Eaton – a global $20B+ manufacturer of safe, reliable and efficient power management solutions

**Electrical Sector**

- **Products**
- **Systems and Services**

- **2015 Sales:** $7.0B
  - 33% of sales
  - Providing safe and efficient electrical solutions from generation through distribution and control

**Industrial Sector**

- **Hydraulics**
- **Aerospace**
- **Vehicle**

- **2015 Sales:** $5.9B
  - 28% of sales
  - Solutions for the world’s most demanding power needs

- **2015 Sales:** $2.5B
  - 12% of sales
  - Mission critical, safe, and reliable solutions

- **2015 Sales:** $1.8B
  - 9% of sales

- **2015 Sales:** $3.7B
  - 18% of sales
  - Leader in fuel economy and emissions reduction
Microgrid – What it is

An integrated energy system consisting of a distributed energy resources (DERs) and multiple electrical loads operating as a single, autonomous system...in parallel to, or islanded from, the existing utility power grid.
The Electric Utility Grid Ecosystem

- Communities and facilities of refuge
- Campus or Industrial Park settings
- Remote/off-grid locations
- Frequency regulation
- Utility Scale DER Support
- Military bases & government facilities
- Critical infrastructure & industrial
The Emerging Power Grids

1. Solar PV plants
2. Wind farms
3. Dispatchable Diesel Generators
4. Natural gas generators
5. Critical loads
6. Controllable loads
7. Sectionalizers
8. .....
9. .....

Diagram:
- Solar PV plants
- Wind farms
- Dispatchable Diesel Generators
- Natural gas generators
- Critical loads
- Controllable loads
- Sectionalizers
- West Feeder
- South Feeder
- North Feeder
- Substation A
- Substation B
- PV Inverter
- Diesel Storage
- Data Center
- Waste water treatment
- Shedable Loads
- Critical Load
- Natural Gas Distribution
- Wind Farm
- Hospital

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Renewables – Trends and Challenges

Major energy sources and percent shares of U.S. electricity generation at utility-scale facilities in 2016

1. Natural gas = 33.8%
2. Coal = 30.4%
3. Nuclear = 19.7%
4. Renewables (total) = 14.9%
   1. Hydropower = 6.5%
   2. Wind = 5.6%
   3. Biomass = 1.5%
   4. Solar = 0.9%
   5. Geothermal = 0.4%
5. Petroleum = 0.6%
6. Other gases = 0.3%
7. Other nonrenewable sources = 0.3%
8. Pumped storage hydroelectricity = -0.2%

Source: EIA July 2014
High Penetration Renewables

Renewables: Wind Profile

Renewables: Solar Profile
Islands Formed on an Outage
-- Hardware and Tools Required

1. Disconnecting devices
2. Resynchronizers
3. Islanding controls for renewable inverters
4. Smart Inverters
5. Diesel storage and Natural gas supply
6. Special generator controls
7. Load and source balancing
8. System configuration tools
9. Load identification and management
10. Communication and controls
11. Power System models
Microgrid Energy System Architecture

**Generation sources**
Diesel/Natural gas generators, Fuel Cells, CHP

**Modular and scalable**
Scale systems seamlessly and efficiently to any sized application, or when generation or load assets are added

**Advanced and intelligent controls and protection**
Simplifies system configuration, reduces project cycle time, enables system adaptability to changing microgrid assets and reduces testing/commissioning time.

**Utility proven control and communications hardware**
Environmentally hardened with a long history of operation in harsh outdoor applications
A Microgrid control system should have both real-time control and energy management functions that operate in the following situations:

- Operation in grid-connected and islanded modes
- Automatic transition from grid-connected to islanded mode to provide uninterrupted power to microgrid loads during abnormal bulk power system conditions and planned interruptions of the system
- Resynchronization and reconnection from islanded mode to grid-connected mode
- Energy management to optimize both real and reactive power generation and consumption
- Ancillary services provision, support of the grid and participation in the energy market and/or utility system operation, as applicable

**Dispatch function:** dispatching individual devices in given operating modes and with specified set-points.

**Transition function:** supervising the transitions between connected and disconnected states, and ensures the dispatch is appropriate for the given state.
Microgrid-ready product and service portfolio

- Hardened controllers
- Optional redundancy
- IEC 61850 comms modules
- Cyber security
- Yukon Visual T&D HMI
- Relays

System Optimization Software
- Overlay supervisory control
- Microgrid/Power System expertise
- CYME dist. system optimization modeling
- Demand Response for gen. / load balance
- Data analytics and cloud data base

Utility Automation Products

- Hardened controllers
- Optional redundancy
- IEC 61850 comms modules
- Cyber security
- Yukon Visual T&D HMI
- Relays

Interconnection Manager
- Integrated solution
- Reclosers/Breakers
- Protection relays
- Microgrid controller

Supporting Electrics
- Switchgear
- Switchboards/Panel Boards
- Transformers
- Regulators
- Services

Smart Inverter Suite
- 1 MW to 2.25 MW
- Smart interface
- PV and energy storage integration

Automation and Project Services
- Turn-key supply
- Total project management
- System design/integration /testing
- Lifecycle services

LV Load and Generator Control
- Smart LV breaker
- Built-in comms
- Fit existing panelboards

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