighted reasons for the decline in domestic productivity. These include:

- fiscal policy, which has resulted in sharp increase in debt, in turn crowding out private investment – especially from 2017 onwards (Hausmann et al. 2022);
- sectoral developments in total factor productivity, particularly in the energy, transport and mining sectors (Hausmann et al. 2022);
- shrinkage of the non-mineral tradable sector, particularly export-orientated manufacturing (Rodrik 2008);

[1] See for instance calculations regarding sources of potential growth in Janse van Rensburg, Fowkes and Visser (2019).

- labour market inefficiencies (Suzuki 2018);
- deterioration of the business climate due to factors such as rising political and social risks, uncertainty over economic policy and the erosion of competitiveness (Faure 2017);
- the effects of state capture on productivity (Ofusori 2020; d'Agostino, Dunne and Pieroni 2012);
- inefficient investments across the economy and loss of skilled workers (both through leaving institutions and emigrating) (Suzuki 2018);
- intensifying levels of corruption, wasteful spending and misgovernment (Van Rensburg, Fowkes and Visser 2019); and
- load-shedding (Mpini, Walter and Makrelov 2019).

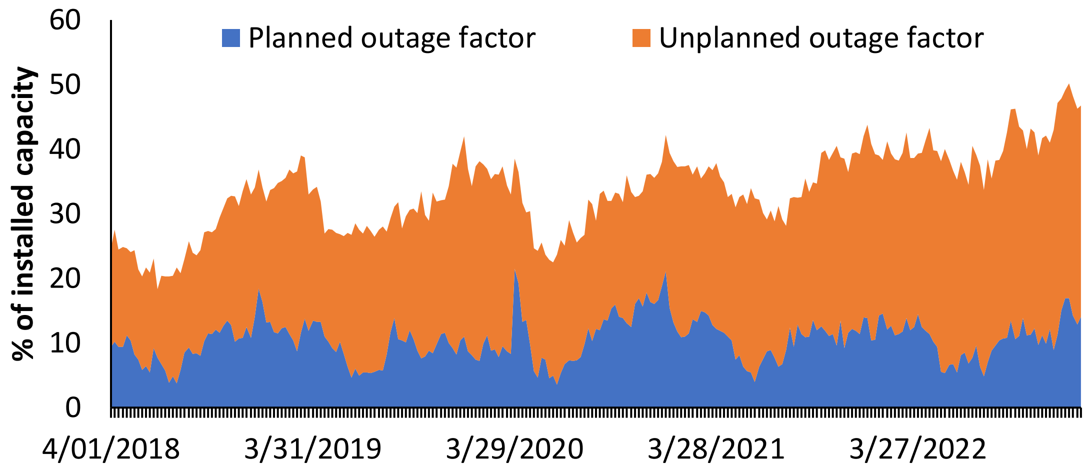
It is important to note that the economy's production potential is not directly observable and is derived from econometrically estimated models. The standard practice among central banks is to decompose real GDP in terms of a trend (a proxy for potential output) and a cycle, using various filtering techniques. The SARB – like most central banks – employs a semi-structured multivariate filter. The outcomes from such filtering techniques largely correspond with the more intuitive production-function approach described above but have the benefit of being less constrained by real-time data availability and limitations.

As mentioned, more recently load-shedding has led to negative productivity and hence a potential impact on output. In the next section we summarise how load-shedding has affected actual and potential output over the last few years and its likely effects in the near future.

