Appendix 1: Alternative Modelling Solution[1]

Recommended 2040 energy mix: least cost with adequate security of supply and maximum decarbonisation

Comparisons are drawn between the IRP_2023 recommended energy mix in 2040, with a recommended energy mix for 2040 developed during a workshop held in Cape Town on 13 March at the Heinrich Böll Foundation. The “consensus” energy mix was independently derived by 5 separate working groups comprising 3 to 4 people per group. Software to enable the analysis was provided to the participants as part of the workshop, conducted by Clyde Mallinson, an experienced energy analyst and modeler.

The table and diagrams below present the results of the analysis alongside the IRP_2023 recommended energy mix. Acknowledging that this was not a modelling exercise using Plexos or equivalent bespoke software, it nevertheless still provides a clear understanding of a resource mix that can be derived with a least cost option analysis. In this analysis, the separate groups endeavored to achieve the lowest average cost (2040) with a security of supply threshold set at no more than a deficit for 3% of the time (262 hours of potential shortfall) based on the same demand projections for 2040 as in the IRP 2023. An additional, semi-arbitrary maximum excess of 35% was set as a boundary condition. Given that the IRP doesn’t cater for new electricity growth in sectors such as transport, industrial heating and cooling, desalination, and green hydrogen production, to name some of the potential uses of “excess” power, this excess was deemed an asset, rather than a liability that would require “curtailment.”

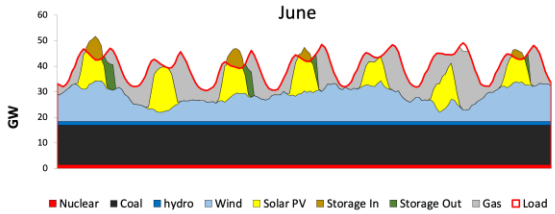
Costs are in today's Rands (2023 - no escalation) taking learning rates into consideration for Wind, Solar and BESS but keeping coal, gas and nuclear constant over time, noting that fuel costs in particular are likely to increase at above CPI levels, if the past is anything to go by. Costs used are a blend from internationally available sources and from the IPPO programme. The costs used to derive the 2023 Rand equivalent prices per kWh in 2040 are weighted average capital and operating costs from 2024 through to 2040.

It further provides a "nice problem" of excess (as in many other countries in the world e.g. Australia and others), where this can be used for a variety of important economic and social considerations. Although the above is not a production cost model as typically employed in Plexos or equivalent modelling, the merits of the energy mix as derived by the groups during the Cape Town workshop can easily be stress-tested using more bespoke, but less intuitive, and generally more opaque modeling platforms.

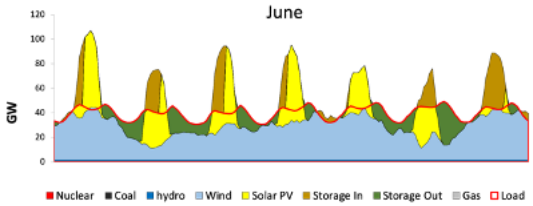
[1] Credit to Clyde Mallinson for the model used, and to the team including At van der Merwe and others, that worked on this in a group workshop on 13th March 2024 in Cape Town.

Energy mix in 2040: Reference case		
Generation technology (GW)	IRP_2023	Cape Town workshop
Nuclear	1.9	0
Coal	22	0
Hydro	2.4	2.4
Gas	23	0
Wind	23	62
Solar PV (Utility + rooftop)	26	94
Pumped hydro storage	2.7	2.7
BESS (4 hours)	7	45
Indicative cost per kWh in 2023 Rands	R1.51/kWh	R0.76/kWh
Excess “SuperPower” (TWh)	2 TWh	118 TWh

