Hydro Tasmania Hybrid Project Update

IPS Connect 2018

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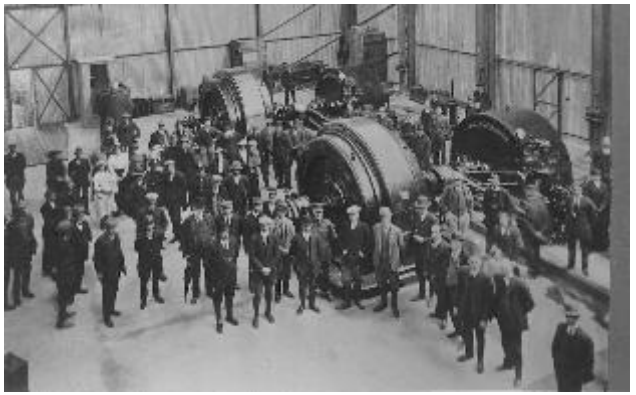
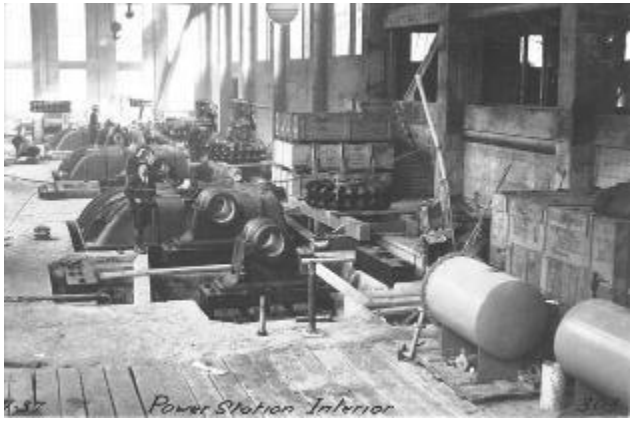
Who we are

GBE owned by people of Tasmanian

Australia's largest Clean Energy producer

- $5.1 billion in assets
- >2,200 MW of hydro generation
  - 30 Powerstations, 59 major dams
- Part owner of large windfarms
- Australia's Largest Renewable Energy Generator
- NEM trader via Basslink
- Owner, Operator, Retailer of isolated Hybrid Power Systems on King & Flinders Islands





