CENTRE FOR RENEWABLE & SUSTAINABLE ENERGY STUDIES

Stellenbosch UNIVERSITY IYUNIVESITHI UNIVERSITEIT

Comments on the IRP 2023

A review of the Integrated Resource Plan 2023 by the Centre for Renewable and Sustainable Energy Studies

22 March 2024

science & innovation
Department:
Science and Innovation
REPUBLIC OF SOUTH AFRICA

Eskom

Background

The Minister of Mineral Resources & Energy, Mr. Gwede Mantashe, published the Integrated Resource Plan (IRP) 2023 for public comments in the government gazette on 4 January 2024. Interested persons and organisations were invited to submit comments on this IRP to the Director-General of the Department of Mineral Resources & Energy (DMRE) by 23 March 2024.

Comments from the Centre for Renewable and Sustainable Energy Studies (CRSES) are compiled in the present document, based on a review of the gazetted IRP 2023 as well as all supporting documents published on the DMRE website by 20 March 2024.

Methodology

The IRP is primarily based on a complex energy model. As such, the input data and assumptions that are fed into this model are critical, as these directly influence the model's results. So, for example, changes to one or two key input assumptions can reallocate billions of rands of planned future investments between different generation technologies, with significant future cost and emissions impacts.

With this in mind, CRSES researchers initially planned to review the IRP 2023 using the following methodology:

- extract the input information that was chosen by the DMRE to inform the modelling on which the IRP outcomes are based, and
- where this chosen information proves to be contentious (either from CRSES's perspective or within the public IRP debate), utilise unbiased reviews of international sources as well as CRSES's own research and modelling results to improve the accuracy and quality of the public debate, and to strengthen the IRP process and outcomes.

However, after a detailed review of the IRP 2023 it became clear that very little information on key input data and assumptions was supplied, and in several cases where information was supplied, it was contradictory or inadequately detailed to critically engage with.

CRSES researchers engaged with their research networks and ultimately the DMRE modelling team to try and resolve this challenge. Although these engagements were valuable, CRSES could only comment on the IRP documentation gazetted or provided on the DMRE's website. ***CRSES therefore concluded that meaningful comment on the IRP 2023 modelling outcomes is not possible given the lack of input information provided by the DMRE.***

The planned methodology was subsequently changed as follows to support the DMRE in validating the input assumptions of the next revision of the IRP, and to support future IRP review processes:

- provide a basic framework of minimum input information that would ideally need to be provided by the DRME to support the credibility of the underlying modelling, and
- use this framework to engage in a conversation with peers in the modelling community, towards identifying where existing information can be shared and establishing where further research is required. A colour coding scale was defined to rate the quality of the information provided in the IRP 2023, defined in Figure 1.

QUALITY OF INFORMATION PROVIDED	
	Information provided with sufficient detail or sources for critical engagement and modelling
	Information provided with insufficient detail or sources for critical engagement and modelling
	No information provided
	Contradicting information provided
	N/A

Figure 1: Description of the colour coding defining the quality of information provided, used in the review of the IRP 2023 provided input information.

Proposed framework, and review of IRP 2023 information

The proposed basic framework of minimum input information, which the DMRE could provide publicly towards supporting the credibility of future IRP modelling, is shown in Figures 2 to 5 (the original Microsoft Excel file is provided with the present document). Comments on the quality of information provided by the IRP 2023 are also provided. The framework groups the following information together:

- Model information, which covers important aspects influencing the behaviour of the model itself.
- Projections information, which focuses on the projected or forecasted growth / trends of various components of the model.
- Generator technology information, which focuses on the cost, emissions and technical performance characteristics of the generators included in the model.

