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Environmental Markets

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Microgrids and Hybrids in Remote Environments

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Outline

- Australian experience
 - Hybrid systems
 - Bushlight
 - Larger Systems
 - Kings Canyon PV.
 - Western Australia wind – diesel grids
 - Remote Systems in general
 - CSIRO research...Agent based control of DG



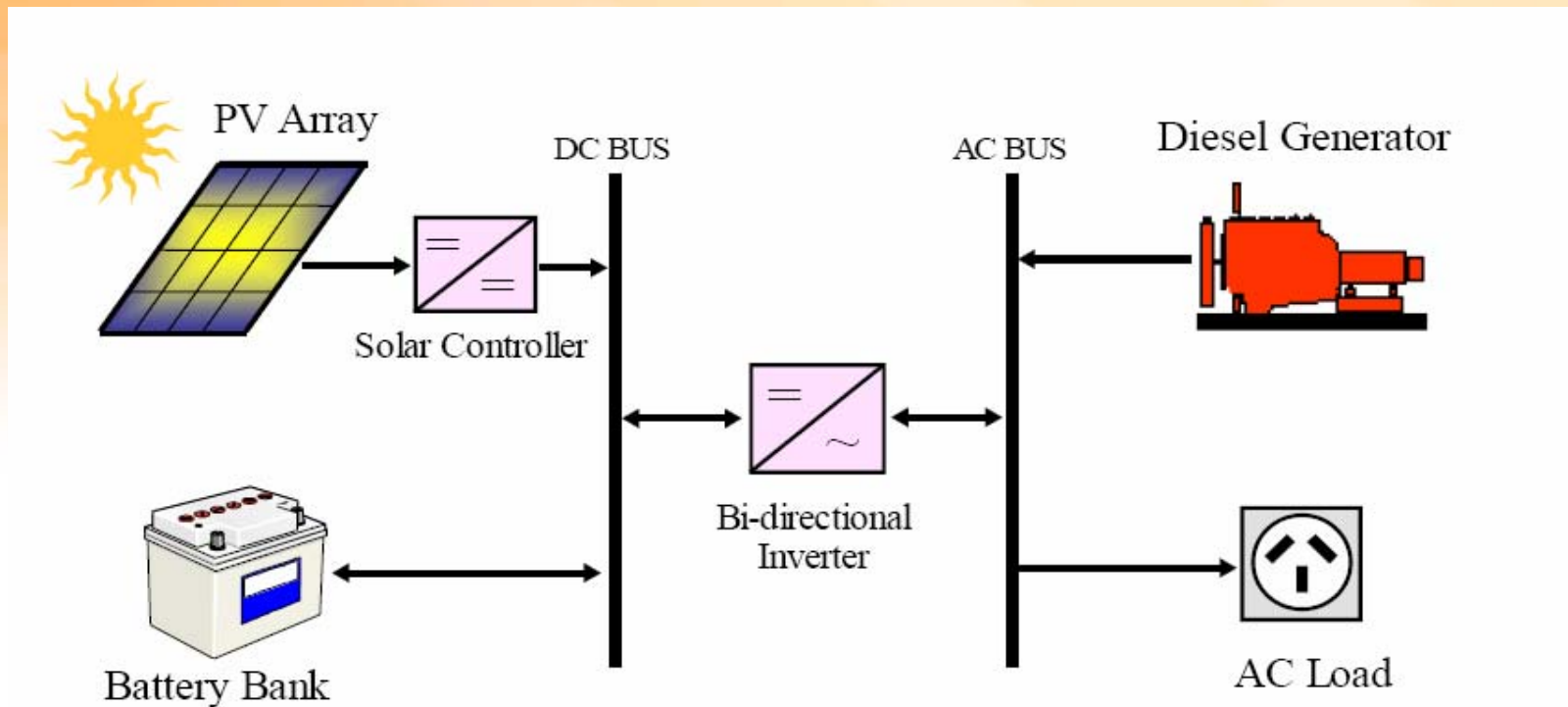


Australian Hybrids

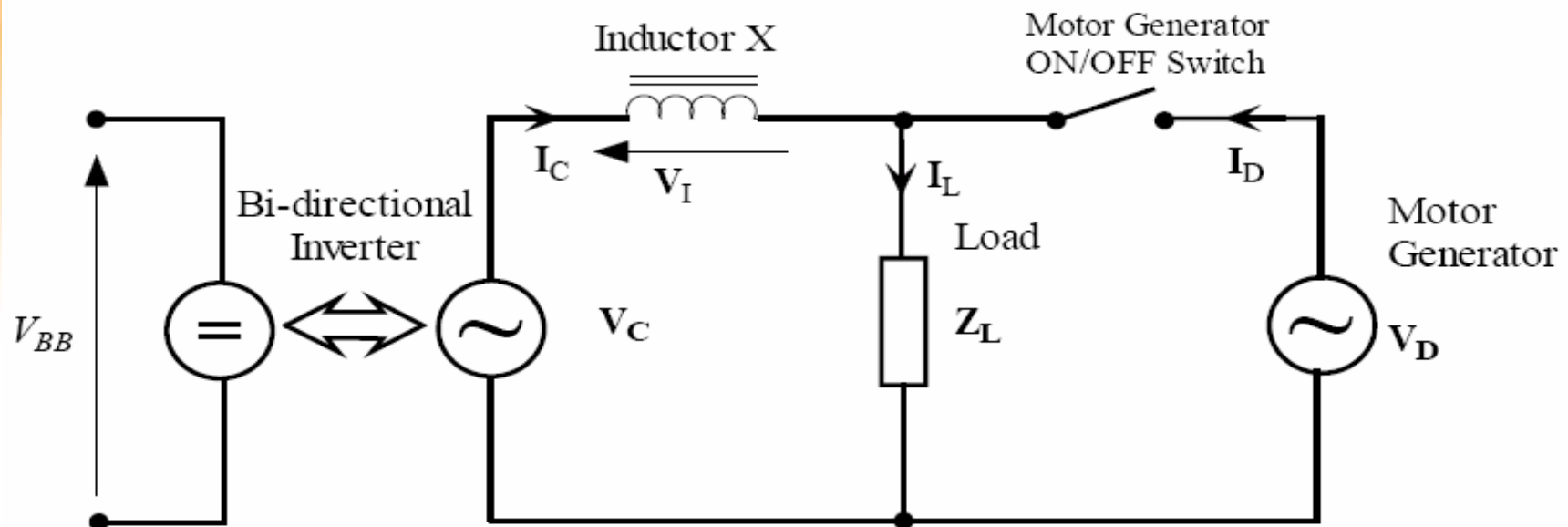
- Large mix of systems.
- Range of locations from coastal to very remote.
- Newer/larger Systems
 - Interactive Inverter Systems operating in parallel with diesel gensets.



