CORNWALL INSIGHT
AUSTRALIA

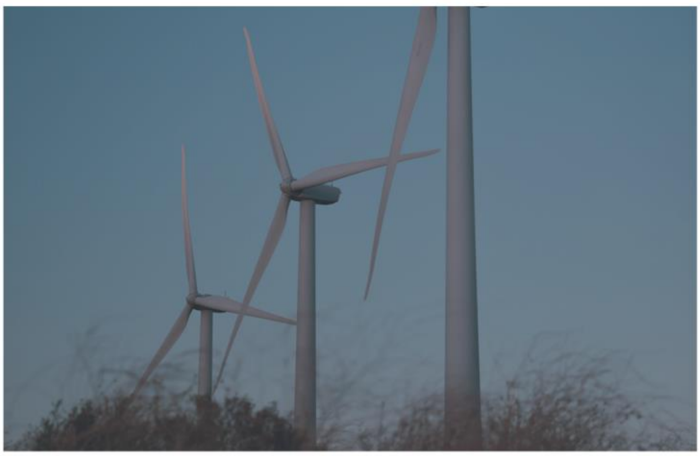
CREATING CLARITY

Essential System Service Modelling

Addendum – Additional Scenario

A report prepared for the Energy Security Board

12 August 2021



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Getting to grips with the intricacies embedded in energy markets can be a daunting task. There is a wealth of information online to help you keep up-to-date with the latest developments, but finding what you are looking for and understanding the impact for your business can be tough. That's where Cornwall Insight Australia comes in, providing independent and objective expertise. You can ensure your business stays ahead of the game by taking advantage of our:

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1 Introduction

Cornwall Insight was previously engaged by the Energy Security Board (ESB) to assess the potential benefit of the proposed reform package for system strength provision, which includes a TNSP-led structured procurement mechanism to deliver an efficient level of system strength on a forward looking basis, and proposed operational scheduling mechanism (such as the Unit Commitment for Security and/or the System Security Mechanism) to schedule this service potentially to an efficient level.

In our previous report, we modelled a world where system strength is provided solely by existing technologies such as synchronous generators, pumped hydro, and synchronous condensers (syncons). The modelling found that in such settings, the NPV of the reform benefit (between FY22/23 and FY39/40, discounted at 5.9% to FY21/22) would be $1.2Bn. This includes a CAPEX saving of $2.1Bn at the expense of an $0.9Bn OPEX increase. The reform package could enable TNSPs to more effectively utilise non-network solutions provided by synchronous generators and pumped hydro, which would reduce or postpone the need for network solutions (i.e., building syncons). The reform would also lower the cost of network solutions, as TNSPs could procure them at an efficient level, achieve economy of scale, and enable resources to share these centrally procured system strength assets.

The previous report noted that the above estimate was an upper bound of the reform benefit. This was because we modelled a scenario with minimal commercial uptake of more advanced inverters (including grid-forming inverters), and new system strength investment comes in the form of only synchronous condensers. The assumptions also reflected a conservative view of technological process that may help to address system strength shortages, namely a conservative view of the amount of system strength services required by inverter-based generation to connect and operate stably out to 2040.

It is likely that more advanced inverters (including grid-forming inverters) could see widespread commercial uptake within the modelling timeframe, resulting in lower cost, as well as smaller amounts of system strength supply. This would likely reduce the amount and cost of system strength that needs to be supplied by traditional synchronous resources in both the reform and no reform cases, reducing the overall reform benefit.

Cornwall Insight has been engaged by the ESB to model the additional scenario representing a world with widespread uptake of advanced inverters and present our findings in this addendum. In summary, the estimated NPV of reform benefit in this scenario is $521.8Mn, which consists of an increase in OPEX of $185.6Mn and a CAPEX saving of $707.4Mn. Together with the previous scenario, the additional result provides a range of estimated reform benefit between $521.8Mn and $1.2Bn in NPV terms. This can be considered to represent the lower bound benefits.

