From Denham to Esperance and Ross Island;

Powercorp's Experience in High Penetration Wind Diesel Systems

engineering innovative power solutions for a better world.

Presenter: Alan Langworthy
Managing Director Powercorp

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Overview

- High penetration of wind energy into diesel power systems is no longer limited by technology.

Overview

In this presentation:

- Powercorp's utility standard wind/diesel, wind/hydro/solar/diesel power systems
- Penetration vs Annual contribution

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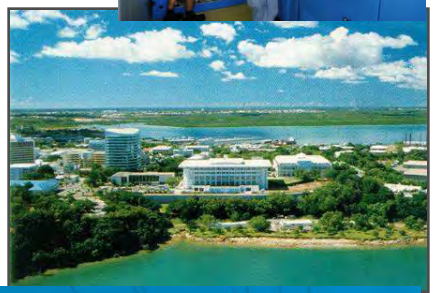
Overview

- Powercorp has built multiple commercial wind diesel power systems
  - Up to 100% wind penetration
  - >50% annual energy contribution from the wind
- Located in:
  - Australia
  - the Antarctic and
  - the Azore Islands, North Atlantic

Overview

- Experienced in turnkey solutions for stand alone power systems
- Focused on
  - innovative control systems and
  - power electronic solutions

  to stabilise wind/solar diesel power stations
- More than 21 years experience in utility applications
- Over 100 Systems installed
- Wind farm construction



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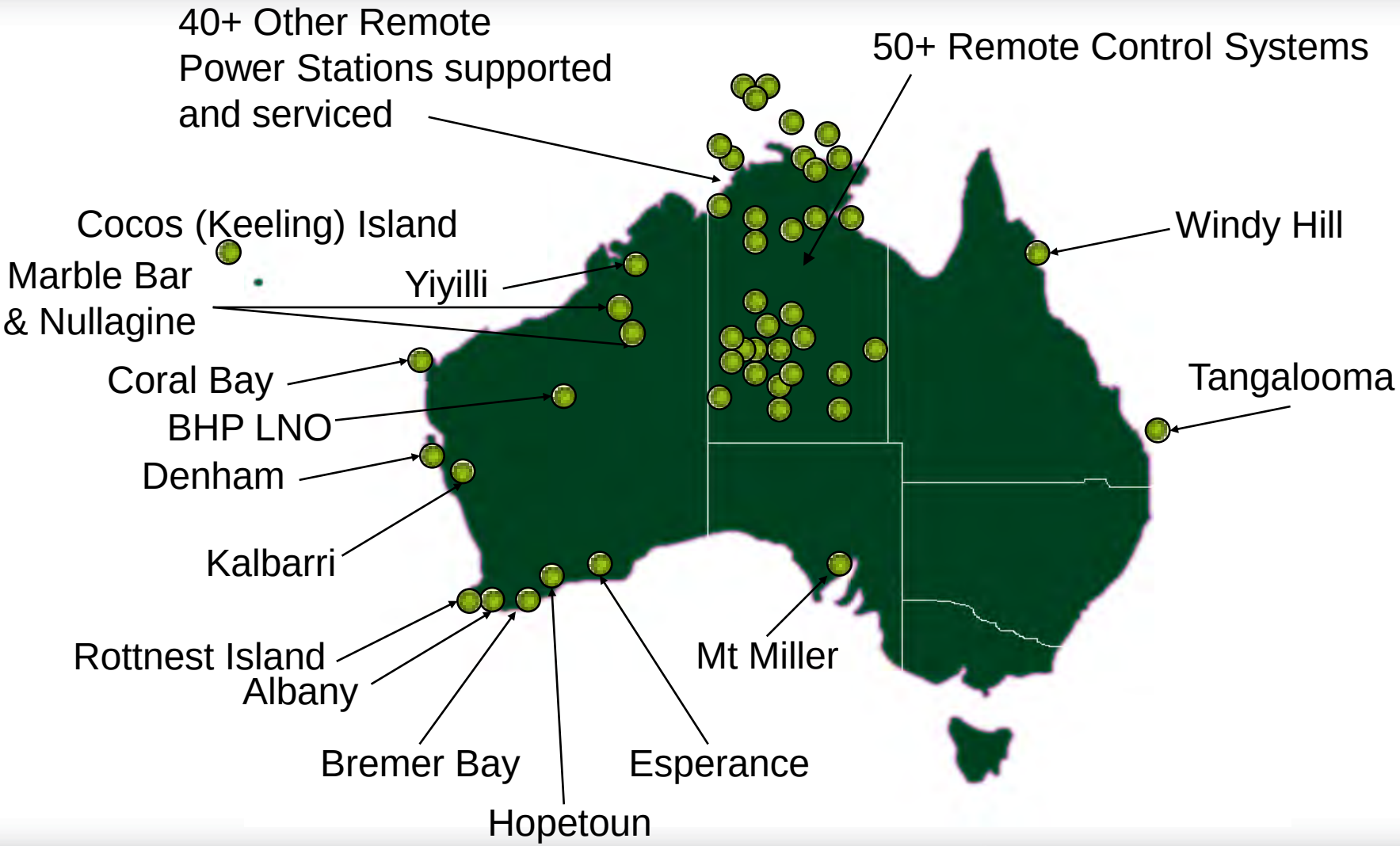
Overview - Australian Projects



