www.csiro.au

Microgrid Research in Australia

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CSIRO

CSIRO today: a snapshot

- Australia's national science agency
- One of the largest and diverse in the world
- Ranked in top 1% in 13 research fields
- Internationally recognised staff
- Award winning talent
- Building national prosperity & wellbeing

CSIRO

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Commonwealth Scientific and Industrial Research Organisation

From Wikipedia, the free encyclopedia

(Redirected from CSIRO)

The **Commonwealth Scientific and Industrial Research Organisation** (**CSIRO**) is the national government body for scientific research in Australia. It was founded in 1926 originally as the Advisory Council of Science and Industry.

Research highlights include the invention of atomic absorption spectroscopy, development of the first polymer banknote, invention of the insect repellent in Aerogard and the introduction of a series of biological controls into Australia, such as the introduction of Myxomatosis and Rabbit calicivirus which causes rabbit haemorrhagic disease for the control of rabbit populations. CSIRO's research into ICT technologies has resulted in advances such as the Panoptic Search Engine[1] (now known as Funnelback) and Annodex[2].

Recently, CSIRO has been actively defending its patent[3] for the use of wireless technologies which are a standard for many modern day laptops. A class action has been filed by US corporations Microsoft, Apple and Dell to renege on paying royalties on the wireless patent filed by CSIRO in 1996.

In October 2005 the journal *Nature* announced that CSIRO scientists had developed near-perfect rubber from resilin, the elastic protein which gives fleas their jumping ability and helps insects fly.[4] On 19

Commonwealth Scientific and Industrial Research Organisation

CSIRO

Agency overview

Formed	1926
Jurisdiction	Commonwealth of Australia
Headquarters	Canberra, Australian Capital Territory, Australia
Employees	6600+

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Where are we?


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NORTHERN TERRITORY
QUEENSLAND
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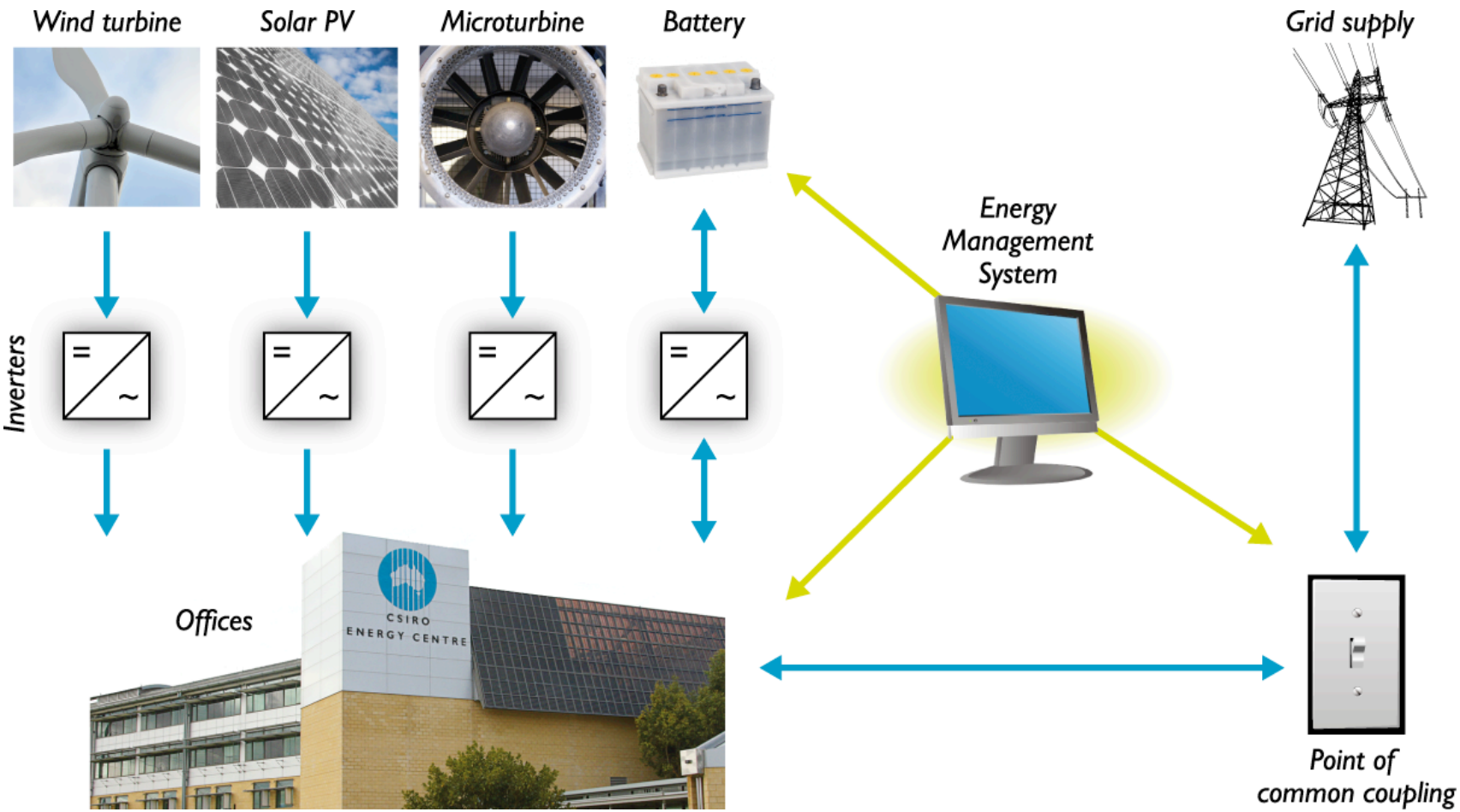
NEW SOUTH WALES
Newcastle
A.C.T.
SYDNEY
ADELAIDE
VICTORIA
MELBOURNE
TASMANIA
HOBART

