Initial comments on draft IRP 2018

By the Energy Research Centre, University of Cape Town

The Energy Research Centre (ERC) at the University of Cape Town (UCT) welcomes the opportunity to comment on the long awaited draft Integrated Resource Plan (IRP), published by the Minister of Energy 27 August 2018, with a request for public comment. (1)

We note that ERC is undertaking further research relating to integrated resource planning and that we plan to further elaborate on these comments by the end of October (the deadline for comments set by Department of Energy (DoE). Furthermore, the Hon F Z Majola, MP, Chairperson of the Portfolio Committee on Energy (PCE) of the Parliament of South Africa, invited comments on the IRP in a public notice, requesting such comments by 5 October 2018. ERC is pleased to submit these initial comments in response to that invitation.

Return to evidence-based planning

Overall, the ERC reads the draft IRP 2018 as an improvement on the base case published in 2016.(2) Together with the IRP 2010,(3) which remained the official capacity expansion plan, it appeared that political factors were driving electricity planning choices. While there are several technical issues which we raise in the following sections, but at the outset we welcome the draft IRP 2018 as a return in general to evidence-based decision-making.

What is an IRP and what should it be?

Good practice in integrated electricity (and energy) planning is to start with the delivery of energy services to people and the economy - for example, mobility, warm food, lighting etc. Electricity can provide those services (but is not necessarily the best and only way to do so), and this informs demand. A good IRP should therefore analysis the interaction between supply and demand-side options to create the least cost plan (one that may meet varying social objectives). thus, electricity generating technologies (the supply side) as an output; the IRP is not a supply-side plan.

Given the rapid technological and economic changes affecting the global and South African energy systems, make it particularly important to take a broader view on the electricity sector. A narrow focus on the supply-side disregards the full integration of transmission and distribution into the energy system, as well as the integration of new sectors into the electricity system (such as the electrification of transport).

An IRP is also more than a technology plan and should include a full analysis of how best to meet important social objectives. thus, it should include further analysis on the following: Other topics which the IRP should say more include: Just transition; externalities; more on energy storage; demand side management; employment (in general, mentioned only to justify coal IPPs) and others. Only if these aspects are included can the trade-offs between different options be adequately assessed.

Demand projections continue to be too high

- Projections of electricity demand have consistently been substantially higher than actual sales. Figure 3 in the draft IRP illustrates very clearly – actual electricity sent out was much lower than in the IRP 2010.

- Despite this, the drafters of the IRP repeat the error. Figure 7 shows smoothly upward sloping higher, middle and lower projections. Given the current economic environment in South Africa (a main driver for demand), it seems likely that even the lower projection will be higher than actual – actual demand should at very least be monitored annually, and the projections adjusted.
- The lower electricity demand projections are based on somewhat lower GDP as a key driver, but 1.33% GDP growth is higher than currently in a recession. While it is understood that governments everywhere assume economic growth will pick up, history suggests that no-growth scenario would provide a more realistic envelope – then actual demand might turn out to fall within the 'cone' between lower and higher projections.
- A premise of the lower demand projection is very questionable: "In developing the forecast, the main assumption was that mining output would continue to grow while other sectors of the economy would suffer as a result of low investment." In what world would output from mining increase while other sectors slump?
- To deal with uncertainty in demand, it would be useful to use scenarios that explore the full range of uncertainty. SA is currently in a recession, and while we hope to get out of it, planning for continued low growth would help to manage the risk of overbuilding - which is very costly to the economy and society. Underbuilding is also risky, so other scenarios should be higher than current - which is included. Modular, flexible supply options can be used to meet security of supply.

Demand side management

- While DSM is defined in the glossary, we find no reference in the draft IRP, nor in the CSIR forecasts for electricity demand. (4)

Distributed generation

- The IRP does include consideration of embedded generation and fuel switching.
- However, the IRP does not fully consider a shift to decentralized electricity systems.
- The DoE would do well to consider the NPC energy paper(5) – in particular a section on 'modular, robust and sustainable energy investment' - and its implications for revising the draft IRP. This would
    - consider the future of the grid much more fundamentally, including shifts in power both physically (generation much more distributed, with smart grids, etc.) and politically (from a few big central producers to many prosumers)
    - Changes in the role of municipal ESDs shifting from on-seller of a monopoly product to manager of complex set of relations with diverse prosumers.

Coal

- The draft IRP does signal a long-term shift away from coal: "The decommissioning of coal plants (total 28GW by 2040 and 35GW by 2050) ... imply that coal will contribute less than 30% of the energy supplied by 2040 and less than 20% by 2050." Diversifying the energy mix has been part of energy policy since 1998, (6) and whether these shift seem unlikely to be fast enough to respond adequately to the challenges of climate change. Furthermore, the draft IRP only recommends a plan up to 2030 (see Time frames below), and in the near-term does propose adding new coal capacity.