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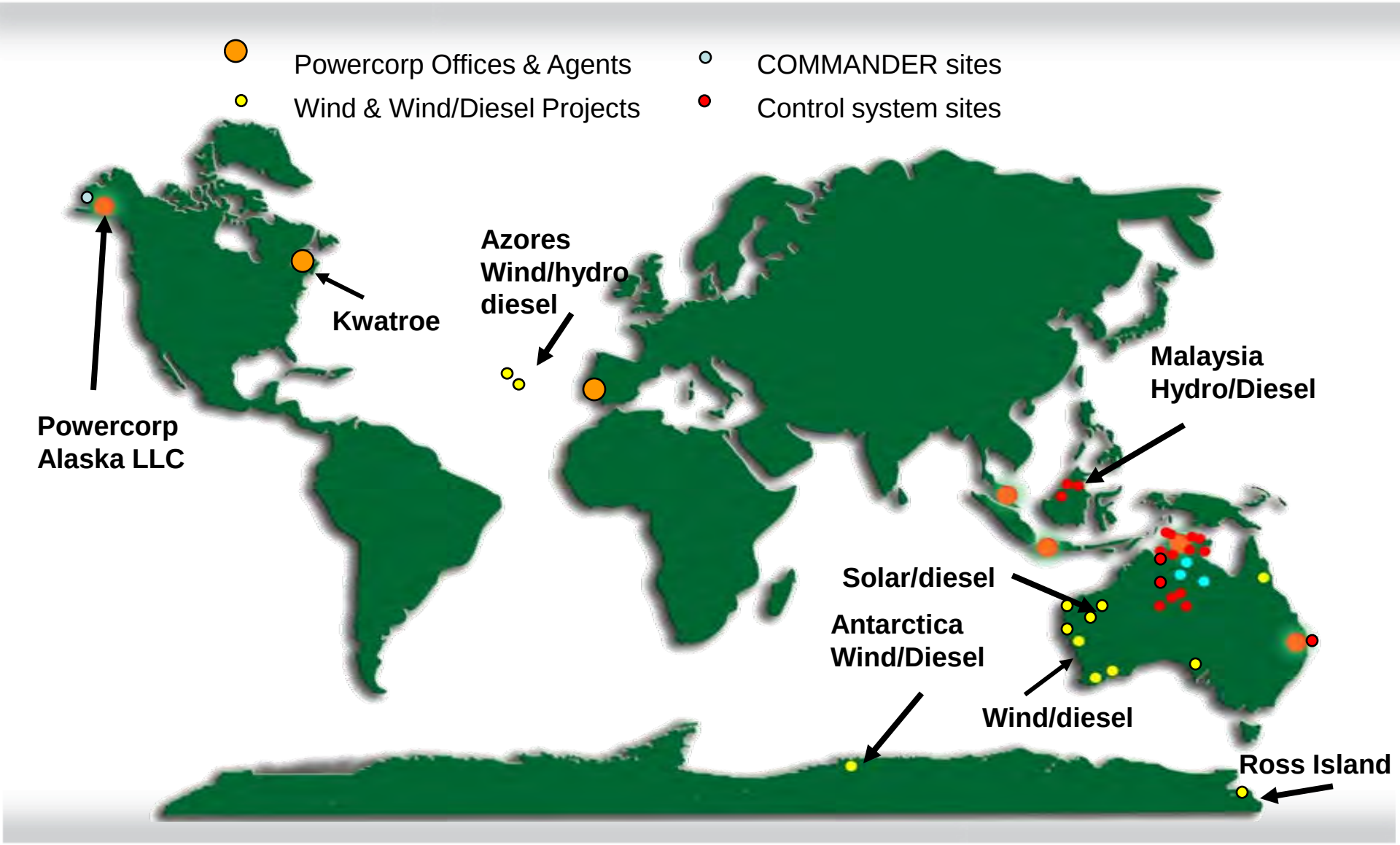
Overview - International Projects



