King Island – Towards a Sustainable Energy Future



Australian Institute of Energy Presentation

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Hydro Tasmania

Overview

- About King Island
- Diesel Power Station (1986)
- Huxley Hill Wind Farm (1998)
- KIREX (2004)
- Solar (2008)
- Resistor (2008)
- Future Options for King Island

King Island


King Island
Image NASA
© 2008 Cnes/Spot Image
Image © 2008 TerraMetrics
318 km
40°38'20.26" S 144°45'07.13" E
©2008 Google
Eye alt 1063.32 km

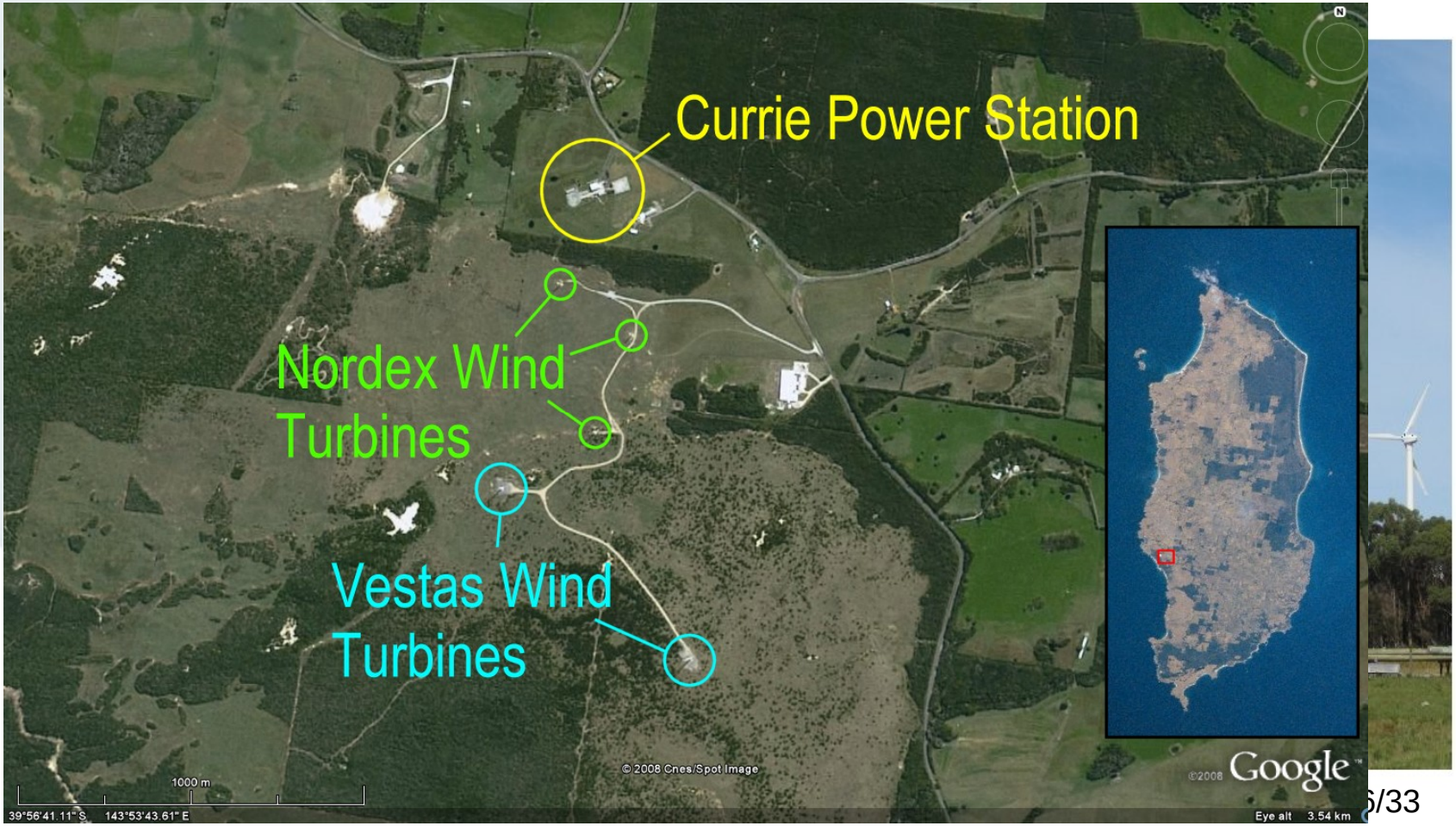
King Island

- Located in Bass Strait
- Around 1600 residents
- Notable industries
  - Dairy
  - Beef
  - Kelp
- Typical residential load profile
- Currie Power Station supplies energy needs
- Excellent wind resource

