IRP comments

Acknowlegment and disclaimer:

Our comments are aimed to contribute and to ensure the wellbeing of all current and future generators, transmitter(s), traders and end users – large and small – to mitigate the devasting effects of the energy shortage in SA.

Introduction/ General

SAIPPA hold the opinion that the IRP in its current form does ***not constitute a firm plan to address the urgent energy security shortages and lacks the sense of urgency required to get the country out of a protracted energy crisis,*** which is causing devastating economic harm. It plans to fail in the first horizon by planning for a deficit - *Business-as-Usual* buildout of capacity - instead of modeling options to remove this shortage. The argument between horizon 1 and 2 is not justified and make no sense as horizon 1 is de facto not an IRP[1] as it does not meet the typical criteria for an optimal modelled solution. For both scenarios *energy security and reduction of GHG emissions* are important.

In our view it is not an option to have a plan that is focusing largely to fail in the first horizon, whilst the second horizon has various scenarios that appear to have been modelled to derive at a particular outcome, instead of modelling for least cost generation, meeting minimum emission standards and GHG, with no shortage of capacity.

From a policy point of view, we believe that there should be consistency between the various policy related documents issued by government – a consistency and integration that is absent in the IRP, and that needs to be incorporated in the new modelling.

There are several aspects in the IRP that are either incorrect or unrealistic in assumptions and/or approach: The most important that we want to highlight are:

1. The deteriorating EAF situation, that will prevail in our opinion.
2. The unrealistic figures for the 900MW per annum DG (distributed generation, much of which is PV rooftop).
3. In essence the document is biased against RE, by using the wrong cost comparison in relations to cost for instance from the IPPO programme and various other sources around the world such as AEMO, IEA India, whilst nuclear and gas cost are almost always used in the lower percentile of cost - hence

[1] See section 2.14 for more details.

optimistically reflected.[2] This results in outcomes that do not compare with what is happening elsewhere in the world. Such approaches should not be in a document of national stature.

4. The air qualities regulated by the DFFE's minimum emission standards are a major risk to SA's electricity supply but are only mentioned in passing. It is unclear whether the cost and loadshedding impacts of the abatement retrofits were adequately considered.
5. References that gas has enormous potential and opportunity from local sources as an option, clean coal, or new nuclear as commercially available solutions should not have been included as candidate technology solutions until much later time horizons.
6. We further believe that the electricity demand projection does not consider the many onsite PV generation installations as modeled and calculated by Eskom, as this is seen as supply instead of reducing demand. This quantum (which is still growing) is general knowledge, and we can provide more details if necessary.
7. Progression from IRP2019 where the changes are neither explained nor defendable, and the removal of elements that have not yet been procured (e.g. the "other" column of Table 5 (DG, CoGen, Biomass, Landfill). This totals 4GW (2023 – 2030) in addition to the short-term critical shortage identified (and was potentially misused for the RMIPPPP for different technologies).

SAIPPA's view on the Methodology employed

> **Commented [AvdM1]:** Brian I first has build this here, later removed to the detailed section but realised that the way they asked this- split the methodology incorrectness+ the cost issue that results in a wrong pathway and incorrect scenario. Hence I brought this back. I think they are just going to dump all the comments in a table and we hence may loose what we are trying to bring over. Therefore I brought this back in the mail heading of the letter.

We have commented under the various headings comprehensively on the methodology employed and challenges thereto. Most of the results offered as pathways in the different Horizons stem, in our opinion, from incorrect assumptions and/or costs and a wrong methodology followed in many aspects. We offer a few of the main concerns as a summary hereunder before focusing on the detailed comments as requested in the DMRE reporting framework.

1. We would like to point out that the description of the methodology does not capture the necessary detail to describe the modelling process that was followed, as an energy system model is optimised over a ***long-term planning horizon***, and it is often necessary to start deploying new capacity years before large "chunky" decommissioning takes place (i.e. large unit coal stations), especially when annual new build limits are enforced (which also should not be done).

[2] SAIPPA is happy to provide more details in this regard, if necessary, but we do believe that the cost comparisons done by e.g. Meridian is readily available. Comparisons of other IRP modelling is also well known and available and reference this incorrect cost comparisons in the current version of the IRP.