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Definitions

- “Simple Fuel Saving” systems (low penetration)
  - Typically less than 25% wind input at any time
  - Diesel governors compensate for wind gusting
  - Increasing wind energy input causes power fluctuations beyond the capacity of the governors or engines to cope
- Problems are;
  - Flicker/power surges
  - Engine damage
  - Blackouts !

Definitions

There is no middle ground!

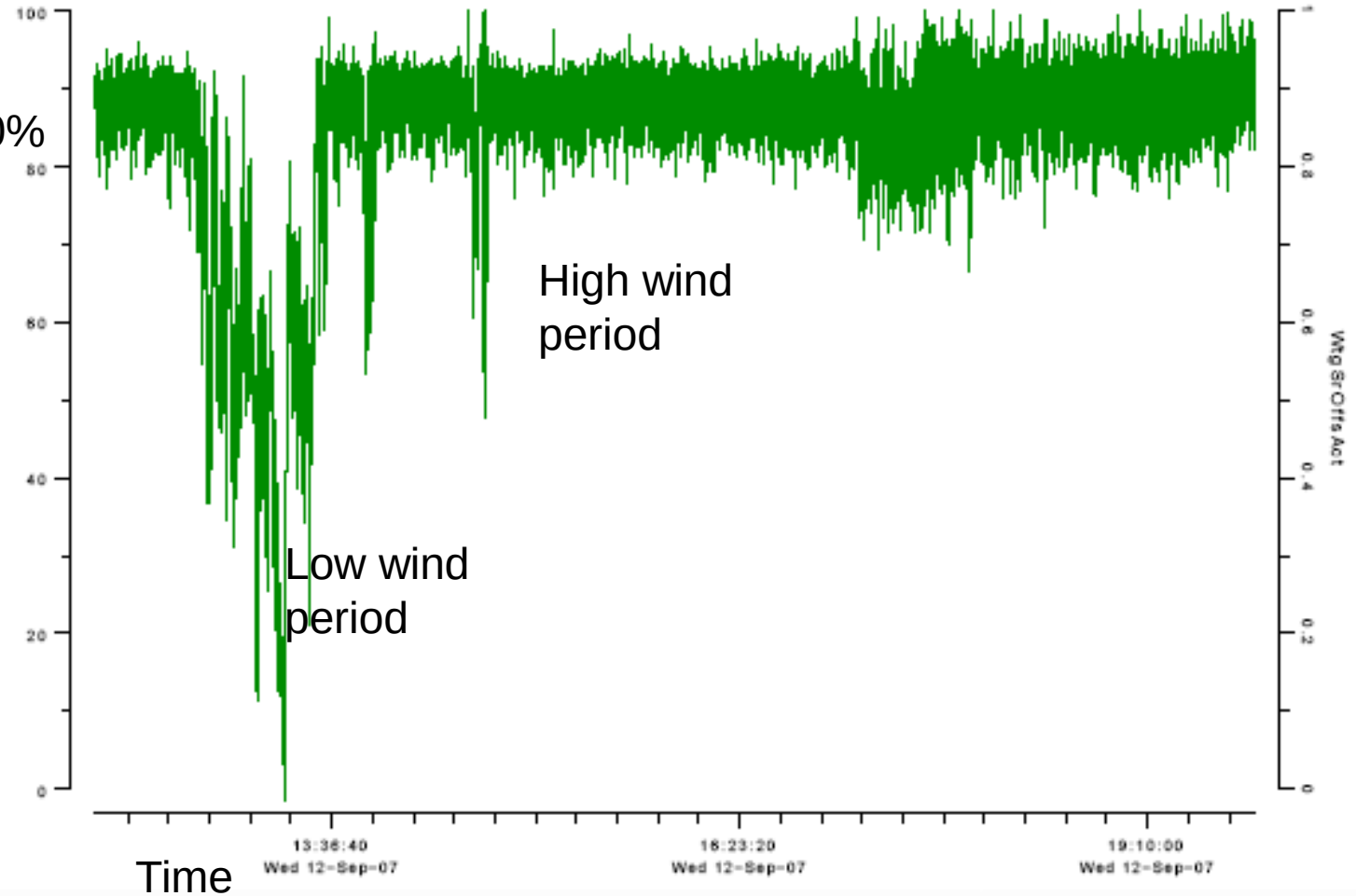
- To achieve high Annual Contribution to fuel savings, the network must be stabilised and all available wind energy must/can be captured
  - This means at any time >95% wind input to the network is not only possible but necessary!
  - Such systems are “High Penetration”
  - Powercorp does this using a flywheel inverter system - PowerStore

