Supergrid Appendix

Methodology

Economic data

Economic Growth Forecasts data was taken from the *AEMO's Inputs, assumptions and scenarios workbook* for the *2022 Integrated System Plan*.[1] The NEM states refer to New South Wales, Queensland, South Australia, Tasmania and Victoria.

Gross State Product (GSP)

The forecasted Growth State Product (GSP) in each year of *Step Change*, *Hydrogen Superpower* and *Strong Electrification Sensitivity* scenarios across each of the NEM states were summed and subtracted from corresponding GSP of the *Steady Progress* scenario (representing current trajectory or business as usual). The difference between each scenario and *Steady State* displayed in the main report represents the change in GSP from the business as usual case (*Steady State*).

Energy security prices

Energy prices from 2021 were normalised to 1 to show the percentage change in price in 2022.

Prices for petrol were taken from the Australian Competition and Consumer Commission's *Report on the Australian petroleum market*, comparing June quarterly prices of 2021 (142 cents per litre) with June quarterly prices of 2022 *without* the effects of the halving of the fuel excise cuts to better represent the true rise in cost of petrol and impacts of global volatility (188 + 24.3 = 212.3 cents per litre).[2,3]

Gas prices were taken from the *Quarterly Energy Dynamics Q2 2022* report from AEMO using the average east cost gas market prices. Q2 2022 prices averaged $28.40/GJ and Q2 2021 prices averaged $8.20/GJ.[4]

Electricity prices of the NEM wholesale spot prices were taken from *Quarterly Energy Dynamics Q2 2022* report from AEMO with in Q2 2022 averaging $264/MWh and Q2 2021 averaging $85/MWh.[4] Fossil fuel contribution to the NEM market in Q2 2022 was from the same document:

- Black coal - 43%
- Brown coal - 15.6%
- Gas - 9.3%
- **Total - 67.9%**

Electricity prices in ACT was taken from the *Retail electricity price recalibration 2022–23* report from the Independent Competition and Regulatory Commission. As a comparison to the NEM wholesale spot prices, *total energy purchase cost* was used, comparing 2021-22 ($95.95/MWh) and 2022-23 ($104.83) as stand-ins for 2021 and 2022.[5] In the absence of available quarterly prices for 2022, the annual 2022-23 was used to represent 2022 prices.

Cost of living modelling

Household energy costs (Gas and electricity)

BZE adopted a residential energy modelling tool provided by Richard Keech, Director at New Energy Thinking.

The model compares the average Australian dwelling of 2.6[6] occupants with an average floor area of 230 m2[7].

The model simulated three scenarios across 5 capital cities on the NEM, with following input assumptions, shown below.

1. BAU: Dual-fuel
2. All-electric
3. All-electric + solar

Table 1: National Supergrid cost of living scenarios with inputs assumptions for Melbourne

Description	BAU	All-electric	All-electric + solar
Star rating	5	5	5
PV capacity [kW]	0.0	0.0	6.6
Battery usable capacity [kWh]	0.0	0.0	0.0
Occupancy (people)	2.6	2.6	2.6
Floor area [m2]	230	230	230
Heating & cooling	GAS DUCTED w EVAP	SPLIT SYSTEMS	SPLIT SYSTEMS
Hot water	GAS STORAGE - MEDIUM	HEAT PUMP - MEDIUM	HEAT PUMP - MEDIUM
Cooktop	GAS	INDUCTION	INDUCTION
Fridge	COMMON MEDIUM	COMMON MEDIUM	COMMON MEDIUM
Showerhead	REGULAR	REGULAR	REGULAR
Energy Class	Dual-fuel	All-electric	All-electric
House Class	Class 1 - separate house	Class 1 - separate house	Class 1 - separate house
Gas connected?	TRUE	FALSE	FALSE

Further assumptions:

- 5 star NatHERS
- Ducted gas heating, gas cooktop and gas hot water storage for each location in BAU
- Energy usage practice: cautious - occupants are mindful of energy consumption.
- Occupancy patterns: working full-time outside of home
- All-electric scenarios equipped with efficient heat pump hot water and split systems
- No further energy efficiency measures adopted including draught proofing, ultra-low flow showerheads, insulation upgrades, etc in all-electric scenarios.

