AUTHORS:
Marthinus J. Booysen[1,2]
Servaas van der Berg[3]
Pieter W. van der Walt[1]

AFFILIATIONS:
[1]Department of Electrical and Electronic Engineering, Stellenbosch University, Stellenbosch, South Africa
[2]Department of Industrial Engineering, Stellenbosch University, Stellenbosch, South Africa
[3]Department of Economics, Stellenbosch University, Stellenbosch, South Africa

CORRESPONDENCE TO:
MJ Booysen

EMAIL:
mjbooysen@sun.ac.za

HOW TO CITE:
Booysen MJ, van der Berg S, van der Walt PW. Some real but mostly unconsidered costs hiding in the dark corners of load shedding. S Afr J Sci. 2023;119(9/10), Art. #16596. https://doi.org/10.17159/sajs.2023/16596

ARTICLE INCLUDES:
☐ Peer review
☐ Supplementary material

KEYWORDS:
load shedding, South Africa, economic growth, social cohesion, demand management

PUBLISHED:
31 August 2023

Some real but mostly unconsidered costs hiding in the dark corners of load shedding

Significance:

Culling electrical demand to save a fickle supply costs South Africa more than you may think. Load shedding is South Africa's new norm, affecting each of us, with individual impacts ranging from annoyance to ruin. Much of our vital and collective electrical lifeline is sacrificed on the altars of convenience, inefficiency, and oversight. This Commentary sheds light on some of the hidden costs of load shedding. We call for custodianship of this crucial and limited shared source of life, and call on government to incentivise electricity generation, preferably the renewable and distributed type.

Context

Our way of life, and often life itself, requires a stable supply of electricity. Establishing the infrastructure to generate this vital energy source is a costly and time-consuming undertaking. Generating electricity also costs money: operational costs include labour costs, maintenance costs, and the cost of fuel – coal in South Africa's case. In South Africa, a parastatal behemoth called Eskom is responsible for the generation, transmission, and a large part of the distribution and retail of electricity. Municipalities do the remaining distribution and sales. Unlike the norm in developed countries, South Africa is especially reliant on electricity for domestic and commercial energy needs. For example, electricity predominantly drives climate control, cooking, water heating, and smelting.

At face value, South Africa's unsubsidised electricity is amongst the cheapest in the world.[1] However, this pricing ignores the numerous government bailouts, which effectively act as hidden subsidies.

Managing electrical grid stability requires a fine balance between supply (generation) and demand (load). Load shedding, a colloquial term for scheduled rolling blackouts, has become the norm in South Africa, with the country currently experiencing load shedding ranging from Stages 1 to 6. Load shedding has resulted in a reduction in the weekly electricity availability factor (hours per week with electricity) from 100% to as low as 63% in the year from March 2022, as shown in Figure 1.[2] Load shedding, by definition, implies that there is an unsatisfied demand for electric energy, and, by design, demand is forcefully reduced to less than available supply, with a safety margin. This forced reduction in demand is needed to ensure that the grid does not collapse, which would result in a complete blackout. Such a blackout could happen in a matter of minutes, and examples exist of such events elsewhere, including in developed countries. A blackout could take days or even weeks to resolve, because the generation units require incremental restarting for synchronisation.[3]

Eskom has a supply crisis, but it cannot be observed in isolation from the demand and potential for demand management. From the demand perspective, the loss of electricity could result in a mere inconvenience (e.g. darkness before bedtime or an inability to cook food at a chosen time), a hindrance (e.g. preventing learners from studying after hours), a health risk (occupants reverting to burning wood for cooking or heating, or broken cold chains for medicines or foodstuffs). Crucially, these energy amputations also lead to lost commerce, production, and business operations – all of which have an adverse impact on economic activity in a country desperate for economic growth.

Restricted growth and risk to social cohesion

Short-term effect on growth

By affecting production, load shedding curtails economic growth. Modelling by the South African Reserve Bank (SARB) indicates that load shedding may have reduced 2022 economic growth by 2.2–2.5 percentage points per annum.[4] Sustained over several years (and currently, prospects for rapid improvements seem poor), such growth foregone by not utilising existing productive capacity on an annual basis translates into thousands of jobs not created, slower growth of wages, particularly for public servants, and constraints on public sector resources that will affect service delivery and the creation and maintenance of infrastructure.

