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Preliminary MUREIL Modelling Results

Overhead vs. Underground Transmission

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The MUREIL Model

Capacity Expansion with Hourly Dispatch Modelling

- Least-cost co-optimisation of generation, transmission and hydrogen
- Focusing on “Transition” modelling from the current NEM to a carbon-neutral NEM by 2050
- Hourly resolution with sampled days
- 5-year step from 2020 to 2050
- Existing generation plants and decommissioning time
- 30% synchronous constraints for frequency control in each NEM state
- Unit Commitment, economic dispatch and optimal DC power flow

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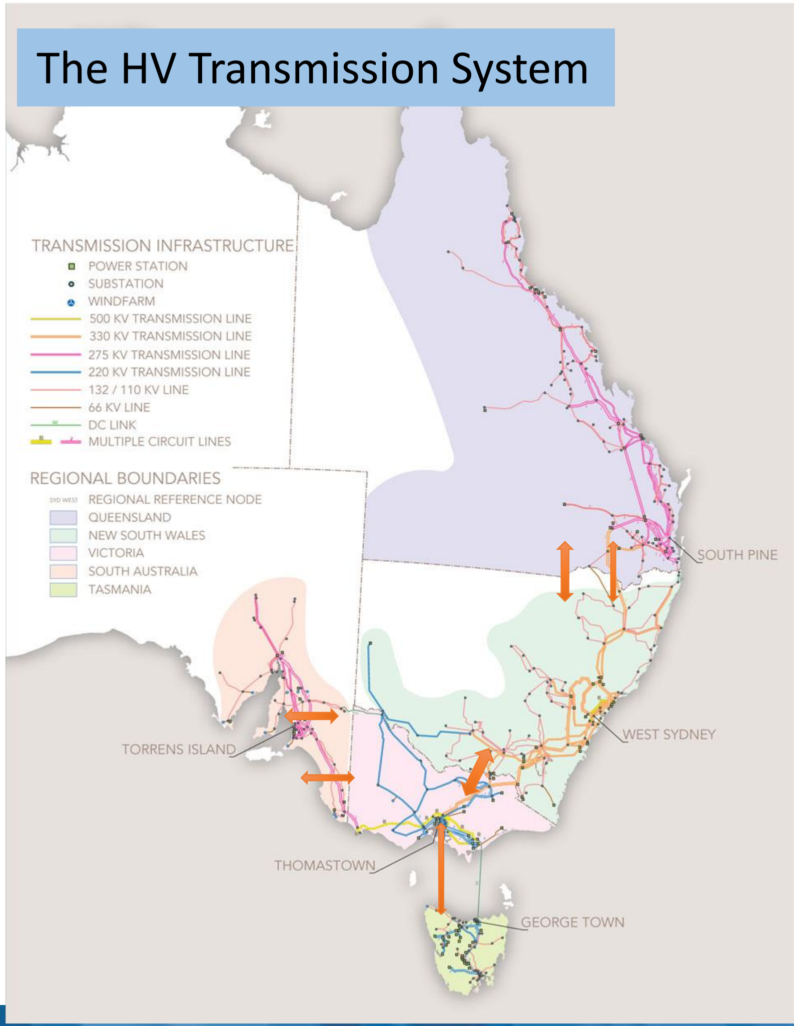
Transmission Network Modelling



Aggregated existing generation

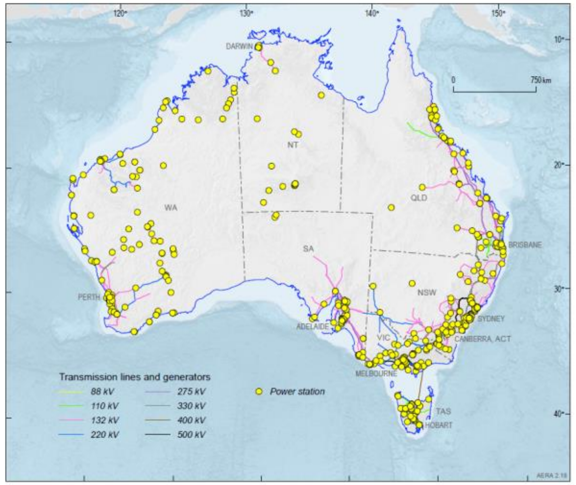
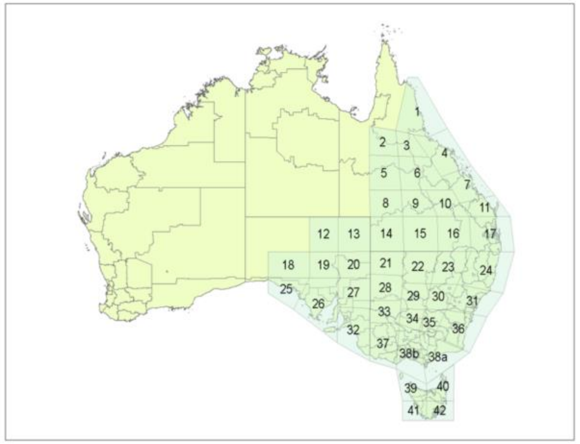
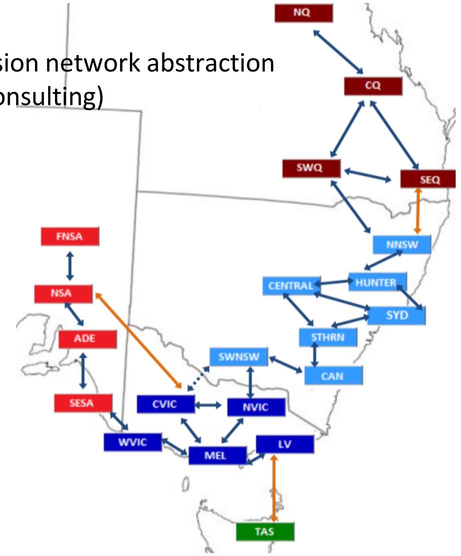


