
South Africans guide to (the) IRP

Process vs product and a guide to why it matters

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“If South Africa had as much electricity as it has energy experts then we would not be in an electricity crisis”

Youtube comment (paraphrased)

Agenda

A question starts the conversation

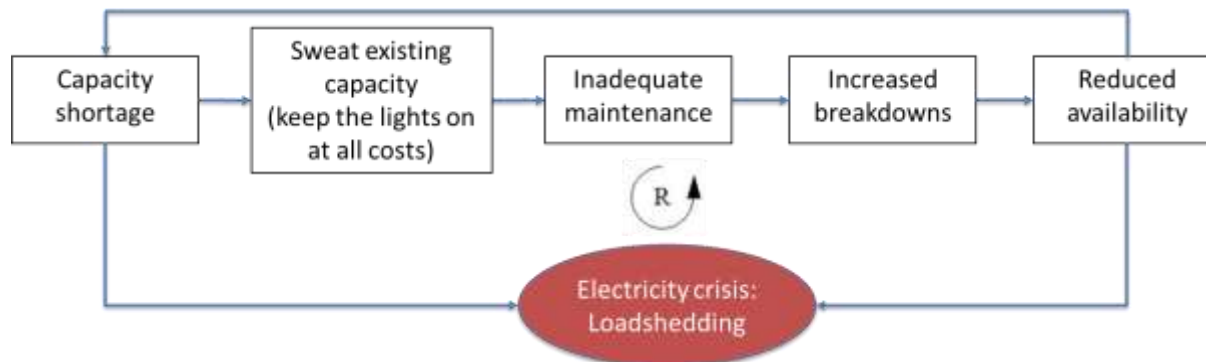
1. How are things going?
2. Energy systems modelling
3. IRP
 - a. What it is not
 - b. What it is
 - c. Key inputs
 - d. Typical outputs
 - e. More considerations
4. Take-away: what is needed for a good IRP, at a high-level?
5. The way forward



How are things going?

Are we in an electricity crisis?

- » Yes
- » Loadshedding is a symptom, not the source
- » Supply is not able to meet demand so demand is controlled/limited/reduced aka loadshedding
- » How did we get here?



Loadshedding

Getting worse?

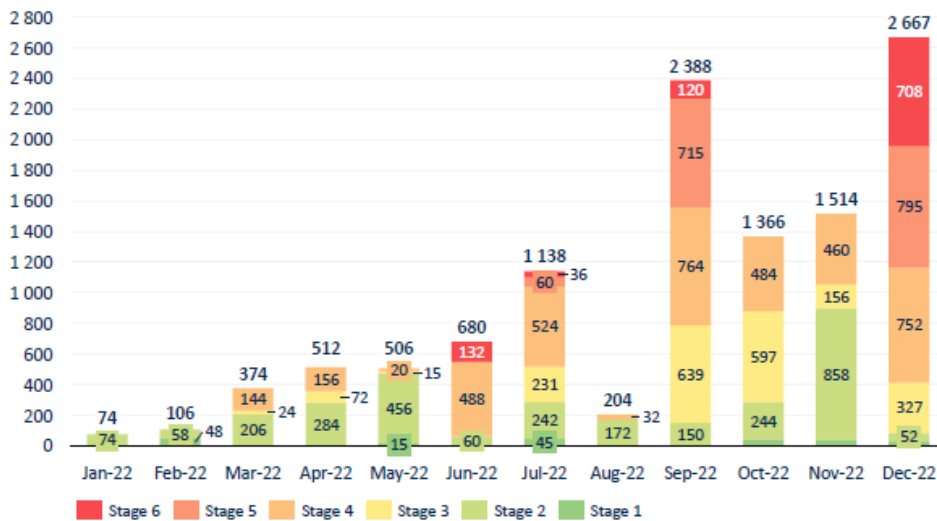


Source: CSIR utility statistics 2022 report

Loadshedding

Getting worse?

