



**CampusEnergy2020**

**THE POWER TO CHANGE**

FEBRUARY 10-14 ▲ SHERATON DENVER DOWNTOWN ▲ DENVER, CO

# Real World What, Why, & Where of Microgrids

MTU / Rolls Royce Power Systems - February, 2020

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A Rolls-Royce  
solution



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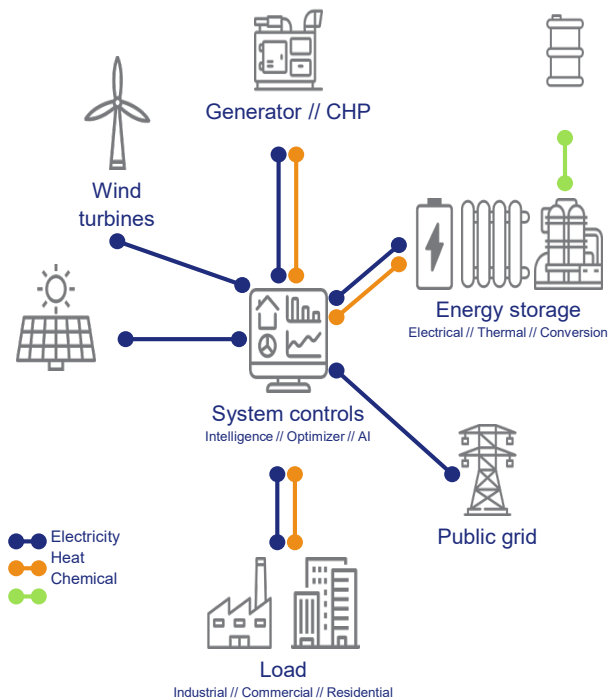
01 Microgrid Solutions - What, Why, & Where

02 Case Study – Pork Processing Facility

# 01

## 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)

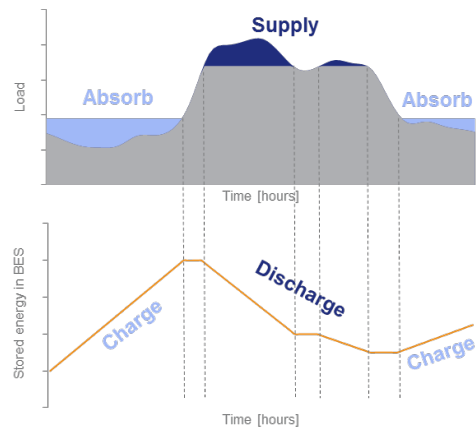
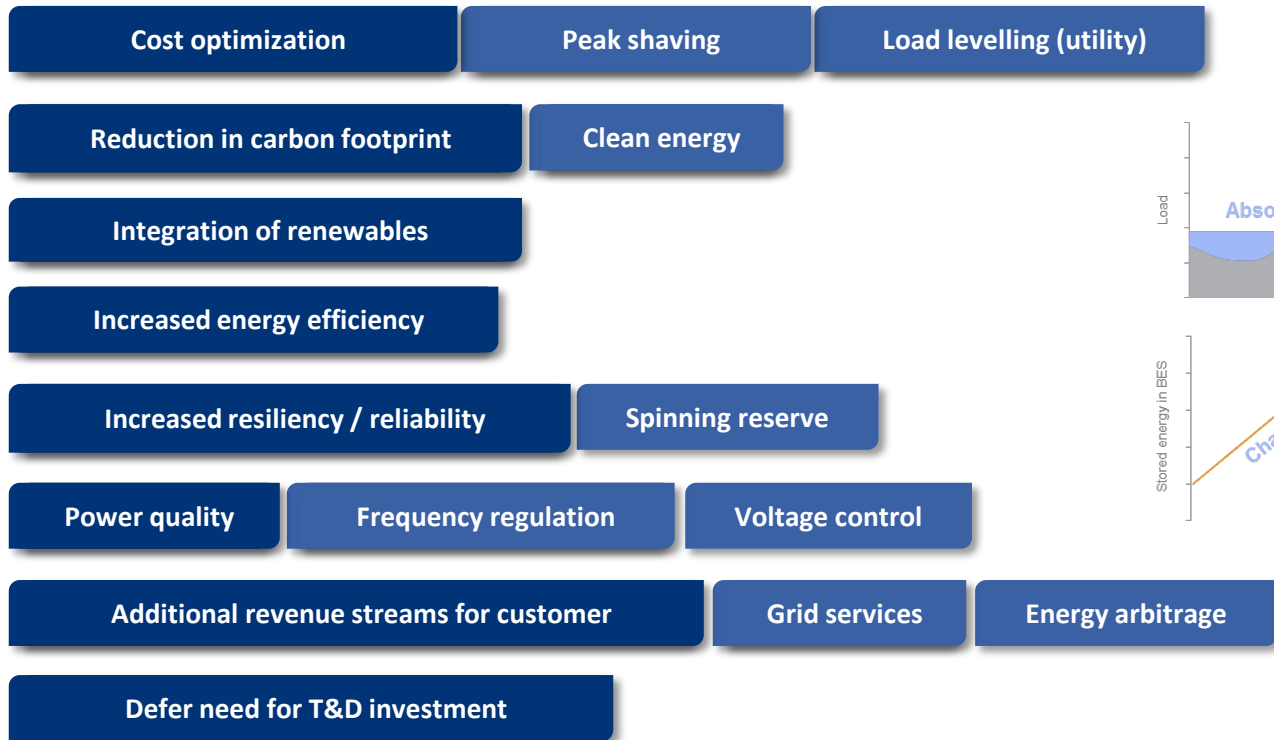
## Control system