2. As mentioned above, we believe the 2 horizons approach is flawed as that would not allow the model to incorporate/ foresee major decommissioning in the coming decade. By having this spilt, it causes the model *to force large chunks of new capacity* straight away instead of rolling out a smooth "realistic" deployment of new build. In our opinion, and from learnings around the world, such an approach is flawed.
3. A further core aspect that needs to be carefully considered in a capacity expansion plan is that of *system adequacy*. Any capacity expansion plan must adhere to an acceptable level of system adequacy (minimised loadshedding AND a **reserve margin**). How operating reserves and reliability requirements[3] are taken into consideration have a major impact on the capacity optimization and should thus be transparent. The document is silent on this critical aspect.
4. There is uncertainty between when a *production cost model was used* and when a *capacity expansion model was used* or whether there was any feedback loop between the two models. The latter is critical for a correct outcome.
5. In both Horizons, it appears that new build constraints were applied as the outcomes across all scenarios show clearly that solar PV could not exceed 900MW per annum up to 2050. Additionally, wind capacity looks to be constrained between 2031-2040, where no more than 17.2 GW cumulative capacity was allowed across all scenarios. *Both from a modelling and practical perspective it does not make sense that the same amount of solar was built in all Pathways despite vastly different technological constraints.* It is also **preposterous** that these limits are constant *MANY years* into the future – any reality of constrained build-capacity should rapidly rise as the industry responds to the demand signals.
6. The Least-Cost (Pathway 1) builds wind, solar and high load factor gas. It is unclear to what extent the modelling constraints *are forcing a high load factor of the gas fleet*, or if this was a *policy decision as an INPUT* to the model, as not enough transparency around the modelling constraints have been provided. *High load factor gas is not consistent with the outcomes of the IRP2019 Least-cost plan*, justifying a more thorough explanation of the results.
7. The Renewables-only scenario (Pathway 2) has a very strange outcome of *building large amounts of CSP as opposed to the much cheaper combination of Solar PV and BESS, and OCGT*. Looking at the results, this is likely a result of the new build limits applied to solar PV (900 MW/y), in combination with very high cost assumptions for new build solar PV and BESS.
8. The document states that Pathways 2 and 3 "sought to explore the impact on security of supply". Our opinion is that this is *a fundamentally flawed objective in*

[3] See CSIR/Meridian study on this.

a capacity expansion model as the security of supply is a function of the energy modelling adequacy specifications (user defined). A properly conducted IRP study would ensure that the same level of *security of supply is achieved across all scenarios*. If the scenario resulted in an inadequate level of security of supply, this is a failure of the modelling approach used, likely caused by an impossible boundary constraint where sufficient new build capacity was not allowed, failure to run production cost modelling after the capacity optimisation, inappropriate reliability criteria and/or an inadequate understanding of the impact of reduced chronological sampling in PLEXOS.

9. Forcing zero OCGT in the high-RE scenario is bizarre! The more RE one builds the more grid capacity, BESS, and OCGT will be required. This should be self-evident! Excluding OCGT seems to have an ulterior motive to "prove that RE is variable" – something that everyone knows, but which with complementary technology options can still create FIRM SUPPLY.

In Conclusion:

We believe that the IRP in its current form is not only seriously/fatally flawed, but inadequate to meet the energy challenges of South Africa.

A completely new process is required that eliminates artificial horizons, starts with a least-cost approach, uses transparent constraints to the model, has more accurate cost inputs – and then creates the appropriate scenarios which can, in the latter stages, be policy adjusted for elements not easily included in the IRP model itself.

NOTE: Grid constraints CAN be modeled in PLEXOS, so that is not one of the external constraints.

Our responses as per the DMRE framework is detailed below:

1. General Comments on the IRP 2023

1.1. IRP Glossary of Terms

Page iv: Glossary of Terms:

a. DMRE, no mention of Minerals
b. OCGT is not typically used in emergency periods, it is typically used in peak periods.

c. REI4P does not include non-renewable energy sources up to this point in the procurement history of SA
d. SSEG generally is below 1 MW

1.2 Page vi: CCGT is combined, not closed, cycle gas turbine.

1.3 Page 1: Clean coal is not commercialized or ready for large-scale deployment. The same for small modular reactors. These should not be options in 2023.

1.4 Page 2: Gas

e. OCGT should be included under Gas
f. Should run scenarios when no gas is available and have to run on diesel

1.5 Page 3: Hydro

g. Run-of-river (not *run-off river*)

1.2. IRP in Context

(Please provide any general comments on the context the IRP should take into consideration, that you think is not captured in the draft IRP)

- TDP and grid

Transmission availability. Has the lack of connection capacity been used as a boundary condition in the model in the early years? It's well known that the current TDP includes 14,000km of transmission lines to be built between 2024 and 2032 with about 3000km by 2027 and a rapid acceleration plan of 11,000km from 2028 to 2032. How is this taken into account (or not taken into account) with regard to the different technologies?

- Behind the meter generation and wheeled power:

It is not clear how behind-the-meter generation and wheeled power will be accurately stripped out of the demand forecast to arrive at the residual demand to be supplied by Eskom (or in the new envisage restructured market the ITSMO.)

- The Cabinet approved of the Green Hydrogen Commercialisation Strategy (GHCS) on October 19, 2023, which underscores a firm commitment to advancing green hydrogen. How is the impact of Hydrogen as an impact on demand taken into consideration? The GHCS emphasizes the integration of this strategy into the IRP through the integration of wind and solar capacity (specifically wind and PV) to support Green Hydrogen development.

