01 Microgrid Solutions - What, Why, & Where

02 Case Study – Pork Processing Facility
Microgrid Solutions
What, Why, & Where
What is a Microgrid?

**Energy demand**
- Electrical
- Combined electrical & thermal

**Distributed energy resources (DER)**
- Renewable (e.g. wind turbines & solar PV)
- Conventional (e.g. diesel / gas generators)

**Energy storage systems**
- Electricity storage (e.g. batteries)
- Thermal storage (e.g. hot water)
- Energy conversion (e.g. Power-to-Gas/-Liquids)

**Control system**
- Intelligent control system with system optimizer

**Interconnected to the grid or island mode**
Why Microgrids?

Benefits of Microgrids

- Cost optimization
- Peak shaving
- Load levelling (utility)
- Reduction in carbon footprint
- Clean energy
- Integration of renewables
- Increased energy efficiency
- Increased resiliency / reliability
- Spinning reserve
- Power quality
- Frequency regulation
- Voltage control
- Additional revenue streams for customer
- Grid services
- Energy arbitrage
- Defer need for T&D investment

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- Power quality
- Frequency regulation
- Voltage control

- Supply
- Absorb
- Discharge
- Charge

- Load levelling (utility)
- Spinning reserve

- Defer need for T&D investment
Why Microgrids?

**Commercial & Industrial: Peak Shaving**

*Typical configuration:* On-grid  
CHP Gas + Battery + PV  

*Key driver:*  
- Reducing peak demands to lower energy costs  

*Additional benefits:*  
- Use of heat and cooling from CHP e.g. for air conditioning  
- Integration of renewables, CO₂ reductions  
- Guaranteed reliability/quality of power

**Remote Locations/ Islands: Off Grid / Reliable & Quality Power**

*Typical configuration:* Off-grid  
Diesel/Gas + Battery + PV  

*Key driver:*  
- Reliable + quality power supply  

*Additional benefits:*  
- Reduced energy costs  
- Integration of renewables  
- Cleaner energy, CO₂ reductions  
- Reduced noise (shut down generators during solar peaks)

**Utility: Grid Services**  
(e.g. Frequency Control, Grid Load Levelling)

*Typical configuration:* On-grid  
Battery-only, or Battery + Diesel  

*Key driver:*  
- Provision of services to maintain high quality grid  

*Additional benefits:*  
- Cost savings e.g. through avoidance of investment in grid infrastructure  
- Energy arbitrage, Virtual power plants
Why Microgrids?

**Independent Power Provider: Energy Trading**

*Typical configuration:* On-grid
Battery + PV/Wind

*Key driver:*
- Generate revenue through energy arbitrage (buying & selling energy) or participation in grid services markets (e.g., frequency response)

*Additional benefits:*
- Integration of renewables, CO₂ reductions
- Improved grid stability

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**Communities/Towns: Electrification + Decarbonisation**

*Typical configuration:* Off-grid
Battery + PV/Wind (+ Gas/Diesel)

*Key driver:*
- Reliable + quality power supply for local community/town

*Additional benefits:*
- Integration of renewables
- Cleaner energy, CO₂ reductions
- Reduced energy costs
- Faster connection for new/growing communities

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Why Microgrids?

Total Microgrid Capacity and Revenue by Region, World Markets: 2015-2024
Why Microgrids?

Power Outages Caused by Major Weather Events

Extreme weather is causing more major power outages
(Major – at least 50,000 customers affected)

- Storms and severe weather
- Cold weather and ice storms
- Hurricanes and tropical storms
- Tornadoes
- Extreme heat and wildfires

Source: Climate central.org
Why Microgrids?

- PG&E shutting off power during high risk periods
- Requesting $2B applied to customer bills over a 2-year period
- Insurance rates increasing as much as 5x preexisting rates

- **Con Edison Points to Record-Breaking Power Usage to Explain Shutdown** - New York Times – July 22, 2019
- Summer heat wave peak load reached a record of 12,063MW
- ConEd proactively shut down power with only a 45 min notice
- Two weekends in a row where NYC had significant power outages
Why Microgrids?

Aging US Transmission System

- **Some areas of the United States**
  - Average age 52 years
  - 40,000 miles of transmission lines
Why Microgrids?