4. Load-shedding has severely affected GDP growth over the last two years

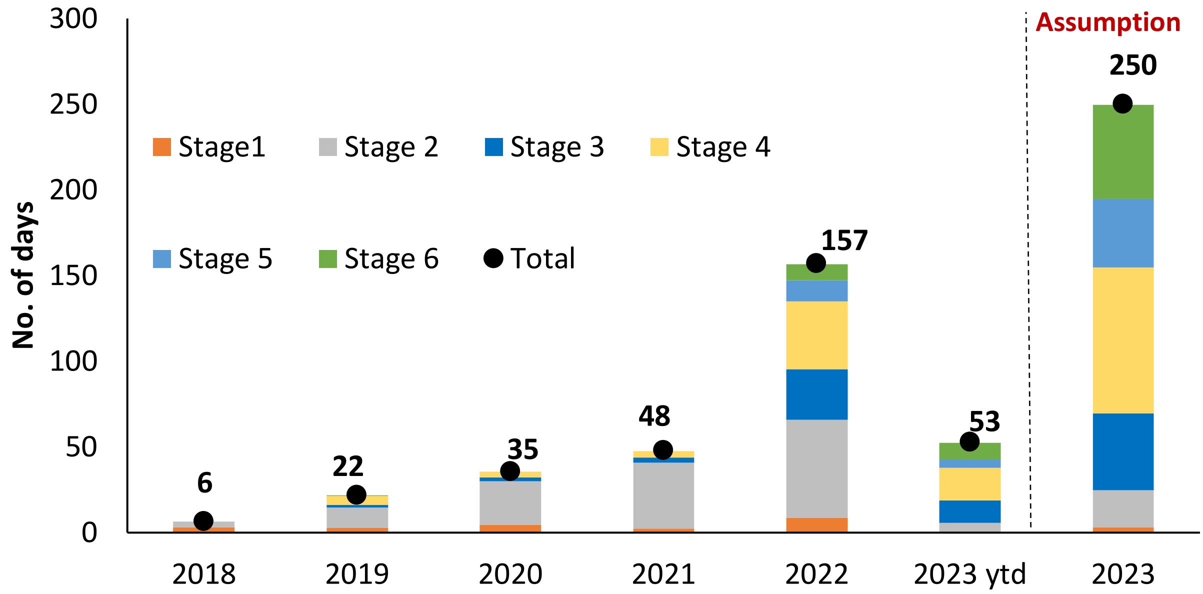
South Africa has experienced sporadic incidents of load-shedding since 2007, with a significant escalation in the last two years (largely caused by unplanned breakdowns at power plants – see Figure 3). The year 2022 was the worst year of load-shedding to date, with the country experiencing 3 776 hours (about 157 days) of power outages. This is significantly higher than the 2021 record of 1 153 hours (48 days) and the 844 hours (35 days) lost in 2020 (see Figure 4). Load-shedding has remained elevated in 2023, with the country already having experienced 2 434 hours, or 101 days, of power outages (i.e. almost every day), as of 16 April. By mid-February of 2023, load-shedding had already exceeded the cumulative totals of 2019 and 2020. It is thus likely that load-shedding will be much worse in 2023 (discussed further in the next section). Load-shedding has severe negative implications for production and overall confidence in the economy, as highlighted by several recent papers (Goldberg 2015; Morema et al. 2019; Mpini, Walter and Makrelov 2019).

Figure 3: Power plant breakdowns have increased



Source: Eskom

Figure 4: Number of days of load-shedding



Source: EskomSePush

5. Various methods used to estimate the impact of load-shedding on GDP

Quantifying the impact of load-shedding is key, as it informs the SARB's GDP and potential GDP forecasts. However, estimating this impact can be difficult, as there are numerous shortfalls and unknowns involved. In this section, we will discuss the various approaches used to estimate the impact of load-shedding on GDP.

5.1 The SARB's methodology

The SARB employs three models to estimate the impact of load-shedding, with each model identifying different impacts.

Model 1 – The first model is based on a methodology developed by Morema et al. (2019)[2] that quantifies the direct impact of load-shedding per production sector, adjusting for weekends, holidays[3] and the electricity intensity of each sector.[4] Load-shedding that takes place after working hours is assumed not to have an impact on sectors that do not operate at that time.[5] We also assume that most businesses have learned how to operate effectively during stages 1 and 2 of load-shedding and that there is thus probably a minimal impact on economic activity at these lower stages.[6] According to Model 1, the direct impact of load-shedding is estimated at around 0.7 percentage points in 2022, with electricity-intensive sectors being more affected.

Model 2 – The second methodology is a dynamic computable general equilibrium model developed by Mpini, Walter and Makrelov (2019). The model is calibrated using empirically estimated elasticities, with the electricity availability factor (EAF) as another key input. This is basically a sectoral model that estimates the impact of a decreasing EAF on the economy. The model has the advantage of being able to capture both direct and indirect effects of load-shedding. Using this model, we find the impact of load-shedding on 2022 GDP growth to be around 3.2 percentage points.

Model 3 – The third model framework regresses quarterly real GDP growth (dependent variables – total and by sector) on the gigawatt hours taken off the grid per quarter (explanatory variable – one of three load-shedding intensity metrics) and a constant term. The load-shedding intensity metrics tested were an unadjusted version of the gigawatt hours taken off the grid, a second version that accounts for weekends and public holidays by half-weighting entries on those days and a third version that applies the same entries as the second version but discards non-conventional working hour load-shedding entries. This model suggests that one additional gigawatt hour of load-shedding will lower quarterly real GDP growth by 0.0003, 0.0004 or 0.0008 percentage points, on average, for the three respective intensity metrics. In particular, model simulations using these frameworks estimated that real GDP growth in 2022 could have been between 1.6 and 1.8 percentage points higher had there not been any load-shedding.

