Reinforcing the New South Wales Southern Shared Network (HumeLink) PADR – EY Market Modelling

TransGrid

12 February 2020

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Methodology

- Linear programming techniques compute hourly time-sequential, least-cost, long-term NEM development spanning 25 years from 2020-21 to 2044-45, following the RIT-T guidelines.
- The Time-Sequential Integrated Resource Planning (TSIRP) model makes decisions that minimise the overall cost to supply the electricity demand for the NEM over the entire modelling period incorporating:
  - Generation of each plant and charging and discharging of storage.
  - Commissioning new plant installed ‘linearly’.
- These hourly decisions take into account constraints that include demand-supply balance, minimum load for generators, inter and intra- connector limits, Southern NSW line and cutset limits, storage limits, build limits, reserve constraints, emission targets, LRET and state RET schemes.
- The model also includes detailed network representations of the Canberra zone by applying a DC load flow approximation methodology to the AC grid.
- Intra and inter-regional losses are captured in the TSIRP model through explicit modelling of dynamic loss equations.

Scenario assumptions

Key drivers input parameter	Scenario			
	Fast Change	Central	Step Change	Slow Change
Underlying consumption	AEMO ISP 2019-20 Fast Change	AEMO ISP 2019-20 Central	AEMO ISP 2019-20 Step Change	AEMO ISP 2019-20 Slow Change
New entrant capital cost for wind, solar SAT, OCGT, CCGT, PSH, and large-scale batteries	AEMO 2019 ISP '2 degree' scenario.	AEMO 2019 ISP '4 degree' scenario.	AEMO 2019 ISP '2 degree' scenario with stronger reductions for wind, PSH and batteries.	AEMO 2019 ISP '4 degree' scenario with weaker reductions for wind, PSH and batteries.
Retirements of coal-fired power stations	Half of stations' capacity retired 2 years earlier than Central. Liddell 2022-2023 fixed.	AEMO Generation Information announced retirement date or end-of-technical-lives.	Half of stations' capacity retired 5 years earlier than Central. Liddell 2022-2023 fixed.	Half of stations' capacity retired 5 years later than Central. Liddell 2022-2023 fixed.
Gas fuel cost	AEMO 2019 ISP: Core Energy 2019, Neutral		AEMO 2019 ISP: Core Energy 2019, Fast	AEMO 2019 ISP: Core Energy 2019, Slow
Coal fuel cost	AEMO 2019 ISP: WoodMackenzie 2019, Neutral		AEMO 2019 ISP: WoodMackenzie 2019, Fast	AEMO 2019 ISP: WoodMackenzie 2019, Slow
Federal Large-scale Renewable Energy Target (LRET)	33 TWh/a by 2020 to 2030 (including GreenPower and ACT scheme)			
COP21 commitment (Paris agreement)	52% reduction from 2005 by 2030, then a linear extrapolation beyond 2030 to 90% reduction of 2005 emissions by 2050	28% reduction from 2005 by 2030, then a linear extrapolation beyond 2030 to 70% reduction of 2016 emissions by 2050	52% reduction from 2005 by 2030, then a linear extrapolation beyond 2030 to 90% reduction of 2005 emissions by 2050	28% reduction from 2005 by 2030, then a linear extrapolation beyond 2030 to 70% reduction of 2016 emissions by 2050
Victoria Renewable Energy Target (VRET)	40% renewable energy by 2025 and 50% renewable energy by 2030			40% renewable energy by 2025
Queensland Renewable Energy Target (QRET)	50% by 2030			Q400 only
South Australia Energy Transformation RIT-T	NSW to SA interconnector (Project EnergyConnect) is assumed commissioned by July 2023			
Western Victoria Renewable Integration RIT-T	The preferred option in the Western Victoria Renewable Integration PACR by July 2025 (220 kV upgrade in 2024 and 500 kV to Sydenham in 2025).			
Marinus Link and Battery of the Nation	Assumed commissioned by July 2033 600 MW bi-directional	Excluded	Assumed commissioned by July 2033 1200 MW bi-directional	Excluded
Victoria to NSW Interconnector Upgrade	The Victoria to New South Wales Interconnector Upgrade PADR preferred option is assumed commissioned by July 2022.			
Snowy 2.0	Snowy 2.0 is included from July 2025			
VNI West	The VNI West ISP 2019 preferred option is assumed commissioned by July 2026			Excluded