Monthly loadshedding
(upper-limit)
[GWh]



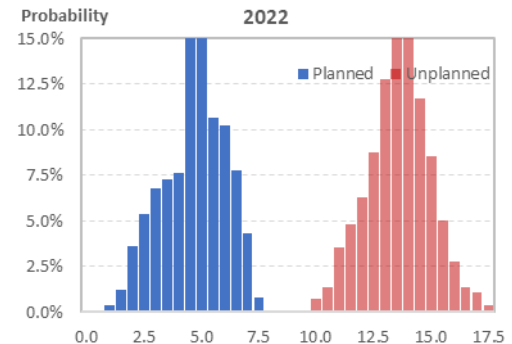
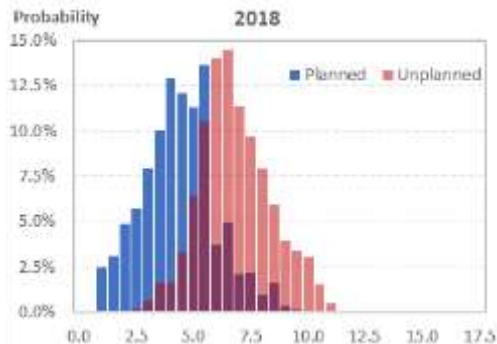
- » Yes, but
- » In 2022 80% of loadshedding was in the 2nd half of the year
- » In 2023, close to 40%

Source: CSIR utility statistics 2022 report

Loadshedding

How did we get here?

Source: CSIR utility statistics 2022 report



Energy systems modelling

Introduction to IRP

- » Energy system modelling is an input to energy planning
- » Technical experts informing decision making (helping to make more informed/better decisions)
- » Multi-disciplinary approach:
 - Engineering (electrical and mechanical)
 - Economics (energy)
 - Mathematical optimization
 - Finance
 - Regulatory
 - Social development, etc.
- » IRP falls under ESM, ESM is wider than IRP (thumb is a finger...)



Finally the
IRP part

What it is not

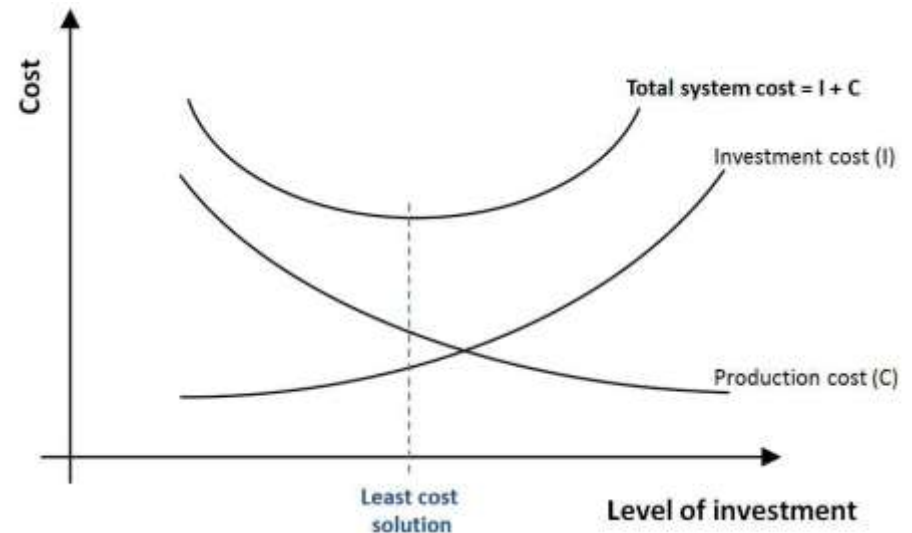
Helps to manage expectations

- » Perfect and all knowing. It is based on assumptions
- » Crystal ball. Nobody knows the future
- » A master. Assists decision making, it does not dictate
- » A policy document. You will not (or should not) find the blueprint there for the liberalization of the electricity sector

