snowyhydro

POWERING EVERYDAY

Managing price risk in the NEM:

The role of pumped hydro

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Context and trends

Outcomes

Snowy Hydro and Snowy 2.0

Comparing Australian and Chinese energy resources and power needs

China	Australia
Plans to build 1,000,000MW of coal plants, equivalent to 360 Eraring-sized power stations.	Plans to build 3,000 – 5,000MW of wind and solar farms, zero coal plants and some gas plants.
China will **import** vast, and growing, quantities of thermal coal	Australia will **export** vast, and growing, quantities of thermal coal

Why?

- Renewables **cannot** resolve China's energy demand problem
- China's wind and solar resource, **per head of population**, is tiny
- Australia's wind and solar resource, **per head of population**, is enormous

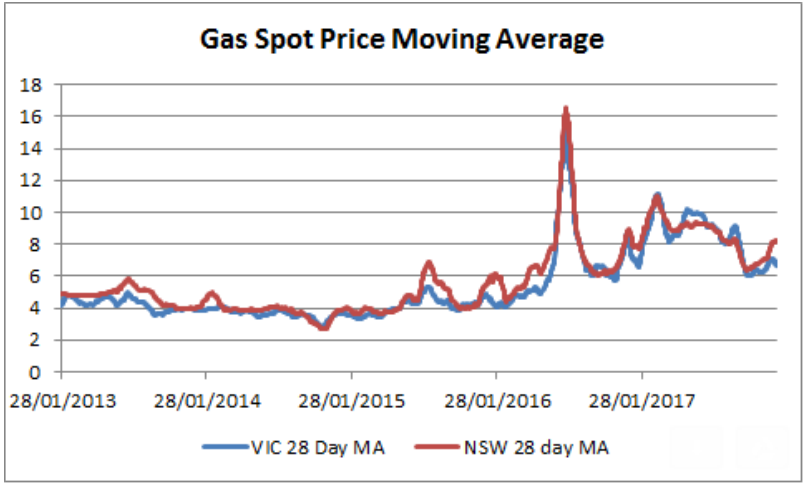
Implications for (black thermal) coal prices

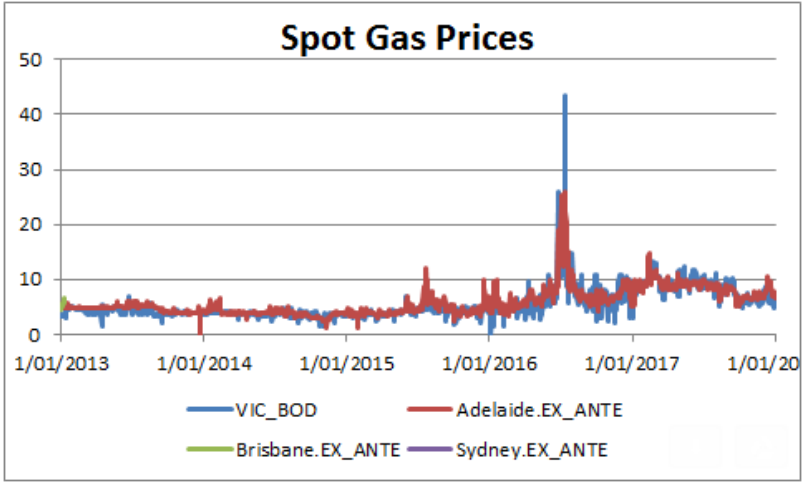
- Traded thermal coal cost indicates future*** fuel cost prices > $50/MWh and short run marginal cost > $70/MWh
- These costs escalate rapidly at lower capacity factors

*** "The future" is 2022 – 2025, when major coal contract re-sets occur.

Implications for gas prices

- Future gas prices will be problematic for the economics of combined cycle plant
- Fuel cost of ~ $85/MWh allows open cycle peaking plant to cover peak and some mid-merit





Another perspective on wind, solar and hydro

Implications
Coal and gas (as fuels) are expensive and getting more so.
Wind energy and solar energy are getting cheaper

- Wind, sunshine and water cannot be exported
- **Wind, solar and hydro are Australia's hedge against international coal and gas commodity prices**

Possible NEM paths are narrowing:

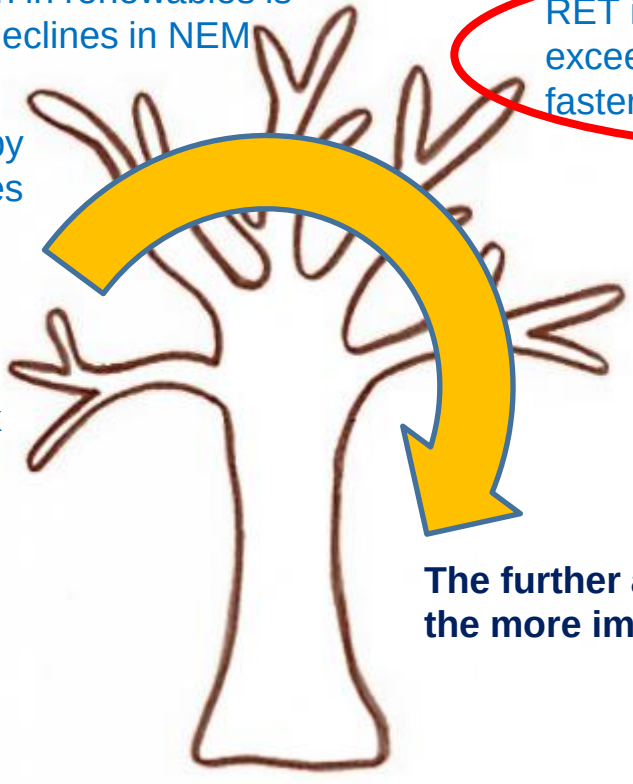
Focus on system reliability

Focus on low carbon emissions

RET is met, growth in renewables is "economic", coal declines in NEM

RET is exceeded, growth in renewables exceeds "economic" level, coal exits NEM faster than expected

RET (33,000GW renewable gen. by 2020) not met, coal still dominates



RET is exceeded, renewables dominate, coal exits faster than the NEM can replace capacity (S.A. revisited)

Climate change focus ends; Coal makes a comeback

The further around the tree we end up, the more important capacity and storage are

Outcomes for the NEM:
1. Intermittency

- The Macadamia Castle in Byron Bay is a zoo and macadamia farm
- The Castle has a large PV facility on its car park roof and free charging for EVs
- The proportion of load covered by its own PV cells has -70% / +20% variability within 5-10 minutes:

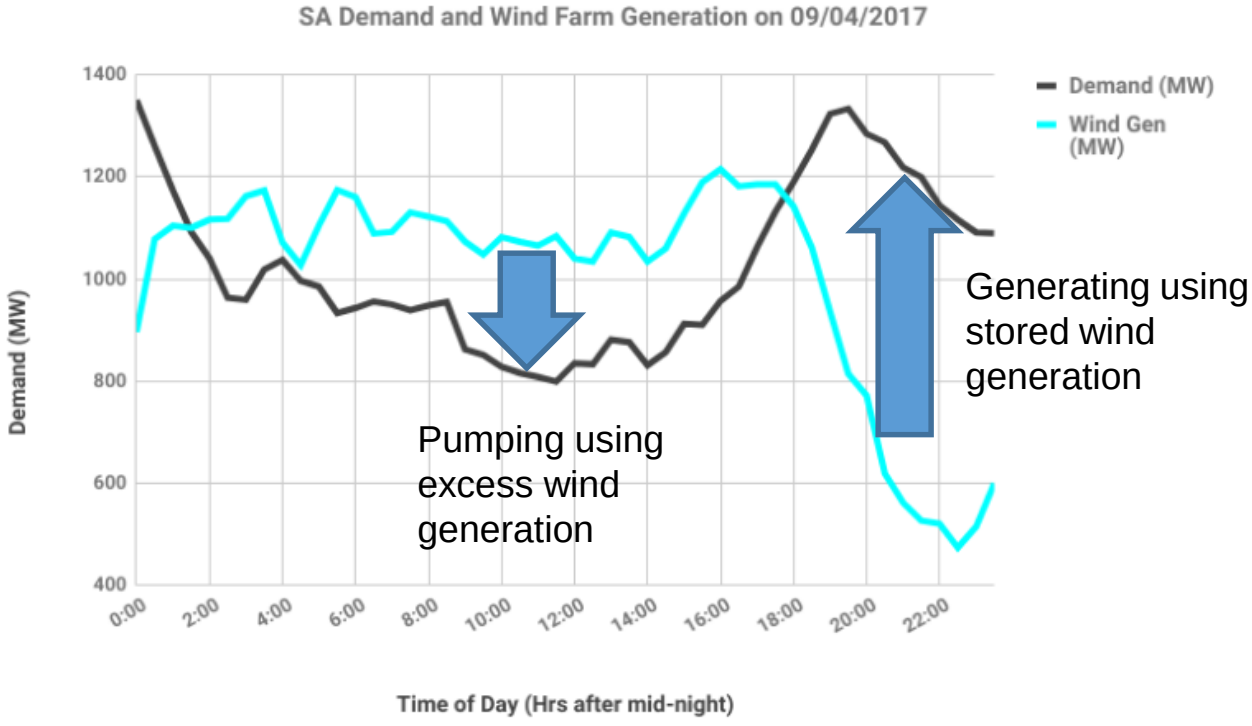
Red = Usage
Green = solar supply

Outcomes for the NEM:
2. Wind and solar droughts (e.g.: a water equivalent)