IRP_2023 Reference



Cape Town Workshop consensus



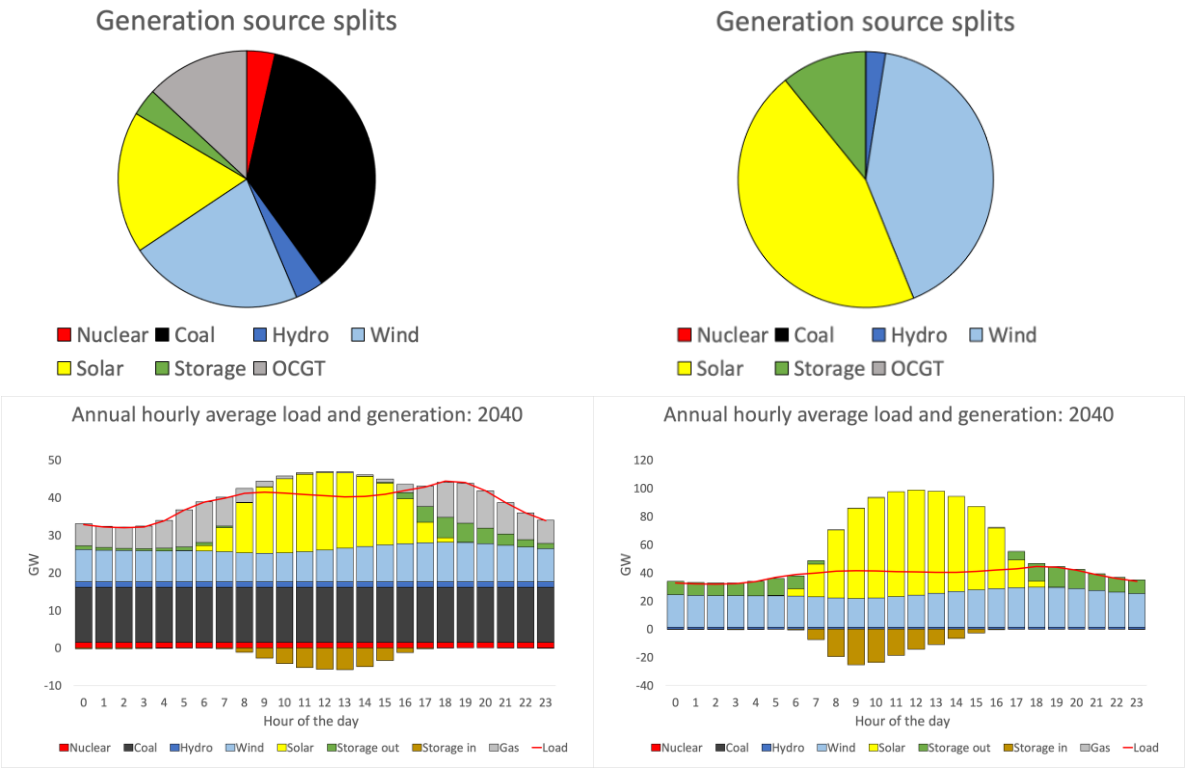


Figure 1. The plots on the left hand side represent the recommended IRP_2023 energy mix by 2040. The first plot shows an illustrative week in June (generally the most challenging month). The pie chart shows the energy generation mix output splits. The third plot is an annual average hourly plot showing demand and supply. The plots on the right hand side are for the 2040 energy generation mix as derived during the Cape Town workshop.