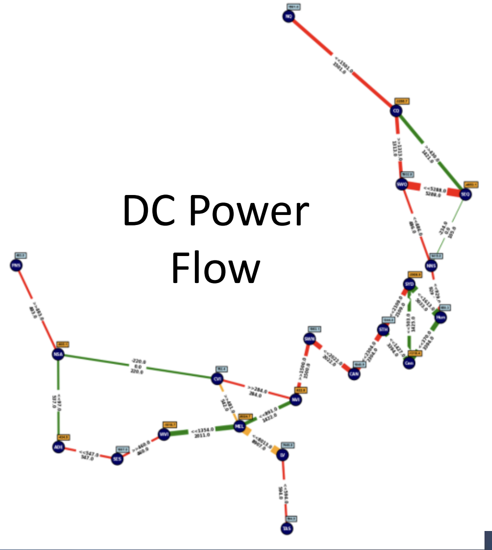
Figure 2.18 Australia's electricity infrastructure
Source: Geoscience Australia

Renewable candidate locations



Transmission network abstraction (ROAM consulting)

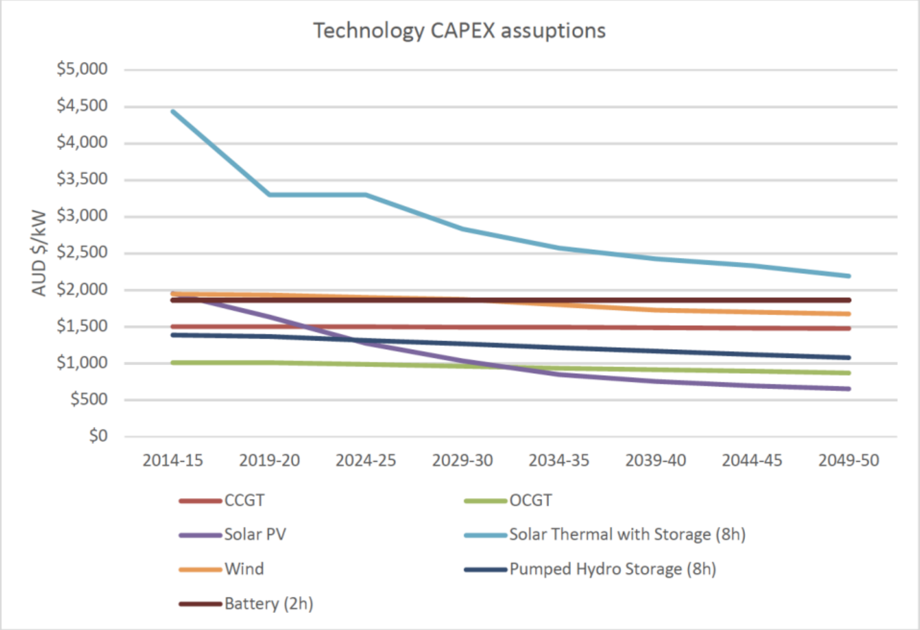




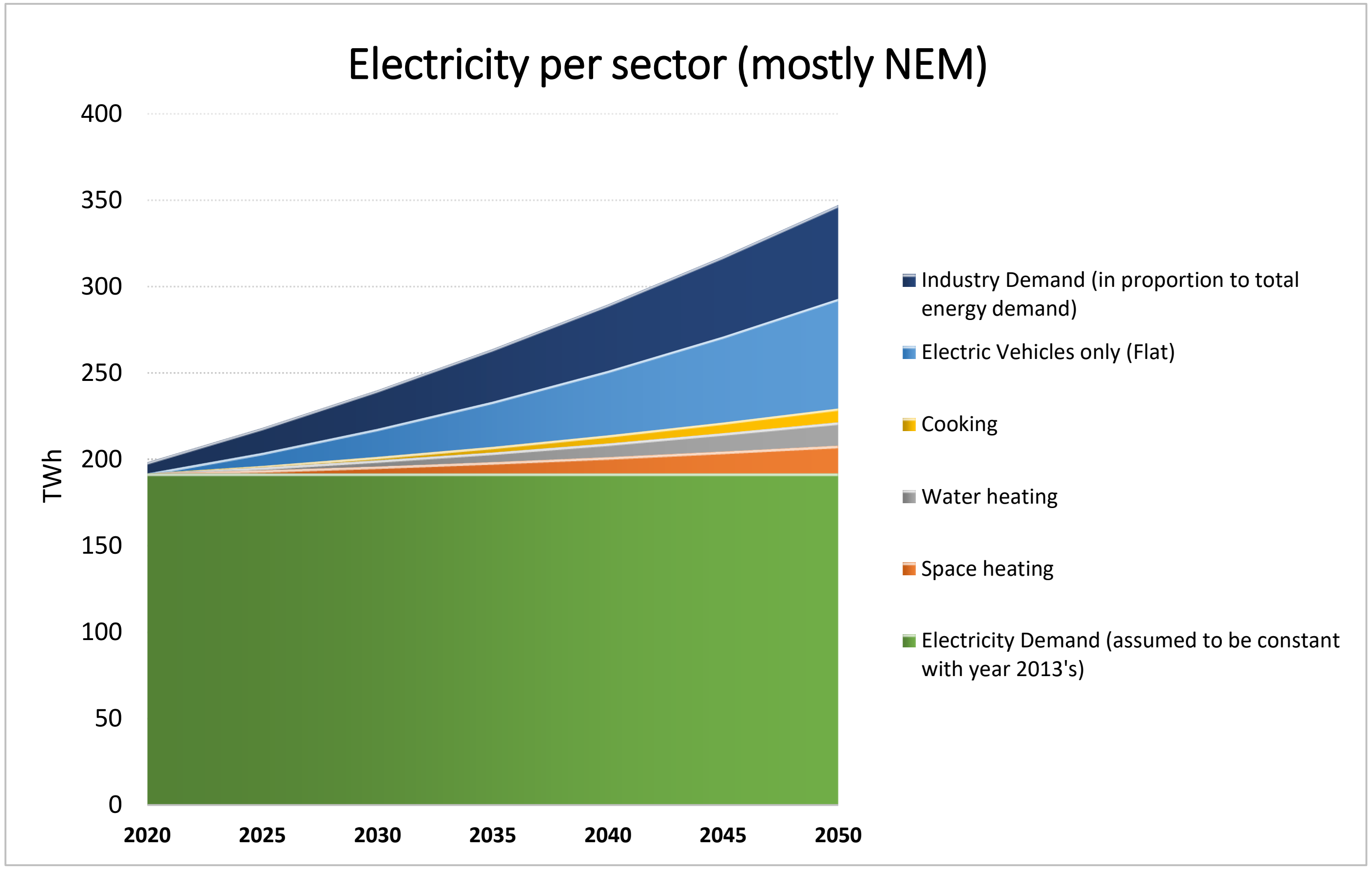
Input Assumptions

Emission cut:

- 2030: -45% of total GHG (economy-wide), -70% in power sector
- 2050: -80% of total GHG, -90-100% power sector



