CLEAN ENERGY COUNCIL

Monday, 23 June 2025

AEMO Draft *2025 Electricity Network Options Report* submission

The Clean Energy Council (CEC) is the peak body for the clean energy industry in Australia, representing nearly 1,000 of the leading businesses operating in renewable energy, energy storage, and renewable hydrogen. The CEC is committed to accelerating the decarbonisation of Australia's energy system as rapidly as possible while maintaining a secure and reliable supply of electricity for customers.

The CEC welcomes the opportunity to respond to AEMO's Draft 2025 *Electricity Network Options Report* (ENOR). The AEMO *Integrated System Plan* remains one of the most important blueprints for the NEM transmission system, and this report is a key input into it.

The CEC has engaged extensively with members to explore the kinds of network augmentation options could be delivered to increase hosting capacity on the network. The suggestions below contain some cost estimates. The CEC urges AEMO and associated planning agencies to assess these options, in addition to those set out in the Report, with a view to exploring their ability to increase network hosting capacity.

The CEC offers the following key recommendations to strengthen the Draft 2025 ENOR and ensure alignment with the ISP's objective of delivering a least-cost, secure and reliable net-zero transition:

1. **Unlocking NSW N5 South-West REZ wind generation –** Many CEC members consider the N5 South-West REZ contains some of NSW's highest-quality wind resources, with capacity factors of 40–45%, offering some of the lowest levelised costs of wind energy in the state. Members also consider the region also presents minimal environmental impact (given existing land clearance), enjoys strong community support, and is subject to limited social-license risk.

   Despite these advantages, around 31 GW of projects in the planning system were unable to secure access rights in the REZ, demonstrating latent demand. In this submission, the CEC outlines **seven** additional transmission options to unlock this potential—ranging from cost-effective "quick wins" to a "Super REZ" vision with 12.5 GW hosting capacity. These options should be considered in the final ENOR.

   The CEC believes the optimal way forward for these proposed options would be:

   1. Initially implement Option 4A (or 4B) as a "Quick Win" for $81M to immediately unlock existing transmission assets (825 MW wind generation pre-2030)

   2. Then implement Option 5A (or 5B) for $1.4-2.6B to fully utilise the existing 500kV with some 330kV upgrades (2,420MW wind generation early-2030s)

   3. Finally implement Option 6A, 6B or Option 7 for $5.0-8.0B in the medium term to become a "Super REZ" – similar to CWO or New England REZs (4,840-6,600 MW wind generation by mid-2030s)

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This is discussed in more detail in the subsequent sections below.

2. **Unlocking more value in existing assets using BESS SIPS and runback schemes –** Given the cost, difficulty and lead times associated with new transmission, projects which unlock capacity on existing transmission present highly efficient "quick win" opportunities. The two best ways to do this is through BESS SIPS and runback schemes.

   While runback schemes are often not preferred due to the added engineering and operational complexity, they should still be considered as the substantial value they can deliver in terms of bringing low-cost energy to the market quickly can likely justify their cost in many scenarios. They can present "quick wins" and accelerate bringing renewable projects to market as interim solutions while longer term transmission projects get built.

   AEMO should consider more runback and BESS SIPS schemes wherever transmission lines are limited due to N-1 constraints (particularly where the focus is unlocking power flows in one direction – i.e., from a REZ to the load centre).

   The CEC notes AEMO's recently released General Power System Risk review, which considers the complexities and challenges associated with these remedial action schemes. However, we consider these schemes, if carefully designed and maintained, offer unique capabilities to markedly increase the economic value of transmission networks by increasing the utilisation of those networks.

3. **Large scale BESS SIPS projects –** Substantial cost savings can be gained on BESS "virtual transmission line" / System Integrity Protection Schemes (SIPS) by having multiple transmission lines protected by the same BESSs. Given that the incremental cost of having a single BESS participating in multiple SIPS schemes is negligible, it effectively reduces the cost of each additional transmission line added to the scheme.

   These BESS SIPS don't need to be individual BESS projects and can be made up of multiple BESSs participating in the scheme (adding a level of reliability through diversification) – or even existing projects like Waratah Super Battery that can be utilised for more schemes.

   AEMO should consider strategic BESS SIPS projects located in load centres that are then utilised to unlock capacity of as many transmission lines as possible in that region.

   This is discussed in more detail in the subsequent sections below.

4. **HVDC transmission capacity underrated –** Several HVDC transmission options in the ENOR appear significantly underrated in terms of transfer capacity. For example, the proposed 932 km, 500 kV double-circuit HVDC line for Broken Hill REZ is rated to only 1,750 MW, or the proposed 110km HVDC line from Heywood to South East SA is only rated for 1,500MW—well below typical transfer capacities of HVDC projects.

   Contemporary 525 kV single-circuit HVDC designs can support 3,000–4,000 MW, while 800 kV systems can exceed 8,000 MW. Bipole configurations maintain 50% capacity under single faults, and contingency impacts should be addressed through BESS "virtual transmission line" schemes at the receiving end to allow the lines to run at full capacity.

   If the limited capacity is due to downstream network constraints, the ENOR should also assess what complementary augmentations are required to unlock full HVDC potential. Larger-scale HVDC projects are only viable if they unlock proportionally large volumes of hosting capacity in high-quality REZs like Broken Hill.

   The only way that these "mega-scale" HVDC projects will stack up is if they unlock an equivalent "mega-scale" amount of hosting capacity in regions with high levels of renewables (and Broken Hill REZ is one of them), so the project should be designed with that in mind.

5. **Undersized 500kV transmission capacity –** Similar to the previous comment on HVDC, a similar concept applies to some of the proposed 500kV double circuit transmission line projects, which appear to have a lower proposed rating than what would be expected. Without unlocking sufficient hosting capacity, these projects would be unlikely to stack up in terms of financial value. If the reason for the limited capacity is due to downstream constraints, then the option should also consider the package of works required to unlock those constraints.

   For example, in Section 3.17, Option 3 involves a 347km 500kV double circuit line from Bundey-Yunta-Cultana East, however this option only unlocks a 1220MW capacity – below the typical expected capacity of a double circuit 500kV line (2200-2800MW for N-1). In comparison, some of the 500kV double circuit options considered have a 3000MW capacity per circuit. Given the high cost of a 500kV double circuit line, this option would only make sense if it unlocked a lot more hosting capacity.