What it is

The South African one

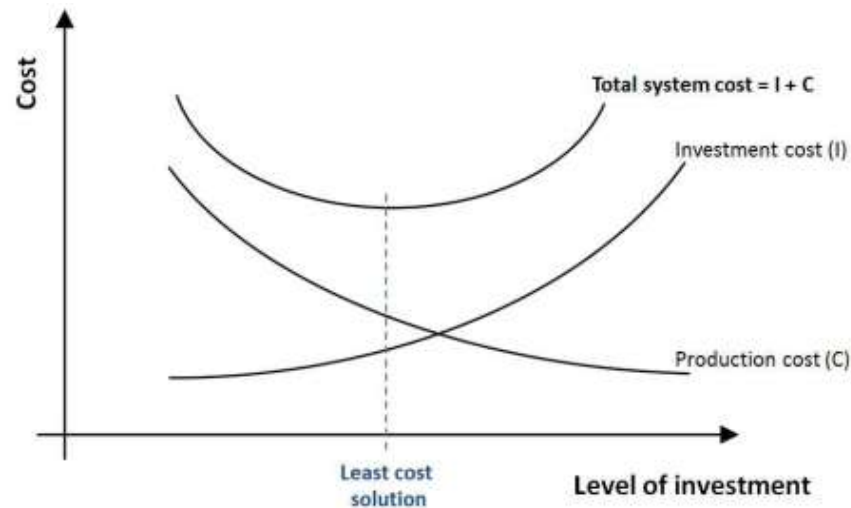
- » Integrated Resource Plan, also loosely known as:
 - Generation expansion plan (GEP)
 - Capacity expansion plan (CEP)
- » Technically it is both supply and demand side, but mostly supply
- » South Africa's IRP is actually a GEP
- » Forward looking, informed by the past
- » Techno-economic model (why):
 - Constraint: supply must meet demand
 - Objective function: least cost
- » Outputs:
 - What to build
 - When and how much
 - What to retire, how much and when
- Who and where not specified



Chicken and the egg

Which one comes first?

- » Capacity/Generation expansion planning and Production (unit commitment)
 - MWs vs MWh
 - Installed capacity (from what to build and when) vs which technology/power plant to dispatch
 - Annual temporal resolution vs hourly or even sub-hourly
 - What to build depends on how the new build will be operated which depends on what is already available to operate
 - When reviewing an IRP it is important to look at both the Build Plan and Generation Output Mix. It might be that a lot of Peakers are being built but most of costs are fuel related which depends on dispatch



Key inputs

Data intensive and forecasting required

- » Demand forecast
- » Customer Resource
- » EAF of Eskom fleet
- » Technology costing with learning rates

How to fix an electricity crisis:

1. Planning for what
2. Reduce demand
3. Increase availability of existing capacity
4. Build new capacity



Key inputs

Demand forecast

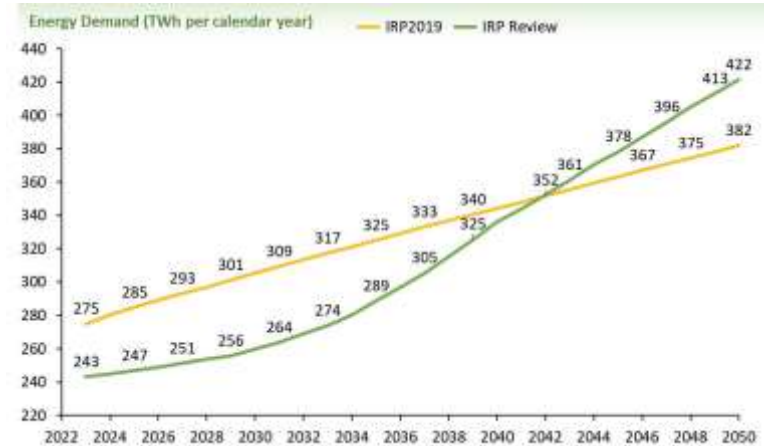
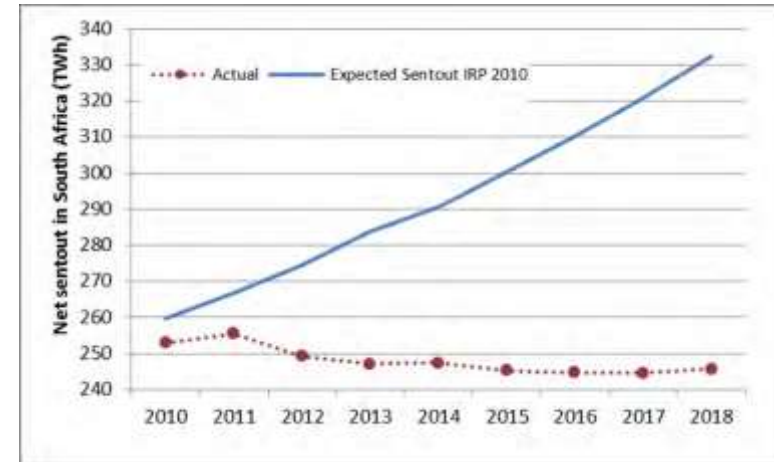
- » Demand refers to both peak demand (around 34 GW) and energy (around 230 TWh)
- » Electricity demand has been slowly declining since 2008, more in terms of energy than peak demand
- » Two elasticities:
 - Income (GDP)
 - Price (Price)
- » Lower GDP growth and higher than inflation tariff increases both pressure demand downwards
- » Add Customer Resource penetration (plus ongoing loadshedding) and demand to be supplied by the utility is likely to stagnant, or decline
- » Demand projections need to be realistic. EVs?