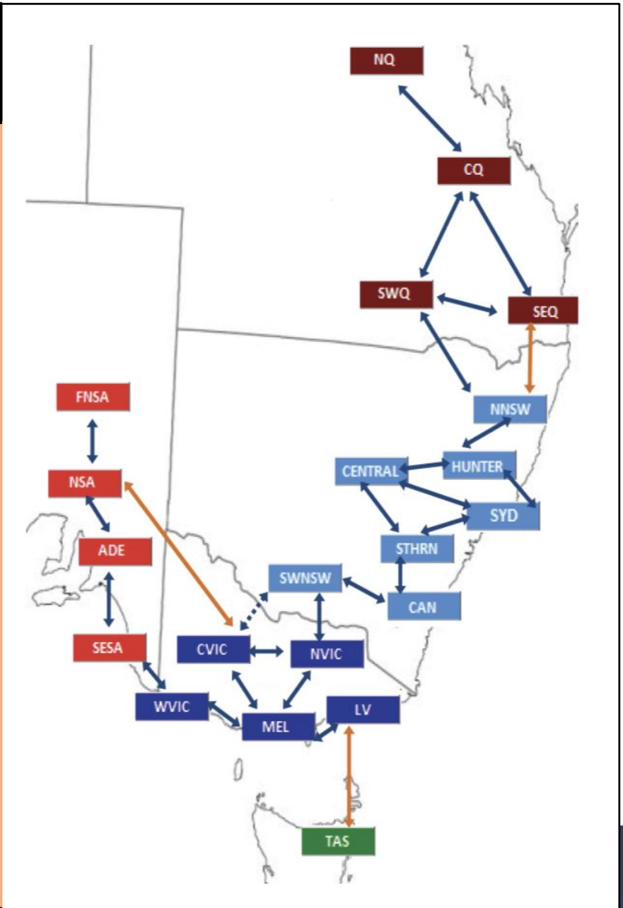
AEMO ISP Technology Cost Projections



Scenarios

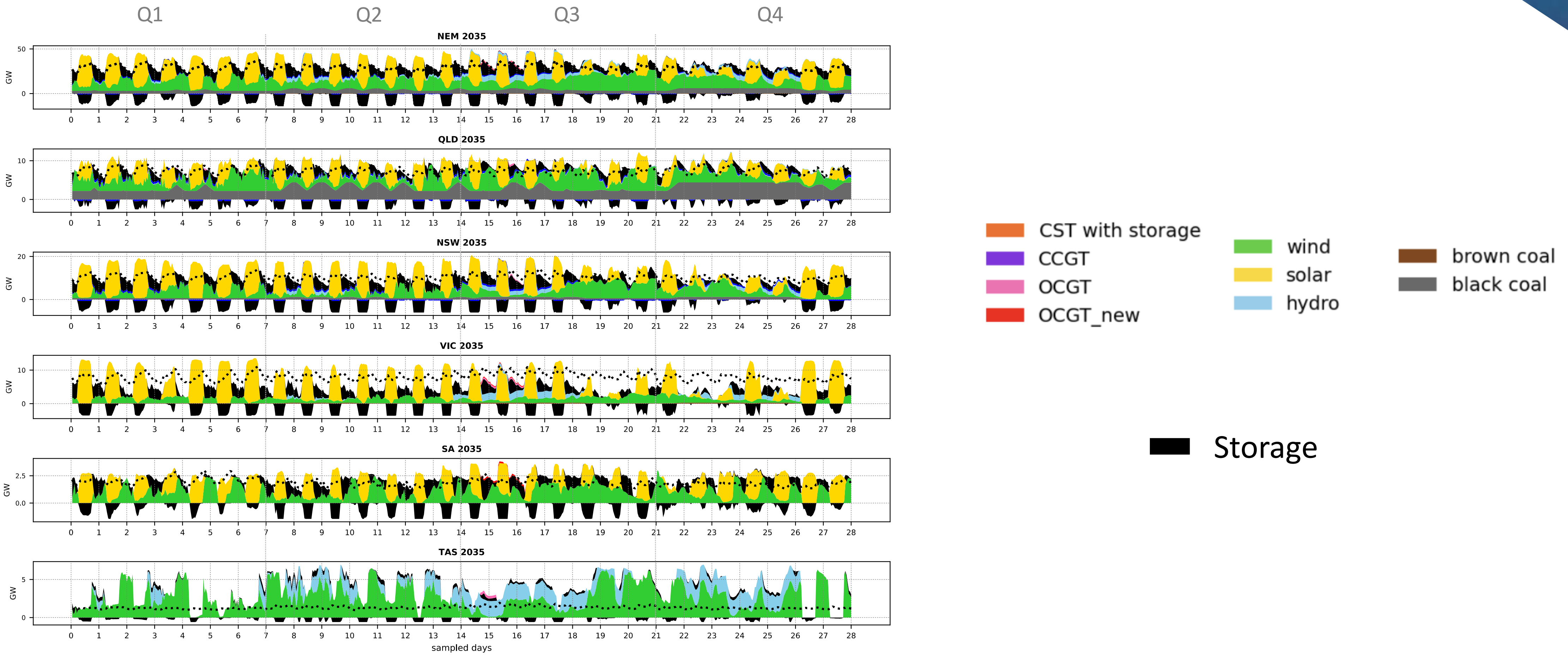
Overhead(baseline) VS. Underground (4X higher costs, except for Basslink)

Line	Node from	Node to	Flow min (MW)	Flow max (MW)	Type	Distance (km)	Overhead cost upgrade (m$/MW)	Underground 4X more expensive (m$/MW)
QNI	NNSW	SWQ	-1078	486	HVAC	415	0.6225	2.49
VIC_NSW	NVIC	SWNSW	-1500	1500	HVAC	150	0.225	0.9
Heywood	WVIC	SESA	-460	460	HVAC	125	0.1875	0.75
NQ to CQ	NQ	CQ	-1501	1501	HVAC	600	0.9	3.6
CQ to SEQ	CQ	SEQ	-1421	1421	HVAC	500	0.75	3
CQ to SWQ	CQ	SWQ	-1313	1313	HVAC	385	0.5775	2.31
SWQ to SEQ	SWQ	SEQ	-5288	5288	HVAC	130	0.195	0.78
NNSW to Hunter	NNSW	Hunter	-929	929	HVAC	220	0.33	1.32
Hunter to SYD	Hunter	SYD	-5033	5033	HVAC	155	0.2325	0.93
Hunter to Central	Hunter	Central	-3394	3394	HVAC	140	0.21	0.84
Central to SYD	Central	SYD	-1425	1425	HVAC	105	0.1575	0.63
STHRN to Central	STHRN	Central	-3394	3394	HVAC	140	0.21	0.84
STHRN to SYD	STHRN	SYD	-2109	2109	HVAC	120	0.18	0.72
CAN to STHRN	CAN	STHRN	-2304	2304	HVAC	115	0.1725	0.69
SWNSW to CAN	SWNSW	CAN	-2022	2022	HVAC	85	0.1275	0.51
NVIC to MEL	NVIC	MEL	-1422	1422	HVAC	216	0.324	1.296
NVIC to CVIC	NVIC	CVIC	-284	284	HVAC	490	0.735	2.94
LV to MEL	LV	MEL	-8907	8907	HVAC	136	0.204	0.816
MEL to WVIC	MEL	WVIC	-2011	2011	HVAC	300	0.45	1.8
MEL to CVIC	MEL	CVIC	-542	542	HVAC	450	0.675	2.7
SESA to ADE	SESA	ADE	-547	547	HVAC	380	0.57	2.28
ADE to NSA	ADE	NSA	-537	537	HVAC	100	0.15	0.6
NSA to FNSA	NSA	FNSA	-493	493	HVAC	200	0.3	1.2
Basslink	TAS	LV	-469	594	HVAC	320	0.761	0.761
Terranora	NNSW	SEQ	-234	105	HVDC	375	0.641	2.564
Murraylink	CVIC	NSA	-220	220	HVDC	150	0.425	1.7