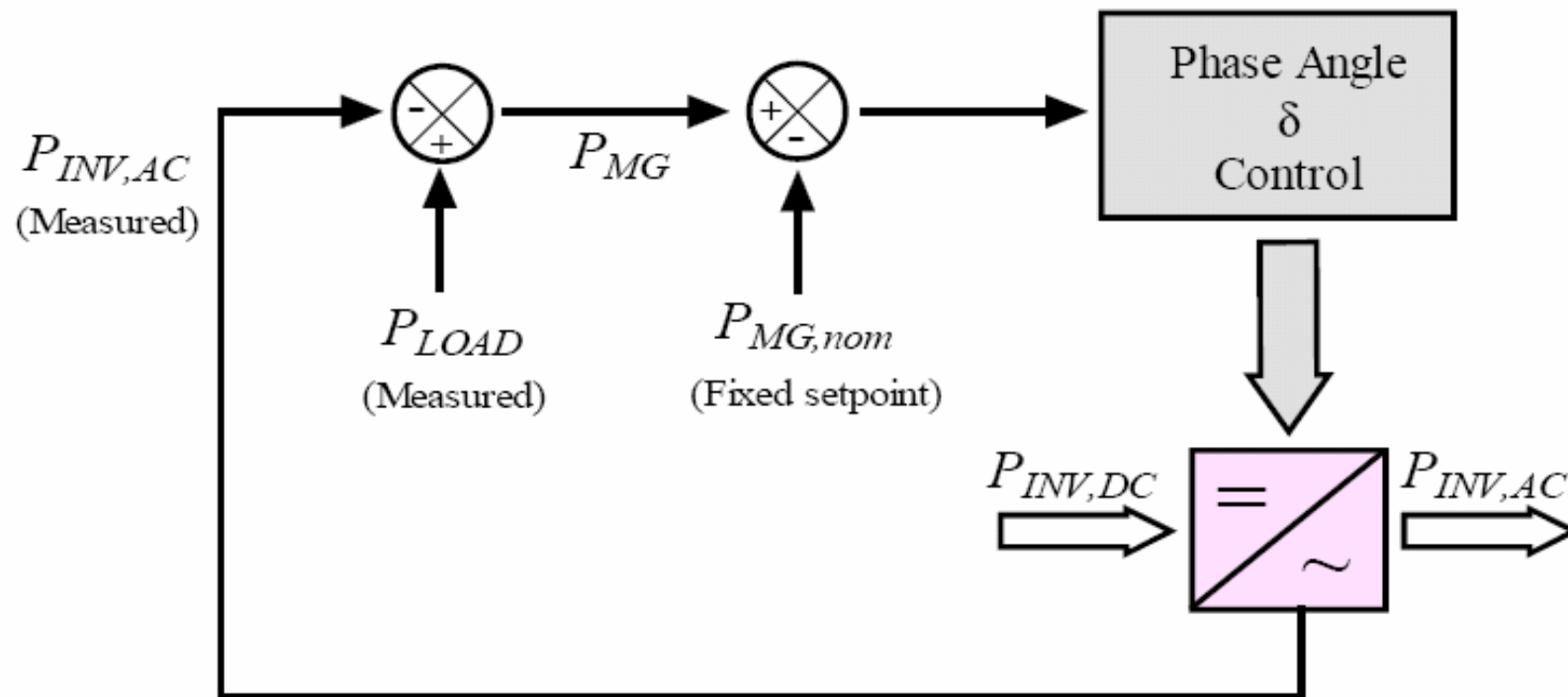
Typical Parallel configured system



Voltage source inverter



Simple local control





Bushlight

- Hybrid systems supplying Aboriginal Communities in Remote Australia.
- Single Hybrid system supplying a small community with multiple dwellings.

