



# Adapting to a changing energy market

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A modern  
mining company

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# Generation transition

- Generation is trending towards intermittent and non synchronous
- Energy prices in South Australia are heading towards zero during peak supply
- The trend is challenging continuous synchronous generation economics
- Grid scale storage that can provide synchronous and dispatchable supply is critical

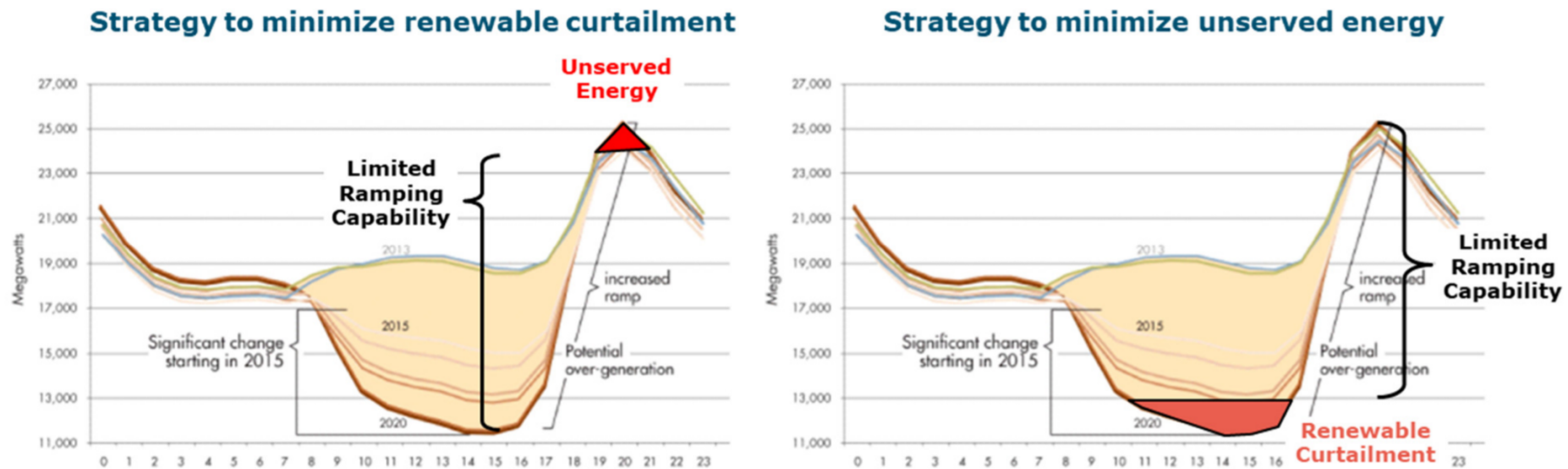


Image: Investigating the Economic Value of Flexible Solar Power Plant Operation 2018 Energy and Environmental Economics, Inc.

# Energy impacts on mining industry

## Mine Site Characteristics

- ／ Often remote, with flat and grid scale loads
- ／ Energy often at grid extremity or even self supplied and costly
- ／ Flat load profile was attractive to “off peak” generation pricing
- ／ Potential to morph loads to harvest non continuous solar and wind