Turned 100 in 2014

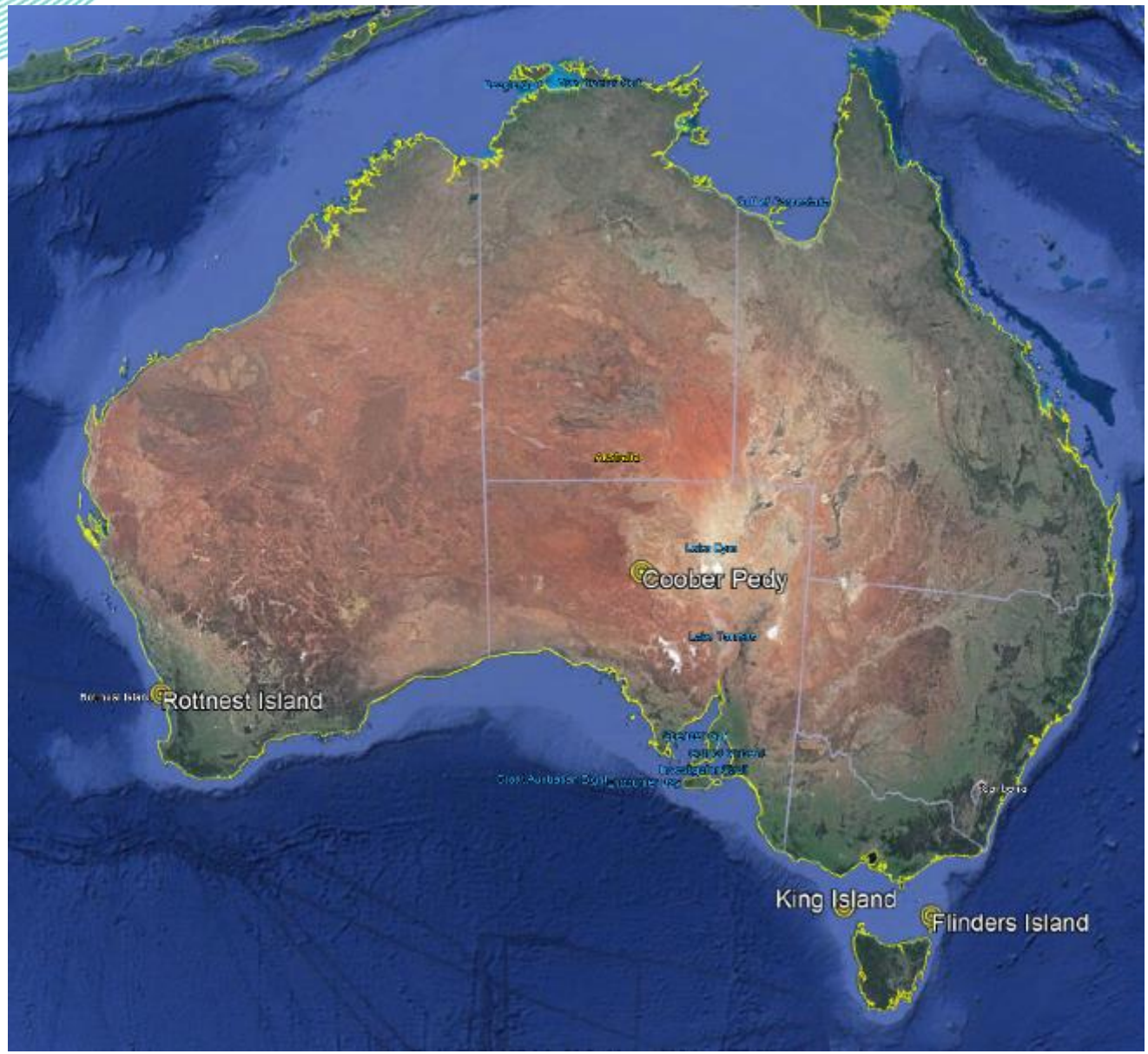
Our Brands

Hybrid off-grid power systems Experience

- Leading hybrid off-grid systems on King & Flinders Islands – our test beds.
- Hybrid Solutions for Rottnest Island & Coober Pedy
- Advisor and Solution Provider
- Project Involvement
  - Yap, Pitcairn, Chatham Islands, Cook Islands, Thursday Island, Norfolk Island, Samoa, Vanuatu, Molokai, Tonga, Marshall Islands

Project Build Locations

Source: Google Earth



King Island Renewable Energy Integration Project

Hydro Tasmania

- HT design & Build
- Test Bed
- Advanced Hybrid Control
- 100% RE Penetration ~8300hr
- Record = 63hr continuous
- 65% RE Contribution
- Increased System Reliability
- Sub 1 second DSM aggregation
- Successful Customer Engagement

Population ~1300, 2.5MW peak load,
12GWh pa, 450km of 11kV distribution

6MW diesel

1.2MW Low Load Diesel (Uni Tas, ONR)

2.45MW Wind, 400kW PV

3MW Dynamic Resistor

2 x 1MVA D-UPS (Flywheel)

3MW/1.6MWh BESS

Biodiesel Trial

DSM Smart Grid

Hybrid Controller

http://www.kireip.com.au/

Australian Government
Australian Renewable Energy Agency

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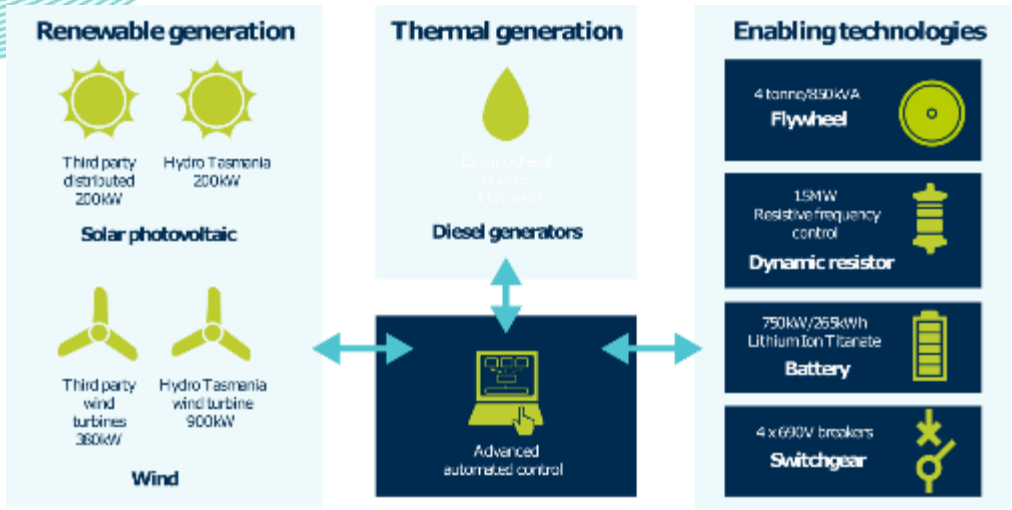
Flinders Island Hybrid Energy Hub

Hydro Tasmania



Scalable modular systems capable of low cost rapid deployment

- Population 600
- 1.3MW peak load, 6.7GWh pa
- 3MW diesel, >200km of 11kV
- **HT Design & Build**
- **Modular Solution**
- **Test off site**
- **Strong Community Engagement**
- **Whole of system Hybrid Control Upgrade**
- **100% RE Penetration**
- **60% RE Contribution**