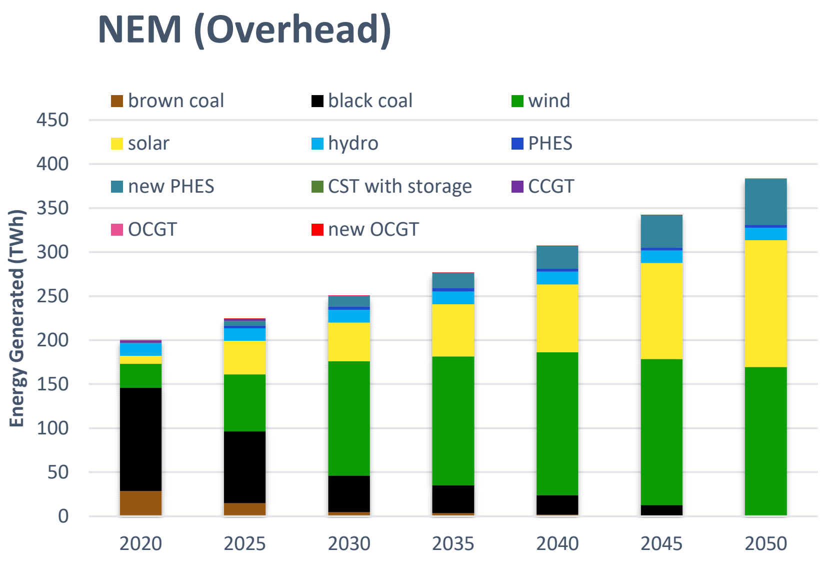


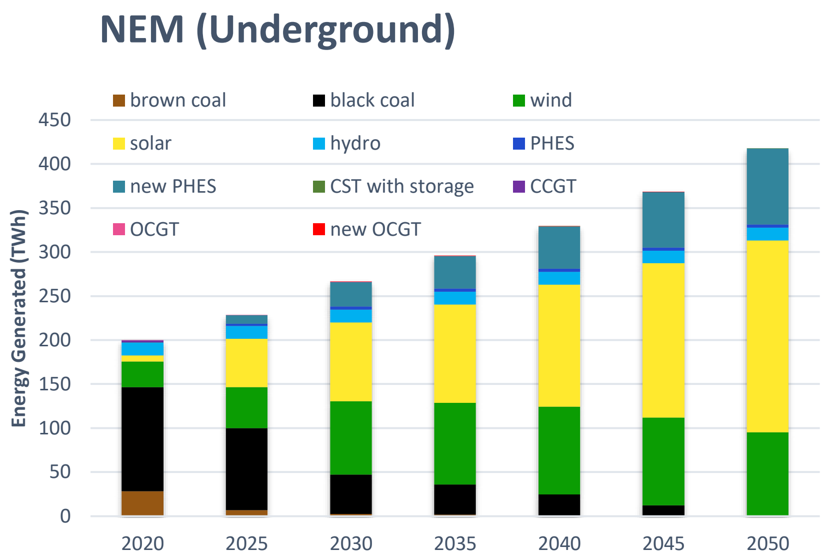
Modelled Hourly Operation (2035)

