Future Grid Cluster Research Industry Symposium Australias Future Grid - Planning for Change and Choice

P1 - Project update (storage)

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How will large-scale grid connected battery storage affect NEM operation?

Effects of Grid Scale Storage

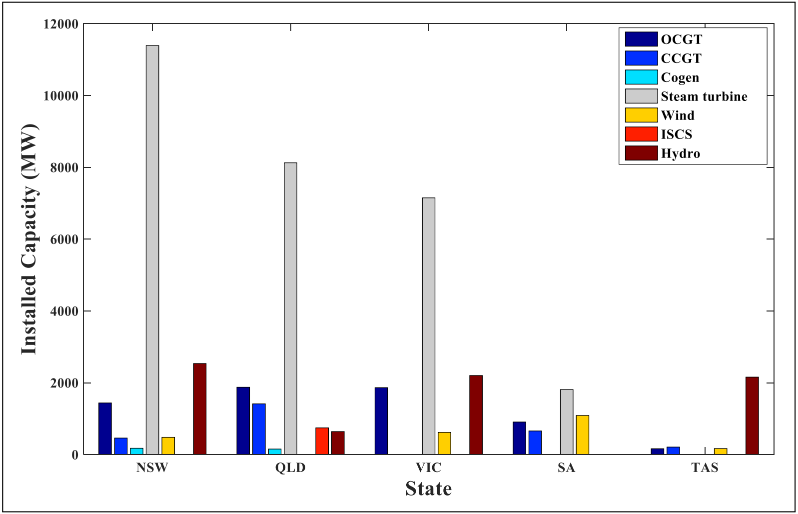
- Hypothetical large scale battery storage at generator/transmission level
- Effect on existing generators - dispatch, efficiencies, SRMC
- Effect on reliability, GHG emissions

Our approach

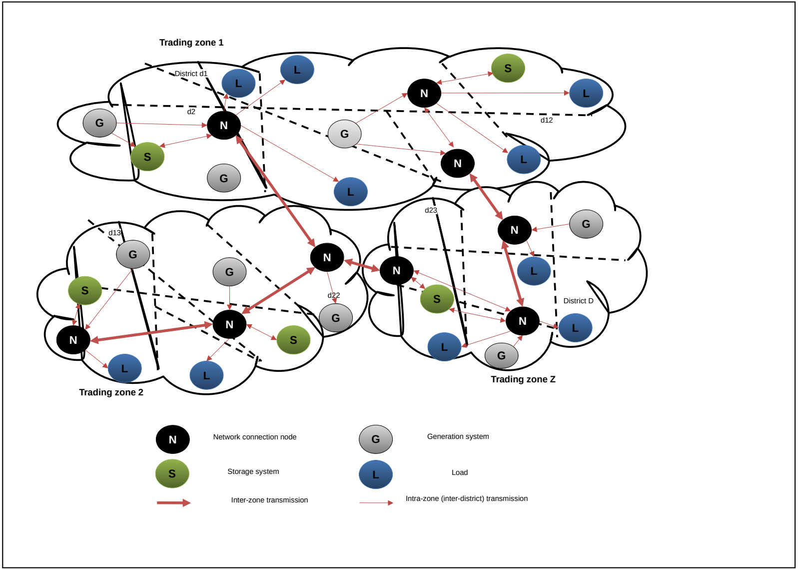
Model

- Use 301 generators from ACIL Allen data & transmission constraints
- Medium fuel price scenario from NTNDP 2014
- Projected demand assumed to be actual 2014 demand
- Losses 7%, reserve capacity 10% of demand
- use CPLEX solver for 1 week beginning Jan, Apr, July, Oct

Generation type in NEM



NEM storage integration



Modelling NEM storage

Given:

- A multi-period planning horizon;
- Available G generators and S units of high-rate battery storage;
- The transmission network topology and capacity constraints;
- The forecast electricity demand and weather condition in each location and period;

Determine:

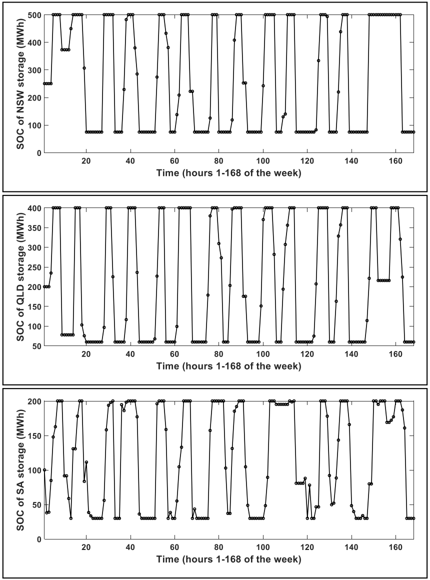
- The periodical operation schedule of each generator and storage system;
- The transmitted load profile over each line;
- Startup and shutdown times and durations
- The CO_2 emission profile (each system and aggregation);
- The periodical short-run marginal cost of each generator and storage;
- The power reliability of each zone over the planning horizon;

Aim to: Find the minimum SRMC over the entire grid.

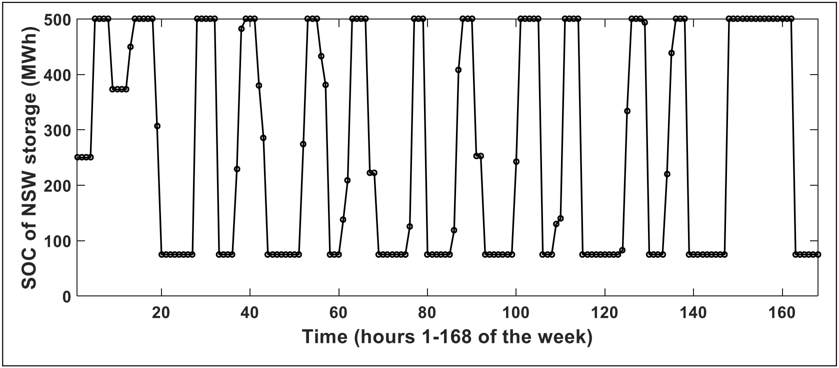
Battery location & capacity

Battery No.	Location	Battery type	Battery size (MWh)	Round-trip efficiency	Dis/charge duration (hours)	Life (years)
S1	NSW	Li-ion	500	0.92	1	8
S2	QLD	Li-ion	400	0.92	1	8
S3	VIC	Li-ion	300	0.92	1	8
S4	SA	Li-ion	200	0.92	1	8
S5	TAS	Li-ion	100	0.92	1	8