To account for climatic differences, usage patterns and population, the average household energy annual cost compared the weighted average of the three scenarios across 5 major cities on the NEM: Melbourne, Sydney, Brisbane, Canberra, Adelaide. It is important to note that the purpose of this work was to specifically model a dual-fuel home with 3 gas appliances compared to an all-electric to demonstrate the benefits of electrification and justify the need for grid infrastructure upgrades. We acknowledge and are aware that homes in Brisbane rarely have gas ducted heating, however, this is a condition of the BAU scenario. Regardless, the all-electric scenarios are applicable to each climate and would be effective retrofit options for any home in those climates, ie: split systems, heat pump hot water and induction cookers (see Table 1) represent significant improvements over other types of technology, gas or other electric types such as resistive heating. While a more granular modelling approach would slightly alter the cost savings, our numbers closely align with those from the Climate Council, the Victorian Government and Rewiring Australia. The model generated cost estimates based on the following tariffs for electricity and gas:

Table 2: Electricity tariffs[8–10]

State	Distributor	Median Price of Power (c/kWh)	Supply Charge (c/day)
QLD	Energex	26	112.9
NSW	Ausgrid	27	88.5
ACT	Evoenergy	29	100.9
SA	SA Power Networks	36	89.9
VIC	CitiPower	28	111.1

Table 3: Gas tariffs (averaged)[10,11]

State	Usage (c/MJ)	Supply (c/day)
VIC	2.37	70.58
NSW	3.51	62.09
SA	4.01	74.55
QLD	4.86	70.65
ACT	3.51	78.9

Model outputs are as follow:

Table 4: Model outputs cost and savings

Locale	Baseline Electricity	Baseline Gas	Baseline Total Cost	All-electric Total Cost	All-electric + PV Total Cost	Savings all-electric	Savings all-electric + PV	Savings all-electric (%)	Savings all-electric + PV (%)
Melbourne	$1,160	$1,799	$2,959	$1,830	$660	$1,129	$2,299	38%	78%
Sydney	$940	$1,166	$2,106	$1,130	$270	$976	$1,836	46%	87%
Brisbane	$1,410	$1,061	$2,471	$1,540	$420	$931	$2,051	38%	83%
Adelaide	$1,390	$2,359	$3,749	$1,970	$550	$1,779	$3,199	47%	85%
Canberra	$1,130	$2,708	$3,838	$1,940	$590	$1,898	$3,248	49%	85%

Table 5: Model energy outputs - Energy imports MJ/annum

Locale	Baseline (MJ/annum)	All-electric (MJ/annum)	All-electric + PV (MJ/annum)	Savings all-electric (MJ/annum)	Savings all-electric + PV (MJ/annum)	Savings all-electric (%)	Savings all-electric + PV (%)
Melbourne	74,680	18,374	-9,724	56,306	84,404	75%	113%
Sydney	35,032	10,795	-20,301	24,237	55,333	69%	158%
Brisbane	30,374	15,551	-19,291	14,823	49,665	49%	164%
Adelaide	62,689	16,383	-17,335	46,306	80,024	74%	128%
Canberra	78,359	19,487	-14,044	58,872	92,403	75%	118%

Table 6: PV exports - kWh/annum

Locale	**Baseline** (kWh/annum)	**All-electric** (kWh/annum)	**All-electric + PV** (kWh/annum)
Melbourne	0	0	4,578
Sydney	0	0	7,002
Brisbane	0	0	7,025
Hobart	0	0	6,513
Adelaide	0	0	5,867
Perth	0	0	4,578

Final presented household energy bills are weighted by the number of dwellings per each capital city.

Vehicle fuel costs

Petrol:

Petrol costs used in the calculations for Figure 5 in the main report were taken from the Australian Competition and Consumer Commission's *Report on the Australian petroleum market*:

- **2021 = 142 cents/litre** based on the averaged June quarter (2021) of petrol prices in the 5 largest cities.
- **Projected = 188 cents/litre** based on the averaged June quarter (2022) of petrol prices in the 5 largest cities represent the projected volatile cost of petrol. In this case, the fuel excise cuts were preserved to better represent what consumers paid and to provide a more conservative estimate.