Record 92 hours continuous Diesel Off

4200 hours of ZDO

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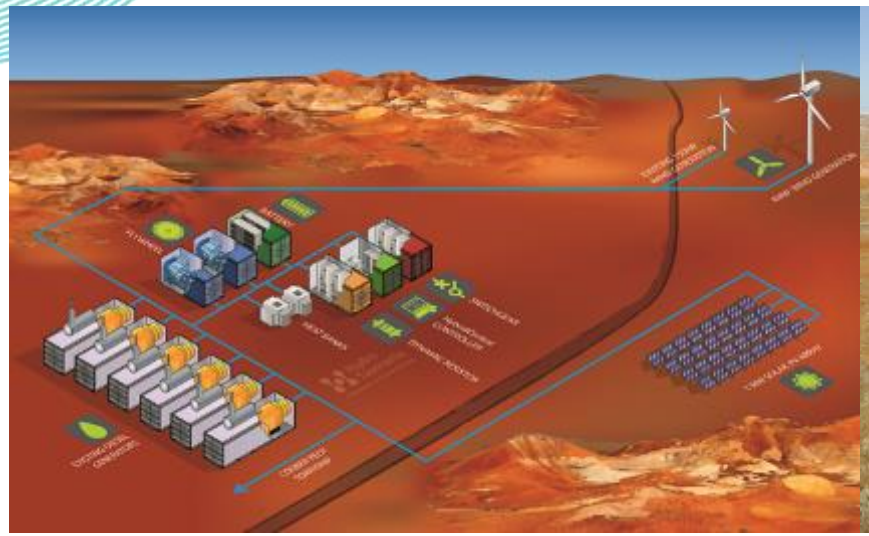
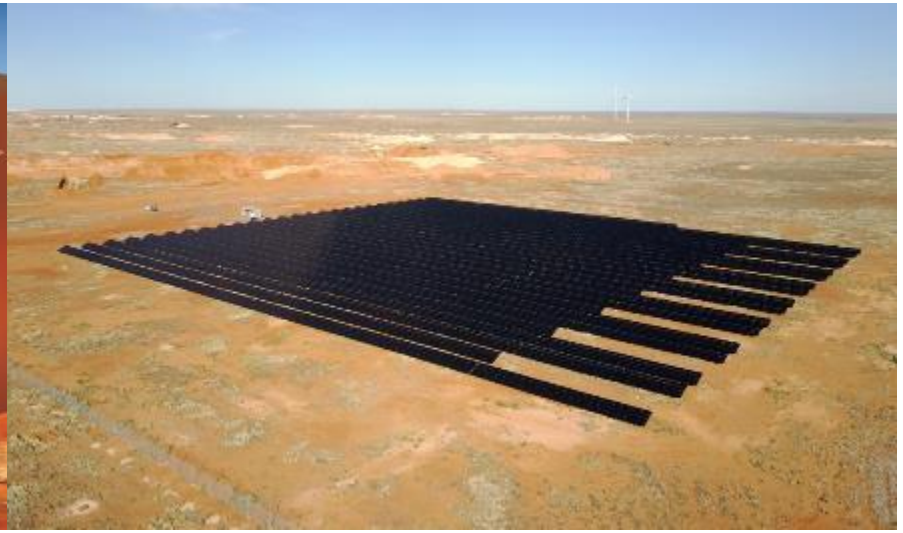
Coober Pedy Renewable Hybrid Project

Hydro Tasmania





Population 1,700, 13GWh annual Energy, 3MW max, 1.4MW ave
8 x 500kW diesels, 4MW wind, 1MW PV

- **HT Design, Owners Eng, Supply of**
  - D-UPS, Dynamic Resistor, LV-HV Switchgear, Hybrid Control
- **70% RE Contribution target**
- **100% Penetration**
- **Hybrid Control 'talks to' existing Diesel Control**
- **Multiple Party Interfacing – Physical and Control**

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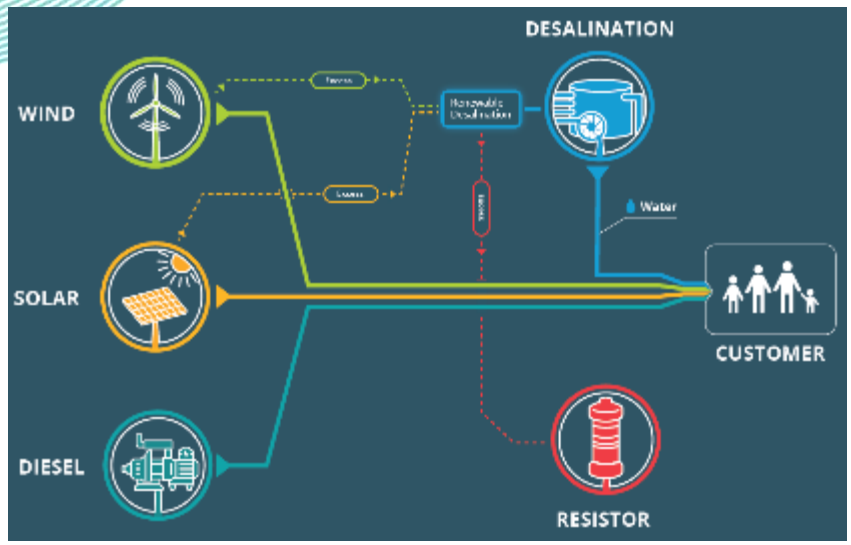
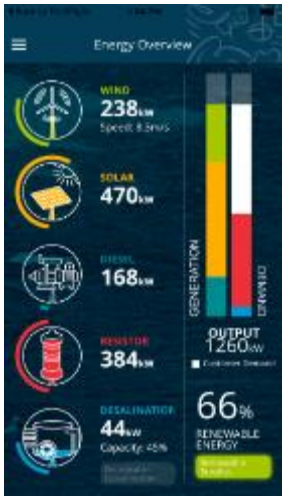
Energy Developments

Rottnest Island Water Renewable Energy Nexus

Hydro Tasmania





- HT EPC
- Integrates Desalination as Energy Storage
- 45% RE Contribution
- 95% Penetrations with LLD
- New Hybrid Control & Diesel Control
- Extensive Training
- Operator Remote Interface
- Education App