Currie Power Station

- Station consists of
  - 6 MW Diesel Capacity
  - 2.45 MW Wind Capacity
  - 100 kW Solar Capacity
  - 200 kW Vanadium Redox Battery
    - 4 hours storage (800kWh)
  - 1.5 MW resistor
- Annual energy demand of around 16 GWh
  - Load between 1.2 and 3.3 MW
- Renewables contributed around 33% of demand in 2005-06
- Owned by Hydro Tasmania, operated by Aurora Energy under contract

Power Station Location



Diesel Power Station

- Commissioned in 1986
- Currently houses four diesel generators
  - Three 1600 kW, 11kV
  - One 1200 kW, 415V
- Four 11 kV distribution feeders (~500 km total)
- Supervisory control system - Sequencer

Diesel Power Station

Diesel Power Station

Huxley Hill Wind Farm

- Commissioned in 1998
- Hydro Tasmania's first wind project, Australia's second commercial wind farm
- Three Nordex N29 Wind Turbine Generators (WTGs)
  - 250 kW each
  - 29m blade diameter
  - 30m tower

Huxley Hill Wind Farm

Huxley Hill Wind Farm Performance

- Provided 15% of annual energy demand
- 580,000 litres of diesel saved p.a.
- 1,550 tonnes GHG emissions avoided

King Island Renewable Energy Expansion (KIREX)

- Expansion of Huxley Hill wind farm
- Installation of Vanadium Redox Battery (VRB) energy storage
- Upgraded control system to effectively manage wind farm and storage
- Completed in 2004

KIREX Wind Farm Expansion

- Addition of two Vestas V52 WTGs
  - 850 kW capacity each
  - 52m blade diameter
  - 60m tower height
  - Active pitch control
- Total wind farm capacity
  - 0.75 MW → 2.45 MW

KIREX Energy Storage - Vanadium Redox Battery (VRB)

- Flow battery
- Consists of cell stacks, inverter and electrolyte storage
- 200 kW capacity (both charge and discharge)
- 800kWh storage capacity (4 hours)
- Designed to smooth out wind variability
- Used primarily in ‘block shifting’ mode

KIREX Energy Storage - Vanadium Redox Battery (VRB)

KIREX – Control System Upgrade

- New station control computer
  - Industrial Programmable Logic Controller (PLC)
- Controls wind power contribution
- Controls charge/discharge of VRB
- Schedules diesel generators
- Maintain system security
  - Spinning reserve