CSIRO Energy Centre

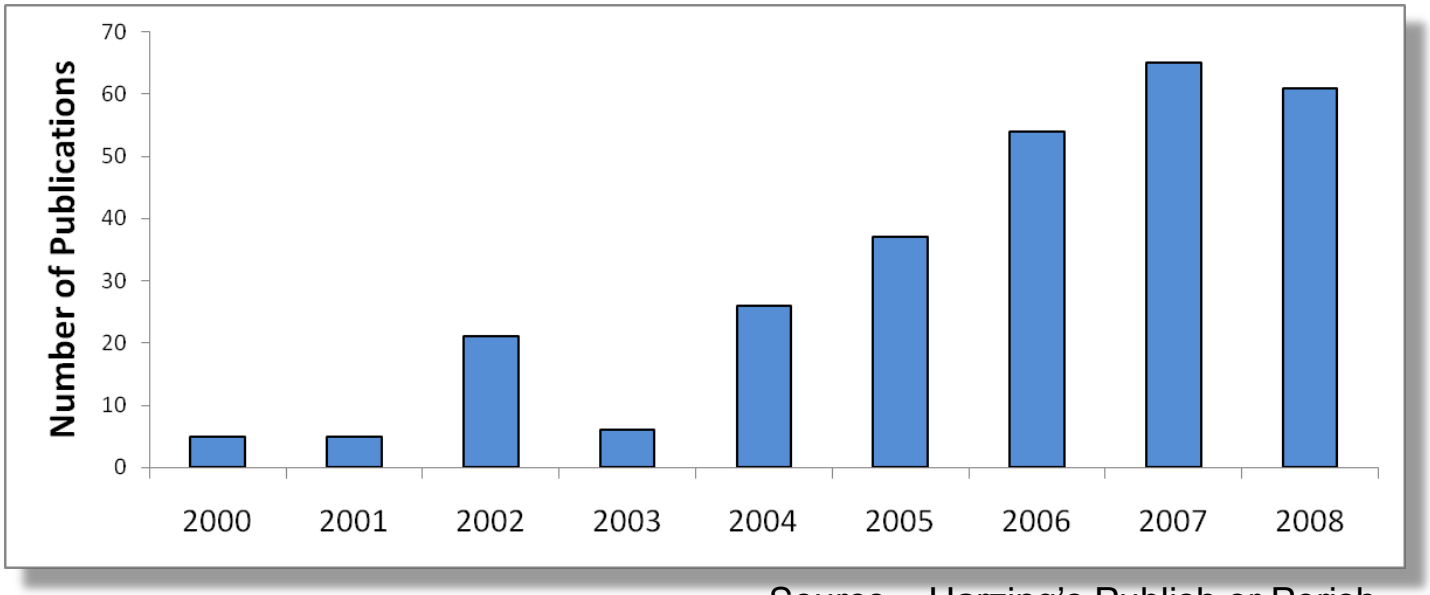
Microgrid at CSIRO Energy Centre, Newcastle