Long-term effect on growth

Growth foregone in the short term does not include the effect of uncertainty – to which load shedding contributes abundantly – on investor confidence and inflows of international capital. This reduces the growth of long-term productive capacity. Such investment is extremely sensitive to changes in perceptions of the growth prospects of an economy and of the likelihood of social and political stability. Foreign exchange is a particularly valuable resource for a smallish country such as South Africa, where capital goods are mostly imported. Investors require a positive investment climate, where there are perceived favourable returns on investment and relatively low risk of social and political conflict. Positive investor sentiment is difficult to achieve while load shedding is so central in our daily lives.

Three phases of post-transition growth

There have been three phases in South Africa's economic growth since the transition to democracy in 1994, shown in Figure 2. Growth was modest until the turn of the century, largely because investors were uncertain whether the new government would implement fiscally prudent policies. Income grew at only around 1.1% per capita per year.

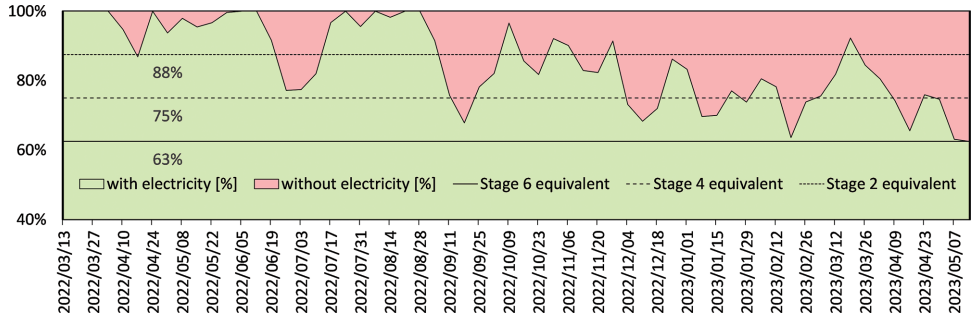

Figure 1: The electricity availability factor, expressed as a percentage of the hours per week, has reduced substantially since March 2022. Derived from Eskom Se Push data, 2023.[2]

Once investors became convinced that the new government would indeed implement sensible macroeconomic policies, per capita growth accelerated to a much more respectable 3.7% between 2000 and the 2008 financial crisis. At this rate of growth, average incomes could double in 19 years. Although negative domestic factors might have put an end to this growth spurt soon enough, its end was precipitated by the so-called "great recession" – a global event. While the rest of the world soon recovered and returned to almost similar levels of growth in the subsequent decade, South Africa's homegrown chickens came home to roost. To the litany of corruption, political decay, uncertainty of ownership, employment proscriptions, failed social delivery – at national, provincial, and increasingly also local level, massive unemployment, crime, and violence was added load shedding. We got stuck in a low growth equilibrium, with per capita growth dropping to a meagre 0.8% per year, before the COVID-19 pandemic worsened an already dire situation. At such a growth rate, a doubling of incomes would not take the 19 years mentioned for the 2000–2008 period, but three generations – 90 years. This while world growth almost fully recovered from the financial crisis, and many African countries showed solid growth.

A zero-sum game strains social cohesion

The failure to return to a more acceptable growth after 2008 should be seen against the backdrop of great uncertainty. Load shedding is not the only impediment to strong economic growth – logistical issues relating to export capacity also contributed. But load shedding considerably exacerbated the already fragile business and consumer confidence.

Poor growth has fuelled social frustrations, and social frustrations that boil over in turn create conditions that constrain growth. South Africa thus now faces something close to a zero-sum game in the economic sphere, with per capita resources almost stagnant. This will make it much more difficult to escape from this vicious cycle of conflict and low growth. Living standards are directly affected by economic growth and rising unemployment. Moreover, we require economic growth to increase the social resources available for social spending, in particular spending on those things that our society still needs – school infrastructure, housing, water and sanitation, a strong early childhood development sector, to name just a few. Where growth is stagnant, those who gain can largely do so at the cost of others, heightening the already high levels of underlying conflict in our society.

Projecting our shed onto GDP

During bouts of shedding, households and businesses are disempowered for 2 to 4 hours at a time, and for an average of 1.5 hours (Stage 2) to 9 hours (Stage 6) per day. The unsatisfied and 'shed' demand does result in lost opportunities for generating revenue from the sale of electricity. However, as Eskom reportedly sells electricity effectively at a loss, we do not consider this cost here.

Although load shedding achieves the goal of severing demand and thereby stabilising the grid, it remains a blunt tool. Consider the electrical loads on the grid. Much of it will be essential and/or could contribute to GDP, but a large part will be non-essential. Separately, much of it will be inefficient, for example, the use of inefficient lighting, the uncontrolled scheduling of water heaters, or the poor thermal insulation of buildings. It therefore stands to reason that a substantial part of the load on the grid, which contributes to the need for load shedding, is discretionary, non-essential or wasteful.