We assume that each household has an average of 1.8 cars and an average annual mileage of 11,100 km per vehicle. Average fuel consumption per vehicle is 11.1 L/100km resulting in an annual average fuel use of 1,232 L per vehicle. These are based on ABS data.[12]

Electric:

Cost of electricity to charge the EVs was based on the average cost per kWh of Table 2, **29c/kWh**. We assume the same number of vehicles (1.8) and same mileage (11,100 km) per vehicle as reported by ABS data.

The supply charge is not included since it is captured in the household energy costs modelling

We did account for any benefits in servicing or other running cost benefits beyond the fuel costs.

Modelling for Building the Foundations

Transmission

NEM transmission updates are based on those identified in the AEMO 2022 ISP Hydrogen Superpower scenario as it aligns with the IPCC 1.5°C ambition of our proposed Supergrid. The transmission projects, their timings and costs are taken from the *Appendix 5: Network investment* and *Appendix 6: Cost benefit analysis* of the AEMO 2022 ISP,[13,14(p. 5)] based on the least-cost development path. All projects with an identified deployment timing up to and including 2027/28 is included in our five year scope.

In our Supergrid proposal, we first aim to electrify as much as possible in the first five years, inline with a Strong Electrification Sensitivity scenario. This is in order to deliver as many of the benefits to households and businesses before eventually pursuing a more Hydrogen Superpower aligned growth around 2030. While the project timing for the Strong Electrification Sensitivity scenario is not available, data from AEMO's *Generation Outlook* in our 5 year timeframe (2027/28),[15] both Hydrogen Superpower and Strong Electrification Sensitivity have similar renewable generation at around 200 TWh and renewable penetration of 84-85%. Therefore we assume that any transmission deployment inline with Hydrogen Superpower will be sufficient to deliver a Strong Electrification type program.

Connections to REIPs are based on our past modelling of the Hunter and Gladstone REIP locations. There are significant decarbonisation ambitions from existing industries as well as new renewable export projects. The final transmission requirements in each location will vary, but in order to capture these opportunities, the scale of transmission needs to be appropriately sized.

- **Hunter**
    - Tomago Aluminium: 3 GW of renewables to supply 1 GW demand with an assumed capacity factor of 30% (additional firming will be needed)
    - Port of Newcastle: 1.6 GW electrolyser for renewable hydrogen
    - AGL and Fortescue: 2 GW electrolyser for renewable hydrogen at AGL's Hunter Energy Hub[16]
    - Preliminary estimates from Beyond Zero Emissions puts the cost of transmission upgrades to be approximately $9 billion should *all* projects progress.[17]
- **Gladstone**
    - Boyne Aluminium smelter: 3 GW of renewables to supply 1 GW demand with an assumed capacity factor of 30% (additional firming will be needed)
    - Stanwell and Sumitomo: 3 GW electrolyser for renewable hydrogen
    - H2U: 3 GW electrolyser for renewable hydrogen
    - Preliminary estimates from Beyond Zero Emissions puts the cost of transmission upgrades to be approximately $19 billion should *all* projects progress.[18]

While the hydrogen electrolyser projects will take time to operationalise, a transmission upgrade delivering up to 3 GW of new renewable generation into each location is needed *at minimum* to support the decarbonisation of the aluminium smelters. This is in addition to the planned transmission upgrades in the area such as the New England and Central West Orana REZ connections which are also needed to support the broader NSW grid pending the closures of Liddell and Eraring coal power plants or the Gladstone Grid Reinforcement which is currently only designed for a capacity of 500 MW.[14,19] The additional capacity unlocked by this REIP specific transmission, which can take form as an expansion of existing transmission investments, will help guarantee ample supply to build investment confidence and progress the proposed hydrogen projects as well as decarbonise existing industries.