- Intelligent control system with system optimizer

## Interconnected to the grid or island mode

# Why Microgrids?

## Benefits of Microgrids



# 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, CO<sub>2</sub> 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, CO<sub>2</sub> 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, CO<sub>2</sub> reductions
- Improved grid stability

## Communities/Towns: Electrification + Decarbonisation



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

**Key driver:**

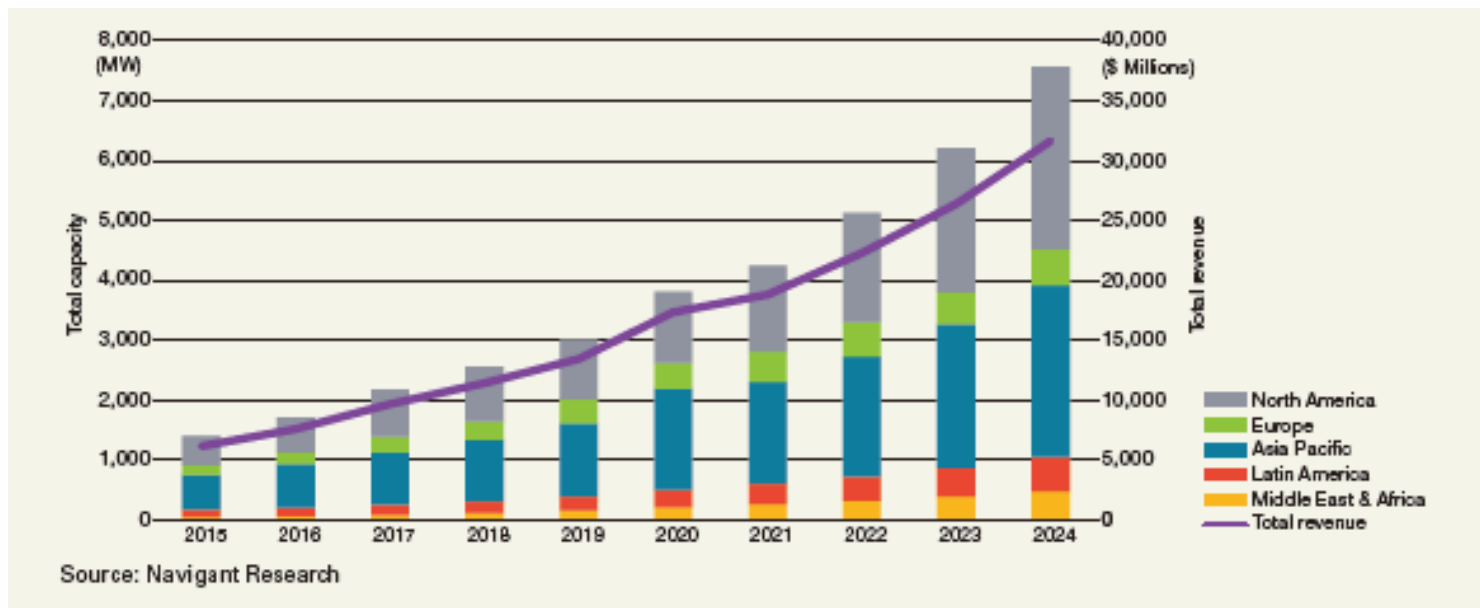
- Reliable + quality power supply for local community/town