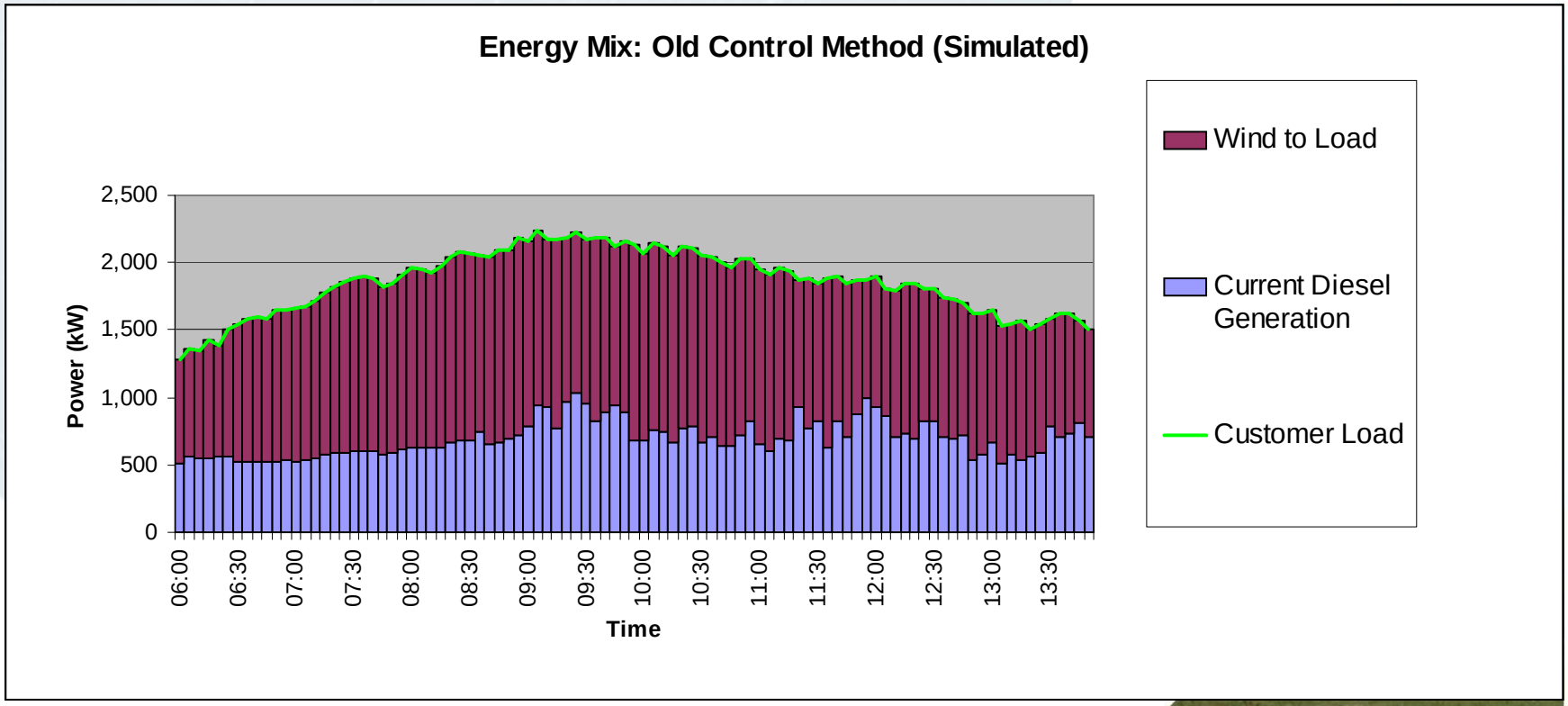
KIREX – Control System Upgrade

- Need to maintain supply/demand balance – Frequency
- Diesels form ‘backbone’ of the system
- Original Huxley Hill installation was small
  - 750 kW
  - 15% annual energy demand
- KIREX upgrade - substantially larger wind farm
  - 2.45 MW
  - 33% annual energy demand
  - Instantaneous Wind Penetration (IWP) method to limit wind output
  - Instantaneous wind contribution of up to 70% of customer load
  - IWP changed according to wind conditions

KIREX – Control System Upgrade

- Can’t control Nordex output
- Vestas have active pitch control
- IWP achieved by first switching off Nordex machines then limiting Vestas output
- Conservative approach to WTG control – 70% IWP target rarely achieved
- Diesels provide frequency control
  - Loaded within regulation range
  - All reserves provided by diesel

Wind management using IWP



KIREX Performance

- Provided 33% annual energy demand (2005/06)
- 1,200,000 litres per year saved
- 3,300 tonnes GHG savings

King Island Solar

- Installed in early 2008
- Owned by KI Solar Pty Ltd
- Six SOLON movers
  - Monocrystalline
  - Dual axis tracking
  - ~100 kW total