6. **Recognising reduced social license risk for existing transmission corridors –** the ENOR describes that the process for including social license considerations via land use mapping. We believe another important consideration is the existence of existing transmission assets. Eg, building a new transmission line in parallel to an existing transmission line has substantially lower social license risk than building an entirely new transmission route.

In general, we also see more opportunity to explore more ambitious and larger network augmentations to support large load growth as per the *Green Energy* scenario in the draft 2025 *ISP IASR*, such as: large capacity (4 GW+) HVDC lines into remote in-land REZs with high renewable resources, and more high capacity interconnection options between regions/sub-regions.

N5 South-West REZ – a high quality wind resource in NSW

Many CEC members have advised that the N5 South-West REZ presents some of the best wind generation resources in NSW:

- **Excellent wind resource validated by on-site measurements –** Multiple CEC members have advised the wind resource in N5 South-West REZ is some of the best in NSW, with projects in the area having capacity factors in the range of **40-45%** (depending on which wind turbine model is used).

  Members advise these capacity factors have been validated by years of on-site measurement data (from met masts, LIDARs and SODARs), making it reliable. AEMO Services and Energy Corporation of NSW will have access to this data based on the recent South-West REZ Access Rights tender. Wind resource can be very hard to predict based on wind maps (due to the impact local features have on the wind dynamics) and it is not uncommon for developers to begin to prospect projects based on wind maps, only to cease those projects once on-site.

  Why does capacity factor matter?

  Levelised Cost of Energy (LCOE) is an indication of costs divided by yield. Capacity factor is an assessment of average yield compared to the capacity of the facility. This means for comparison:

  - Increasing a plant's capacity factor by 1% from 40% results in a **2.5% decrease** in LCOE.
  - N5 South-west REZ wind (assume 44% cap factor) is up to **25% cheaper** than the ISP assumptions for wind in New England REZ (36% cap factor)
  - The ISP assumption of 29% capacity factor for N5 South-west REZ overstates the LCOE by **40% extra cost**, misrepresenting the competitiveness of this zone.

- **Flat topography and high hosting capacity –** Unlike REZs constrained by topography (e.g., New England, where wind must be sited on ridgelines where the wind resource is concentrated), N5 South-West offers large expanses of flat land. This allows for more widespread turbine deployment at larger capacities without lowering that capacity factor.

- **Cheaper to build –** The site is expected to have lower capex costs than many other regions. Comparing with New England REZ for instance, N5 South-west REZ is flat, cleared land – while New England REZ is reliant on wind turbines being installed onto hilly or uncleared terrain, which is more expensive to build. The area has also already been extensively assessed for transport, constructability, accommodation, etc. by the many projects in the area.

- **Environmental and Planning Approvals Impact –** The majority of the land where projects are located is historically disturbed land already cleared for grazing or cropping, and hence there is minimal environmental impact across the whole REZ. Other key planning approvals risks such as visual amenity and noise amenity are broadly lower than other REZs due to the region's low population density.

- **Social License –** There is support for the wind farms in the region from landholders, local councils, Traditional Owners and the local community.

This is validated by it being one of the most popular areas for renewable project development in Australia with an estimated 35 GW of projects in the planning system (19.65 GW wind, 10.17 GW BESS and 4.54 GW solar) which all competed for the 3.56 GW of access rights for grid capacity. There are **31 GW worth of projects still seeking a pathway** for their energy.

Many of these projects are in the later stages of development, with years of wind measurements, land agreements, years of community consultation, extensive ecological surveys, tender prices for construction and engineering studies having already been completed. Through this stage, many of the major project risks have already been retired (such as poor wind resource, community opposition, construction pricing or significant environmental impact) meaning that there is high confidence that these projects can be built if they just had more transmission capacity.

This is in comparison with many of the other proposed regions for augmentation discussed in AEMO's draft 2025 *Electricity Network Options Report* which have far less projects, or less-advanced projects, as in the N5 South-west REZ, and still subject to some of the risks that may render projects unviable.

Transmission Options for unlocking the N5 South-West REZ

The draft *AEMO Electricity Network Options Report 2025* includes a good start of considered options which include to unlock further capacity in the N5 South-west REZ:

1. Option 1 (**1,300 MW**) – Converting the existing Dinawan<>Wagga<>Gugga 330 kV double circuit line to 500 kV

2. Option 3 (**250 MW**) – BESS SIPS scheme in Sydney/Newcastle/Wollongong load centre

The report also discusses two options in SNSW-CNSW (Section 3.9) which effectively unlock substantial transfer capacity from Dinawan (effectively South-West REZ) to Sydney, but aren't framed as being N5 South-West REZ projects:

3. SNW-CNSW Option 3 (**6,000 MW**) - new 500kV double circuit line from Dinawan-Gugaa-Bannaby

4. SNW-CNSW Option 4 (**3,000 MW**) – new 500kV single circuit line from Dinawan-Gugaa-Bannaby

The CEC believes that given the strategic potential to N5 South-West REZ in accelerating the energy transition and reducing LCOE to NSW consumers, it is important for more options to be assessed, from "quick wins" to considering strategic transmission build-out opportunities. This is particularly the case given many other ambitious options considered in the report (such as the Broken Hill to Bannaby HVDC transmission line).

It is worth noting that the focus of CEC's members is about unlocking transmission capacity from N5 South-West REZ into the Sydney-Newcastle-Wollongong (SNW) load centre. It is less critical to unlock transfer capacity into South Australia (as it is not forecast to be common for NSW to export large amounts of wind capacity to South Australia).

The CEC's members have proposed several possible projects that could do this of which more detail is included in the **Appendix** of this submission. These options assume that all ISP projects deemed committed, anticipated and actionable projects are built.