1.3. Role of the IRP in a liberalised market

(Please provide any comments on the role of the IRP in a liberalised market)

As per the envisaged liberalisation of the market we will transition gradually (over a 5-year period) toward competition, especially in the generation part of the value chain in SA. In this period more and more private generation under Schedule 2 of

ERA will be established[4] and will take over part of the need currently envisaged by the IRP. Most important to note in this period will be the need for a growing need for capacity, ancillary serviced and the balancing of the market and even a possible capacity market. The need to have a formal IRP determination bid rounds will gradually became less and less as the market takes the challenge up over time.

It is thus important for the SA Government not to embark on generation plans that cause some stranded investment that will burden the affordability of supply to the SA population.

1.4. IRP in relation to other government policies and plans

From a policy point of view, we do believe that there should be consistency between the various policy related documents – a consistency, integration and interdependency that is absent in the IRP, that needs to be incorporated in the new modelling. The following documents should speak to each other:

- IRP2023,
- The Electricity Regulation Amendment Bill (2023),
- The Electricity Pricing Policy (2022),
- The Transmission Development Plan (2023-3032),
- The DFFE's Minimum Emission Standards (NEMA 1998),
- The Just Energy Transition Framework (2022) and JET Investment Plan (2022), and
- other sector policies such as the Green Hydrogen Commercialisation Strategy (2023).

[4] It is reported that there is a huge pipeline of projects (around 10GW plus) – mostly VRE. As regulatory barriers are removed, the national wheeling framework established risk will diminish and more bilateral, PPAs and direct market participation will follow. The need of and IRP and determinations as currently contemplated in ERA will change.

2 EC_IRP 2023 Framework

<table>
<tr><th>IRP Reference</th><th>Broad sections of the IRP</th><th colspan="2">Please provide comments on the following</th></tr>
<tr><td colspan="4">1.1. GDP and Economic Indicators
(Please provide comment on the assumptions of GDP & economic indicators used in the IRP)</td></tr>
<tr><td rowspan="3">Electricity demand projection model ESRG SANEDI Report Rev 1.pdf doc
(Pg 12 – 13)</td><td>1. The assumptions on the electricity demand forecast. Are the projections realistic?</td><td>YES</td><td>NO X</td></tr>
<tr><td>2. If the selection above is No, provide reasons for your answer.</td><td colspan="2">• It is incorrect that loadshedding ends only when the Eskom EAF improves. The plan (IRP) needs to have a resource mix going forward taking SA out of the energy shortage – not plan for energy shortages. The IRP need to take the worsening Eskom EAF into account. Details of this is available on the Eskom generational forecast portal. Cannot build the plan on an unrealistic improvement of the IRP.
• New generation from unproven resources or very expensive resources (like the LNG prices) are incorrect and unrealistic assumptions in an IRP.
• The TDP availability are not taken into account in the IRP.
• Embedded generation and behind the meter development are taken on in the supply side. This is incorrect as it decreases demand - not improve supply. The figure of some 900 MW is vastly incorrect- see Eskom's calculations of 5,4GW in this regard.
• Demand from green hydrogen initiatives (as per the Governments plan on this) needs to be taken into account in the IRP. Government cannot have different plans that does not speak to each other.
• Electricity demand in the IRP 2023 is based on a projected upward economic growth trajectory over the period of the analysis. A high growth scenario is utilised in the IRP 2023 economic scenario. The model assumes economic growth above that of the IDC's January 2024 economic projections and higher than that achieved in the past.</td></tr>
<tr><td>3. Suggest alternatives to the proposed projections with details.</td><td colspan="2">• Rather use the NT economic outlook that indicates that the GDP will/ may recover from 2025 – if electricity generation capacity picks up. Also include the green hydrogen initiative. The energy demand (in TWH) is much too optimistic- we do believe that the 2029 forecast was much more realistic.</td></tr>
</table>

		• With the new market and private sector initiatives the amount that the" national IRP" need to provide will be declining and the projected line in figure 2 of the IRP is by far too optimistic. • The IRP should indicate the need to facilitate the construction of transmission lines and private initiatives in this regard.
1.2. Technology Choices & Costs ***(Please Provide comments on the assumptions of energy technology costs)***		
Section 1 (pg 1 to 6) **Section 4.5** (pg 15 to 17) **Annexure C** (pg 33 to 39) **Reference study** Supply-Side Cost and Performance Data for Eskom Integrated Resources Planning 2022-2021 Update	4. Solar PV	• The costs used in the IRP is by far too high for Solar PV if compared to the latest Bid rounds and international benchmarks. (see the detail cost comparisons of Meridian in this regard) • What capacity factor assumptions are used for Solar PV? • These costs need to take learning curves into account – not transparent mentioning was made of this.
	5. Concentrated Solar Power	CSP is not used around the world anymore due to the cost of that vs PV solar and BESS. Cost in terms of international benchmarks by far too optimistic in the IRP. It should not have been considered at all. Solar PV+ BESS cheaper alternative.
	6. Wind	• The costs used in the IRP is by far too high for wind if compared to the latest Bid rounds and international benchmarks. (see the detail cost comparisons of Meridian in this regard) • What capacity factor assumptions are used for Wind?
	7. Battery Energy Storage System	• No learning rates for BESS -this is not aligned with multiple global forecasts of renewable energy cost trajectories. • The cost levels used for BESS in the IRP, against the last IPPO project, as well as reported learning rates for BESS (and recently published figures in this regard) indicates a complete incorrect choice/ approach used in the IRP[5]. • There is also no indication of how the report is arriving at the allocations, particularly the 2000 MW of BESS.
	8. Pumped Storage	• We are aware of some private (smaller) sites - such determinations should be included in the IRP. • Pumped storage projects are challenged by their long lead times. Consideration should be given to spend limited funds for the initial