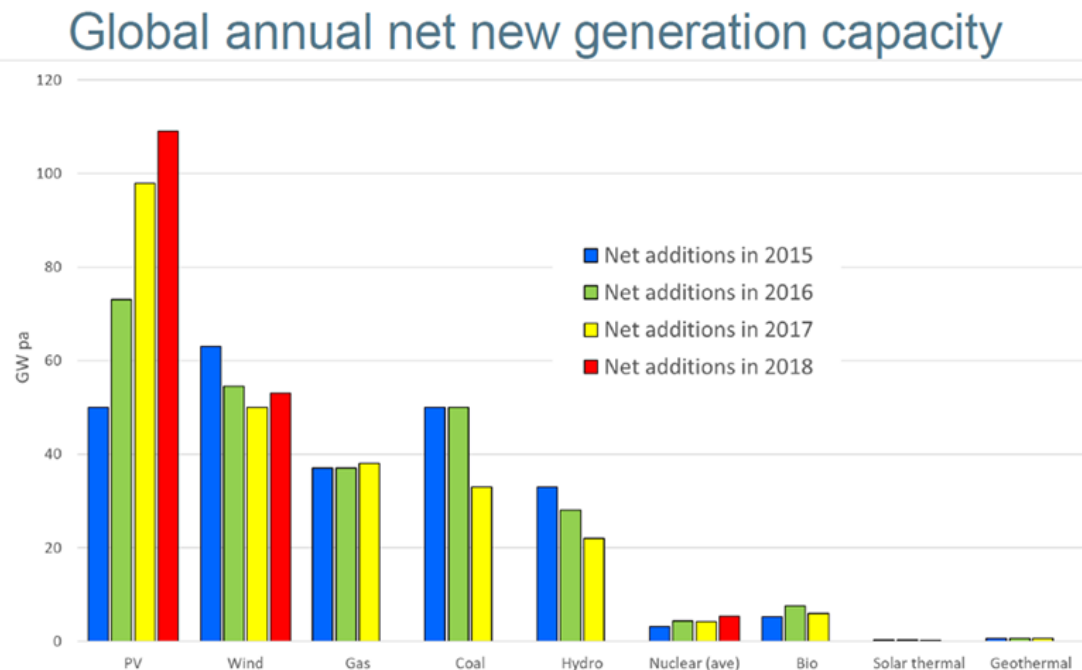


Image: Making Pumped Hydro Great Again  
ANU - Pumped Hydro Energy Storage 26  
February 2019

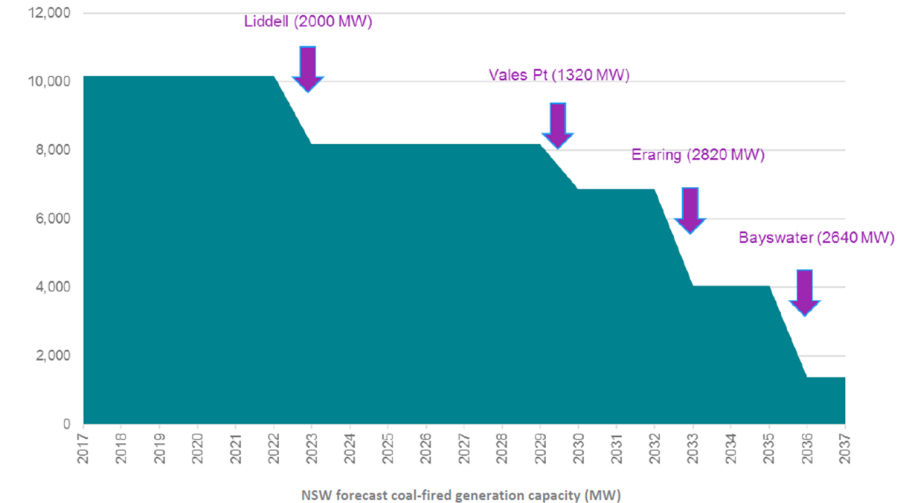
# New generation and interconnection

- Interconnection seen as a solution
- South Australia – renewable infiltration; adapting to storage e.g. Pumped Heat Electrical Storage (PHES) proposals
- New South Wales – large and synchronous, dominated by an ageing profile
- Interconnection helps grid from a global perspective, but also presents other considerations

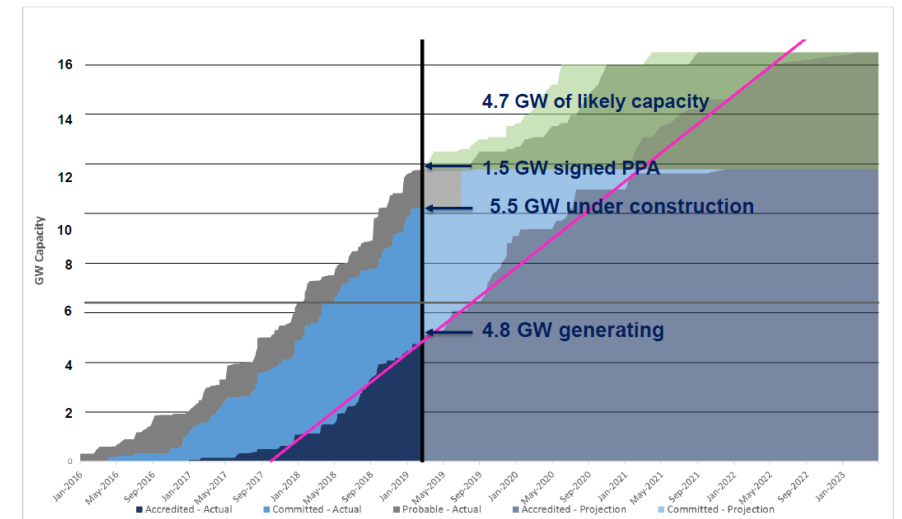
Image (top): Investigating the Economic Value of Flexible Solar Power Plant Operation 2018 Energy and Environmental Economics, Inc.