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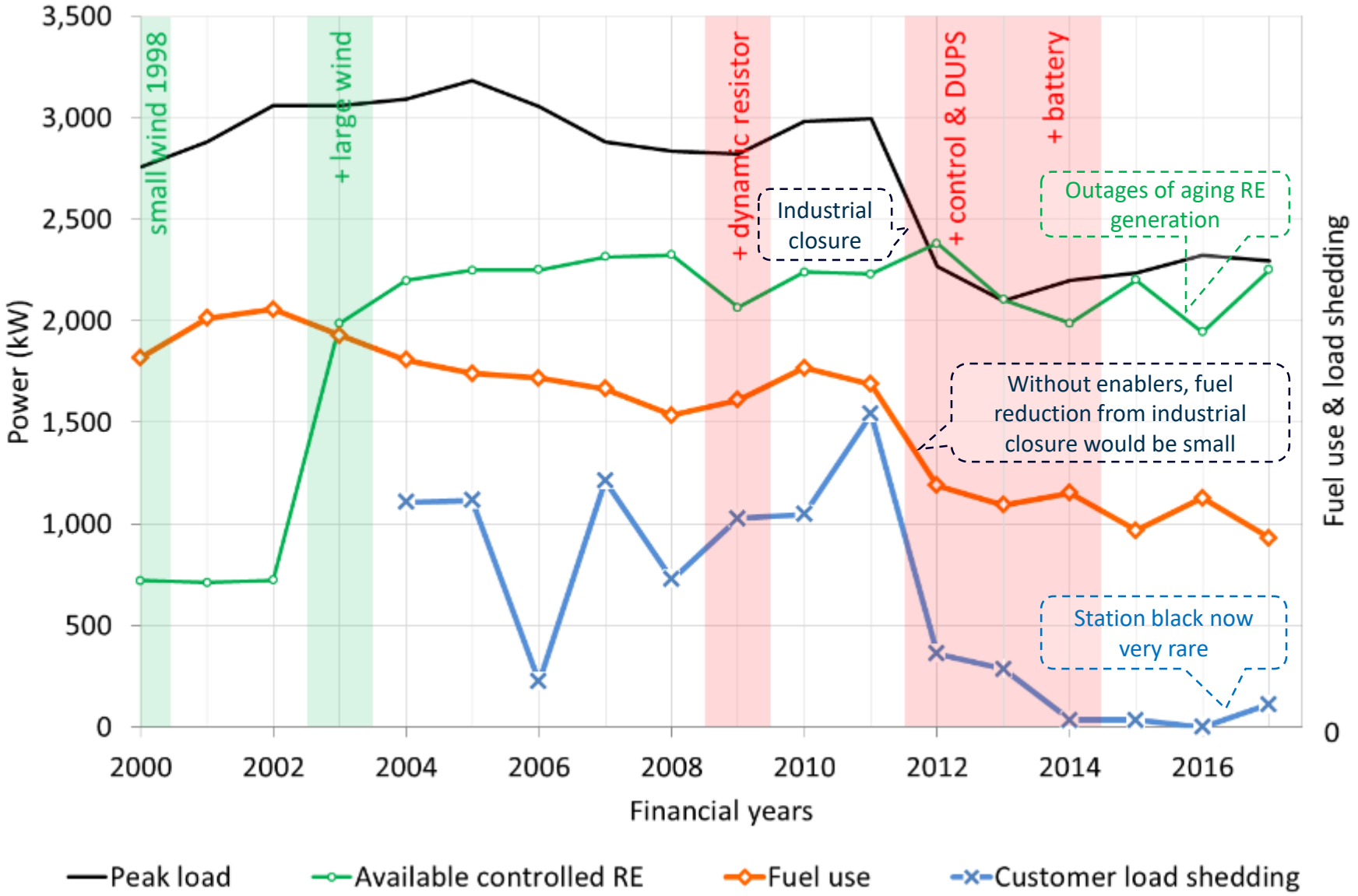
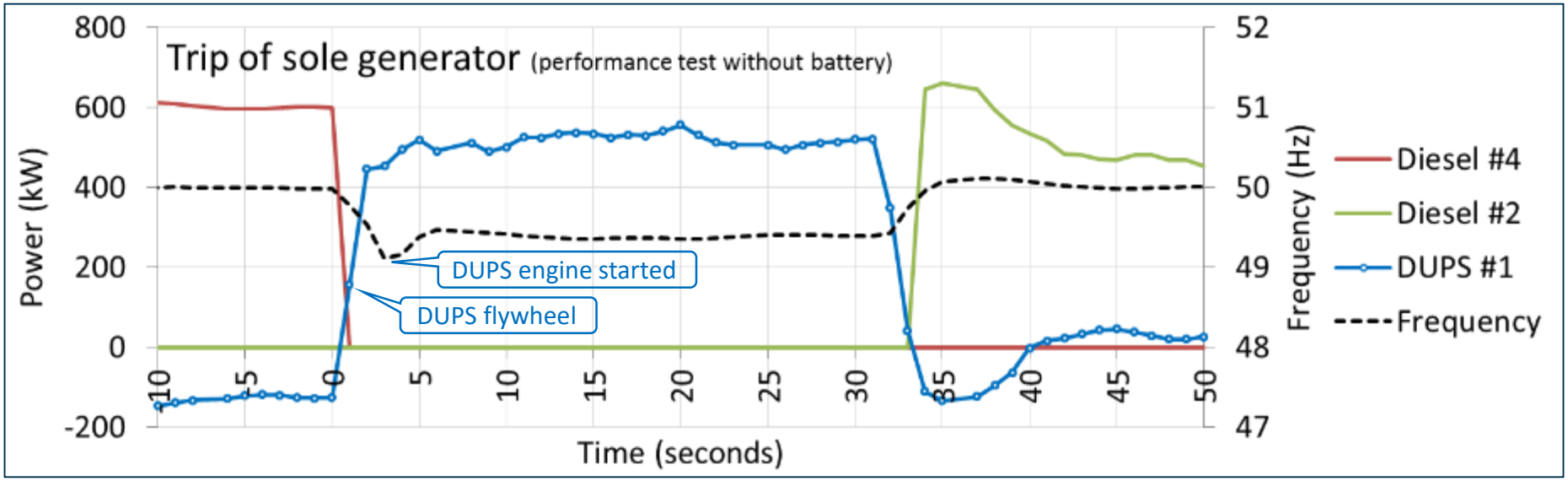
Outcomes & Learnings

