

Response to the NFCRC Tentative Findings report

by John Newlands

My response concerns the relative priorities of the Commission's key recommendations on

Further processing
Electricity generation
Disposal of waste

I wish to address these issues from a somewhat different angle. My fear is that the possibility of years of inaction or indeed SA going backwards economically could detract from the Commission's work. Defence contractors talk of a 'valley of death' between projects and I fear the same for any expanded nuclear fuel cycle in SA. In rough order of concern I would list

- would-be nuclear waste exporters get cold feet
- major new interstate transmission is built perpetuating SA coal dependence
- the federal government introduces nontrivial carbon pricing, say over \$20 per tCO₂
- unexpected retirement of east coast coal baseload plant
- hefty gas price increases possibly following an oil price rebound
- SMRs that can be installed quickly take another decade
- 4th generation technology approved by western nations arrives soon after SMRs
- Gwh scale energy storage is mandated regardless of cost

In my opinion the possible urgency of some of these concerns is not given enough weight in the tentative findings. A very real scenario for SA is years of no private income for waste disposal while SA electricity becomes more dependent upon fickle gas supply or interstate coal, possibly with the addition of a national carbon price. That could represent a decade or more of neither SA's economy nor electricity supply improving despite the State's natural nuclear fuel cycle advantages. I believe the Commission's proposals for a waste facility and fuel recycling would run more smoothly if electricity generation came first. I will suggest how that might be further investigated. By coincidence the federal electricity regulator AEMO released a reportⁱ within days (Feb 19) of the Commission's findings. That report argued that SA will soon lack adequate synchronous generation and must consider energy storage and enhanced interstate connection. However no assessment was made of the cost or implementation timeline of these measures.

I might add that my personal opinion is that countries using commercial radioactive materials are obliged to keep the products indefinitely on their home soil, including material sent away and returned in chemically stable form. Any country that is not built on swamp should be capable of this. I know others share that view, namely that exporting nuclear waste is something of a copout. Possibly that opinion could escalate in any country that makes moves to export waste. Nonetheless if one or more foreign countries is willing to pick up the tab for an SA waste facility with little or no Australian public funding that must be regarded as a bonus. Against this is the danger that if it fails to materialise it will appear that the Commission has failed to pick a winner.

Additionally there is the 'chicken and egg' issue of the advent of 4th generation nuclear that could use much existing waste near its source. Some 4th gen proponents claim future electricity costs will be as low as coal while achieving much higher fission burnup than 3rd generation nuclear. If true that might eventually make enriched uranium/light water reactors and long distance transmission obsolete while greatly reducing the future waste problem. However I do not think we should wait for

4th gen as it may not arrive when critically needed. Conceivably the commercial breakthrough could occur in Russia or China with the West reluctant to adopt that technology.

Gas fired generation is neither low carbon nor cheap. Since the Feb 19 report on SA electricity reliability AEMO also published a report on east Australian gas supply issuesⁱⁱ. The spot wholesale price of east Australian gas is in the \$5-\$6 per gigajoule range at the time of writing having hit \$8 on occasion. Supply concerns including diversion to more profitable export LNG could return. Moreover as gas prices are partly linked to oil prices some geopolitical incident could cause a rapid price escalation. Therefore SA's foreseeable 50% gas dependence should be a major cause for concern.

There seems to be good prospects for light water small modular reactors such as the NuScale with its 50 MWe modules. Both the US and UK aim to have some NuScale units connected to the grid by 2025. The earliest that SMRs could go online in SA is towards the year 2030, an agonisingly long wait. The eastern seaboard remains the best place for large (gigawatt scale) nuclear due to demand, transmission capacity, existing switchyards and already built cooling infrastructure. Large utility companies like AGL, Engie and Origin have each said they would like to exit high carbon generation. The return of non-trivial carbon pricing could make interstate electricity imports quite expensive for SA. For example a \$20 CO2 price could add \$25 per Mwh to Victorian brown coal imports, unless evaded by offsets, free permits and the like. Since Australia has already been down this path with the \$23-24 carbon tax it cannot be ruled out indefinitely.

