1. The role carbon neutral methane can play in reaching net zero

The penetration of wind and solar power generation in the electricity grid must become very high in order to move to a net zero emissions energy sector in Australia. This creates its own unique problems as these forms of generation are intermittent. There are periods where wind and solar:

- Produce for extended periods at low outputs (e.g., over a month), and
- Do not complement each other reliably in terms of when they are producing or where they are producing.

This gives rise to electricity supply reliability concerns which are becoming better understood and managed by system operators. But the issues for investors and customers is how much renewable energy storage investment will the system need, what is the nature of that storage and its utilisation, and how much will it cost?

South Australia's (SA) generation provides us with valuable real-world input data into modelling and simulating future net-zero generation and what the storage requirements might look like under circumstances where there are extended renewable energy "droughts".

Through this type of analysis, it becomes clear that carbon neutral methane can play a critical economic role using existing gas infrastructure, relative to other investment options.

1.1. South Australia as an example

OGW have examined the historical SA electricity sector data over a 2-year period (2019-2020). This real-world example demonstrates:

- The (current) reliance on highly flexible natural gas supply as a transition fuel;
- The criticality of the existing gas infrastructure and storage assets for that flexible supply, to achieve world class high levels of renewable electricity production in that state; and
- The commensurate much lower sector emission because of this mix (no coal generation in the state) - already at least a third of its neighbouring state of Victoria.

SA had the highest level of wind generation capacity within its energy mix of any Australian State or Territory (2,140MW). The central solar PV generation in SA was comparatively low (378MW), but rooftop solar PV penetration was relatively high (1,417MW) and SA is linked to Victoria with transmission capacity of 820MW. Renewable generation contributed 55% of the energy generated, supported by gas generation at 43%.

The SA data shows an extended period of 30 days (6/7/20-4/8/20) with a relatively low output of renewable electricity generation (23% wind, 4% solar) and the highest contribution of gas-fired generation (69%). This is due to well-known weather effects such as prolonged cloud cover impacting solar generation and high-pressure systems suppressing wind generation.

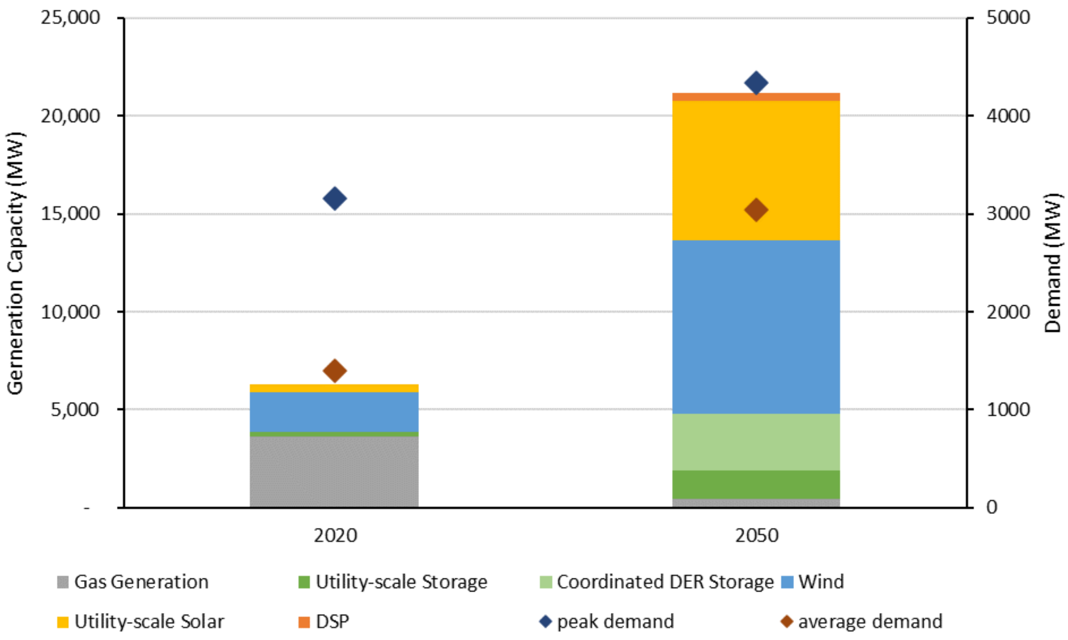
1.1.1. What does the 2022-ISP net-zero forecast for SA look like?

To understand what net-zero might look like for a scenario with an extended renewable energy drought, we looked at:

- AEMO's 2022-ISP Step Change Scenario forecast of the technologies and capacity that would be built in SA towards 2050, and
- Used the 2020 30-day central generation traces to simulate a possible outcome.

The analysis was kept simple to understand the likely magnitude of the firming energy required and worked on the premise that when there was a renewable energy drought in SA, this was also the case in the neighbouring states that are connected by transmission to SA (as the correlation was not considered firm enough for State inter-dependency).

Figure 1: Capacity and demand for SA now and in the net-zero future



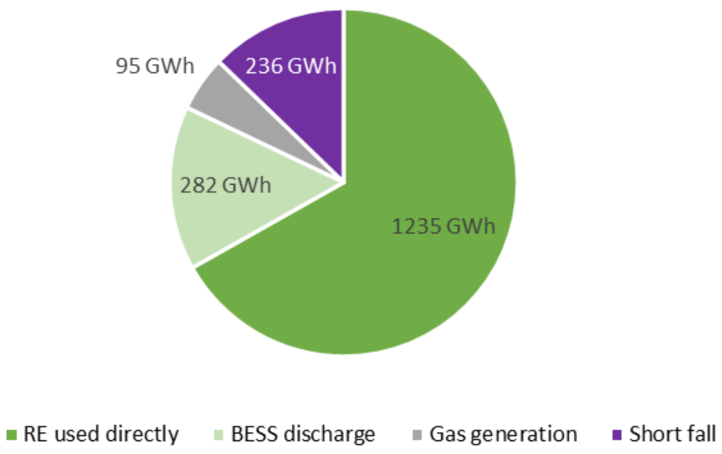
Source: OGW Modelling using SA data and ISP Step Change Scenario forecasts - note peak demand increases by approximately 1,000MW by 2050.