- Table 7:[1] "Proposed Updated Plan for the Period Ending 2030" in the draft IRP adds 1000 MW of coal in 2023-24. These are presumably coal IPPs.

Coal IPPs add costs and greenhouse gas emissions

- ERC research has demonstrated that the inclusion of the coal IPPs in the electricity system raises energy costs and increase GHG emissions. The additional discounted system costs to meet the low-PPD trajectory with the coal IPPs is R27.9bn. (7)
- Even in a base-case scenario for coal (making favourable assumptions), these negative effects of coal IPPs would undo the effects of the carbon tax. If forced in as in the draft IRP, the existing fleet would have to run at lower load factors to allow for the coal IPPs. (7)
- The comparison of IPPs using coal and those using renewable energy is limited.

Decommissioning should be endogenous, not an arbitrary 50 years

- The draft IRP does foresee decommission of coal plant (12 GW by 2030 and reaching a total of 28 GW by 2050), and lower shares of coal in the fuel mix for electricity than in previous plans.
- However, the basis of decommissioning is an arbitrary 50 year life-span. Several stations have already had 'life-extensions', but the full costs of life extension and higher are not included.
- ERC research points to a better approach, in which decommissioning is based on endogenous factors. This should take into account the risks to coal supply by station – see Table 2 in a Coal Transitions report by ERC. (8)
- South Africa's contribution to climate change mitigation must mean that no new coal capacity should be added in the final IRP.

Importing hydro-power – if political, then all the politics

The recommended plan includes 2500 MW of hydro in 2030. The draft IRP motivates this in order to "facilitate the RSA-DRC treaty on the Inga Hydro Power Project in line with South Africa's commitments contained in the NDP to partner with regional neighbours". From ERC's research, we see no analytical basis for including power from Inga. If this is a political decision, then the security of supply from the DR Congo and along all transmission lines to South Africa would also need to be taken into account.

Gas – lots of it, what is it, from which source and technology?

- The draft IRP includes a large amount of new capacity from "gas/ diesel": 11,930 MW in total, with 3,830 MW In 2018 (this year – being built where?) and another 8,100 MW added between 2026-29.
- It is entirely unclear what fuel and technology shares are – how much diesel (to run very expensive OCGT?) and how much gas – in OCGT, CCGT or CC-GE?

[1] Confusingly, there are two Tables numbered 7 in the draft IRP. In these comments, "Table 7" refers to the recommended plan on p. 41 (not the capacities on p.49, unless specified).

- It is also unclear whether gas is to come from shale gas fracking or imported as liquefied natural gas (LNG). There are significant differences in price – and ERC research has shown that "there is a clear inflection point at a price between USD 10 and USD 11/Mbtu. This is most visible in the unconstrained cases, in which the function of gas in the energy system changes dramatically below that price, which will be explored in more detail below. The large-scale use of shale gas is related purely to the assumed availability of shale gas at lower prices, since the inflection point is below the minimum price point of LNG, thus different price range assumptions would lead to a different gas mix." [9]
- LNG does have the advantage of lower investment. Floating storage regasification units (FSRU) can import LNG without investment in onshore regasification infrastructure.
- Gas can help balance the intermittency of solar PV and wind (until other storage options such as batteries become more affordable). It is also worth noting that using gas for GTL would be inefficient, compared to using compressed natural gas (CNG) directly in vehicles.
- The estimates of the amount shale gas available in the Karoo have been decreasing. It is now uncertain whether the shale gas in the Karoo, including in two scientific assessments in 2016.[10,11] More recently, a single study undertook actual measurements and found "no desorbed and residual gas, despite high total organic carbon value [and that gas] to be metamorphosed and overmature".[12] In plain language, the gas may have been 'cooked' and not much may be usable. The study deflates resource estimates to 13 tcf and suggest that, to be economically viable, the resource would be required to be confined to a small, well-delineated 'sweet spot' area.[12]
- Natural gas has lower greenhouse gas emissions than coal at the point of combustion. However, the risks of fugitive methane – CH_4 physically leaking to the atmosphere – can off-set the emission reductions. This requires careful management and has been explored in relation to shale gas fracking.[13]

Renewable energy is least cost and there is no rationale for annual build limits

No justification is provided for placing constant limits on annual investment in renewable energy technologies. In IRP 2010, these limits were based on experiences from early renewable investors ten years before, but the world has moved on considerably since then. While there may be realistic short-term limits on potential investment in specific technologies (based on

Renewable energy is already the least-cost technology for electricity generation. The draft IRP acknowledges this: " The scenario without renewable energy annual build limits provides the least-cost option by 2030." … " The scenario without renewable energy annual build limits provides the least-cost option by 2050"(p.12). However, the draft IRP persists in imposing annual build constraints, which has no credible rationale. The IRP does not explore nor cost important possible scenarios (such as shifting RE build earlier in the modelling period to ensure energy security and support industrial development (through consistent procurement).

