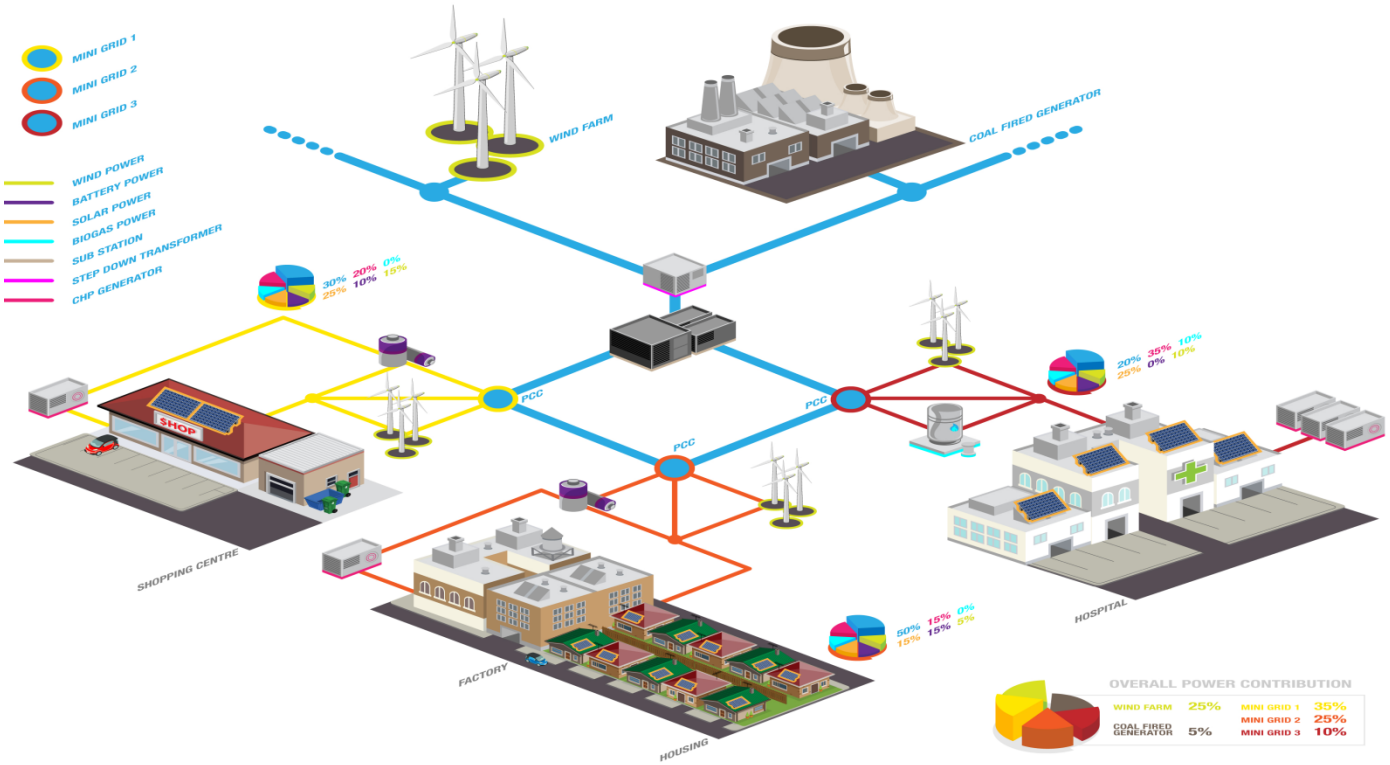
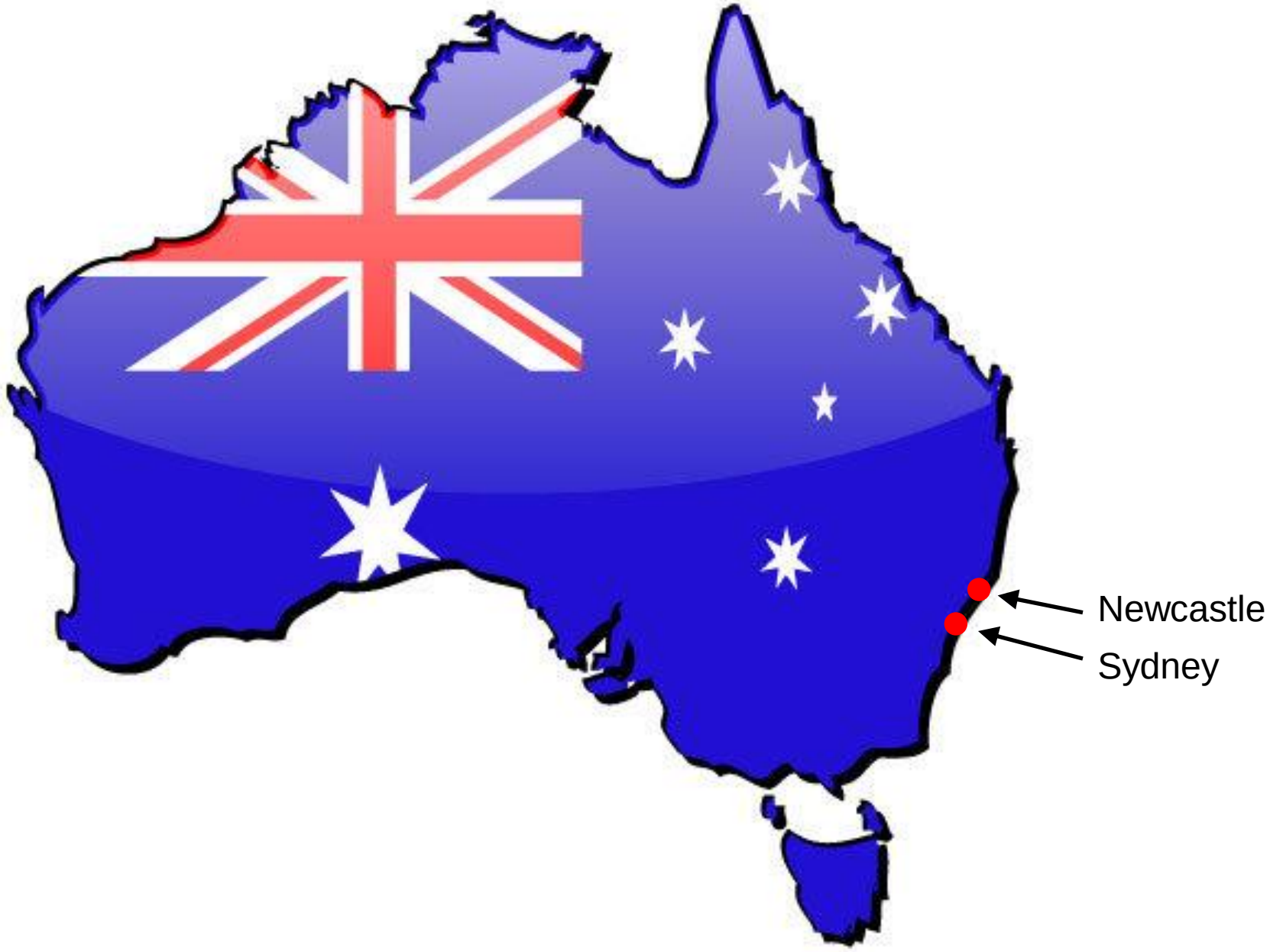