[5] There are multiple cost references available including real time cost for developers. These are freely available – we do not also supply these as we are confident that the modelers must be able to access these and not only the EPRI (seems to have been primarily used)

		development of some large pump storage projects (e.g. Tubatse), to give SA the option to implement those projects in a shorter lead time in future IRPs. Pumped storage and similar large storage projects could have an important role to play as South Africa decarbonises.
	9. Compressed Air Energy Storage	N/A
	10. Green Hydrogen Gas	• Longer term planning needs to incorporate the ambitions in the green hydrogen commercialisation strategy and specifically the integrations with grid expansion and modernisation issues.

	11. Gas	• Although positive to consider GAS due to some recent discoveries and other initiatives it is too early to use this as firm in the IRP:
		• However, to fully capitalise on this potential, structural and regulatory reforms are imperative.
		• Prices used for gas is unrealistic as we do not have the infrastructure as yet to supply these quantities.
		  ○ FSRU requires extensive development over time- 2 year + leases etc
		  ○ Regasified LNG via connected via existing or new gas transmission pipelines to the generation sites is still long into the future.
		  Unless more certainty cannot take this into account in an IRP plan.
		• Worldwide LNG price volatility on LNG gas prices (linked to oil) with a rising indication(especially in Europe)
		• The load factor used for gas – 50% is too high taken into account the current coal fired fleet. With an increasing VRE this will change over time. IN a lower load factor regime gas would be more for peak periods rather than the way it was modelled. The gas load factor needs to be corrected for the different period for what it will be used.
		• We could not find alignment with the regional gas master plan (RGMP).
		• Is the 1 220 MW of new gas capacity procured, coming online in 2025 in the Emerging Plan referring to Karpowership projects?

	12. Nuclear	• We are of the opinion that the choices around unclear is more around emerging technologies(SMRs) and very large sites. • In the former this is unproven technologies and as far as the latter large similar scale has always had huge overruns in capital cost with long delays. • Again the comparison costs that was used for this in the modelling are unrealistic optimistic- overruns and real comparisons should be used to correct the cost used.

	13. Coal	• No explanation of the operational constraints and flexibility requirements of the existing coal fleet given that increasing share of renewable energy would result in low capacity factors of the coal fleet, • If the unavailability of the current coal fleet and its unpredictability (see Eskom announcement regarding this) is taken into consideration, as well as the emissions problem that needs to be fixed, re cost- the cost figure used (much lower capacity factor) is too low. Needs to be corrected • What was the assumed coal price and coal thermal efficiency used in the modelling? • What emissions factor assumptions are used for, coal and how does the IRP taken into account the current emissions inadequacy? • and industry appetite to invest in coal-fired power. •
1.3. Environment, Climate Change & Security of Supply Nexus ***(Comment on the assumptions of environment, climate change & security of supply nexus)***		
Section 3.5 (pg 10 to 11) **Annexure C** (pg 38)	14. Stakeholder to provide comments on how South Africa is progressing on climate change commitments.	• The emission from the Eskom power stations is not in control and does not meet the required standards. This will have a significant effect on the available generation and needs to be considered in what is real long-term availability from the fleet. • It is not clear whether the IRP2023 has taken into account both the cost and loadshedding implications for Eskom to comply to the DFFE's Minimum Emission Standards.
	15. Stakeholder to provide comments on how South Africa can balance objectives on reducing carbon emissions whilst ensuring energy security.	• In our model, which is aligned with what many of the competent independent experts have shown, we have achieved a much larger share on RE, allowed for more storage (BESS and other forms), required high capacity of OCGT (with decreasing utilisation), and have decommissioned the fleet to a much larger extent (which also enables optimum utilisation of the coal fleet – including enabling long-enough outages to ensure higher EAF of the units underpinning power supply for many years while new capacity is built. • This fundamentally addresses the requirement for energy security, job created through new-build projects, localisation of manufacturing, and the resultant economic growth and flourishing of people, and also the carbon reduction requirements. See **Appendix 1** for a modelling exercise as an alternative IRP – as an illustration of what can be achieved.