There is little prospect of the Renewable Energy Target being watered down even though the 2020 national target of 33 Twh is unlikely to be met. SA's wind and solar generation is therefore guaranteed market share for the foreseeable future. At the time of writing the Large Generation Certificate subsidy under the RET is worth about \$80 per Mwh. In 2014 when LGCs were half that it was estimated the RET nationally imposed a CO2 avoided cost of \$59 per tonne relative to average grid costs. The late carbon tax closed at \$24.15 and must be regarded as economically more efficient since it decreased national emissions (now increasing) and is cheaper on a marginal basis. To the RET shortcomings must now be added the reliability concerns pointed out by AEMO. South Australia needs dispatchable generating capacity which is price stable, largely independent of interstate power flows and which can complement highly variable but quota protected renewable generation.

A customised Candu to start construction this decade

I suggest further investigation into the construction of a pressurised heavy water reactor which has both variable output and the ability to do a form of fuel recycling. The Enhanced Candu 6 has a nominal output of 800 MWe. However already built variants of the Candu can both load follow and re-use spent uranium from light water reactors, a form of minimal (non-chemical) fuel reprocessing. Using a steam condenser bypass the reactors in Bruce B generating station in Ontario can reduce output by 40%. Conceivably a reactor could be custom made with 500 – 800 MW rapidly variable electrical output, say by 50 MW a minute needed because of SA's weather related supply and demand changes. That would complement SA's 'must take' wind and solar generation which is about 41% on an annual basis but which can fall to near zero at times.

The Advanced Fuel Cycle Reactor (AFCR) form of the Candu in Quinshan China has 700 MWe output and can re-fission spent uranium fuel pellets without the need for chemical processingⁱⁱⁱ. That could be a backdoor approach to fuel recycling. It can also fission thorium which seems likely to meet public approval based on favourable comments in the media. In Canada the standard EC6 uses unenriched uranium. If large coal baseload plants (eg Hazelwood Vic or Eraring NSW) on Australia's

east coast were to be replaced by large light water nuclear plants then an SA based Candu could re-use that fuel. An already built SA reprocessing capability might then soften critics of east coast large scale nuclear. The cry 'nowhere to put the waste' would be largely answered. Spent pellets or fuel rods could also come from overseas. Later chemical or pyro processing and 4th generation technology could achieve even higher burnup depending upon the cost to benefit ratio. The onus must be on SA to get the ball rolling on nuclear electricity.

I seriously question several assertions in the power plant viability report. It suggests (figure 2) that PHWR electricity would cost around \$A240 per Mwh. In Ontario the expected LCOE for new plant is \$C77 per Mwh^{iv}. I'm also puzzled by the view that rooftop solar installations will continue strongly when they have clearly declined from the 2010-2012 peak^v as feed-in tariffs are withdrawn. At this stage there is little evidence that batteries will have a disruptive effect on electricity supply. Recent east Australian electricity demand is not flat as claimed for SA but increasing about 1.7% a month^{vi} or just over 2% a year and by extrapolation could be 20% higher in a decade.

Note these suggested PHWR modifications are not first-of-a-kind. The standard EC6 plant to be built as Atucha 3 in Argentina^{vii} is expected to take 8 years to complete with Chinese finance. Admittedly Argentina like Ontario has prior experience with this kind of reactor and government guarantees may lower the cost of capital. The talk was of \$6 bn overnight cost for this reactor. Conceivably with impediments urgently cleared away such a reactor could be built here with Chinese help in the period 2017-2025. It would be seawater cooled sited on Fleurieu Peninsula or in the 'Iron Triangle' area at the top of the gulfs. The investment would be low regret even if technologically superseded since it has an ongoing job to do. Conversely if alternatives do not materialise the investment would be far sighted.