The table below is a summary of these options:

Option	Extra Transmission Capacity from SW REZ to SNW load	Hosting Capacity	Cost	Description
4A	**750 MW** (750MW on 330kV)	825 MW wind 750 MW solar 375 MW BESS **= 1,950 MW**	**$81M**	**Maximise use of existing transmission with a runback scheme** • 750 MW runback scheme on SW REZ generators for trip of one of the 330 kV PEC or 500 kV PEC lines • 750 MW contingency covered by FCAS market • Additional 500/330 kV transformer at Dinawan
4B	**750 MW** (750MW on 330kV)	825 MW wind 750 MW solar 375 MW BESS **= 1,950 MW**	**$301M - $748M**	**Runback scheme + BESS SIPS** • 750 MW BESS "Virtual Transmission Line" SIPS (located in SNW load centre) • Avoids the need for the 750 MW runback to be covered by the FCAS market
5A	**2,200 MW** (2200MW on 330kV)	2,420 MW wind 2,200 MW solar 1,100 MW BESS **= 5,720 MW**	**$1,463M - $2,592M**	**Additional 330 kV SW REZ Transmission + Unlock 500 kV Capacity with BESS SIPS** • New Double Circuit 330 kV twin-sulphur transmission line from Dinawan to the furthest new generator in SW REZ (~220-300 km) • 6-bay switching station at that location to terminate the new 330 kV lines to existing 330 kV PEC • 2x 330 kV feeder bays at Dinawan • 2.2 GW inter-trip scheme for SW REZ generators for trip of 500 kV PEC or HumeLink line • 1450 MW BESS "virtual transmission line" scheme to cover for the contingency • 750 MW contingency covered by FCAS market • 2x Additional 500/330 kV transformers at Dinawan • 2x STATCOMs for voltage support
5B	**2,200 MW** (2200MW on 330kV)	As above	**$1,684M – $3,257M**	**Option 5A but no reliance on FCAS Contingency market** (ie, all runback/inter-trip volumes are covered by the BESS SIPS)
6	**4,400-6,000 MW** (2800MW on 330kV)	4,840 MW wind 4,400 MW solar 2,200 MW BESS **= 11,440 MW** To 6,600 MW wind 6,000 MW solar 3,000 MW BESS **= 15,600 MW**	**$4,998M**	**SNSW-CNSW Option 3 (double circuit 500kV line Bannaby-Gugaa-Dinawan) + 330 kV circuits in SW REZ** • 450 km double circuit 500kV transmission line from Bannaby to Gugaa to Dinawan • 4x Additional 500/330 kV 1500 MVA transformers at Dinawan • 384 km double circuit 330 kV transmission line from Dinawan to Buronga • 2x 330 kV feeder bays at Buronga • 2x 330 kV feeder bays at Dinawan • 2x STATCOMs for voltage support at Bannaby and Gugaa *No BESS SIPS, runbacks or inter-trips in this option.*
6B	**4,400-6,000 MW** (4000MW on 330kV)	As above	**$5,264M - $5,798M**	**Option 6A but with an additional 1200MW BESS SIPS scheme** to run all 330kV circuits between Buronga and Dinawan at 100% thermal capacity.

Option	Extra Transmission Capacity from SW REZ to SNW load	Hosting Capacity	Cost	Description
7	**4,800-6000 MW** shared between N5 South-west REZ and N4 South Cobar REZ (2800MW on 330kV)	5280 MW wind 4800 MW solar 2400 MW BESS **= 12,480 MW** to 6600 MW wind 6000 MW solar 3000 MW BESS **= 15,600 MW**	**$7,954M**	**Unlock capacity of South-west REZ via *N13 South Cobar*** Both of the following options from the *Electricity Network Options Report* are built, unlocking capacity in both South Cobar REZ and in South-west REZ: • Option 2 – 500 kV double circuit line from Dinawan to South Cobar substation • Option 3 – 500 kV double circuit line from South Cobar substation to Elong Elong substation (Central West Orana REZ) • 330kV double circuit transmission lines between Dinawan and Buronga for SW REZ generator connections • 4x 1500 MVA transformers at Dinawan *No BESS SIPS, runbacks or inter-trips in this option.*

It's worth noting that all options except for Option 7 involve assets augmentations being within or beside existing transmission corridors, which substantially reduces the social license risk when compared to building entirely new corridors in greenfield areas.

The CEC suggests an optimal pathway would be:

1. Initially implement Option 4A (or 4B) as a "Quick Win" to immediately unlock existing transmission assets (delivering **825 MW** wind generation **pre-2030**)

2. Then implement Option 5A (or 5B, 5C) to fully utilise the existing 500kV with some 330kV upgrades (unlocking an additional **1,760-2,420MW** wind generation **early-2030s**)

3. Finally implement Option 6B or Option 7 in the medium term to develop SW REZ into a "Super REZ" (to deliver **4,840-6,600 MW** wind generation by **mid-2030s**)

It should be noted that some of these solutions may require an increase in capacity from Bannaby into SNW load centres (ie, the CNSW-SNW constraint). Given that these constraints exist for many of the other proposed options assessed in the *Electricity Network Options Report*, we have focused on simply getting to the energy at Bannaby. AEMO would need to look at these options in conjunction with the projects proposed in CNSW to SNW section of the ENOR (Section 3.8) that unlock this capacity.

Efficient use of BESS SIPS schemes

The *Electricity Network Options Report* includes several options for BESS SIPS to unlock capacity on transmission lines (by acting as a virtual transmission line).

However, to get the most value out of the transmission network, the CEC proposes the following:

- **One BESS, multiple schemes –** the cost of installing a single BESS "virtual transmission line" scheme to unlock capacity in a single transmission line corridor is equal to the cost of a short-duration BESS of the required MW (likely 30-min to 1 hour storage duration). From the CSIRO GenCost report, this is ~$889/kW in 2025.

  However, the incremental cost of using this same BESS to operate in a SIPS for a second transmission line of equal or less capacity has **negligible cost**.

  Since multiple transmission lines (on different towers) tripping simultaneously is not a credible contingency, the BESS can more efficiently be utilised by proposing BESS projects that are integrated into multiple schemes.

  It is important to note that this does not mean the scheme needs to be a single BESS; rather a portfolio of BESSs could be included into the same series of schemes.

  The CEC proposes that AEMO should consider in its *Electricity Network Options Report* concepts that involve identifying multiple transmission line constraints that can be unlocked simultaneously through a single BESS scheme.