Definitions

- Typically >50% of the fuel per annum can be saved in such high “Annual Contribution” systems
- To go further
  - Demand Side Management is the lowest cost solution, this can increase fuel savings typically to 60%
- Beyond this
  - long term storage “batteries” are needed
    - Unfortunately, at present, such batteries are very high expensive and it is difficult to justify the additional benefits

Definitions

Coral Bay - 8 Hour Wind Penetration Graph



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Key Technology - PowerStore

Project Experience

- Q: How did we reach this understanding and achieve these solutions?
- A: Over 21 years of commercial project experience

Project Experience - Automation

- Many Fully Automatic Multiple Diesel Systems

Original multiple diesel automation and control systems

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Project Experience – Wind/Diesel

Station	Wind/Hydro	Diesel
Denham	990kW	1,600 kW
Mawson	600kW	550kW
Esperance	5,600kW	14,500kW
Hopetoun	1,200kW	2,560 kW
Cocos Island	100kW	950kW
Bremer Bay	600kW	1,250kW
Rottnest Island	600kW	1,300kW
Coral Bay	825kW	2,560kW
Graciosa	800kW	3,200kW
Flores	600kW/1,100kW	4,000kW
Ross Island	900kW	9,360kW

Project Experience - Denham

- Powercorp's first high penetration >90% wind diesel power system at Denham WA

4 x E30 WTG

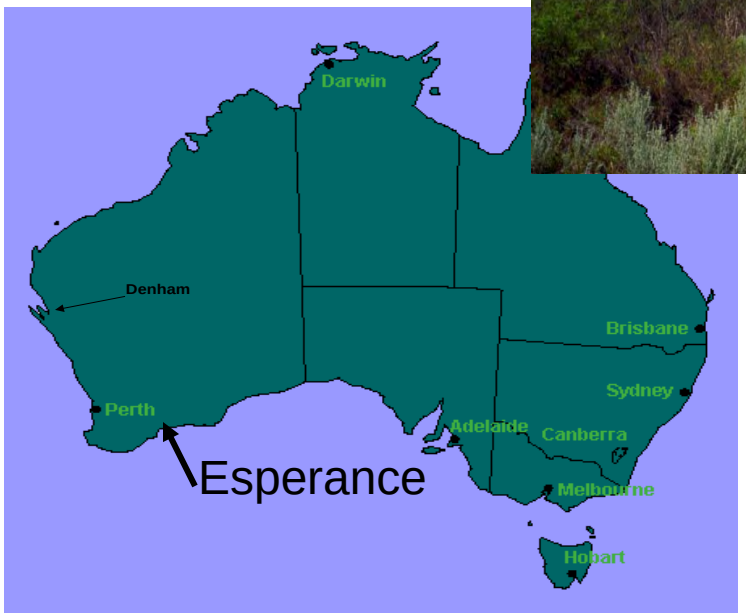
Diesel Engine Hall

Project Experience - Esperance

Vestas and ENERCON turbines

Esperance, Nine Mile Beach Wind Farm

Diesel Engine Hall - Gas Turbine Replacement Power Station



Project Experience - Mawson

High Penetration Wind/Diesel Power System

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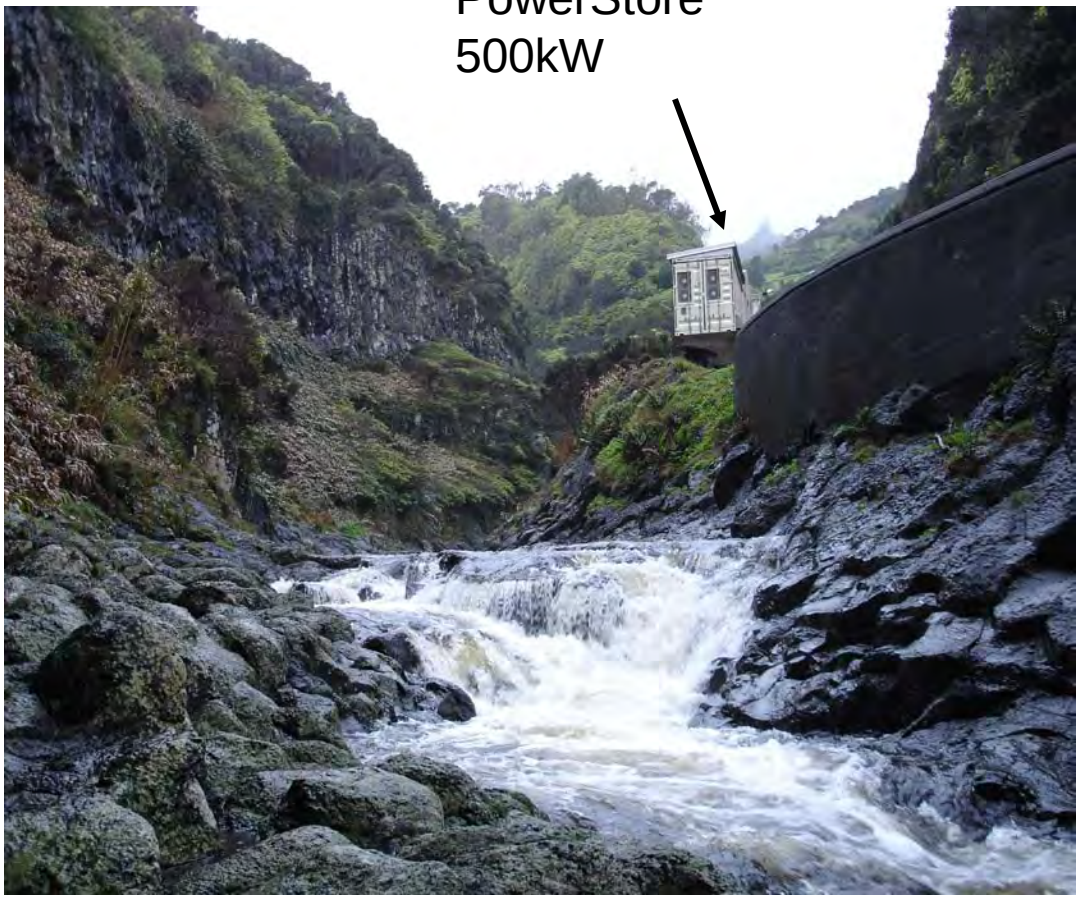
Project Experience - Flores



- High penetration wind/hydro/diesel power station
- Powercorp's PowerStore technology makes it possible to run Flores on Hydro and Wind alone ("Diesel Off" mode)