Demand forecast

Customer Resource

Energy Availability Factor (EAF)

Technology costing



Total Customer Demand = Utility Supplied + Customer Resource Supplied

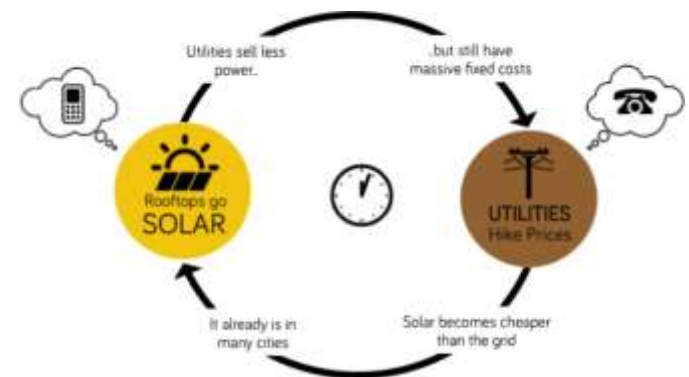
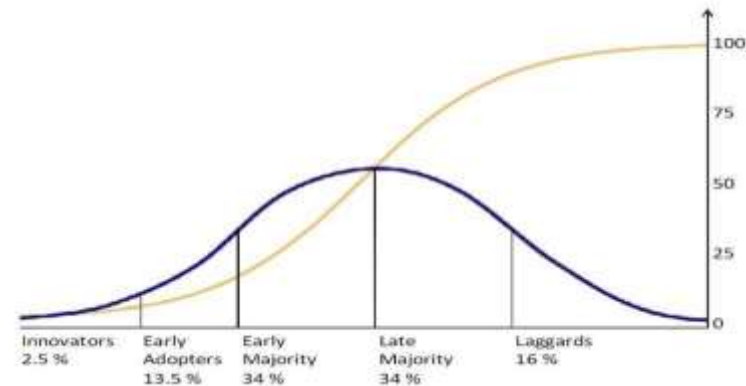
Utility Supplied = Total Customer Demand – Customer Resource Supplied

Key inputs

Customer Resource

- » Only until fairly recently electricity customers were captive. Solar PV is a technology disruptor. Customers now have choice.
- » Drivers of rooftop PV adoption:
 - Tariffs increases
 - Cost of rooftop PV goes down
 - Quality of service goes down
 - Neighbours install one, access to credit, etc.
- » Estimated installed capacity of embedded generation of about 5 GW
- » Customer Resource not only reduces *Utility Supplied* demand in magnitude but also changes the profile (duck curve)
- » What happens to non-affluent customers that cannot afford rooftop PV?

Demand forecast
Customer Resource
Energy Availability Factor (EAF)
Technology costing