- **Greater utilisation of BESS SIPS –** The goal should be that any power flow routes that are effectively transporting active power from renewable generation to the load centres should be running at as close to 100% of the thermal capacity as possible through the use of BESS SIPS (and any additional reactive plant required for the greater power flows).

  While designing such a system may be complex from an engineering perspective (with BESS virtual transmission lines needing to be matched with equivalent inter-trips in these zones), it would still be substantially cheaper than building new transmission lines (particularly given the cost of transmission lines are increasing, while the cost of BESSs are decreasing). Unlocking further generation capacity in high-resource areas will be critical to lowering power prices in NSW.

- **BESS only needed on one side if inter-trips/runbacks are used –** if we only need to unlock capacity in one direction (i.e., from REZs to load centres), we can install a single BESS on the Sydney side and an equivalent intertrip or runback scheme on the generators, saving the need to have BESS SIPS on both sides of the line.

What is a runback scheme, "virtual transmission line" or System Integrity Protection Scheme (SIPS)?

Transmission lines are operated to ensure the system remains secure post-contigency. This often means that major double-circuit transmission lines can only use the "emergency rating" of one of their lines (which is expected to carry the full pre-contingency load if the other transmission line experiences a fault). This can become a lot more complicated in meshed networks.

Extra power can be sent down the transmission line with the use of an inter-trip or fast runback scheme, where both circuits of the transmission line might be loaded to full capacity pre-contingency. When one of the transmission lines is disconnected due to a fault, a signal is sent to disconnect a level of generation that would ensure that the other transmission line remains below its emergency rating (when separating interconnectors between regions, an inter-trip also ensures that the other region doesn't experience excess generation and frequency spikes). The loss of generation which occurs after such an inter-trip scheme can be covered by the FCAS Contingency market (as the market sees it as no different than the loss of a generator).

Where the size of the inter-trip would exceed the largest single contingency for which FCAS is procured for (750 MW in NSW), then a BESS acting as a "virtual transmission line" can unlock further capacity. A BESS system can reserve capacity equal to the size of the contingency, and then when the line is tripped, a signal can be sent to that BESS to dispatch an equivalent amount of energy.

These recommendations are intended to help AEMO achieve its objectives of delivering a secure, reliable and affordable net-zero energy system. Unlocking high-capacity REZs like South-West NSW, optimising transmission investments with efficient BESS use, and fully aligning with NSP plans will be essential to Australia's clean energy future.

The CEC acknowledges and thanks staff from Windlab for their particular support in the development of this submission. Many other CEC members also contributed to the detail of this submission.

The CEC welcomes the opportunity to engage with AEMO and other relevant agencies on the detail of this report and will convene relevant representatives from key CEC member organisations accordingly.

Further queries can be directed to James Eastcott at jeastcott@cleanenergycouncil.org.au.

Kind regards

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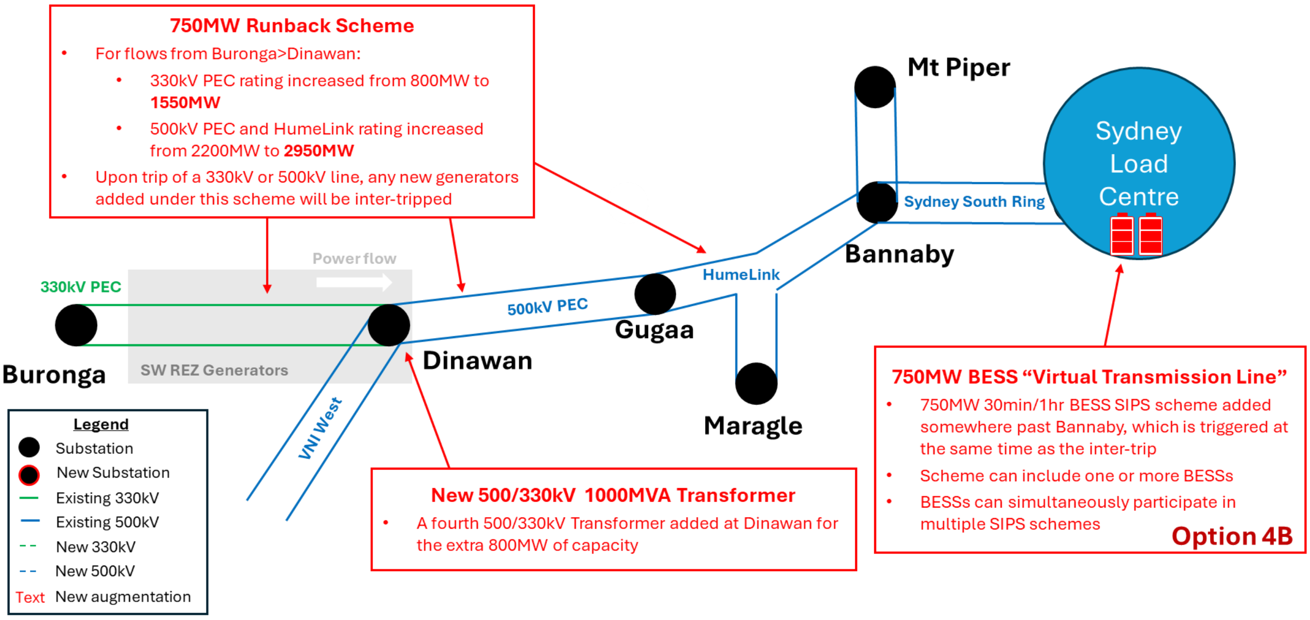
Appendix – SW REZ Transmission Options

This section discusses the SW REZ transmission options in more detail. A few common points on them are as follows:

- None of the options increase any transfer capacity from SW REZ to Buronga. During the very rare times that power flows in that direction, N5 South-west REZ generation will be constrained to existing transfer limits.
- All options assume that all ISP Actionable, Committed or Anticipated projects (including HumeLink, Project EnergyConnect and Sydney South Ring) are completed
- All options focus on unlocking capacity for N5 South-West REZ to transfer power to Bannaby Substation. Any constraints that exist between Bannaby and the various load centres (Sydney, Wollongong, Newcastle, etc) may need some of the additional augmentation projects described in the CNSW to SNW section of the ENOR (Section 3.8).
- Hosting capacity has been calculated based on a ratio of 110% wind, 100% solar and 50% BESS of the transmission capacity:
    - Given this REZ should be focused on unlocking wind resource, market studies find that optimal BESS studies is 50% (after which it begins to compete for capacity with wind (since it will charge during the day and export in the evening as wind ramps up)).
    - BESSs assumed to operate based on pure market signals (energy arbitrage and FCAS) – so is not being used for "congestion relief".
    - SW REZ diurnal profile has a nighttime bias, which allows a lot of solar during the day.
    - There are other combinations of these options (eg, reducing wind + solar, may unlock more BESS capacity) but the 110:100:50% split appears most optimal to plan based on
- All options are "preliminary assessments" only and have not undergone detailed power system studies, scoping or pricing assessments, which would be the next step to validate them. AEMO and Transgrid are best placed to do these assessments.

