MicroGrid Solutions

Energy Solutions & Industry Services
Schneider Electric at a glance:

Making energy:
Safe • Reliable • Efficient • Productive • Green

The global specialist in Energy Management

- 140,000 Employees
  - 25,000 North America

- U.S. Energy & Sustainability Services
  - 1,050 employees U.S.

Diversified end markets – FY 2012 sales¹

Utilities & Infrastructure 20%
Industrial & Machines 24%
Data Centers 17%
Non-Residential Buildings 30%
Residential 9%

¹Use or disclosure of data contained on this sheet is subject to the restriction on the cover of this document.
Why is the power out?
When will the power be back on?
What are you doing to keep it from happening again?
Major Components of Microgrids

- **Energy Supply System**
  - Distributed Generation (like renewable sources, small combustion turbines)

- **Energy Efficiency Measures**
  - Minimize energy use

- **Demand Response**
  - Reduce non-critical load when operating in isolation

- **Energy Management Systems**
  - Maintain balance and stable Systems
  - Real-time response, predictive and forecasting analysis

- **Utility Grid Interconnection**
Microgrid drivers at a glance

- New sources of DER creating instability on the campus
- Grid Reliability, Efficiency, Renewables
  - 2 hour downtime/yr. vs. 2 minutes
- MG Storage coming of age $500 kWh @ 85% round trip efficiency
- CHP 80% efficient, cheap and clean gas
- CHP gets renewable incentives in many states,
- Ancillary Services provided from the demand side will fund projects
- Shore Power “de-islanding” benefiting from air quality concerns
- Eco districts

Eco districts

Shore Power “de-islanding” benefiting from air quality concerns

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Grid Reliability, Efficiency, Renewables

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Shore Power “de-islanding” benefiting from air quality concerns
What is the Grid?

- Spinning reserves balance supply and demand
- Wholesale price variation can not always be passed on
- Weather, accidents, energy security events impact T&D System
What is the “SMART” Grid?

- Centralized generation

Two way communication and software

- Utility network
- Consumers
- Efficient Homes, commercial
- Electric Vehicles & Energy Storage
- Industry
- Buildings
- Datacenters
- Critical Loads

• Communication between utilities and consumers allows
  1. Ability to shift load
  2. Resultant reduction in wholesale price variation
  3. Perhaps greener generation, conventional and renewable

BUT, weather, accidents, war, terrorism still impact T&D System reliability
What exactly is a “MicroGrid?”

The ability to Island and operate independent of the Grid.
1. Energy Security - accidents, weather, war, terrorism
2. EE – lower cost, Ancillary Services,
3. Both
What makes it a Microgrid?

An integrated **energy system** consisting of interconnected loads and **distributed energy resources** which as an **integrated system** can operate *in parallel with* the grid or in an intentional *islanded* mode.

**Have to have:**
- Distributed Generation (conventional or renewable)
- Critical loads
- Controls to Island and shed - preserving most critical load - System Stability
- Relaying integration

**Usually have:**
- AMI and SCADA Software
- Sequence of Events (SER)
- Storage / utility as storage
- A communications network

**Why?**
- Energy Security
- Net Zero track?
- Ancillary Services
- Demand Response?
- Volt/Var, Regulation
- Fuel Switching?
- Integration of DER
- Stability?

Storage? SCADA?
Microgrids enable “Energy Security”...

...and are a platform for “Net-zero.”

Energy Security generally means:
• National durability of supply
• Less dependence on imports
• Fuel/utility diversity and sufficiency to meet demand
• Ability to fight a war without the “grid”
• Grid resistance to cyber attacks

Local Energy Security
• Reliability of water, gas, electricity, or uranium
• Sustainment of a MG (base or campus)
• A catch all term for “reliability” or energy/power quality
• Resistance to terror attacks
• A driver for Net Zero campuses
• A driver for utility distribution microgrids
• Power distribution resistance to cyber threats, breaches

http://www.ect.coop/industry/crime/oklahoma-substation-damaged-from-gunfire/48151
Microgrids by Control Approach:

• **Remote Microgrid** - Stand alone and volatile non-infinite bus

• **Microgrids** with closed transition
  – **Storm Mode MG** – manual islanding
  – **Dynamic or Load Preservation MG** - generation in continuous parallel operation with automatic controls
  – **Shore power MG** a floating “reverse” microgrid
  – **Utility Distribution or Community Microgrids**
  – **Ancillary Services** Demand side sale of kWh, DR, Volt/VAR, Frequency or Regulation services through CSP/Utility

• **Partial Microgrids**
  – **Open Transition MG** – sectionalizing switches, dropped loads, or DER energized after grid event
  – **Partial Islanding for demand response** or load shedding for cost savings
Real-Time Microgrid Management

