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100% renewable energy for islands : Case studies of successful approaches

Simon Gamble

Manager Hybrid Off-Grid Solutions

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Hybrid power system capability

- Government owned business – 100 year history
  - approx a third of Australia's renewable energy generation
- Utility responsible for generation, distribution and retail in the Bass Strait islands (develop, own & operate)
  - High cost systems, power is subsidised
  - renewable energy used to reduce operating cost
- Developer, owner and operator of world leading hybrid off-grid systems
  - Valued advisor to utilities
  - Successful turnkey contractor, systems integrator

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entura

momentum energy

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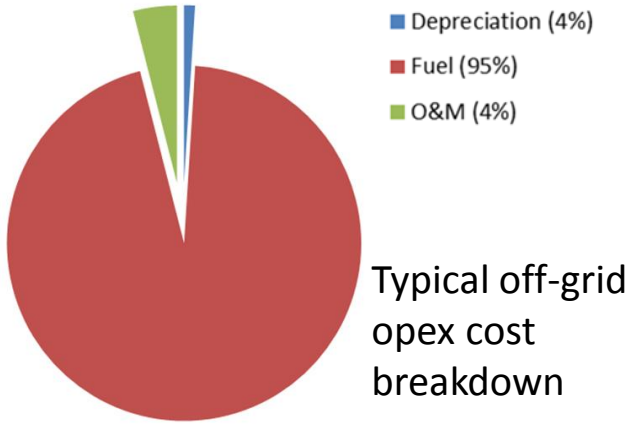
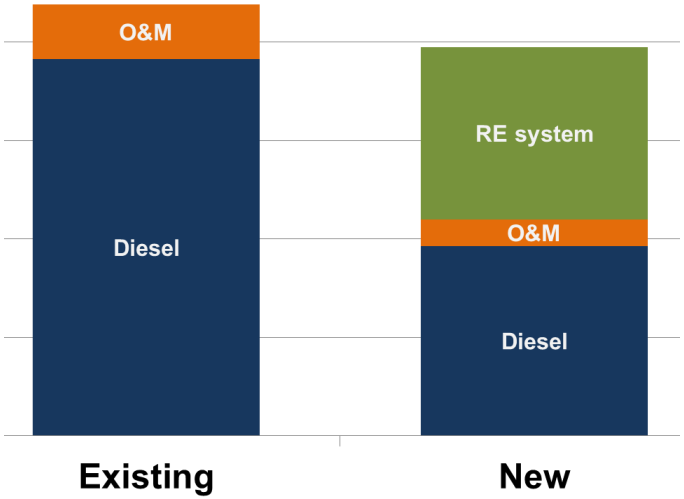
Hybrid power systems
Benefits and challenges

- Off-grid power
  - significant cost & supply challenges
  - security / reliability a key concern
- Renewable energy technologies can offer significant cost and performance benefits – lower LCOE
- Adding renewable energy can introduce reliability issues
  - Displacing synchronous generation
  - requires enablers –> range of options
- Hybrids can be costly and complex -> planning
  - Potential for underutilisation of assets – over investment
  - Potential for poor operability – low reliability



Typical off-grid opex cost breakdown



LCOE reduction

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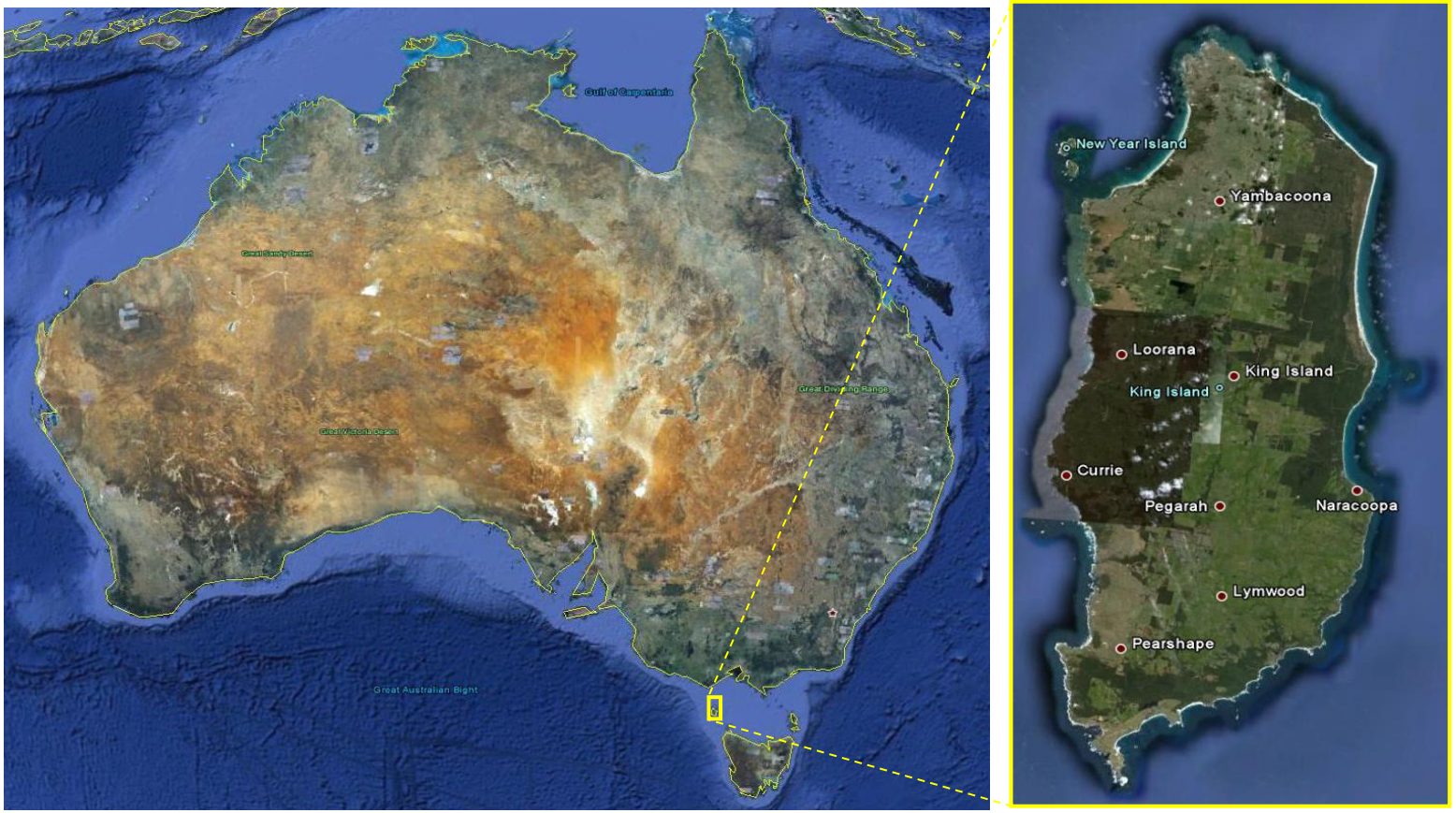
King Island case study : 1998-2014