Based on the recently announced NSW Hunter and Central Coast requiring 1 GW capacity to host 2 GW of generation,[20] we assume a transmission line capacity of 1.5 GW will be able to support 3 GW of renewable generation. *AEMO's Transmission Cost Report* estimates a generic cost of $1,833/MW/km for connecting REZ's to industry/export centres.[21] Assuming a distance of approximately 300 km, we require a rounded up figure of $1 billion for each location ($2 billion in total) for transmission to decarbonise aluminium and seed the foundations of REIPs in the Hunter and Gladstone.

We stress that this represents a *minimum* infrastructure spend based on the existing aluminium smelters which have flagged the intention to transition to renewables. If we are to capture additional renewable industry opportunities such as green chemicals, renewable hydrogen and green alumina, the scale of the transmission infrastructure will need to be appropriately increased. This should be proactively planned for and supported by state and Federal governments in close coordination with industry and developers.

The connection in WA is based on a transmission link in the Pilbara to drive decarbonisation of existing mining operations and accelerate the work of the Independent System Operator on better integrating the networks in the North West Interconnected System.[22] The proposed transmission link is a 200 km line from Port Hedland then Karratha to strengthen the backbone with a capacity of 1.5 GW and potentially harness synergies with Fortescue's Pilbara Transmission Project.[23,24] This is roughly $550 million using the estimates from *AEMO's Transmission Cost Report* of $1,833/MW/km.[21]

The connection in NT is based on two options and has merits based on a recent report from Original Power.[25,26] Our internal estimates for both cost approximately $450 million but are based on HVAC technology:

- An additional Darwin to Katherine line (300 km) with a capacity for 800 MW. This can help bring on additional renewable energy to support local communities, help decarbonise Darwin and open up new industry opportunities. We use the AEMO cost estimate of $1,833/MW/km. This upgrade also supports the Darwin-Katherine Electricity System Plan and the growth of Renewable Energy Hubs, particularly the Sunshine for Sale scenario to unlock a $40 billion economy for NT.[27]

- Build a line from Katherine to Tenant Creek (600 km) for a capacity of 200 MW. This to spearhead opportunities for remote communities, help deliver energy security along with new renewable development proposed and owned by First Nations communities. There is the potential to further expand this to Alice Springs. Given the longer distance, we are doubling the cost estimates to $3,666/MW/km to represent transmission loss factors.

We note, given the long distances, the cost estimates used will need to be adjusted. HVDC technology may be more suitable and is in fact the preferred option proposed by Original Power. However, we were unable to obtain cost estimates for HVDC developments in Australia. Nevertheless, given the increasing use of HVDC in countries such as China, Europe and for the Sun Cable Australia-Asia PowerLink project in Australia, we believe a realistic consideration of HVDC in Australia is warranted. In addition, given the similar transmission corridor proposed from Sun Cable, from Alice Springs to Darwin, a potential additional use of the funding is to enable First Nations communities and other stakeholders to have equitable access to the Sun Cable transmission infrastructure. This builds up trust and goodwill from the local communities, opening up new renewable resources and opportunities for future developments.

Storage

Medium Duration Energy Storage: The storage capacity required over the next 5 years (to 2027/28) was taken from the AEMO 2022 ISP Generation Outlook data, based on both the Hydrogen Superpower and Strong Electrification Scenario projections;[15] both are aligned to the IPCC 1.5°C ambition of our proposed Supergrid.

At 2027/28, the scenario requirements for grid scale storage are as follows (insufficient data available to model storage for WA and NT):

Table 7: Grid scale storage requirements from the AEMO 2022 ISP (not including Snowy Hydro 2.0)

Capacity (MW)	Hydrogen Superpower	Strong Electrification
Deep Storage	160	160
Medium Storage	6,405	6,045
Shallow Storage	749	749
Total Energy (GWh)		
Deep Storage	6	6
Medium Storage	50	49
Shallow Storage	1	1

Deep storage in the 5 year time scale (160 MW/6GWh) is already supplied by existing storage while shallow storage is already economical to develop and does not require government support. The key capacity gap is medium storage (4-12 hr) which for both scenarios is at 6 GW and 50 GWh. This is the equivalent of a 6 GW, 8 hour battery storage project to hold 50 GWh.