Bushlight

PO Box 8044,

Alice Springs 0871

AUSTRALIA

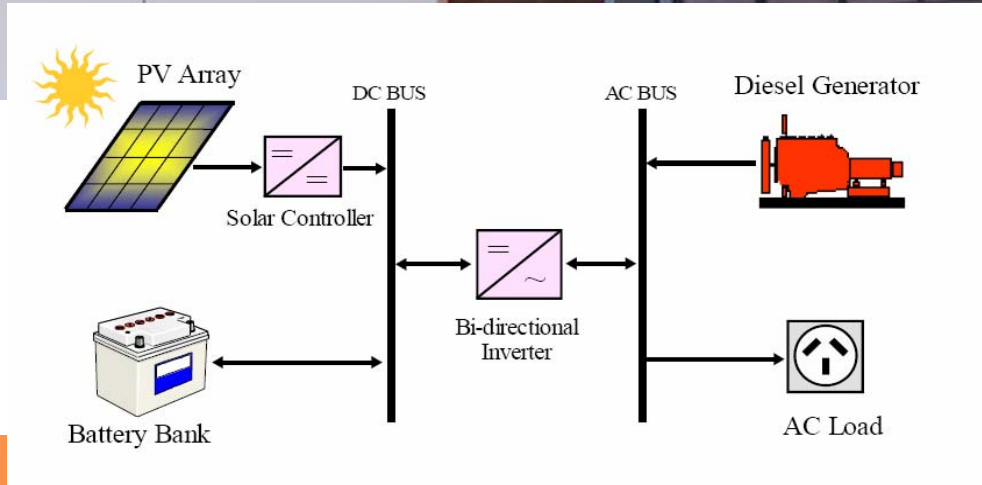
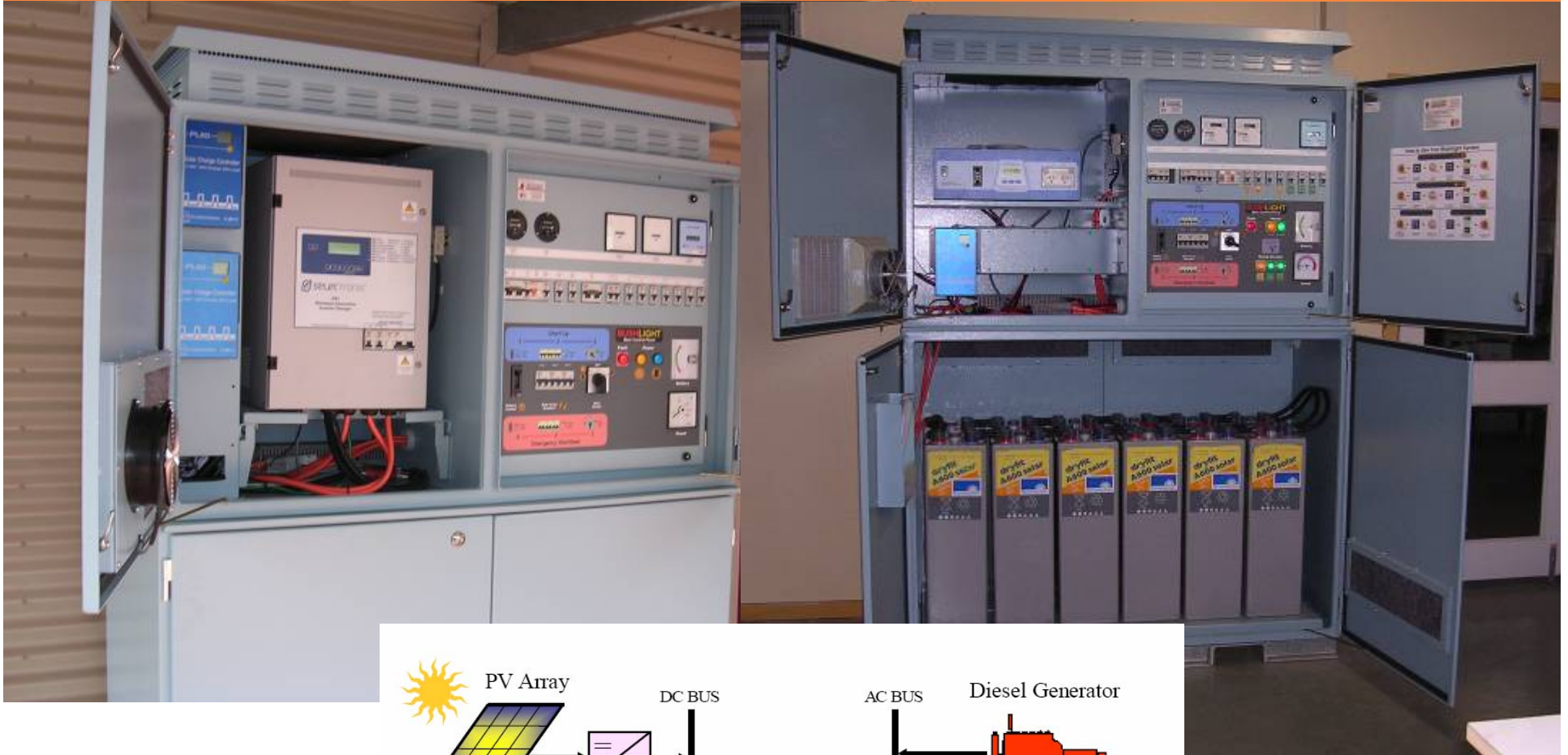
telephone: +61 8 8951 4344 fax: +61 8 8951 4333