Input Data – Supply

- Existing and new wind and solar projects are modelled based on nine years of historical weather data at hourly resolution, correlated with demand profiles at hourly resolution.
- Forced outage rates for coal generators are based on EY analysis of historical performance. EY's analysis applies generator-specific full forced outage rates.
- Coal-fired generation is treated as dispatchable between minimum load and maximum load.
- Gas-fired CCGT plant also typically have a must-run component and so are dispatched at or above their minimum load to deliver efficient fuel consumption.
- Intermittent renewables, in particular solar PV, wind and run-of-river hydro are dispatched according to their resource availability as they cannot store energy.
- Conventional hydro with storages, PSH and batteries are dispatched in each trading interval such that they are most effective in reducing the costs of generation up to the limits of their storage capacity.
- Retirement dates for the Central scenario are sourced from the latest Generation Information expected closure year document at the time of modelling.

Input Data – Renewable Supply

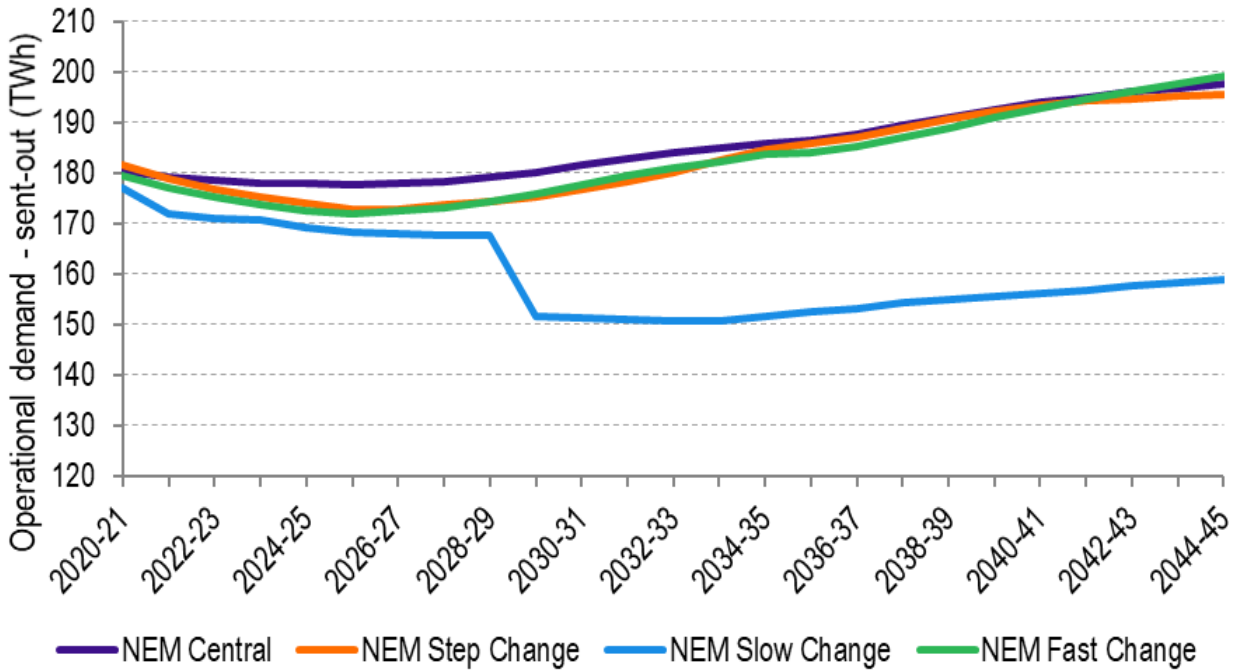
- Wind and solar capacity expansion in each REZ is limited by three parameters based on AEMO's 2019 Input and Assumptions workbook.
  - Transmission-limited total build limit (MW) representing the amount of capacity supported by current intra-regional transmission infrastructure.
  - A transmission expansion cost ($/MW) representing an indicative linear network expansion cost to develop a REZ beyond current capabilities and connect the REZ to the nearest major load centre.
  - Resource limits (MW) representing the maximum amount of capacity expected to be feasibly developed in a REZ based on topography, land use etc.
- The TSIRP model incurs the additional transmission expansion cost to build more capacity up to the resource limit if it is part of the least-cost development plan.

