OUTA

ORGANISATION UNDOING TAX ABUSE

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OUTA comments on the determination for 2 500 MW new nuclear build

Submission to the National Energy Regulator of SA

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OUTA comments on the NERSA concurrence with the Ministerial Determination on the procurement of 2 500 MW new generation capacity from nuclear

Submitted to:

National Energy Regulator of South Africa (NERSA)
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Introduction

The Organisation Undoing Tax Abuse (OUTA) is a non-profit civil action organisation dedicated to working for a better South Africa. OUTA was established to challenge the abuse of authority, in particular the abuse of taxpayers' money. We have a strong interest in the electricity sector, because state-owned entity Eskom has been mismanaged for years, resulting in higher prices and social hardship for consumers, substantial bailouts with taxpayers' funds which should have been available for alternative spending, and a devastating effect on the economy. The choice of energy mix and subsequent determinations in terms of Section 34 of the Electricity Regulation Act will impact the lives of both the South Africans of today and future generations.

Let us be clear: OUTA opposes the Minister's determination and the proposal for new nuclear power build. We do not see any scenario in which South Africa could afford this.

If NERSA makes the wrong choices today, many people could be burdened with unaffordable and unreliable energy for decades. In the case of nuclear energy, given that the build time is at least a decade hence, those responsible for making these choices will also not be around to be accountable.

OUTA therefore submits these comments in the public interests and appeals to NERSA to consider the impact on future socio-economic well-being of the country in its decisions made today.

OUTA also asks NERSA for an opportunity to make an input at the public hearings on this matter.

Overall remarks

NERSA is governed by the Electricity Regulator Act 2006, whose objectives are to:

> (*a*) achieve the efficient, effective, sustainable and orderly development and operation of electricity supply infrastructure in South Africa;
>
> (*b*) ensure that the interests and needs of present and future electricity customers and end users are safeguarded and met, having regard to the governance, efficiency, effectiveness and long-term sustainability of the electricity supply industry within the broader context of economic energy regulation in the Republic;
>
> (*c*) facilitate investment in the electricity supply industry;
>
> (*d*) facilitate universal access to electricity;
>
> (*e*) promote the use of diverse energy sources and energy efficiency;
>
> (*f*) promote competitiveness and customer and end user choice; and
>
> (*g*) facilitate a fair balance between the interests of customers and end users, licensees, investors in the electricity supply industry and the public.

In addition, it needs to take into account the National Environmental Management Act principles which are legally binding on any decision which affects the environment.

The Promotion of Administrative Justice Act requires administrative decisions to take into account all relevant considerations[1] and to be rationally connected to the purpose for which such decisions are taken, the purpose of the empowering provision and the information before the administrator[2].

According to the Integrated Resource Plan 2019 (IRP 2019), published by the Department of Mineral Resources and Energy (DMRE),[3] an energy mix with large amounts of renewable energy is the cheapest energy supply option until 2030 and post 2030. However, there is uncertainty regarding

[1] Section 6(2)(e)
[2] Section 6(2)(f)(ii)
[3] Department of Energy. 18 October 2019. *Integrated Resource Plan 2019*. Notice no. 1360, Government Gazette 42784 of 18 October 2019. This replaced the incorrect version published the same day in Gazette 42778.

technology development and demand projections which mean that further studies are needed. And long-term commitment to technology choices should be avoided.

Although renewable energy is the cheapest, restricting the amount of renewable energy does not significantly change the price path up until 2030.

Therefore, the commitment now to any new nuclear build (which is the most expensive), even if it will be built post 2030, will have the consequence of reducing the amount of new renewable energy in an updated IRP. Such a forcing of nuclear build into the mix will increase the price of electricity post 2030 more than would be the case if renewables were brought online. This would place an additional unnecessary burden on future generations and electricity consumers post 2030 who would pay higher prices for electricity and would be saddled with the costs of decommissioning, waste disposals and spent fuel storage. These are unknown costs, and to make such inflexible decisions in the face of such uncertainty is irrational.

The IRP indicates that further longer-term energy studies are needed. Between now and the next iteration of the IRP, the only rational choice, should additional capacity be needed, is to build additional renewable energy. This can be done in an incremental manner as with the Renewable Energy Independent Power Producer Procurement Programme (REIPPP).

Should any provision be needed now for post 2030, the most affordable mechanism to add capacity is to issue additional section 34 determinations for additional renewable energy capacity. This was proposed by a previous minister to allow renewable energy power plants in the IRP to be commissioned earlier than planned to address system constraints.

Historical context

The IRP 2010 (published in 2011)[4] contained 9 600 MW of new nuclear capacity. This was widely condemned by civil society. In terms of the IRP purportedly being the electricity plan in the public interest, it should be noted that the nuclear build was forced in despite it not being the least cost.

"Initially it was intended to include a no-nuclear scenario by forcing out the new nuclear fleet. However following the modifications of inputs as discussed above (specifically the learning rates for new technologies and higher nuclear capital costs) the cost-optimal output from the model for the Adjusted Emission scenario does not include any new nuclear capacity."[5]

Revelations that emerged from the court case won by Earthlife Africa and the Southern African Faith Communities' Environment Institute (SAFCEI) (which in 2016 halted secretive plans then to build nuclear generation)[6] and further information which has become public during the Zondo Commission[7] and elsewhere clearly indicate that the nuclear case was premised on flawed data and appeared to be part of a manipulated process of state capture towards the benefitting of a few and for which the public would pay.

In a 9 December 2015 presentation to cabinet[8] (declassified as part of the Zondo Commission hearings) as part of the attempts to gain Treasury's approval, the following was presented:

[4] Department of Energy. 6 May 2011. *Integrated Resource Plan for Electricity 2010-2030*. Government notice no. R.400. Government Gazette 34263 of 6 May 2011. Available online here: http://www.energy.gov.za/IRP/2010/IRP_2010.pdf

[5] IRP 2010, page 39

[6] Earthlife Africa Johannesburg and Another v Minister of Energy and Others (19529/2015) [2017] ZAWCHC 50; [2017] 3 All SA 187 (WCC); 2017 (5) SA 227 (WCC) (26 April 2017). This is the case brought by Earthlife Africa Johannesburg and the Southern African Faith Communities' Environment Institute (SAFCEI) which halted the nuclear deal. The judgment is online here: http://www.saflii.org/za/cases/ZAWCHC/2017/50.html

[7] The Judicial Commission of Inquiry into Allegations of State Capture, Corruption and Fraud in the Public Sector including Organs of State.

[8] Extract from Cabinet minutes of 9 December 2015, including Cabinet Memorandum no. 13 of 2015, dated 8 December 2015, "Recommendations on the Nuclear New Build Programme (NNBP) Financial Implications: Proposed Funding Model and Risks Identification and Mitigation Strategies" and the presentation to Cabinet. Annexure 12 to Nhlanhla Nene's submission to the State Capture Commission, October 2018.

In 2015, the rand dollar exchange was approximately R15 to the dollar, but the cabinet presentation used an exchange rate of one dollar to R10. The cost of the new build was presented without any interest charges and failed to calculate the financial implications for the fiscus of any delays or overruns.

Cabinet was presented with a picture of how 24 people from other African countries were studying nuclear subjects, but in fact none of them were studying nuclear power. Their study fields were nuclear medicine or agriculture and it is difficult to find any reason for the inclusion of such information in the motivation for the building of a nuclear power plant.

Slide 6 of the Cabinet presentation presents a total projected shortfall of 25 920 MW by 2030. It is unclear why Cabinet was provided with this scenario and not with the DMRE IRP 2010 update using a credible modelling method. The presentation then presents a low-cost scenario of $5 000/kW through to a medium scenario where cost overruns are 50%. Under their assumptions, apparently National Treasury had modelled an upper limit scenario of $7 500/kW which translates into R720 billion for 9 600 MW.

The Cabinet presentation of 2015 also presented a scenario where a phase 1 of 2 400 kW was built with a price tag of only R156 billion.

Most importantly, the funding model assumed that there would be a ring-fenced special purpose vehicle (SPV) for project financing, that "equity amounting to 30% of the project cost is provided by government…", that "Government guarantees all debt issues in the SPV" and that "debt is repaid through tariff with increases taking place on commissioning so that all financing can be repaid over a 20 year period…"[9]

[9] Presentation to Cabinet, slide 20.

In considering how to reduce the risks of such a project, one suggestion brought to the table was "Tariff path: raising tariffs early would reduce fiscal costs by shifting some of the burden to electricity consumers".[10]

In other words, electricity consumers would be forced to pay for building nuclear power plants before they received any electricity from them.

One slide presents how seven other African countries were planning to build nuclear plants, most supposedly to have placed orders by 2020.[11] OUTA ponders if this was a "keeping up with the Joneses"-style motivation that South Africa should build such a vanity project. In fact, it is not confirmed if any of these countries have actually placed a firm order.

OUTA directs NERSA's attention to documents such as this Cabinet presentation and minutes in order for NERSA to be better informed in its decision-making about this nuclear determination for which OUTA can find no substantive motivation. OUTA is concerned that that the decision that led to the Minister's determination currently before NERSA was based on such similar presentations.

If South Africa had succeeded in embarking on a new nuclear build (as proposed in IRP 2011), South Africa could have now added R972 billion to its liabilities (calculated using $5 000/kW, the actual 2015 dollar-rand exchange rate, plus 25% financing costs and 10% owners' development costs[12]), an unthinkable debt increase given the pandemic of the last year. With cost overruns of 50%, the price tag would have been heading for R1 458 billion.

Fortunately, the entire nuclear deal was found to be unlawful due to the manner in which government attempted to bulldoze through proper procedures, and civil society won the court case with one of the findings being that NERSA must hold public consultations.

[10] Presentation to Cabinet, slide 21.
[11] Presentation to Cabinet, slide 4.
[12] 9 600 MW built at $5 000/kW at $1 to R15 gives an overnight cost of R720 billion, plus R180 billion in financing costs (10%) plus R72 billion in owners' development costs (10%), a total of R972 billion.

Another suggestion made in that 2015 Cabinet presentation was to phase in the proposed 9 600 MW, as suggested by building only 2 400 MW, which is similar to what is being proposed in this determination. OUTA is therefore concerned that history is now repeating itself.

Nuclear power is an industry which needs careful, ethical and expert oversight. Our government has previously demonstrated a willingness to enter into secret deals on nuclear power. The former cabinet minister who signed that deal remains in a senior position in Parliament. The chairperson of the energy committee which approved that deal is now in cabinet. In the light of that revolving door history and recent events, red lights are flashing and it would be foolish if we failed to be concerned over government intentions.