King Island Solar

King Island Solar

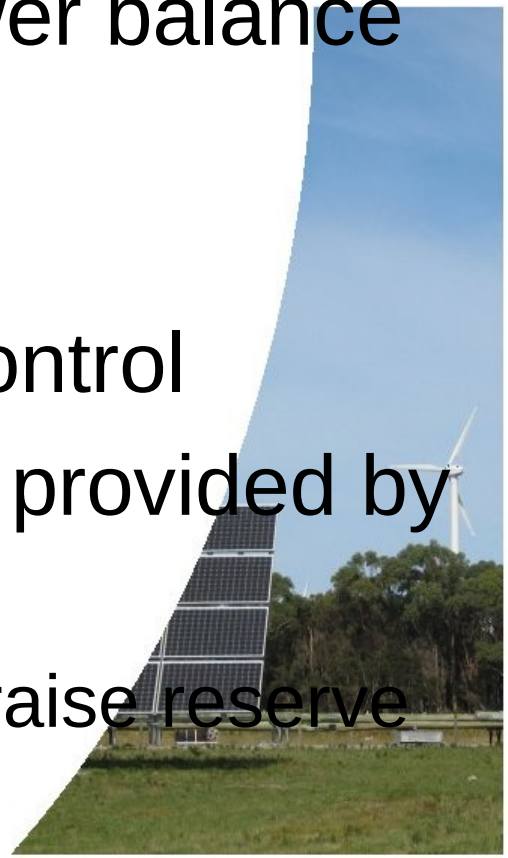
King Island Solar

Resistive Frequency Control

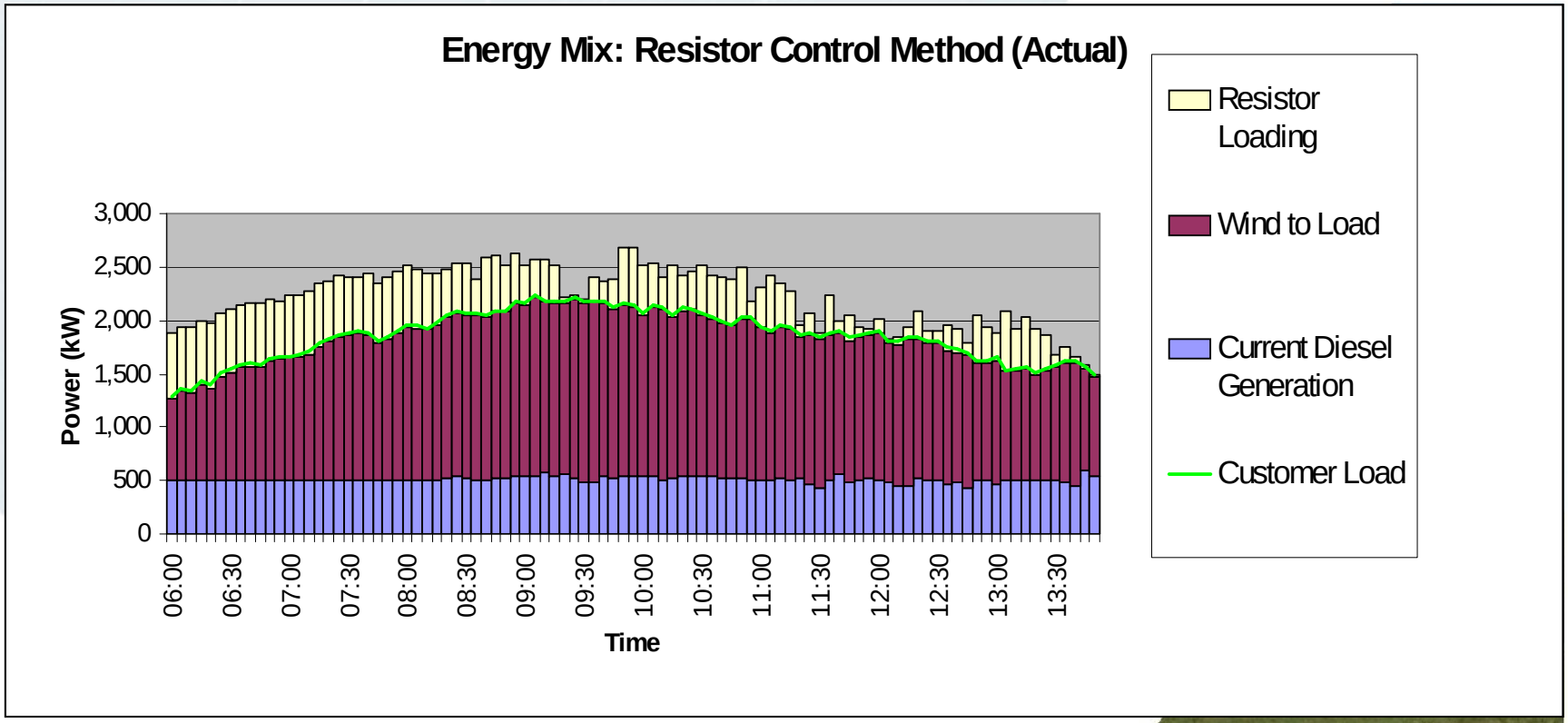
- Began operation in early 2008
- 1.5 MW variable resistor
- Augmentation of control system
- Optimises use of renewables
  - Reduces diesel consumption
- Increases system security