- Sample of REZ zone annual capacity factor data

Region	REZ	Wind		Solar SAT
		High quality	Medium quality	
Queensland	Far North Queensland	56%	52%	28%
	North Queensland Clean Energy Hub	45%	37%	32%
	Northern Queensland	Tech not available	Tech not available	31%
	Isaac	41%	35%	30%
	Barcaldine	38%	34%	32%
	Fitzroy	42%	36%	29%
	Wide Bay	34%	29%	28%
	Darling Downs	42%	37%	30%
New South Wales	North West New South Wales	Tech not available	Tech not available	30%
	New England	37%	35%	28%
	Central West New South Wales	38%	34%	28%
	Broken Hill	36%	32%	31%
	South West New South Wales	31%	31%	29%
	Wagga Wagga	28%	26%	28%
	Cooma-Monaro	38%	36%	Tech not available

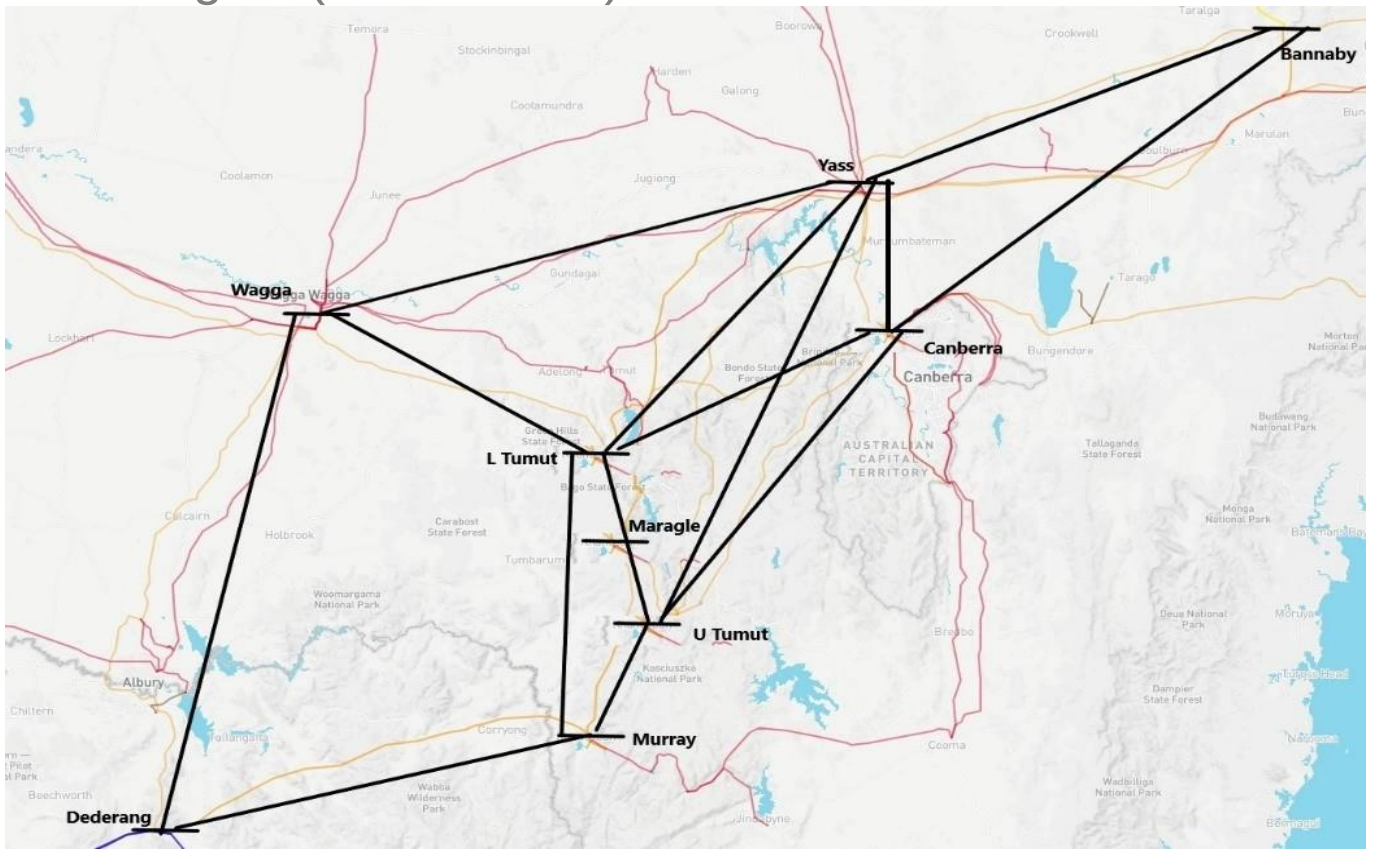
Input Data – Demand