Rationale for determination

According to the Minister, the rationale for the determination is: "**To commence the process to procure the new nuclear energy generation capacity of 2 500 MW as per decision 8 of the Integrated Resource Plan for Electricity 2019 – 2030 (published as GN 1360 of 18 October 2019 in Government Gazette No. 42784) (IRP 2019).**"[13]

In point 1 of the Ministerial determination (the determination itself is undated but NERSA received it on 6 August 2020[14]), the reason given is that this is in line with Decision 8 of the IRP published on 18 October 2019 (IRP 2019).

[13] Minister of Mineral Resources and Energy Gwede Mantashe, undated, "Determination under Section 34(1) of the Electricity Regulation Act, 2006 (Act no. 4 of 2006)". Point 1.
[14] NERSA, 23 November 2020, "Consultation Paper: Concurrence with the Ministerial Determination on the Procurement of 2 500 MW generation capacity from nuclear".

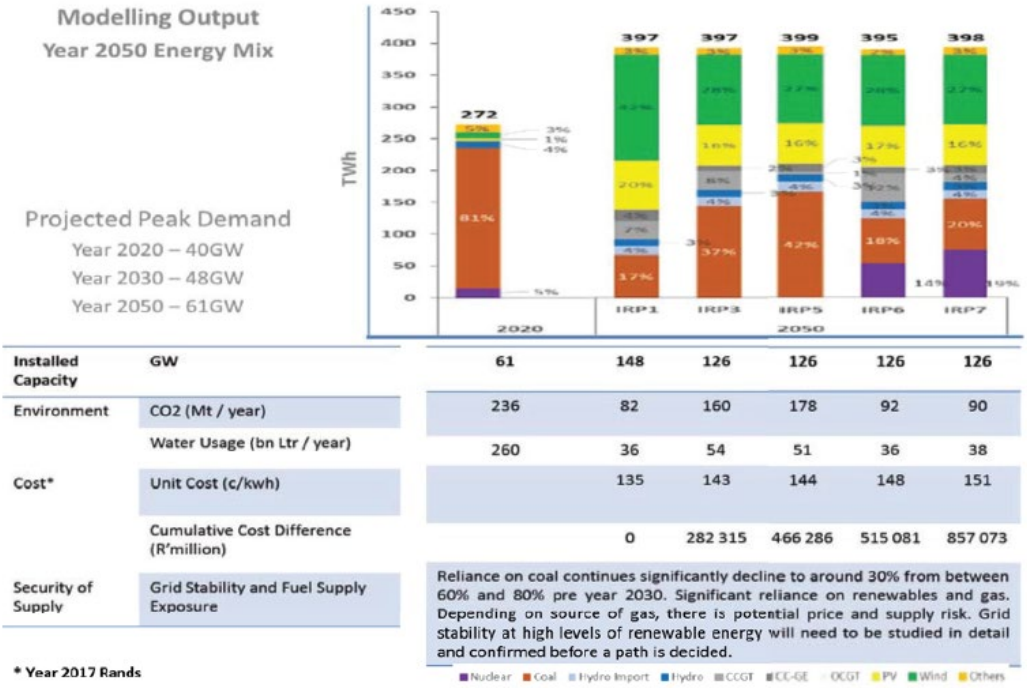
Post IRP 2010, in subsequent draft IRPs which took into account new technology developments and the decreasing costs of renewable energy and the increasing costs of fossil fuels, the most affordable and energy secure electricity mix did not include any nuclear energy.

- In the correct version of IRP 2019, Decision 8 states: "Commence preparations for a nuclear build programme to the extent of 2 500 MW at a pace and scale that the country can afford because it is a no-regret option in the long term."[15] (Our emphasis.)
- This is quite different to the incorrect version of IRP 2019, which was published earlier the same day and included Policy Position 8: "immediately commence the nuclear build programme to the extent of 2 500MW because it is a no-regret option in the long term and in case the Inga project does not materialize".[16]

The differences are very important. If the Minister had opted to follow the incorrect version, then a ministerial determination might be the correct step to take. But the correct version is much more cautious. It foresees the need to assess what the country can afford. Neither NERSA nor DMRE have published any recent reports on the feasibility or affordability of the proposed determination to the best of our knowledge.

It is also important to read IRP 2019 where it specifically refers to the post-2030 period. This states that renewable energy will be the least cost option: "The scenario without RE annual build limits provides the least-cost option by 2050."[17]

[15] IRP 2019, page 53.
[16] Department of Energy. 18 October 2019. *Integrated Resource Plan (IRP 2019)*. Notice no. 1359, Government Gazette 42778 of 18 October 2019. This was subsequently replaced the same day by notice 1360 in Gazette 42784.
[17] IRP 2019 (correct version), page 89 of the IRP on page 94 of the gazette.



Installed Capacity	**GW**	**61**	**148**	**126**	**126**	**126**	**126**
Environment	CO2 (Mt / year)	236	82	160	178	92	90
	Water Usage (bn Ltr / year)	260	36	54	51	36	38
Cost*	Unit Cost (c/kwh)		135	143	144	148	151
	Cumulative Cost Difference (R'million)		0	282 315	466 286	515 081	857 073
Security of Supply	Grid Stability and Fuel Supply Exposure	Reliance on coal continues significantly decline to around 30% from between 60% and 80% pre year 2030. Significant reliance on renewables and gas. Depending on source of gas, there is potential price and supply risk. Grid stability at high levels of renewable energy will need to be studied in detail and confirmed before a path is decided.					

Nuclear Coal Hydro Import Hydro CCGT CC-GE OCGT PV Wind Others

* Year 2017 Rands

Scenario Analysis Results for the Period 2041–2050

The above table[18] gives us an indication of the electricity price per kWh or unit of electricity. If we compare the least-cost option (Scenario 1) with Scenario 7, which has a lot of nuclear energy, we see that the price of electricity is R1.35/kWh in Scenario 1 vs R1.51 in Scenario 7. The estimated price is 12% higher when nuclear power is included. The price of electricity is already spiralling out of control, and this is a not insignificant increase.

This tells us that if we buy 50 units of electricity directly from the power station, if there are a lot of renewable energy power stations, it will cost R67.50. If there are nuclear power stations in the mix, the cost will be R75.50. This would increase each year due to inflation.

One flaw in the way the IRP is used in South Africa is that it restricts the amount of renewable energy that can be built each year. Experts have argued that these build limits are too low. This means that in the future, South Africa may not have enough electricity as coal-fired power stations come to the end of their life. This does not affect the price of electricity until 2030, but if we do not

[18] Table "Scenario Analysis Results for the Period 2014-2050", page 91 of the IRP on page 96 of the gazette.

build much more renewable energy, and we allow government to approve building more nuclear power, we will be facing increasing electricity price hikes. As government proposed procuring new nuclear power now, these increases will come in faster.

If we look at the modelling output year 2050, the Scenario 7 with some nuclear energy in the mix incurs an additional cost of R857 billion, compared to the RE Scenario 1. These costs will be passed on to the consumer via the electricity tariff. In other words, with the information available now, the addition of nuclear energy to the energy mix of the future will increase the price of electricity and be a burden on electricity consumers. Forcing nuclear energy into the energy mix means artificially raising the price of electricity and therefore impacting on the economy.

Affordability

The IRP 2019 decision on nuclear refers to implementation "at an affordable pace and modular scale".[19]

There has been no information forthcoming from the DMRE, NERSA or any other branch of government on what "affordable" means, or even an indication of the costs.

We argue that a nuclear new build is not affordable.

Planning a nuclear new build takes no account of the fiscal crisis.

National Treasury DG Dondo Mogojane described the situation in October 2020:

"For several years, the National Treasury has been warning that an absence of fiscal space would leave South Africa vulnerable to external shocks. That risk is now a reality. At the time of the 2020

[19] IRP 2019, Decision 8, page 48, gazette page 53.

Budget, economic growth was already low and the fiscal position had deteriorated significantly. South Africa has begun heading into a debt spiral.

"Government is spending far more than it collects in revenue. As a result, debt has mushroomed. A failure to halt and reverse this pattern will harm the livelihoods of South Africans for many years to come. Left unchecked, the interest payments on that debt will become one of government's largest expenditure items over the medium term. An ever-increasing share of tax revenue will not go to hospitals, schools or social grants – instead, it will be transferred to bondholders.

"Cabinet has resolved to reverse this pattern."[20]

Treasury predicts the economy will contract by 7.2 percent in 2020/21.

It predicted that gross national government debt would increase from R3.6 trillion (63.5 percent of GDP) in 2019/20 to R3.97 trillion (81.8 percent of GDP) in 2020/21 and to R4.83 trillion (86 percent of GDP) in 2022/23.

Debt-service costs are expected to reach R301.1 billion in 2022/23.

South Africa needs to see government plans to control spending, not to increase it by introducing an unaffordable vanity project.

The generator, buyer and procurer

In terms of the Minister's determination, the generator, buyer and procurer could all be various branches of the state, possibly even the same entity.

[20] National Treasury. 24 June 2020. "Supplementary Budget Review 2020." Available online here: http://www.treasury.gov.za/documents/national%20budget/2020S/review/FullSBR.pdf

Generator of electricity

"The generator of this electricity produced will be either Eskom Holdings (SOC) Limited, or any other organ of state, or in partnership with any other juristic person."[21]

The Ministerial determination states that the generator will be either Eskom or another organ of state or a partnership with other juristic person. This implies that the state will therefore be involved in and therefore will be funding the building of the nuclear power plants.

Given that nuclear power has the most expensive capital costs of any alternative electricity generation, OUTA queries why the state must bear the costs of this new build.

We also raise concerns as in the process of the last attempt at nuclear build in 2015, the agreement with Russia stated that the new build would go ahead without any agreement about the financing. This would obviously leave the door open to South Africa being locked into a large capital-intensive project which it could not afford. Is history repeating itself?

Buyer of electricity

"The buyer of the electricity will be Eskom Holdings (SOC) Limited or any entity determined through the Eskom's unbundling process as the future buyer of electricity."[22]

This at least appears to be in line with the restructuring process taking place at Eskom at the moment. Given that the future would consist of many buyers of electricity, that sentence should be corrected to reflect the plurality of future electricity buyers.

[21] Minister's Determination, point 2.
[22] Minister's Determination, point 3.

Procurer

"The procurer of the nuclear new build programme will be the Department of Mineral Resources and Energy, or any other organ of state, or in partnership with any other juristic person.

The procurer designated above will be responsible for determining the procurement process which will be established through a tendering procedure that is fair, equitable, transparent, competitive and cost-effective." [23]

The procurer will be the entity tasked with ensuring that the procurement process meets the lawful requirements. The wording of the determination appears to envisage a scenario where there would be a partnership between the state and some other entity and it does not preclude the generator being the procurer.

The state has an unimpressive track record in corruption-free procurement. Parliament's inquiry into Eskom and the Zondo Commission have both heard sufficient to raise significant concerns about power station procurement and management. Could this new nuclear build once again be being promoted primarily as a vehicle for further looting?

The risk of runaway costs

The determination refers to the need for procurement which is cost-effective. [24] Unfortunately, South Africa does not have a good track record in this regard.