**Additional benefits:**

- Integration of renewables
- Cleaner energy, CO<sub>2</sub> reductions
- Reduced energy costs
- Faster connection for new/growing communities

# Why Microgrids?

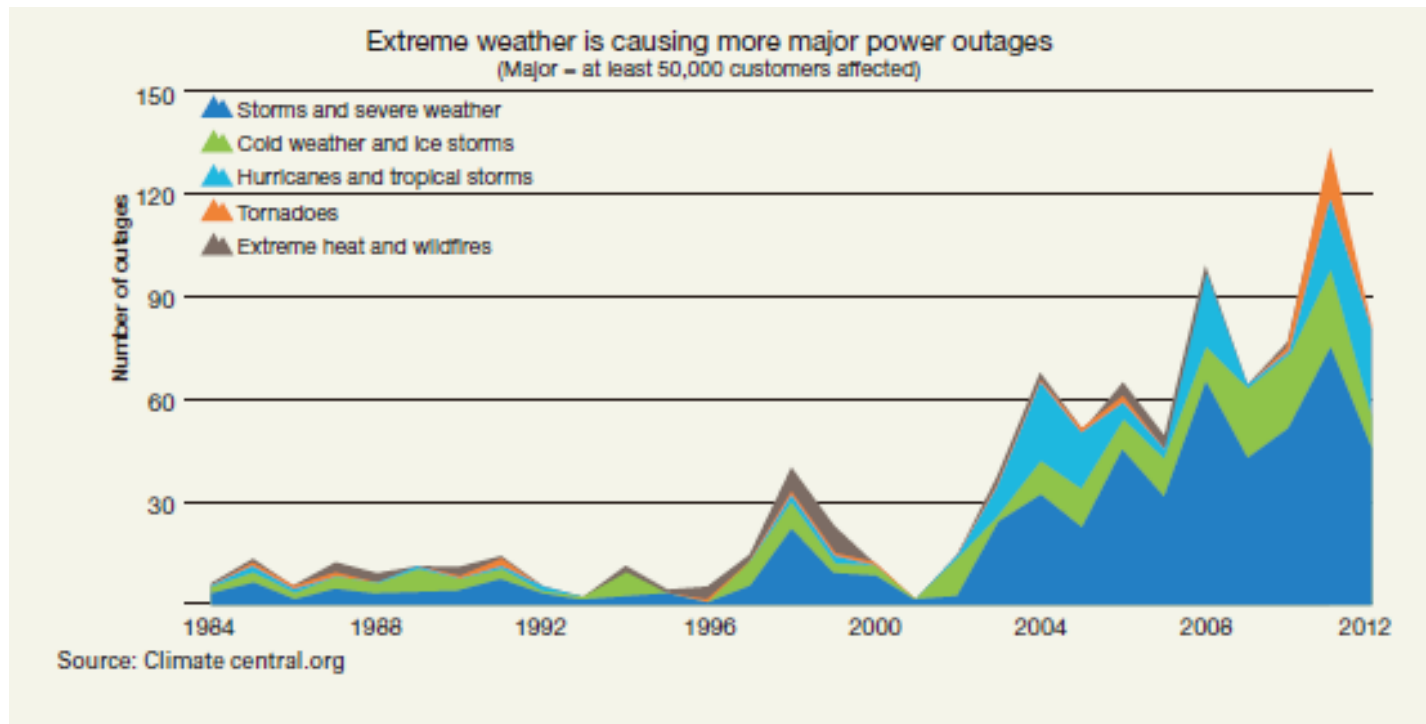
## Total Microgrid Capacity and Revenue by Region, World Markets: 2015-2024