Why are Microgrids important?

- Before 2015, *Pike Research* forecasts that over 3.1GW of new Microgrid capacity (1m homes) will come online worldwide, representing a total market value of $7.8 billion.
- Utilities beginning to embrace Microgrids rather than viewing them as a threat.

Source: Smart Grid News, Oct 29, 2009

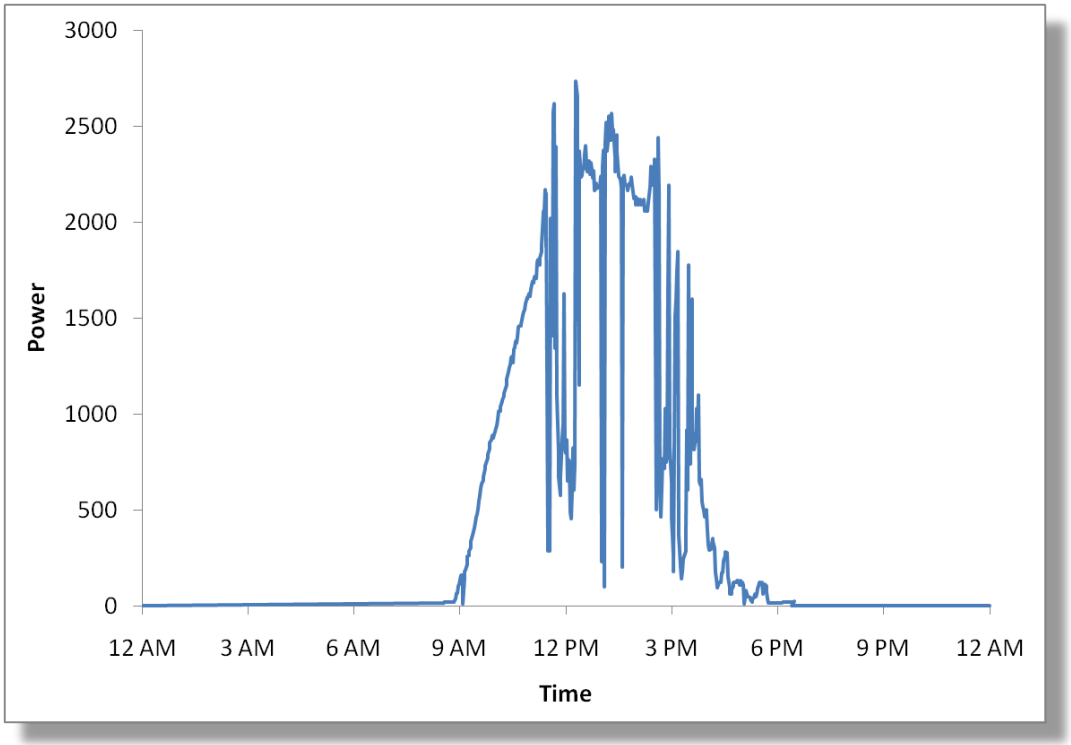


Source – Harzing's Publish or Perish

What are the expectations?