As illustrated earlier, South Africa can't afford runaway costs.

We do not need to look far to see another example of this. The initial expected cost for Medupi was R80 billion in 2007 (2007 Rands), this was revised to R154 billion (2013 Rands) and by 2019, Medupi

[23] Minister's Determination, points 4 and 5.
[24] Minister's Determination, points 4 and 5.

was independently estimated to cost R234 billion (2019 Rands).[25] Kusile started in 2008 and was expected to be completed by the end of 2014; however, the project is still not completed. The original cost was estimated at R69.1 billion; by July 2016, the cost-to-completion was placed at R160 billion.[26] [27]

In OUTA's submission to NERSA in response to Eskom's 2018/19 RCA pricing application, OUTA submitted that NERSA's previously allowed tariff increases allowed Eskom to:

- Fund a more than R65 billion overrun on Medupi; and
- Fund a more than R50 billion overrun on Kusile. [28]

Nuclear energy is not cheap and for a country which is so heavily in debt and where Eskom holds the majority of that debt, how would it be rational to burden Eskom with additional debt, or to allow the state in any way to stand as guarantor for any nuclear-related new build debt?

New nuclear isn't as cheap as Koeberg

There is a narrative which continues to claim that Koeberg electricity is the cheapest electricity. If we had to compare the operating costs of a 35-year-old solar farm or wind farm where all the capital costs had been paid off, this might be a viable comparison. (Given that renewable energy plants have no fuel costs, nuclear in comparison would still presumably be more expensive.) It is disingenuous to compare the costs of a 35-year-old power plant where the capital costs have been

[25] https://en.wikipedia.org/wiki/Medupi_Power_Station#:~:text=to%20mill%20crushers.-,Cost%20escalation,R234%20billion%20(2019%20Rands).
[26] Chris Yelland. 29 July 2019. "The crisis and Kusile and Medupi continues…" Moneyweb. Available online here: https://www.moneyweb.co.za/news/south-africa/the-crisis-at-kusile-and-medupi-continues/
[27] Tshidavhu, Fhumulani, & Khatleli, Nthatisi. (2020). An assessment of the causes of schedule and cost overruns in South African megaprojects: A case of the critical energy sector projects of Medupi and Kusile. *Acta Structilia*, *27*(1), 119-143. https://dx.doi.org/10.18820/24150487/as27i1.5 Also available online here: http://www.scielo.org.za/scielo.php?script=sci_arttext&pid=S2415-04872020000100005
[28] Liz McDaid. 3 February 2020. "OUTA submission to NERSA on Eskom's RCA 2018/19 application". OUTA. Available online here: https://www.outa.co.za/web/content/170539

paid off with the current operating costs of a power plant that must still pay off its capital costs. In fact, such comparisons often use the most expensive renewables tariff from the REIPPP first bid round which seems to be obvious misinformation. See appendix A which provides a costing table used in IRP 2019.

Decommissioning costs

Nuclear energy produces toxic waste which must be stored for hundreds of thousands of years and, when the plant is decommissioned, parts of the plant structure which are contaminated by radiation also need to be disposed of safely. In addition, the land on which the power plant stands is contaminated (as with the gold mines of South Africa) and needs to be rehabilitated.

These costs must be added to the build costs.

> "In the UK repeated failures of the provisioning for decommissioning, including using methods similar to those used by Eskom, have resulted in future taxpayers be liable for a bill in excess of £100bn (R1.8tn) to decommission its existing nuclear facilities." Prof Thomas estimates the decommissioning costs of Koeberg's two reactors (1 860 M) at R34bn, as current US estimates are around R18 240/kw.[29]

In 2019, the estimates for the UK liability had risen to probably £134bn.[30] (Prof S. Thomas).

At that price, a nuclear new build 2 500 MW power station would cost R45.6 billion to decommission. This must be added into the costs.

If NERSA was to concur with this determination, it would potentially set South Africa on an electricity price trajectory which would disadvantage the majority of South African citizens. It would also

[29] Prof Steve Thomas, quoted in Southern African Faith Communities' Environment Institute (SAFCEI), "Submission into the Draft Integrated Resource Plan", 5 October 2018. Available online here: https://safcei.org/wp-content/uploads/2018/10/SAFCEI-submission-into-parliament-process-on-irp-final-final-ltthd.pdf

[30] Prof Steve Thomas

potentially put the country into a debt position where its annual debt would far surpass its revenue. (See calculations on total capital build costs elsewhere in this submission).

IRP 2019 expresses a degree of certainty in its confidence to ensure energy security until 2030. In terms of the pricing path of electricity, the DMRE has indicated that IRP 2019, even with restricted build of renewable energy, will not change the price of electricity until 2030.

From NERSA's perspective, this would indicate, that as of 2019, the electricity price would not be affected much even with the restriction of renewables. This is an important point as renewable energy provides the least-cost path forward at this point.

Post 2030, the IRP expresses uncertainty. The IRP needs to be updated regularly and as a subset of the Integrated Energy, and the Electricity Regulation Act states that it must take place annually.

Given the uncertainty, the IRP states the necessity for a detailed energy path study: "The huge difference between scenarios beyond 2030 will, however, make it necessary to undertake a detailed energy path study that will inform a next update of the IRP."[31]

By rushing into a new nuclear build now, this will restrict South Africa from pursuing an electricity path that is sustainable, affordable and fulfils the legal obligations of NERSA. In OUTA's view, NERSA would therefore be failing in its mandate if it concurs with the minister's determination.

The no-regret option

NERSA defines the no regret option as follows: "No-regret option is not defined in the IRP 2019, however here it is assumed to mean those options that generate net social or economic benefits

[31] IRP 2019, page 98, on page 103 of the gazette.

irrespective of whether or not climate change occurs, as well as across a range of possible climate futures. They build resilience to future climate shocks while also delivering near-term benefits."[32]

Under this definition, OUTA submits that the ministerial determination for 2 500 MW nuclear new build is **not** a no-regret option. The no-regret decision is to conduct the detailed feasibility studies and costings. Part of the preparation for the decision as to whether nuclear energy will form part of the future is to carry out the necessary studies. This has not been done.

In an attempt to find out on what basis the government is once again following a nuclear path, SAFCEI (one of the parties who successfully took the government to court over its unlawful action with regard to the previous nuclear deal) asked Eskom and the DMRE for any such affordability or economic feasibility studies. These requests were sent through using the Promotion of Access to Information Act (PAIA) on 3 December 2020. To date, nearly two months later, there has been no meaningful response. It is therefore unclear if such studies exist but have been kept secret, or if they don't exist at all. If the information exists, then the public will not have access to this in time for this comment process, due to the delays in the PAIA process, and will not be able to comment on such studies as part of the NERSA consultation process.

OUTA therefore believes that NERSA should refuse to concur with the determination and should ask the Minister to make another determination once the DMRE has conducted the further studies outlined in IRP 2019 and published them.

Governance

South Africa is part of the global Open Government partnership, whose aim is to get governments to govern in an open manner. Key to that is transparency, accountability and public participation.

[32] NERSA Consultation Paper, Page 10.

Historically, the nuclear industry has shown that it is shrouded in secrecy, fails to be accountable and public participation is limited.

This round of attempted nuclear power in South Africa shows those same problems.

The nuclear regulator

Those countries that decide to build nuclear power plants must have an effective system of nuclear governance. This means that they have to have a nuclear regulator, a separate regulator that oversees nuclear safety. Our nuclear regulator has a board which is supposed to include a member of civil society to ensure some accountability to the public. The tenure of the previous board ended in December 2019. The new board was confirmed by Cabinet only on 5 August 2020, and announced the following day,[33] but this new board failed to include a civil society representative.

The same day of the NNR announcement, Minister Mantashe handed over his determination to NERSA. This raises concern that the NNR board was appointed solely to provide a veneer of respectability to the nuclear sector's governance to aid the processing of the determination. The public only got to know about the existence of the determination when NERSA held a board meeting in November to decide on the public participation process, a further indication of lack of transparency.

We want civil society representatives on the National Nuclear Regulator board. We want transparency and ethical decision-making, to ensure that South Africa is never compromised by another secret nuclear deal.

[33] GCIS. 6 August 2020. "Statement on virtual Cabinet Meeting of 5 August 2020." Available online here: https://www.gov.za/speeches/statement-virtual-cabinet-meeting-wednesday-5-august-2020-6-aug-2020-0000

Governance includes preventing corruption

South Africa has a bad track record of endemic corruption.

Transparency International ranks South Africa at number 69 out of 180 countries on its list of perceived levels of public sector corruption, with a score of just 44 out of 100, and cited South Africa's inability to manage corruption-free Covid-19 spending.[34]

We are acutely mindful of the danger that such enormous and prohibitively expensive projects as a new nuclear build may be promoted by those who see primarily the potential for unlimited looting.

Governance includes strong project management

We also note that South Africa has repeatedly failed to deliver large-scale infrastructure on time and on budget, but the government appears to have done little to address this very serious problem.

There are an unfortunate number of examples; here are three: Eskom's Medupi and Kusile coal-fired power stations and the Giyani water scheme which saw spending rocket from R500 million to R3 billion but hasn't delivered the promised water.

Good governance requires transparency and adherence to processes

Secrecy enables the manipulation of processes for ulterior motives.

The DMRE's actions raise concerns in this regard, as it appears determined to secure a new nuclear build regardless of whether it is appropriate or affordable.

The Minister has been remarkably tardy at getting the process of procuring emergency generation power underway. Eskom's struggle to keep the lights on is now legendary so the need for emergency

[34] Transparency International. 28 January 2021. "Corruption Perceptions Index 2020." Available online at: https://www.transparency.org/en/cpi/2020/index/zaf

power – the “risk mitigation” generation – has long been discussed. Although IRP 2019 was finally gazetted in October 2019, it took another four months for the Minister to issue the draft determination for 2000MW of short-term risk mitigation capacity, to be online by December 2021. A Request for Proposals (RFP) was finally issued in August 2020, with a deadline of late December. If bidders are expected to keep to that December 2021 delivery deadline, it means the DMRE will have given itself longer to get the paperwork in order than it gives bidders to build the generation plants.

In June 2020, the Minister issued a Request for Information (RFI) for 2500MW of nuclear build, with a deadline for submissions of 25 September2020. It is worth noting that this was done before any determination was issued, but that any relevant information arising from this process has not been made available to the public. While it was emphasised that this is not the procurement itself but rather an assessment of available technologies, it brings procurement a step closer. That RFI also stakes that the DMRE “intends to launch a Nuclear New Build Power Procurement Programme in line with the approved 2019 Integrated Resource Plan to ensure security of supply of energy with affordable, reliable and baseload nuclear power”. This is not in fact in the correct IRP 2019, but is in an earlier, incorrect version; the correct version says the decision is to commence “preparations” for nuclear build.