# Why Microgrids?

## Power Outages Caused by Major Weather Events



# Why Microgrids?

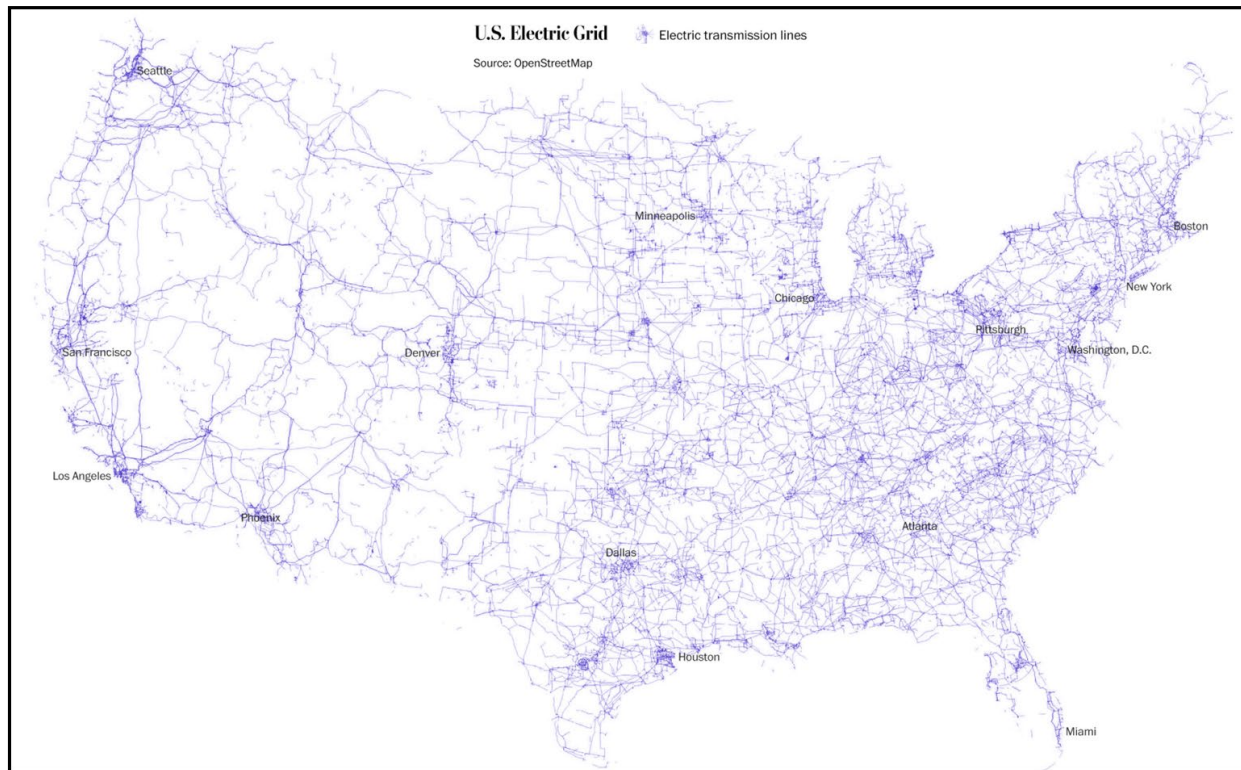
- **California, Wary of More Wildfires, Is Paying for Them Already** - New York Times – July 22, 2019
- PG&E shutting off power during high risk periods
- Requesting \$2B applied to customer bills over a 2-year period
- Insurance rates increasing as much as 5x preexisting rates



