OUR ENERGY TRILEMMA

WE OWN
WE OPERATE
WE CONSULT
• There are three challenges that have to be addressed when facing investment in energy and demand.

• These three elements make up the Energy Trilemma:

1. Energy Security
2. Energy Equity (Accessibility & Affordability)
3. Environmental Sustainability
## Background – Energy Trilemma Index

- Where is Australia on Energy trilemma Index?

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Source: World Energy Council
BACKGROUND – IS 100% RENEWABLE NETWORK POSSIBLE?

- Australian National University found that a 100% renewable energy grid is possible in Australia.
- Zero-emissions grid would rely on wind and solar, supported by pumped storage hydropower.
- Photovoltaic and wind now cheaper than gas and coal, and will get cheaper.
- Pumped storage hydropower can provide system stability.
- Coal-fired power generation now considered a legal and financial risk.
- Study led by Professor Andrew Blakers.
BACKGROUND – DRIVERS OF TRANSITION

Lifetime Cost - Bloomberg New Energy Finance

Figures for particular generation technologies across their lifetime:

• The most efficient modern coal plants, $134 - $203/MWh*
• Wind, $61-118 /MWh
• Baseload gas, $74-90/MWh
• Large-scale solar, $78-140/MWh

*Note: Engie has revealed the decommissioning, site remediation and rehabilitation of the Hazelwood power station and mine will cost at least $743m.

For energy storage (Entura’s high level estimation):

• Hydro Pumped Storage, $40-100/MWh of peak generated
• Battery Energy Storage Systems (BESS), $100-200/MWh of energy discharge
BACKGROUND - DRIVERS OF TRANSITION

Forecasts (from Bloomberg New Energy Outlook)

- “Cheaper coal and cheaper gas will not derail the transformation and decarbonisation of the world’s power systems. By 2040, zero-emission energy sources will make up 60% of installed capacity. Wind and solar will account for 64% of the 8.6TW of new power generating capacity added worldwide over the next 25 years, and for almost 60% of the $11.4 trillion invested.”

In Australia

- 6,000MW of renewable energy planned to be connected by 2019 to meet the current Renewable Energy Target.
- Likely to be made up of 35% wind and 65% solar PV generation.
- Pumped storage required to support system stability.
BACKGROUND - DRIVERS OF TRANSITION

Fluctuations in wind and solar energy

The need for storage and network stability

Pumped-storage hydropower can level out the fluctuations in availability of wind and solar energy, helping to regulate voltage and frequency across the network.

A functioning AC power system needs:

• Inertia;
• Fault level control;
• Frequency control;
• Voltage control;
• Plus energy to function to an acceptable standard.
PUMPED STORAGE – CONCEPT

- Off Peak: Water is pumped up into the upper reservoir
- Peak: Water flows from the upper reservoir to the lower reservoir generating electricity
The Ronkhausen Pumped Storage built in 1969 in Germany
PUMPED STORAGE - BENEFITS

- Improves the quality of alternative energy sources such as wind, small hydro, solar, and tidal power that exhibit an intermittent supply characteristic
- Regulates frequency to meet sudden load changes in the network
- Serves as emergency power reserve

‘extracted from ASCE Guidelines’
PUMPED STORAGE - TYPES

- Pure pumped storage
- Mixed pumped storage
- Water transfer pumped storage
- Small pumped storage
- Underground pumped storage

Gordon underground power station
PUMPED STORAGE – FACTORS TO CONSIDER

- Head
- Storage and Dam Safety
- Environmental/Social
- Permits and Approvals
- Economics and Financials

Koepchenberk pumped storage built in 1930 in Germany
KIDSTON PSP – QUEENSLAND

- Feasibility Study completed by Entura
- 250MW with 6 hours of continuous generation
- Abandoned Kidston gold mine in North Queensland
- Genex Power the proponent
- Construction expected to commence in 2017
3D Illustration of Kidston PSP
PUMPED STORAGE – HOW TO IDENTIFY A Viable SITE

- GIS-based Master Plan Study
- Abandoned Mine Sites
- Heights close to sea, lakes, or rivers
- Utilising existing dams
- Preferably close to the grid
PUMPED STORAGE - RECOMMENDATIONS

- Assess and screen possible South Australian sites
- Concept study on priority sites
- State government to endorse, promote, and accelerate developments
- Support from Australian Renewable Energy Agency and Clean Energy Finance Corporation
REMOTE AREA POWER SYSTEMS (RAPS)

- Solar and wind as primary
- Geothermal
- Diesel/Biodiesel as backup
- Battery as storage

REMOTE AREA POWER SYSTEM - COOK ISLANDS

**Client:** Ministry of Finance and Economic Development (Cook Islands Government) (funded by Asian Development Bank, Global Environment Fund, European Union and Japanese PEC grants)

**Location:** Cook Islands

**Date:** 2015–2017

Developing and integrating renewable power systems to provide secure and sustainable electricity in remote areas.

REMOTE AREA POWER SYSTEM - YAP, MICRONESIA

**Client:** Yap State Public Service Corporation (funded by the Asian Development Bank)

**Location:** Yap, Federated States of Micronesia

**Date:** 2014–2017

Developing and integrating a renewable power system to provide secure and sustainable electricity in remote areas.
QUESTIONS?
CONTACTS

Mohsen Moeini | Specialist Dams and Hydropower Engineer
E: mohsen.moeini@entura.com.au P: (03) 8628 9770

Alan Barrett | National Business Manager Water
E: alan.barrett@entura.com.au P: (03) 6245 4500

Dale Bryce | Director Customer Strategy & Market Development
E: dale.bryce@entura.com.au P: (03) 8628 9772
PUMPED STORAGE – COMPONENTS

- Upper Reservoir and Intake
- Lower Reservoir and Intake
- Waterways
- Power Plant
  - Turbine/Pump
  - Generator/Motor
  - Auxiliaries, etc.
- Switchyard
- Access
- Etc.