For brevity, we will refer the readers to the previous report for detailed methodology as well as modelling inputs and assumptions. This addendum will outline the changes in assumptions we made in the new modelling and will present the key results from both scenarios side by side for ease of comparison. The rest of this report is organised as follows:

- Section 2 outlines the new input assumptions used for this additional scenario.
- Section 3 presents the key results from the new scenario together with the corresponding results from the previous run.

2 Assumptions used for additional modelling

The additional scenario represents a future world where advanced inverters such as grid-forming inverters are widely adopted by new inverter-based resources (IBR), which requires significantly less system strength (represented in MVA fault capability) to support their output. At the time of our modelling, there is limited information on the cost of advanced inverters and lack of any industry-wide consensus regarding their uptake trajectory. As the new modelling is intended to provide a lower bound of the reform benefit, we modelled a hypothetical scenario where the widespread uptake of advanced inverters occurs throughout the entire modelling period from FY22/23 to FY39/40. The adoption of advanced inverters is treated as an exogenous factor in our model and applies to all new IBR entering from FY22/23 for both the reform and no reform cases. This has led to the following changes in modelling assumption in the new scenario:

Lower SCR ratio modelled

The adoption of more advanced inverters is assumed to significantly reduce the amount of system strength required to host IBR output in the new scenario. Based on discussion with the ESB, we assumed the following:

- A short circuit ratio (SCR) of 0.5 for new solar and wind farms (i.e., 0.5 MVA fault capability to support 1 MW output). The ratio was 3 in the previous scenario. However, existing and committed solar and wind farms continue to require an SCR of 3.
- Batteries do not consume or supply system strength. In the previous scenario, an SCR of 3 was applied to batteries as well.

Due to data limitation, we assumed that the SCR requirement, while significantly lowered due to widespread uptake of advanced inverters, is met by syncons, synchronous generators and pumped hydro. If new innovation became available to meet SCR requirement at lower costs, they would do so in both the reform and no reform cases and would likely further reduce the reform benefit.

Lower minimum system strength requirement for NSW and Queensland

Based on discussion with ESB to obtain a lower bound in the additional modelling run, we have reduced the minimum system strength requirement in NSW and QLD by 1/3 (noting this does not represent AEMO's view or actual practice in the future). As a result, the new minimum requirement (in MVA fault capability) is 10,613 and 6,369 respectively for NSW and Queensland in the new scenario. While this represents an extreme view of what the minimum requirement could be in NSW and Queensland, we consider this appropriate for the purposes of this additionally modelling run that reflects system conditions out to 2039. However, this should not be taken as a reflection of current market dynamic, nor of existing system conditions.

Modelling investment for minimum system strength requirement in the no reform case

In the previous scenario, we did not explicitly model syncon investment for minimum system strength in the no reform case. As new IBR were previously assumed to bring their own syncons to meet an SCR of 3 in the no reform case, this led to large amount of syncon investment. Assuming these syncons could be turned on by TNSPs or AEMO, they would supply enough system strength to meet the minimum requirement.[1]

With the widespread uptake of advanced inverters, it is unclear whether the minimum system strength requirement would be reduced, or whether IBR with advanced inverters could contribute to the supply for minimum system strength. We took the conservative approach by assuming the minimum system strength requirement in each region stays constant over the modelling period (as

[1] *If we were to assume TNSPs had to ignore these syncons and invest additionally to meet the minimum requirement in the previous no reform case, it would lead to even higher reform benefit.*

they did for the previous scenario) and only synchronous generators, pumped hydro and syncons can contribute to this requirement. Due to the low SCR of 0.5 for new IBR plant, syncons brought by individual entrant in the new no reform case might not be enough to supply minimum strength (together with other synchronous generation that are online for economic reasons) in some regions. Therefore, in the new no reform case, we have explicitly modelled investment by TNSPs to meet the minimum requirement.[2]

[2] *Note in the no reform case, it is assumed that TNSPs cannot effectively utilise non-network options including contracting with generators and pumped hydro due to the lack of operational scheduling mechanism.*