- **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

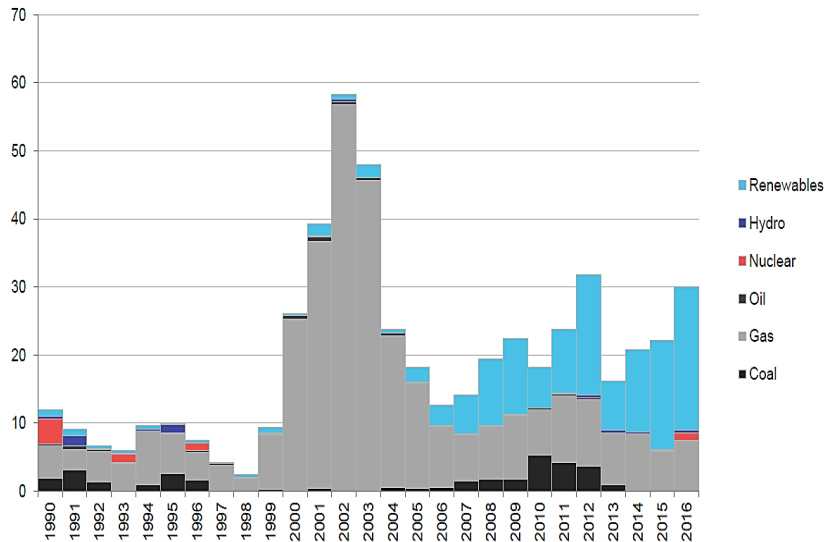


FIGURE 3 – US energy overview: Electric generating capacity build by fuel type (GW) [2]

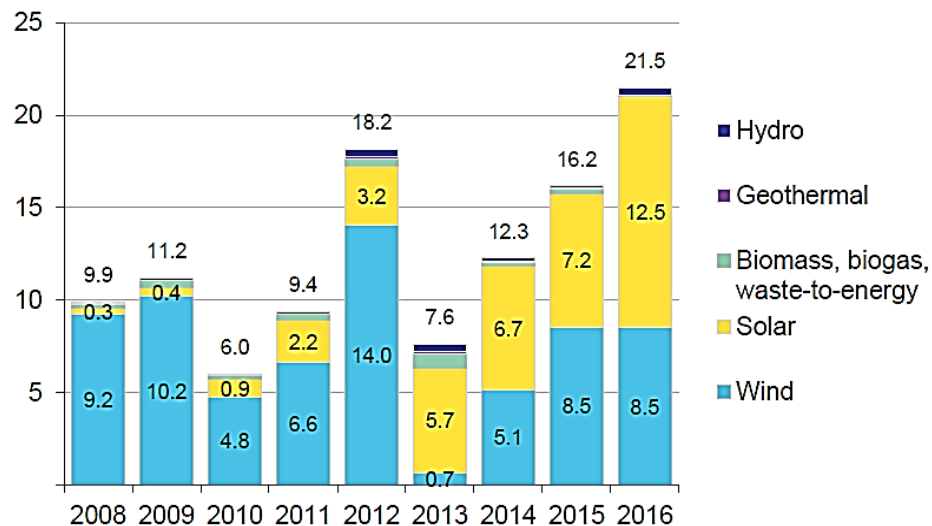
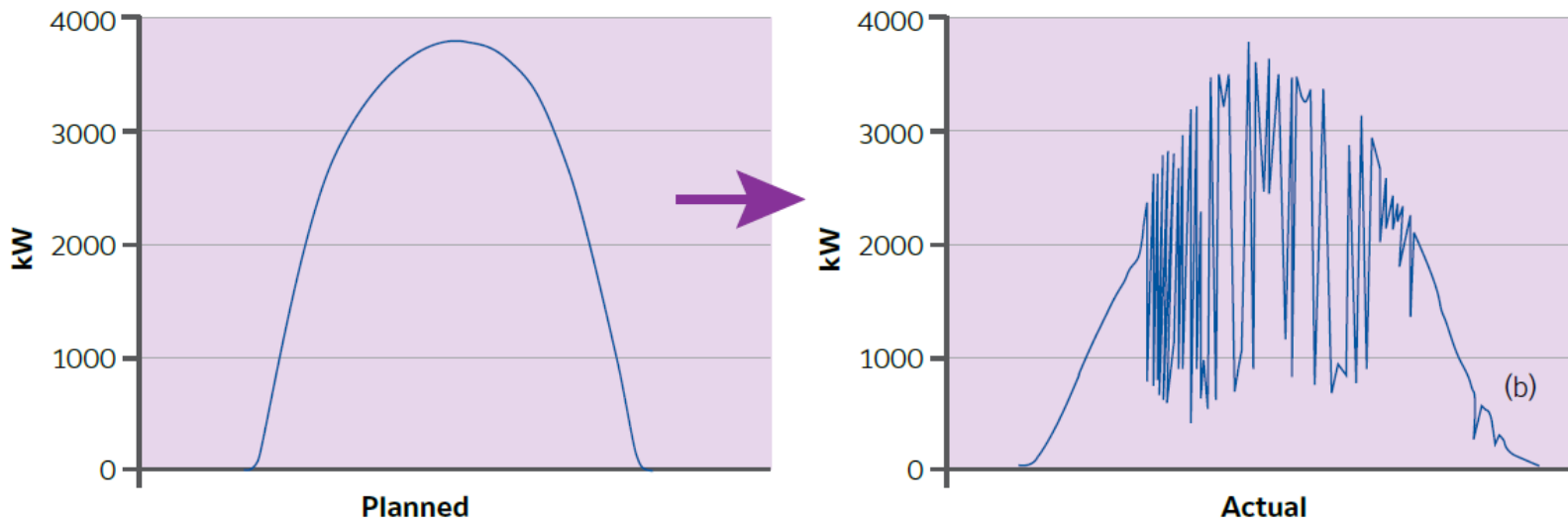