Commented [AvdM2]: Add here Clyde's model results

1.4. Horizon 1 (up to 2030): Reference & Scenarios *(Please provide comments on the five scenarios considered on Horizon 1)*		
Section 5 (g 18 to 23)	16. Firm Initiatives	• No clear explanation as to what the "Emerging Plan" is in Horizon 1 and how it was derived at, But this plan - results in load shedding (4.6-13.1TWh per annum between 2024 and 2027). **It fails to meet the security to supply objective.** • In both Horizons, it appears that new build constraints were applied as the outcomes across all scenarios show clearly that solar PV could not exceed 900MW per annum up to 2050. • No mention of impact due to programme delays. Many RMIPPP projects have not reached FC and others have environmental problems. Many others do no longer have grid capacity allocation. This need to be taken into consideration to have a realistic plan. • In all five scenarios we will have loadshedding - except for the 5th with the unrealistic assumption of the EAF~ 70%. Such a plan in our opinion is not an IRP and must have alternatives to have supply security • The Least-Cost (Pathway 1) builds wind, solar and high load factor gas. It is unclear to what extent the modelling constraints *<u>are forcing a high load factor of the gas fleet</u>* as not enough transparency around the modelling constraints have been provided. *<u>High load factor gas is not consistent with the outcomes of the IRP2019 Least-cost plan</u>*, justifying a more thorough explanation of the results. • This Renewables-only scenario (Pathway 2) has a very strange outcome of building large amounts of CSP as opposed to the much cheaper combination of Solar PV and BESS. Looking at the results, this is likely a result of the new build limits applied to solar PV (900 MW/y), in combination with very high cost assumptions for new build solar PV and BESS (with no learning curves attached to these). • The document states that Pathways 2 and 3 "sought to explore the impact on security of supply". Our opinion is that this is *<u>a fundamentally flawed objective in a capacity expansion model as the security of supply is a function of the energy modelling adequacy specifications</u>* (user defined). A properly conducted IRP study would ensure that the same level of security of ***<u>supply is achieved across all scenarios</u>***. If the scenario resulted in an inadequate level of security of supply, this is a failure of the modelling approach used, *<u>likely caused by an impossible boundary constraint where sufficient new build</u>*

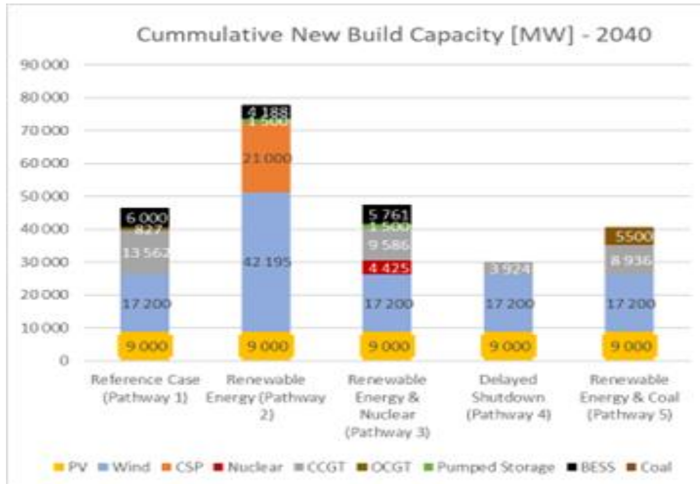
		capacity was not allowed[6], failure to run production cost modelling after the capacity optimisation, inappropriate reliability criteria and/or an inadequate understanding of the impact of reduced chronological sampling in PLEXOS. It is quite alarming that this crucial modelling input seems very poorly understood and utilised. • The outcomes of the nuclear scenario (Pathway 3) show very minimal *new build of flexible capacity with large new build nuclear fleet (low flexibility) and a three-fold increase in wind capacity (low flexibility)* in the last decade as opposed to the reference scenario. Pathways 2 and 3 are also vastly different in capacity mix and expected energy shares (not shown) by 2040. **Our view is that this is not logical and needs serious reconsideration.** •
	17. Reference	• The Eskom EAF does not align with Eskom 's own generation outlook and is unrealistic. The IRP is not clear in the description of the different scenarios (Section 2.5)
	18. Firm Initiatives and All-Initiatives	• It is not about the initiatives that have already surfaced, but rather to model *what is required*!
	19. Firm Initiatives and Gas	• Ditto.
	20. Firm Initiatives and Recovery	• Eskom's plant EAF of 70%+ considered in 2019 IRP was deemed unrealistic by many at the time, and now a high figure is used again. We cannot see that this will work and that such an assumption (hope) is risky for the country to base an IRP on. • Considering that Eskom's fleet is ageing and the reduced time for extended programmes of planned outages due to load shedding as well as Eskom's limited maintenance capability, a scenario that follows the current Eskom plant

[6] This refers to both methodology concern in the IRP as well as an outcome under scenario 1. Methodology inadequacy results in challenges in the scenarios. In our opinions the wrong outcomes are derived due to a wrong methodology approach and/ or wrong costing. We trust that these points come over clear.