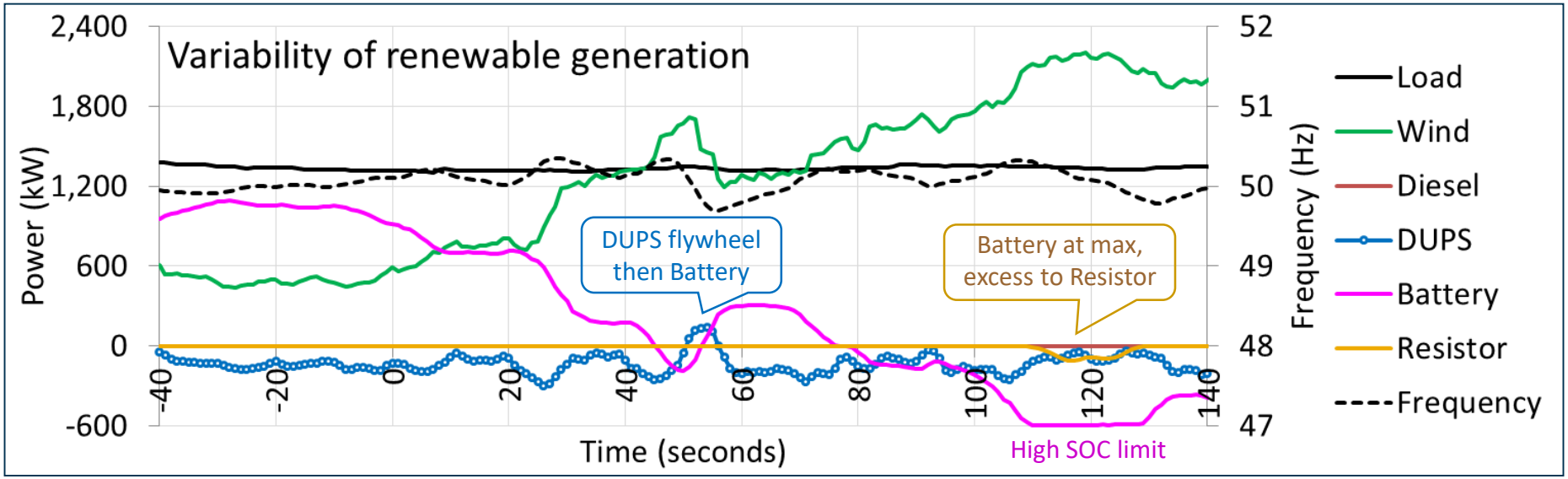
- Performance Outcomes
- Supplier Experience Examples
- Cost Trends