In July 2020, in the Supplementary Budget, the DMRE cut R1.5 billion from the Integrated National Electrification Programme grants for electrification of homes but retained funding for the Nuclear Energy Corporation (NECSA), which has a dismal record of financial accountability including audit disclaimers in 2017/18 and 2018/19.

On 9 October, the Minister referred to the wrong IRP when answering a question in Parliament on energy policy, incorrectly stating that the policy is to “immediately commence with small-scale nuclear build programme to the extent of 2 500 Megawatt (MW) by 2030”. This is the document which was incorrectly published as IRP 2019, and replaced the same day. The correct version refers to the decision to commence “preparations” for a nuclear build programme.

On 16 October, the US International Development Finance Corporation announced it had signed a letter of intent to help US-based NuScale Power develop 2500MW of nuclear energy in South Africa.

On 13 November 2020, the DMRE advertised a tender for a service provider "to develop a discussion paper on nuclear power and non-power research, development, and innovation". This seems to be aimed at replacing the 2008 nuclear policy which the DMRE still uses. The contractor will have just three months to research policies, strategies and plans of six nuclear vendor countries and at least eight countries with nuclear energy programmes.

We note that despite the DMRE's apparent enthusiasm for new nuclear build, it has failed to explain how South Africa will be able to afford this.

Process issues

In order to provide adequate answers to NERSA's questions on the determination, more information is needed from the DMRE or NERSA. What additional information on this issue has NERSA collected since August 2020 – or before – and, if it has additional reports, why have these not been made public?

In NERSA's timeline for processing the determination of 149 days, the analysis of public comments is allocated only five days. Given that this is a matter of significant public interest and a large number of comments should be anticipated, how is it possible that NERSA will have sufficient time and capacity to consider adequately all the comments it receives? If NERSA does not have sufficient time to read and respond adequately to public input, how could NERSA claim that each submission has been considered in coming to its decision?

IRP 2019 clearly envisages a number of studies that must inform the energy path post 2030. NERSA does not refer to this paragraph in its discussion document nor does it refer to the section of the IRP where DMRE cautions against long-term commitments. Certain paragraphs in the NERSA discussion

document appear to indicate that NERSA is biased towards the approval of the determination yet NERSA claims that it has no views either way.

Further responses to NERSA questions

OUTA has provided this overview of its comments and these should be applied to whichever question they are applicable. In addition, several specific details are provided in response to the more detailed questions.

Response to NERSA question 1

NERSA question 1: Is this 2 500MW of nuclear capacity section 34 determination compliant with the IRP 2019 as gazetted by the Minister of Mineral Resources and Energy?

No. The IRP states that the procurement must proceed at the "pace and scale" that the country can afford. There is no information provided to justify that the 2 500 MW is affordable and so we would argue that the ministerial determination is premature and does not comply with the IRP 2019.

Should such information be available, this information must be provided to the public to ensure meaningful participation. OUTA would argue that should NERSA be privy to such information and make a decision on the basis of such information without placing such information in the public eye, this would render the consultation process meaningless and, in our view, would fail the requirements of the Promotion of Administrative Justice Act.

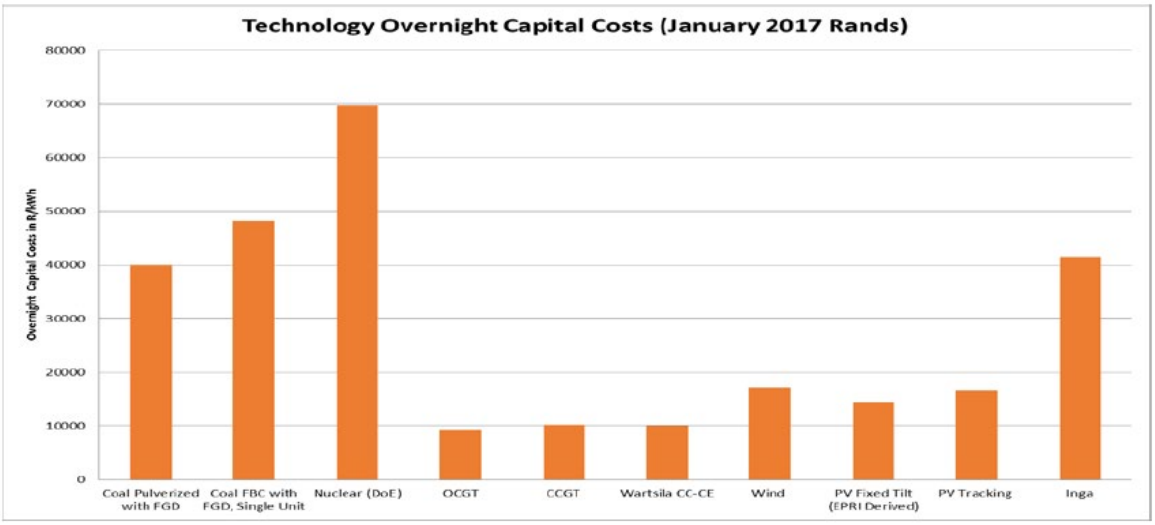
NERSA must also apply its mind separately and cannot accept the Minister's opinion that in 2020/21, nuclear build is affordable.

In the IRP 2019, the DMRE states that it uses an Ingérop study (dated 2013) for its nuclear prices. While EPRI provided costs for PV and wind, the costs adopted in the plan for these technologies were from the South African REIPPP. It is not clear if additional nuclear costs from more recent nuclear developments have been included in costing information that NERSA is using in its deliberations.

When working out the cost of energy, there are different components that need to be considered.

a. The building costs: For comparison purposes, these are expressed as the overnight capital cost, calculated as if the power station is built overnight. The finance costs in the construction period, which must also be paid by consumers, are substantial. They will depend on the interest rate for loans but for the UK, French electricity company Électricité de France (EDF) has estimated they would be equal to the overnight cost.[35]

   The graph below shows the comparative overnight costs of different power station builds (as per the 2017 calculations used by Government). The costs on which this graph are based are in Appendix A.[36]



b. The time factor: In reality, power stations take a long time to build. To build a power station, the country or company building the power station takes out a loan and so has to pay back

[35] Steve Thomas, 2021.
[36] The costs were sourced from the DRME and were used to compile IRP 2019. This information was obtained through a PAIA application by the Centre for Environmental Rights.

the interest on the loan. The longer a power station takes to build, the more expensive it will be. The cost of building nuclear power stations increases substantially as they take a minimum of 10 years from placing the reactor order to commercial operation whereas wind and solar power stations only take a couple of years to build.

As an illustrative example, if we assume that the capital cost is $7 500/kw, then for the 2500MW that the Minister wants to start building now, the cost at today's exchange rate ($1 to R15 in January 2021) would be R281.250 billion. However, this overnight capital cost is not realistic as nuclear power stations take a minimum of 10 years to build. Assuming additional costs of finance at 25% plus an owner development cost of 10%, a more realistic estimate would be R379.688 billion.

So a total number for 2500MW is about R380 billion. That is if all goes well. And if there are other cost overruns and the project is delayed, then it is possible that the project costs could double. Refer to Medupi and Kusile costs discussed elsewhere in this document.

The example above is based on the costs which Cabinet considered in December 2015. [37] However, Cabinet's calculations were based on an exchange rate that was two years old at the time, and omitted finance costs and owners' development costs.

We also point to this comment in Prof Steve Thomas's submission:

> "IRP 2019 states its assumptions are based on the 2013 Ingerop report commissioned by the South African government as an input to an earlier version of the IRP. This report is not only badly out of date, but it was also of highly questionable quality bringing in data of dubious quality and for old reactors using designs that would be unacceptable today. It found an average value of construction cost of ~US$5000/kW. This appears to be based on cost estimates for 15 projects with a range of US$2750-6700/kW. The size of this range for a technology that had then been commercially exploited for 50 years is troubling in itself. At the time of the estimates, seven of the projects had not started construction and, in fact three of these were abandoned before construction started. Two of the projects in Korea use old technology no longer offered. By 2020,

[37] Extract from Cabinet minutes of 9 December 2015, including Cabinet Memorandum no. 13 of 2015, dated 8 December 2015, "Recommendations on the Nuclear New Build Programme (NNBP) Financial Implications: Proposed Funding Model and Risks Identification and Mitigation Strategies" and the presentation to Cabinet. Annexure 12 to Nhlanhla Nene's submission to the State Capture Commission, October 2018.

only Cost estimates made before construction starts are notoriously a very poor indicator of actual costs. Two of the projects are in China and are little more than half the average and it is questionable whether data from China can be relied upon or whether they are a good guide for elsewhere.

"If we discount abandoned projects, projects using old technology, projects where up to date cost estimates are not available and ones where construction has actually started, the average is about US$8800/kW, 75% higher than the Ingerop estimate."[38]

See our table below for an estimate based on Cabinet's costing.

Building 2 500 MW could cost R380 billion			
	2015 Nuclear calculations as per the parameters presented to Cabinet (by the Energy Security Cabinet subcommittee) – low cost	2015 Nuclear calculations as per the parameters presented to cabinet (by the Energy Security Cabinet subcommittee) – National Treasury's high cost	2021 Nuclear calculations, using $7 500/kW and January 2021 exchange rate
Cost used by Cabinet to build $/kW	$2 500/kW	$7 500 /kW	$7 500
Exchange rate used	$1:R10	$1:R10	$1:R15
Total Cabinet calculated to build 9 600 MW	R240 bn	R720 bn	
Cost to build 2 500 MW	R62.5 bn		R281.25 bn
Finance costs (25%)	Not calculated	Not calculated	R70.313 bn
Owners' development costs (ODC) (10%)	Not calculated	Not calculated	R28.125 bn
Cost to build 2 500 MW	$6.25 bn / R62.5 bn	R187.5 bn	R379.688 bn

The costs of build could be even bigger if there are delays in building. See the example of Medupi and Kusile elsewhere in this document.

c. The fuel costs: Coal and nuclear power stations need fuel, which must be mined and processed and transported to the power station. This means the nuclear power stations add

[38] Steve Thomas. January 2021. "Submission to NERSA on South Africa's proposed nuclear power programme."

to the emissions greenhouse gases due to the mining, processing, transport and disposal of the fuel, whereas for solar and wind power stations, the fuel is free and produces no emissions.

The table below shows the fuel costs per station type.

	Value used in the model, in Rand per gigajoule[39]
Coal pulverised	31 (~R558/t)
Coal (FBC) discard coal	15.5 (~R279/t)
LNG	135.70
Nuclear Fuel cost	9.10
Solar CSP	Zero
Solar PV	Zero
Wind	*[40] Zero

Looking at the IRP 2019 cost assumption and then updating them, it would seem logical to assume that a revision of the 2019 IRP to extend beyond 2030 would continue to not include any nuclear build. Neither DMRE nor OUTA has a crystal ball and, given the economic situation, if NERSA was to approve this determination, it would show a scant regard for future generations and the long-term affordability of electricity.