Figure 1 shows that the changes forecast by the 2022-ISP produces a significant reduction in firming gas generation from around 3,600MW today to only 426MW in 2050. The 2022-ISP scenario shows a move to a reliance on (dispatchable) battery storage of 4,376MW to provide firming, and a significant over-build of renewables at 16,000MW to manage peak demand. The battery storage forecast is short duration (2 to 12 hours) and relies on 66% of the capacity coming from co-ordinated behind-the-meter storage.

1.1.2. How does this future scenario work with a renewable drought?

We ran the 30-day historical renewable energy drought with the 2022-ISP forecast capacities using a simple time-sequential model to test the outcomes and this is shown in Figure 2. The short fall of energy required is 236 GWh (shown by purple wedge) and would need to be supplied (firm) from interstate or deep energy storage e.g., would consume 2/3 Snowy 2.0 storage in 30 days.

Figure 2: Wind drought outcomes using the 2022 ISP forecasts for 2050.



Source: OGW Modelling

The 2022-ISP doesn't include carbon neutral methane such as biomethane or renewable methane in its input assumptions but is it feasible as an alternative to close the shortfall gap?

- The 236GWh short fall for the 30-day drought equates to only 2.6PJ of carbon neutral methane, and
- For the entire 12 months under the net-zero scenario requires only 10 PJ in total to firm the renewable generation for SA.

This relatively small quantity of carbon neutral methane can be feasibly sourced from bioenergy/biomethane developments[1] and from the methanation of the carbon dioxide that would also come from the production of biomethane. Carbon neutral methane production at economic costs is the key as it is of pipeline quality and can use all the existing gas infrastructure.

- Gas storage on the east coast alone is some 150 PJ or 40,000 GWh equivalence.
  - This would produce 20,000 GWh through a gas generator (at 50% efficiency) representing a huge renewable electricity storage "battery" (e.g., 60 x Snowy 2.0).

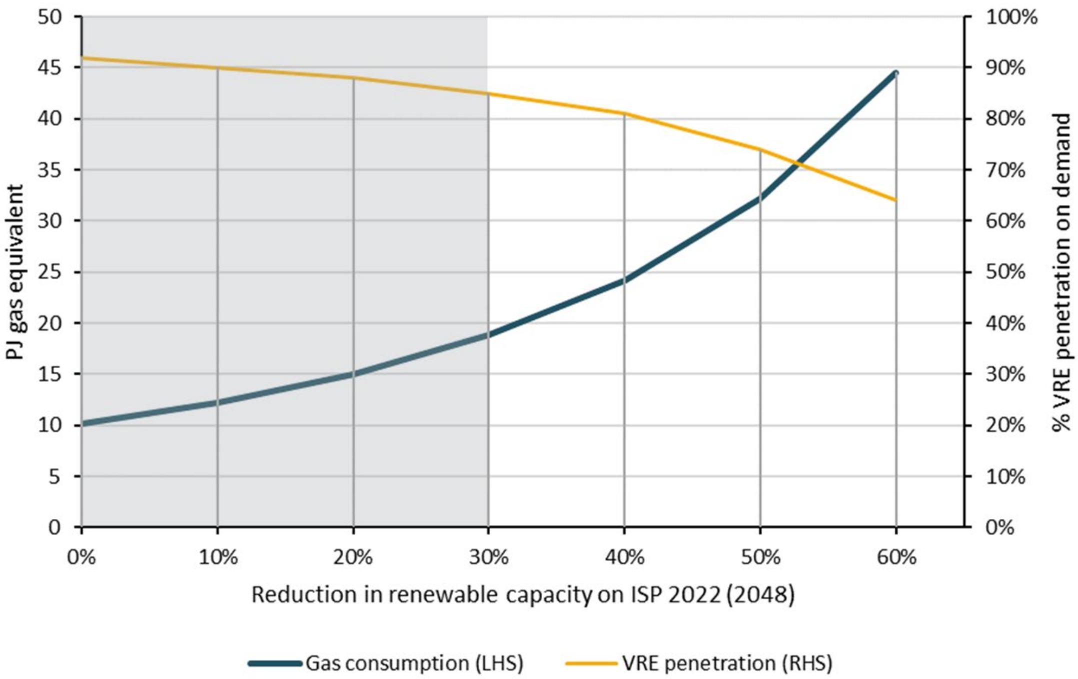
1.1.3. Diminishing return of renewable energy over-build

We examined how much further carbon neutral methane can contribute to the economic outcomes in the future - the volume of gas required and its impact in reducing the capacity of renewable generation installed in the 2022-ISP forecast for 2050. As shown in Figure 3 it only takes an additional 10 PJ of carbon neutral methane to yield a reduction of 30% of installed renewable capacity (approximately 4,700MW).

While the modelling is simplified and not economically optimised, it does highlight the benefits that the inclusion of carbon neutral methane as energy storage using the existing gas infrastructure (sunk assets) can bring in reaching net-zero by 2050, and significantly reduce the renewable energy overbuild.

1 Australia's Bioenergy Roadmap, Enea and Deloitte for ARENA, November 2021

Figure 3: Influence of the use of carbon neutral methane and the renewable generation penetration.



Source: OGW Modelling

A more detailed paper will be published in the near future.

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