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2 The estimates from this method feed mainly into the SARB's baseline forecast, while the other methodologies are used as a benchmark.

3 Sectors assumed not to operate on weekends/holidays will not be affected by load-shedding during those times.

4 This captures sector-specific characteristics, with sectors that are less electricity intensive assumed to be less affected. Even for sectors that are very electricity intensive, we assume that not all operations are dependent on electricity and that a percentage of their operations will continue during load-shedding.

5 For example, the finance sector is assumed to work for nine hours a day, so load-shedding after 17:00 should not affect the sector. The mining sector, however, is assumed to operate non-stop, so load-shedding at night would still affect it.

6 Furthermore, as much as higher stages of load-shedding will have some impact on economic activity, the impact is assumed to be slightly minimised by businesses running back-up power in the first few hours of load-shedding.

5.2 Other institutions' methodologies and results

The SARB is cognisant that other methodologies can be used to measure the impact of load-shedding, and therefore conducted an analytical survey.[7] Appendix A summarises these methodologies and their estimates of the impact on GDP growth in 2022.

Intellidex's and Investec's models are similar to SARB model 1, while PWC's model is similar to SARB model 2, and FNB and Absa use a model similar to SARB model 3. However, the results are quite different, and this is largely due to differences in the underlying assumptions made by each institution. Overall, the SARB's estimate ranges between -1.2 and -3.0 percentage points, while other institutions' estimated impacts range from -0.4 to 4.2 percentage points (see Table 1). Although the wide range of estimates is indicative of the uncertainty related to quantifying the exact economic cost of load-shedding, it is nonetheless clear that load-shedding has had a severe negative impact on growth.

Table 1: Expected load-shedding impact on 2022 GDP growth[8]

Institution	Methodology	Impact (%)
Absa	Ordinary Least Squares (OLS)	1.3
FNB	OLS	0.4–0.5
Investec	Working day adjustments	0.2–0.4
PWC	Input-output modelling	3.5–4.2
Intellidex	Working day adjustments	0.9–2.2
SARB (Model 1 – Morema, Rakgalakane, Alton and Mjandana (2019))	Working day adjustments	0.7
SARB (Model 2 – Mpini, Walter and Makrelov (2019))	CGE	3.2
SARB (Model 3 – SARB Quarterly Bulletin, March 2022)	OLS	2.1

Source: SARB, Absa, FNB, Investec, PWC and Intellidex

6. Loadshedding also negatively impacted potential growth

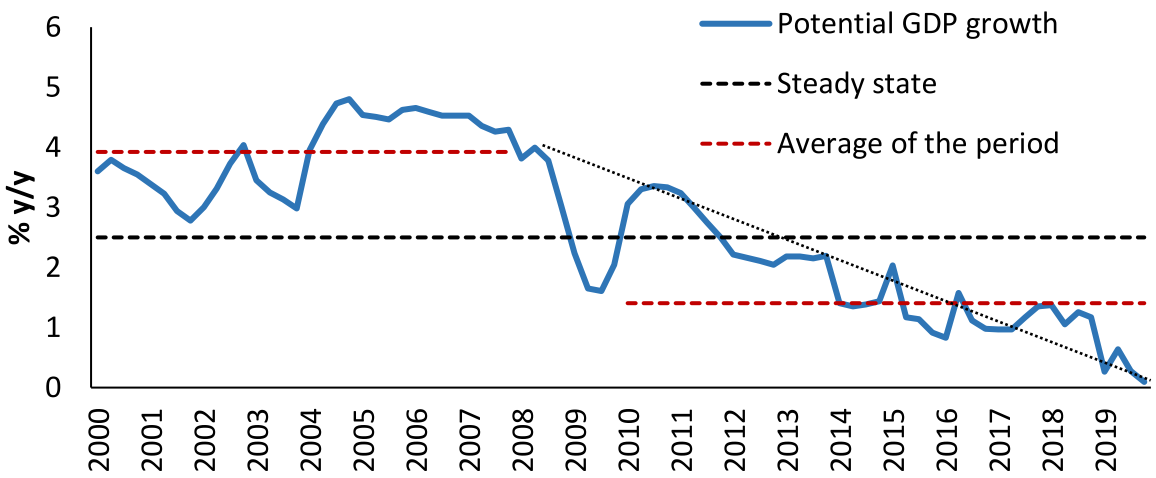
Given the definition of potential output (discussed in Section 3), power cuts can be expected to reduce productive time, thereby limiting the economy's production capacity. For example, a machine that normally operates for 24 hours using electricity cannot operate for the full 24 hours when load-shedding is in effect. The direct impact of load-shedding (as described in Section 4) is incorporated into our potential GDP estimate. It is important to note that load-shedding thus equally impacts actual and potential GDP (and hence does not impact the output gap).[9] Not surprisingly, load-shedding has been one of the major factors contributing to potential GDP growth slowing in line with actual GDP. Figure 5 shows that potential GDP growth averaged 3.9% pre-GFC but slowed to an average of 1.4% post-GFC and is estimated to be around 0.7% in 2022. Given that load-shedding is expected to be worse in 2023, potential growth is forecasted at 0.0% in 2023. This is well below the steady state of 2.5%.