Email: enquiries@bushlight.org.au

Web: <http://www.bushlight.org.au>









Larger Hybrid systems

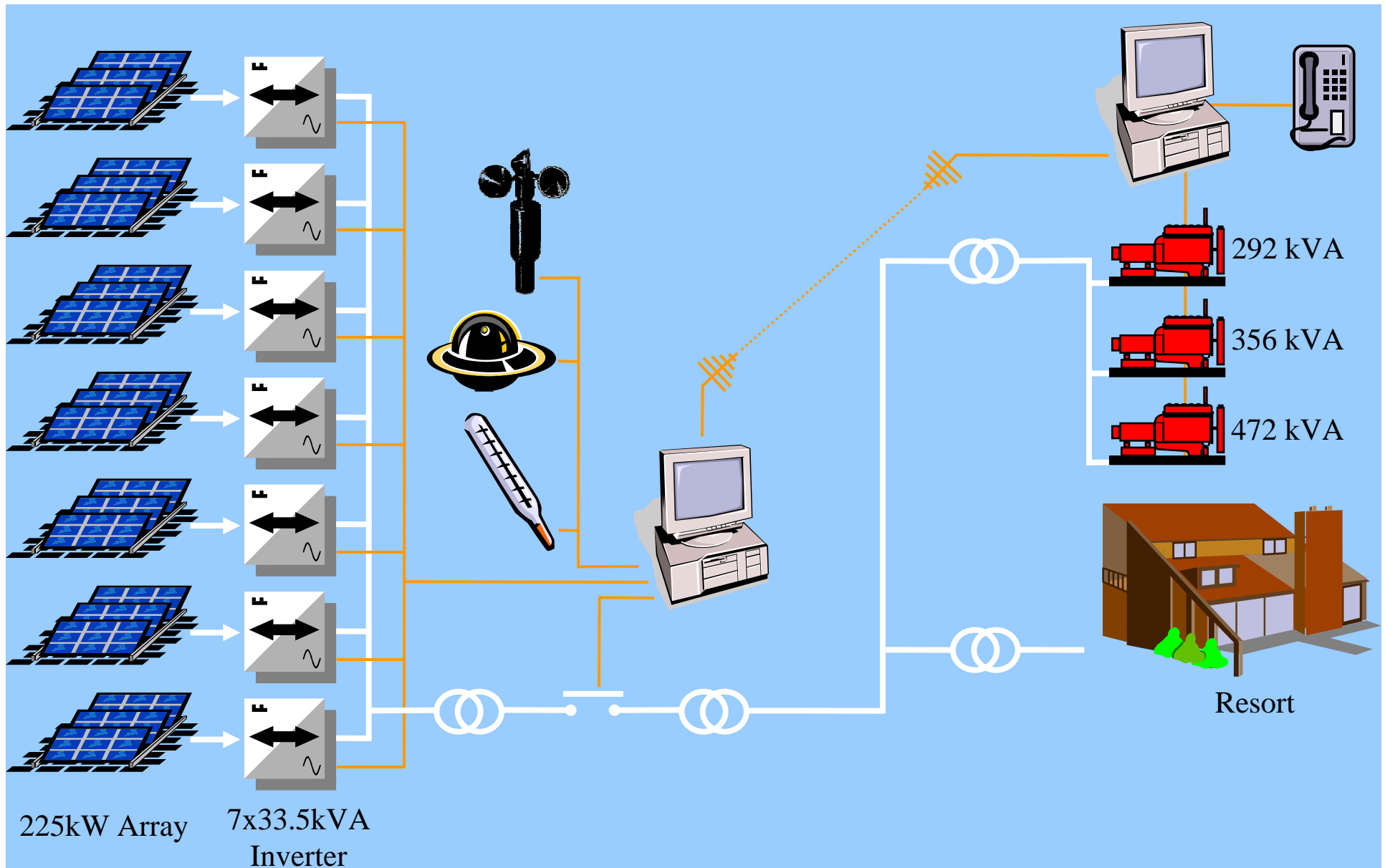
- Can be more distributed
- Control systems use:
 - frequency/voltage droop characteristics
 - Communication systems for overall control & emergency situations.