- We would like microgrids to:
  - Provide power security (military)
  - Provide reliability (manufacturing)
  - Incorporate high renewable penetration
  - Have neutral or good effect on network
  - Be “turnkey” and “plug and play”
  - Be cost effective

What are the challenges?

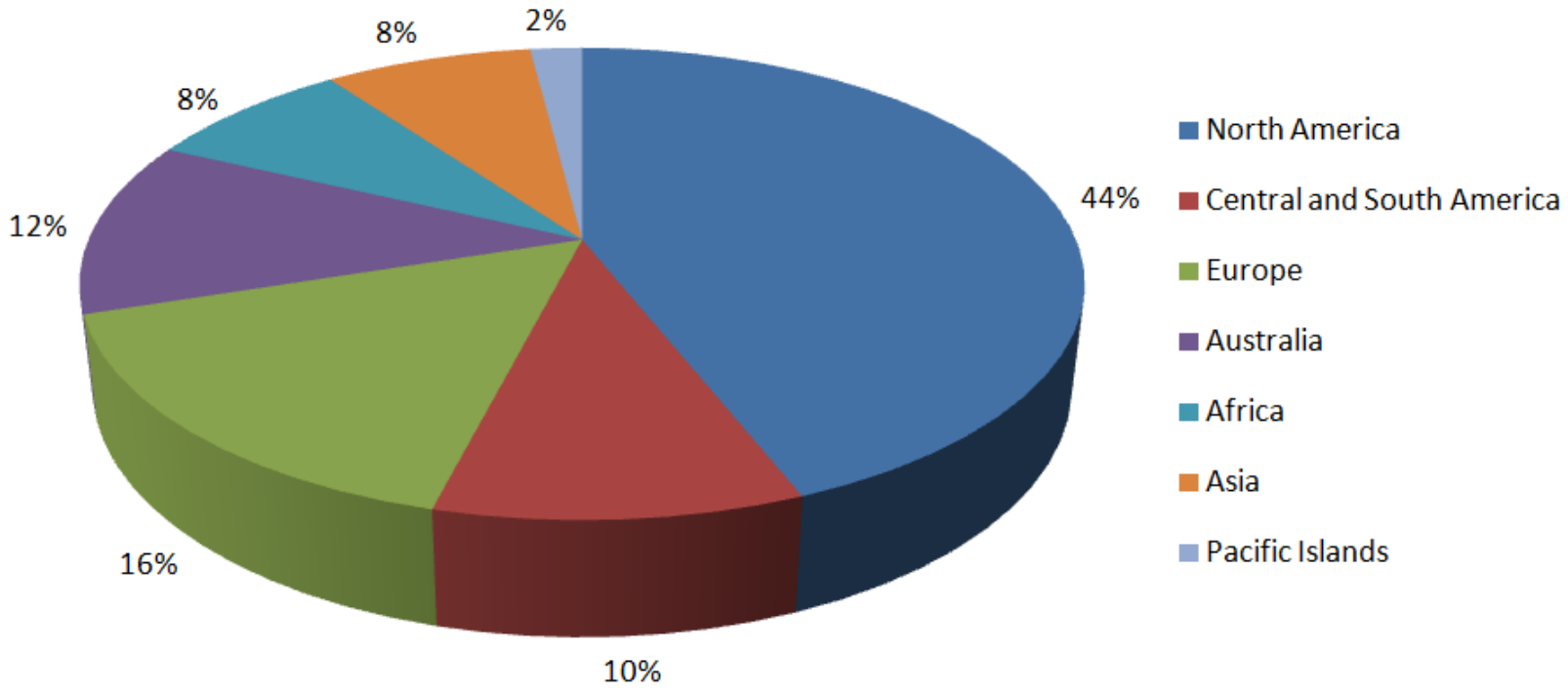


- Control – reliable power from intermittent sources
- Planning – the best mix of PV, wind, diesel, battery etc.
- Cost – is it really worth it?
- Protection – how to handle faults

Taming renewables - solutions

- Mix different types – solar, wind, gas cogen.
- Load prioritisation and shedding
- Storage – batteries, supercaps, flywheels
- Use smart techniques:
  - Forecasting
  - Weather data
  - Optimisation of loads & generation

Where are all the microgrids?