7 Many thanks to Nelene Ehlers, Konstantin Makrelov and analysts from Absa, FNB, Investec, PWC, Intellidex, BER, Econometrix and Momentum for their valuable responses.

8 Most of these estimates were received in November 2022.

9 The output gap measures the difference between actual and potential GDP.

Figure 5: Potential GDP growth (1990–2019)



Source: SARB

7. Load-shedding risk likely to remain high until at least 2024

The significant deterioration in Eskom's generation capacity has raised concerns about how long load-shedding will persist. In our view, the risk of rolling power outages will remain high in 2023 and into the early part of 2024 as a result of the unreliability of existing power capacity, alleged sabotage, corruption and other factors. Furthermore, prolonged load-shedding will likely continue as Eskom embarks on a major repair, new capital investment projects and maintenance projects that are only expected to be completed over the next 12 to 18 months (see Table 2). According to Eskom, these projects and breakdowns will remove at least 4 500 MW of generation capacity – equivalent to stage 5 load-shedding. This supports our view that Eskom's generation capacity will remain constrained for some time while repairs are in progress.

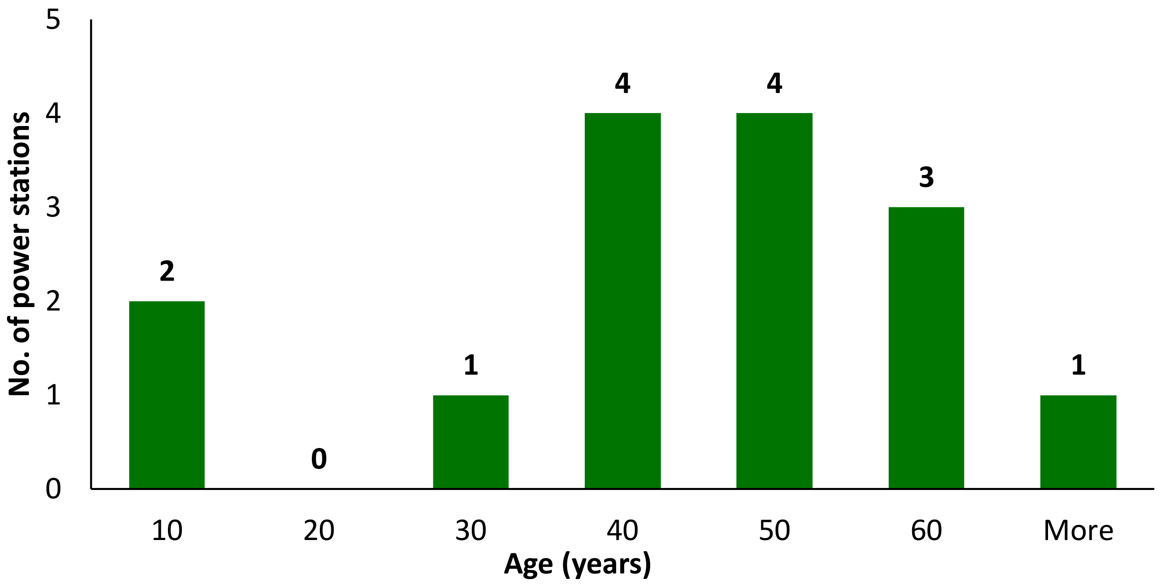
Table 2: Eskom's major repairs and maintenance projects