Option 4A/4B – Unlocking existing transmission using runbacks and “virtual transmission”

Extra Transmission Capacity from SW REZ to Sydney	Extra Hosting Capacity	Cost
750 MW	825 MW wind 750 MW solar 375 MW BESS 4hr **= 1950 MW**	4A: **$81M** 4B: **$301 - 748M**



Option 4 is about getting the maximum value out of existing 330kV and 500kV lines by using the full capacity of the 330kV transmission lines pre-contingency. There are two versions of this:

- **Option 4A –** unlocking capacity of the 330kV and 500kV lines using a runback scheme, with the FCAS markets supplying the lost generation (keeping the contingency below 750MW)
- **Option 4B –** if AEMO or Transgrid deem that contingency unacceptable, then using a BESS SIPS scheme (located on Sydney side) to cover for that contingency

While Option 4B may generally be preferred to avoid the complexity of engineering and operations that a pure inter-trip or runback scheme brings, it is up to ~10x more expensive when implemented in isolation, hence should only be used when the BESS SIPS is utilised for multiple “virtual transmission line” schemes (and hence the cost is spread over multiple projects).

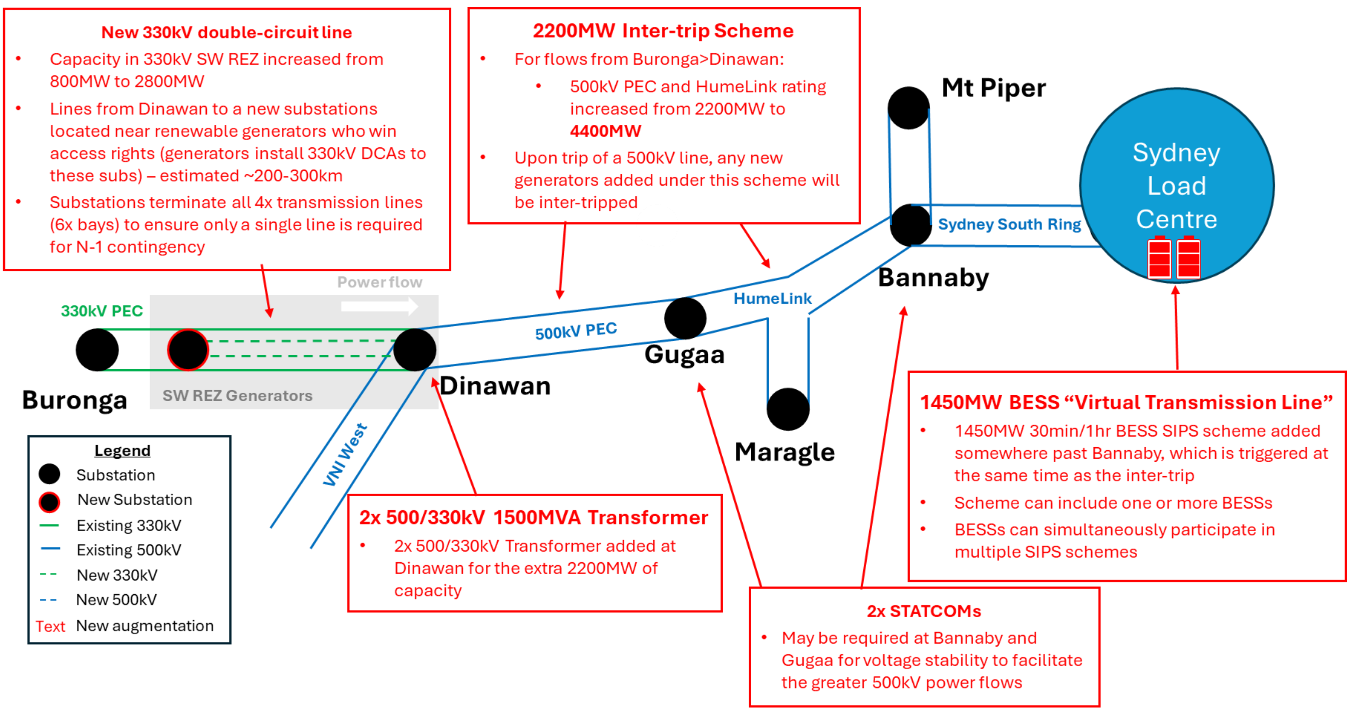
Option 4A does not exceed the single biggest contingency (and hence FCAS volumes) in NSW, and as such should be seriously considered.

It is assumed that no extra voltage support is required on the 330kV PEC network (STATCOMs, etc) to support the extra power as all the generators will be bringing voltage control, and many of them will have grid-forming BESS so there should be sufficient 330kV voltage support between Buronga and Dinawan.