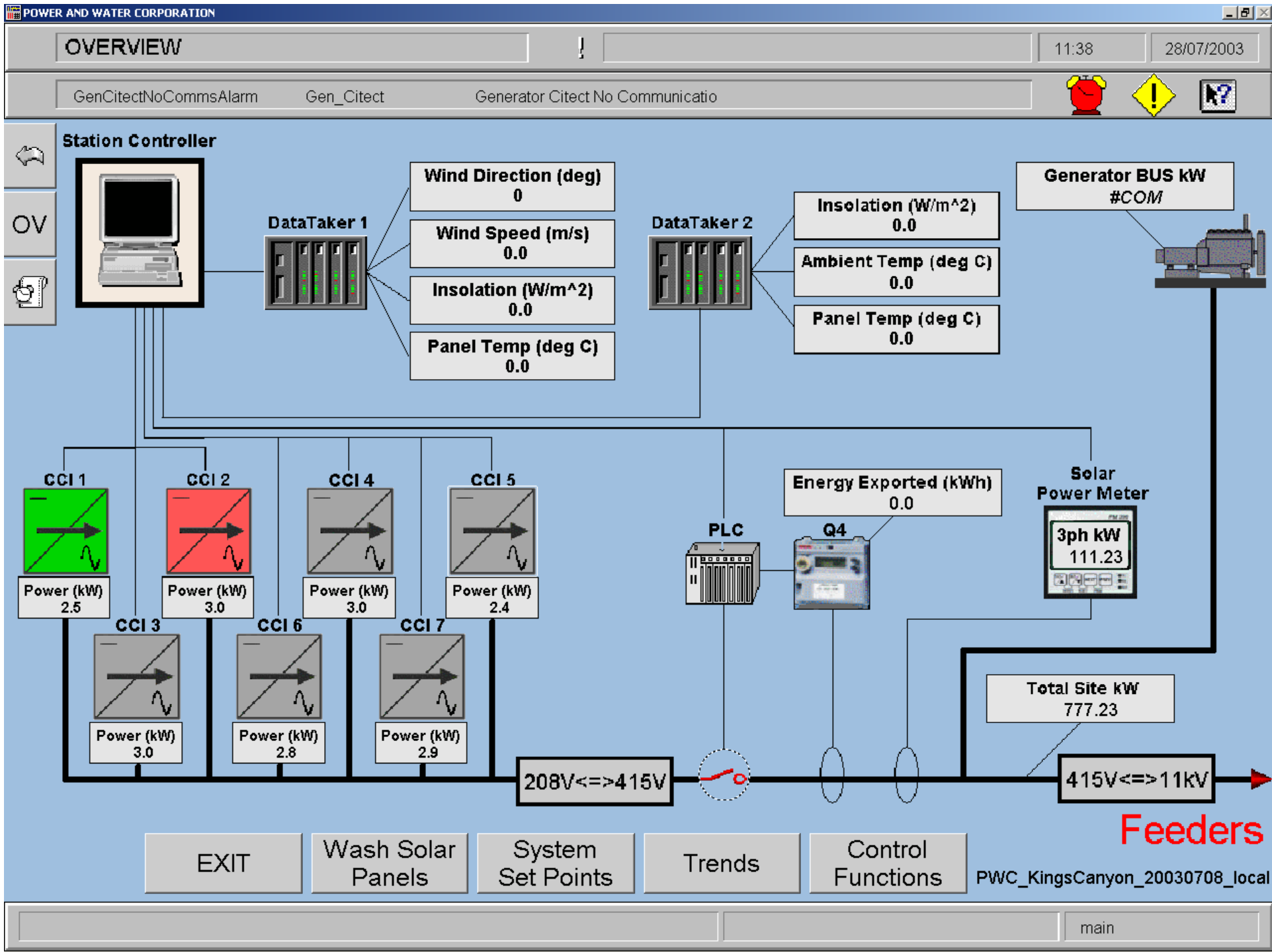
Kings Canyon

An aerial photograph of a solar farm in Kings Canyon. The solar panels are arranged in a grid pattern on a reddish-brown dirt area. The surrounding landscape is arid with sparse green shrubs and trees. A dirt road runs along the right side of the solar array. A small white building and a vehicle are visible near the top right corner of the solar panel area.

225kW PV Array
7 x 33.5kW Inverters

Kings Canyon Schematic





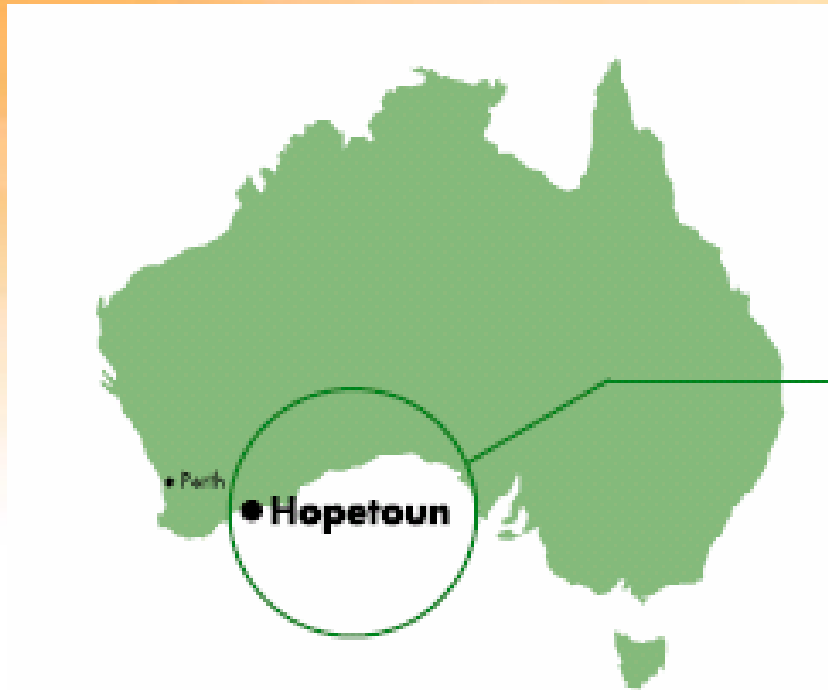


Wind Diesel Systems in Western Australia.