King Island long term performance



Preventing blackouts

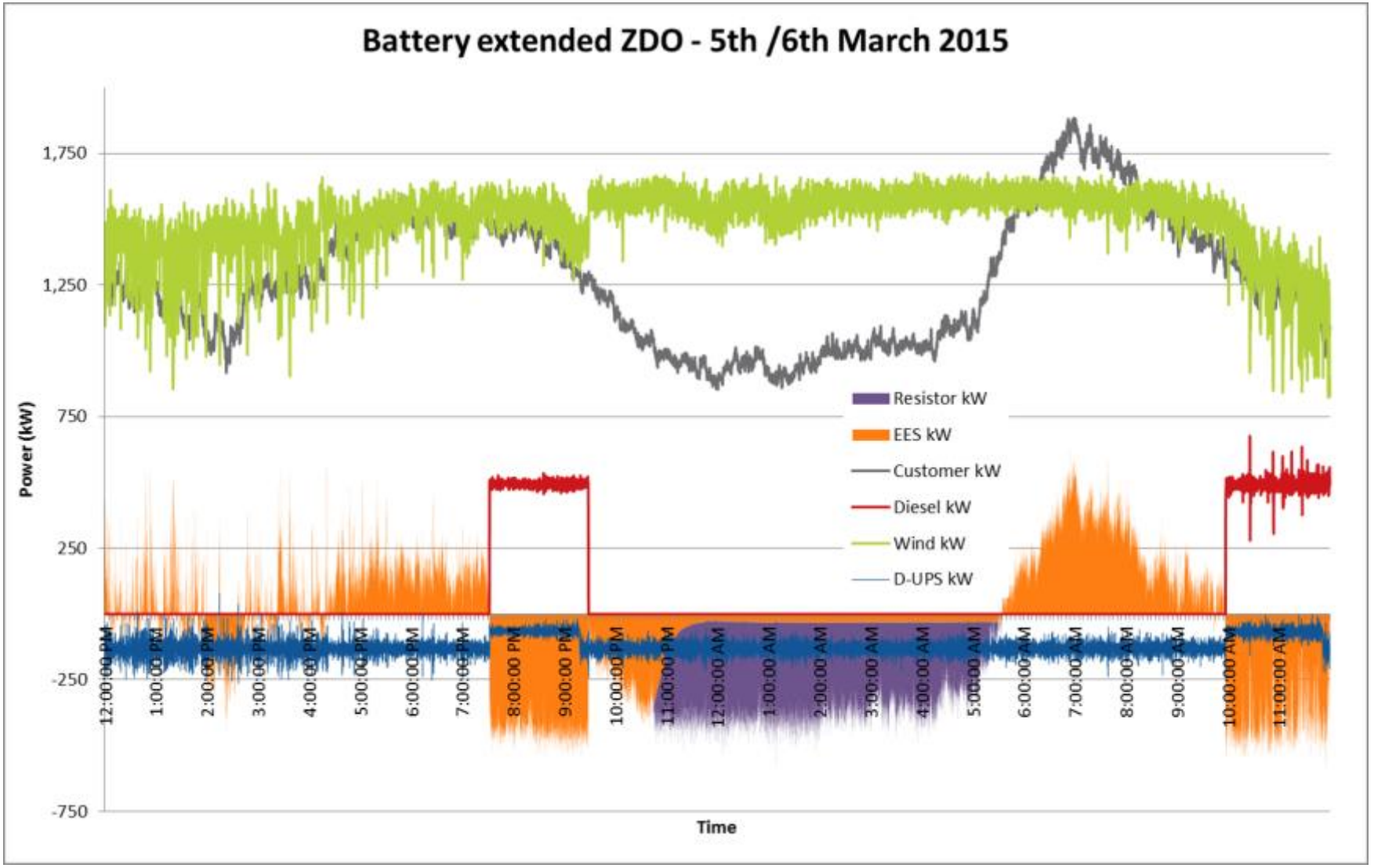




King Island system operation

Extended “diesel off” operation

Combined performance of enabling systems



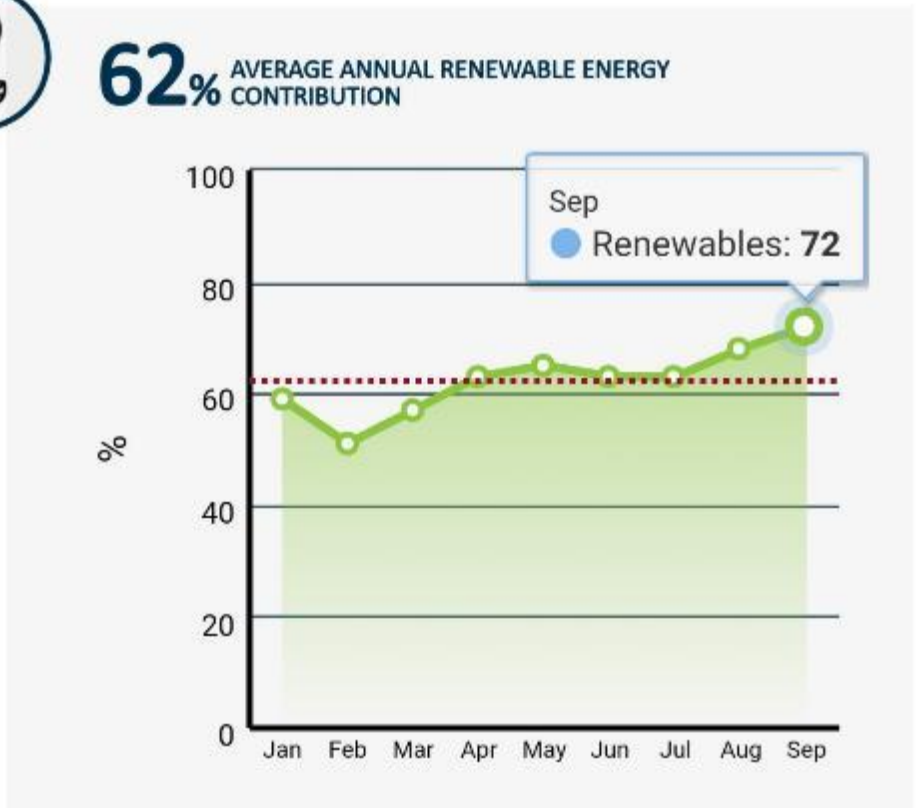
Performance outcomes

Short term assessment

- Coober Pedy - 6 month RE % match to model Warranted
- Model based, many variables
- 70% RE targets met

Long term assessment

- Measurable
- Variable load, RE availability and resource
- Calibrates models used for other projects
- Operator experience: Could they use it?



Flinders Island Performance to date

Supplier Experience

Novel applications

- Unlikely to understand intended purpose
- Don’t know what they don’t know
- Have a solution but haven’t asked what is the problem
- Want to address issues on site not before

Experience

- Often not aware of their weaknesses
- Best suppliers less interested in small or remote projects
- Responsibility split across subcontractors

Equipment

- Non-core functions can perform poorly
- ‘Easy’ may mean ‘haven’t considered’

Suppliers are not Utilities

Example: King Island battery

Supply concerns

- In 2012 this was new tech. 4 of 5 tenderers since left market
- Good components with integration shortfalls
- Supplier small team so limited skill base for unexpected challenges

‘Internal’ situation

- Significant building & install costs
- Rigid schedule, high expectations
- Much labour to rectify