It has been suggested in other forums that SA dispatchable generators should consist of independent modules under 200 MW such as we see at the Torrens Island B gas fired power plant. For spinning reserve calculations the firm capacity of the PHWR proposed could be regarded as 500 MW. Conceivably if SA had a 1500 MW demand day while must-take wind and solar produced a high 1200 MW then that 500 MW would be unneeded particularly at a higher wholesale power price. Unless special provisions were made a 500 MWe minimum nuclear plant would have to be offlined while gas or imports filled the gap. To keep the reactor on load a spell of pre-emptive desalination at Pt Stanvac could top up the reservoir. That could use perhaps 85 MW based on the capacity of the onsite diesels. A new desalination plant using say 40 MW of grid electricity on Eyre Peninsula could conserve piped River Murray water for water stressed Pt Lincoln and help supply Olympic Dam. That second desal would replace the cancelled Whyalla 250 megalitre per day desalination plant. In so doing it would help close the loop on the nuclear fuel cycle since nuclear power would directly provide an input to uranium mining.

Modelling could determine how often a power surplus might occur, regrettably a consequence of the RET, an enforced quota system. What seems like excess generating capacity now could be justified if long term desalination, reduced river reliance, population growth, electric car charging, carbon pricing or a failed east coast baseload plant impose major energy needs in future. That's with or without other major projects going ahead such as defence contracts. I predict due to such extraneous factors SA will need more not less electrical generation hopefully with the right attributes regarding price, reliability and emissions. The alternative and currently probable outcome is greater electricity consumption that is expensive, unreliable and emissions intensive.

Co-locate domestic intermediate with domestic and foreign high level waste

In my opinion only a site in or near Woomera Prohibited Area will be widely accepted for high level waste. Suggestions in the media of Maralinga area seems at odds with the action of former Premier Rann in handing back a swathe of that country to the aboriginal community. Currently there are two mines inside the WPA that have decline tunnels, Challenger and Prominent Hill. The latter's Ankata decline is expected to be depleted by 2022. Miners wear dosimeter badges due to uranium mineralisation even though uranium is not mined. Groundwater is 40 km away. Recalling the views of RC witnesses from Finland and Sweden it meets the criterion of existing infrastructure not a greenfield site. Perhaps an existing mine could be modified to a layout similar to the facility under construction near Olkiluoto Finland. An above ground Intermediate level waste could be 'nearby' (under 100km in outback terms) also within the WPA and work in tandem with the geological repository.

If home grown high level waste initiated the geological repository that would act as an icebreaker for accepting foreign material. In contrast there is the possibility that a waste facility that exclusively used foreign material might be a sore point while SA electricity was expensive and potentially unreliable.

In summary

- If overseas funding leads to an SA waste facility well and good
- Make an early in-principle decision to combine intermediate and high level waste facilities in the Woomera area
- If no private waste funding is committed within a year or other electricity security issues weigh heavily consider current nuclear generating technologies
- In particular evaluate fast tracking a customised PHWR able to both load follow and re-use spent uranium fuel pellets
- With this or additional technology extend this to the foreign waste and domestic fuel cycling options after local experience.

Notes

ⁱ SA electricity reliability

<http://www.aemo.com.au/News-and-Events/News/News/Joint-report-further-investigates-stability-of-South-Australias-evolving-power-system>

ⁱⁱ East Australian gas outlook

<http://www.aemo.com.au/News-and-Events/News/News/Timely-gas-reserve-development-key-to-meeting-longterm-gas-demand>

ⁱⁱⁱ Once-through uranium and PHWR

<http://www.world-nuclear-news.org/E-The-AFCR-and-Chinas-fuel-cycle-11111401.html>

^{iv} PHWR LCOE in Canada

<http://www.cbc.ca/news/canada/toronto/bruce-power-1.3348633>

^v Historical uptake of PV in Australia

<http://www.cleanenergyregulator.gov.au/RET/Forms-and-resources/Postcode-data-for-small-scale-installations#Smallscale-installations-by-installation-year>

^{vi} Australia's increasing electricity demand

<http://www.pittsh.com.au/assets/files/Cedex/CEDEX%20report%20March%202016.pdf>

^{vii} PHWR construction in Argentina

<http://ansnuclearcafe.org/2014/09/24/presenting-atucha-iii/>