Minigrids- Are We Serious?

Glenn Platt
CSIRO Energy Technology
Australia

www.csiro.au


Newcastle
Sydney

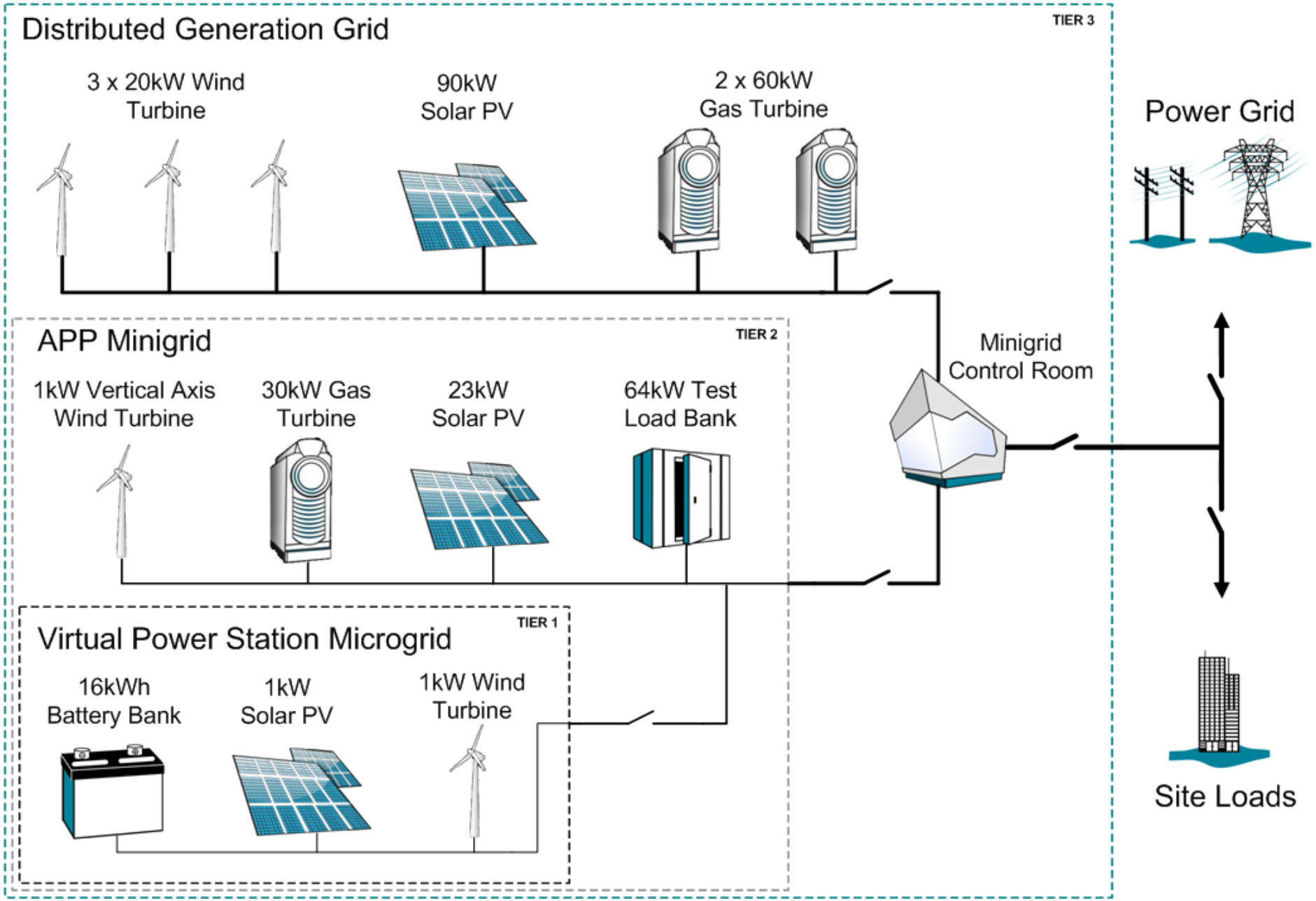
CSIRO work on Minigrids

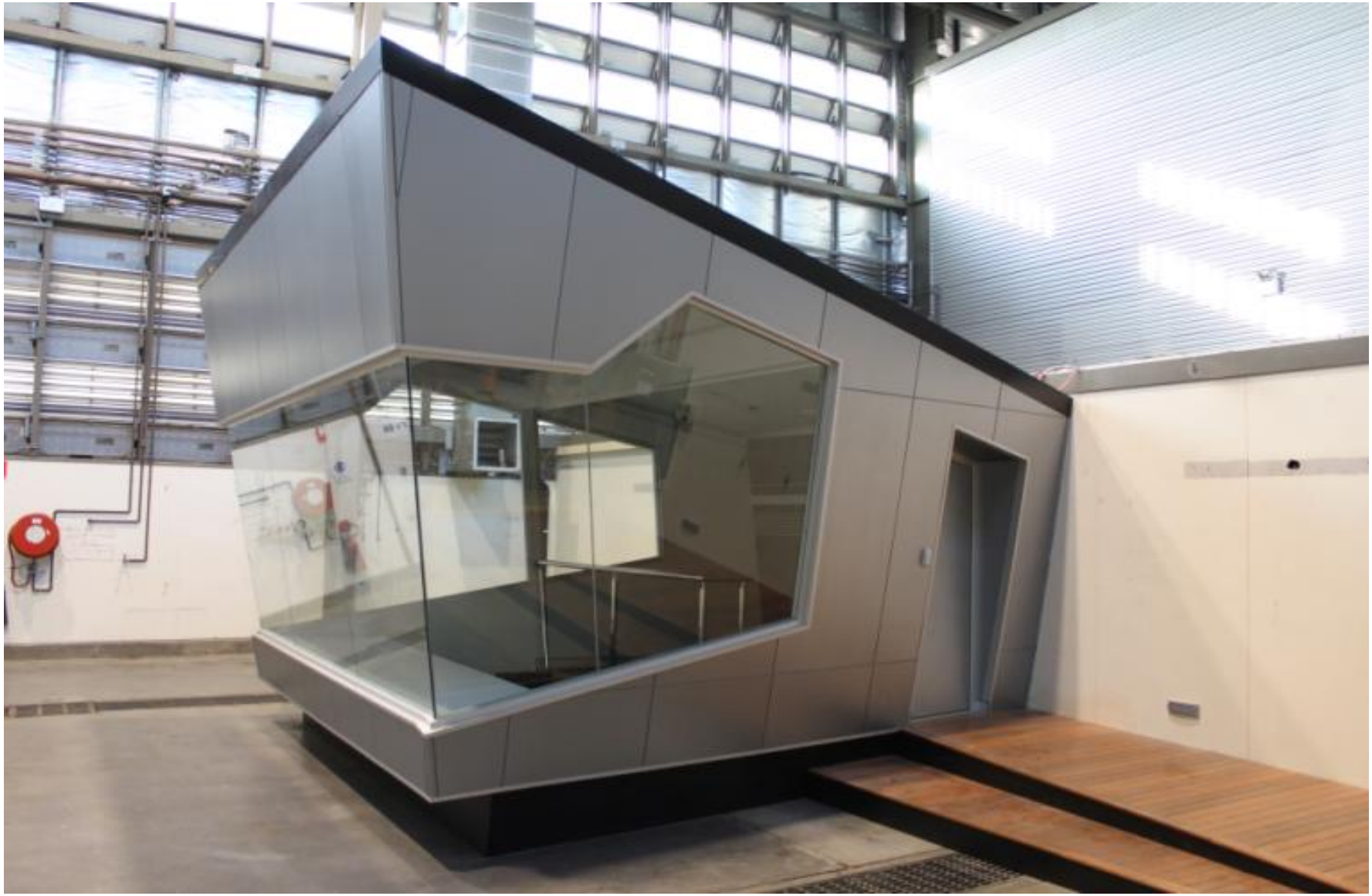
- Microgrid planning tools using GA
- Microgrid dynamic systems modelling & control
- Load demand forecasting using AI
- Demand side management
- Intelligent sensor networks