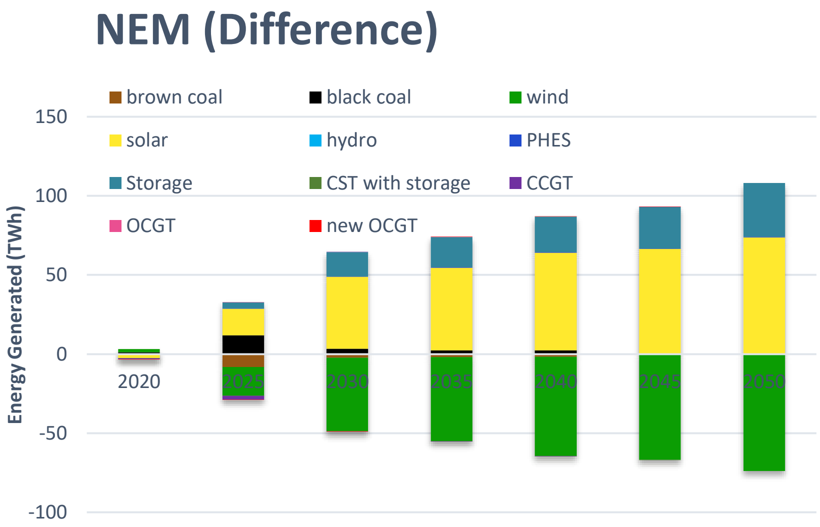
The "underground" transmission scenario



Difference in NEM Generation Mix

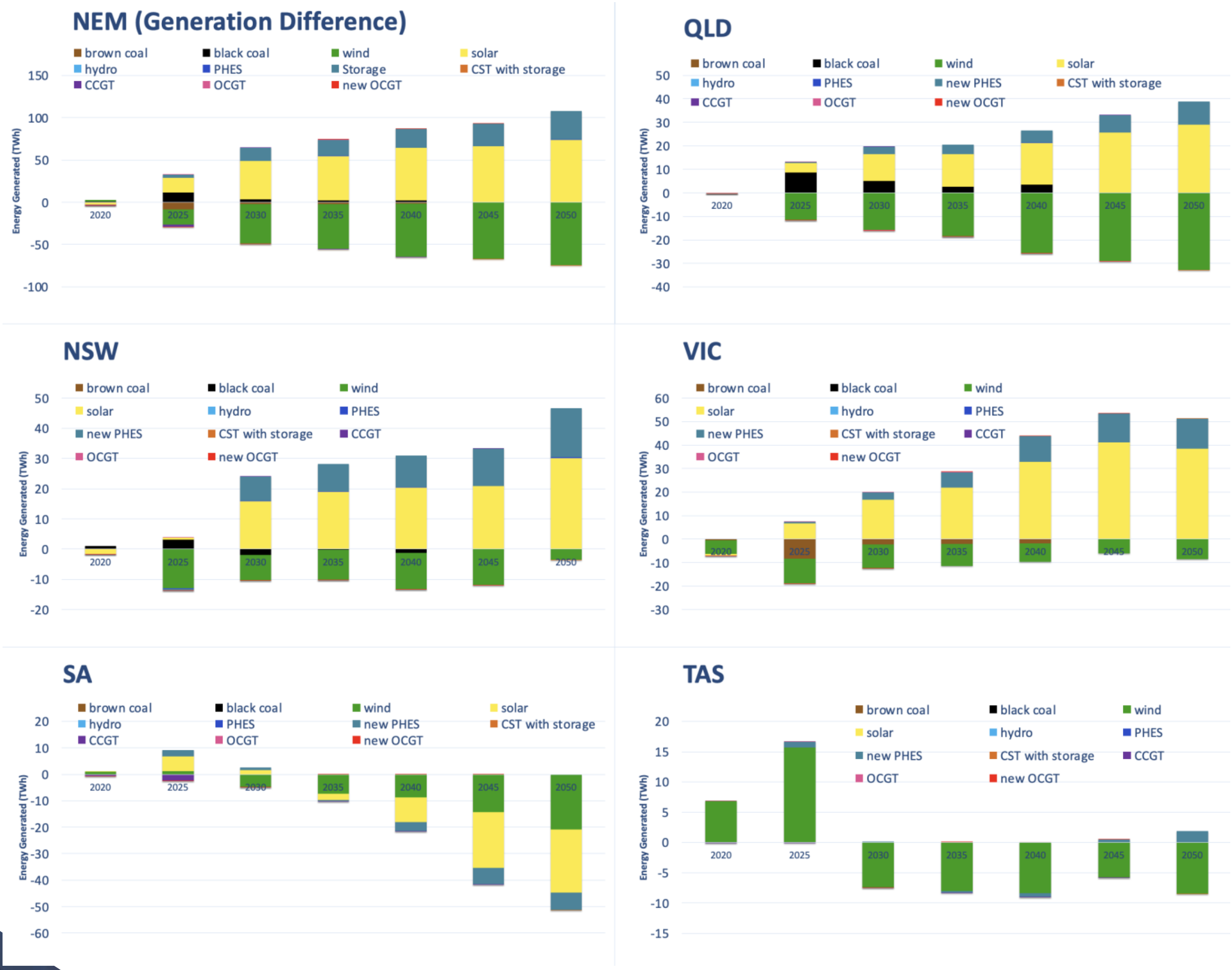




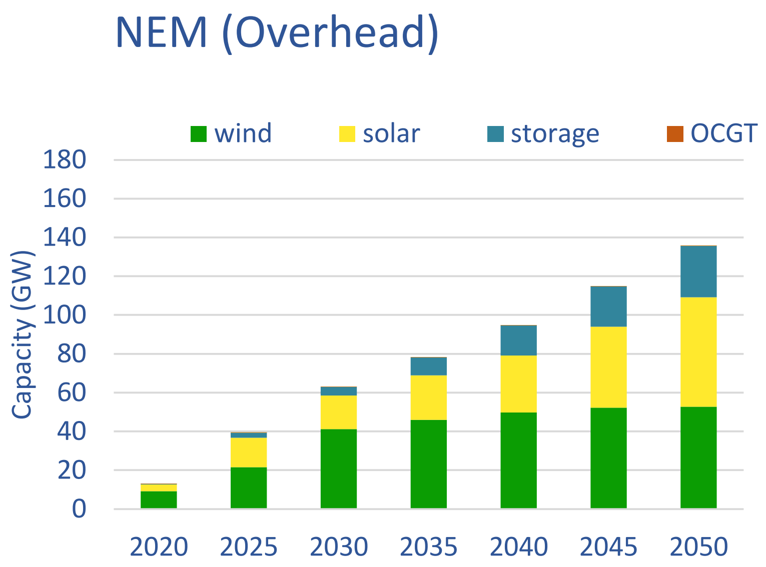


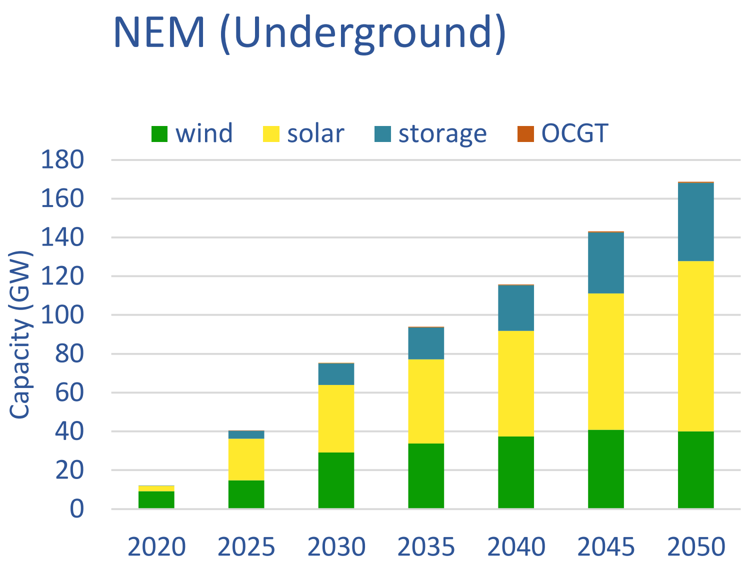
- More solar PV and storage
- Less wind

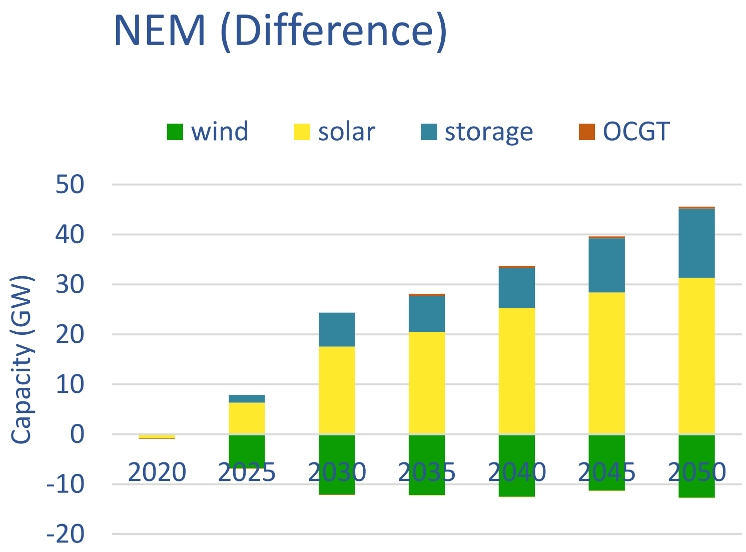
Difference in State Generation Mix



Difference in NEM New Capacity



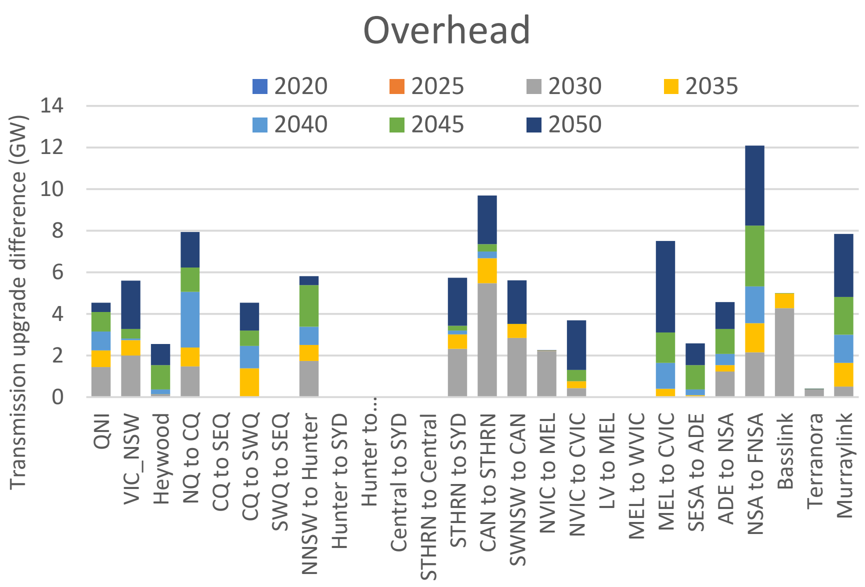


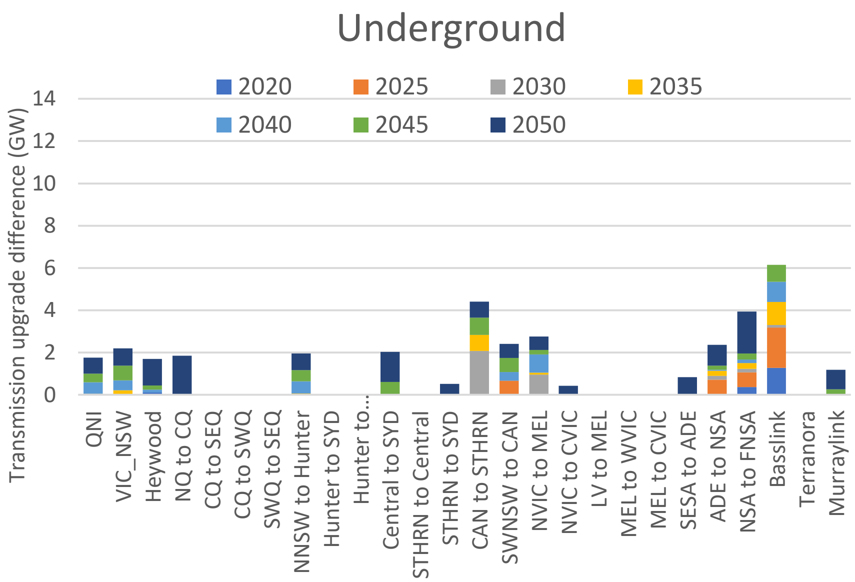


- More solar PV and storage
- Less wind

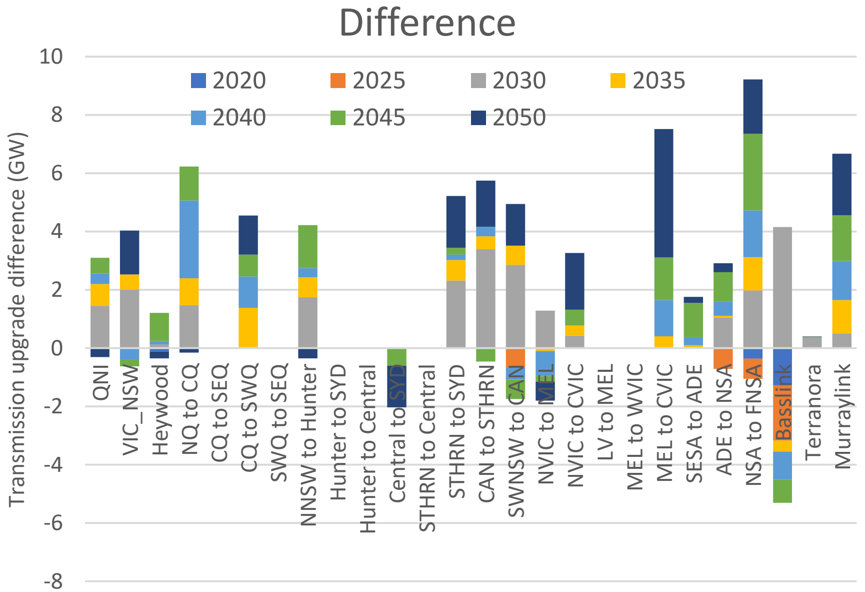