Source: Google Earth

Population 1,600 2.5MW peak load 6MW diesel 12GWh pa 450km of 11kV



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1998 – First Wind Farm

Low renewable energy penetration

15% reduction in diesel

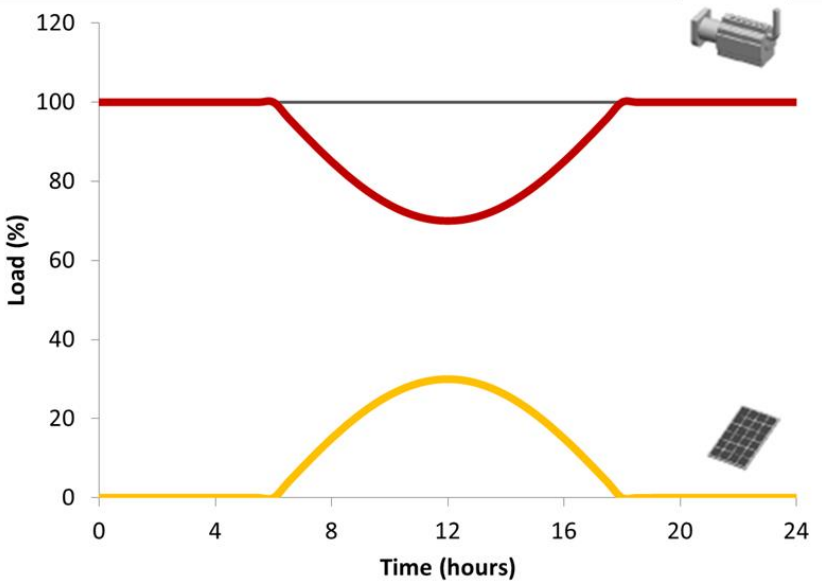
750kW wind

"Low hanging fruit"

Deliberately limited RE installed

No impact to operations

Simplified Solar PV example



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2004 – Wind Farm Expansion

Medium renewable energy penetration

30% annual reduction in diesel

Note minimum diesel operation

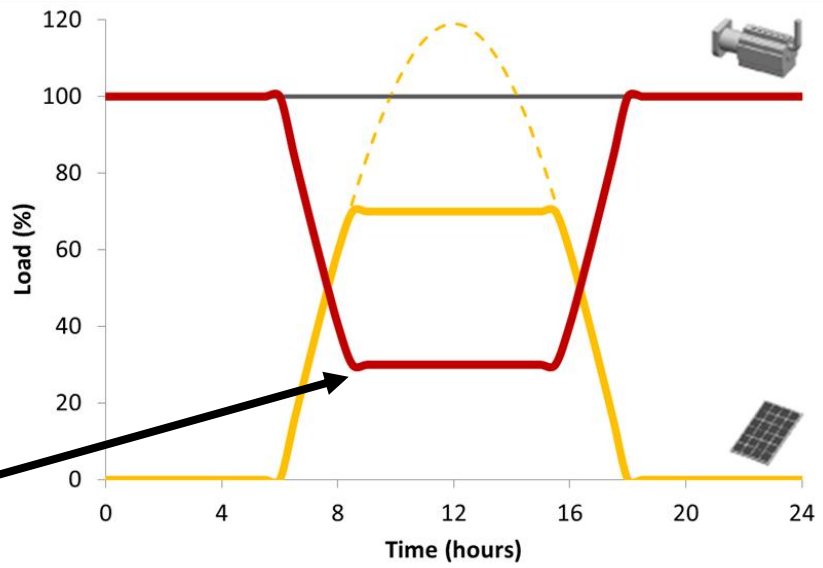
2.45MW wind (1.2MW min load)

RE controlled (limited) protect diesels

Some RE is wasted (curtailed)

At this point you need enablers

Simplified Solar PV example



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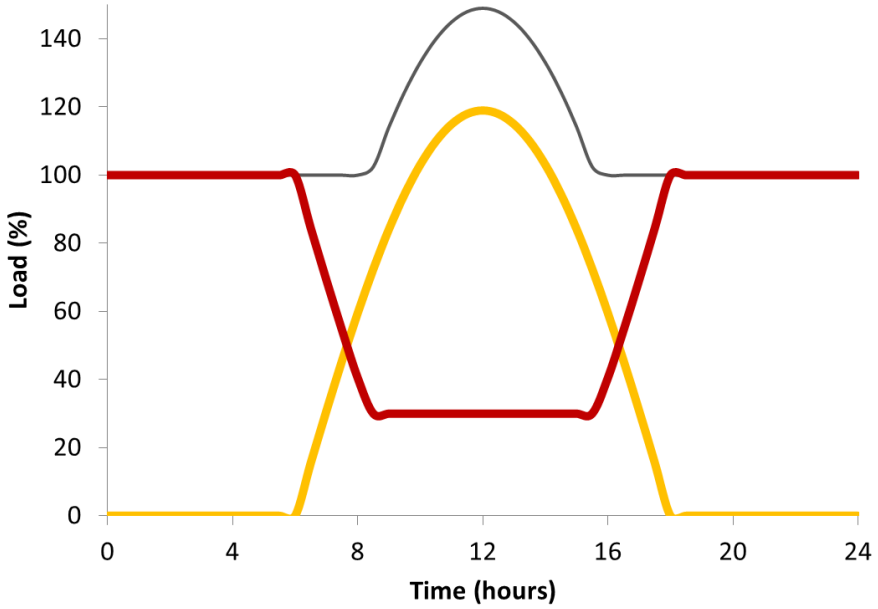
2008 – First enabling technology

Enhanced medium renewable energy penetration

Enabling technology – Dynamic Resistor (Load bank) elements



35% annual reduction in diesel

- Resistive elements artificially increase the load: convert excess to heat
- Load balance is maintained (dynamically by resistors) – not diesel generators
- More RE is utilised – more diesel savings

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Counterintuitive : taking spilled energy & converting to a useful service

2014 – Diesel off operation

Ability to operate at 100% RE penetration

King Island flywheel – supports system without diesel generation
Consumes spilled renewables to operate
Also an instant start diesel generator to provide firm capacity

- The need to always operate diesel generation has been a key barrier to renewables
  - Next logical challenge to switch off

To achieve 100% RE penetration systems require:

- Surplus RE capacity
- Full automation – high speed communication and control
- Enabling systems – that replace all services provided by diesels
  - Inertia, voltage regulation, fault current, reserves, firm capacity

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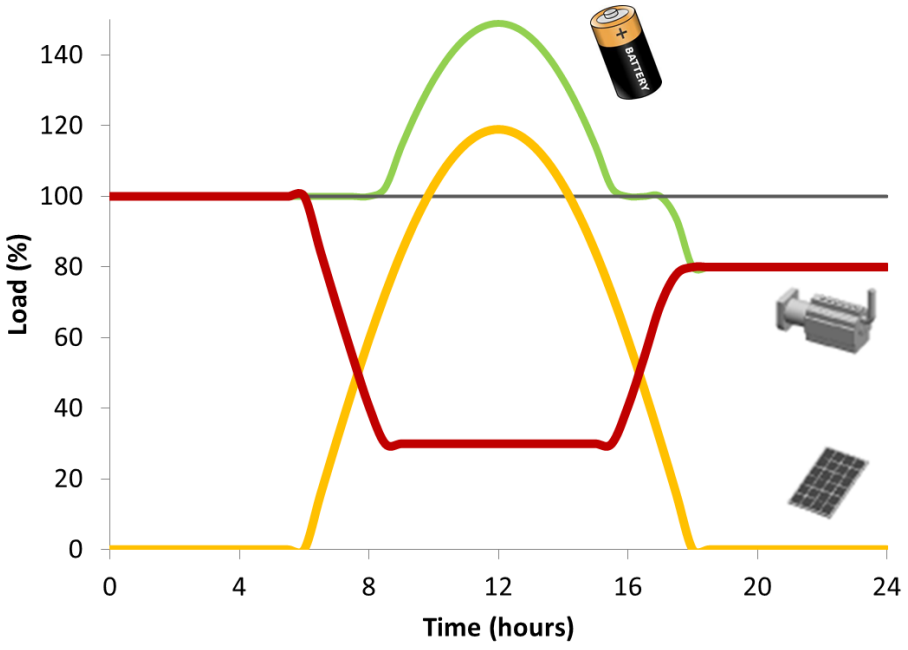
2014 - Energy Storage