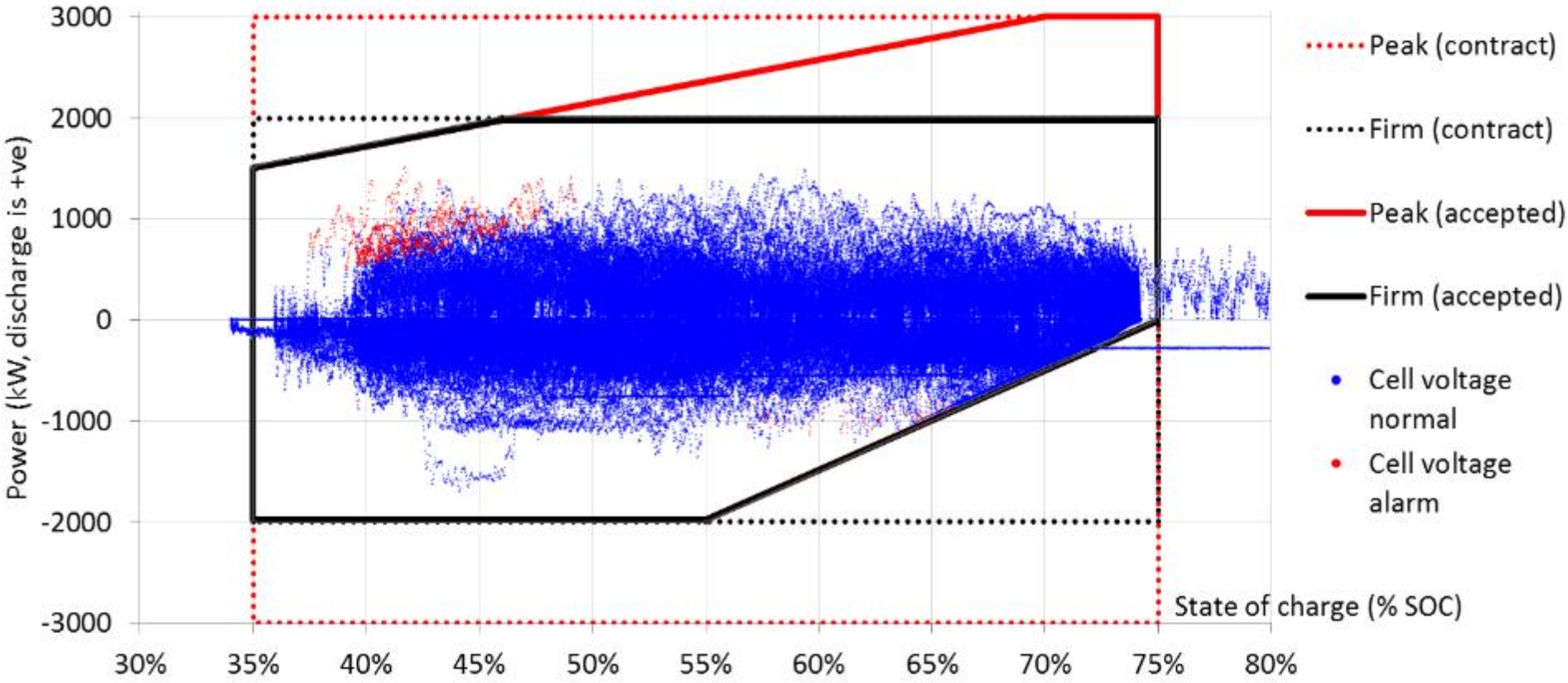
Learnings

(next page)

- Good contract and spec. is important
- Perilous to overlook control system
- Many failure modes with critical service impacts
- Collaborative approach rather than straight to hard contract mechanisms (they are the stick)
- Our in-house skills were core

Example: King Island battery

Item	Contracted	Actual (Feb 2016)	Solution
Power capability	± 2 MW firm ± 3 MW max	Varies considerably with SOC and idle time	Improve battery control system. Revise operating principle. Accept new limits.
Discharge capacity	1.63 MWh	1.4 MWh	Accept new limit.
Reliability	99%, 200 days MTBF	82%, 6 days MTBF	Improve battery control system. Revise operating principle. New service level agreement.
Availability	95%	25%	



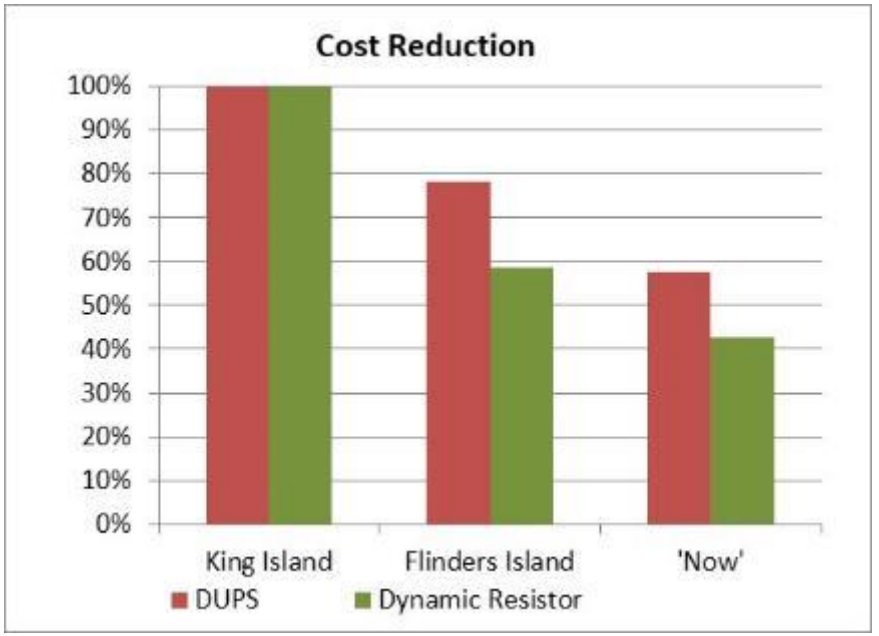
Cost Trends

Past

- Reliant on Grants
- ‘Demonstration Project’