Electricity retailers have to deal with risk as well as averages

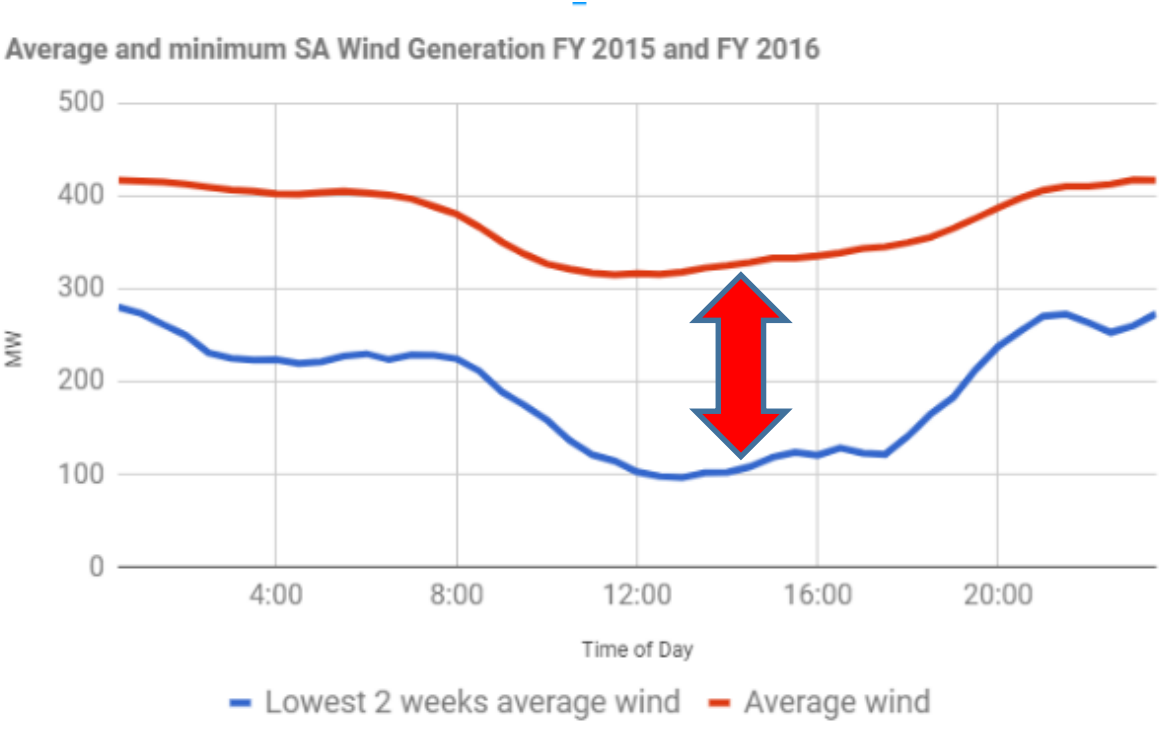
A real-life example of excess wind generation

An event like this is may be way off in NSW / Victoria, but this really happens in South Australia:



A real-life example of wind drought

Solar and wind droughts will be practical realities of the new NEM



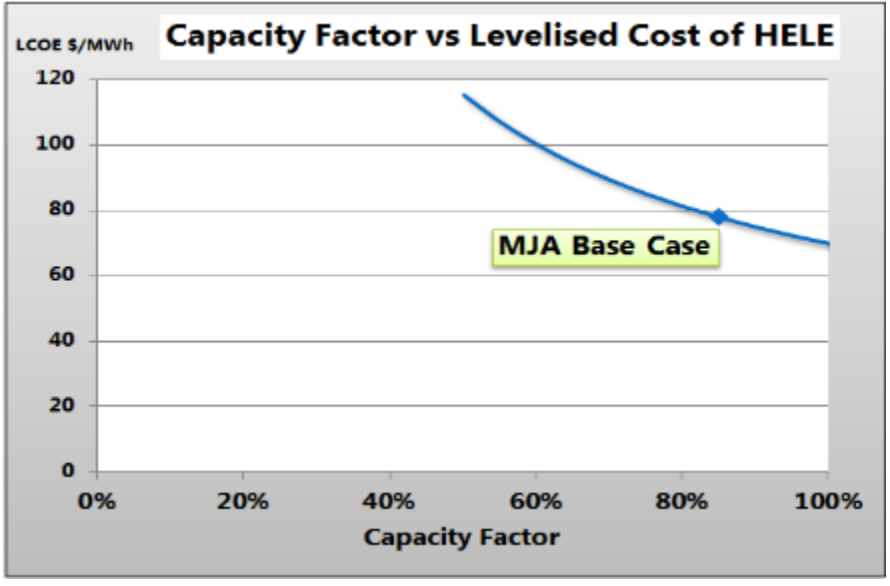
This difference (2 week average - 2 week minimum) = 60GWh over 2 weeks.