Response to NERSA question 2

NERSA question 2: In light of the decommissioning of a significant amount of base load capacity by 2030, and South Africa's reliance on natural resources extraction and beneficiation as significant drivers of economic development, should this base load capacity be added post 2030 and why? Is this an important consideration in the broader integrated industrial policy and why?

[39] Taken from the draft IRP 2018 which was issued for public comment. Department of Energy. "August 2018. Integrated Resource Plan 2018."
[40] IRP 2018 did not include the fuel cost of renewable energy in its tables.

In short, OUTA believes that nuclear energy would not be the answer to any increased energy demand from minerals beneficiation. OUTA also believes that given the delinking of energy intensity and economic growth, IRP 2019 provides sufficient analysis of future demand.

This question appears to assume that South Africa would continue to rely on natural resource extraction and beneficiation and, from the question, it is assumed to mean mineral resources and not solar and wind resources, which are also natural resources. The question appears designed to elicit a "yes" answer on the assumption that South Africa will continue to develop only from mineral resources and extraction, and that an energy intensive economy is the only way forward for industrial policy. OUTA disagrees with this and would point out that such a stance is at odds with the trends outlined in the figure below.

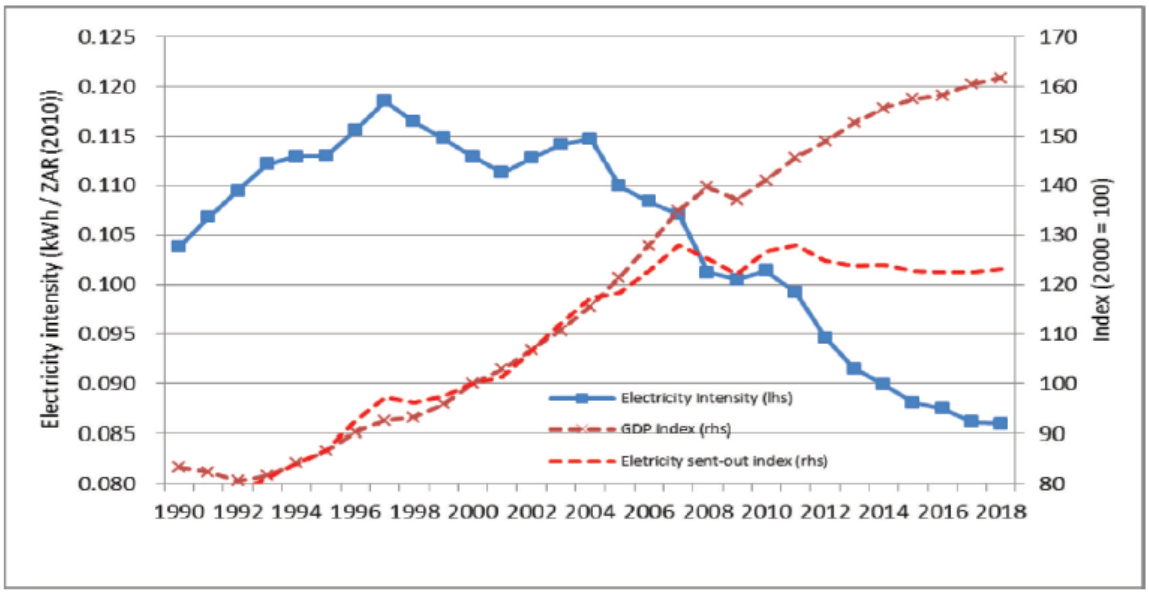


Figure 4: Electricity Intensity History 1990–2016 (Source: Own Calculations based on Statistics SA Data)

The Industrial policy framework from the Department of Trade and Industry states in its analysis of the constraints on the development of the industrial economy: "Similarly, there is a need for sufficient and cost-effective energy supply via a reliable distribution system".[41] The implication is

[41] Department of Trade and Industry. Undated. "National Industrial Policy Framework." Available online at: http://www.thedtic.gov.za/wp-content/uploads/NIPF_r2.pdf

that a least-cost energy supply would be preferred. However, this document dates from 2009 and OUTA requests NERSA to provide additional information regarding industrial policy with which the public could then engage.

For the purposes of industrial requirements, we refer NERSA to the IRP 2019 that states that "The scenario without RE annual build limits provides the least-cost option by 2050". If we want to ensure reliable energy at least cost, then the suggested mix is increasing renewable energy, not nuclear.

NERSA also refers to an outdated concept of "base load". In its definitions, NERSA states that "base load generation means the generating facilities within a utility system, which are operated to the greatest extent possible to maximise system mechanical and thermal efficiency and minimise system operating cost. Typical example is the coal power station".

According to the US Energy Information Administration, base load is "The minimum amount of **electric power** delivered or required over a given period of time at a steady rate"[42].

NERSA appears to conflate the need for the electricity system to deliver a minimum demand at all times with a power station needing to produce power at all times.

This can be likened to a factory that runs 24 hours a day. It does not mean that each factory worker has to work 24 hours a day, as long as there is sufficient work going on to produce the expected output.[43]

With regard to base load, the Rocky Mountain Institute's Amory Lovins stated: "That widely heard claim is fallacious. The manifest need for some amount of steady, reliable power is met by

[42] US Energy Information Administration. Online glossary, available at: https://www.eia.gov/tools/glossary/index.php?id=B
[43] Steve Thomas. January 2021. "Submission to NERSA on South Africa's proposed nuclear power programme."

generating plants collectively, not individually. That is, reliability is a statistical attribute of all the plants on the grid combined."[44]

OUTA's response to the question assumes that NERSA is attempting to understand whether there is a need to add 2 500 MW nuclear into the mix to maintain energy security. We refer to the IRP 2019. In light of this question, it seems it would be important from an educational perspective to highlight the definition of energy security as per the IRP 2019.

"Energy security in the context of this IRP **is defined as South Africa developing adequate generation capacity to meet its demand for electricity,** under both the current low-growth economic environment and even when the economy turns and improves to the level of 4% growth per annum. Generation capacity must accordingly be paced to restore the necessary reserve margin and to be ahead of the economic growth curve at least possible cost"[45] (our added emphasis).

In response to public comments on the IRP which were concerned with Eskom's inability to provide electricity consistently, DMRE responded that as part of the IRP technical studies, a "system adequacy" test was conducted. Such a test it is assumed would ensure that the system would deliver electricity to sufficient reliability despite the unreliability of Eskom's various power plants individually.

Overall, we assume that the methodology used to derive the IRP 2019 was robust. In the IRP 2019 (page 76), in response to assurance of the model, it states: "The simulation models and data set input used were independently verified by CSIR, NREL as well as PLEXOS developers for quality assurance. Most utilities in the world follow the methodology we are using".[46]

[44] Amory B Lovins. 13 October 2009. Rocky Mountain Institute. "Four Nuclear Myths." Available online at: https://rmi.org/wp-content/uploads/2017/05/RMI_Document_Repository_Public-Reprts_2009-09_FourNuclearMyths.pdf
[45] IRP 2019, page 11, on gazette page 16.
[46] IRP 2019, page 77, on gazette page 82.

In response to the need for sufficient energy supply for industrial growth, it is worth pointing out that GDP growth is decoupling from electricity intensity, potentially indicating a change in the structure of the economy.

Response to NERSA question 3

NERSA question 3: What other base load options are available that the country could invest in? Justify the preferred option?

The IRP on the post-2030 period states that "The scenario without RE annual build limits provides the least-cost option by 2050".[47] The implication is that solar PV and wind with other options as outlined in the IRP2019 would provide sufficient energy security at most affordable cost. With reference to the "base load" term, please see answer to question 2 above.

Response to NERSA question 4

NERSA question 4: Comment of the type of technology in the determination in line with the following:

i. Energy security considering both security of supply and security of demand.

ii. Efficient, effective, sustainable and orderly development and operation of the electricity supply industry from production through to consumption.

iii. The interest of present and future electricity customers is safeguarded against, inter alia, stranded assets, environmental impact and energy security.

iv. Use of diverse energy sources and energy efficiency.

[47] IRP 2019, page 89, on gazette page 94.

v. International best practices.

vi. Mitigation of climate change by the reduction of greenhouse gasses and other environmental imperatives.

i. Energy security considering both security of supply and security of demand.

According to the International Energy Association, (IEA), "The clean energy transition is bringing a major structural change in the generation profile of electricity systems around the world. Variable renewable generation has already surged over the past decade, driven by cost reductions and favourable policy environments and this trend is set to continue and even accelerate in line with climate change objectives. Meanwhile, conventional power plants, notably those using coal, nuclear and hydro, are stagnating or in decline".[48]

Energy systems are therefore focused on ensuring energy security with energy efficiency (reducing demand) and various renewable resources to supply.

Eskom reported that municipalities ended the 2018/19 year using 986 GWh below what was assumed: [49]

- Western Cape region contributed 301 GWh less than was assumed, as a result of intensive energy savings in the Cape Metro and various other municipalities in the Western Cape. The impact from the drought in the Western Cape also negatively affected the sales.

[48] International Energy Association. Available online at: https://www.iea.org/topics/energy-security
[49] Eskom. August 2019. "Regulatory Clearing Account (RCA) FY 2019. Submission to NERSA." Table 11 on page 44.

- Kwa-Zulu Natal region was 574 GWh lower than assumed mainly due to Richards Bay Alloys switching off their two furnaces. In addition, Karbochem lowered production due to feedstock shortages and technical plant problems.
- The Southern region (Eastern Cape) was 122 GWh lower than what was assumed due to third party infeed or wheeling which offset the consumption taken from Eskom in Nelson Mandela Bay municipality.

This trend towards energy savings and switching away from Eskom is evident from this extract from OUTA's submission to NERSA from the 2018/19 RCA consultations.

ii. Efficient, effective, sustainable and orderly development and operation of the electricity supply industry from production through to consumption.

The experience of South Africa in the recent history of nuclear technology has clearly shown that nuclear energy is anything but orderly and sustainable. The failed Pebble Bed Modular Reactor (PBMR) project (R10 billion estimated expenditure when it was halted) and the attempted imposition of 9 600 MW nuclear energy by the previous presidency, luckily stopped by civil society, show us that nuclear energy is anything but orderly. Its long lead times and, for the small modular reactors (SMRs) apparently planned, lack of commercially available examples to follow, mean that its cost trajectory is likely to follow that of a NASA rocket launch.

At the time of the new nuclear build as per the 2010 IRP, the $/Rand exchange rate was approximately $1 to R7. The current exchange rate now is approximately $1 to R15. If the new nuclear build deal had gone through, the costs including overnight costs and the interest, and without any delays, would have resulted in more than doubling of the cost of the project.