GA - Genetic Algorithms

AI - Artificial Intelligence

HVAC - Heating, Ventilation and Air Conditioning


Distributed Generation Grid
TIER 3
3 x 20kW Wind Turbine
90kW Solar PV
2 x 60kW Gas Turbine
Power Grid
APP Minigrid
TIER 2
1kW Vertical Axis Wind Turbine
30kW Gas Turbine
23kW Solar PV
64kW Test Load Bank
Minigrid Control Room
Virtual Power Station Microgrid
TIER 1
16kWh Battery Bank
1kW Solar PV
1kW Wind Turbine
Site Loads



Current Work

- Islanding with minimal storage
  - No reciprocating engine
  - Multiple power electronics
  - Inverters *evolve* control
- Sensor minimal fault detection
- Generation & load forecasting then matching
  - Black box learning
  - Multi agent coordination

Background

"The world is not on course to achieve a sustainable future"

- Intergovernmental Panel on Climate Change (IPCC) (Working Group Three), Climate Change 2007 - Mitigation. 2007, IPCC

Background

A single cascading blackout in the United States left fifty million people “surviving in a darkened, dangerous, hobbled economy”

- C. Marnay and O. C. Bailey, The CERTS Microgrid and the Future of the Macrogrid, in ACEEE Summer Study on Energy Efficiency in Buildings. 2004: Pacific Grove, California.

Background

The supreme engineering achievement of the 20th century is aging, inefficient and congested, and incapable of meeting… future energy needs… without operational changes and substantial capital investment”

- United States Department of Energy, Grid 2030: A National Vision for Electricity’s Second 100 Years. 2003, United States Department of Energy - Office of Electric Transmission & Distribution: Washington.

Planning of Minigrids

- Many options, and some are competing:
  - Choice of generation types
  - Choice of unit size
  - Placement of generation units
  - Amount and type of storage
- Many measures of success:
  - Reduce installation cost
  - Reduce CO_2 emissions
  - Reduce electrical line losses
  - Maximize waste heat usage

What is the solution?

- Artificial intelligence techniques:
- Optimization Types
  - Particle Swarm Optimization
  - Fuzzy Systems
  - Evolutionary Algorithms
  - Simulated Annealing

What is wrong with these solutions?

- A lack of easily accessible tabulated results
- Details of real-world load and generator details
- An absence of well-defined test problems
- Insufficient knowledge of contemporary comparative metrics
- A lack of standards for communication of problems and results

What is wrong with these solutions?