To provide 60GWh requires:

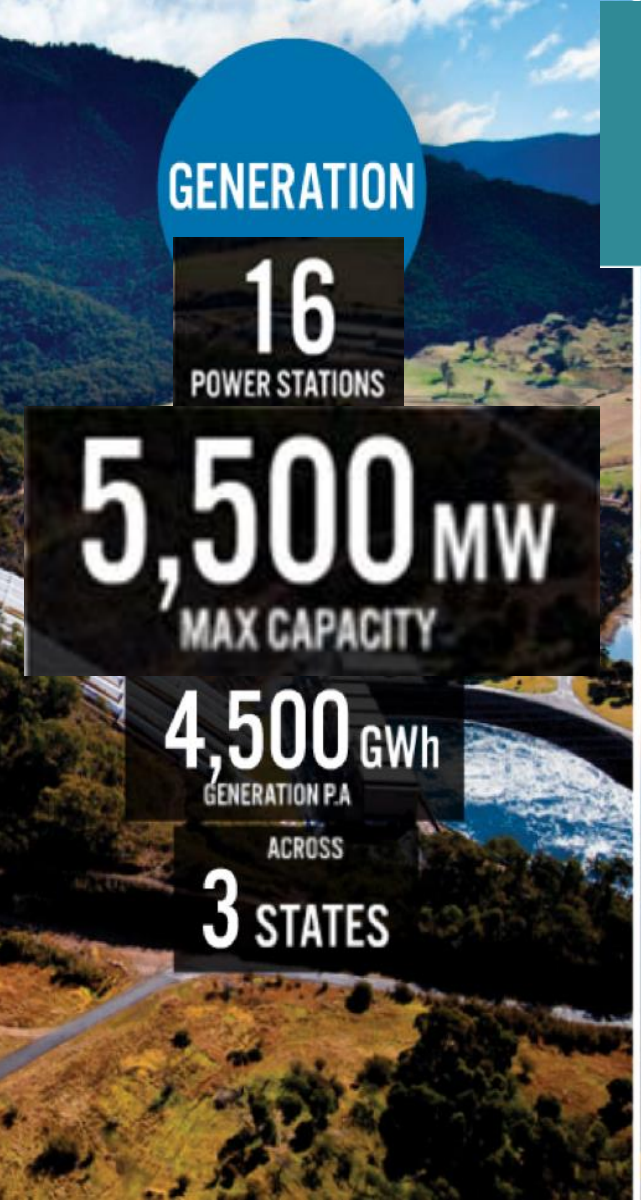
- **465 South Australian batteries, fully charged ($30billion??), or**
- **a 200MW gas plant running continuously for 300 hours, or**
- **200MW ramp-up of combined cycle gas, and**
- **Snowy 2.0**

This problem is 3 times as big in Victoria and 5 times as big in NSW

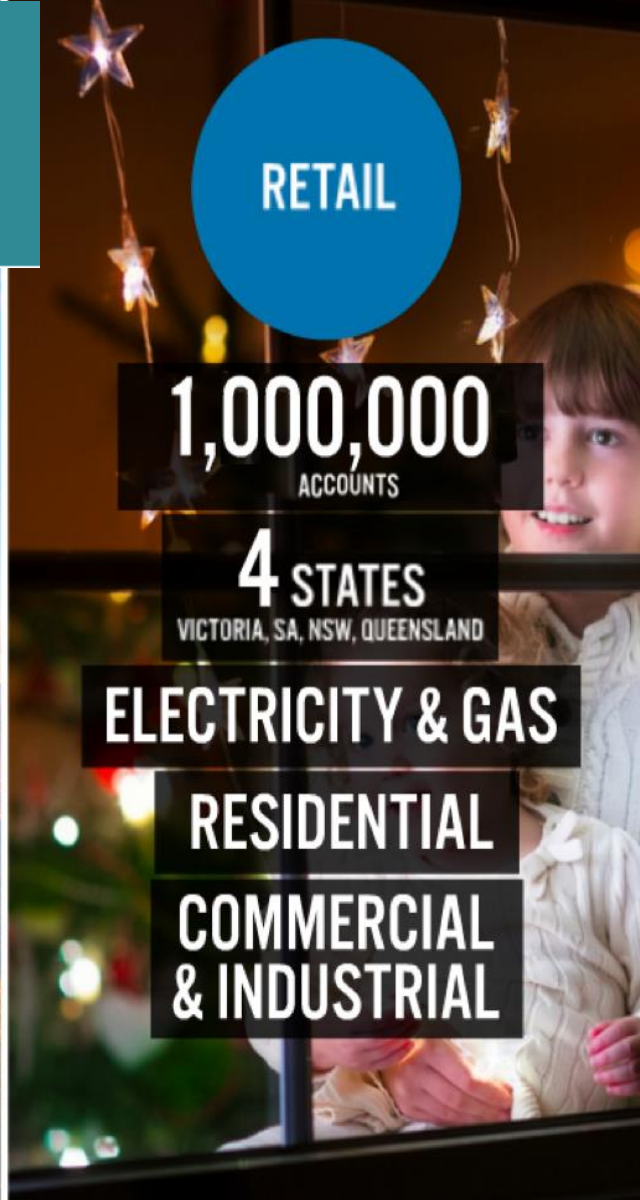
Outcomes for the NEM:
3. LRMC for new coal plants