Quantifying the cost of load shedding is a daunting task, with estimates varying. Using SARB's estimation of ZAR899 million per day, and that Stage 6 loadshedding requires 6 GW of load being shed, we can calculate the cost per kilowatt-hour (or colloquially known as a 'unit') of non-essential loads that contributed to the need for load shedding. For a 24-hour cycle, this is the equivalent of 144 GWh (gigawatt-hours) or 144 million kWh of energy shed per day. The cost to the economy of these loads can therefore be estimated as ZAR899/144 kWh = ZAR6/kWh. We will use this crude estimation to try to quantify the cost of some of our discretionary uses.

Water heating

Although hygiene is important, most usages of hot water, especially those involving large volumes, are discretionary. To heat 80 L of water (the volume for a typical bath) during winter requires 5 kWh. This means that the economy subsidises each (discretionary) bath by ZAR30 *if the water is heated from the grid in a period of load shedding*. Additionally, and maybe more importantly, there are more than 5 million electric water heaters in South Africa, and each one consumes an estimated 10 kWh per day, and adds an average of 1 kW to the national evening peak load. Therefore water heating contributes approximately 50 GWh to the daily demand (~10% of the daily grid supply), and 5 GW to peak-time demand. Research has shown that smart, centralised, schedule-control and energy-conscious plumbing can reduce this by up to 22%.[6] An option that can substantially reduce energy required for water heating is heat pumps, but they are expensive, require servicing, and are prone to breakdowns. More importantly, in our abundantly sunny climate, solar thermal and solar photovoltaic (PV) solutions exist that can heat water with limited or no dependence on the grid.

Electric vehicles

Drivers of electric vehicles claim to save a lot of money, because the cost per kilometre of fuel could be four times as much as that of electricity.[7] Although this is beneficial to the owner (a realistic gain of approximately ZAR1.50/km), the economy will effectively be subsidising those with electric vehicles at approximately ZAR6/kWh, *if they charge from the grid when Eskom must shed load*. Given a nominal efficiency of 0.2 kWh/km, that is a subsidy of ZAR1.20/km. In effect, those who can afford to buy electric vehicles and charge from the grid may unwittingly be undermining the economy for their own financial gain. Those who can afford to buy electric vehicles should be encouraged to install their own distributed generation.

Poorly insulated dwellings

South African houses are notoriously poorly insulated. The exact figures are heavily dependent on the specifics of the house in question. However, even a small fin oil heater in a poorly insulated house consumes 2 kWh every hour. The economy would therefore be subsidising poorly insulated houses by ZAR12 per room per hour while the grid is load shedding. Homeowners should be incentivised to improve insulation.

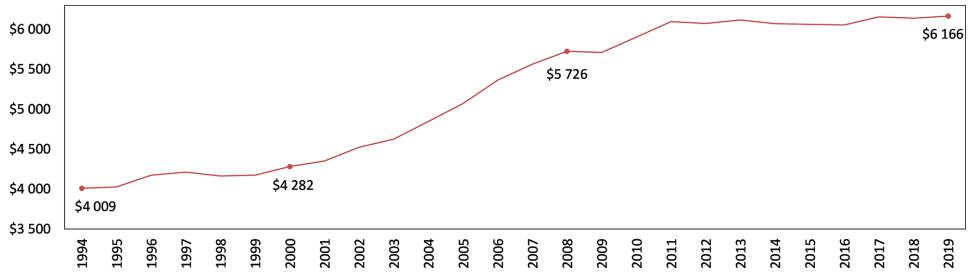

Figure 2: Gross national income per capita in 2015 USD, 1994 to 2021.[5]

Cost to households, schools, and universities

Household inverter/battery and solar solutions

In a desperate attempt to keep the lights on, many households and businesses that can afford to do so, are installing battery-backup solutions. The cost of doing so could range from approximately ZAR25 000 to ZAR100 000 when including only an inverter and batteries, and not including a solar plant. This price increases by approximately 50% when adding solar power and the requisite municipal approvals. Comparing this to our GDP per capita (ZAR110 000), and considering that half of employed South Africans earn less than ZAR60 000 per year from their job, investing in a battery backup with solar is clearly a costly and substantial investment. It is therefore tempting for homeowners to install a battery backup without the solar component.

Our simulations have shown that as much as 70% of peak-time household load shedding is curtailed when 15% of households – i.e. the affluent users that can afford it, who are also the heavy users – install battery-backup solutions without solar supplement. Doing this reduces load shedding to mere shifting the load in time, which can come at a large collective cost because it will seriously limit Eskom's ability to stabilise the grid. Adding solar generation to such systems must be strongly encouraged.