- The TSIRP model captures operational demand (energy consumption which is net of rooftop PV) diversity across regions by basing the overall shape of hourly demand on nine historical financial years ranging from 2010-11 to 2018-19, as for intermittent renewables.
- The modelling used AEMO's 2019-20 ISP 10% POE peak demands.
- Annual operational demand in all scenarios for the NEM from AEMO's 2019 Input and Assumptions workbook is:



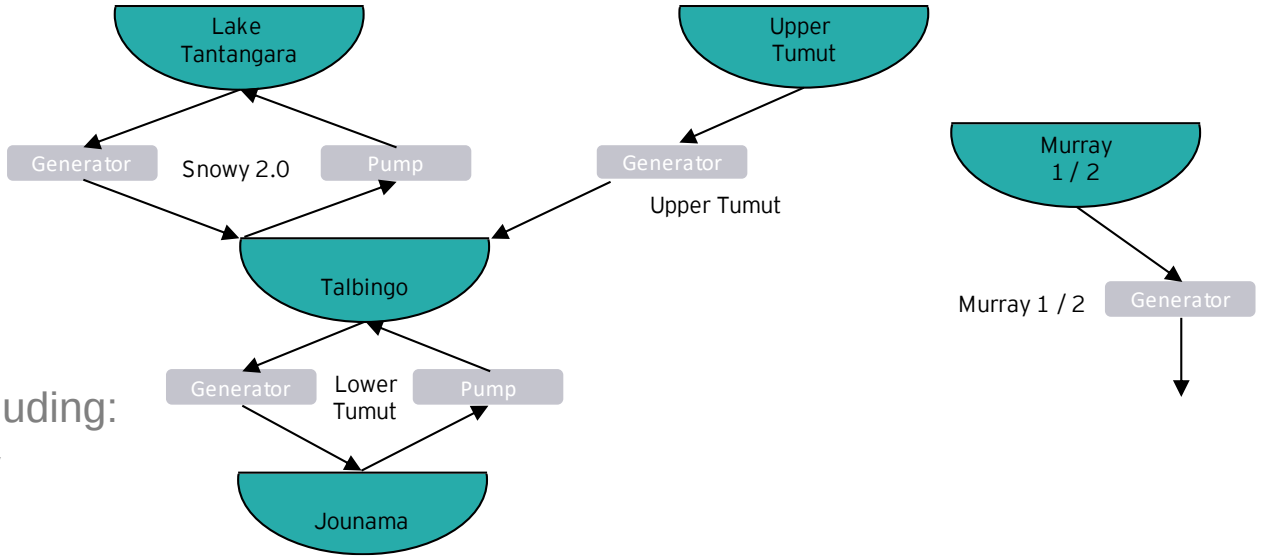
Input Data – Transmission

- TransGrid elected to split New South Wales into sub-regions or zones in the modelling
- To achieve a more detailed forecast of southern NSW network flows, where the proposed upgrade is to be built, the Canberra subregion (South NSW) is further subdivided into nine nodes
- Dynamic loss equations are computed for inter and intra- connectors
- Inter and intra- connector limits are applied
- Cutset limits (such as Snowy or CAN/YAS to Bannaby cutsets) are applied