- **Denham**
- **Hopetown**
- **Bremmer Bay**



Hopetown Wind – Diesel System



Photos curtesy of D&WS
Diesel & Wind Systems (Perth)
www.daws.com.au





Hopetoun



1. The two new Low Load Diesels
installed at Hopetoun



2. The windturbine at Hopetoun

Photos curtesy of D&WS Diesel & Wind Systems (Perth) www.daws.com.au

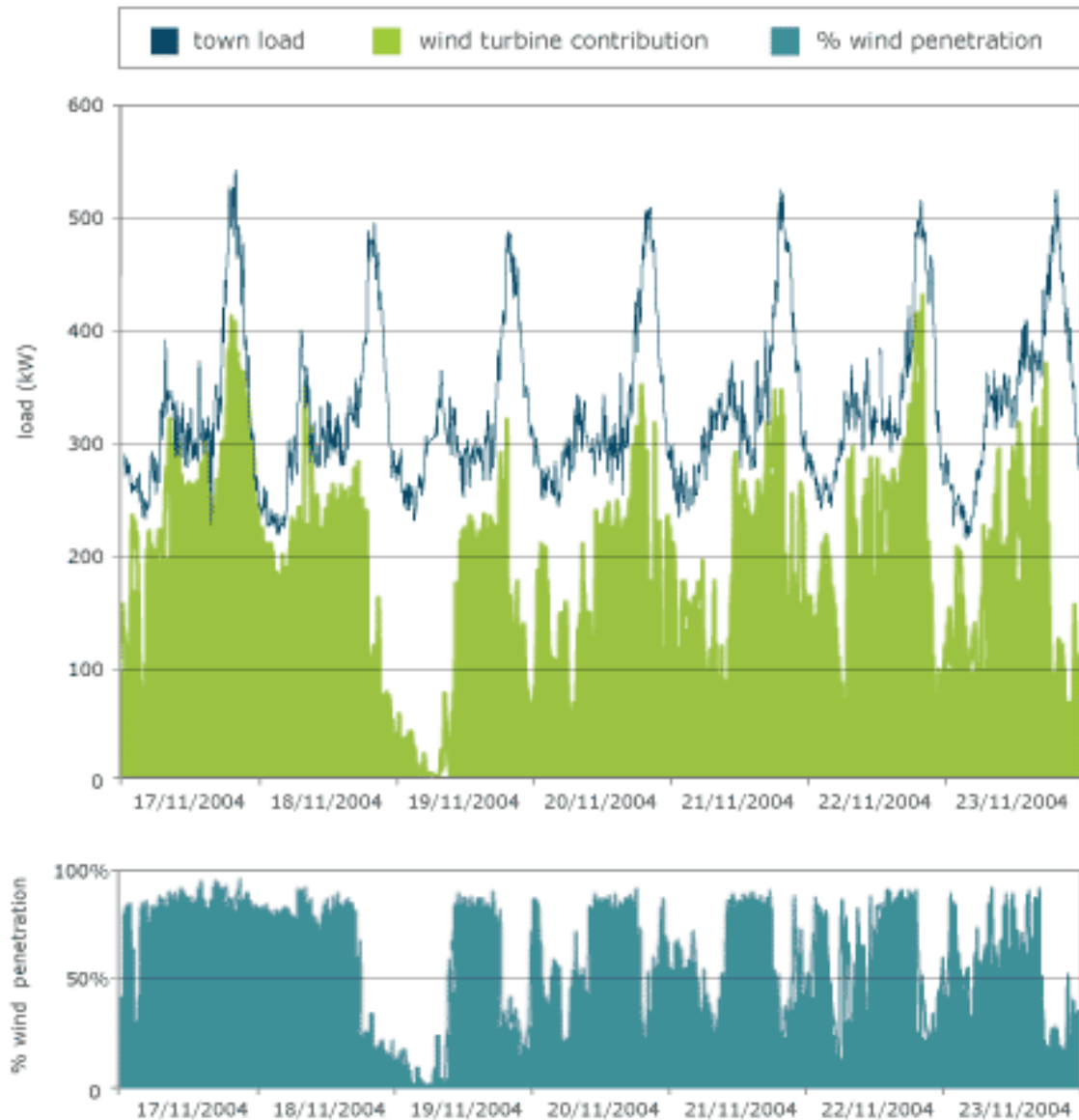


Hopetown

- 1 600kW Enercon E-40 wind turbine
 - Inverter connected turbine
 - 5km from diesel
- 2 320kW low load diesel generators
- Master system controller
- Two dynamic inverter controlled load dumps 16 sec rated.
- Fuel consumption without wind generator 980,000 litres/annum
- Fuel saving with wind generator expected to be 400,000 litres/annum