An enabling technology option for high RE penetration



- Absorb excess RE (increase the load)
- Recover excess RE (power injected)
- Provide a range of services
  - Reserves – sustain 100% RE
  - Regulation – frequency control
  - Power – system security
  - Block shifting – energy recovery

Australia's largest battery – 3MW / 1.5MWh King Island

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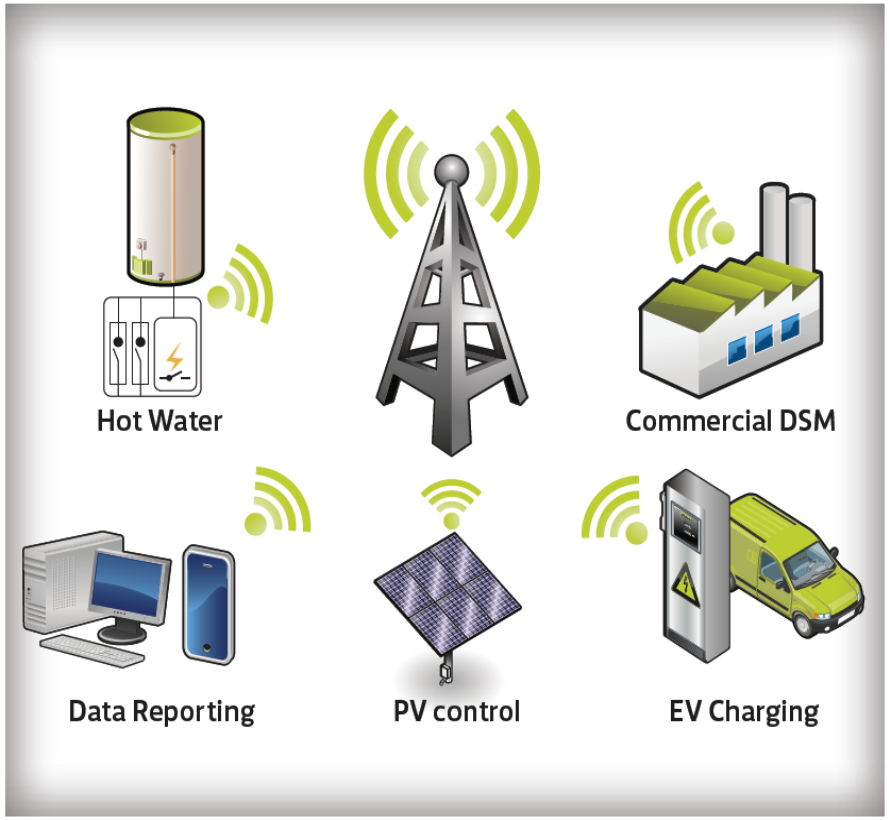
2014 - Demand management

Real-time aggregated load control

- Aggregates controllable customer load to provide ancillary services
  - supports system during high renewable energy variation
- Fast discrete load shedding
  - Prevents feeder level load shedding – no customer impact
- Charging electric vehicles during periods of excess RE generation
  - Shift RE to transportation
- Real time data provided to customers via smart phone app



Wireless private network

Round trip response : 500ms

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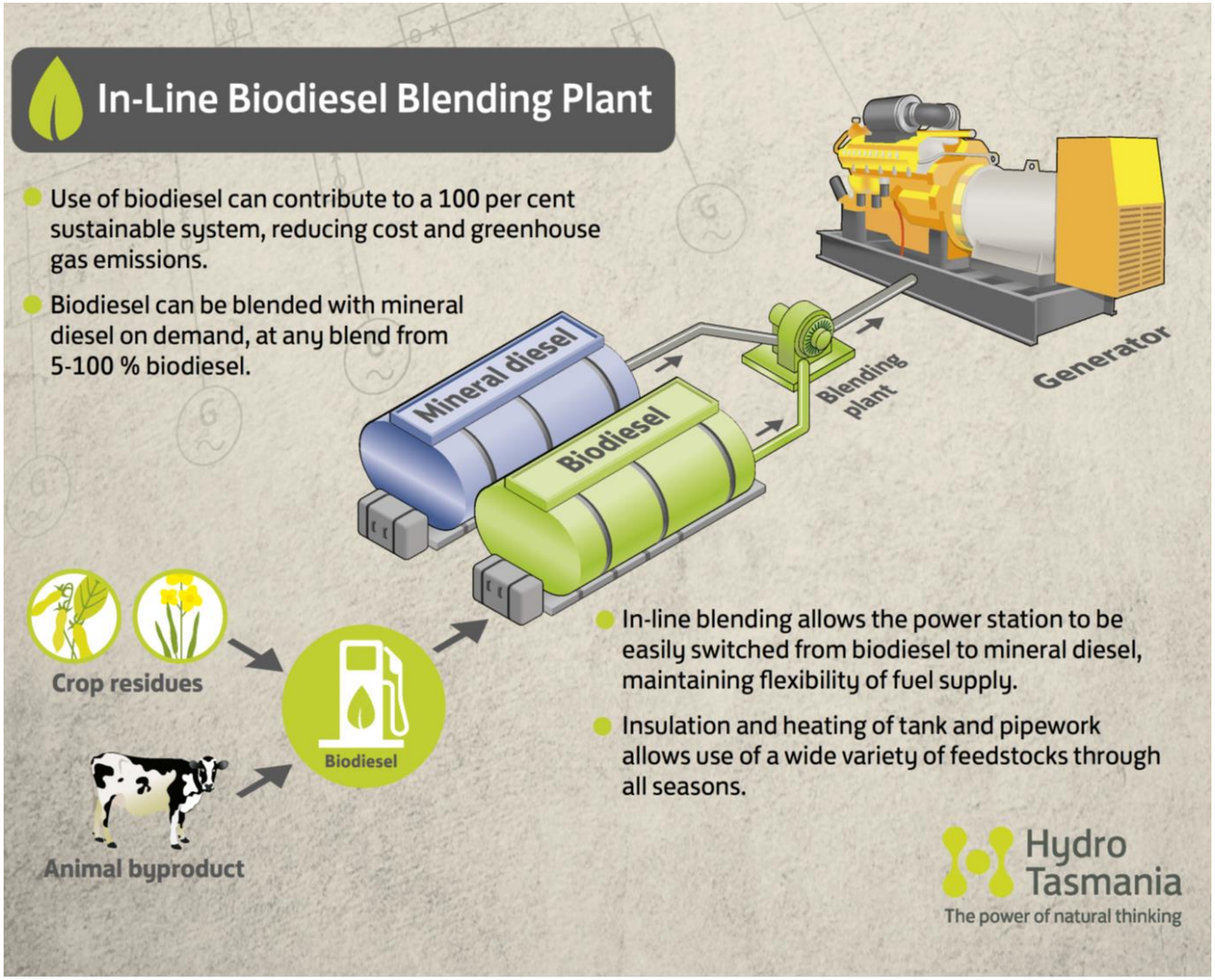
2014 - Biodiesel blending facility