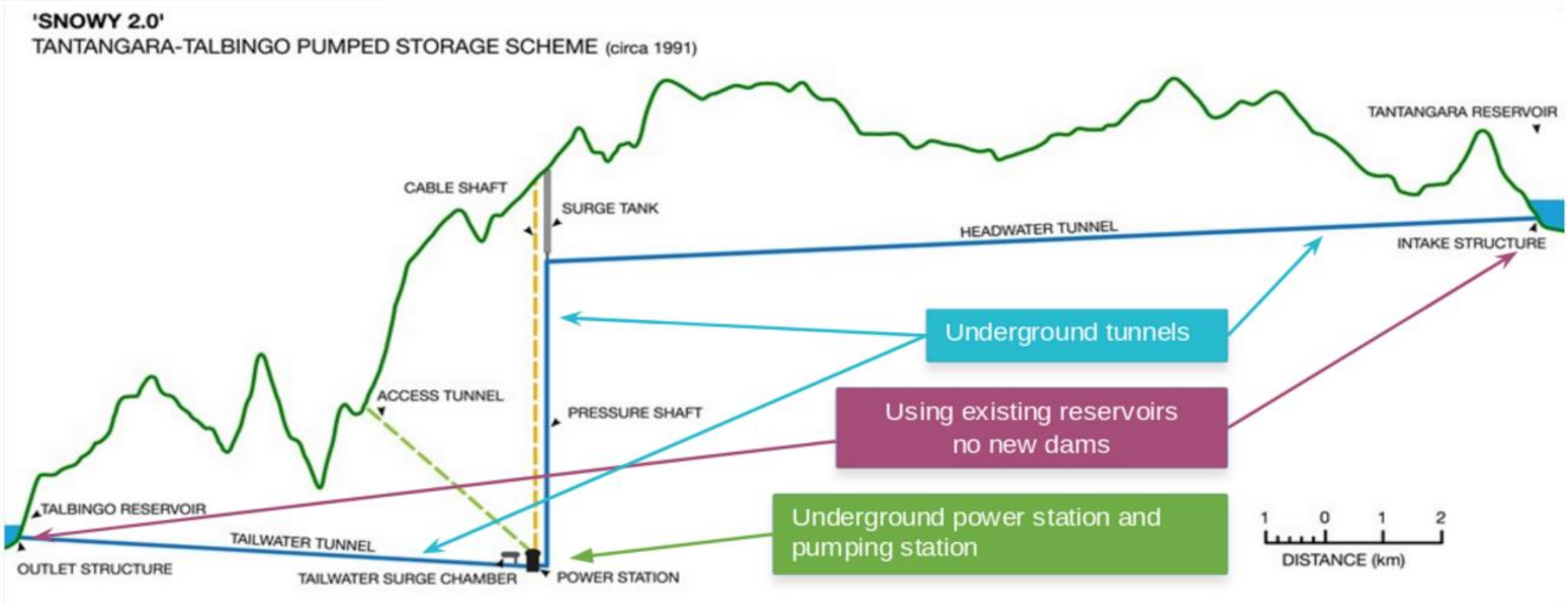
Snowy 1.0


GENERATION
16
POWER STATIONS
5,500 MW
MAX CAPACITY
4,500 GWh
GENERATION P.A
ACROSS
3 STATES


LARGEST RENEWABLE GENERATOR
THIRD LARGEST GENERATOR
BY CAPACITY
FOURTH LARGEST RETAILER
IN THE NEM


RETAIL
1,000,000
ACCOUNTS
4 STATES
VICTORIA, SA, NSW, QUEENSLAND
ELECTRICITY & GAS
RESIDENTIAL
COMMERCIAL & INDUSTRIAL

Snowy 2.0

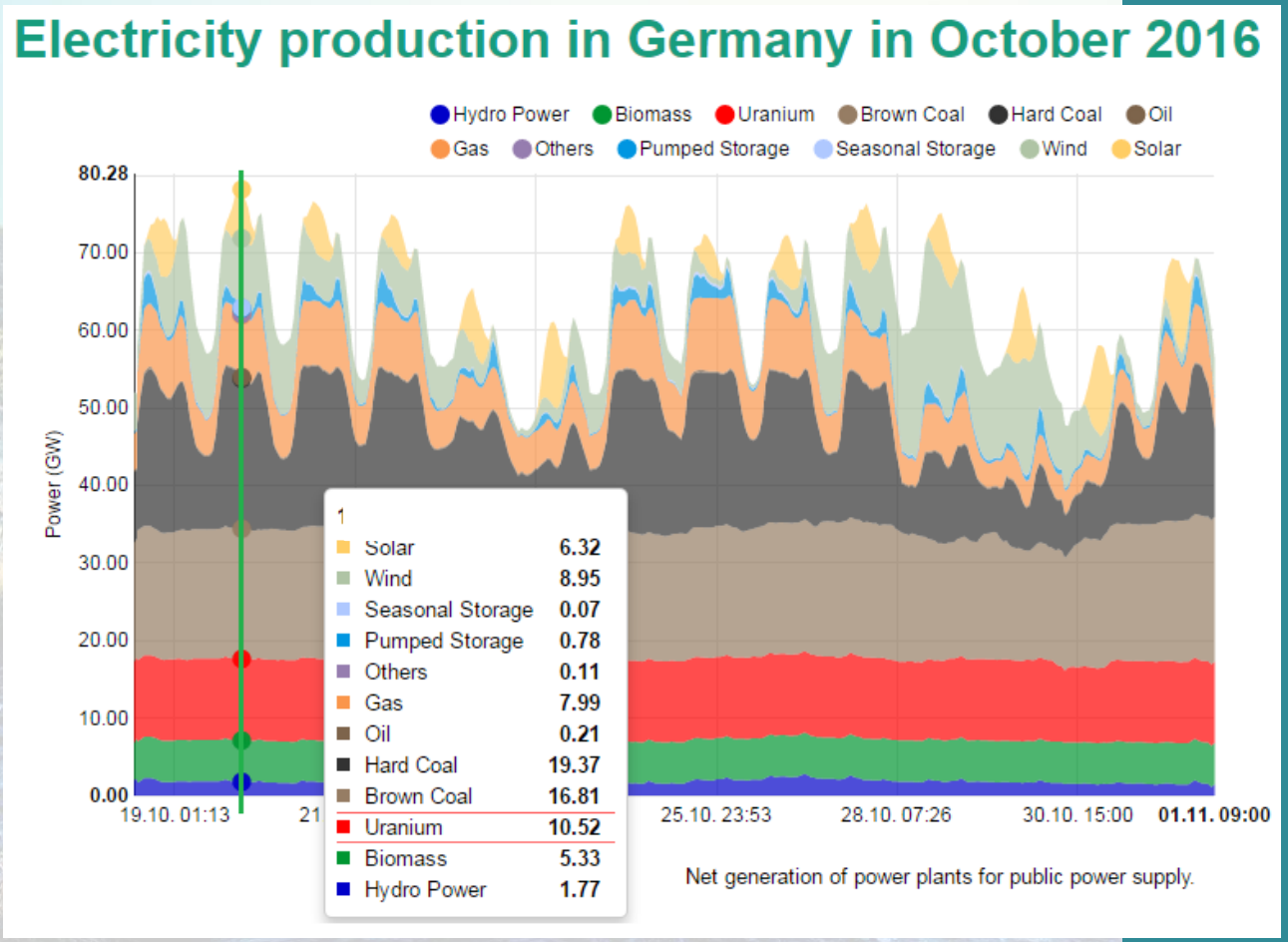

'SNOWY 2.0'
TANTANGARA-TALBINGO PUMPED STORAGE SCHEME (circa 1991)
TANTANGARA RESERVOIR
CABLE SHAFT
SURGE TANK
HEADWATER TUNNEL
INTAKE STRUCTURE
Underground tunnels
ACCESS TUNNEL
PRESSURE SHAFT
Using existing reservoirs
no new dams
TALBINGO RESERVOIR
TAILWATER TUNNEL
Underground power station and
pumping station
OUTLET STRUCTURE
TAILWATER SURGE CHAMBER
POWER STATION
1 0 1 2
DISTANCE (km)

What makes Snowy 2.0 so prospective for us:

Benefits of Snowy 2.0	Risks to Snowy 2.0
Location in the middle of the NEM - Great to absorb surplus energy - Efficient to supply energy and capacity	Approval processes for EIS
Proximity to major load centres and reliable access to transmission	Approval processes for transmission
Storage size and cost - Snowy 2.0's capital cost translates to $174 for a 13.5kWh domestic battery	Absolute dollar cost
Capacity size and response speed - The difference in altitude between the storages provides enormous, instant capacity	Excess construction of gas plants and batteries
Diversity of revenue streams - capacity, energy storage and ancillary services	NEM decarbonisation doesn't happen