Snowy 2.0 operation assumptions

- In all scenarios Snowy 2.0 is assumed to be commissioned in 2025-26 (July 2025)
- In our modelling, the storage level of Talbingo reservoir factors in all the following:
  - inflows from Snowy Hydro T1/T2 (Upper Tumut) hydro scheme,
  - inflows from Tantangara reservoir due to Snowy 2.0 generation,
  - inflows from Jounama reservoir due to Tumut 3 pumping,
  - outflows to Tantangara reservoir for Snowy 2.0 pumping,
  - outflows from Tumut 3 to Jounama reservoir.
- The storage capacity of Snowy 2.0 is approximately equivalent to seven days of continuous operation.
- A number of sensitivities have been conducted around the operation, development and capacity of Snowy 2.0 to verify the robustness of the modelling outcomes and their dependence on Snowy 2.0, including:
  halving storage, reducing capacity, and reducing efficiency



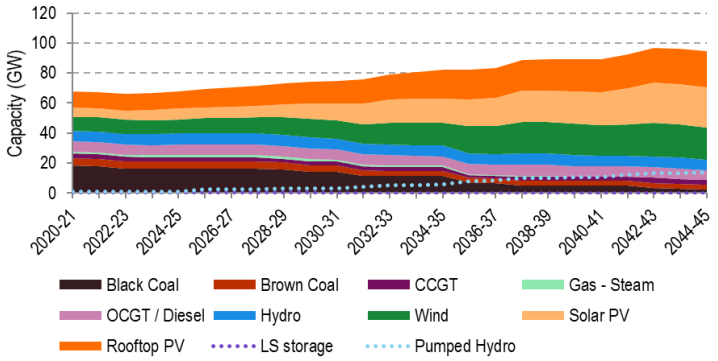
Forecast gross market benefit outcomes

- The table shows the forecast gross market benefits (millions real June 2019 dollars discounted to June 2020 dollars) over the modelled 25-year horizon, with the preferred option highlighted.

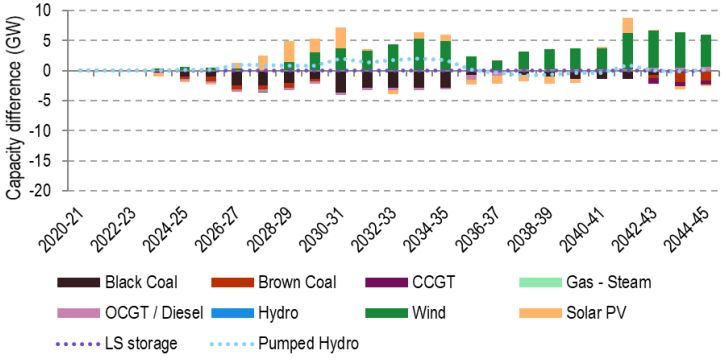
Option	Scenario			
	Slow Change	Central	Step Change	Fast Change
1A	897	992	1,113	1,045
1B	1,167	1,394	1,583	1,517
1C	1,108	1,331	1,516	1,467
2A	1,154	1,798	1,942	1,988
2B	1,412	2,245	2,511	2,533
2C	1,517	2,306	2,550	2,573
3A	1,005	1,621	1,757	1,806
3B	1,321	2,198	2,496	2,508
3C	1,504	2,291	2,545	2,562
4A	1,070	1,738	1,912	1,961
4B	1,506	2,438	2,742	2,777
4C	1,628	2,505	2,778	2,816