- Contemporary studies have:
  - failed to explore a diverse set of problems
  - lack analytical rigour
  - offer scant comparison between approaches
  - often fail to use models based on real-world loads or generators

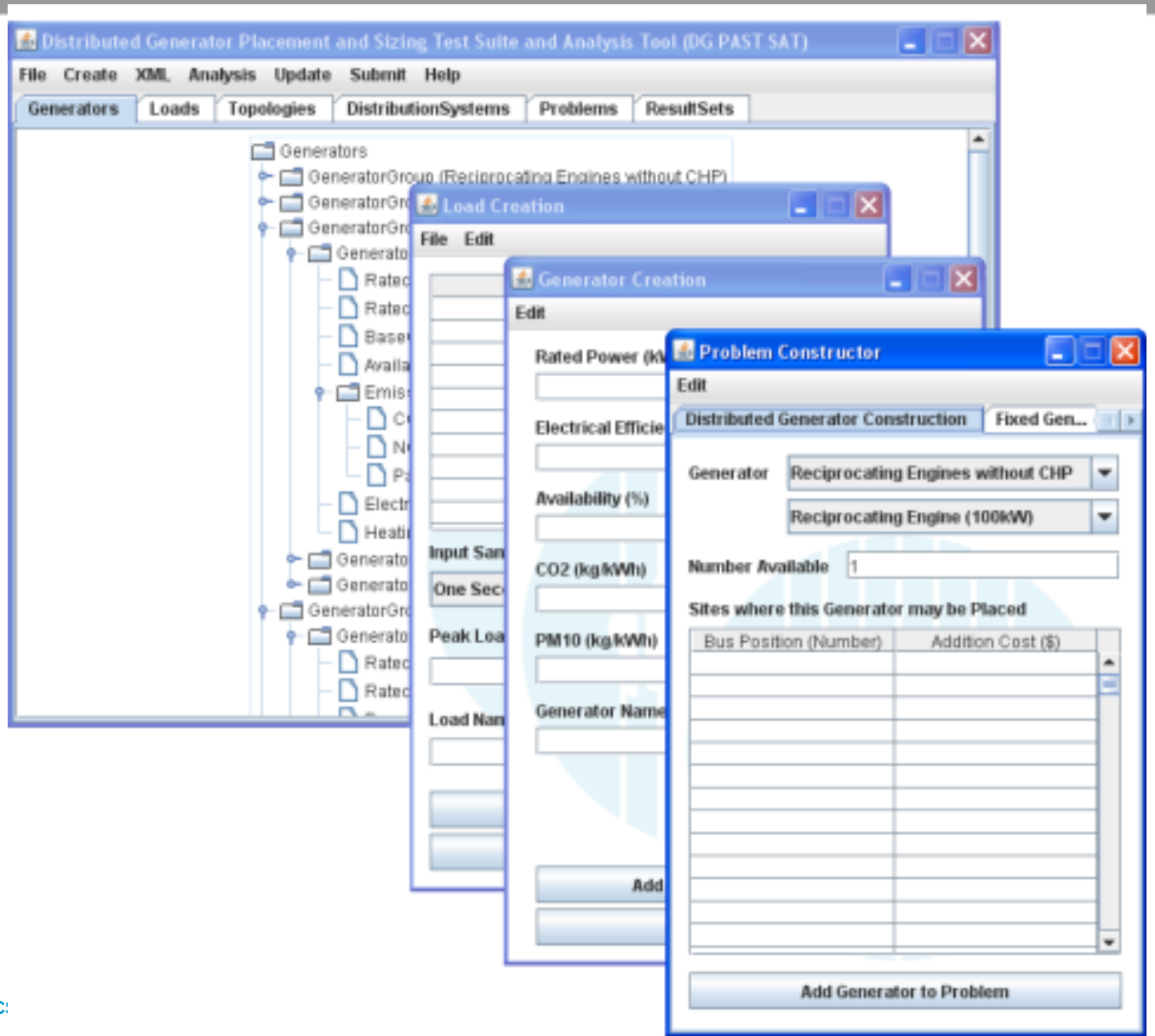
DG-PAST-SAT (Distributed Generator Placement and Sizing Test Suite and Analysis Tool)

- Distribution network topologies
- Load characteristics and profiles based on real donated data
- First unified collection of such problem components
- Example problems - effects of load intensity and position, generator availability and size, network topology, line impedance and waste heat use

DG-PAST-SAT (Distributed Generator Placement and Sizing Test Suite and Analysis Tool)

- Problem visualization
- All elements XML specified, with full schemas available
- Dynamic repository - enables creation and sharing of new resources and performance results

Demonstration



CSIRO

Conclusion

- Studies thus far lack:
  - Commonality in problem sets
  - Sufficient comparison between differing approaches
  - Realistic systems
- Our free software tool includes:
  - Standard models for plant
  - A variety of problems
  - Comprehensive analysis utilities
  - Uploadable extension
- Lets work together here