Fuel flexibility, emissions reduction



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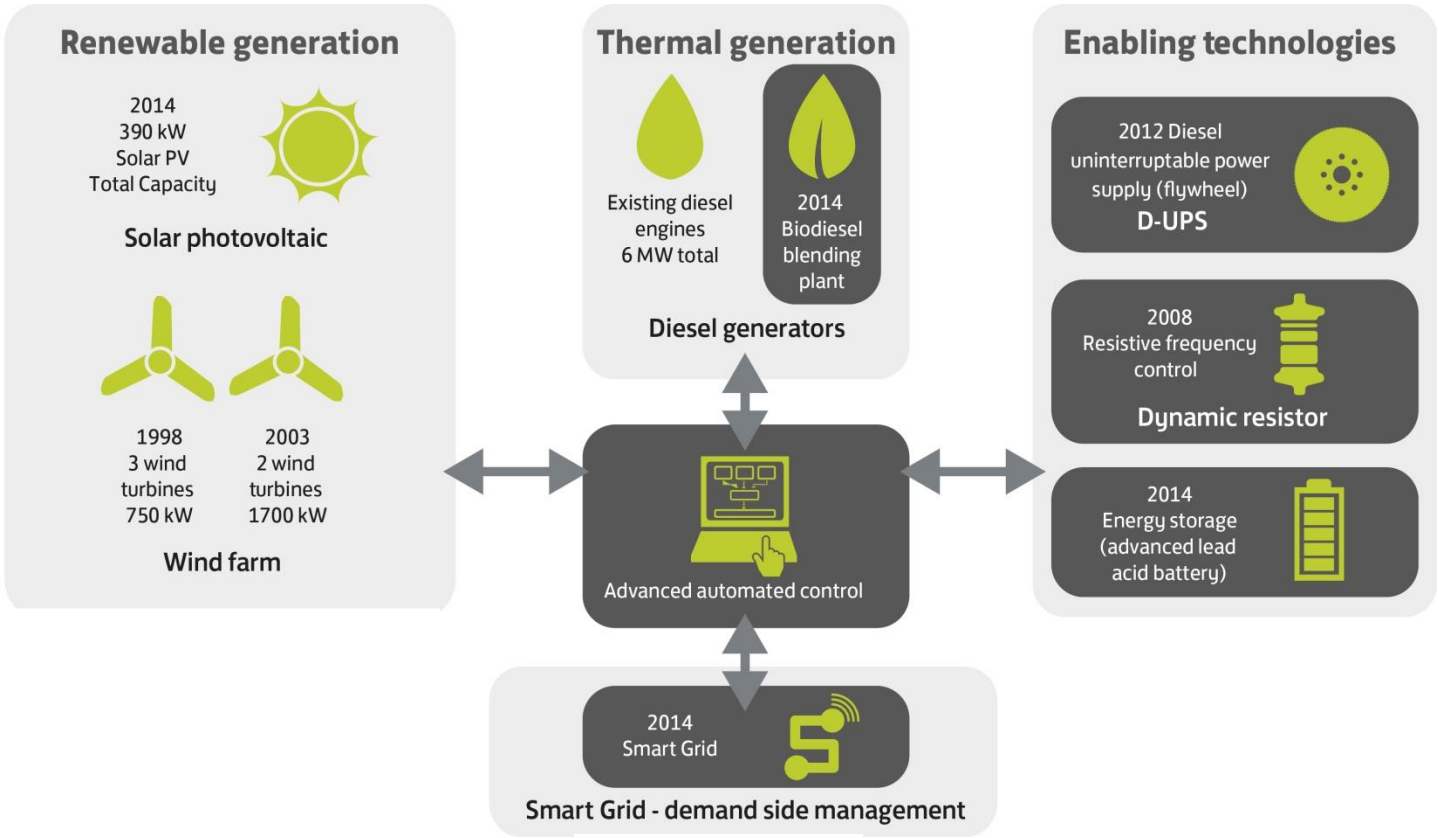
King Island

Proven, robust, reliable utility grade advanced hybrid
World first 100% renewable operation at MW scale

$2m savings per year

>3,000 hrs of 100% renewable operation



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ARENA
Australian Government
Australian Renewable Energy Agency