Project Experience - Flores

ENERCON 2 x E33 300kW and Nordex 2 x 100kW wind turbines

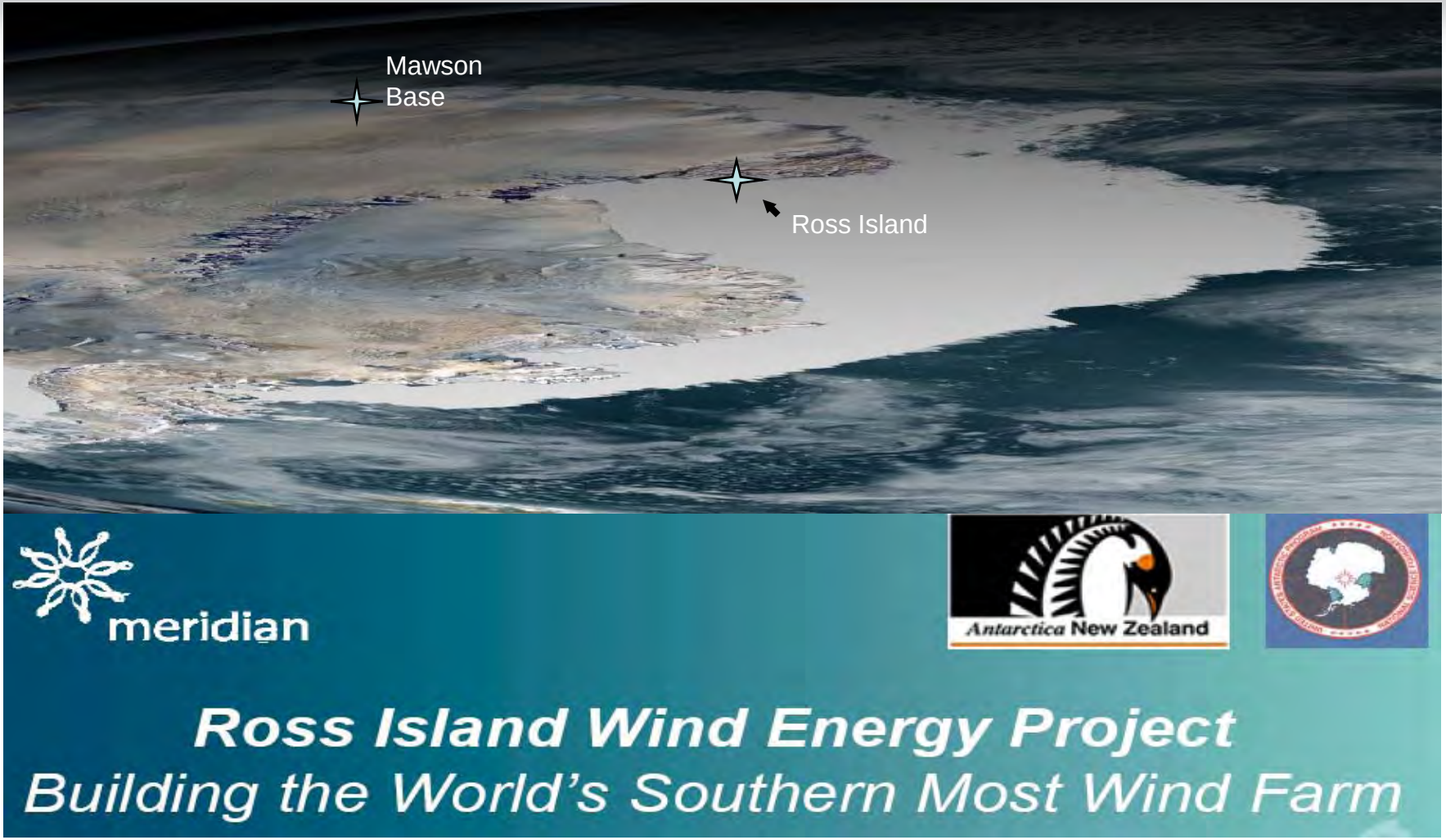
Project Experience - Flores

Limited storage hydro generation

Project Experience - Flores

Combined hydro (1,100kW) and diesel power station (4,000kW)

Project Experience - Ross Island Antarctica



"Meridian Energy is building the Ross Island Wind Farm in an Alliance with Antarctica New Zealand and with support from the US National Science Foundation"

Project Experience - Ross Island Antarctica

Scott Base

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- New Zealand's Scott Base houses up to 100 people, average load ≈ 150kW.