With scarce financial resources available, South Africa does not have money to burn. If South Africa committed to such a nuclear plant, it would mean that the country would not have much-needed money for other priorities including energy priorities.

Already, we have seen that in the Covid-19 period, DMRE continued to demand funds for the state-owned Nuclear Energy Corporation (NECSA) at the expense of the electrification of 86 000 houses.

iii. The interest of present and future electricity customers is safeguarded against, inter alia, stranded assets, environmental impact and energy security.

The environmental impact of a nuclear power station is that it produces toxic long-lived waste that has to be stored forever. It also produces nuclear spent fuel that poses a security hazard in that it can be used to make nuclear weapons. Such additional costs also include the need for a sophisticated nuclear regulatory system which includes a special nuclear regulatory body, the National Nuclear Regulator (NNR), a waste disposal institute and that there should be money available for decommissioning at the end of the life of the power plant.

According to the IRP 2019, a renewable energy mix provides the least-cost electricity supply until 2030 and again until 2050. The only scenario where nuclear energy is needed is when renewable energy build is forcibly constrained. And this comes at a cost to the consumer.

Nuclear is already too expensive and there is no need for nuclear power plants post 2030, unless South Africa stops building new renewable energy plants. There is therefore a strong likelihood that any nuclear commitment now will crowd out cheaper energy sources in the future.

Should the energy system be transformed, consumers would hopefully have the power to choose which power plants from which they would like to buy.

In the IRP public comments process, the overwhelming demand was for affordable electricity. In their discussion of the electricity tariffs, the DMRE was clear in its analysis that as electricity tariffs rise, "we can expect more electricity users to look for alternatives like rooftop PV system".[50] In addition, non-technical losses are increasing at a municipal level.

> "At a certain point the willingness to pay (WTP) threshold is breached for more and more municipal customers, and they either actively pursue alternative sources to meet their energy demand, or they stop paying for the electricity service. Consumers can expect the electricity disruptions (driven by load shedding or poor quality of supply) and high tariffs to drive the WTP threshold even lower. Requests by industrial and commercial electricity users to deviate from the IRP and to develop their own generation exemplify the trend. While at this stage it is not quantified, most residential estates, commercial parks and shopping centres have installed PV systems to supplement grid supply."[51]

OUTA's submission in February 2020 to NERSA on Eskom's RCA 2018/19 outlined this problem as follows:

> "The media over the last few years have raised the issue of non-payment of municipal electricity accounts. This is common knowledge as is the impact of the rising cost of electricity on the ability of the poorer and more vulnerable citizens to pay.
> "This is not a new phenomenon as indicated by the following in a 2011 HSRC report:
>
> > 'We looked at the impact of a once-off 25% increase in the electricity price. In this case, the Consumer Price Index (CPI) for all households rises by 0.88%, with 0.53% coming from direct effects and 0.35% from indirect effects. The impact is greater on poor households than on rich ones. This is driven almost entirely by the direct impact, which in turn is driven by the relative shares of total expenditure on electricity. Thus the richest households allocate 0.8% of their expenditure to electricity, so the 25% price rise raises their expenditure by 0.2%. By contrast, the poorest households spend 5.4% of expenditure on electricity, so the 25% increase raises their expenditure by 1.35%. Against this, the indirect effects are

[50] IRP 2019, page 16, on gazette page 21.
[51] IRP 2019, page 16, on gazette page 21.

relatively uniform across household groups, contributing **0.40%** to the CPI increase for the poorest **and 0.32%** to that for the richest'.[52]

"Rising residential tariffs over the last decade have certainly continued to impact more on the poor and vulnerable in the same way as highlighted above. Rising electricity tariffs are unsustainable, and we would argue a driving force for increasing inequity in the country. StatsSA pointed out that by 2018, municipalities were increasingly using off-grid energy to service some indigent households, through the implementation of Free Basic Alternative Energy (FBAE). From this article: 'To what extent are municipalities providing these sources, including solar energy? Of South Africa's 213 local and metropolitan municipalities, 49 indicated that they are servicing indigent households with at least one form of off-grid energy source, according to the Non-financial census of municipalities report'.[53] Other sources which indicate the extent of energy poverty include the general household survey for example."

Given that a nuclear power generation would be expensive, if customers are offered a choice, they would be unlikely to choose nuclear. This would mean that the nuclear power plant would not generate sufficient revenue to cover its debt repayment and it would most likely decline into a death spiral. Given that nuclear power plants are backed by state funds, this would lead to the state having to pick up the tab for what has become a stranded asset. **There is no scenario in which new nuclear power plants are viable unless the government stops all renewable energy builds, and forces people to pay for the nuclear energy costs.** However, already people have no money for electricity and such a bizarre action would then lead to less and less people able to afford electricity for their homes, and would push the price of goods up, leading to inflation. This would deepen poverty and exacerbate inequality and would not lead to increased revenues. The end result would still be a stranded asset but it would drag the country down with it.

[52] Dr Miriam Altman et al. March 2011. Electricity Pricing and Supply with special attention to the impact on employment and income distribution: Final Report. HSRC. Available at: http://www.hsrc.ac.za/uploads/pageContent/3022/Making%20informed%20decisions%20about%20electricity%20-%20SDC%20-%20Jan%2030%20-%2011%20v4.pdf

[53] Statistics SA. 4 June 2018. Energy and the poor: a municipal breakdown. Available at: http://www.statssa.gov.za/?p=11181

iv. Use of diverse energy sources and energy efficiency.

Energy efficiency has been largely underestimated in South Africa. In OUTA's submission to NERSA on previous Eskom tariff applications, the following example was made with regard to efficiency, based on data from Eskom's application:

> "During 2013/14, Eskom spent R1.36bn on DSM whereas the MYPD3 decision for the 2013/14 financial year was R1.46bn. The progammes installed resulted in 409MW of savings during the year. To save energy costs R1.36bn for 409MW = R2.53m per MW. Illustratively, to build coal, Medupi cost R105bn for 3990MW = R26.30m per MW, an order of magnitude higher. But Medupi is not up and running properly yet, and we are reliant on even more expensive electricity generation."

Using diverse energy sources does not mean the use of nuclear energy. The use of diverse resources should involve the exploration of diverse renewable energy sources, storage and a strong move to shift the demand profile to reduce the demand for peaking plants.

v. International best practices.

It is not clear what NERSA is asking for here, but according to the World Nuclear Industry Status report 2020[54], it would seem that international best practice is not to build many new nuclear power plants.

[54] Mycle Schneider et al. September 2020. World Nuclear Industry Status Report 2020. Available online at: https://www.worldnuclearreport.org/-World-Nuclear-Industry-Status-Report-2020-.html

Nuclear power companies, even with state backing, are failing and the trend is increasingly towards larger amounts of renewable energy. For example, Chinese reactor vendor company SNPTC has been allocated South Africa by the Chinese government. However, SPIC, the parent company of SNPTC is the world's largest solar generator and third-largest wind producer, by capacity, with 22.2GW and 20.6GW of capacity respectively compared to only 4.8GW of nuclear capacity.[55]

vi.	**Mitigation of climate change by the reduction of greenhouse gasses and other environmental imperatives.**

Nuclear energy is not as carbon intensive as coal and other fossil fuels. However, it comes with its own toxic waste products.

With regard to climate change, this extract from the World Nuclear Industry Status report 2019[56] provides some context.

Some extracts from this report:

- "To protect the climate, we must abate the most carbon at the least cost – and in the least time – so *we must pay attention to carbon, cost, and time, not to carbon alone".*[57]
- "**Non-Nuclear Options Save More Carbon *per Year*.** While some nuclear countries had a particularly fast build-up in the 1970s and 1980s (Belgium, France, Sweden, U.S.), many nuclear countries show *faster* build-up of renewables than in their nuclear program (China, Germany, Italy, India, Spain, U.K., and Scotland individually). A key point is that while current nuclear programs are particularly slow, current renewables programs are particularly fast (as WNISR has documented over the past decade). According to a recent assessment, new nuclear plants take 5–17 years longer to build than utility-scale solar or onshore wind power,

[55] Steve Thomas. January 2021. "Submission to NERSA on South Africa's proposed nuclear power programme."
[56] Mycle Schneider et al. September 2019. World Nuclear Industry Status Report 2019. Available online at: https://www.worldnuclearreport.org/IMG/pdf/wnisr2019-v2-lr.pdf
[57] WNISR 2019, page 15

so existing fossil-fuelled plants emit far more CO2 while awaiting substitution by the nuclear option. In 2018, non-hydro renewables outpaced the world's most aggressive nuclear program, in China, by a factor of two, in India by a factor of three.

> "Stabilizing the climate is urgent, nuclear power is slow. It meets no technical or operational need that these low-carbon competitors cannot meet better, cheaper, and faster. Even sustaining economically distressed reactors saves less carbon per dollar and per year than reinvesting its avoidable operating cost (let alone its avoidable new subsidies) into cheaper efficiency and renewables."[58]

Response to NERSA question 5

NERSA question 5: Provide what you consider to be the risks and challenges associated with the allocated capacity in terms of the objects of the Electricity Regulation Act mentioned in question 3 above.

The responses outlined above indicate that from OUTA's point of view the risks and challenges associated with building new nuclear power undermine energy security in that the outcome is most likely to crowd out new affordable, safer renewable energy plants that can enhance South Africa's energy security.

Response to NERSA question 6

NERSA question 6: Comment on the lead time for the deployment of nuclear power plant of circa 10 years, from design, licensing, construction and commissioning.

[58] WNISR 2019, page 25

i. Considering the lead time above, what would be the most suitable time to commence preparations if nuclear was to be a no-regret option to replace the base load capacity to be decommissioned post 2030?

Preparations for any potential nuclear plant must be based on detailed studies on the viability both technical and economic and financial. By approving a ministerial determination, NERSA risks pushing out more viable affordable energy options.

The answer to (i) is probably never. But the way to decide that is for the DMRE to conduct the various studies outlined as needed in the IRP 2019: "This IRP is developed within a context characterized by very fast changes in energy technologies, and uncertainty with regard to the impact of the technological changes on the future energy provision system. As we plan for the next decade, this technological uncertainty is expected to continue and this calls for caution as we make assumptions and commitment for the future in a rapidly changing environment. Accordingly, long-range commitments are to be avoided as much as possible, to eliminate the risk that they might prove costly and ill-advised".[59]

The IRP does acknowledge the need for decisions such as nuclear needing long lead times.

However, in its conclusions from the modelling of various scenarios, the DMRE draws some conclusions:

> "The scenario without RE annual build limits provides the least-cost electricity path to 2050.
> "Without a policy intervention, all technologies included in the promulgated IRP 2010–2030 where prices have not come down like in the case of PV and wind, will not be deployed because the least-cost option only contains PV, wind and gas.
> The significant change in the energy mix post 2030 indicates the sensitivity of the results observed to the assumptions made. A slight change in the assumptions can

[59] IRP 2019, page 11, gazette page 16.