Schools

South Africa's education system is in a dire state, with poor performance in international tests in mathematics and reading. Although a large part of teaching in most schools is not heavily dependent on having electricity, losing valuable teaching time due to load shedding impacts the overstressed system even further and makes it even harder to overcome some of the deficits with subjects such as computer-based technology in many of our poorest schools. In this context, it is crucial to future development that teaching, and school administration, are not interrupted by load shedding and that school expenses are managed well. Schools have two options to manage load shedding: installing a generator and installing battery-backup/inverter systems. It is important to note that the capital and operating costs of these solutions could be reduced substantially if essential loads are split from the rest. Unfortunately, the time, skills, and resources to manage this are rare. The cost to install a generator depends on which loads are hooked up, but could be as much as ZAR250 000 for a small school to ZAR1 million for a large school with a hostel. What breaks the bank is the running cost of the diesel. At one admittedly large school we are supporting, the unbudgeted diesel cost is ZAR72 000 per month. The alternative, a battery-backup/inverter solution, for a school could range from ZAR100 000 for a small school to ZAR2 million for a large school. Again, adding solar provision increases the cost. Schools should be provided with timely guidelines on what is needed and what is affordable to overcome the worst of load shedding.

Universities

Our tertiary institutions are by no means spared from load shedding. As lectures and research cannot wait and sit idle, most universities have installed diesel generators. These generators entail a substantial capital expenditure but the operational cost of running them is frightening. Data provided by the Minister of Higher Education, Science and Innovation in 2023 reported the *daily* cost of diesel at Stage 6 to be ZAR197 019 for the University of Cape Town; ZAR892 473 for the University of Johannesburg; ZAR492 000 for North-West University; ZAR2 201 711 for the University of Pretoria; and ZAR342 939 for Stellenbosch University. The total for the 13 universities reported on was ZAR2 041 909 per day at Stage 3 and ZAR4 469 618 per day at Stage 6. This does not consider the cost of maintenance for the generators. In comparison, the NSFAS (National Student Financial Aid Scheme) budget for 2023 was ZAR47.6 billion, which supports 900 000 students at up to ZAR65 000 per year.[8] This means that for every *day* of Stage 6 load shedding, an additional 69 students could have been supported for a *year's* studies from the savings of the universities alone.

Conclusion

The pervasiveness of electricity in our lives, and our modern society's dependence on it, is mirrored in the inescapable and extensive impact of its interruption through load shedding. The intricate network that constitutes the so-called grid inextricably links us and our common destiny across its numerous divides. As was the case with Cape Town's #DayZero drought in 2017/2018, it does and will affect us all to some extent.

Although our fragile grid has a severe generation shortfall, its cost and implications must be observed in balance with the extant demand. This is especially true given the flexibility and inefficiencies and discretion inherent in the antipodal demand.

This Commentary has highlighted some hidden costs. An example of an obfuscated cost is that of electric vehicles being charged from the grid during load shedding, which results in a cross-subsidy of its mobility from the fiscus. The cost of electric vehicles means that the owners tend to be wealthy. They should be encouraged to provide their own renewable supply. Another example is that of the discretionary use of large volumes of heated water, which again results in cross-subsidisation. All users, but especially those who can afford to heat large volumes of water, should be incentivised to use the abundant solar resources for heating.

Crucially, many of the hidden costs of load shedding are a consequence of powering non-essential or inefficient loads. Demand management efforts should be redoubled, and participation in such schemes should be incentivised. Moreover, efforts to improve efficiency of existing loads should be rolled out and awareness campaigns initiated. In addition to rolling out centralised large-scale generation and battery storage systems, conditions are right for the speedy deployment of decentralised renewable energy generation and trading thereof.

What is considered expensive, essential, and wasteful is certainly fuzzy and subjective and will be different across the various spectra of our diverse society. But when it comes to balancing the grid to prevent a blackout of unknown duration, especially given our fragile political and economic landscape and societal frustrations, the sums on the left and right of the power scale are prime, and the need for grid stability unambiguous. Demand must be clamped to less than supply, preferably without impacting on essential services and economic powertrains.

Like a nation at war, South Africans are in a tight spot with limited options and restricted room for manoeuvre. This is expected to be the case for years to come. We all need to carefully re-assess our self-indulgences and decisions for the common good. This is not a time to look out for the self, but to keep our collective eyes on the front and focus our sustained and shared survival.

Competing interests

We have no competing interests to declare.

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