Component	Estimated Cost	Description
Runback scheme	$1M	• Mostly involves settings in protection relays and engineering hours • All new generators pursuing connection into SW REZ would be subject to this scheme • A trip of a single circuit on the 330kV PEC line, 500kV PEC line or HumeLink would trigger a fast runback of generators within the SW REZ (to avoid overloading the lines) • To avoid complexity, this does not need to be overly optimised (eg, trying to minimise the size of the runback amounts based on pre-contingent network flows) – it can simply activate for all new generators for any of these trips, even if in some scenarios it may be more than required.
500/330kV 1000MVA Transformer + associated equipment (switchgear, circuit breakers, bunds, protection, etc) at Dinawan	$80M	-
Total Option 4A	$81M	-
750MW 1-hour BESS operating with a SIPS scheme	$220-667M	• The cost of a dedicated 750MW SIPS BESS is quite high at $667/kW (per CSIRO GenCost report) • However, this can be made more efficient by using BESSs to participate in multiple BESS SIPS schemes (eg, Waratah Super BESS could theoretically participate in this scheme in conjunction with its existing scheme for no extra cost), which reduces the effective price of each individual scheme (as there is almost no incremental cost) • Assuming the same 750MW BESS is participating in 3x such schemes, its effective cost is reduced to 33% • Also worth noting that multiple BESSs can be contracted to be part of a single SIPS scheme (which also improves reliability)
Total Option 4B	$301-748M	Variance based on whether the BESS scheme is participating in a single SIPS scheme, or up to three concurrently.

Option 5A – Additional 330kV SW REZ Circuits + 500kV SIPS scheme

Extra Transmission Capacity from SW REZ to Sydney	Extra Hosting Capacity	Cost
2,200 MW	2,420 MW wind 2,200 MW solar 1,100 MW BESS **= 5,720 MW**	**$1,463 - 2,592M**



Option 5A is about using more capacity of the existing 500kV transmission lines using a SIPS scheme and then extra 330kV double circuit transmission lines within PEC to the generators:

- A SIPS + intertrip scheme to unlock 2200MW of capacity on the 500kV PEC and HumeLink transmission lines
  - Any new generators connecting to SW REZ would be tripped for loss of one of the 500kV lines. Inter-trip likely required (instead of runback) given the size of the scheme and to prevent frequency issues on SA side
  - 1450MW BESS SIPS scheme to provide additional power for loss of that generation (with the remaining 750MW being under the single contingency limit, and covered by the FCAS Contingency market)
- An extra 330kV double circuit transmission line from Dinawan to the furthest generator that wins access rights in the SW REZ
  - The new 330kV transmission lines will be built to a higher capacity twin-sulphur conductor with 1200MW transfer capacity.
  - With a total thermal capacity of 2x1100MW (new) + 2x800MW (existing) = 4000MW and a largest contingency of 1200MW, leaving 2800MW capacity

Component	Estimated Cost	Description
330kV Transmission Line	$714-1072M	• Assumes double circuit **twin-sulphur** 2586MVA (from AEMO Transmission Cost database) • Range of distances **200-300km** depending on which generators win access rights
New 330kV 6-bay switching station	$80M	• 6-bays to cut into the existing 330kV PEC double circuits and terminate the new 330kV PEC double circuit • Terminating all lines here means that only a single line worth of capacity is required for the N-1 case
500kV inter-trip scheme – 2200MW	$1M	• Mostly involves settings in protection relays and engineering hours • All new generators pursuing connection into SW REZ would be subject to this scheme • A trip of a single circuit on the 330kV PEC line, 500kV PEC line or HumeLink would trigger an inter-trip of generators within the SW REZ (to avoid overloading the lines) • To avoid complexity, this does not need to be overly optimised (eg, trying to minimise the size of the runback amounts based on pre-contingent network flows) – it can simply activate for all new generators for any of these trips, even if in some scenarios it may be more than required.
1450 MW BESS SIPS Scheme	$322-967M	• The cost of a dedicated SIPS BESS is quite high at $667/kW as per CSIRO gencost report • However, this can be made more efficient by using BESSs to participate in multiple BESS SIPS schemes (eg, Waratah Super BESS could theoretically participate in this scheme in conjunction with its existing scheme), which reduces the effective price of each individual scheme (as there is almost no incremental cost) • Assuming the same BESS is participating in 3x such schemes, its effective cost is reduced to 33%. • Also worth noting that multiple BESSs can be contracted to be part of a single SIPS scheme (which also improves reliability)
2x500/330kV 1500MVA Transformer	$180M	• Includes associated equipment (switchgear, circuit breakers, bunds, protection, etc) at Dinawan
2x 300MVAr STATCOMs + associated equipment (transformer, switchgear, circuit breakers, bunds, protection, etc)	$104M	• Given the substantial increase in transmission line capacity on the 500kV lines, it is expected that a STATCOM will be required for voltage support at Gugaa and Bannaby
Total	**$1463-2592M**	Variance based on: • whether the BESS scheme is participating in a single SIPS scheme, or up to three concurrently • length of transmission lines required based on location of REZ generators

Option 5B – Option 5A, but assume no reliance on FCAS Contingency

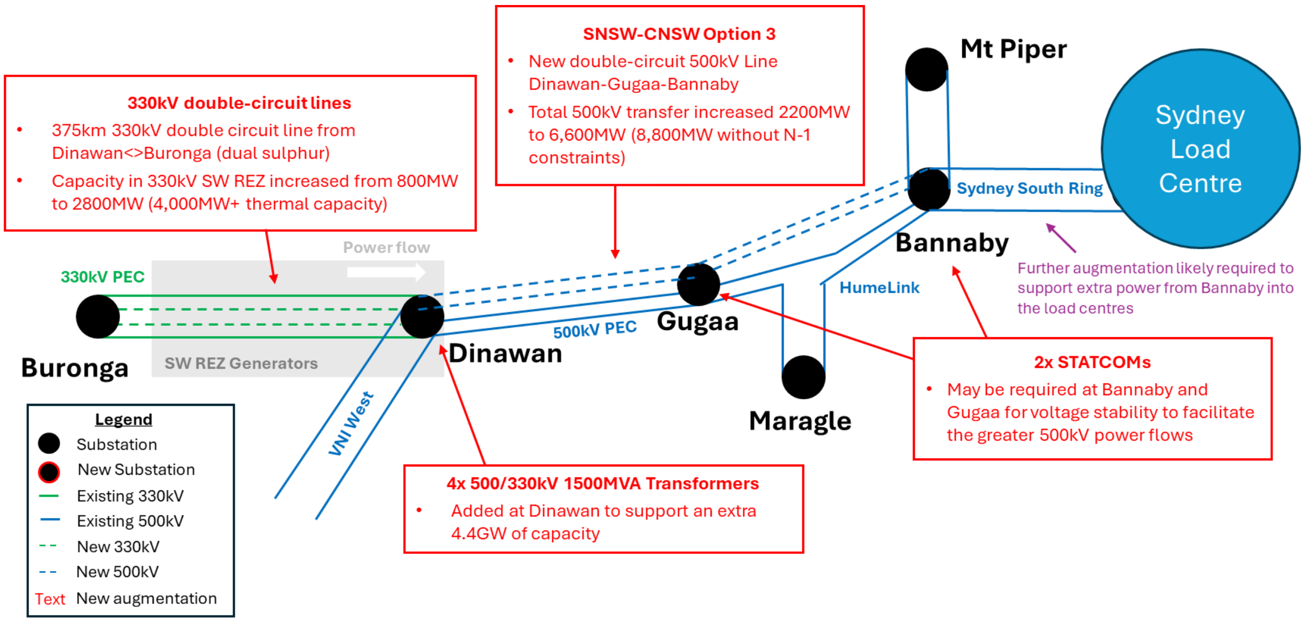
Extra Transmission Capacity from SW REZ to Sydney	Extra Hosting Capacity	Cost
2,200 MW	2,420 MW wind 2,200 MW solar 1,100 MW BESS **= 5,720 MW**	**$1,684 – 3,257M**