- Australia has a significant number for its population size – why?

Why does Australia like Microgrids?

Location	Purpose	Renewables
CSIRO, Newcastle, New South Wales	Experimental	110kW PV
Kings Canyon, Northern Territory	Tourism	225kW PV
Coral Bay, Western Australia	Isolated	825kW wind
Bremer Bay, Western Australia	Isolated	660kW wind
Denham, Western Australia	Isolated	920kW wind
Esperence, Western Australia	Isolated	3600kW wind
Hopetoun, Western Australia	Isolated	1200kW wind
King Island, Tasmania	Isolated	110kW solar
Rottnest Island, Western Australia	Tourism	600kW wind

Microgrids in the future grid

"It wasn't that long ago that microgrids were commonly thought of in the utility industry as negatives: They were supposedly unsafe. And worse, they were competition. But it looks like more utilities and other industry players see them as critical building blocks that will help ensure the efficiency and reliability of the Smart Grid."

•- Are We Taking Microgrids Seriously — Finally?
www.smartgridnews.com Feb 18, 2010

How can microgrids help the network? Some scenarios:

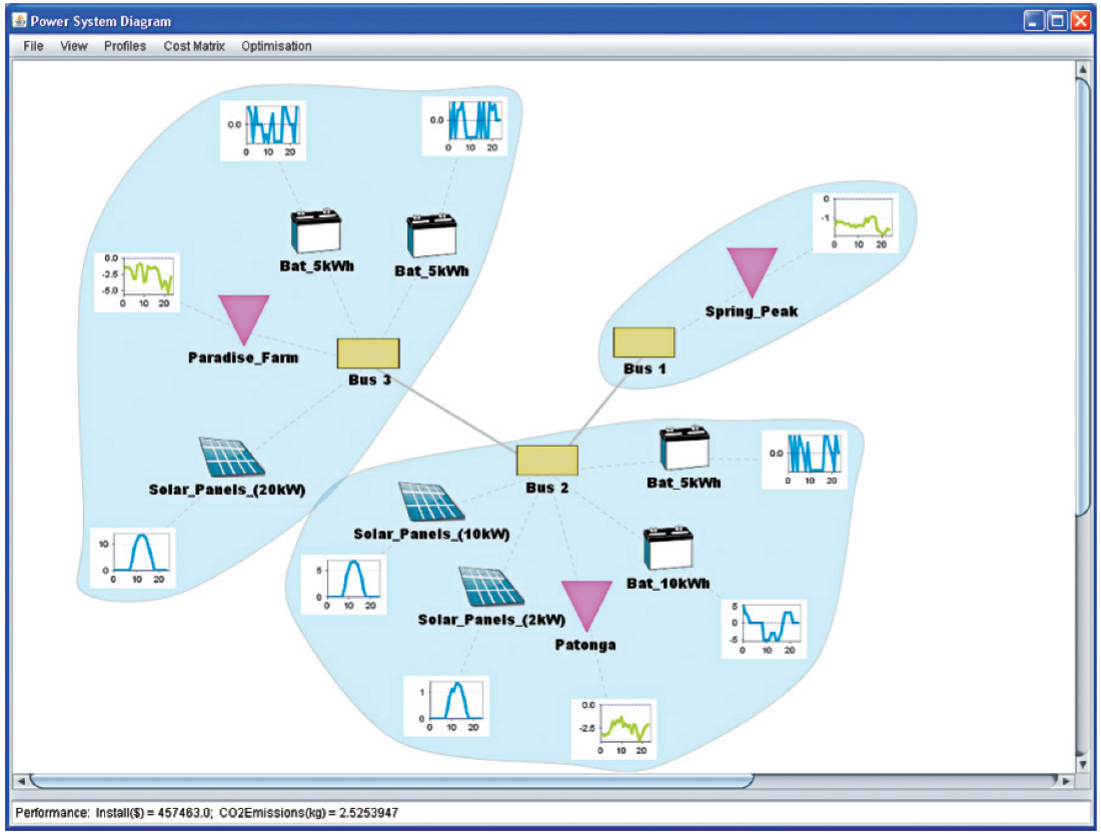
1. Microgrid operated independent of utility:
   - Appears as regular load, but more intermittent because of renewable energy sources
   - Stability issues worse
2. Microgrid controlled by utility
   - Signal from utility to curtail load
   - Renewable problem remains, but its Microgrid operators problem
3. A mixture of both
   - Time of use tariffs
   - Depends on good local control of Microgrid
   - Solution is a compromise between cost and technical limits