> therefore change the path chosen. In-depth analysis of the assumptions and the economic implications of the electricity infrastructure development path chosen post 2030 will contribute to the mitigation of this risk."[60]

The conclusion that OUTA draws from the DMRE scenario analysis is that given the uncertainty of the future energy path, it behoves government to do its homework before committing scarce resources to nuclear energy.

At best, this determination is premature and there is a lot more homework needed.

According to the DMRE, existing electricity regulations on new generation capacity enable the minister of energy to undertake or commission feasibility studies in respect of new generation capacity. Without these studies, committing to new nuclear energy would be foolhardy and irrational.

Response to NERSA question 7

NERSA question 7: What would be the advantages brought about by SMRs, and is it possible for these to complement intermittent technologies such as renewables?

NERSA appears to be in possession of information that the public does not have access to, as this question is presented in a biased manner. The question assumes that there are advantages to SMRs, but as OUTA has no knowledge of any commercially viable SMRs nor any of their associated advantages, we are unable to comment until and unless we receive the information which has caused NERSA to take this position.

According to the World Nuclear Industry Status Report 2020, the following was reported: "Small Modular Reactors or SMRs have made little progress ever since the first WNISR assessment in 2015,

[60] IRP 2019, page 91, gazette page 96.

as this edition's update concludes: 'delays, poor economics, and the increased availability of low-carbon alternatives at rapidly decreasing cost plague these technologies as well, and there is no need to wait with bated breath for SMRs to be deployed'." [61]

However, the manner in which this question is posed appears to contradict the statement in the consultation paper to the effect of NERSA not having formulated a position:

> "NERSA has not yet formulated any opinions on the issues that are raised in this consultation paper, but is raising them so that stakeholders can give their opinions and input on these issues in order to assist NERSA to make a well-considered decision."[62]

Response to NERSA question 8

NERSA question 8: Comment on the impact of nuclear technology on the electricity tariff and how this may affect demand for electricity in the longer term, and how this may affect future investment decisions and how long the investment cycle is, where applicable.

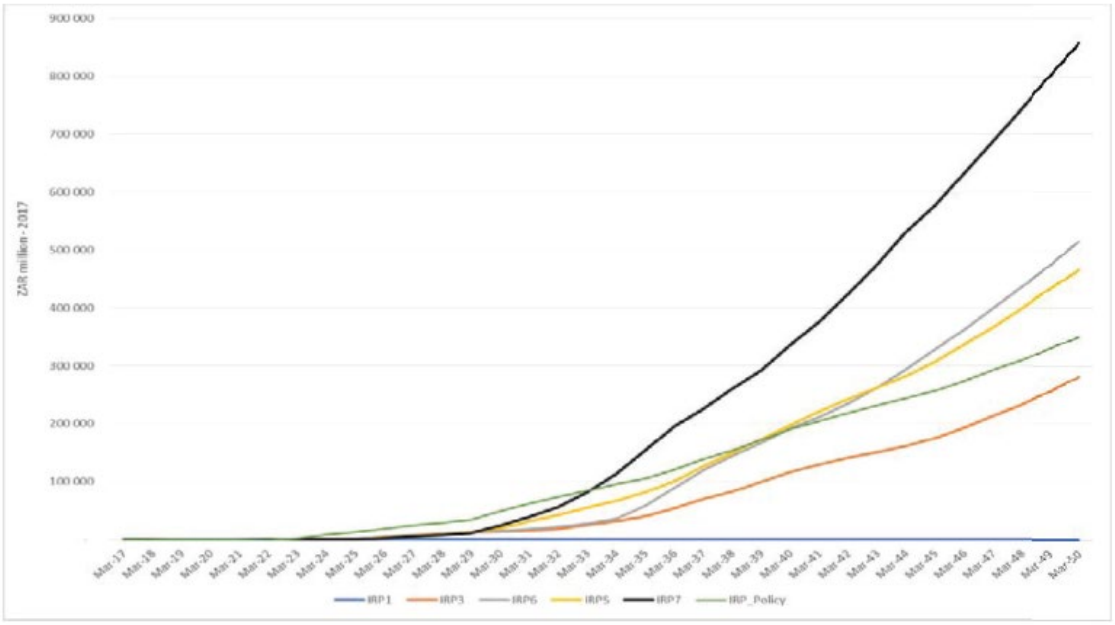
IRP 2019 notes that the price paths to 2030 do not change for the different scenarios – but that is because nuclear is not part of the mix during this period.

> "There is therefore no difference in tariff path for the different scenarios up to 2030, while the choice of technologies and their associated costs, taking emission mitigation requirements and capacity building into account, will drive the price path beyond 2030. Cumulative by 2030 deviation from the least cost case (IRP1) will results in additional costs to the consumer.
>
> Hence, it makes no difference for this version of the IRP Update which scenario is adopted up to 2030. The huge difference between scenarios beyond 2030 will, however, make it necessary to undertake a detailed energy path study that will inform a next update of the IRP."[63]

[61] WNISR 2020, page14
[62] NERSA Consultation Paper, Page 10
[63] IRP 2019 page 98, gazette page 103

It should be noted that the IRP1 case (Scenario 1, with unlimited renewable energy) contains no new nuclear energy.

The graph below, from the same section of IRP 2019, [64] illustrates the price path. Scenario 7 (with nuclear build) is clearly the most expensive trajectory.



Cumulative Comparison of Tariff Paths for the Scenarios

Response to NERSA questions 9 to 13

NERSA questions 9 to 13: Technology costs

Our responses are broadly covered in the preceding sections. In addition, OUTA supports the submission by SAFCEI and particularly, the technical submission that Prof S Thomas submitted as part of SAFCEI's submission.

[64] IRP 2019 page 97, gazette page 102

Response to NERSA question 14

NERSA question 14. Provide your comments on Eskom or any future entity of the unbundled Eskom as the generator of the new generation capacity. Provide your comments under the following three scenarios:

(a) Status quo remains, that is, Eskom is not unbundled and remains a state-owned vertically integrated utility.

(b) Eskom being unbundled and Generation, Transmission and Distribution are separate state-owned entities.

(c) Eskom is not viable and privatised, but as outlined in (a) or (b) above.

(a) Eskom is debt ridden and it would be irresponsible to add to its burden by burdening it with the generation of new nuclear power.

(b) Eskom generation will also be burdened by debt and should not be asked to include any nuclear generation. Should private companies wish to build power plants with their own money, this is then their risk, but no state or Eskom guarantees should be allowed.

(c) This is a strange question but in either case, it would not be responsible to burden Eskom with new expensive nuclear power plants which would further exacerbate the unaffordability of electricity.

Response to NERSA question 15

NERSA question 15. Comment on the feasibility of a partnership between Eskom and other juristic person in view of Eskom's current balance sheet. What would the risks to electricity customers associated with this arrangement be?

Given that new nuclear power will be the most expensive option, if Eskom is forced to take on the new build, it can only worsen its existing debt situation. Given that Eskom is effectively not a going concern and needs constant bailouts from the state, the additional burden would further impact negatively on the state's ability to raise funds for the needs of the public, for example, hospitals, schools, electrification of households etc.

Response to NERSA question 16

NERSA question 16: Give your comments with regard to the ownership model:

a) IPP owned;

b) joint venture (RSA & IPP);

c) state utility owned; or

d) any other applicable model.

The ownership model should be private. With no state guarantees. The IPPs received subsidies initially in their tariffs. Given that nuclear energy is a mature technology, no such subsidies should be provided.

Further, Eskom, or whichever entity is the buyer on behalf of the state, should be blocked from signing-power purchase contracts with any private nuclear operator until that operation is online and providing electricity. In other words, Eskom and other state entities should not be used to fully fund a privately owned new nuclear build. An example to illustrate this issue: Eskom signed a power-purchase contract with Bokpoort CSP for R26.844 billion which expires in 2035[65], for a power station which owner ACWA Power notes cost $517 million (about R7.755 billion at January 2021 exchange rates) to construct[66]. In the case of this contract, there were strong hints of corruption, as then Eskom executive for transmission, Mongezi Ntsokolo, was simultaneously on the boards of both Eskom and the Bokpoort power station when the contract was awarded.

If nuclear energy is to be part of the future, it needs to compete with more affordable alternatives. However, such competition must include the external costs of nuclear, including the costs of waste disposal and decommissioning.

Such funds cannot be simply a book entry as is the current situation with Eskom, but must ensure that such funds are kept in a separate fund. This is to avoid such companies escaping their future responsibilities as we have seen in the mining sector.

[65] Written reply to Parliament, published on 17 November 2017, by Minister of Public Enterprises Lynne Brown, compiled by the department's director-general Richard Seleke. Reply RNW1731-171117. Available online here: https://static.pmg.org.za/RNW1731-171117.docx

[66] "Key facts" on Bokpoort CSP IPP on the ACWA Power website, available here: https://www.acwapower.com/en/projects/bokpoort-csp-ipp/

Response to NERSA question 17

NERSA question 17: Provide your comments on the chosen buyer for the capacity. Provide your comments under the following three scenarios:

a) Status quo remains, that is, Eskom is not unbundled and remains a vertically integrated utility, with the Single Buyer situated within the System Operator.

b) Eskom being unbundled and Generation, Transmission (Wires and System Operator that includes Single Buyer Office) and Distribution are separate entities.

c) Eskom being unbundled and Generation, Transmission (Wires) and Distribution are separate entities. A form of ISMO is instituted, with the System Operator also encompassing a Single Buyer Office.

d) Eskom is not viable and privatised, but as outlined in (a) to (c) above

The Minister's determination states that the buyer of the electricity will be Eskom Holdings (SOC) Limited or any entity determined through the Eskom's unbundling process as the future buyer of electricity.

As per the response above to NERSA's question 16, OUTA believes that no state subsidies or guarantees or loans should be offered to any nuclear power plant.

Response to NERSA question 18

NERSA question 18: How should the cost recovery be handled to ensure that the generator earns its revenue. The response should be in terms of the ownership models outlined in question 15 above.

The generator must be a standalone entity with no guarantees, or preferential treatment. If the generator is unable to earn its revenue due to nuclear electricity being too expensive, the generator should go bankrupt and cease to exist. However, given that OUTA believes that this is most likely to be the case, we are very concerned that there are sufficient decommissioning and clean-up funds available when needed. These funds must be secured in a separate physical account, not a book entry.

Response to NERSA questions 19 and 20

NERSA question 19: Provide what you consider to be the risk associated with the chosen buyer.

NERSA question 20: Must the buyer be paid only for power required by the system, i.e. the generator takes the risk for reduction in demand?

Currently Eskom gets paid by consumers even if it fails to predict the demand accurately, which affects the price as Eskom losses due to demand lower than predicted are loaded onto customers through future price increases. The Regulatory Clearing Account mechanism is not appropriate to a state-owned monopoly.