The comments in the frameworks below reference the following sources, as provided by DMRE[1]:

[1] EPRI Report: Supply-Side Cost and Performance Data for Eskom Integrated Resource Planning (Jan 2021 base year for cost, provided in "New Tech assumptions Integrated Resource Plan, 2023")
[2] Lazard, April 2023 (provided in "New Tech assumptions Integrated Resource Plan, 2023")
[3] DMRE (provided in "New Tech assumptions Integrated Resource Plan, 2023")
[4] Eskom (provided in "New Tech assumptions Integrated Resource Plan, 2023")
[5] Demand Projection Model in Support of IRP Update 2023 – Energy Systems Research Group, University of Cape Town

[1] https://www.dmr.gov.za/news-room/post/2150

Model Information	Comments	Status
Technology options	Information on which technology options were selected within broad categories has not been supplied(was OCGT or SCGT or CCGT selected under gas; Was thin film or multi-crystalline single axis tracking selected under PV).	
Cost of Unserved Energy	The report does not provide this value. However, if the cost from "Cost of Unserved Energy 5 Year Review and 2020 Update" released by Eskom was used, there is a concern that the cost to business enterprises may be vastly overstated given that the cost to any business with backup diesel generators should simply be costed close to the R8/kW cost of this back up generation.	
CO2 Cost	A rand per ton penalty for CO2 is supplied. However, the information required to calculate the tons of CO2 released (fuel composition and plant heat rate) is not provided.	[3]
Curtailment Penalty	This can possibly be obtain from purchase cost data if that is supplied with sufficient granularity, but this is not currently the case.	
Demand Side Management	Information on method of implementation and associated costs is not supplied.	
Demand	This supplied at a sufficient level to align modelling efforts, but it would ideally be provided with hourly sectoral profiles.	[5]
Build Constraints	Details on the build constraints that were implemented during the modelling process are not disclosed. Annual build constraints appear to have been applied in the least-cost expansion plan. Why were artificial constraints on RE generation capacity, leading to unserved energy, implemented instead of unconstrained modelling (especially for Horizon 2)?	
Discount rate		
Temporal resolution	Was every year modelled in Horizon 1? What intra-year time sampling was utilised in Horizon 2?	
Nodes	Not explicitly provided.	
Transmission cost assumptions	Not explicitly provided.	
Transmission build-out assumptions	Not explicitly provided.	

Figure 2: Proposed framework for sharing of model information, which covers important aspects influencing the behaviour of the model itself. Comments are included here on the quality of the information shared by the IRP 2023.

Projections Information	Comments	Status
Demand projection scenarios & energy balances	What is the motivation for the choice of a single demand profile given the historic inaccuracy of demand growth projections (previous IRPs have always considered at least three demand pathways)? Should the impact of green hydrogen on demand not be considered?	[5]
Embedded Generation	What is the details on the origin of the projection that is used. What is the technology make up for this anticipated imbedded generation?	[4]
Electrification rates	What assuptions are being made for electrification of transport, industry etc.?	
Green hydrogen and PtX projects	What is the rationale & implications of exclusion given that according to the Green Hydrogen Commercialisation Strategy gazetted in 2022: “a number of GH2 projects are considering funding of the grid infrastructure as part of the overall project funding, increasing affordability and accelerating grid development. GH2 projects could serve as an enabler to grid strengthening allowing for more RE projects to be connected for electrification.” Even if additional RE capacities must be installed by H2 developers, wouldn’t one need to analyse what impact those new builds have on local grid and transmission capacities (unless all GH2 projects are required to be off-grid and wheeling is excluded)?	
Commercial availability	What is the feasibility of clean coal and new small modular nuclear as candidate technologies/options in 2023 - are these commercialised/ready for large-scale deployment?	

Figure 3: Proposed framework for sharing of projections information, which focus on the projected or forecasted growth / trends of various components of the model. Comments are included here on the quality of the information shared by the IRP 2023.