		EAF decline should be considered. The gap created in generation supply by the reduced Eskom plant performance needs to be catered for by renewables, BESS (or other storage), gas to power, etc.
	21. Comment on the observations and proposed interventions in Horizon 1.	• Horizon 1 present a situation where SA remain in darkness due to unserved power and is characterised by reduced capacity additions from renewables. We believe this is not a realistic transition and does not meet the normal IRP requirements and should not be like that at all. • Further the reduced new capacity from wind and solar undermine the country's overall decarbonization plans. The role of gas should be seen as a transition fuel, coupled with VRE to provide flexibility, and not to replace procurement from wind and solar. The GCCA used in the IRP 2023 is outdated and has been updated by Eskom. • **It's simply not correct that loadshedding can only be reduced by dispatchable technologies- please see IRP plans of Australia and others around the world in this regard, how their VRE as a ratio in their mix looks and what is in their pipeline. If need be, we can provide this – but there were many seminars in SA the last couple of months in this.** • BESS allocations tail off after 2028 and the IRP is unclear on why this approach was taken. BESS represents an easy way to make more capacity available on the power grid while increasing penetration of renewables. • The assumptions that the decline of Eskom EAF will settle or improve have not been substantiated. The scenarios created do not consider that the declining trend may continue (As it has since the previous 2 IRPs). • The IRP is silent on the assumption regarding energy efficiency. Energy efficiency is a DSM intervention that should not be ignored but must rather be brought to the fore/ prioritised. • We will provide under horizon 2- other scenarios examples of reference modelling in this regard across the complete planning horizon.
1.5. Horizon 2 (2031 - 2050): Energy Pathways (Scenarios) ***(Please provide comments on the guiding principles and the energy mix of each energy pathway considered for Horizon 2.)***		
Section 6 (pg 24 to 27) **Annexure C** (pg 33 to 39)	22. Reference	• *No scenarios give any figures of the cumulative installed capacity (including cumulative decommissioning) and there is thus no indication of the actual installed capacities per scenario in the 2030+ horizon*. As an energy plan- woefully inadequate and cannot be used as such and need to be rectified in the new/updated modelling.

		• Additionally, wind capacity looks to be constrained between 2031-2040, where no more than 17.2 GW cumulative was allowed across all scenarios. Both from a modelling and practical perspective it does not make sense that the same amount of solar was built in all Pathways despite vastly different technology constraints. • *No graphs included on hourly dispatch profiles per technology to demonstrate representative weeks from each of the modelling scenarios* – this would provide valuable insights into how the supply/demand balance looks for the different technology mixes. Without this there is no evidence of any balance in the scenarios. We do recommend that this be added in the update scenarios. • Figure 20 shows the unserved energy per scenario*. Here it is evident that the modelling approach is deeply flawed* (see previous comments on this topic) *as significant differences in UE can be observed across scenarios*. Similarly, the comment in Section 6.2 **stating that a renewable energy pathway does not result in security of supply cannot be supported if compared by previous work done by the CSIR and in other studies around the world.** • Figure 20 of IRP (P37) shows the unserved energy per scenario. Here it is evident that the modelling approach is deeply flawed (see previous comments on this topic) as significant differences in UE can be observed across scenarios. Similarly, the comment in Section 6.2 stating that a renewable energy pathway does not result in security of supply cannot be supported by the work that was done. • Pathway 4 is a delayed coal shutdown scenario. It is unclear *what cost assumptions were assumed in extending the life of the coal station*s but there seems to be an increase in total system cost relative to the Reference scenario (Figure 22) attributed to a *three-fold increase in fixed costs.* Overall CAPEX and Variable costs were reduced resulting from delayed new build capacity and lower capacity factors of expensive-to-run gas plants. • Pathway 5 is essentially Pathway 1 with the allowance of *clean coal technologies. It is very odd to see such an expensive technology being chosen as part of the energy mix,* seemingly replacing BESS and gas. There is however no mention of clean coal being forced into the plan. Comparing Pathway 3 and 5 also seems to indicate strange results. One cannot make any logical sense of the outcomes, as not enough information has been provided.