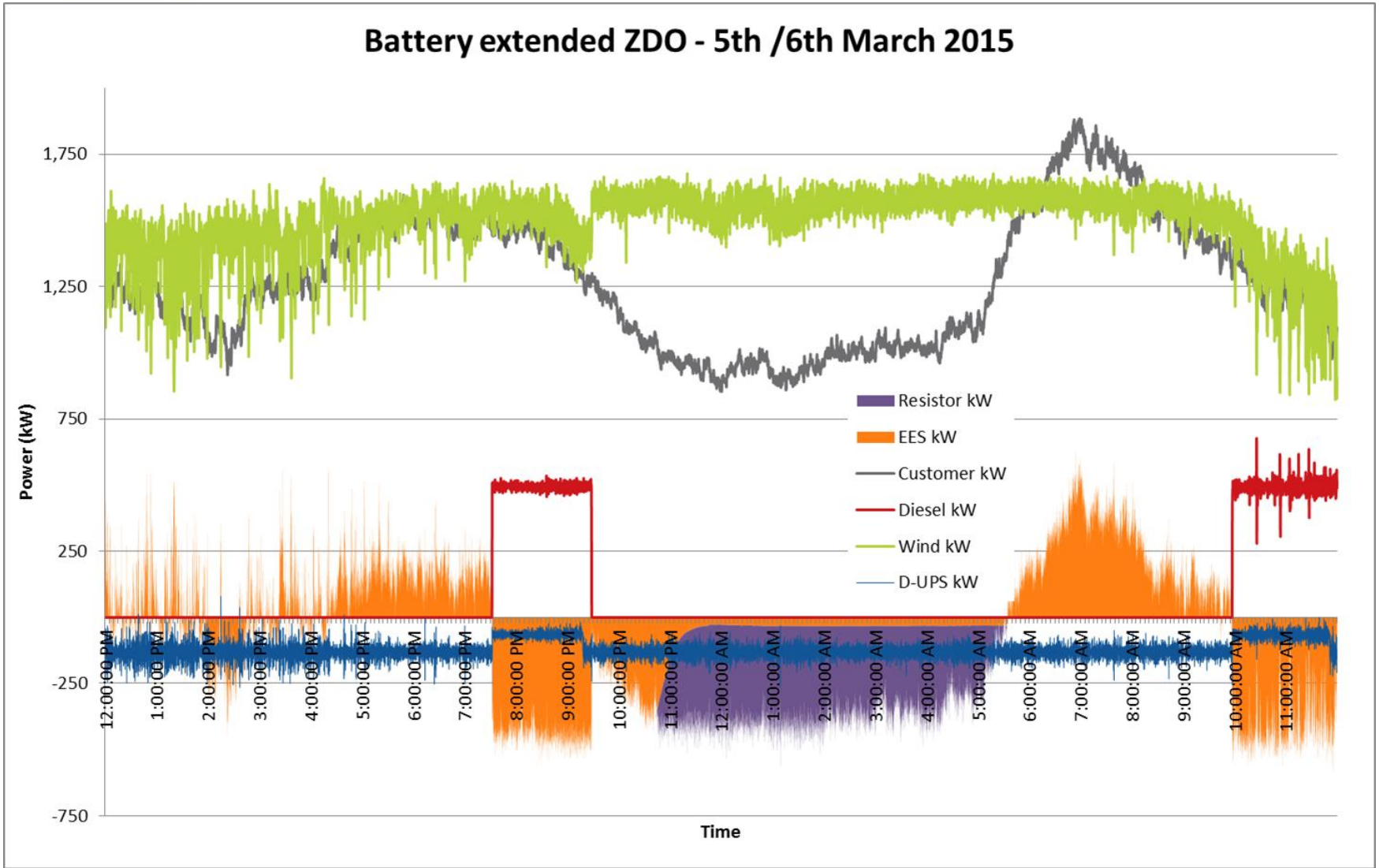
esaa

UNAA
United Nations Association of Australia
WORLD ENVIRONMENT DAY AWARDS
WINNER 2014

King Island system operation

Extended “diesel off” operation

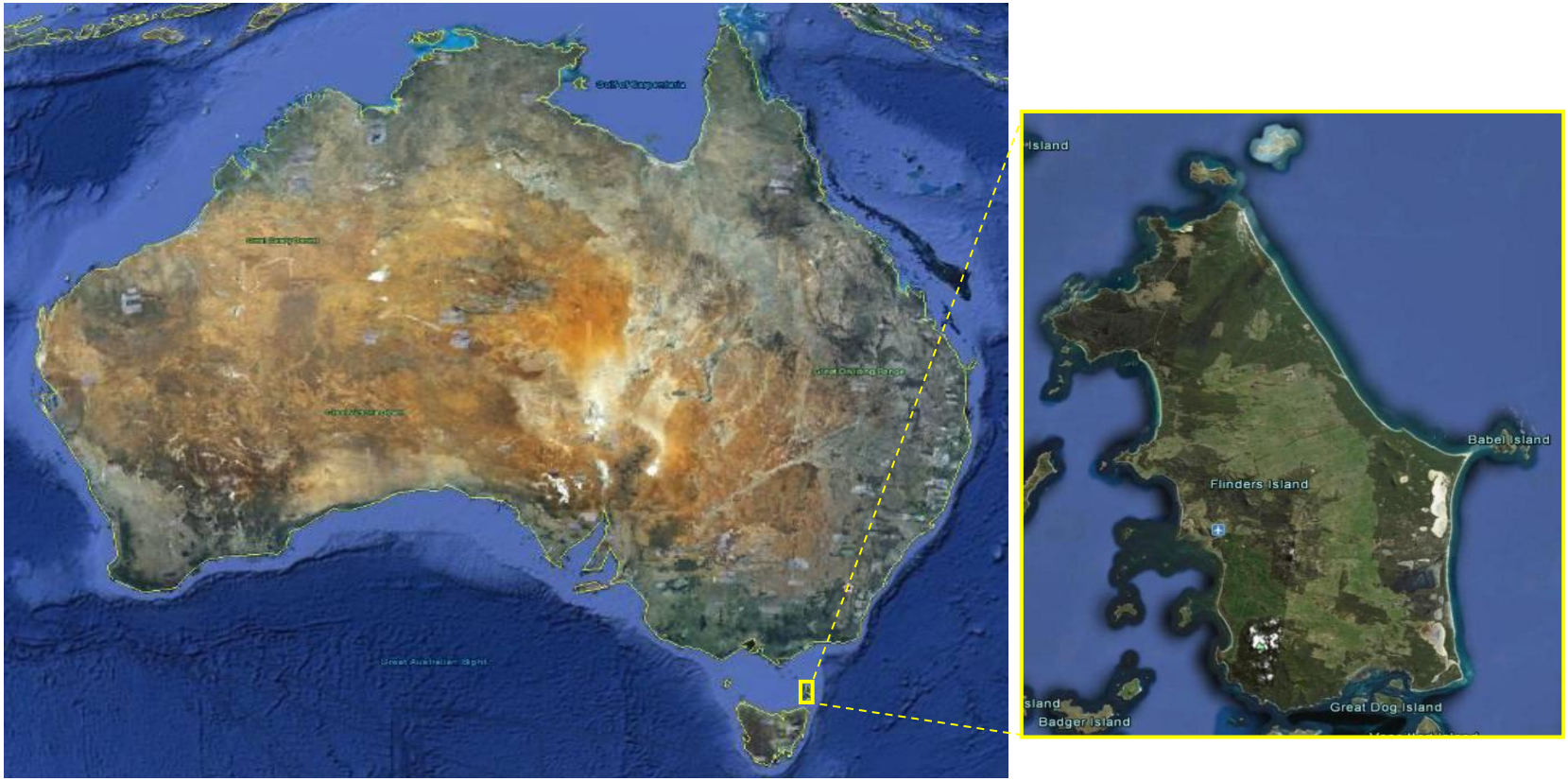
Combined performance of enabling systems



Flinders Island case study : 2015-2017

Source : Google earth

Population 600 1.3MW peak load 3MW diesel 6.7GWh pa >200km of 11kV



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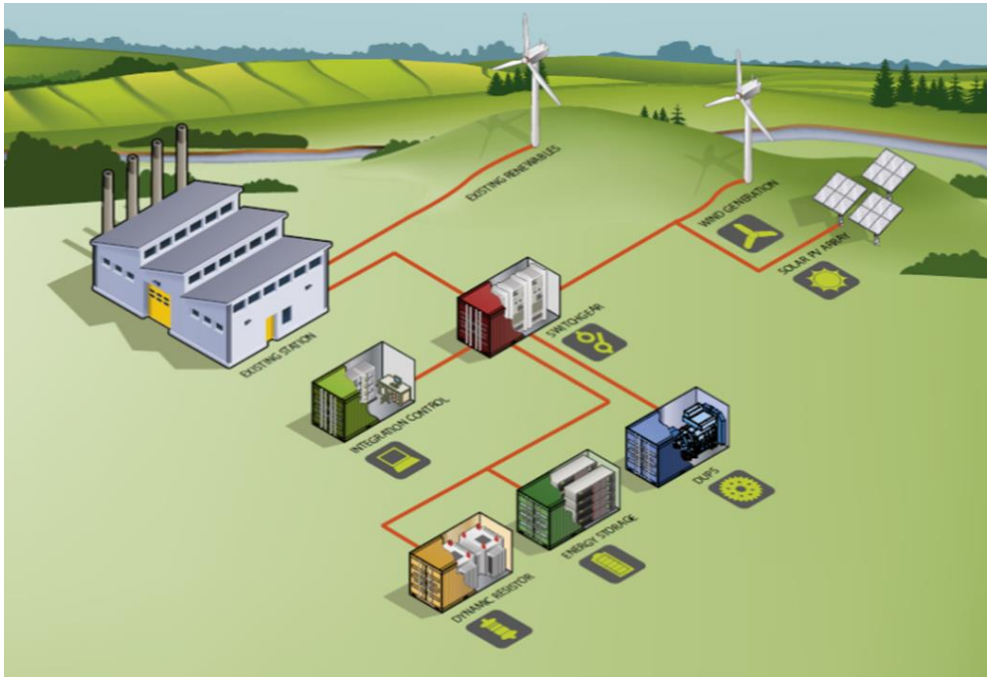
Objective : reduce cost of deployment