Unit	Generating capacity (MW)	Reason	Date taken offline	Expected return to service
Koeberg 1	920	Refuelling, regular maintenance and replacement of three steam generators	8 December 2022	June 2023
Kusile 1	720	Duct failure	23 October 2022	To be determined (anticipated to remain offline for months)
Kusile 2	720	Precautionary delay due to Unit 1 duct failure	23 October 2022	To be determined
Kusile 3	720	Precautionary delay due to Unit 1 duct failure	3 November 2023	To be determined
Kusile 5	800	A fire during commissioning in the gas air heater delayed the commercial operation	17 September 2022	July 2023
Medupi 4	794	Generator explosition	8 August 2023	August 2024

Source: Eskom

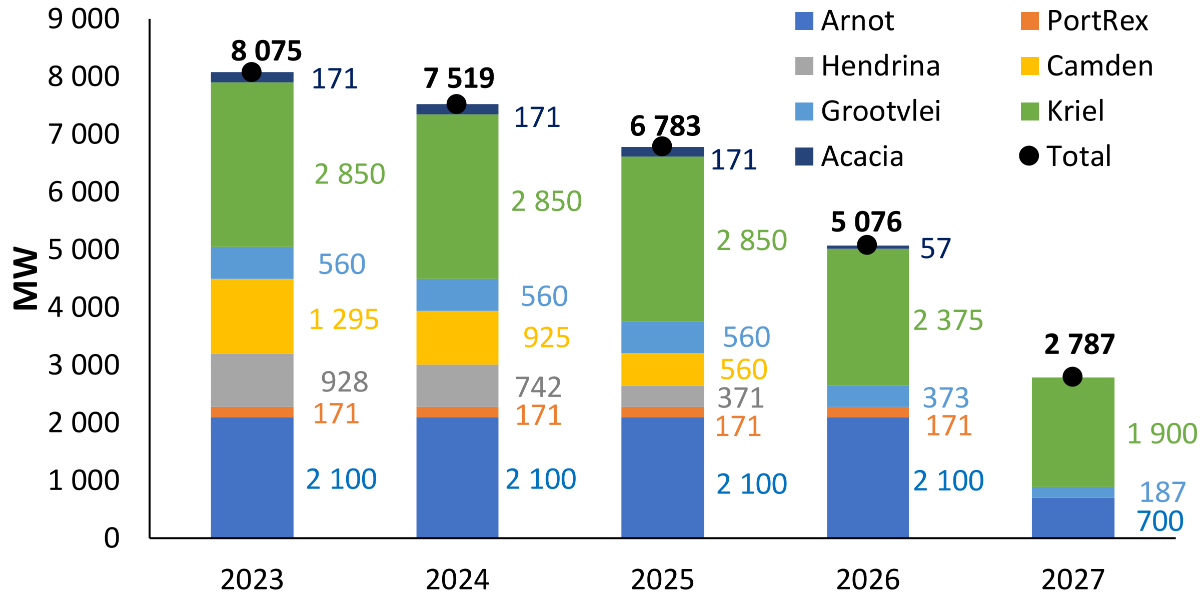
Furthermore, several existing coal-fired power stations are very old (see Figure 6) and will have to be taken offline at the end of their licenced operating lives, in line with the Minimum Emission Standards regulations. In October 2022, the 1 000 MW Komati power station became the first to be completely shut down. Seven other generating units (Arnot, PortRex, Hendrina, Camden, Grootvlei, Kriel and Acacia) are also expected to be gradually taken offline over the next five years. This is expected to reduce Eskom's generation fleet by 5 288 MW between 2023 and 2027 (see Figure 7). This will likely put further strain on Eskom's generation capacity – hence the need for energy reforms to help minimise these constraints.

Figure 6: Age of Eskom's coal-fired power stations



Source: Beeld Nuus

Figure 7: Assumed capacity shutdown



Source: Eskom

8. Energy reforms might bring some reprieve

The best opportunity to ease South Africa's energy constraints is through the implementation of key structural reforms. President Cyril Ramaphosa announced an 'energy action plan' in July 2022 that contains several interventions aimed at tackling the country's current electricity crisis.[10]

While these energy reforms are encouraging, the SARB assumes that they will only begin to have a meaningful impact on energy constraint towards the second half of 2024. There is upside risk to this assumption, as the government also aims to implement structural reforms in other sectors to resolve some of the structural constraints discussed in section 3. Details of these reforms are covered by Operation Vulindlela.[11] Table 3 (in Appendix B) shows some of the progress made in implementing structural reforms. If they are fully and efficiently implemented, these reforms could significantly boost both actual and potential GDP growth, which presents an upside risk to the SARB's forecast. However, it will take some time to undo the damage caused by the structural and productivity impediments described earlier, so the positive impact of these reforms will likely raise (potential) growth slowly.