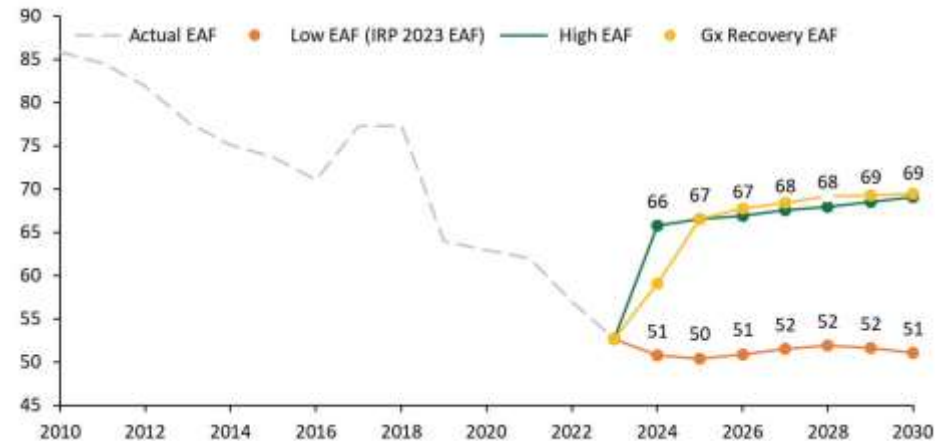
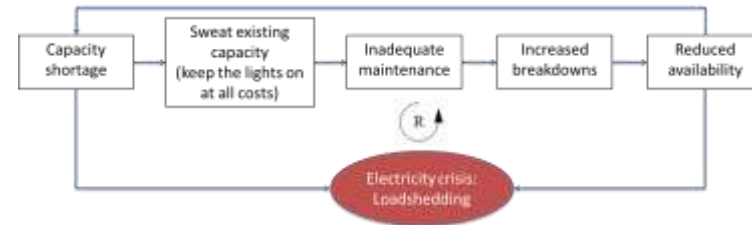
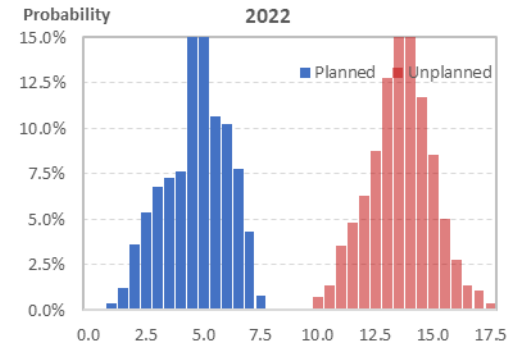


Key inputs

Energy Availability Factor (EAF)

- » $EAF = 1 - (PCLF + UCLF + OCLF)$
- » Important to distinguish between planned maintenance and breakdowns
- » A 70% EAF may be better than a 75% one:
 - 20% planned maintenance and 10% breakdowns vs
 - 5% planned maintenance and 20% breakdowns
 - Planned maintenance has benefits
- » There are ongoing government efforts to improve Eskom's EAF (NECOM)
- » EAF projections need to be realistic

Demand forecast
 Customer Resource
Energy Availability Factor (EAF)
 Technology costing

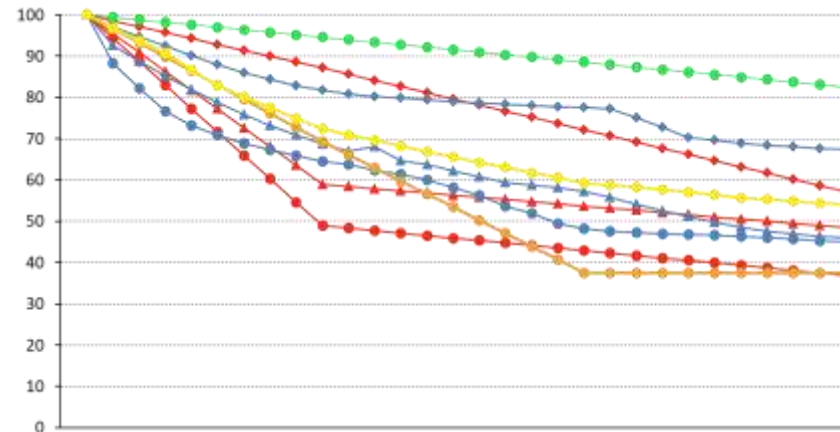


Key inputs

Technology costing and learning rates

- » What does a technology cost now and what will it cost in the future?
- » Costing 101:
 - Capital costs [R/kW]
 - Overnight costs, other costs also need to be considered like interest during construction
 - Learning rates
 - Interest rate
 - Fixed O&M [R/kW per year]
 - Not dependent on usage
 - Variable O&M [R/MWh]
 - Dependent on usage
 - Fuel [R/GJ]
 - What the fuel costs delivered to site, now and in the future
 - Efficiency of power plant matters
 - Market evolving from variable to fixed cost dominant

Demand forecast
Customer Resource
Energy Availability Factor (EAF)
Technology costing



Typical outputs

The very least that should be shown

- » Build plan (“the table”)
- » Generation mix
- » Price path
- » GHG and pollutants path
- » Sensitivities
- » Trade-offs

Table 1: Published Draft IRP 2018 (Approved by Cabinet for Consultation)