This option is the same as Option 5B, except if AEMO does not want to rely on FCAS Contingency markets to cover 750MW of the inter-tripped amounts, then the BESS SIPS scheme has to be increased to 2200MW adding.

Component	Estimated Cost	Description (variance from Option 5A)
Option 5B	$1463-2592M	As per 5B
750MW extra BESS SIPS quantity	$221-665M	As per 4B
Total	**$1684 - 3257M**	

Option 6A – New 2x500kV lines + 2x 330kV lines

Extra Transmission Capacity from SW REZ to Sydney	Extra Hosting Capacity	Cost
4,400-6,000 MW (Up to 4400-6000MW at Dinawan and up to 2800MW on the 330kV lines)	4840-6600 MW wind 4400-6000 MW solar 2200-3000 MW BESS **= 11440-15600 MW**	**$4,998M**



Option 6 **does *not* rely on any inter-trips or SIPS schemes** (unlike options 4 and 5).

It is a combination of the SNSW-CNSW Option 3 proposal in the ENOR (which involves a new double circuit 500kV lines from Dinawan-Gugaa-Bannaby and 4x new transformers at Dinawan) and then a new 330kV double circuit line from Buronga-Dinawan.

While the ENOR states that this option can unlock 6000MW of extra SNSW-CNSW capacity, due to N-1 contingency limits, we have been conservative in showing the lower range as being only 2400MW per circuit (and upper range of 3000MW). However, if the full 3000MW is available, we definitely support framing it around the full amount.

This option also unlocks an extra 2800MW of capacity at Buronga, which might even help connect any additional resources from the Broken Hill REZ.

Component	Estimated Cost	Description
ENOR SNSW to CNSW (Section 3.9) Option 3: • 450km double circuit 500kV line from Dinawan-Gugaa-Bannaby • 4x 1500MVA transformers at Dinawan	$3522M	Assumes 4x Olive DCST 6699MVA build, as per AEMO Transmission Cost Database

2x 300MVAr STATCOMs + associated equipment (transformer, switchgear, circuit breakers, bunds, protection, etc)	$104M	• For voltage stability, assumed to be required at Bannaby and Gugaa • Due to all the generation in SW REZ which will have their own voltage support and potentially grid-forming BESS, not assumed to be required on the 330kV side
~375km double circuit 330kV transmission line from Dinawan to Buronga	$1340M	• Assumes double circuit **twin-sulphur** 2586MVA (from AEMO Transmission Cost database)
2-new 330kV feeder bays at Buronga	$16M	As per AEMO Transmission Cost Database
2-new 330kV feeder bays at Dinawan	$16M	As per AEMO Transmission Cost Database
Total	**$4998M**	

Option 6B – Option 6A + 1200MW BESS SIPS scheme

Extra Transmission Capacity from SW REZ to Sydney	Extra Hosting Capacity	Cost
4,400-6,000 MW (Up to 4400-6000MW at Dinawan and up to 4000MW on the 330kV lines)	4840-6600 MW wind 4400-6000 MW solar 2200-3000 MW BESS **= 11440-15600 MW**	**$5,264-5,798M**