Integration activities traditionally costly and time consuming

King Island development required significant on site construction, expected as a first time development



Flinders Island Hub utilises modular scalable enabling systems requiring minimal site works

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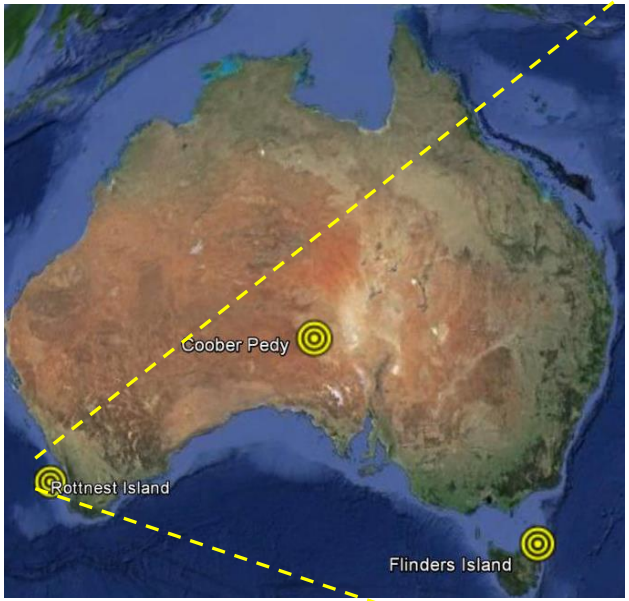
Flinders Hub progress

Installation and site overview

Rottnest Island case study : 2015-2017

Source : Google earth

Tourist island | 600,000 visitors pa | 1.1MW peak load | 2.1MW diesel | 5GWh pa



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ROTTNEST IS

renewable energy

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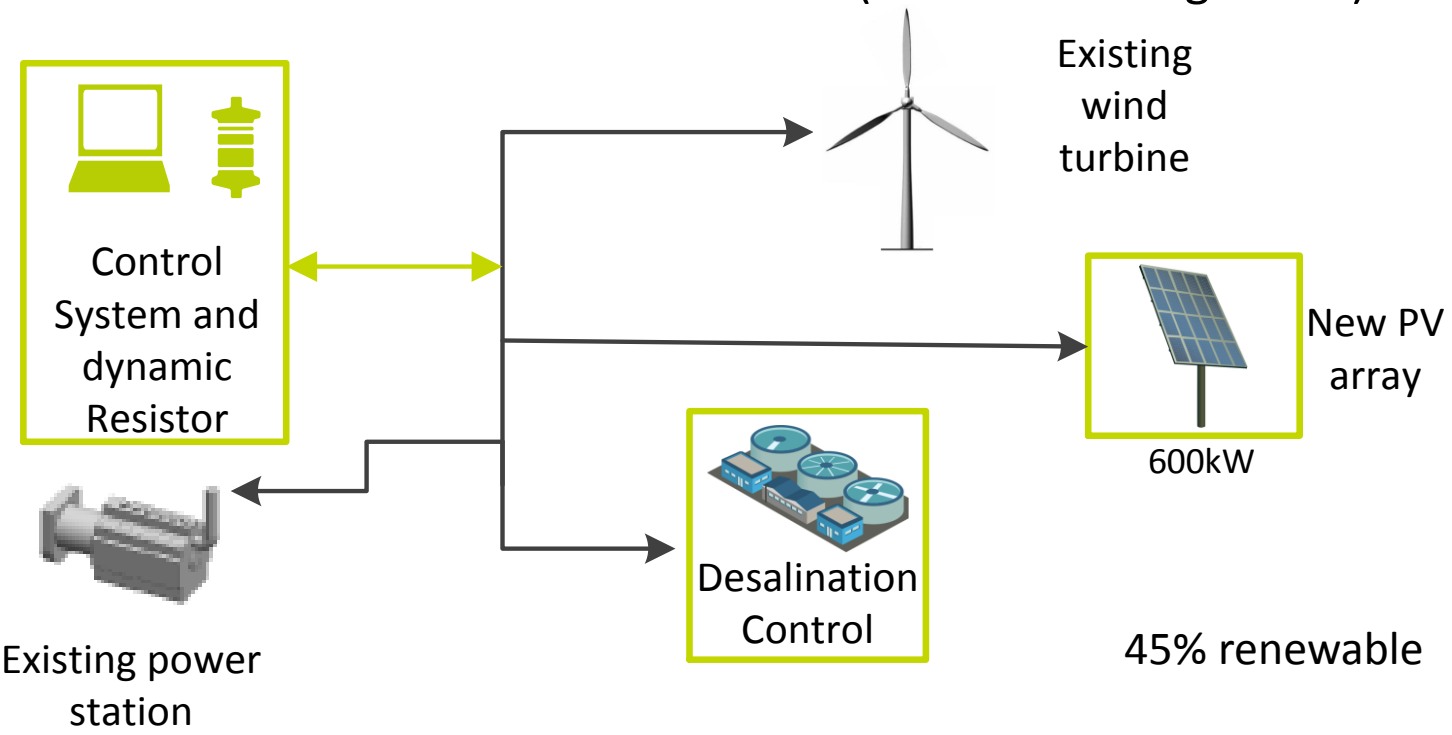
ROTTNEST ISLAND WATER RENEWABLE ENERGY NEXUS PROJECT

Supplying cleaner, lower cost energy and water services in remote communities

Integrate wind and solar PV with water desalination (demand management)



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45% renewable

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ROTTNEST ISLAND WATER RENEWABLE ENERGY NEXUS PROJECT

Due for completion by March 2017 ($6.3m)

- Install 600kW solar PV (integrate with existing 600kW WTG)
- Supply control system and dynamic resistor
- Implement demand management of desalination
  - “shift” renewable energy using demand response