Generator Information	Level of detail required	Comments	Existing Plant									New Build													
			Coal	Nuclear	OCGT	BESS	Pumped	Hydro	Wind	PV	CSP	Coal	Nuclear	Repurpos	OCGT	CCGT	SCGT	BESS	Pumped	Hydro	Wind	PV	CSP	CCUS	Hydrogen	Biomass
Cost																										
Fuel Cost	Ideally this information is required at per station basis, but there are valid concerns about commercial information. Cost per fuel type would be an over simplification. A reasonable compromise might be to provide average values for 3 categories per fuel type with list of stations that fall into each.	The plan calls for a lot of gas, but supporting documents have a single fuel price assumption. Some analysis of (or reporting on already executed analysis of) the sensitivity of the plan to fluctuations in the gas price is needed.										[1]	[3]	[3]	[1]	[1]	[1]							[1]		[1]
Fixed O&M	For the most part rand per kW installed value by technology, but it would be useful to distinguish within categories with large disparity in costs (e.g. 2 costs for CSP for trough and tower plants or 2-3 cost groupings for various coal plants).											[1]	[3]	[3]	[1]	[1]	[1]	[2]	[4]		[2]	[2]	[1]	[1]		[1]
Variable O&M	Rand per kW produced value for each technology, distinguishing within categories when applicable (with high variability in costs).	Does the DMRE intend to adjust the O&M cost of gas power plants considering the significantly higher load factors compared to the assumptions used by EPRI?										[1]	[3]	[3]	[1]	[1]	[1]	[2]	[4]		[2]	[2]	[1]	[1]		[1]
Capital Cost	Cost per kW installed per technology type.											[1]	[3]	[3]	[1]	[1]	[1]	[2]	[4]		[2]	[2]	[1]	[1]		[1]
Overnight cost												[1]	[3]	[3]	[1]	[1]	[1]	[1]	[4]		[1]	[1]	[1]	[1]		[1]
Lead times & project schedule												[1]	[3]	[3]	[1]	[1]	[1]	[1]	[4]		[1]	[1]	[1]	[1]		[1]
Expense schedule												[1]	[3]	[3]	[1]	[1]	[1]	[1]	[4]		[1]	[1]	[1]	[1]		[1]
Import costs	Import costs (from Mozambique & DRC)																									
Start Cost	This cost should distinguish between hot, warm and cold starts where relevant per technology. For coal plant the cost should be provided for each size category of plants in the system.																									[1]
Purchase Cost	The cost at which power is being purchased and agreements under which it is being purchased (i.e. must run conditions) for IPP power. If there is confidentiality concerns then group the IPPs by region or price should provide adequate information.																									
Learning rates		This requires consideration per technology, particularly for horizon 2. Using constant factor of 20.6% based on the CPI and ignoring cost learning, defies global trends.																								
Emissions																										
Emissions per kWh or per KJ fuel burnt	The same granularity as the fuel cost and heat rate data would be ideal, with the alternative being defining the data per technology type.	The DMRE raises Minimum Emission Standards as a risk with no indication how this will be managed. Please provide the approach to MES?										[1]		[1]	[1]	[1]	[1]							[1]		[1]
Starting Emissions	This information would need to distinguish between hot, warm and cold starts where relevant per technology. If the fuel consumption is already indicated under the start cost, this parameter can be calculated from that.																									

Figure 4: Proposed framework for sharing of generator technology modelling information, focused on the cost and emissions characteristics of the generators included in the model. Comments are included here on the quality of the information shared by the IRP 2023.