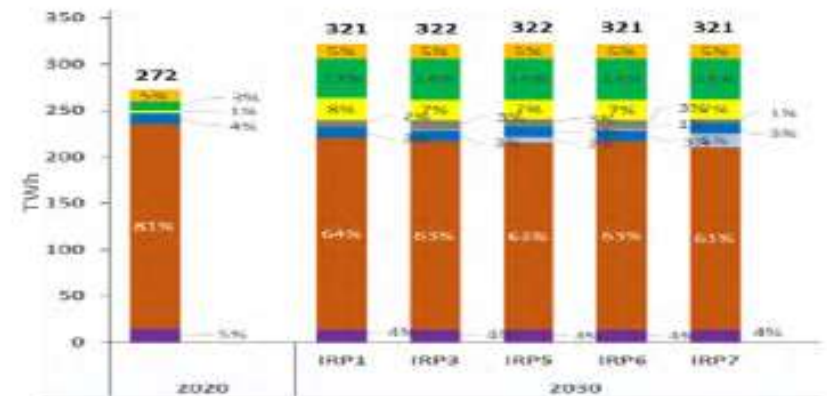
	Coal	Nuclear	Hydro	Storage (Pumped Storage)	PV	Wind	CSP	Gas / Diesel	Other (Gen, Biomass, Landfill)	Embedded Generation
2018	39 126	1 860	2 196	2 912	1 474	1 980	300	3 830	499	Unknown
2019	2 155					244	300			200
2020	1 433				114	300				200
2021	1 433				300	818				200
2022	711				400					200
2023	500									200
2024	500									200
2025					670	200				200
2026					1 000	1 500		2 250		200
2027					1 000	1 600		1 200		200
2028					1 000	1 600		1 800		200
2029					1 000	1 600		2 850		200
2030			2 500		1 000	1 600				200
TOTAL INSTALLED	33 847	1 860	4 696	2 912	7 958	11 442	600	11 930	499	2600
Installed Capacity Mix (%)	44.6	2.5	6.2	3.8	10.5	15.1	0.9	15.7	0.7	

Installed Capacity
 Committed / Already Contracted Capacity
 New Additional Capacity (IRP Update)

Source: 2019 IRP



Integrated Resource Plan (IRP2019)



More considerations

Life is grey and there is more to life than least cost

- » Sensitivities (uncertainty with inputs)
- » Scenarios (the what-ifs)
- » Trade-offs (for example):
 - What is an acceptable cost premium to further reduce CO₂ emissions by 10%
 - What is an acceptable cost premium to create 10% more jobs and/or save 10% more jobs
- » GHG commitments (informal and/or formal). Do we reach our targets?
 - If not, why not?
 - If we do, how much quicker could we do so and what cost premium?
- » Minimum Emissions Standard (MES)
 - How to improve the local air quality for communities around coal power stations? What are the associated impacts?
- » Just Energy Transition (JET)
 - How is this translated into the IRP?

Take-aways

What is needed for a good IRP, at a high-level?

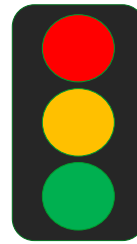
1. Overarching policy is in place: place the flag
2. Promote process over product. This facilitates ongoing engagement and transparency. We should not be arguing about the outputs, we should discuss the inputs and assumptions.
3. Executed and hosted by a neutral third party(ies). If possible, supported by international partners.
4. Inputs and assumptions are made publicly available and discussed
5. Updated at regular intervals: two to three years
6. Least cost used as reference case. Sensitivities and trade-offs are provided
7. Generation expansion planning expands to capacity expansion planning: include Tx
8. Electricity sector is expanded to full(er) sectors
9. Provides longer term confidence of new builds aka provides comfort to the market
10. Evolves with the market



The big question:

Does the IRP assist South Africa to move forward by making more informed/smarter energy decisions that showcases government's commitments and provide comfort to the market?

Take-aways



Score-card: 7/20 (35%)

Room for improvement

What is needed for a good IRP, at a high-level?

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Way forward

We are where we are, how to move forward?

- » “Any IRP is better than no IRP”. I disagree.
- » IRP was released in early January 2024. Initially deadline for comments was 23 February, extended to 23 March.
- » Fair to say the 2023 IRP was not well received and concerns have been raised.
- » Some inputs, including costing, were later released. Good step towards transparency.
- » There will need to be concerted effort on **constructive criticism**. I do not believe this is the time to reform the way the IRP is done. For now: how to get the best possible IRP out fairly soon that provides comfort to the market. Hopefully, the formal comments/feedback will equip IRP Team to finalise the IRP
- » After the 2023 IRP is finalized/out, there should be a deep dive for the next one