3 Results

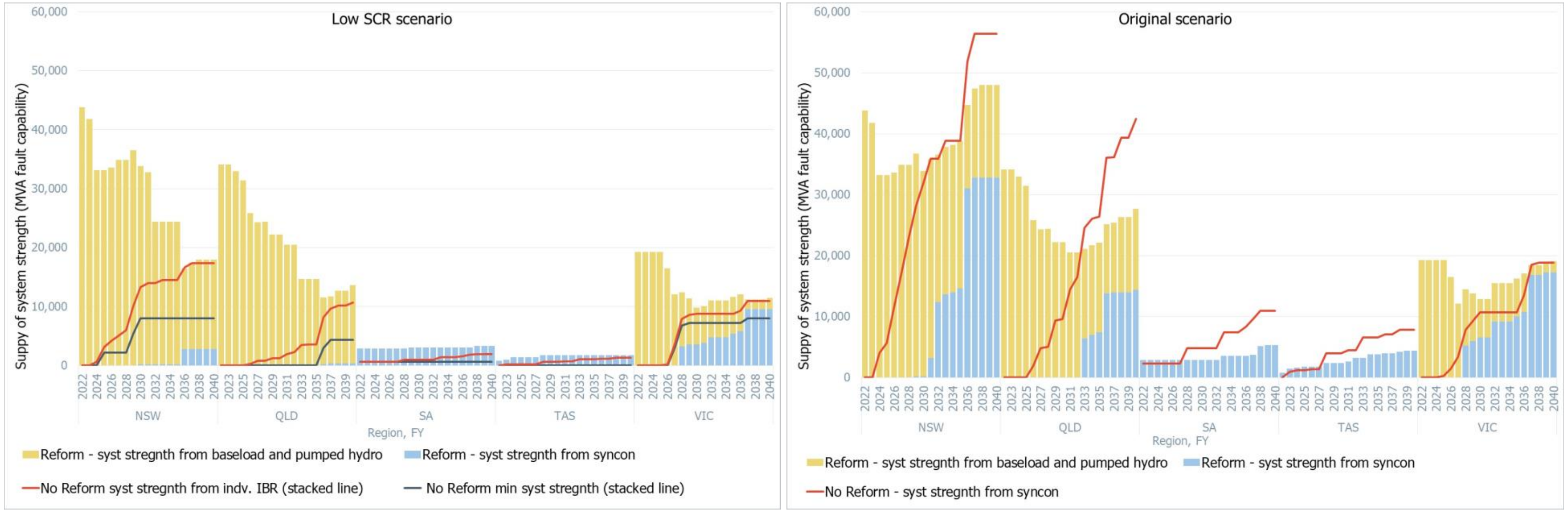
Due to the low SCR required to host new IBR output, the removal of batteries from system strength demand, and the lower minimum system strength requirement in NSW and Queensland, the new scenario has less investment in syncons in the reform case (Figure 1). The reduction is most significant in NSW and Queensland due to their reduced minimum system strength requirement. In addition, both regions have a large amount of pumped hydro (and ~2000 MW coal in Queensland) in later years, which could be used as non-network solutions by TNSPs to provide system strength in the reform case. The model shows Victoria has the highest need for syncon investment in the new scenario, due to its lack of coal units and lack of sufficient quantity of pumped hydro post 2035.

Figure 1 System strength investment vs change in synchronous and IBR capacity – Reform case

Source: Cornwall Insight

Figure 2 presents the comparison of syncon build in the reform (shown as blue staked bars) and no reform (show as stacked lines) cases. In the new scenario, we explicitly modelled investment for minimum system strength in the no reform case. Due to the low SCR assumption, syncons invested by individual entrants are not sufficient to provide minimum system strength. This has led to some additional syncon investment (blue lines) in NSW, Victoria, and Queensland, mostly in late years following the retirement of coal units. In the reform case, TNSPs are able to effectively contract with the remaining synchronous generators and pumped hydro to provide system strength to both meet minimum requirement and host additional IBR output. Therefore, we have shown system strength that could be provided by these non-network options as the yellow stacked bars on top of syncon investment in the reform case. In later years, the total system strength provided in both cases are similar, but TNSPs are able to avoid significant CAPEX in the reform case by utilising non-network options.