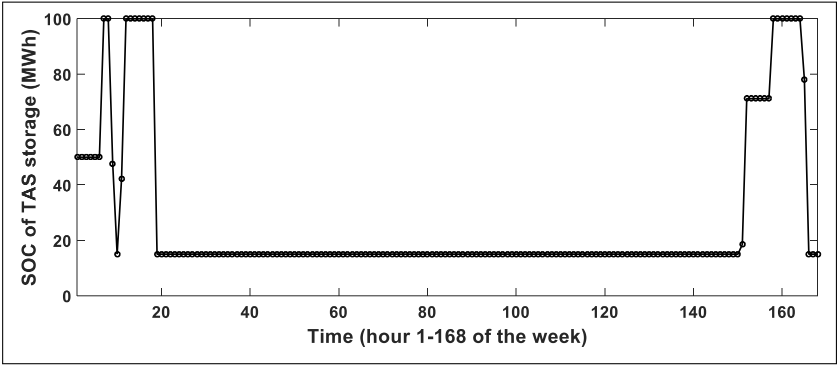
Results - Battery SoC in each region



Results - Battery SoC in NSW



Results - Battery SoC in Tas



Key results with 1.5 GWh storage, 1st week July 2014

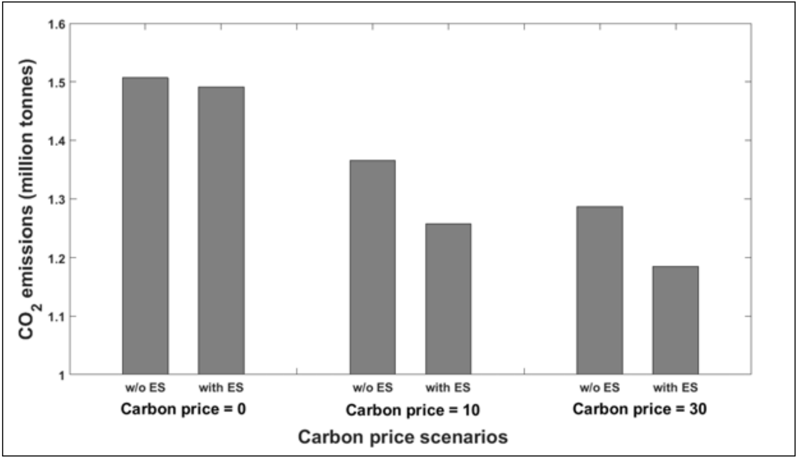
	Without storage	With 1.5 GWh storage	Difference
Average online units	177.8	175.8	
Units always off	99	102	
Units always on	155	153	
Units partially on	47	46	
Units without any load	17	15	
Number of hot starts	829	821	
Number of warm starts	22	37	
Number of cold starts	14	10	
Overall capacity factor	43.84	44.47	
Capacity factor exclalways-off units	65.32	67.26	
Capacity factor exclalways-off and always no-load	71.32	72.74	1.42
Economic values$M			
Total SRMC	107.40	106.37	**1.03**
Fuel cost total	39.8	39.0	
FOM generators	53.4	53.4	
FOM storage	-	0.36	
VOM+startup	13.8	13.5	
Key results			
Total CO_2emissions (tonnes)	3,588,134	3,564,824	23,309
CO_2intensity (tonne/MWh)	0.940	0.934	
SRMC of delivered electricity	28.14	27.87	
Reliability (%)	100	100	
Renewable share	27.66	27.77	
Storage charge from renewables (%)	-	42.65	

Effect of carbon price on use of storage

First 72 hours of April

Carbon Price	$0			$10			$30		
	No storage	1.5 GWh storage	diff	No storage	1.5 GWh storage	diff	No storage	1.5 GWh storage	diff
Demand (GWh)	1613			1613			1613		
Total CO_2 (ktonne)	1506	1491	15	1365	1256	108	1286	1184	101
CO_2 intensity (tonne /MWh)	0.934	0.924		0.847	0.79		0.797	0.734	
NEM renewable ratio (% of total generation)	27.7	28.0		33.4	33.4		33.8	33.6	
Renewable to storage ratio (% of total input to storage)	-	30.1		-	0.001		-	0.001	
Total SRMC of NEM ($million)	45.57	44.82	0.75	60.15	58.38	1.77	86.26	82.54	3.72
SRMC (MWh)	28.25	27.78	0.46	37.29	36.19	1.10	53.48	51.17	2.31

Impact of carbon price & storage

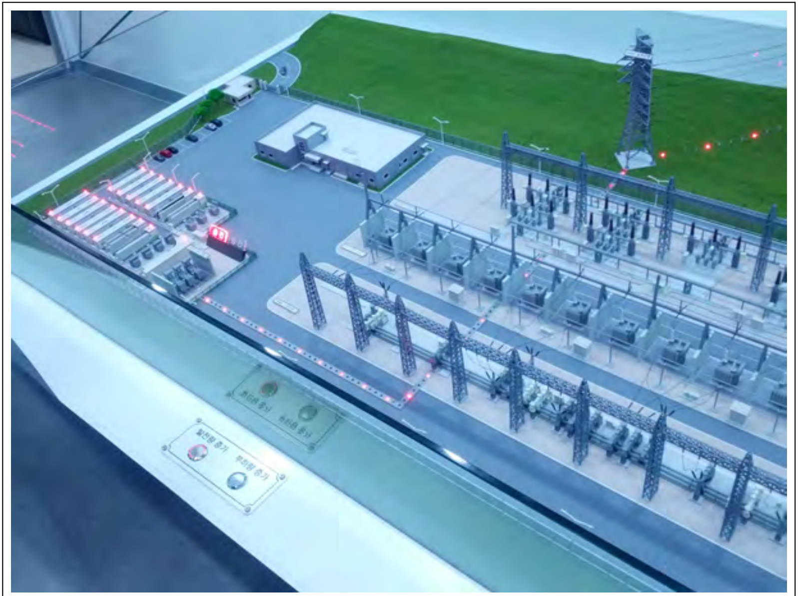


Initial Conclusions

Derived from very limited (4 x 1 week) simulations:

- Incorporating 1.5 GWh of battery storage in the NEM increases overall capacity utilisation of existing generators, and reduces cold starts, partial loading etc
- Storage results in lower GHG emissions, despite inherent round-trip losses
- Carbon price has a strong impact on GHG savings arising from use of storage

Korea Kepco West - Ansung 24 MW/8 MWh for frequency regulation



Kepco WestAnsung

Kepco Power & Energy

Kepco battery modules