Resistor - Concept

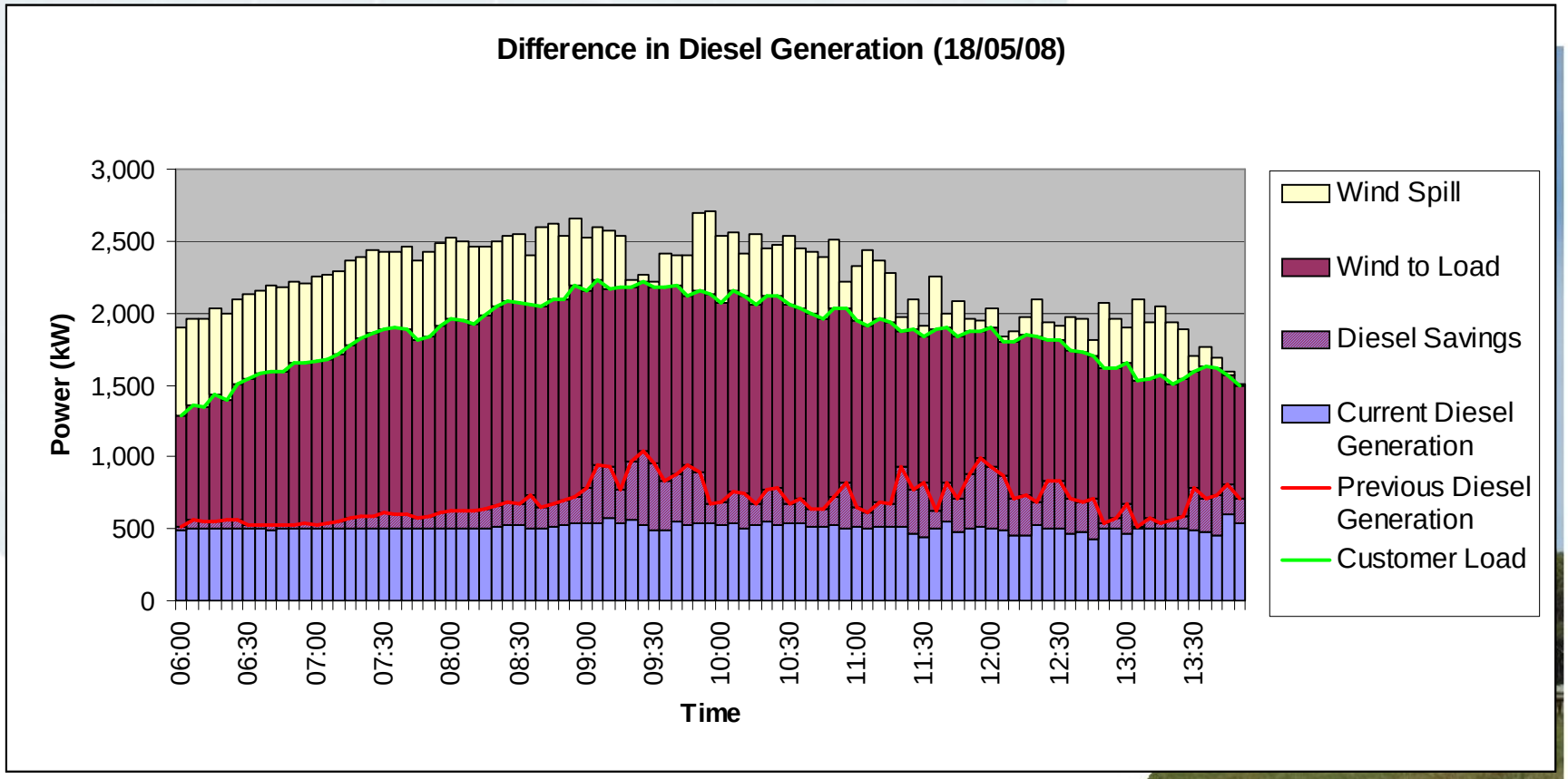
- Wind output is not limited, power balance achieved by resistor loading
- Diesel runs at minimum load
- Resistor provides frequency control
- Fast Raise and Lower reserve provided by Diesels and resistor
  - Wind power now contributes to raise reserve



Wind Management using Resistor



Wind Management using Resistor



Resistor Modules

Resistor – Expected Performance

- Increase renewable contribution
  - 33% → 45%
- Decreased reliance on diesel generation
- Increased power system reliability

Resistor – Future Options

- Precursor to Carbon Block Energy Storage System
  - Proof of frequency control concept
- Potential to replace resistor elements with other storage technologies
- Could become standard product to enable high renewables penetration in other RAPS systems

King Island – Future Options

- Continued diesel reduction forms a part of Climate Change strategy
- Reduced dependence on fossil fuel
  - Energy security
  - Cost of supply
- Projects
  - Wind farm expansion
  - Alternative fuels
  - Energy storage
  - Marine power trial