What is our path and target?

- Goal #1: Microgrids will have high renewable penetration
  - Better design through the use of AI for planning
  - Improved operation (load shedding, battery dispatch) using AI
  - Incorporate weather forecasting using AI
  - New options for protection systems
- Goal #2: Microgrids will be part of the Smart Grid
  - Simulation of effects of multiple microgrids on distribution system
  - Apply game theory to understand how microgrids might “play” the tariff structure, within their own constraints

Current work on Microgrids – Planning Tool

- Issues:
  - What generation?
  - Where?
  - Batteries?
  - Use of heat?
- Optimisation:
  - Installation cost
  - Maintenance cost
  - CO_2 emission
  - Electrical losses

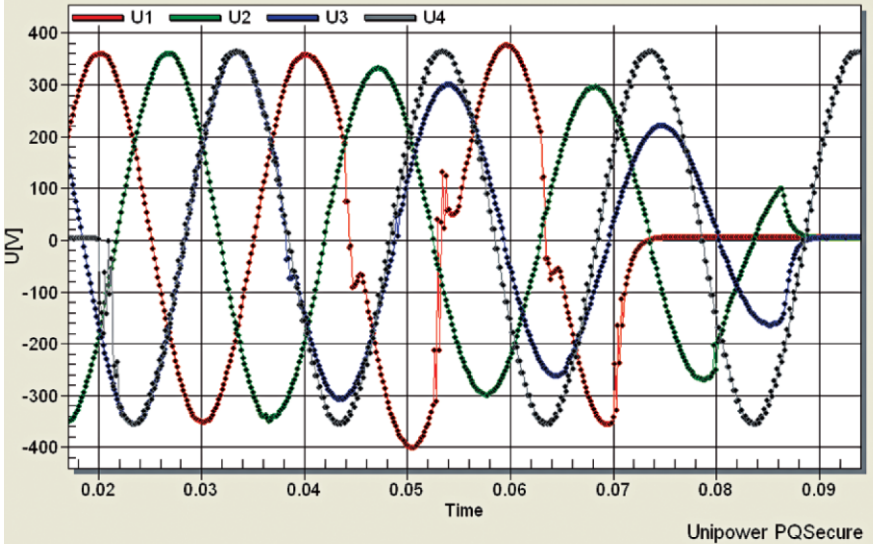


Current work on Microgrids – Control

- Electrical energy is difficult (or expensive) to store
  - supply must match consumption
- Conventional grid:
  - Amount of generation is changed to suit load
  - Many sources and consumers – fine-grained
- Microgrid:
  - Time-varying nature of renewables
  - Load can be adapted to suit generation
  - Few sources and consumers – coarse-grained
  - Use frequency and voltage, or rely on high-speed data communications?
  - Prediction of generation (weather data)
  - Prediction of load (customers habits)
  - Amount and type of storage

Current work on Microgrids – Control

- How do inverters interact?
- Response to sag and flicker?