Estimates from GenCost puts battery storage (8 hrs) at $357/kWh in 2022. This converts to a cost of $18 billion, of which the government will support 20% in underwriting.

The 20% figure is based on past and existing energy storage programs:

- NSW Emerging Energy program: $47.5 million government funding to leverage $366 million in private investment (13%)[28]
- VIC Energy Storage Targets: $157 million to help secure $1.7 billion in private investment (9%)[29]
- SA Hornsdale Power Reserve expansion: $23 million in state and Federal funding for a $71 million expansion (32%)[30]

New Storage Technologies were calculated based on existing projects (see Table 8). A government grant contribution of $400 million at 32% of the total project cost can drive an approximate $1.25 billion worth of new storage projects, with an approximate storage capacity of 360 MW/2900 MWh. This can be a variety of projects with one potential mix being two grid scale-up/deployment projects ($500 million, 100-200 MW), 5-7 pilot projects ($30 million, 1-5 MW) and 6-8 commercialisation projects ($5 million, < 1 MW). The final mix and government contribution will vary depending on the specific projects. However, this provides a starting point for how to support home grown energy storage technologies.

Table 8: A selection of government supported energy storage projects from ARENA

New Storage Projects	Total Cost ($m)	Government Funding (%)	Capacity (MW)	Storage (MWh)
MGA Thermal	2.84	44%	0.5	5
Yadlamalka Energy	20.3	28%	2	8
Raygen	30	50%	3	50
Broken Hill Compressed Air	652	7%	200	1600
Average	**176**	**32%**	**51**	**416**

Pumped Hydro Energy Storage (pumped hydro) support should focus on progressing the most developed pumped hydro projects or projects that have obtained federal or state government commitments. The $300 million grant funding can go towards providing infrastructure, grid connections, renewable developments and other key delivery components. This is similar to the support provided to the Kidston or Snowy 2.0 Pumped Hydro projects (see table 9) at around $50-$100 million per project. Potential candidates include the Oven Mountain Pumped Hydro and Borumba Dam Pumped Hydro projects though final candidates will need to be individually assessed.[31,32] We propose that any remaining funding go towards feasibility and pre-feasibility studies for identifying and fast tracking additional pumped hydro opportunities, particularly those that support industry, can re-use brownfield locations (ie: old mining pits) or are off-river. Based on past projects, we expect government contributions to these feasibility studies to range between $0.3 to $1.5 million.

Table 9: A selection of government supported pumped hydro projects: Feasibility projects (top section) and infrastructure and other delivery components (bottom section)

Project	Gov Funding ($m)	Type
Centennial Pumped Hydro	0.364	Technical studies
OMPS New England PHES	0.951	Benefits Study
Shoalhaven pumped hydro	1.6	Feasibility Study
Middleback Ranges	0.5	Pre-feasibility study
Kidston Pumped Hydro (ARENA)	47	Delivery/shared learnings
Kidston Pumped Hydro (CEFC)	54	Debt finance for solar
Snowy Hydro 2.0	125	Grid infrastructure finance

Distribution

There have been issues in the past around *gold plating* of the distribution networks, leveraging their position as a regulated monopoly to grow their asset base at the cost of consumer bills. Regulatory reform is needed to ensure a proper balance between necessary upgrades and cost to consumers. However, until this reform is passed, our recommendations on distribution should be consumer and community led. Community groups, neighbourhoods, schools, community hubs, industries etc are the ones to direct federal funding of distribution projects.

Enabling DER component is based on *Ausgrid's Draft Plan for 2024-29*. An estimated investment of $153 million on network, ICT and smart metering as well as $50 million on innovation is required to connect 1.6 million customer energy assets such as PV, batteries and EVs. This represents 89% of their 1.8 million customers with an average spend of $125 per customer required to implement DER uptake and/or electrification; we assume the remaining 11% are already connection ready. Given the wide geographic range of Ausgrid's network, spanning metropolitan and regional areas, we assume their upgrade cost estimates can be applied to the rest of the nation. Taking the number of households as a measure of customers, ABS data has 10 million households in 2021.[33] Using the Ausgrid estimates, we assume 89% of them also require a spending of $125 to enable DER uptake and orchestration, totalling to an equivalent spend of $1.1 billion. We propose that the Federal government supports 30% of this cost or $335 million with the remaining 70% to be privately funded and/or supported through state government programs.