What makes Snowy 2.0 prospective for us:

Case Study: Germany

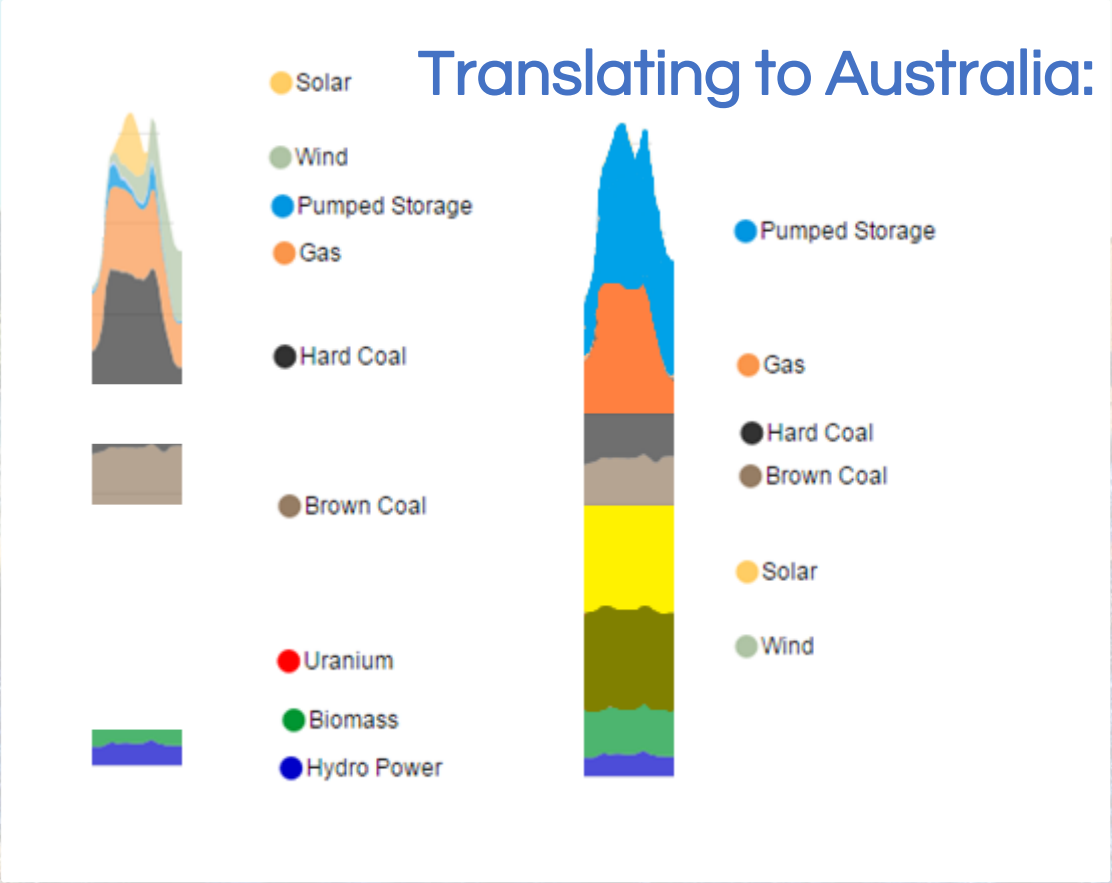


Notes:

- Diversity of fuel sources **and interconnection**
- Wind is ~10%
- **Coal is ~45%**
- German industry is protected by:
- Diversity of energy supply
- Economic value-add
- Their currency