9. The growth multiplier might disappoint

The SARB and other analysts assume that the recently announced energy reforms will lift the energy constraint towards the latter part of 2024. Although the additional investment is likely

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10 Further details regarding the energy action plan announced by the President can be found at https://www.stateofthenation.gov.za/.

11 For more details on these reforms, see https://www.stateofthenation.gov.za/operation-vulindlela.

to raise overall gross fixed-capital formation, the growth multipliers might be smaller than is generally perceived, for at least two reasons:

1. Solar investment typically has a very high import content. Anecdotal evidence suggests this might be as high as 80% for typical household installations. Consequently, a large part of the investment stimuli will be lost via increased imports.
2. With industry allocating fixed-capital formation to electricity generation in favour of expanding capacity, the longer-term incremental capital output ratio (ICOR) will most probably come under further pressure. Janse van Rensburg, Fowkes and Visser (2019) argue that the marginal unit of capital has become steadily less productive over the post-crisis period, reflected in a rising ICOR from 2010 onwards, consistent with intensifying corruption and wasteful spending. There is a risk that the renewed shift from investing in capacity instead of expanding plant capacity may result in a new round of declining investment efficiency.

10. Concluding remarks

Due largely to structural constraints, South Africa’s domestic growth has been on a declining trend since it peaked at around 6% prior to the GFC. Such a relentless growth slowdown over a period of more than 10 years (even when excluding the COVID-19 pandemic years) cannot be explained by cyclical factors. The growth slowdown should rather be attributed to supply-side factors. Although investment and capital stock growth have slowed since the GFC, the bulk of the decline in potential growth relates to a host of negative productivity shocks.

Over the last two years, load-shedding (largely caused by unplanned breakdowns at power plants) has had a significant negative impact on productivity – and hence on potential output. In 2022 the country experienced 157 days of load-shedding, its highest annual total to date. The economic cost of load-shedding is severe, as it negatively impacts production and overall confidence in the economy. In fact, the SARB models estimate the impact at between -0.7 and -3.2 percentage points of GDP growth, while other institutions’ estimates range between -0.4 and -4.2 percentage points.

Eskom’s generation capacity is likely to remain constrained for some time. The risk of rolling power outages will remain high in 2023 and into the early parts of 2024 due to unreliable power capacity, alleged sabotage and other factors. Consequently, prolonged load-shedding will likely continue as Eskom embarks on major repairs, new capital investment and maintenance projects over the next 12 to 18 months. Furthermore, several coal-fired powered stations are very old and will have to be taken offline as they reach the end of their licenced operating lives.

It is therefore essential that the implementation of energy reforms is hastened and that private sector participation and investment is strongly encouraged to avert a further slowdown in actual and potential economic growth.

Appendix A: Other institutions' methodologies

Absa – Absa uses a simple OLS regression of real GDP growth (dependant variable) and electricity available for distribution (explanatory variable), including a dummy variable for the second and third quarters of 2020. This simple equation produces a statistically significant coefficient of 0.16. In other words, a 1% quarterly decline in electricity consumption is associated with a 0.16% quarterly decrease in GDP. From this, Absa estimates that power cuts reduced real GDP growth by 1.3 percentage points in 2022.

Intellidex – Intellidex runs a variety of models using Eskom's data, real GDP growth and monthly indicators. Load-shedding is treated like working-day adjustments. This information on the number of working days is found in a range of banking-sector data and anecdotal evidence from clients in different sectors, especially on adaptation and impact. Using this methodology, the impact of load-shedding per stage/per day is estimated at around R125 million on average. For 2022, load-shedding is estimated to have reduced real GDP growth by 0.9 percentage points.

FNB – FNB estimates an OLS simple regression using the SARB's Load-Shedding Intensity Index (explanatory variable) and sectoral and aggregate GDP levels. The Load-Shedding Intensity Index coefficient on GDP is estimated to be around -0.01121 (lower than that of SARB Model 1). FNB also assumes that stages 1 and 2 of load-shedding are relatively 'normal' and not problematic for most companies/sectors. On average, load-shedding is expected to shave off around 0.4–0.5 percentage points of 2022 growth (excluding the impact in the first quarter).