We note that there is currently a Distributed Energy Integration Program administered by ARENA. The Enabling DER component of the national Supergrid builds on this program, focusing on the delivery of the DER systems. The substantial federal government contribution is designed to progress trials towards delivery and commercialisation as rapidly as possible.

Ensuring equity is based on a couple of assumptions around costs on the various key opportunities identified in the report

- Distribution upgrades to low-income and disadvantaged areas based around distribution substation upgrades to help enable the broader electrification of towns and neighbourhoods. Using data from *Distribution Annual Planning Reports* from Ergon, Ausgrid and Jemena (specifically their limitation report data),[34–36] we find an average distribution upgrade cost of $5 million. This includes upgrades to substations, feeders, transformers, switchboards, circuit breakers and other augmentations. We assume that this represents the type and cost of works needed to help enable electrification of neighbourhoods and towns.
- Standalone Power Systems are estimated to cost $200,000 per unit based on figures from Western Power, spending $37 million to install 180 standalone power systems.[37]
- New connections to connect renewables (1-5 MW) from land users/owners and farmers to distribution estimated to be $1 million for a distance of 2-3 km.[38]
- Edge of grid upgrades to help decarbonise farms and communities estimated to be $60,000. Costs from *Farm Powered*.[38]

We focus the majority of the spending on Standalone Power Systems as these have established benefits to save on maintenance costs and build social licence and support regional communities. Importantly, standalone power systems can bring about significant energy independence and energy sovereignty to First Nations communities in remote regions.

Connections to medium scale renewables for land users/owners and farmers and farming decarbonisation also has significant support to help regional communities, opening up additional revenue streams and increase social licence around renewables.

Distribution upgrades to support low-income and disadvantaged areas have a slightly lower spend as it will take time to electrify households and increase EV uptake. As a result, we assume that distribution capacity will be reached at a later date.

Table 10: Allocation of the distribution funding for ensuring equity

Ensuring Equity	Cost per unit	Number of units	Cost
Fast tracked distribution upgrades	$5,000,000	35	$175,000,000
Standalone Power Systems and microgrids	$200,000	2000	$400,000,000
Connecting mid-scale renewables	$1,000,000	300	$300,000,000
Edge of grid upgrades	$60,000	600	$36,000,000
			$911,000,000

Enabling Communities

Based on confidential in-person feedback, price lists from Energex,[39] and quotes, we estimate a new network connection fee of $100k to $1 million, depending on the site. We assume an average distribution upgrade cost of $500k, which includes works such as substation and switchboard upgrades, for the electrification of schools, government buildings and other community hubs, installation of EV chargers at local shopping strips and other community/public spaces. With an allocation of $500 million, this corresponds to 1,000 community hubs upgraded to enable electrification, the uptake of renewables and EV charging technologies.

Enabling industry costs are taken from distribution upgrades in industrial areas from Ausgrid's *Network Investment Committed Projects 2020*.[40] In addition, projects that added new network capacity like Ergon's Gracemere substation and Endeavour Energy's Aerotropolis Foundation Supply was included to represent the impacts of transitioning industrial clusters from gas to renewable electricity as well the establishment of new renewable industries such as:

- Battery/Electrolyser/Wind turbine manufacturing
- Zero-emissions mining sites
- Renewable critical minerals processing
- Zero-emissions food/beverage/paper processing and manufacturing
- Renewable hydrogen production
- Green steel/aluminium/alumina production

Table 11 below outlines the projects that contributed to our estimates.

