Experimental Power Grid Centre and its Microgrid Research

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EPGC is a program under ICES which, like other A*STAR RIs, is part of MTI.
Experimental Power Grid Centre (EPGC)

- Program funded from Mar 2007 – Mar 2012
- Government funding of S$38M (USD 31M)
- Two components
  - national-level infrastructure for R&D, test-bedding and demonstration of sustainable energy technologies
  - a pool of researchers with core capabilities in grids and renewable energy technologies
EPCG’s Mission

• To undertake Research and Development activities in defined core areas for intelligent and decentralised power distribution, interconnection and utilisation

• To develop collaborative R&D with A*STAR Research Institutes, Universities, Industry and Singapore Public agencies

• To promote quick adoption and implementation of innovative technologies
Technological Capabilities

Capabilities existing in A*Star
- Information Processing
- Cyber Security
- Data Communications
- Sensors
- Fuels/BioFuels
- Storage Materials
- Packaging
- Fuel Cells
- StarHome
- High Performance Computing
- Asset Management

Capabilities existing in EPGC
- Renewable Energy Systems
- Power Converter Systems
- Flexible and self-healing
- Large complex systems
- Storage systems
- Diagnostics
- Smart Demand Response
- Decentralized Control
- Plug and Play
- Life cycle assessments
- Smart users

Confidential
Research Facility For Grid Technology

@ Fusionopolis

@ Jurong Island
On Google map ...
What is the EPGC facility?

Rating
1 MW

Initial Assets
600kW

- Flow Batteries
- Microturbines
- Fuel Cell
- EV charging

Emulators

Control and Energy Management

Energy Assets

Power Infrastructure

Building

ICES
<table>
<thead>
<tr>
<th>Type of assets</th>
<th>Description</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Photovoltaic system</td>
<td>• Mono-crystalline</td>
<td>20 kWp</td>
</tr>
<tr>
<td></td>
<td>• Poly-crystalline</td>
<td>20 kWp</td>
</tr>
<tr>
<td></td>
<td>• Amorphous</td>
<td>20 kWp</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Internal combustion engines/generators</td>
<td>• Diesel generator unit 1</td>
<td>250 kVA</td>
</tr>
<tr>
<td></td>
<td>• Diesel generator unit 2</td>
<td>125 kVA</td>
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<tr>
<td></td>
<td>• Diesel generator unit 3</td>
<td>50 kVA</td>
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<td></td>
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<tr>
<td>Storage</td>
<td>• Lead-acid batteries</td>
<td>110 kWh</td>
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<td>• Lithium-ion batteries</td>
<td>40 kWh</td>
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<tr>
<td></td>
<td>• Ultra-capacitors unit 1</td>
<td>90 kW</td>
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<tr>
<td></td>
<td>• Ultra-capacitors unit 2</td>
<td>60 kW</td>
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<tr>
<td></td>
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</tr>
<tr>
<td>Programmable loads</td>
<td>• Load bank 1</td>
<td>R:62 kW, L:100 kVar, C:95 kVar</td>
</tr>
<tr>
<td></td>
<td>• Load bank 2</td>
<td>R:375 kW, L:400 kVar, C:285 kVar</td>
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<tr>
<td></td>
<td>• Load bank 3</td>
<td>R:190 kW</td>
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<tr>
<td></td>
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<tr>
<td>Emulator</td>
<td>• Power grid</td>
<td>90 kW</td>
</tr>
<tr>
<td></td>
<td>• Wind turbine</td>
<td>10 kW</td>
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<tr>
<td></td>
<td>• PV emulator</td>
<td>(future)</td>
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</table>
Conceptual Diagram of Power Network

Main Utility Grid

Transformer 1 MVA

Power Supply

Power Grid Emulator

Transformer 2.5 MVA

Wind Turbine Emulator

PV Emulator

Programmable Load

Bus A

Bus B

Bus C

3P4W, 3KA

Impedance Emulator

Future Asset

Diesel Generator

Ultra Capacitor

Battery

PV

Fuel Cell

Inverter

Indoor DETS Area

DETS Bus, 3P4W, 2KA

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Experimental Power Grid Facility

ICES A*STAR

Serial Configured Grid
Importing From Grid

Loop Configured Grid
Exporting To Grid

Bus-A

Bus-B

Bus-C

Bus-A

Bus-C

Bus-B

Bus-C

Bus-B

Bus-A
Experimental Power Grid Facility
ICES A*STAR

Utility Grid

Summary
Total Generation: 820kW; 436kW
Total Load: 590kW; 360kW
Power To Grid: 2100kW; 1050kW

HV PCC

MG LV PCC

Bus-C

0.230 MW 0.140 MVAR
0.622 MW 0.403 MVAR
0.235 MVAR 0.160 MVAR

Power Grid Simulator

Bus-A

0.300 MW 0.120 MVAR
0.600 MW 0.240 MVAR
0.200 MW 0.100 MVAR

Islanded Grid

Power Grid Simulator

Radial Configured Grid
Exporting to Grid

Radial Configured Grid
Importing From Grid

Bus-B

0.160 MW 0.040 MVAR
0.400 MW 0.120 MVAR
0.200 MW 0.060 MVAR

Bus-A
Singapore as a Living Lab

New Concepts → Prototype → First Adoption → Scale Up for Global Markets

Research & Development → Experimental Test-bed → “Live” Test-bed

Intelligent Energy Distributed Systems
- Experimental Power Grid Center
- Pulau Semakau Eco-Park
- Islanded Grids
  - Pulau Ubin Test-bed
- Zero Energy Building
- Electric Vehicle Test Bedding
- Punggol Eco-Precinct
- Clean Tech Park
- Intelligent Energy System Pilot project

Partner Agencies:
- EDB Singapore
- Energy Market Authority
- jtc Corporation
- National Environment Agency
- ICES
What we offer

• **Resources** - Power systems and power engineering capabilities
• **Lab facilities and tools**
  • Wide range of high end simulation tools
  • State of the art R&D Facility (scheduled for Nov 2011)
  • Leveraging on other labs in Singapore
• **Value-add R&D activities**, integrated in A*STAR framework and capable of delivering proof of concept prototypes and finished products
• **A wide technology reach** (leverage from existing A*STAR research institutes capabilities)
Challenge: Multi-domain Modeling and Simulation
Core research to develop robust electrical power structures through iGrids
DC and AC Grid integration in core iGrids

Supergrids

HVDC Link

BiPolar HVDC

Microgrids
Real-time control of EPG needs faster rates of control and data flow
EPGC Facility: Building

Main Entrance

Test Bays

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PV Installation

- Roof Mounted PV Arrays
- Mono and poly-crystalline PV
- Thin Film Amorphous PV
Equipment in EPGC

HV Panel
LV Panel
Transformer
Diesel Generators
Load Banks
Uninterruptable Power Supply
Control System
RTUs
Wind Turbine Emulator
Confidential
Electrical Storages
Thank you!

Please feel free to contact us!