Changes

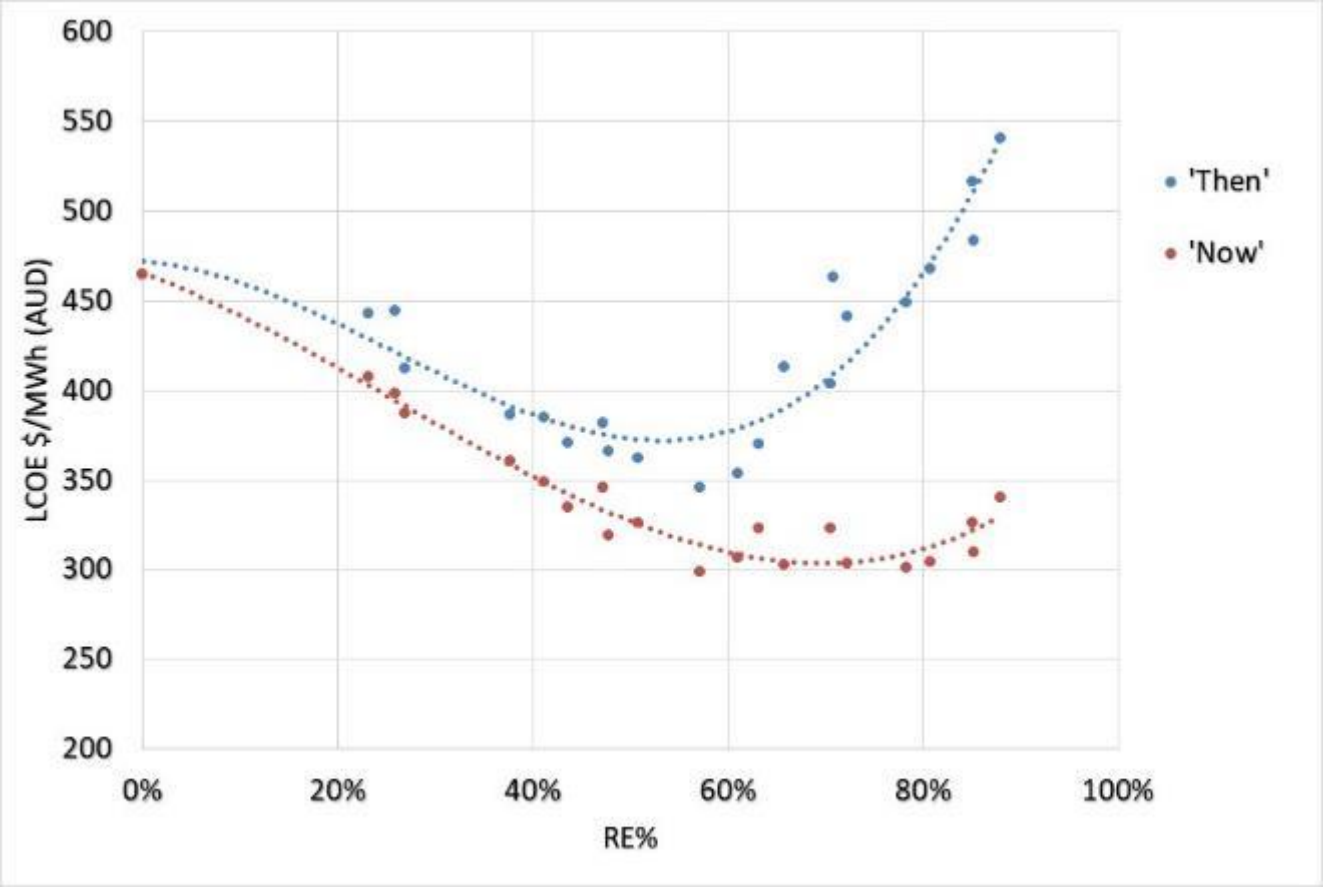
- Wind, PV, BESS all reducing in cost
- Enabling technologies reducing in cost
- Simplified approaches
- Greater Industry Experience



Cost Impact Over Time

LCOE TREND

- Multi MW system
- Wind & PV
- Multiple BESS, Enabler options
- Higher RE achievable



Flinders Island
Locals thoughts

https://www.youtube.com/watch?v=kcwnv-MBQ_M

Pictures

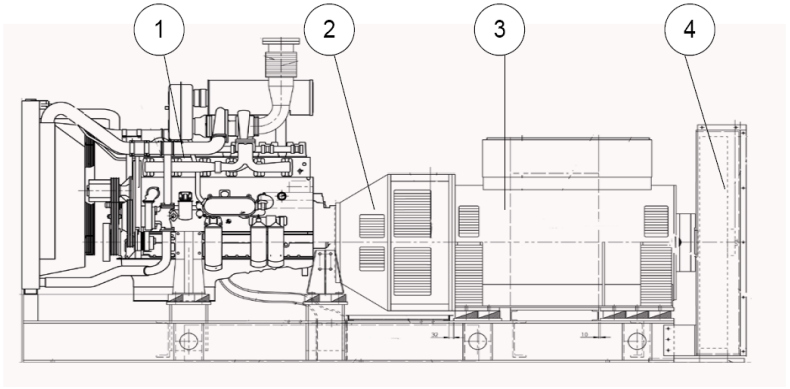
Modular scalable enablers

Installation process

Flywheel module

Pictures

King Island DUPS Unit



1. Diesel engine
2. Electromagnetic clutch
3. Synchronous motor/clutch
4. Flywheel

Pictures

Pre-Site Factory Acceptance Testing

Pictures

Flinders Island Hybrid Hub

Mahalo

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