Scenario outcomes without HumeLink upgrade - Capacity

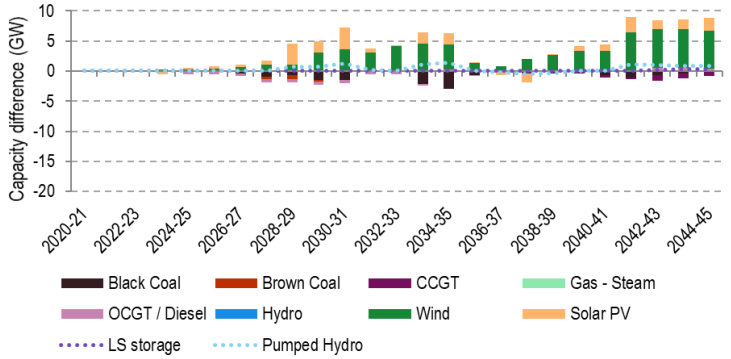
Central



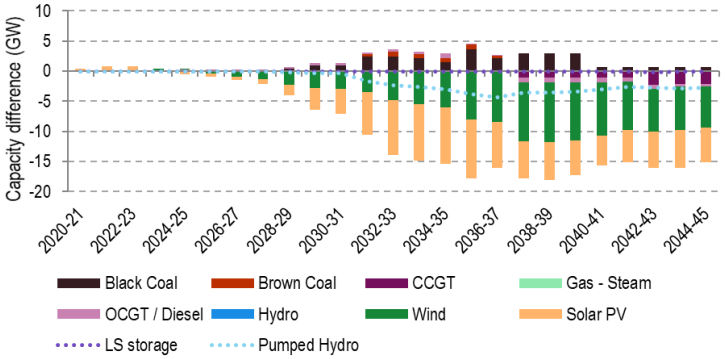
Step Change (relative to Central)



Fast Change (relative to Central)



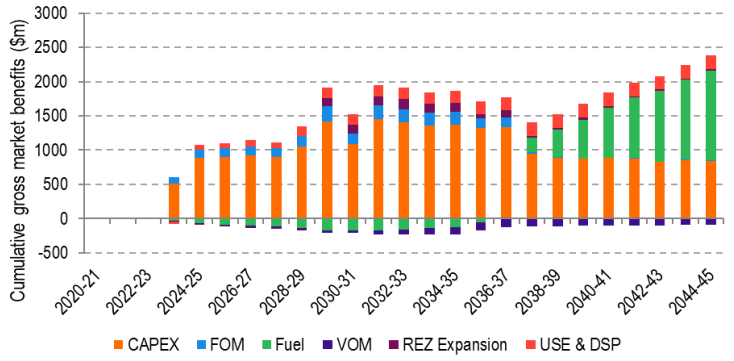
Slow Change (relative to Central)



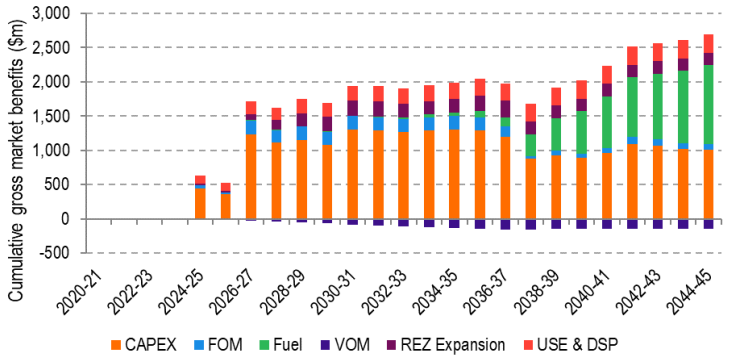
Option 3C outcomes – Forecast cumulative gross market benefits