Australian industry is not

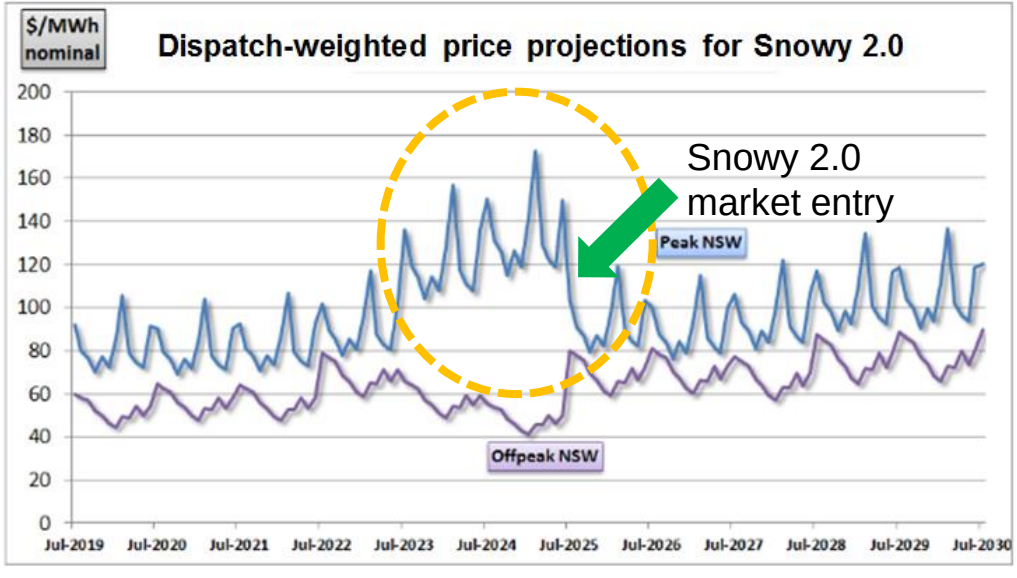
Case Study: Germany



- The solar mid-day supply peak will be excess to demand
- Overnight wind will charge car batteries at some future point
- Domestic gas supply will need to underpin energy production (not just capacity for demand spikes)
- Australia can't rely on imports through interconnects

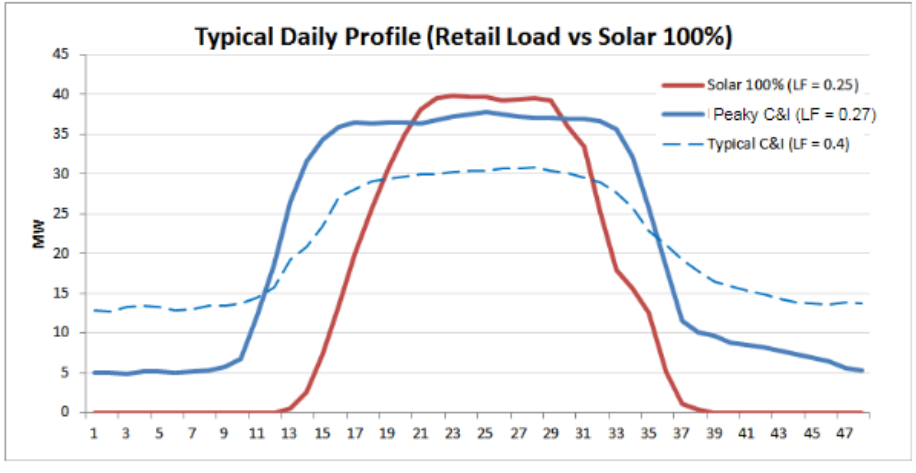
Snowy 2.0 will:

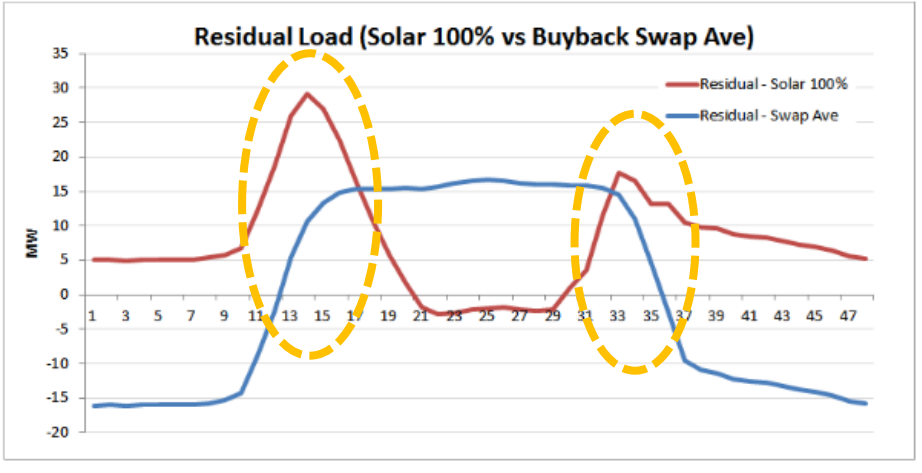
- Constrain peak prices and capacity (“insurance”-type) pricing
- Make wind and solar economic by underpinning off-peak prices and turning intermittent generation into “firm” power
- Future-proof the NEM by enabling central, cheap, huge energy storage to address the risk of wind and solar droughts



Snowy's capabilities are perfect for providing "firming" or "sleeving" products

- Snowy offers solar, wind and composite firming products that "firm" a renewable source to supply a flat load or any load shape including a load following swap.
- The customer can choose between 50%-100% of expected consumption (and other options around consumption flexibility)
- Snowy manages contract risk, the PPA and the counterparty





- **Pricing is very attractive for customers!**