Scott Base at Midnight – 24hr daylight in Summer

Project Experience - Ross Island Antarctica

McMurdo Station

meridian

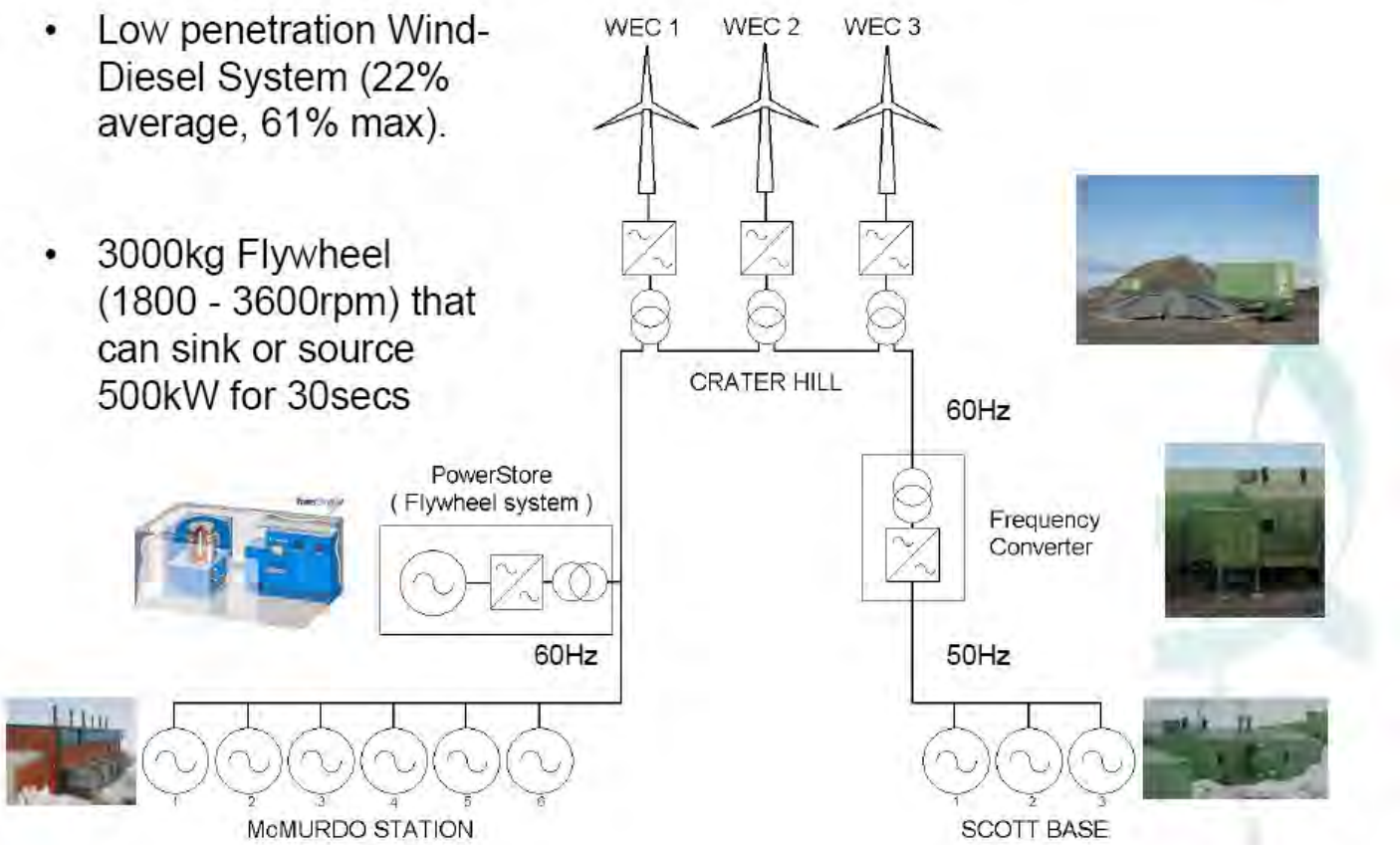
- US McMurdo Station (3km from Scott Base) houses up to 1250 people. Average load ≈ 1.6 MW

Project Experience - Ross Island Antarctica

RIWE Stage 1 – Crater Hill Wind Farm

meridian

- Low penetration Wind-Diesel System (22% average, 61% max).
- 3000kg Flywheel (1800 - 3600rpm) that can sink or source 500kW for 30secs