Hopetown - Wind Penetration



Graphs curtesy of D&WS Diesel & Wind Systems (Perth) www.daws.com.au



Remote systems are the hardest of all systems

- Long way away
- Harsh environment
- Difficult cultural issues
- Low funding
- Lack of education and training
- Need for quality systems
 - Reliability, Reliability, Reliability!
- IEC TC82...Standards on PV and Systems
 - IEC TC82-Joint working group JCWG
 - IEC 62257 Series “Recommendations for small renewable energy and hybrid systems for rural electrification”

MICROGRIDS - The Bad and the Ugly





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Microgrids in Remote Locations.

- Minigrids or microgrids have considerable potential application in developing countries
 - Need right social context
 - Need all other factors in place (Education & Training)
 - Need to get small systems working reliably first.

Distributed Energy in CSIRO Australia

www.ict.csiro.au

- A realistic solution to large-scale deployment of DE resources in the distribution network
 - To impact the Australian network in 3 – 8 years time
- Adaptive, intelligent, distributed agents for various applications
 - Local end-use optimisation
 - Aggregation for network benefits
- A communications infrastructure
 - Communicating over the internet at least initially
- A new set of features in the Australian NEM
- Our **assumption** is that part of the growing supply-demand gap in Australia will be filled by Distributed Energy units
 - placed close to load centres
 - at connection levels where SCADA is not cost effective
 - and does not have enhanced functionality

One Framework, Many Applications

www.ict.csiro.au

Application	Benefit
Demand-side management for a retailer's customers	Manage risk of exposure to wholesale prices
Island management for a distribution business	Defer capital expenditure on enhanced lines
Virtual generator harnessing geographical & technological diversity	Create a new business and encourage uptake of DG

The Agent Mindset

www.ict.csiro.au

Agents run on local devices and measure,
make decisions, and act in the real world

- Local control is good for:
 - Robustness
 - Scalability
 - Consumer acceptance
- Contrast with SCADA:
 - Prohibitively expensive to extend to consumer level
 - Top-down control is not scalable and sometimes not desirable
 - **Opportunity**: agents can be a last-mile solution



We're using PDAs
for demo systems

Plus “tiny agents”
(motes) to gather
fine-grained data

Framework equally
applicable to server-
based applications

Key Technologies

www.ict.csiro.au

- Coordinating a set of loads and generators to achieve both local and system goals
 - Local goals typically cost effectiveness
 - System goals involve aggregated response
 - Requires local modelling (by an agent) of capabilities and constraints of loads and generators
- Scalable and timely aggregation of distributed capacity across 10^4 , 10^5 , 10^6 , ... consumers
 - System response > 30 MW in order of minutes with communication delays in order of seconds
- BREAKTHROUGH WE AIM AT: **demonstrating emergent behaviour to a desired outcome**
 - Complex systems techniques: decentralised clustering, dynamic hierarchies, scale-free or small-world networks

What's Happening Now

www.ict.csiro.au

- Writing an agent-based software framework
 - Joint project with Infotility (Boulder / San Francisco)
 - Alpha release presently under test
 - Creating a uniform agent environment and a reliable platform across a diverse set of devices
- Developing multi-agent coordination algorithms
 - Focus: coordination in 04/05 and scalability in 05/06
- Demonstrating in hardware at Newcastle, Australia
 - Cooperating loads and generators in June/July
- Embarking on a trial with an industry partner
 - We won't do front-end deployment ourselves
- Looking for commercial partners in 05/06

DER Agent Demonstration in Newcastle

www.ict.csiro.au

- Heating/cooling loads
 - Two cool rooms
 - One HVAC zone
- Distributed generation
 - Microturbine
 - Three photovoltaic arrays
 - Wind turbine
- Weather station
- Information sources
 - Market data
 - Weather forecasts





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Thank you