			Existing Plant									New Build														
Generator Information	**Level of detail required**	**Comments**	**Coal**	**Nuclear**	**OCGT**	**BESS**	**Pumped**	**Hydro**	**Wind**	**PV**	**CSP**	**Coal**	**Nuclear**	**Repurpos**	**OCGT**	**CCGT**	**SCGT**	**BESS**	**Pumped**	**Hydro**	**Wind**	**PV**	**CSP**	**CCUS**	**Hydrogen**	**Biomass**
Performance																										
Plant Life	The schedule on which production units are expected to shut down is supplied only for Eskom in the IRP, but Eskom is not the only entity running older generating plants.		[4]	[4]	[4]	[4]	[4]	[4]	[4]	[4]	[4]	[1]	[1]		[1]	[1]	[1]	[1]			[1]	[1]	[1]	[1]		[1]
Heat Rate	Single data points on unit efficiency supplied is on the Eskom website for some generating units. Ideally a heat rate curve per station should be provided for all fuel burning plants in the system. If not possible, groupings similar to that requested for fuel costs would be helpful.		[4]	[4]	[4]							[1]	[1]	[4]	[1]	[1]	[1]						[1]	[1]		[1]
Capacity factor (%)		Are all new build assumptions based on the EPRI report? What operational constraints were applied to the OCGT & CCGT gas generation in terms of min/max capacity factors? Above 80% capacity factor of peaking power station (diesel OCGTs) is very high. The highest annual average capacity factor for diesel peakers was in 2023 at 17%? Could the model rather limit the capacity factor/diesel available to determine the amount of unserved energy?										[1]	[1]		[1]	[1]	[1]				[1]	[1]	[1]	[1]		[1]
Cycle Efficiency	Round trip efficiency per station/installation.																	[1]								
EAF		It appears that the low EAF scenario does not contain a continuation of the declining EAF trend. Does this incorporate poor performing/older coal power plants coming offline, which improves the EAF?	[3]	[3]	[3]	[3]	[3]	[3]	[3]	[3]	[3]															
Production Profiles	The hourly production profiles that are being used as input assumptions, as well as information on the technology selection, simulation method, timespan and actual years covered by the dataset is required.																									
Max Gen	This was supplied for most existing plant in the 2019 IRP, but should be included in the information issued in support of the 2023 IRP for completeness.		[3]	[3]	[3]	[3]	[3]	[3]	[3]	[3]	[3]	[1]	[3]	[3]	[1]	[1]	[1]	[1]	[4]		[1]	[1]	[1]	[1]		[1]
Min Gen	Information per power station would be ideal.											[1]	[1]		[1]	[1]	[1]	[1]	[4]		[1]	[1]	[1]	[1]		[1]
Starting Ramp Rate	Information per power station would be ideal.																									
Operational Ramp Rate	Information per power station would be ideal.																									
Planned Outage Rate	Information per power station would be ideal. If not available per station, distinguishing by technology type would still be helpful.											[1]	[1]		[1]	[1]	[1]	[1]			[1]	[1]	[1]	[1]		[1]
Planned Outage Durations	Information per power station would be ideal. Min, mean and max duration number would be useful- if not available per station, then distinguishing by technology type.																									
Unplanned Outage Rate	Information per power station would be ideal. If not available per station, distinguishing by technology type would still be helpful.											[1]	[1]		[1]	[1]	[1]	[1]			[1]	[1]	[1]	[1]		[1]
Unplanned Outage Durations	Information per power station would be ideal. Min, mean and max duration number would be useful- if not available per station, then distinguishing by technology type.																									
Partial Outage Proportion	Distinguishing by technology type would be useful.																									
Reserve Margin Contribution	How much each generating unit can contribute to each type of reserve margin. In this case simply providing information by technology type would not provide sufficient granularity and grouping similar units and providing the average would be needed if individual plant information cannot be supplied.																									
Degradation over time	Was any performance degradation considered?																									

Figure 5: Proposed framework for sharing of generator technology modelling information, focused on the technical performance characteristics of the generators included in the model. Comments are included here on the quality of the information shared by the IRP 2023.

Conclusions

CRSES's comments on the IRP 2023 can be summarised as follows:

- The IRP 2023 is a national electricity generation capacity expansion plan that is meant to guide significant capital investments in the crucial area of electricity provision, a primary driver for South Africa's social and economic development. ***A robust and well-informed public conversation on the decisions contained in the IRP 2023 will strengthen this plan*** and build resilience into the South African nation's energy future.
- ***A robust and well-informed public conversation can only occur if the input information on which the IRP 2023's outcomes and decisions are based is made available to the public.*** Not making such information sufficiently available will result in a public conversation that is not necessarily based in fact, with the loudest and most persuasive voices polarising the conversation.
- More importantly, ***an IRP feedback process where insufficient information is provided to the public can damage the trust between government and the rest of society***, allowing conspiracy theories and allegations of bias to spread because the facts are not available. Ultimately with an information gap, the IRP process becomes susceptible to misinterpretation with a risk of being discredited.
- ***CRSES concluded that the published IRP 2023 information was inadequate for it to provide meaningful comments on the IRP outcomes.***
- Instead, ***a framework of minimum publicly available input information for a credible IRP was developed***, that we hope will guide the DMRE and their modelling team in future iterations of the IRP towards supporting the credibility in the public domain of the outcomes from the model.
- CRSES used this framework to highlight where it considers the information provided by the IRP 2023 to be inadequate.

It is the sincere wish of the researchers at CRSES that the framework and comments provided here will support the IRP modelling team in their important work and help guide our nation's electricity planning on an optimal and resilient path.