- Provide monitoring of microgrid level resources
- Identify capabilities of generators; especially renewables
- Determine historical behavior of renewables (vs. weather input)
- Provide monitoring at Point of Common Coupling (PCC)
- Provide forecast of load and renewable production
- Calculate costs/benefits of microgrid operation, including forecasting
- Optimize operation of utility resources
- For a Utility, DMS can allow for monitoring and managing multiple microgrids
DG is best controlled from a grid quality control system

1. MAINS and INTERCONNECT
   Where DER is in continued parallel operation, high speed control allows preservation of the most critical load, even potential export of DER

1c – Dynamic control relies upon knowing
   Precise load data, even if it is several seconds old

1b - High speed grid data, Freq.
   Triggers armed loads to shed, site wide Relaying and control retrofits and analysis

2. Rotating DER sources can be used as an anchor resource to safely repurpose grid tied solar fuel Cells

3. BiDirectional high speed inverters can add MG stability (voltage, frequency) and increase system capacity (kVARs)

4. Arc Fault Mitigation
   Can save a substation

5. SER can pinpoint a root cause in minutes vs. hours or days

Reliable SCADA, with near time load data and Real time source data is the key to “State of the Art” Microgrid controls. System Stability data is the other key

Stranded load data can be brought into an otherwise isolated Microgrid in a cyber secure way
Oncor MicroGrid

4 MG Zones including 9 generation assets
(2) PV arrays
(1) Microturbine
(2) Batteries
(4) Generators

http://microgridknowledge.com/rumor-is-true-oncor-unveils-first-of-a-kind-microgrid/
15 kV Metal Clad line up that supplies Berth 91/93 at the Port of Los Angeles. This is a container ship electrical distribution system.

POLA system one-line from the SCADA control screen.
Refinery Load Preservation Microgrid

Keeping 160MW+ of CHP up when the grid is down

<table>
<thead>
<tr>
<th>Location</th>
<th>Several Locations, including California, USA</th>
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</thead>
<tbody>
<tr>
<td>Scope of Work</td>
<td>Design, engineer and construct a load preservation Microgrid for 165 MW co-generation systems serving 185 MW of load in initial phase. 90% net zero (gas fired CHP</td>
</tr>
<tr>
<td></td>
<td>• 7 cycle islanding to preserve steam system and cogeneration from tripping off line</td>
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<tr>
<td></td>
<td>• 100 breakers shed at high, medium and low voltage, closed transition</td>
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<tr>
<td></td>
<td>• Export of power to SCE Utility</td>
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<td></td>
<td>• Integration of Sequence of events recording</td>
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<td></td>
<td>• Typical of 15 similar projects in chemicals, refining, and paper</td>
</tr>
<tr>
<td></td>
<td>• Existing CHP retrofits</td>
</tr>
</tbody>
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Annual Savings Over $10 Million in outages 1999-2013
USCG Net Zero, EE, Water, and Renewable Energy

US Coast Guard, Puerto Rico

Location: San Juan, PR / Aguadilla, PR

Investment: $49,984,324

Annual savings: $1,862,504 / year + 4M kWh @ 8% < utility

This project was the first to combine a Renewable Energy Services Agreement in a federal ESPC.

Over 300 Coast Guard buildings and housing units in Puerto Rico received the following ECMs:

- Building Automation System optimization
- Improved indoor air quality
- Lighting retrofits and controls
- Water conservation measures
- Variable Refrigerant Flow (VRF) cooling units
- Cool roofing systems
- Solar window tinting
- ~3 MW of solar photovoltaic power was installed onsite, financed and owned by a third party and operated and maintained by Schneider Electric
- 13 months construction timeline met
- no change orders

Total Impact: 28% energy reduction + 35% renewable energy production = 63% net zero
GSA Region 7 Energy Savings and Renewable Energy

General Services Administration, Region 7

Location: Multiple sites across Texas

Investment: $17,934,397

Annual savings: $1,031,290 / year

Scope of work: A total of 14 federal buildings in eight different Texas cities received the following ECMs:

- Building Automation System integration
- Central plant upgrades
- Data center controls upgrades
- Lighting retrofits and controls
- Water conservation
- Irrigation system controls
- ~1 MW of solar photovoltaic power was installed across five different sites.

Energy and Water Savings + Clean Generation
Retrofitting critical Microgrid infrastructures:

1. Load preservation without interruption:
   - The fastest, most precise and flexible control available for diverse, campus wide DER when islanding from an unstable grid

2. What can’t be prevented must be located and contained:
   - Sequence of Events Recording and Disturbance Direction Detection -get the system back on line in minutes vs. days

3. Prevent or minimize damage through optical arc termination retrofits
Advanced Microgrid Solutions
& Distributed Energy Resource Management

Welcome

Learn More About Microgrids
› How microgrids are changing the energy landscape
› How a microgrid can benefit you
› Energy and economic trends driving adoption
› Our advanced solutions
› The Schneider Electric difference

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Microgrids Deliver the Ultimate in Energy Flexibility
› Learn how
Thank you!

Questions?

Contact:
Jim Plourde
Schneider Electric
Jim.Plourde@schneider-electric.com
603.265.6556