Project Experience - Ross Island Antarctica

Final Inspection – Commissioned McMurdo Station PowerStore (Flywheel) Building

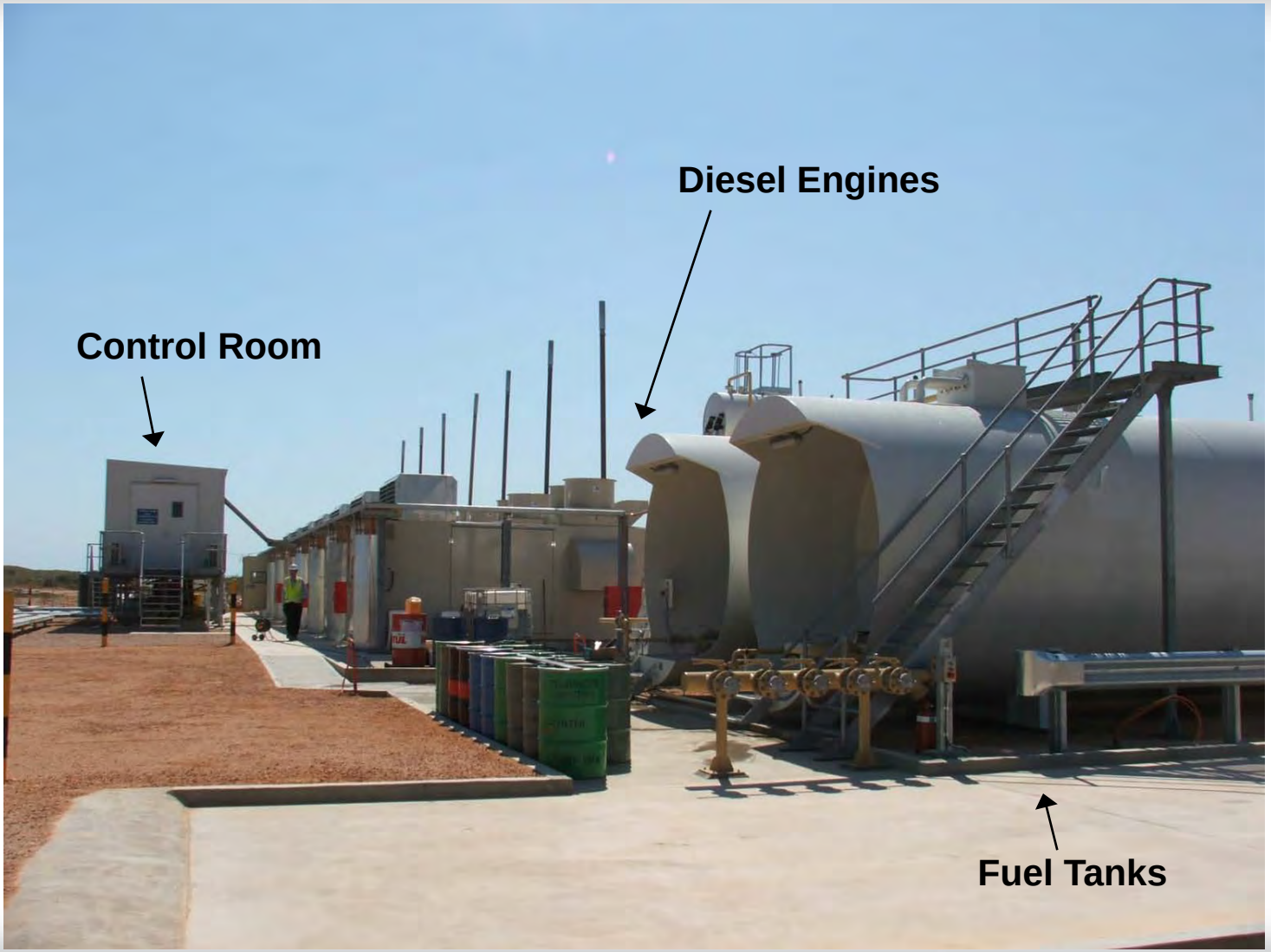
Project Experience - Coral Bay

Project Experience - Coral Bay

Coral Bay high penetration Wind/Diesel power station (Cyclonic region)

3 x Vergnet WTGs

Project Experience - Coral Bay



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Summary

- Powercorp is a world leader in wind/diesel power generation
- These systems are typically high penetration and offer maximum fuel savings
- Exceptional power quality (often better than city quality)

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Summary

- Utility standard power quality is achieved through
  - use of flywheel and high speed, MW scale, power electronic inverters (PowerStore)
  - a Distributed Control System (DCS) and Smart Grid

- All of these projects are
  - in operation today,
  - commercially viable, and
  - saving fuel due to the technical advances made by Powercorp over 21 years of targeted work in this field

Thank you!
Questions welcome.

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