Table 11: Distribution upgrades and their capital costs

Distribution upgrades	Cost
Waratah 132/33kV STS refurbishment	$17,000,000
Port Stephens, Stockton ZS 11kV switchgear replacement	$5,500,000
Addressing increased customer demand requirements in the Rozelle area	$23,200,000
Gracemere substation and powerline route	$8,600,000
Service constraints at Maffra Zone Substation	$15,170,900
Service constraints at Clyde North Zone Substation	$11,387,600
Luddenham, Kemps Creek & Badgerys Creek Network Constraints	$41,900,000
Aerotropolis Foundation Supply	$66,100,000
Average cost	**$23,607,313**

On average, we estimate a distribution upgrade cost of $23.6 million. With a grant of $600 million and a 50:50 co-contribution from government grant and private investment, this is estimated to upgrade 50 industrial sites around Australia to enable electrification and new renewable industries. The size of the average project in the estimates used (Table 11) was chosen to represent industrial clusters around the size of an industrial park. In the case of REIPs, multiple clusters may make up a broader REIP location. For example, in the Hunter REIP, there may already be four potential different industrial sites for these distribution upgrades:

- Upper Hunter around AGL's Liddell Energy Hub
- Tomago/Hexham

- Port of Newcastle/Mayfield/Waratah
- Kooragang Island

System Security

The projected costs are based on AEMO's 2022 ISP Appendix 7 which is based on the Step Change scenario. Data for system security spending for the Hydrogen Superpower scenario was not publicly available, therefore we extrapolate spending using the available Step Change data. From the Hydrogen Superpower scenario at the year 2027/28, renewables account for 85% of the electricity generation. This is the equivalent to the year 2031/32 of the Step Change scenario, of which $3 billion in investment into system security is required. A 50% government support for these system security assets is $1.5 billion in the 5 years to 2027/28.

The $200 million to support new system security technology implementation and scale up is based on funding outlined in Table 12. We propose that this funding support 2-3 large scale deployments that are similar in scale to the Neoen Big Battery expansion project ($50-$100 million) and are focused on next generation system security technologies such as advanced grid forming inverters/batteries. The remaining funds can be used for pilot and demonstration projects for additional system security technologies such as use of wind farms for FCAS services or community batteries for system security to remote and regional locations ($1-$10 million).

Table 12: Government funding (primarily ARENA) for system security projects

Project	Gov Funding ($m)	Type
Neoen Big Battery (CEFC + SA + ARENA)	73	Battery for FCAS and Inertia services
Musselroe Wind Farm FCAS Trial (ARENA)	0.477	FCAS services from wind farms
Powerlink Cost-Effective System Strength Study	0.491	Grid forming batteries study
AGL Broken Hill Grid-Forming Battery	14.83	Grid forming battery demonstration

Key reports for further reference

Report	Author
Market Sounding Report on Transmission	KPMG, prepared for the Clean Energy Council and Energy Networks Australia
Setting up industrial regions for net zero	Australian Industry Energy Transitions Initiative
Sunshot: Australia's opportunity to create 395,000 clean export jobs	Accenture, prepared for WWF, ACF, BCA, ACTU
Victorian Transmission Investment Framework, Preliminary Design	Victorian Government, Environment, Land, Water and Planning
Ausgrid: Our Draft Plan for 2024-29	Ausgrid
Mitigating biodiversity impacts associated with solar and wind energy development	IUCN, the Biodiversity Consulting Company
Clean Energy Agreement Making On First Nations Land: What Do Strong Agreements Contain?	First Nations Clean Energy Network. O'Neill, L., Riley, B., Hunt, J., & Maynard, G.
Climate Transition Action Plan	AGL
Queensland Energy and Jobs Plan	Queensland Government
Whole of System Plan	Government of Western Australia, Energy Transformation Taskforce
Annual Report 2021	Australian Energy Infrastructure Commissioner
Energy Vision	Transgrid
2022 Electricity Statement of Opportunities	AEMO
2022 Integrated System Plan	AEMO
Modelling Electricity Bill Impact of Transmission Project Delays	Endgame Economics, For NEXA Advisory
Farm Powered	Farmers for Climate Action
State of the Energy Market 2022	AER
Building Trust for Transmission	RE-Alliance

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