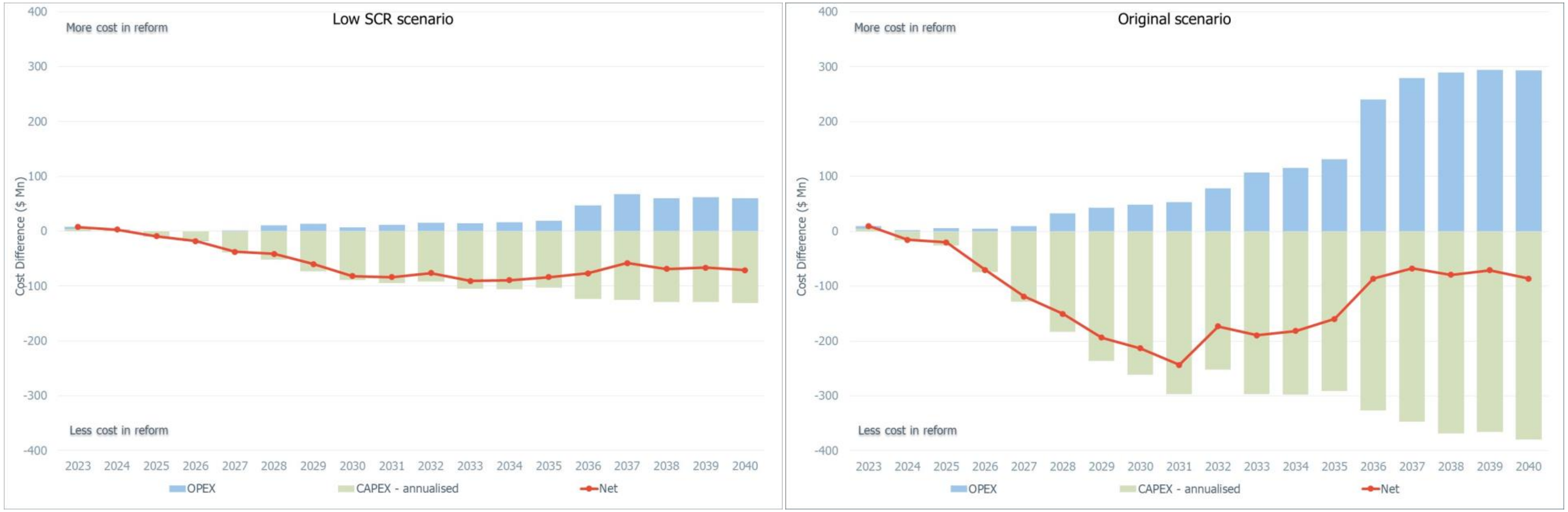
Figure 2 Syncon build comparison, Reform vs No Reform



Source: Cornwall Insight

The total annual cost difference is shown in Figure 3. In the new scenario, the estimated NPV of reform benefit is $521.8Mn, which includes changes in OPEX ($185.6Mn increase) and annualised CAPEX ($707.4Mn saving) between FY22/23 and FY39/40, discounted to FY21/22 at 5.9%. In comparison, the NPV benefit in the previous scenario was $1.2Bn, including an increase in OPEX of $0.9Bn and a CAPEX saving of $2.1Bn. The cost differences in the current scenario are lower, as the smaller SCR means there is lower demand for system strength and hence less procurement in both the reform and no reform cases. Together with the previous scenario, our modelling provides a range of reform benefit between $521.8Mn and $1.2Bn.

Figure 3 Overall cost difference by year



Source: Cornwall Insight Australia

Figure 4 presents more details on the comparison regarding operating cost and generation pattern between the reform and no reform cases. Consistent with Figure 3, lower SCR means there is lower system strength demand, which leads to less instances of IBR curtailment. This has led to smaller difference in generation mix and reduced the OPEX gap between the reform and no reform cases compared to the previous scenario.

Figure 4 Annual operating cost (top) and change in generation mix (bottom), Reform vs No Reform

Source: Cornwall Insight

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