Removing build constraints on RE makes no significant difference up to 2030, but constrains the least-cost option after 2030.

The draft IRP states that imposing annual build limits on RE does not affect cumulative installed capacity and energy mix up to 2030; while for 2030-50, imposing annual build limits on renewable energy will restrict the cumulative renewable installed capacity. If it makes no difference in the short-term (for which the plan is recommended) and constrains the least-cost option – why have build limits?

Draft IRP assumes lower learning rates than seen in recent past.

Technology learning rates assume that, over 35 years, the overnight. Capital costs of PV reduce by 26% and wind by 11% (calculated from Table 1). The CSIR Energy Centre reported that over four years, the costs of solar PV dropped by 83% and wind by 59% (In Nov 2011, solar PV at R3.65 / kWh and wind at R1.51; by Nov 2015, both at R0.62 / kWh). (14)

Table 1: Implicit cost reductions for electricity generating technologies over 35 years

	R / kW 2015	R kW 2050	
PV (fixed tilt)	16861	13425	-26%
PV (tracking)	17861	14221	-26%
wind	19208	17287	-11%
nuclear	55260	53768	-3%

Better alternative to build limits would be improving temporal fidelity in dispatch modelling

A NREL study examined deployment limits for wind and solar in SA IRP. (15) Three possible considerations: Technology Availability, Grid Flexibility or Dynamic Performance Constraints. Of these, grid flexibility appears to ERC to be the most likely explanation for the otherwise inexplicable inclusion of build limits in the draft IRP. The NREL study acknowledges that "system planners may have concerns that a large quantity of wind and solar power generation will lead to insufficient grid flexibility to integrate these variable and uncertain sources of energy without some combination of: significant energy curtailment (leading to harder-to-finance or more expensive renewable IPP contract prices), unreasonably steep ramps for the conventional fleet (leading to reliability issues), and/or more frequent cycling of the conventional fleet (leading to increased maintenance costs). Such concerns might lead to analysts imposing an overall penetration limit (percentage of total generation) for variable renewable resources." However, the study goes on to propose a better solution to such concerns "Implementing an improved temporal fidelity for the model will help produce an internally-consistent system with sufficient grid flexibility, mitigating the need to place penetration limits on wind and solar to address flexibility concerns." (15)

Build local industry through smaller, modular and cheaper options

The draft IRP recommends reducing pace and scale of new capacity additions and review of Ministerial determinations *after* REI4P bid window 4. While no new capacity is needed right now, consideration should be given to not completing the last two units of Kusile and rather building least-cost renewable energy.[16] The recent history of building a RE industry through REI4P programme but then stalling it has shown that investment in local industry, manufacturing of components and associated jobs are placed at risk. Investing in smaller, more modular and least-cost technologies makes more sense.

Managing electricity sector GHG emissions via carbon budgets

The draft IRP suggests that applying a "carbon budget as a constraint to reduce greenhouse gas emissions or maintaining the peak-plateau-decline constraint as in IRP 2010 – 2030 will not alter the energy mix by 2030." [1]

Good to have a carbon budget approach, but should be least-cost and 5 year rather than 10 year

A carbon budget approach for the electricity sector should be derived from an economy-wide least cost mitigation analysis,[8] and take into consideration the socio-economic implications of allocating carbon space to the electricity sector (where mitigation costs are lowest).

The carbon budget approach in the draft IRP to greenhouse gas (GHG) emissions constraints assumes 10 year periods. However, 5-year cycles are preferable because:

- To be consistent with national policies and measures, including company-level carbon budgets[17]
- Cycles in the Paris Agreement, with legal obligations to submit nationally determined contributions (NDCs) every five years under Article 4.9; and five-yearly global stock-take under Article 14;
- A decade is simply too long to make any adjustments, given a very rapidly changing electricity sector

Table 1 shows the simple conversion of 10 year carbon budgets as in the draft IRP to 5 year budgets; the latter could be further smoothed or gradually stepped down.