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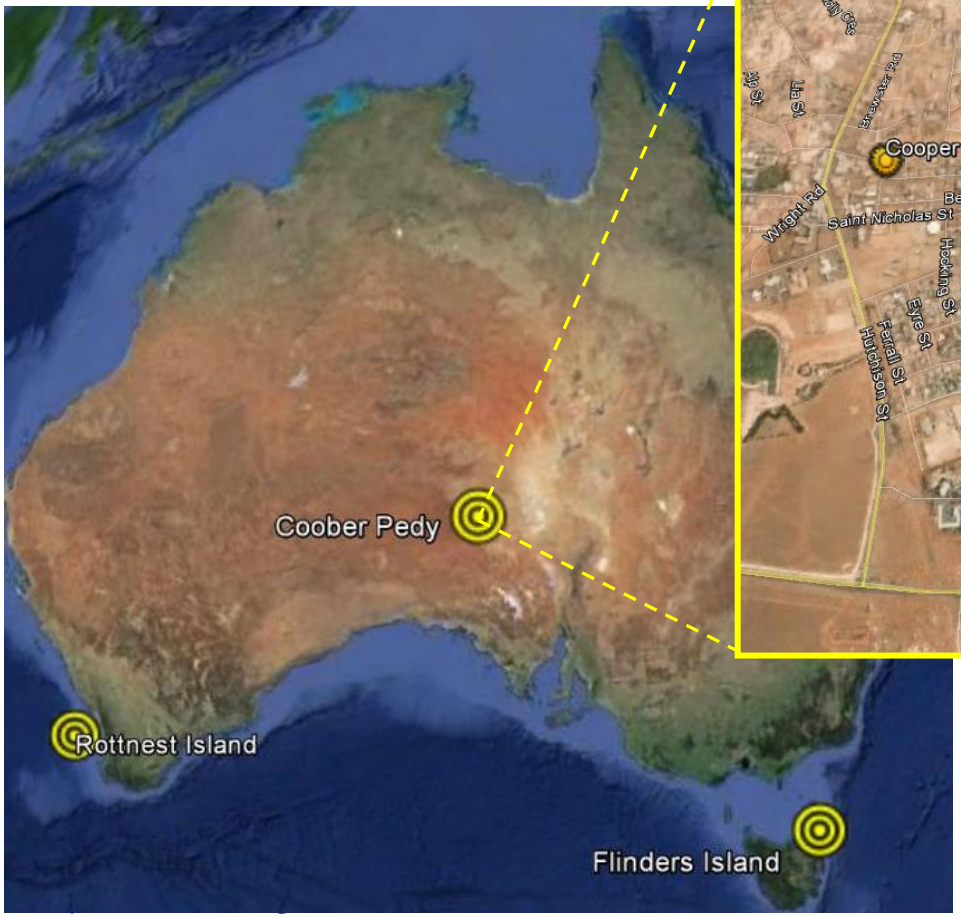
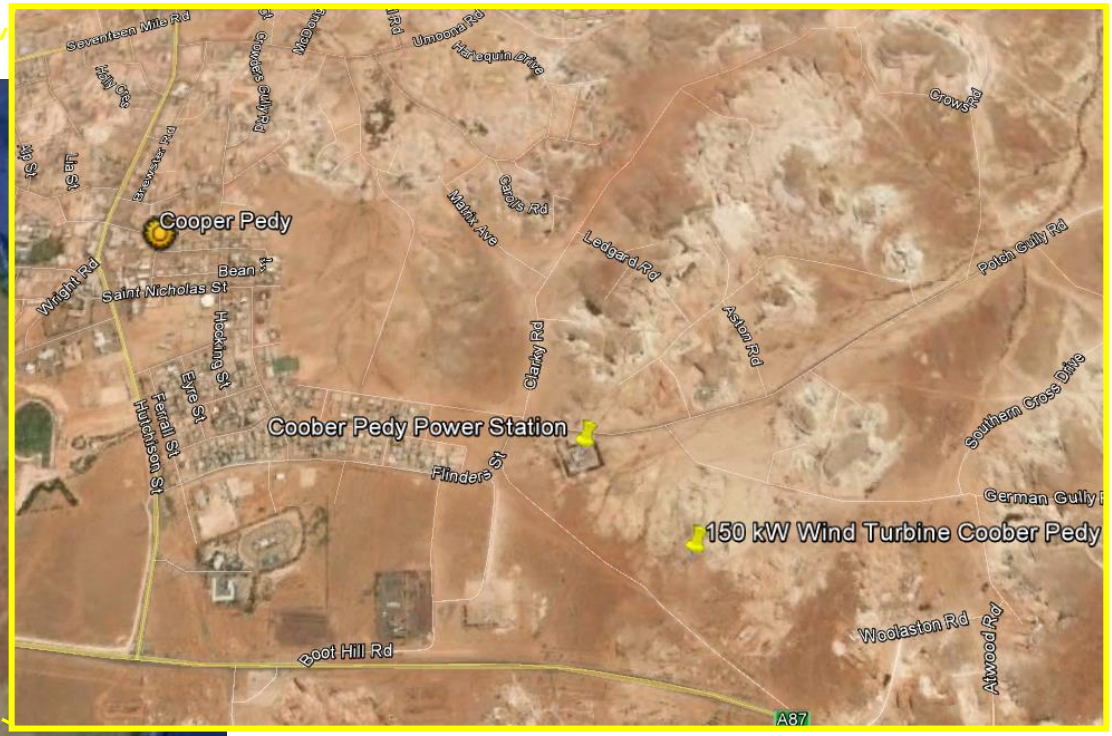
Coober Pedy case study : 2016-2017