millions real June 2019 dollars discounted to June 2020 dollars

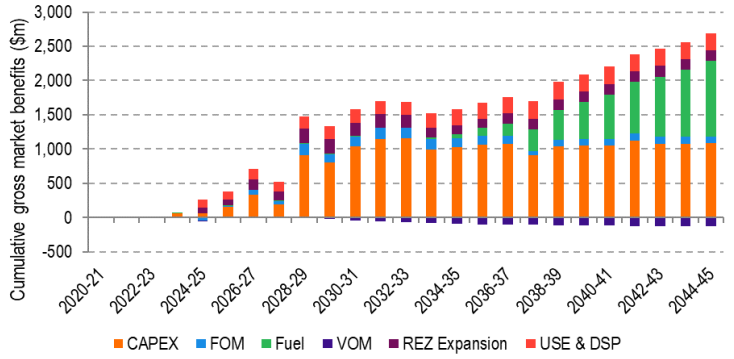
Central



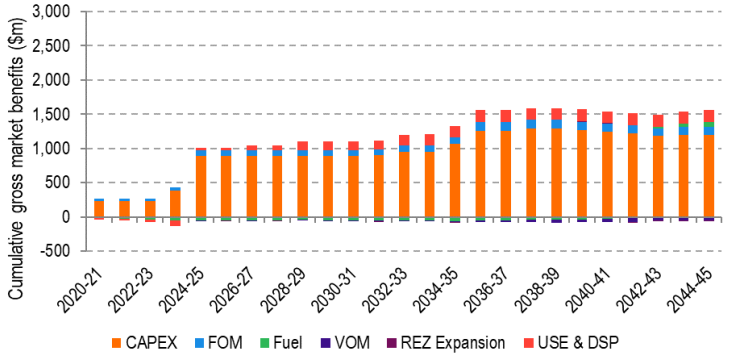
Step Change



Fast Change

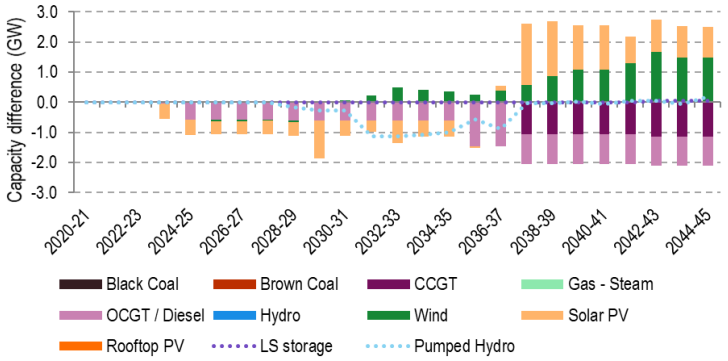


Slow Change

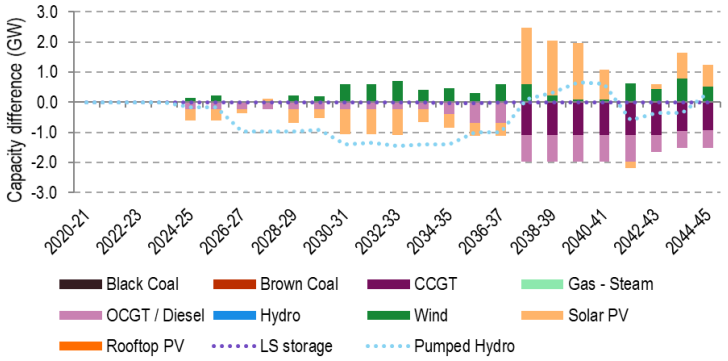


Option 3C outcomes - Capacity (Option 3C minus Base case)