	23. Renewable Energy	We believe that the use of RE in completely inadequate in this horizon as it stems from the fact that the wrong cost assumptions are used. (see our reference modelling in the late section in this review)
	24. Renewable Energy and Nuclear	• Renewables+ BESS comparison to nuclear: we fail to see the choice of nuclear vs PV Solar + BESS. For example, let's take the nuclear + renewables + storage scenario. Due to its high capital cost and low fuel cost, nuclear plants can normally only produce cost-competitive if they are running in baseload mode, i.e. 100 % output. The problem is that ramping the nuclear power output down to compensate for increased solar and wind production when the sun is shining and the wind is blowing will reduce the annual power output of the nuclear plant without a substantial corresponding reduction in fuel cost. This will result in an increase in the nuclear power cost per kWh. • Our opinion is that the nuclear cost vs VRE+ BESS is not correctly modelled to yield this scenario – only if the scenario is forced in the model can it be achieved in this manner.
	25. Delayed Shutdown	• Delayed shutdown should only be considered while insufficient new-build capacity can be constructed. • The costs and benefits must be clearly articulated (starting with reduced loadshedding in the near-term). • More jobs can be created by building new capacity than can be saved by keeping the old plants going.
	26. Renewable Energy and Coal	• Eskom's new build plants have been constructed with design flaws. It is unrealistic to assume that they will be able to maintain high performance factors over long periods of time. Scenario's considering irregular performance in new build plants needs to be considered so that the gap can be filled by other energy technologies.
	27. Comment on the energy mix of each energy pathway.	• As can be seen in the graph below it is evident that Solar PV is constraint across all the scenarios, wind seems to be lifted for only Scenarios 2 with no indication of how the coal fleet operates. It does not make sense that the same amount of solar is built in all pathways despite of different technology constraints. • The mix is thus vastly incorrect and should not be used going forward.

		
	28. Comment on the guiding principles informing the pathways.	From the above it is clear that the guiding principles guiding the pathways is woefully incorrect and inadequate
	29. Comment on the observations in Horizon 2.	VRE is also constraint in this horizon whilst other technologies have been given preference resulting in unnecessary high cost not achieving the required IRP result of meeting GHG and energy security at least cost. Out view I that this horizon and all pathways will have to be redone taking the correct cost assumptions into considerations not constraining the model against VRE's+ BESS.
	30. Propose additional scenarios and energy pathways to be considered.	From this observation it follows that the following two outcomes should at least be tested: • Model scenarios of no constraint VRE's+ BESS.

1.6. Grid: Transmission & Distribution ***(Please provide comments the new build outcomes from the analysis in the IRP, as far as the transmission and distribution grid capacity is concern.)***		
Section 3.7 (pg 11) **Section 4.4** (pg 15) **Annexure A** (pg 30-31) **Figure 5** (pg 15) **Figure 12** (pg 31) **Study References used** Eskom, “Transmission Development Plan (2023-2032) Eskom, “Transmission Generation Connection Capacity Assessment of the 2024 Transmission Network (GCCA 2024); March 2022	31. Critically analyse the outcomes of the scenarios and energy pathways in relation to the transmission and distribution grid availability.	• It is welcomed that there is a focus on the transmission grid in IRP2023. • But **how was the TDP** (up to 2032 and beyond) translated into modelling constraints given that a single node model with no spatial disaggregation was used in PLEXOS? No evidence is provided in this regard. If not used correctly, it leads to wrong *(artificial outcomes) in modelling scenarios.* The latter seems to be evident in various of the scenarios, • Was curtailment modelled (or not modelled)?

Eskom, "Medium-Term System Adequacy Outlook", October 2022 NERSA SAGC, The South African Grid Code System Operation code, Rev 10, 2022		
1.7. Methodology & IRP Development Process ***(Please provide comments on methodology & IRP Development Process)***		
Section 2 (pg 7 to 8) **Section 3** (pg 9 – 11)	32. Comment on the frequency of the IRP review.	• Every 2- 3 years a review on the previous is necessary – but not a 100% deviation from previous plans to start almost afresh.
	33. Comment on the IRP methodology.	• General: The IRP should outline a country's power strategy and provide clarity on such a strategy and the diverse range of technologies that can be adopted. It does *not do so in addressing the issues of energy security; cost of energy, GHG and sustainability*. It should take a long-term view with clear and transparent descriptions of the different terms. • We would like to point out that the description of the methodology does not capture the necessary detail to describe the modelling process that was followed as an energy system model is optimised over a *long-term planning horizon*, and it is often necessary to start deploying new capacity years before large "chunky" decommissioning takes place (i.e. large unit coal stations), especially when annual new build limits are enforced. • As mentioned above, we believe the 2 horizons are flawed as that would *not allow the model to incorporate/ foresee major decommissioning in the coming decade.* By having this spilt, it results the model to force large chunks of new capacity straight away instead of rolling out a smooth "realistic" deployment of new build. In our opinion and from learnings around the world such an approach is flawed.

