## **Coral Bay**

System Performance of a Real High Penetration Wind/Diesel Hybrid Remote Area Power System

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# powercorp



#### **Presentation Key Points**

- Coral Bay
  - Economic High
     Penetration
     Wind/Diesel with
     stabilisation
- Homer Modelling

   Verification of Results
- Powercorp DCS and "Smart Grids"
  - Introduction to capabilities





#### **Coral Bay**

- Located on the West Coast of Western Australia
- Tourist town, with 140 permanent residents and a large peak of tourists during holidays
- Close to World Heritage listed
   Ningaloo reef









#### **Power Station Details**

- Current Power Station commissioned in August 2007
- 7x 320kW "Low Load Diesel" generators
- 3x 200kW (site rated) Vergnet tilt-up wind turbines
- 1x Powercorp PowerStore 500kW Flywheel





#### **Coral Bay SLD/SCADA**

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OVERVIEW SCREEN		CORAL-BAY		16:54:27
Generator 1 Generator 2 Generator 3 6% LF 0.50 gen 22kW STOP STOP RUN 320 320 320 320 320 320 320 320	Generator 4 6% LF 0.46 gen 19kW RUN 320 A A A A A A A A A A A A A	Generator 5 Generator STOP 320 A A A A A A A A A A A A A A A A A A A	r 6 Generator 7 Generator 8 STOP STOP 320 320 A M M A A A A 95kW 128kW 122kW ONLINE ONLINE Wind Turbine 1 Wind Turbine 2 Wind Turbine 3	REPORTS
Station Windfarm	Network Info	Genset Feeder	Environment	RESET
Status	Frequency	Upper Configuration	Maximum Capacity	RESET
RUNNING	49.98Hz	1 2 3 4 5 6 7 8	960 kVV	
Generator Output	Power Factor	Intended Configuration	Maximum Capacity	
34k\/\/	0.61 gen	1 2 3 4 5 6 7 8	640 kVV	
Spinning Reser∨e 595kW	System Load 343kW	Lower Configuration	Maximum Capacity <b>0 kVV</b>	
Local Power	Wind Penetration	Switch Down Timer	Config Set Point	
18kVV	91 %	0h 0m 0s	370 kVV	
Reporting	Commissioned			



#### **Power System Statistics**

- For 2008
  - Maximum demand :
    - 781kW
  - Energy Generation:
    - Wind: 1,582 MWh
    - Diesel: 1,770 MWh
  - Energy Consumption:
    - Consumer: 3,142 MWh





#### Power System Stats – Contd.

- Maximum Wind Penetration:
  - > 100%
- Annual Wind Contribution (2008):
   – 47%
- Coral Bay is High Penetration!





#### Wind Penetration Frequency Distribution



**Coral Bay - Wind Penetration Frequency Distribution** 

Penetration (% of demand)

The Coral Bay Power System derives more than 80% of its power from the wind, for more than 1/3 of the time!



#### Modelling in Homer

- Powercorp uses HOMER to economically justify projects to customers
- Pre-Release version has Powercorp PowerStore built-in to allow simple analysis of impact on system





### Modelling Input Data

- Verification of HOMER
  - Load data
    - From data recording at Coral Bay, 2008
  - Wind data
    - From data recording at Coral Bay, 2008





#### Homer Results

- Homer
  - Wind Energy 1,372MWh
  - Diesel Energy 1,770MWh
  - Annual Contribution 45%

- Real System 2008
  - Wind Energy 1,582MWh
  - Diesel Energy 1,734MWh
  - Annual Contribution 46.95%







#### **Coral Bay Economic Modelling**

- No WEC
  - AU\$0.619/kWh
- 1x WEC 200kW
  - 18% Annual Wind Contribution
  - AU\$0.557/kWh
- 2x WEC 200kW
  - 35% Annual Wind Contribution
  - AU\$0.514/kWh
- 3x WEC 200kW
  - 44% Annual Wind Contribution
  - AU\$0.507/kWh





#### What Is PowerStore?

- PowerStore is a kinetic energy storage device
- PowerStore holds a small amount of energy for use at high power rates
  - 18MWs / 5kWh
  - +/-500kW per unit available now
- PowerStore is scalable
  - Add more units for more power and/or more energy





#### **PowerStore Concept**



- Modular Inverter Design to change kVA rating
- Fully Integrated with local or grid generation
- Highly dynamic performance with large power ratings
  - 500kW with sub-cycle performance
  - 100% of power available at any charge level



#### Features of PowerStore

- Stabilize power systems to allow higher renewable penetration
- Adds short-term spinning reserve to allow reduction of diesel running





#### Where to from here?

- Future of Power
   Generation Control
  - DCS Distributed
     Control System
- Higher Penetration Wind/Diesel Systems
  - "Smart Grid"
     Technology





#### **Distributed Control System**





**Distributed Control System** 

- Distributed Control System
  - Removes single points of failure from power station control systems
  - Ensures overall higher availability of plant
  - Generator and WEC controller "agnostic"
  - Extensible to meet site requirements
  - Enables "Smart Grids"
- Used at Ross Island





#### DCS – How Does it Work?





#### **DCS & Dealing with Disaster**

- All units can "see" information about all other units
- Information is published frequently – failures are announced in milliseconds
- Corrective actions are built into the firmware
  - Actions are generic by nature





#### Smart Grids

- What is a smart grid?
  - An interconnection of "smart" loads and generation
  - Loads can be scheduled on and off depending on capacity of generation
  - Generation can be scheduled depending on critical loads





#### Why do we need Smart Grids?

- Intelligent Scheduling of Loads
- Peak Demand Reduction
- Efficient and Controlled Integration of Distributed Generation





#### What Loads Can Be "Smart"?

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- Anything with storage, that can be interrupted or scheduled
  - Pumping potable water
  - Pumping sewage
  - Brine Tank Chillers
  - Electric In-Line Heaters
  - Heaters
  - Air-conditioners
  - Freezers

**Solahart** 

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#### **Smart Grids and Renewables**

- Use "Smart Grids" to increase renewable contribution
  - Move energy utilisation from times with no renewables, to times with peak renewables
  - Optimization of storage sizes depending on the pattern of usage and renewable availability





....Beyond 60% Renewable...

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- Long term energy storage
  - Hydro pumping
  - Battery accumulators

Air Fill

Valve

- Flow Batteries
- Compressed air



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#### Conclusion

- Coral Bay
  - High penetration
  - Grid quality power
  - Lowest cost operation
- Homer Modelling
  - Results verified within 2% of real system
- Powercorp DCS and "Smart Grids"
  - Will revolutionise remote area power systems