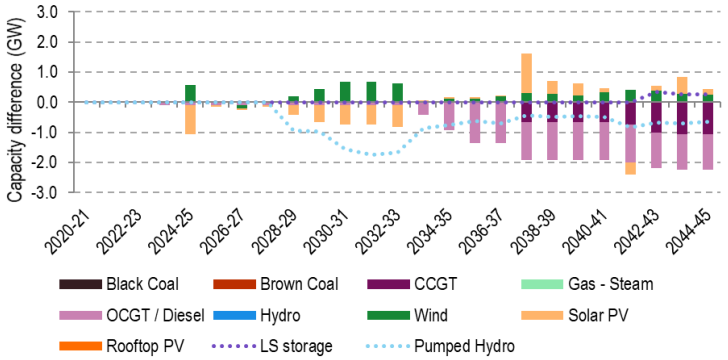
Central



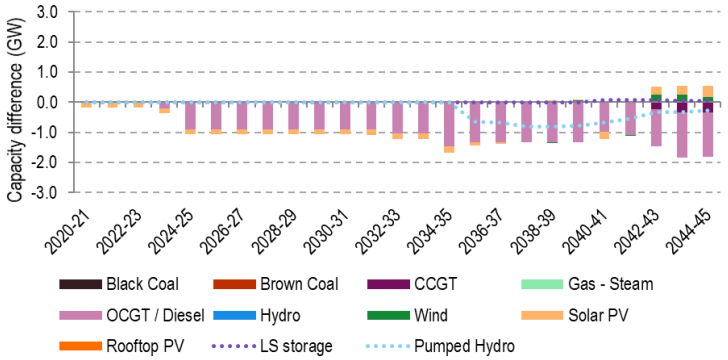
Step Change



Fast Change



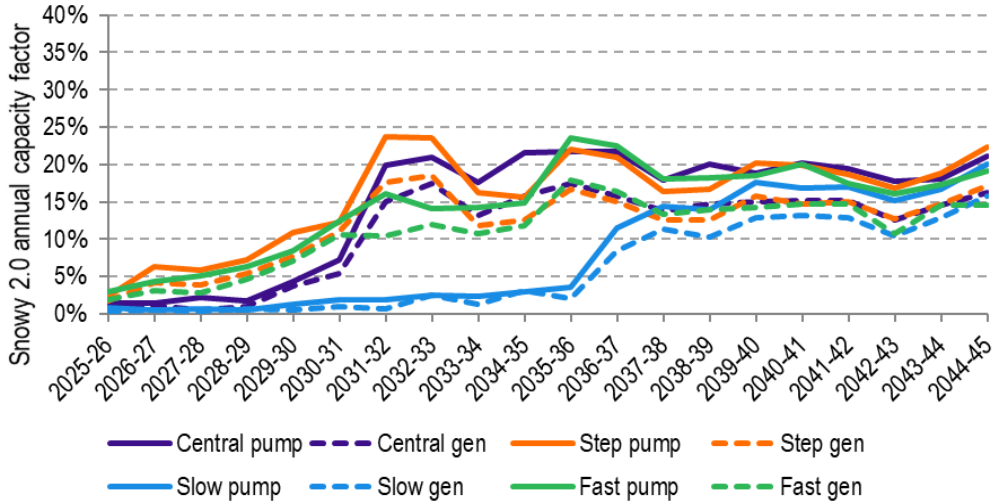
Slow Change



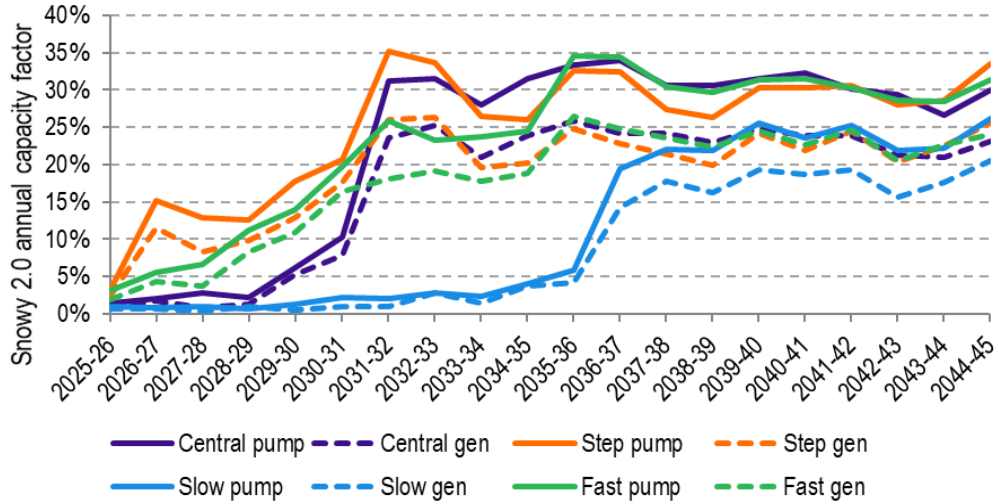
Option 3C outcomes - Snowy 2.0 operation

- Snowy 2.0 operation increases earlier in the Step and Fast Change scenarios and later in the Slow Change scenario, corresponding to earlier and later assumed coal retirements.

- Base Case



- Option 3C



Sensitivities outcomes

- Forecast gross market benefits compared to the Base case, millions real June 2019 dollars discounted to June 2020 dollars

Sensitivity	Scenario				
	Slow Change	Central	Step Change	Fast Change	High DER
Option 3C	1,504	2,291	2,545	2,562	N/A
Snowy 2.0 does not proceed	1,123	1,559	N/A	N/A	N/A
Economic retirements (a) earlier retirements (b) earlier and deferred retirements	N/A	(a) 2,327 (b) 1,536	N/A	N/A	N/A
High DER scenario	N/A	N/A	N/A	N/A	2,148
QNI Stage 2	N/A	N/A	N/A	1,810	N/A
50% POE	N/A	1,981	N/A	N/A	N/A
Staged development of Option 3C	979	2,010	2,412	2,412	N/A
Commissioning of VNI West delayed	N/A	2,200	N/A	N/A	N/A
Demand management	N/A	2,294	N/A	N/A	N/A

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