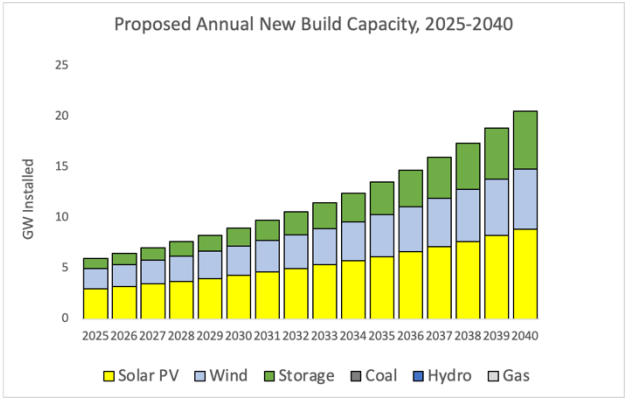


Figure 2. Proposed annual new build of solar wind and storage

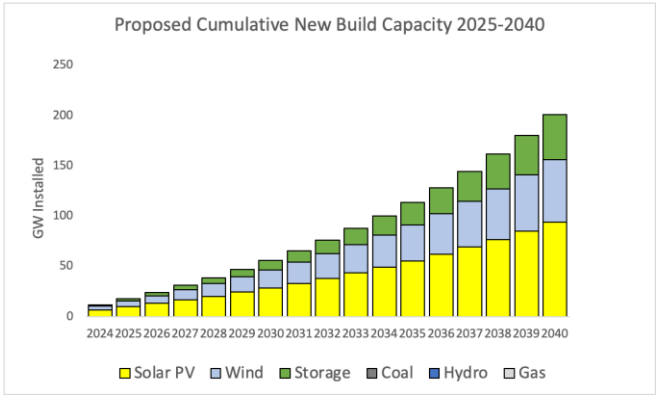


Figure 3. Cumulative proposed new build through to 2040

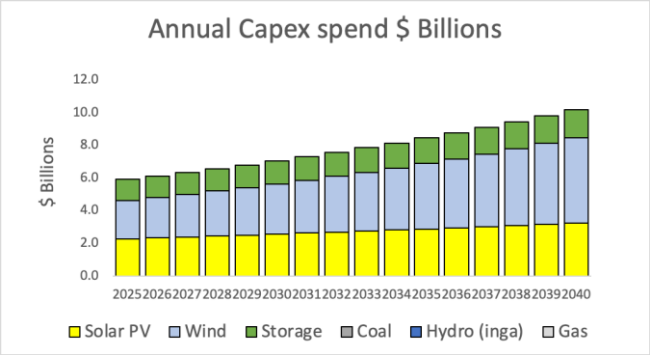


Figure 4. Annual capex in $b for proposed new build

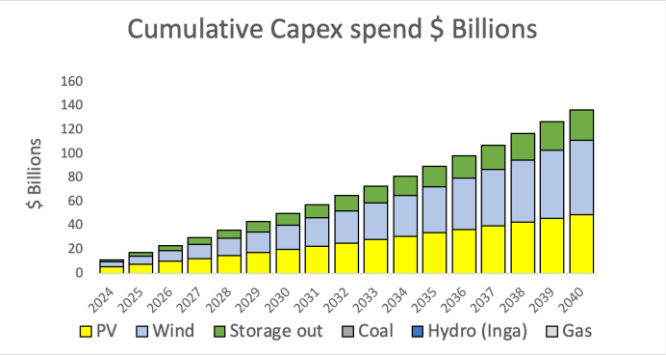


Figure 5. Cumulative cost of proposed new build in $b

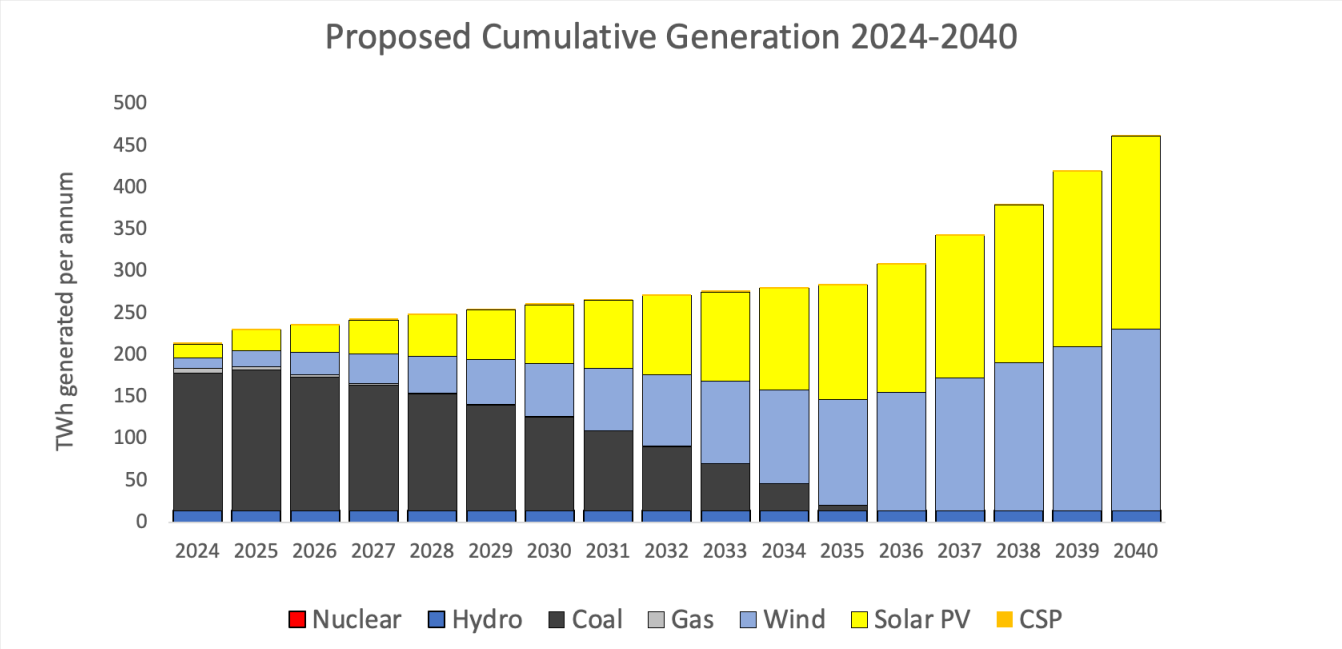


Figure 6. The changing energy mix from 2024 through to 2040. Note that nuclear (Koeberg) was not included, as it is not at all certain that it will be issued with a life extension licence, given the many serious issues raise by the international nuclear energy agency. Coal is retired as and when sufficient new wind, solar and storage is installed, and is fully decommissioned by 2036. Storage is not shown as a source of new generation, as it is a net consumer of energy, but plays an all-important balancing role, as depicted in Figure 1.