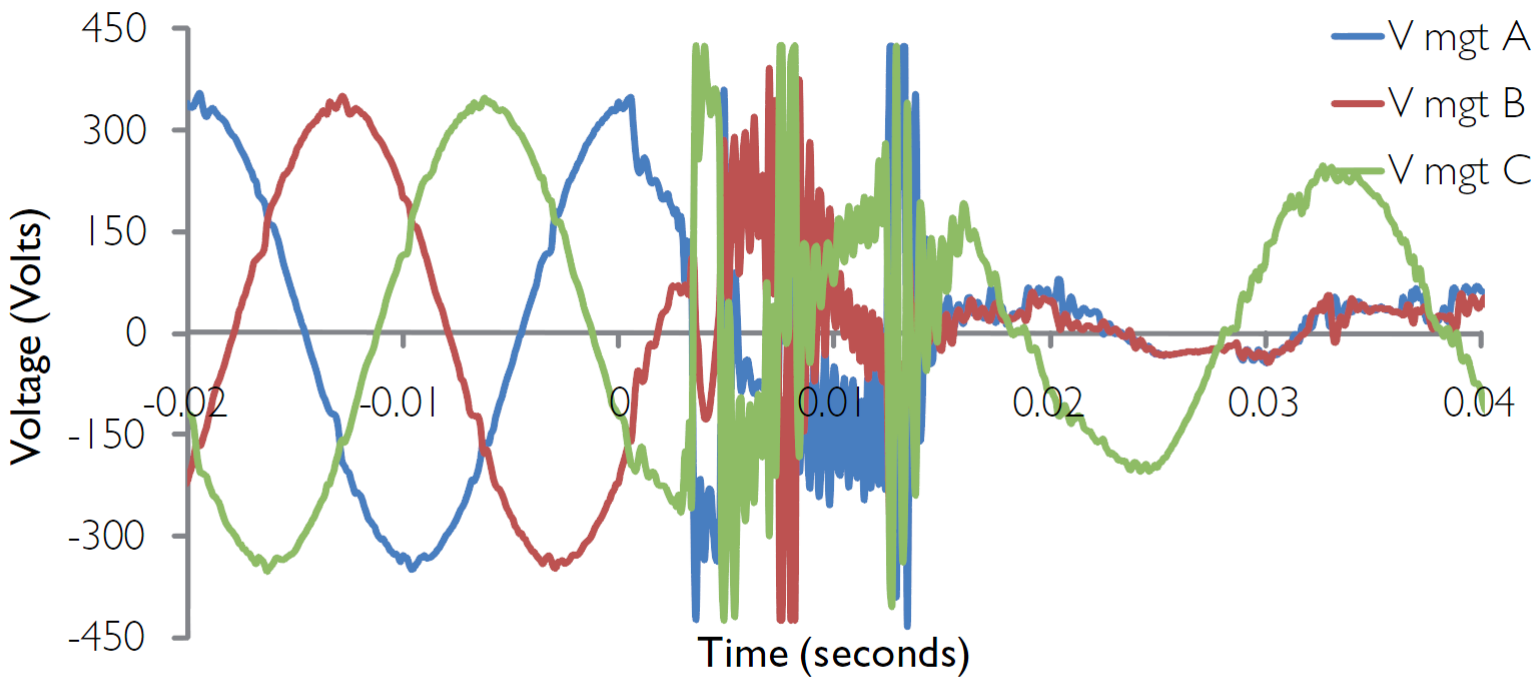
Current work on Microgrids – Protection

- Conventional grid:
  - Short circuit leads to large currents flowing
  - Detect this and open switches to isolate

- Microgrid:
  - Larger fault currents when grid connected
  - Smaller fault currents when islanded
  - Difference may not be detected – more data needed
  - Frequency changes, rate of change, harmonics
  - Characterise normal operation, use pattern recognition / AI
  - How to detect with minimum sensors

Current work on Microgrids – Protection

- What types of electrical fault occur in a Microgrid?
- Are they the same as those in a grid – connected site?
- How can faults be distinguished from benign phenomena?



Future Microgrid Challenges

- How to extend Microgrid research into the distribution (utility) grid:
  - Microgrids as a low cost, low risk entry point into the “smart grid”
  - Our experimental facilities as testing ground for the “smart grid”
- Challenges:
  - Improve control of electrical properties of the grid
  - Incorporate more renewable energy

CSIRO microgrid laboratory

CSIRO microgrid laboratory