		• A further core aspect that needs to be carefully considered in a capacity expansion plan is that of ***system adequacy***. Any capacity expansion plan must adhere to an acceptable level of system adequacy. How operating reserves and reliability requirements[7] are taken into consideration, have a major impact on the capacity optimization and should thus be transparent. The document is silent on this critical aspect.
		• In our view the IRP lacks on critical modelling assumption like the following:
		    ○ As higher penetration of RE takes place temporal resolution of the modelling and how sampling of timesteps was dealt with need to be evident,
		    ○ There is uncertainty between when a ***production cost model*** was used and when a ***capacity expansion model*** was used or whether there was any feedback loop between the two models. The latter is critical for a correct outcome,
		    ○ How was the ***spatial aspects of wind and solar PV production profiles considered*** given that a single node model with no spatial disaggregation was used,
		    ○ What was the ***reliability criteria*** assumptions, such as the enforcement of a ***minimum reserve margin*** and the allocation of firm capacity to different technologies,
		    ○ Clarity on the ***lead times*** for new build capacity,
		    ○ The assumed cost of unserved energy and the weighted average cost of capital (WACC) – critical in our opinion, not transparent and evident in the model
		• There is no mention of the actual energy storage amount per plan. ***It is basically flawed to report BESS in only a MW number - the MWh storage capacity of the technology needs to be stated as well.***
		• No graphs showing the ***energy generated per technology.*** This is the ***fundamental outcome of any energy system modelling study***. It is well known that the energy mix cannot be determined based on installed

[7] See CSIR/Meridian study on this.

		capacity alone and the IRP document in our opinion is thus woefully inadequate in its current reporting of scenarios.
1.8. Studies on Emerging Technologies ***(Please recommend any references to studies on emerging energy technologies that you deem important to inform some of the assumptions made on the development of the IRP to bring it to the attention of the DMRE.)***		
		N/A
1.9. Gas to Power load factor ***(Please provide any comment on Gas to Power load factor and supply chain implications)***		
• It is not sensible to assume a certain quantum and load factor for gas to power as an input to the model. The least-cost should be modelled, and then the gas supply chain challenges (which are acknowledged as they are well known) should be assessed from that starting point. Scenarios for varying supply options should then be developed to critically assess the gas supply challenge. Only then can the veracity of the modelling approach be defended, and a useful outcome achieved to work on the detail of gas supply options – including imported LNG, local gas, etc.		
1.10. Coal Decommissioning strategy ***(Please provide any comment on Coal Decommissioning strategy)***		
• There are serious questions about the new coal decommissioning schedule outlined in the document: ○ Questionable that Eskom can make investments to ensure compliance with legally stipulated minimum emissions standards (MES), or ongoing concessions, which carry serious health consequences. In addition, the power station's units need to be offline while the abatement retrofits are being installed - this will increase the amount of loadshedding unless/until additional alternative capacity is also installed. It is unclear how the costs of the retrofits and the increased loadshedding were accounted for in the IRP modelling. ○ The document does acknowledge this indicating that a balance will have to be found between energy security, the health impacts and economic cost of early shutdown. ○ In the new market (see approached ERA by the National Assembly) the old responsibility of Eskom as supplier of last resort disappears – it's highly unlikely that this vision will play out. • The plan to delay coal plants shutdown needs to align with the air quality policy. Instead of speaking about shutting down, there should be consideration for conversion to gas as many of the older stations are close to gas lines. • In the "delayed shutdown" scenario (delaying the shutdown of 5 key power stations), which five stations (and their units) are extended and by how long?		

1.11. CBAM Implications *(Please provide any comment on the impact of CBAM)*
• There are very serious hurdles on the horizon for exporters, and on the job numbers that could be shed if these exports cannot thrive (and indeed grow). South Australia is becoming a magnet for green industrialisation, which major opportunities for job creation and local manufacture.
1.12. Eskom EAF ***(Please provide any comment on Eskom EAF recovery and sustainable performance)***
• See the various other notes and comments on the unrealistic EAF assumptions. In previous IRP the same approach was followed with the disastrous effect of increasing loadshedding in SA. Let's not make the same mistake.
1.13. Technology learning curve ***(Please provide any comment on Technology learning curve)***
• The complete omission of learning rates implies uncertainty around cost assumptions, yet no sensitivity analysis was performed on cost assumptions. It is modelling best practice to perform sensitivity analysis to understand the impact of uncertain assumptions. Strongly recommended that this be added in the updated IRP
1.14. EPC challenges and capacity ***(Please provide any comment on impact of EPC challenges and capacity)***
• A realistic assessment of the current EPC constraints should be made – with evidence to support it. • More importantly a study is required that established how quickly such capacity can be redeveloped as demand grows and definitive demand signals are created. • **It is <u>fatalistic</u> to assume that the current constraints continue beyond a year or 2.**
1.15. How can the development of the IRP be improved? ***(Please provide any further ideas or comments that can assist the DMRE to improve the development of the IRP)***
• Look at the many "private" IRP modelling efforts that were done, and made publicly available, as well as those done by public sector institutions such as the CSIR. Please compare that and to previous versions (like 2019) and IRPs around the world. Our challenge with the outcomes is evident. • There should be increased transparency and the PLEXOS model used by the DMRE to model the IRP2023, which should be made available.

Appendix 1 – see separate file