Investec – To calculate the total cost of energy lost per day across different stages of load-shedding, Investec uses Eskom's value of energy expected to be lost per day for the different stages of load-shedding, as well as the National Energy Regulator of South Africa's (NERSA's) 2020 estimate for the cost of unserved energy.[12] The result suggests that load-shedding is expected to shave off at least 0.9 percentage points of 2022 GDP growth. Investec then assumes that at least 60% to 80% of businesses have backup power (generators), resulting in a lower impact of between 0.2 and 0.4 percentage points.[13]

PWC – PWC conducted a literature review[14] of domestic and international approaches to find a link between the cost of unserved energy and the cost of load-shedding. It found that the ratio between planned and unplanned load-shedding is roughly 50%. This ratio is then applied to the last two total-cost estimates from NERSA, which were roughly R87/KWh and R100/KWh. These calculations were based on input-output modelling results and use a 50% ratio to determine a R44–R50/KWh estimate. PWC's results suggest that the impact of load-shedding was between 2.4% and 2.9% of GDP in 2021. Based on an estimate of 4 500 GWh of load-shedding for 2022, PWC estimates the impact for 2022 to be between 3.5% and 4.2% of GDP.

12 The total cost arising due to an electricity outage for a unit of energy.

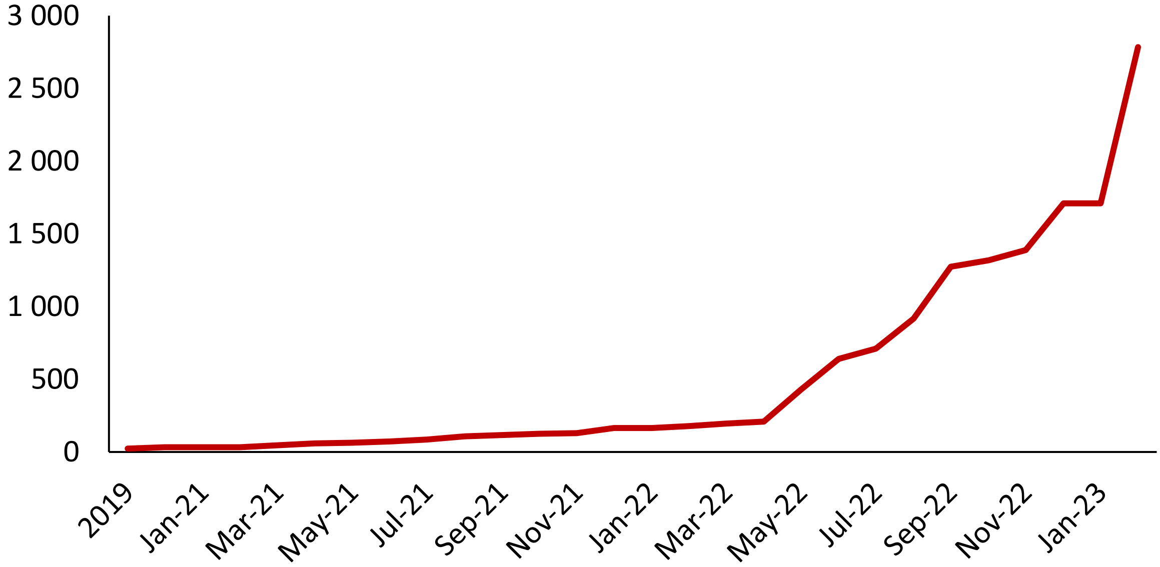
13 Load-shedding was assumed to continue at stage 2 from November and up until 15th December 2022.

14 The main assumption, based on our literature review and experience conducting our own Environmental Impact Assessment modelling, is that the cost of load-shedding is between R44/KWh and R50/KWh.

Appendix B: Energy reforms

One of the key reforms in this package is the abolition of the licensing threshold for embedded self-generation. This is expected to contribute significantly to alleviating the energy crisis in South Africa. There is already some evidence that more private sector businesses are taking advantage of the removal of the licensing threshold.[15] Data from NERSA indicate that applications for around 2 600 MW worth of self-generation projects were received between January 2022 and February 2023. This is significantly higher than the applications for about 130 MW worth of projects received between 2019 and 2021 (see Figure 8).

Figure 8: Cumulative applications for self-generation projects



Source: NERSA

Other initiatives to reduce load-shedding include improving Eskom's coal-fleet performance; converting old coal-fired power stations to renewable sources as they reach the end of their life cycle; commissioning units 5 and 6 at Kusile as quickly as possible; the possible import of power from neighbouring countries; and demand-management strategies (see Figure 9). The roadmap to ending load-shedding indicates that 8 822 MW could be added in 2023 from other sources, a further 8 665 MW in 2024 and more than 29 000 MW beyond 2024.