In the event that there is a properly constituted independent system and market operator (ISMO), the buyer should act in the consumers' interest and buy the cheapest electricity available at the time of demand.

The contract between the buyer and the generator should be based on accurate forecasting by the ISMO.

Response to NERSA question 21

NERSA question 21: In the event that Eskom as an organ of state is designated as generator and buyer, how will this arrangement affect the fairness, transparency, competiveness and cost effectiveness of nuclear procurement as far as electricity customers are concerned? Should this arrangement be encouraged?

The designation of Eskom as generator and buyer would exacerbate the current unfair situation. Such an arrangement is unacceptable and, should NERSA condone this, NERSA would be acting contrary to the public interest.

NERSA should actively prohibit such an arrangement.

Response to NERSA question 22

NERSA question 22: Provide your comments on the DMRE as the designated procurer of this capacity.

The Minister's determination sets the procurer of the nuclear new build programme as the DMRE or any other organ of state or in partnership with any other juristic person.

The biggest difficulty here is the need to guard against corruption.

The South African government has a dismal record in this regard, and it extends to numerous government departments and organs of state. Eskom itself is a prime example, with the construction

of Medupi and Kusile glaring examples of malfeasance. The previous attempt at a nuclear new build programme showed that the DMRE was prepared to flout procedures to suit its own agenda. The very existence of the Minister's current determination, which flies against the spirit of IRP 2019 and ignores South Africa's very real fiscal difficulties, indicates that problems remain in that department.

We are not sure of the answers here. But we have huge concerns about an organ of state taking on a project of this magnitude, complexity and cost under the current circumstances of entrenched government corruption and mismanagement. It is difficult to escape the assumption that such projects are favoured by sectors of government precisely for those reasons, as they provide many more opportunities for rent seeking and patronage.

We believe that the systems of procurement and management of mega projects have been so badly abused that a national conversation may be needed to repair these and rebuild citizen confidence in government. A key requirement for rebuilding citizen confidence is transparency in such projects, and the lack of hard, detailed information about the nuclear new build proposal does not inspire trust in those promoting it.

Response to NERSA questions 23 to 25

NERSA question 23: Which other organ of state is best positioned to be the procurer of this capacity and why?

NERSA question 24: Provide your comments in respect of juristic persons that may partner with the state or the nature of the partnership for purposes of this procurement.

NERSA question 25: Which funding model would be suitable for this capacity to ensure a lowest price for the consumer?

See above (question 22) for our concerns on corruption and mismanagement.

The funding model must ensure that the state is not liable for any build costs.

Response to NERSA question 26

NERSA question 26: What is the most cost-effective model of plant construction (e.g. turnkey approach, split package approach and multi-contract approach) to avoid excessive cost overruns, noting that the recent Eskom new build was a multiple EPC contract approach, managed by Eskom. To what extent should Eskom be involved in the actual construction management of the build programme?

The determination states that the procurer will determine the procurement process, through tendering that is fair, equitable, competitive and cost effect.

We believe that Eskom should not be involved at all.

Eskom has shown a clear inability to manage mega construction projects, and is teetering on the edge of bankruptcy due particularly to its failed management of the Medupi and Kusile builds.

We question whether any department of state has the capacity to manage and implement such a complex build, in the light of government's track record on mega projects.

Response to NERSA questions 27 to 31

NERSA question 27: In the event a non-turnkey solution is preferred, how should the nuclear build work under construction (WUC) be dealt with in the future Multi-Year Price Determinations (MYPDs), given the long lead times of the technology?

NERSA question 28: In the event the generator is in partnership with Eskom and another juristic person, should this jointly operated asset qualify under Eskom RAB when considering the MYPD application?

NERSA question 29: Provide your view on the method chosen for the procurement of the new generation capacity.

NERSA question 30: State how the procurement process proposed can be reconciled with Eskom being the designated generator of this power.

NERSA question 31: Provide what you consider to be the procurement-related risks associated with the capacity in this determination.

If any nuclear new build is to take place, the builder must take the risk of being able to deliver electricity at a cost competitive prices to the buyer at the time the nuclear plant is ready to sell electricity. Any nuclear new build must therefore not rely on any state backing through guarantees, loans, or any guaranteed price as, given the uncertainty, it is not possible to guarantee the price. However, the buyer must be duty bound to buy the least cost electricity which will be in the public interest.

There should not be any arrangement where customers incur costs for electricity that is not available at the time that they buy it. The costs of building the reactor should not be paid for upfront in the tariff.

We note this comment by NERSA in the Consultation Paper:

> "The IRP 2019 highlights that 'Taking into account the existing human resource capacity, skills, technology and the economic potential that nuclear holds, consideration must be given to preparatory work commencing on the development of a road map for future expansion programme'."

The IRP says **consideration** must be given. That consideration is regarding the preparation for nuclear road map. However, the consideration is premised on an assumption that is not backed up by any facts. Without proof of such "human resource capacity, skills, technology and economic potential", this is an empty statement.

The note is with regard to the decommissioning of coal plants where the IRP supports the additional capacity needed. This obviously refers to renewable energy with possible inclusion of nuclear. However, there are no facts to support any "potential nuclear benefits" whereas the renewable energy programme has already delivered such socio-economic benefits.

In 2019, in accounting to Parliament for NECSA, the then chair of NECSA Rob Adam explained:

> "The problem was that for a decade and a half there was talk of a nuclear new build. NECSA was requested to retain nuclear capabilities during that period, but the nuclear build never materialised. Rather than draw on the fiscus, NECSA was advised to look for commercial opportunities, some of which were possible, and some not. Commercial viability became questionable. A central challenge was the salary bill. The NECSA salary bill was R800 million, and the grant received from the DoE was only R513 million."[67]

The extra R300 million spent on salaries could have been allocated to the installation of solar water heaters, with the creation of installer and maintenance jobs and the provision of water heating services to predominantly poorer households.

[67] Minutes of the meeting of the Portfolio Committee on Energy on 5 March 2019: "SA Nuclear Energy Corporation (NECSA) on its 2017/18 Annual Report". Available online at: https://pmg.org.za/committee-meeting/28019/

Response to NERSA question 32

NERSA question 32: Comment on the socio-economic impact of nuclear new build programme on South Africa (e.g. job opportunities and localisation).

Building a new nuclear power plant is not the answer to South Africa's socio-economic problems.

The jobs will be in the construction phase and if the government wishes to create jobs in construction, OUTA suggests it will be more cost-effective to build schools and hospitals rather than nuclear reactors.

In 2020, during the height of the Covid-19 pandemic, the DMRE continued to fund NECSA at the expense of rural electrification.

The Auditor-General gave NECSA a disclaimed opinion as the audit outcome for the 2018/19 financial year. A disclaimed opinion is given when the auditor is unable to form an opinion due to the poor quality of financial statements presented. The nuclear programme of DMRE enjoyed a 28% increase from its 2018 allocation, whereas other programmes within the department managed only single digit increases in most cases. The reason for increasing NECSA's budget despite its poor record of accountability has no sound financial logic.

In 2020, Departments were asked to reduce their allocations due to the pandemic. DMRE reduced its electrification budget by R1.5 billion leaving 86 000 households to go without the planned electrification, while continuing to fund NECSA its full allocation of more than R1 billion. This is one example of how socio-economic objectives are undermined by dogged determination of vanity projects like nuclear power plants.

How is it rational to approve building a nuclear reactor, when government cannot afford to link households to the grid or provide them with solar geysers?

See elsewhere in this document for additional comments on how the electricity tariffs associated with nuclear power will impact on society.

Response to NERSA question 33

NERSA question 33: Do you agree with the determination as provided by the Minister?

Response: NO.

For the reasons listed above, OUTA does not support this determination.

OUTA requests an opportunity to present at public hearings that take place with regard to this matter.

Contact person:

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Appendix A

See the table below for a comparison of the costs of power generation technology.

Comparing the costs: power generation technology

	Rated capacity, MW net	Total Overnight cost, Rand/kW (Jan 2017 Rands)	Fixed O&M cost (Rand / kW / Year)	Variable O&M cost (Rand / MWh)	Fuel cost (Rand / gigajoule)
Coal pulverized with flue gas desulfurisation (FGD)	4500 MW	R40 031	R1 044	R90	R31
Coal fluidised bed combustion (FBC) with FGD, single unit	250 MW	R48 319	R702	R195	R16
Nuclear (Dept of Energy)	1400 MW	R69 764	R1 094	R42	R9
Open cycle gas turbine (OCGT)	132 MW	R9 226	R181	R3	R136
Combined cycle gas turbine (CCGT)	732 MW	R10 131	R187	R25	R136
CC-CE	150 MW	R9 980	R169	R74	R136
Internal combustion engine (ICE) 2MW	2 MW	R14 394	R476	R79	R136
Internal combustion engine (ICE) 10MW	9 MW	R15 427	R536	R136	R136
Internal combustion engine (ICE) 12MW	12 MW	R9 268	R395	R65	R136
Demand response	500 MW	R0	R9	R1 467	R0
Pumped storage	333 MW	R22 736	R205	R0	R0
Lithium-ion, 1 hour storage	3 MW	R11 165	R697	R4	R0
Lithium-ion, 3 hours storage	3 MW	R14 533	R697	R4	R0
Compressed air energy storage (CAES), 8 hours storage	180 MW	R19 378	R240	R3	R0
New battery, 4 hours storage	4 MW	R27 646	R697	R4	R136
Wind	139 MW	R17 142	R684	R0	R0
PV fixed tilt	10 MW	R14 355	R302	R0	R0
PV tracking	10 MW	R16 555	R320	R0	R0
Concentrated PV	10 MW	R56 863	R354	R0	R0
Concentrating Solar Power (CSP) trough, 3 hours storage	125 MW	R97 641	R1 154	R1	R0
CSP trough, 6 hours storage	125 MW	R62 560	R1 185	R1	R0
CSP trough, 9 hours storage	125 MW	R147 877	R1 216	R1	R0
CSP tower, 3 hours storage	125 MW	R87 126	R1 062	R1	R0
CSP tower, 6 hours storage	125 MW	R60 862	R1 108	R1	R0
CSP tower, 9 hours storage	125 MW	R58 833	R1 139	R1	R0
Biomass forestry residue	25 MW	R57 067	R1 868	R75	R36
Biomass municipal solid waste (MSW)	25 MW	R161 424	R7 303	R129	R0
Landfill gas	5 MW	R17 935	R2 678	R70	R0
Biogas	5 MW	R87 242	R2 191	R57	R0
Bagasse Felixton	49 MW	R18 148	R175	R9	R83
Bagasse Gen	52 MW	R34 793	R397	R27	R83
Hydro	2500 MW	R12 892	R89	R0	R0

Source: Department of Mineral Resources and Energy. The department used this to compile IRP 2019; it was obtained through a PAIA application by the Centre for Environmental Rights.