Source : Google earth

3MW peak load 3.9MW diesel 13GWh pa



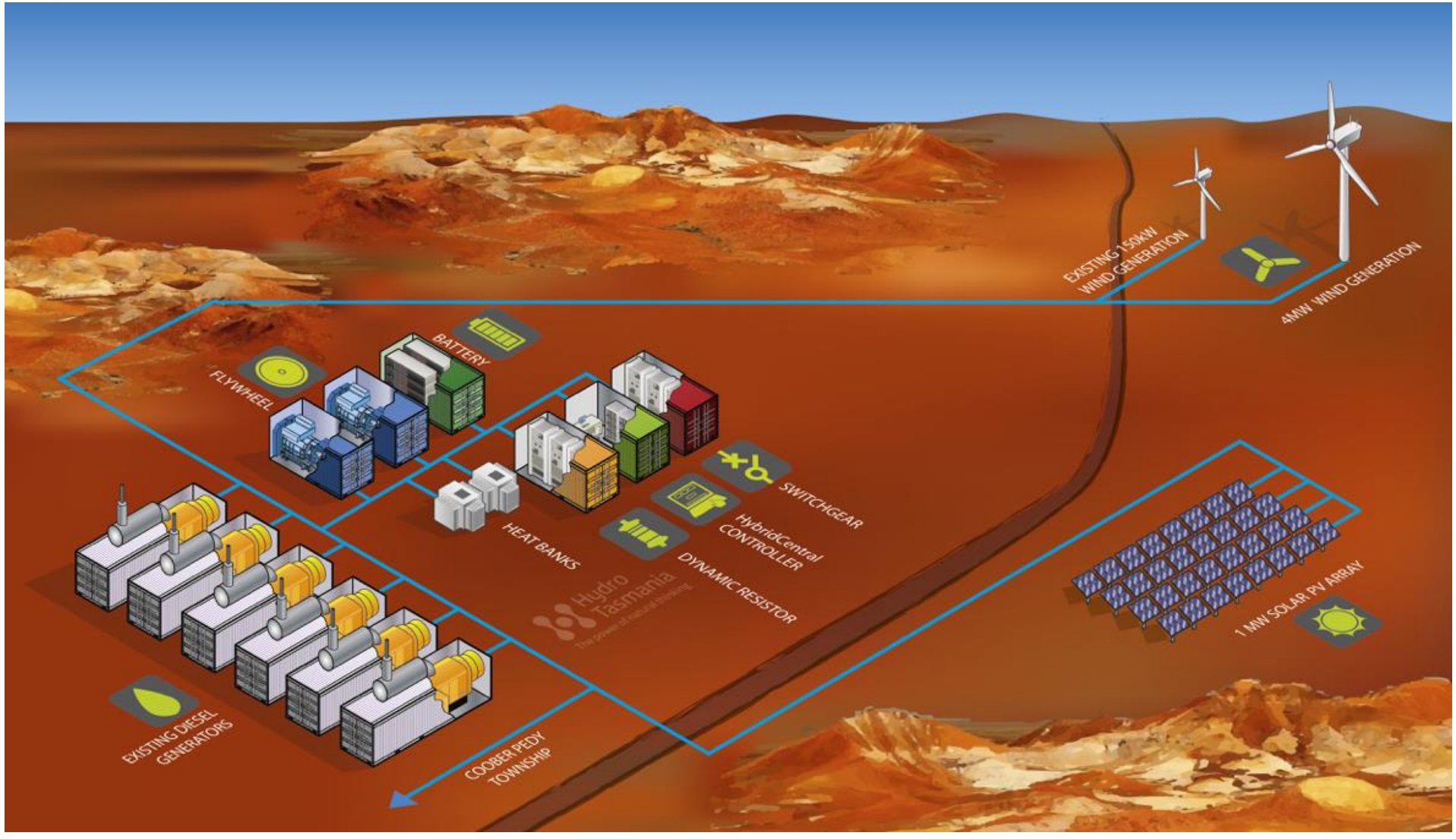


Remote inland mining town (islanded):

- hot, dry arid climate
- excellent solar,
- good wind

Coober Pedy Renewable Hybrid Project

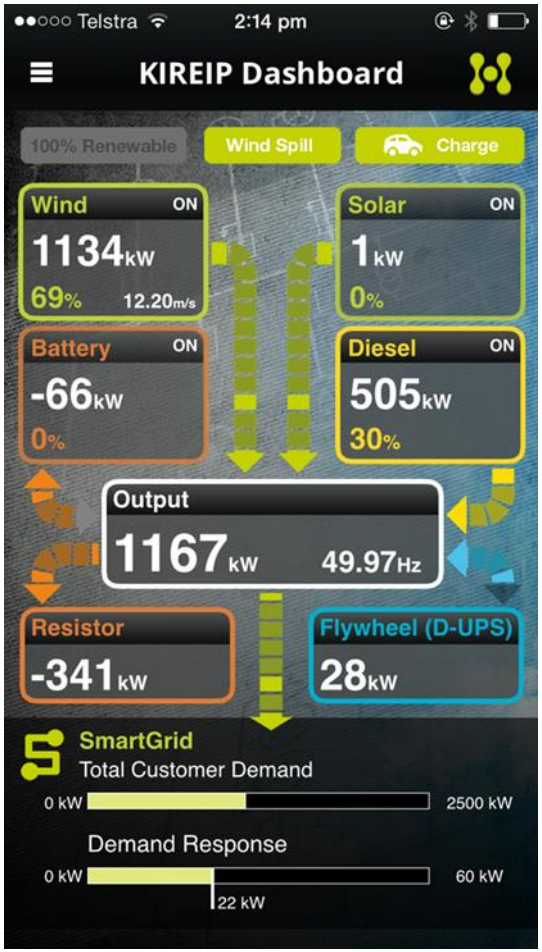
Hydro Tasmania engaged as D&C contractor

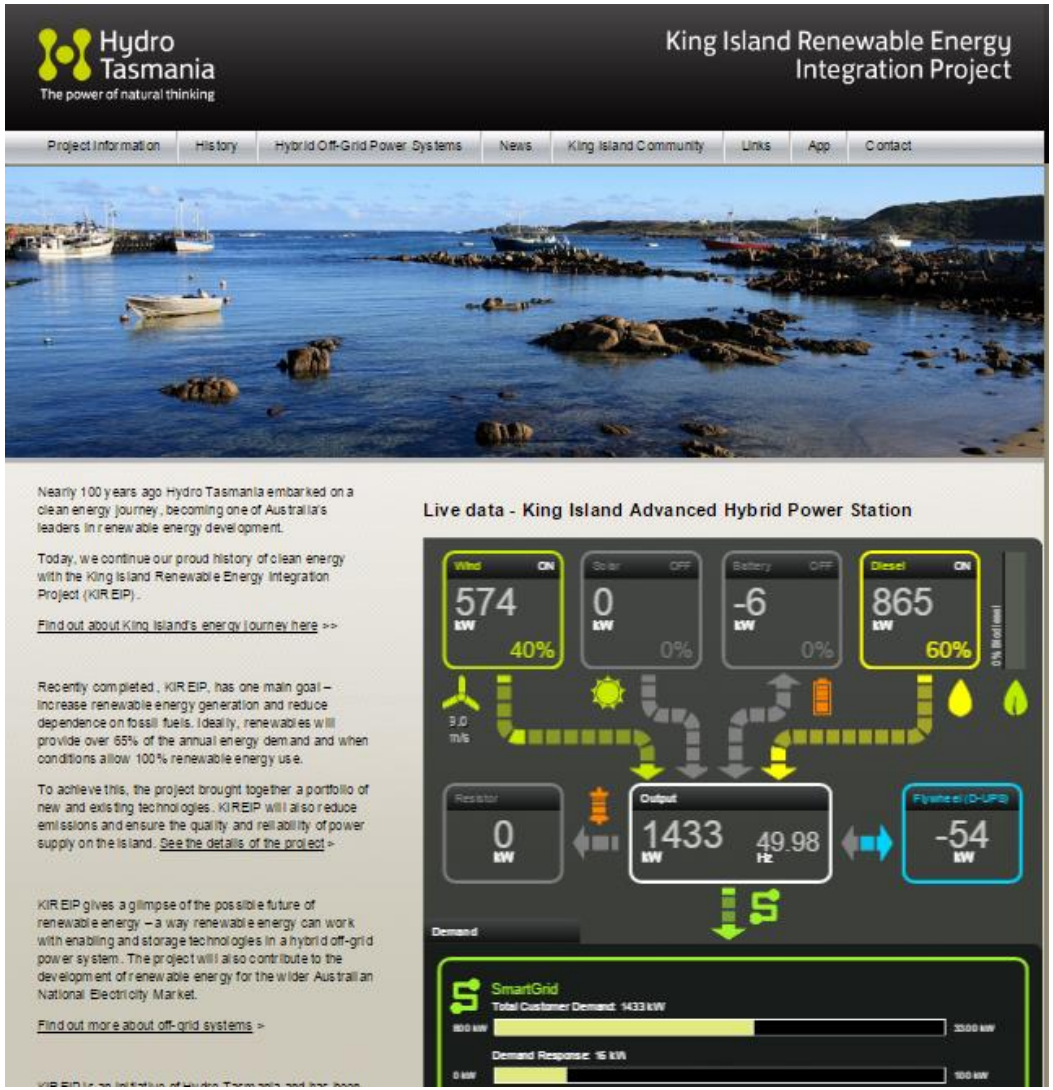


Want to see a 100% RE hybrid operating?

See ioS smart phone app & web site

www.kireip.com.au





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Thank you

Further information:

Hybrid Off-Grid Solutions

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www.kireip.com.au

“KIREIP” iPhone app

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