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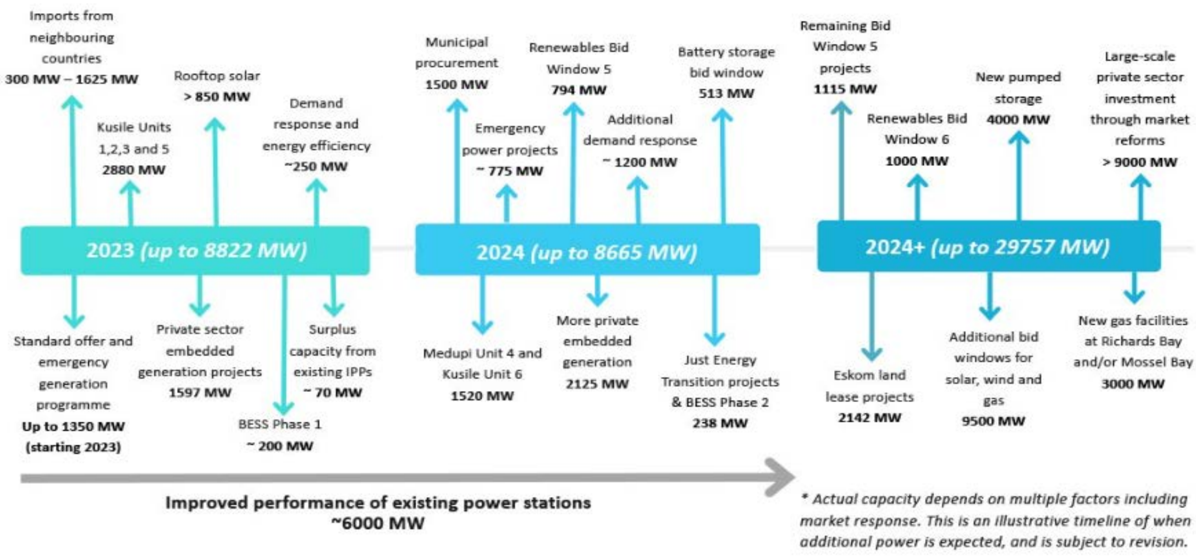
15 For example, Anglo American partnered with EDF Renewables to form a joint venture called Envusa Energy, with the aim of developing up to 600 MW of renewable power, and the potential to ramp it up to 3–5 GW by 2030. Gold Fields has also indicated that it will be developing its own solar power capacity for its mining operations. As of July 2022, a total of 73 self-generation projects were reported to be planned or under development in the mining sector with a plan to develop up to 5.1 GW of renewables capacity.

Figure 9: Roadmap to end load-shedding



Source: The presidency and Engineering News

Table 3: Status of reforms as of 2022Q2

#	ACTIONS	STATUS
1	Raise licensing threshold for embedded generation	Blue
2	Implement emergency procurement of 2 000 MW	Red
3	Procure new generation capacity in terms of IRP 2019	Green
4	Enable municipalities to procure power from independent power producers	Blue
5	Restructuring of Eskom	Green
6	Improve Energy Availability Factor (EAF) to over 70%	Red
7	Address institutional inefficiencies in municipal electricity distribution	Amber
8	Complete spectrum auction	Blue
9	Complete migration from analogue to digital signal	Red
10	Finalise Rapid Deployment Policy and Policy Direction	Green
11	Streamline process for wayleave approvals	Green
12	Improve water-use license application process	Green
13	Revive the Blue Drop, Green Drop and No Drop water quality monitoring system	Blue
14	Establish an independent economic regulator for water	Green
15	Finalise the revised raw water pricing strategy	Green
16	Establish a National Water Resource Infrastructure Agency	Green
17	Address institutional inefficiencies in municipal water distribution	Amber
18	Corporatise the Transnet National Ports Authority (TNPA)	Blue
19	Improve efficiency of ports	Amber
20	Establish Transport Economic Regulator through Economic Regulation of Transport Bill	Green
21	Finalise the White Paper on National Rail Policy	Blue
22	Implement third-party access to freight rail network	Green
23	Publish revised Critical Skills List	Blue
24	Review Policy Framework and processes for work visas	Blue
25	Expand visa waivers and explore visa recognition system	Green
26	Implement e-Visa system in fourteen countries, including China, India, Kenya, Nigeria	Blue

RAG STATUS			
REFORM COMPLETED (Blue)	CRITICAL CHALLENGES IN IMPLEMENTATION (Red)	SOME CHALLENGES OR DELAYS IN IMPLEMENTATION (Amber)	REFORM ON TRACK OR UNDERWAY (Green)

Source: National Treasury

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