- 62% = New power plant construction is renewable energy
- 73% = One year increase in solar
- 70% = Renewable capacity increase since 2008
- 244GW = Total renewable capacity

FIGURE 3 – US energy overview: Electric generating capacity build by fuel type (GW) [2]

FIGURE 4 – US energy overview: Renewable energy capacity build by technology (GW) [2]
Why Microgrids?

Variable Output of Renewable Energy

- 4.6MW solar array over a day – planned vs. actual output
- The planned smooth ramp up and ramp down are in contrast to the actual output.
- An area “depending” on this power will need other dispatchable assets
Why Microgrids?

• Capacity factor = Time at max power
• Low capacity factor generation require (i.e. wind and solar)
  • Reciprocating engines
  • Battery storage
Why Microgrids?

Reciprocating Engines can start, synchronize and ramp to full power in <5 min

Running Reciprocating Engines can handle 10% step loads and ramp power ~1%/sec

Reciprocating Engines meet grid support needs for frequency containment, restoration and reserve replacement
Why Microgrids?

- Remote Villages
- Remote Mines
- Military Bases
- Island Utilities
- Industry
# Why Microgrids?

<table>
<thead>
<tr>
<th>Industry</th>
<th>Microgrids</th>
<th>Distribution Grids</th>
<th>E-Mobility Infrastructure</th>
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</thead>
<tbody>
<tr>
<td>- Load management to avoid peak demands and additional charges</td>
<td>- Balancing renewable generation and demand (e.g. hybrid energy systems)</td>
<td>- Managing peaks and loads to avoid capacity problems in grids</td>
<td>- Battery power for charging stations to reduce impact on grid infrastructure</td>
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<tr>
<td>- Backup power for critical consumers</td>
<td>- Increasing the utilization of renewable energy and overall system efficiency, with possibility of reduction in carbon emissions and use of fossil fuels</td>
<td>- Integration of larger RE shares</td>
<td>- Fast charge options for vehicles and electrical trains</td>
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<tr>
<td>Small Commercial</td>
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<td>- Participation in capacity and balancing energy markets (positive &amp; negative)</td>
<td>- High power availability</td>
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<tr>
<td>- Increase in energy economics, lowering the energy cost</td>
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<td>- Backup power</td>
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<tr>
<td>- Integration of RE (e.g. rooftop PV)</td>
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<tr>
<td>Renewable Energy</td>
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<td>- Integration of fluctuating energy generation into grid, buffer for intermittent loads, smoothening the renewable generation</td>
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<td>- Utilization of renewable energy in peak demand times</td>
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<td>- Output and ramp control to avoid rapid voltage and power sags on the grid</td>
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<td>- Hybrid power plants (e.g. on islands)</td>
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Why Microgrids?

The further downstream distributed energy are located on the electricity system, the more services they can offer to the system at large.
Microgrid Validation Center

Our first building block to becoming a global leader in Microgrids

- Demonstration of our competence as a solution provider in energy sector
- Development and validation of new algorithms and technologies
- Simulation of customer defined requirements in a real environment
Microgrid Validation Center

- Highly flexible test environment, modular set-up
- Flexibility to integrate renewable energy sources
- Sophisticated MTU control system
Winkelmann, Automotive Components Supplier
Ahlen, Germany, Europe

MTU Scope:
- 99.8% availability guarantee – MTU Value Care Agreement
- 6 x CHP units for heat and power
- MTU MCS Process Control
- Digital connectivity through MTU Go!Act and MTU Go!Manage tools
- Collaboration with strategic partner, Getec, for complete installation

- Fully disconnected from grid at end of 2018, with no reduction in power
- Reduced energy costs (no grid fees)
- Independence from grid operator – ability to manage/forecast future energy costs
- Disconnection from grid to island in <8hrs
- In total ~9MW electrical and ~10MW thermal energy (solar = future scope)
Case Study
Pork Processing Facility
Microgrid Case Study

Granjas Carroll - Pueblo, Mexico

- Independent of grid
- 7.7 MWe high speed gas CHP gensets
- 2 MWe high speed diesel genset
- 3 fuel stocks
- Single system master controller
Microgrid Case Study

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Microgrid Pork Processing Facility
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