Difference in State New Capacity

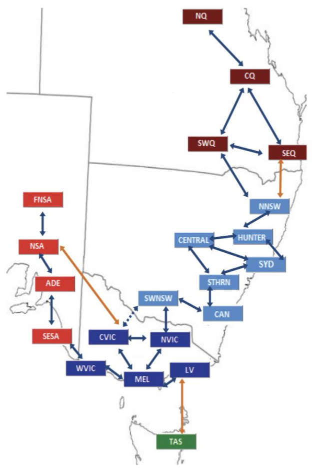
Difference in New Transmission Capacity





- Total new Overhead: 98 GW
- Total new Underground: 37 GW
- Reduced by 62%





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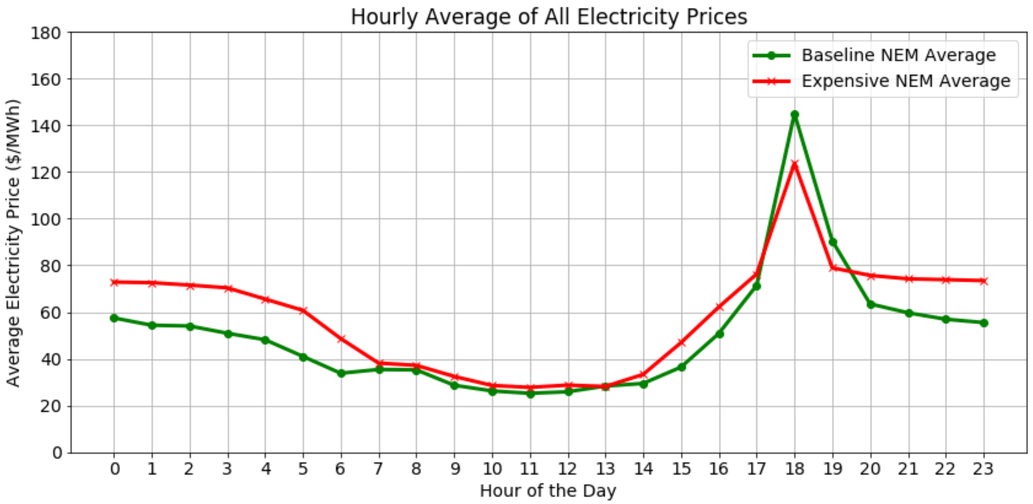
Cost of Electricity

Increased by 18% in the “Underground Transmission” scenario

30-year average system long-run marginal costs

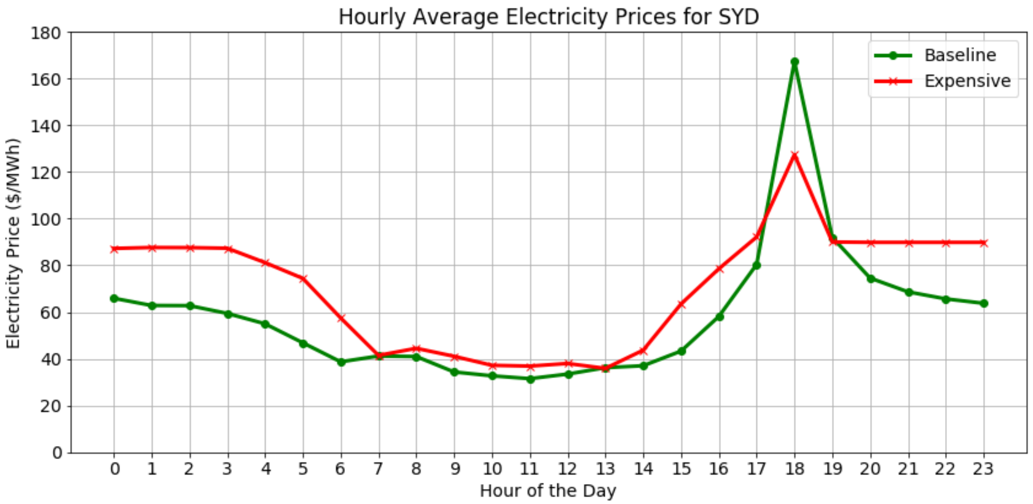
$66/MWh (**Overhead**) vs. $78 (**Underground**)

Example - Period: 2030 - 2035



Average NEM

Example - Period: 2030 - 2035



Sydney

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Conclusion and Future Work

Underground transmission will increase electricity costs, reduce wind, and increase solar PV and storage adoption.

Future work will Identify possible overhead and underground transmission lines:

- Assess current overhead transmission infrastructure and capacity
- Identify possibilities for new overhead transmission lines to meet increased capacity needs
- Consider feasibility of underground transmission options in certain areas

Explore trade-offs between options:

- Incorporate behind-the-meter generation and storage options
- Increasing transmission enables greater geographic diversity of renewables but has land use and community impacts
- Storage provides flexibility but is costly
- Flexible loads like hydrogen production can soak up excess renewable generation but need to scale up
- Coordinating EV charging with renewable availability avoids peak demand impacts
- Further refined modelling and sensitivity assessment are needed to meet various renewable, reliability and emission goals.