Image (bottom): Clean Energy Regulator - Pumped Hydro Energy Storage 26 February 2019.

## Thermal generation is retiring

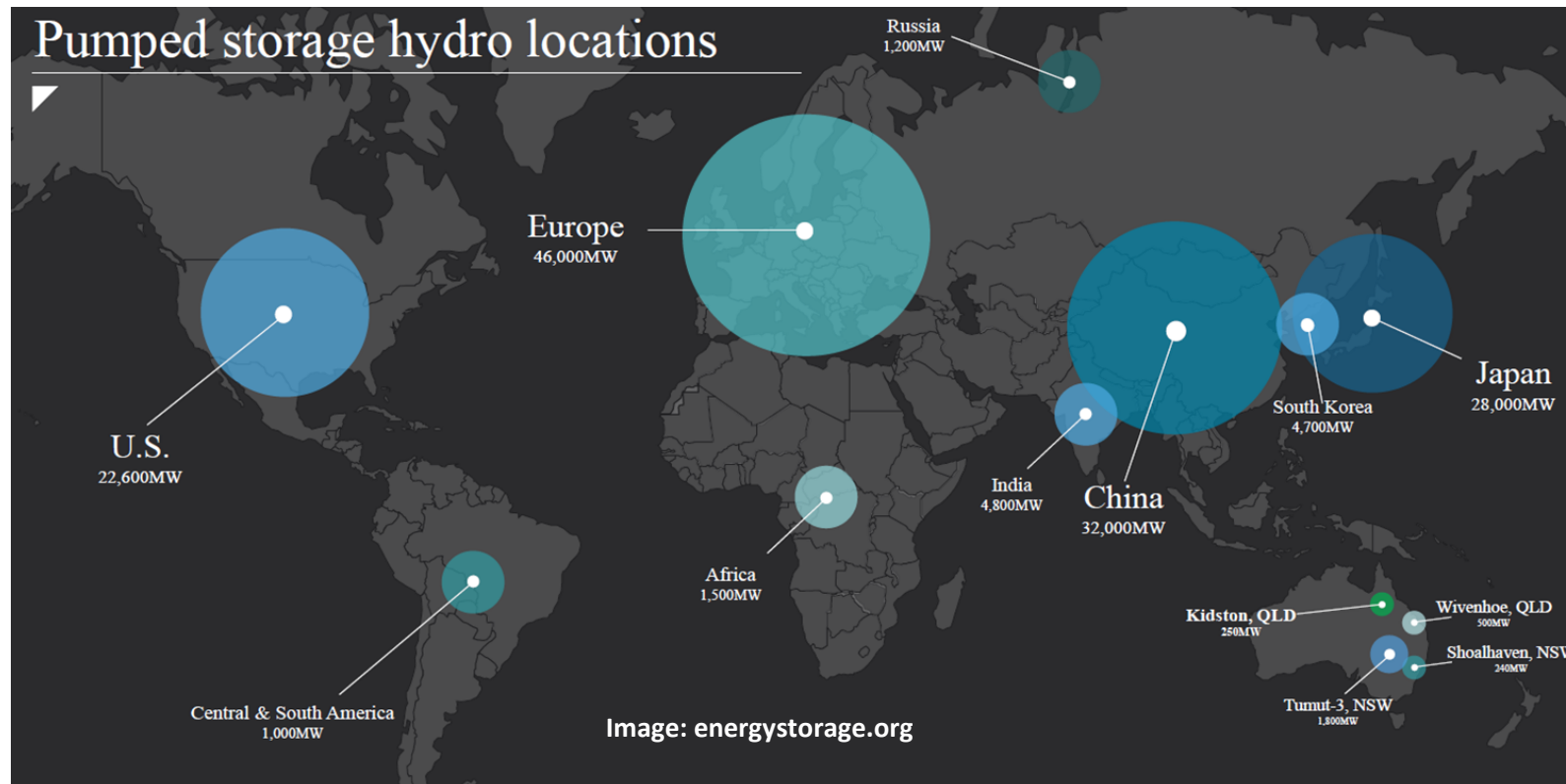


## Renewable energy project pipeline



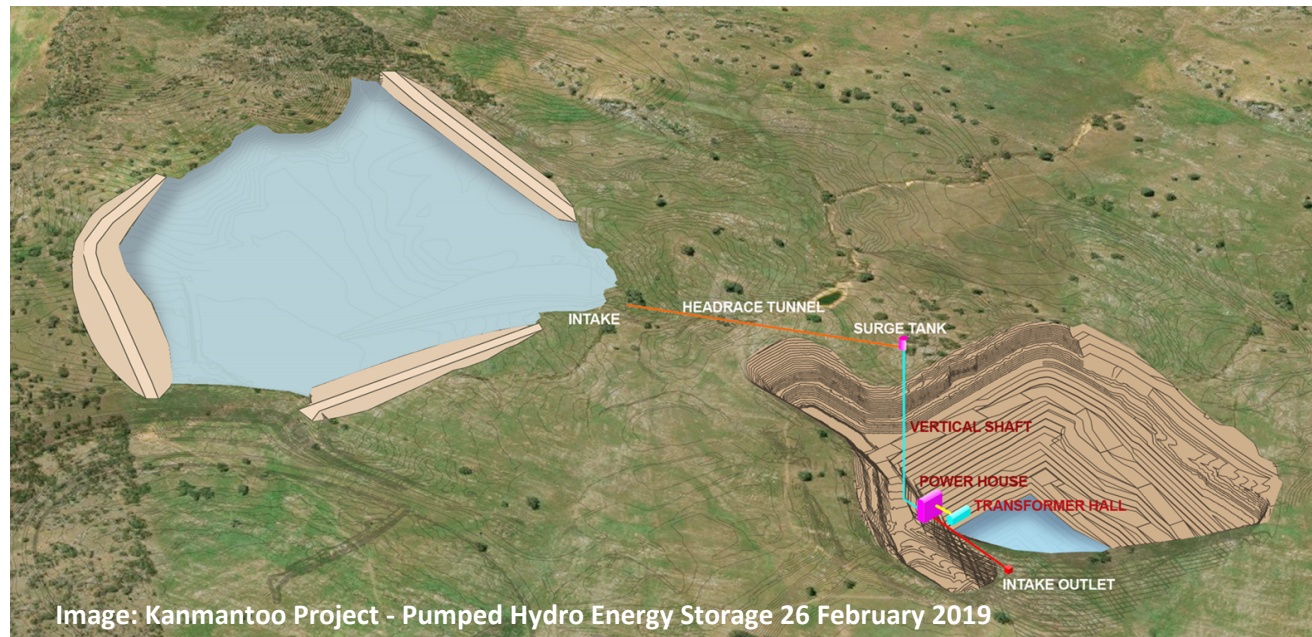
# Pump storage is dominant as a global storage method

- Storage becomes critical as intermittent renewables approach 50%
- “Globally there is more than 160GW of installed pumped hydro 97% of all storage (2% in Australia)” (Blakers ANU - 26 February 2019)



# Pump storage is dominant as a global storage method

- / Synchronous generators are often the owner of PHES (buyer of continuous)
- / Australian has hills, mining creates similar environments conducive for pumped hydro
- / Geology and minimising water jacking play a significant role in both the cost and viability of sites