Table 1: Emission reduction constraints / carbon budgets over 10 years from IRP

Source: based on Table 5 in draft IRP (1st and 2nd column) adding 3rd column

	10 years	5 years (calculated – simply halved)
	Mt CO_2-eq	Mt CO_2-eq
2021-2030	2750	1375
2031-2040	1800	900
2041-2050	920	460

The 5-year carbon budgets in Table 1 can be compared against peak, plateau and decline (PPD) trajectory in national policy; [18] and the nationally determined contribution, which states that the “national carbon budget range for the period 2021-2025 is 1.99 -3.01 Gt CO2-eq and for 2026-2030 is in the range of 1.99 to 3.07 Gt CO2- eq” [19]. Table 2 compares the carbon budgets from the draft IRP (halved, as for Table 1) to carbon budget based on least-cost mitigation analysis. The latter are generated from ERC SATIM model running a Coal Transitions Carbon Cap scenario, which imposes a 9.4Gt cap to entire energy system. [8] The model therefore chooses which sectors reduce energy GHG emissions most cost-effectively

Table 2: Comparing 5-year carbon budgets for electricity, draft IRP to least-cost analysis

Source: Col 2 draft IRP (halved for 5 years), column 3 from SATIM Power[8] and 4th and 5ht columns calculated

	5 years (IRP halved)	5 years SATIM power	Difference	Difference (SATIM / IRP)
	Mt CO_2-eq	Mt CO_2-eq	Mt CO_2-eq	%
2021-2025	1375	1131	-244	-18%
2026-2030	1375	1112	-263	-19%
2031-2035	900	521	-379	-42%
2036-2040	900	508	-392	-44%
2041-2045	460	164	-296	-64%
2046-2050	460	187	-273	-59%

It can be seen from Table 2 that that carbon budgets from a SATIM power are significantly lower than those from the draft IRP in absolute units (Mt CO_2-eq). The relative differences tend to get larger over time. The SATIM power carbon budgets for the electricity sector are closer to a zero-emissions electricity sector by 2050 than the draft IRP carbon budgets.

International environment is such that more ambitious actions is needed. Countries are expected to show progression in each successive NDC, and to take more stringent domestic mitigation measures.

More rapid decarbonization is possible in electricity and so the share of carbon budget can be expected to decline over time

The assumption of a fixed share is at odds with research for SA and globally, which shows that more rapid decarbonization is both possible and lower cost in the electricity sector than in others. [20-24] This finding will very likely be confirmed In the IPCC’s forthcoming report on 1.5 °C.

Meanwhile, pursuing more rapid decarbonisation will have economic benefits, given that renewable energy provides more jobs than conventional generating capacity (cite: co-benefits and Bischof-Niemz and Creamer, 2018). Other important socio-economic impacts include lower health burdens on especially poor communities living near coal-fired power stations through improved air and water quality.

Hence ERC recommends that rapid decarbonization in electricity is translated into decreasing shares of 5-yearly national carbon budgets.
Long term ambition
thought about in national context
sectoral emission targets
DEA would allocate company-level carbon budgets consistent with sectoral shares, and enabling SA to remain within its national carbon budget

Air quality

The draft IRP is not consistent with compliance with the Air Quality Act [(25)] and its minimum emission standards. The IRP should as a minimum include compliance with the Act.

Time-frame: take a long-term perspective on short-term decision, and update every two years

The IRP 2010 has effectively a 20-year plan; the draft IRP 2018 has not changed the end date of 2030. By only recommending a plan up to 2030, it is effectively an 11-year plan. This on its own is insufficient. ERC recommends that the findings for 2050 be utilised to provide a long-term perspective, that decisions are identified for the short-term (building on the decision-tree approach in the unofficial IRP 2013 update), and that the IRP be updated every two years. An approach of adaptive management is appropriate to complex systems, rapid change and high degrees of uncertainty – all of which characterize SA's electricity sector.

Background: Summary of recommended plan

Table 7 in the draft IRP presents a recommended plan. Some key features

- Distinguishes between committed and new additions, thereby assuming that all committed will be built
    - including all units of Kusile
    - committed REI4P bid window 4 projects
    - "The committed Renewable Energy Independent Power Producers Programme, including the 27 signed projects and Eskom capacity rollout ending with the last unit of Kusile in 2022, will provide more than sufficient capacity to cover the projected demand and decommissioning of plants up to approximately 2025." [(1)]

Table 3: Recommended plan

Source: draft IRP, Table 7 in that document [(1)]

	Coal	Nuclear	Hydro	Storage (Pumped Storage)	PV	Wind	CSP	Gas / Diesel	Other (CoGen, 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)
Embedded Generation Capacity (Generation for own use allocation)

Table 7: Proposed Updated Plan for the Period Ending 2030

- Additional capacity
  - 1,000 MW of coal – presumably IPPs
  - 2,500 MW of hydro, imported from Inga
  - 5,670 MW of solar PV,
  - 8,100 MW of wind, and
  - 8,100 MW of gas/diesel.
- There is no additional capacity for nuclear power, concentrating solar power (CSP) or storage.
- Decommissioning schedules are presented for existing coal (12 GW up to 2030), nuclear and other power plants.

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