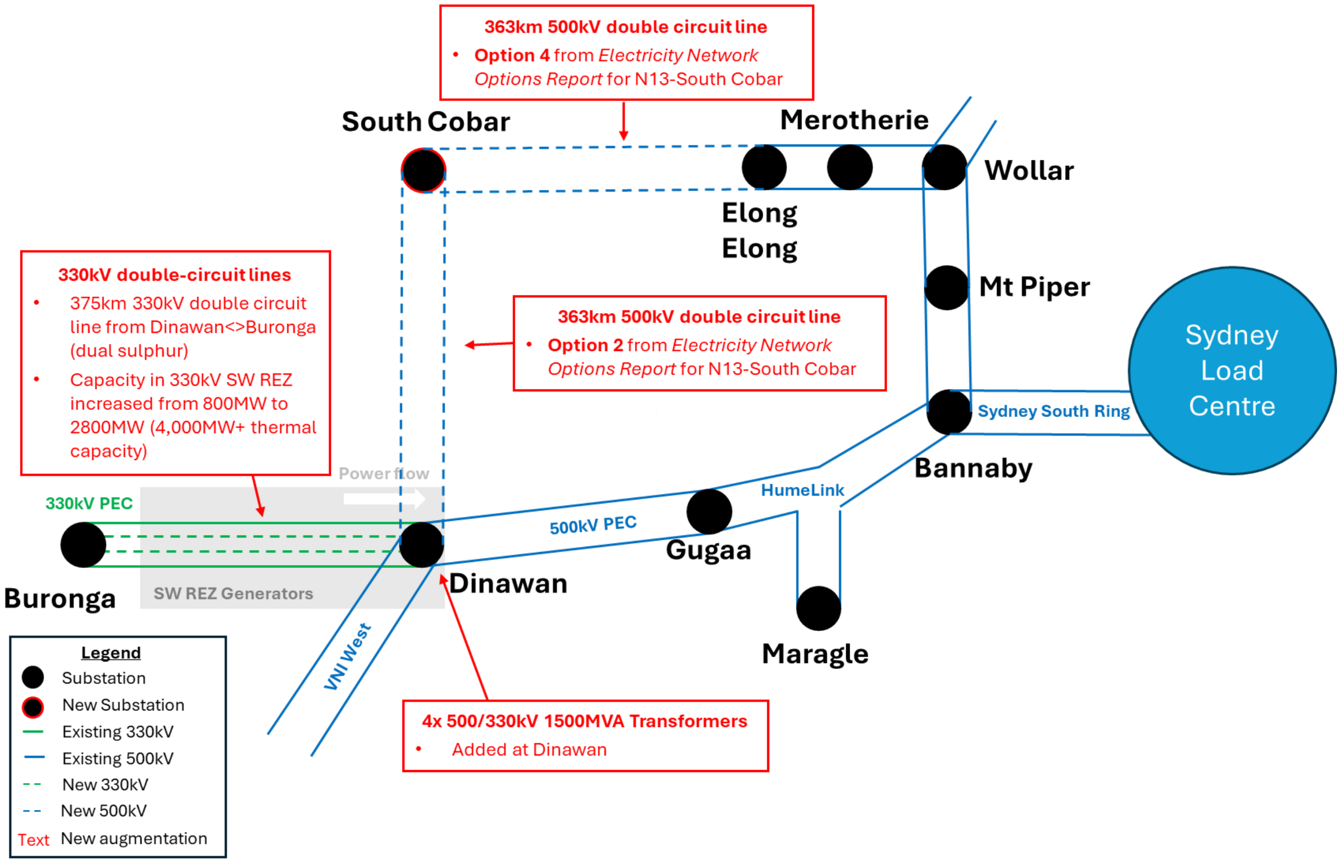
Option 6A, but with a 1200MW BESS SIPS scheme to allow:

- all of the 330kV circuits between Dinawan and Buronga to run at full capacity

Component	Estimated Cost	Description (variance from Option 5A)
Option 6A	$4,998M	As per Option 6
1200MW BESS SIPS	$266-800M	• The cost of a dedicated SIPS BESS is quite high at $667/kW (per CSIRO Gencost report) • However, this can be made more efficient by using BESSs to participate in multiple BESS SIPS schemes (eg, Waratah Super BESS could theoretically participate in this scheme in conjunction with its existing scheme), which reduces the effective price of each individual scheme (as there is almost no incremental cost) • Assuming the same BESS is participating in 3x such schemes, its effective cost is reduced to 33%.
Total	**$5264 - 5798M**	

Option 7 – Unlocking N5 South-west REZ via South Cobar REZ

Extra Transmission Capacity from SW REZ to Sydney	Extra Hosting Capacity	Cost
4800-6000 MW (4800MW across Dinawan and South Cobar REZ, 2800MW on 330kV SW REZ)	5280-6600 MW wind 4800-6000 MW solar 2400-3000 MW BESS **= 12480-15,600 MW**	**$7,954M**



The *Electricity Network Options Report* features several options for connecting the South Cobar REZ. Options 2 involves a 500kV transmission line from South Cobar to Dinawan, and Option 4 involves a 500kV transmission line from South Cobar to Elong Elong (in the N5 South-west REZ). Both these options focus on unlocking capacity for South Cobar REZ.

However, by building both Option 2 and Option 4, we effectively create a 500kV "loop" within NSW which unlocks capacity for both N5 South-west REZ *and* South Cobar REZ (both of which have excellent wind and solar resource).

It also results in more effective use of the 500kV transmission system, as the loop provides parallel paths that the 500kV lines can be run harder – given each 500kV double circuit has a thermal rating of 6600MVA, we have been assumed that each circuit can effectively transfer 2x2400-3000MW. The whole loop then effectively has 4x 500kV transmission lines and if each has a 2400-3000MW rating and only one is required for contingency, then we are actually adding an additional 4800-6000MW capacity. Clearly additional detailed studies are required to validate the exact number (and whether additional augmentations will be required to acheive this rating), but it is clearly more efficient than just radially connecting 500kV lines to South Cobar.

After that, an additional 330kV double circuit line can be run in parallel from Dinawan to Buronga. This unlocks capacity both in N5 South-west REZ, but potentially also for a future Broken Hill REZ.

Component	Estimated Cost	Description
N13 – South Cobar – Option 2 • New South Cobar 500/330 kV substation with 3x 500 kV diameters, 3x 1500 MVA transformers, 3x 330 kV diameters • Expansion of Dinawan 500 kV switchyard by 2x 500 kV diameters • New 357 km 500 kV DCST transmission line from Dinawan to South Cobar 500/330 kV substation • 100 MVAr shunt reactor on each new circuit at South Cobar and Dinawan, including a switching station halfway between South Cobar and Dinawan for reactive line compensation.	$3186M	From AEMO Electricity Network Options Report
N13 – South Cobar – Option 4 ~~• New Cobar 500/330 kV Hub with 3 x 500/330/33 kV 1,500 MVA transformers~~ • New 500 kV DCST line from Cobar to Elong Elong with Quad Orange conductor • Install 150 MVAr, 500 kV reactors at both ends of the new Cobar - Elong Elong 500 kV circuits, including a switching station halfway between South Cobar and Dinawan for reactive line compensation, including a switching station halfway between South Cobar and Elong Elong for reactive line compensation. • Augment Elong Elong 500 kV substation to accommodate new lines	$3036M	• Cost of Option 4 from AEMO Electricity Network Options Report is $3,189M • Since the cost of the New Cobar substation is already covered in Option 2 above, we remove ~$150M from cost
4x 500/330kV 1500MVA Transformer + associated equipment (switchgear, circuit breakers, bunds, protection, etc) at Dinawan	$360M	-
~375km double circuit 330kV transmission line from Dinawan to Buronga	$1340M	• Assumes double circuit **twin-sulphur** 2586MVA (from AEMO Transmission Cost database)
2-new 330kV feeder bays at Buronga	$16M	As per AEMO Transmission Cost Database
2-new 330kV feeder bays at Dinawan	$16M	
Total	**$7954M**	