- / Horizontal transfer should be low pressure and high pressure kept to a minimum



# Pump storage is morphing

Variable speed technology is allowing progressive precise storage:

- / Able to cope with extreme volatility
- / Minimises curtailment through flexibility
- / Provides fast and big residual last compensation

## Modular Multilevel Converter (MMC)

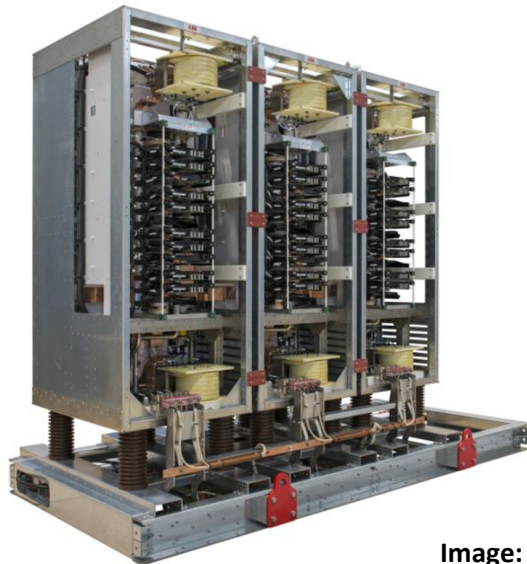


Image: ABB (Grimsel II, Switzerland) Pumped Hydro Energy Storage 26 February 2019.



# Summary

The energy market is rapidly changing and this causes challenges ... but also significant opportunities:

- / Managing load profiling is critical
- / Avoiding curtailment requires grid scale storage – PHES is adapting
- / Mining can replicate environment that enables pumped hydro natural advantage
- / Collaborate between Energy and Mining is absolutely critical