FIGURE 4 – US energy overview: Renewable energy capacity build by technology (GW) [2]

# Why Microgrids?

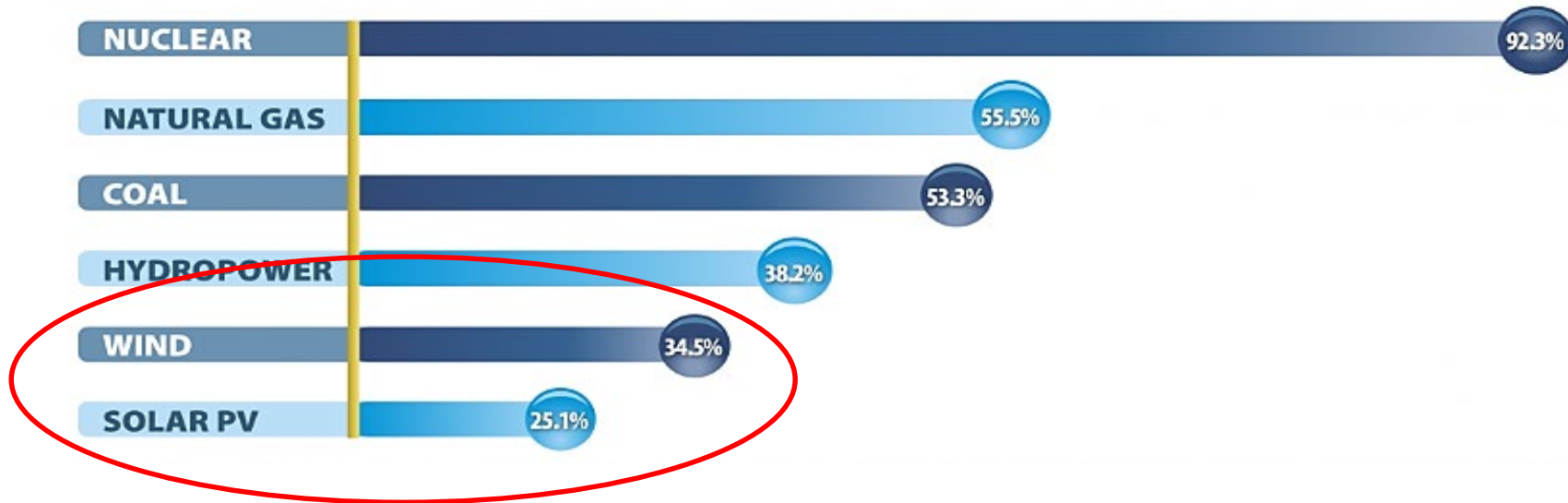
## Variable Output of Renewable Energy

- 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

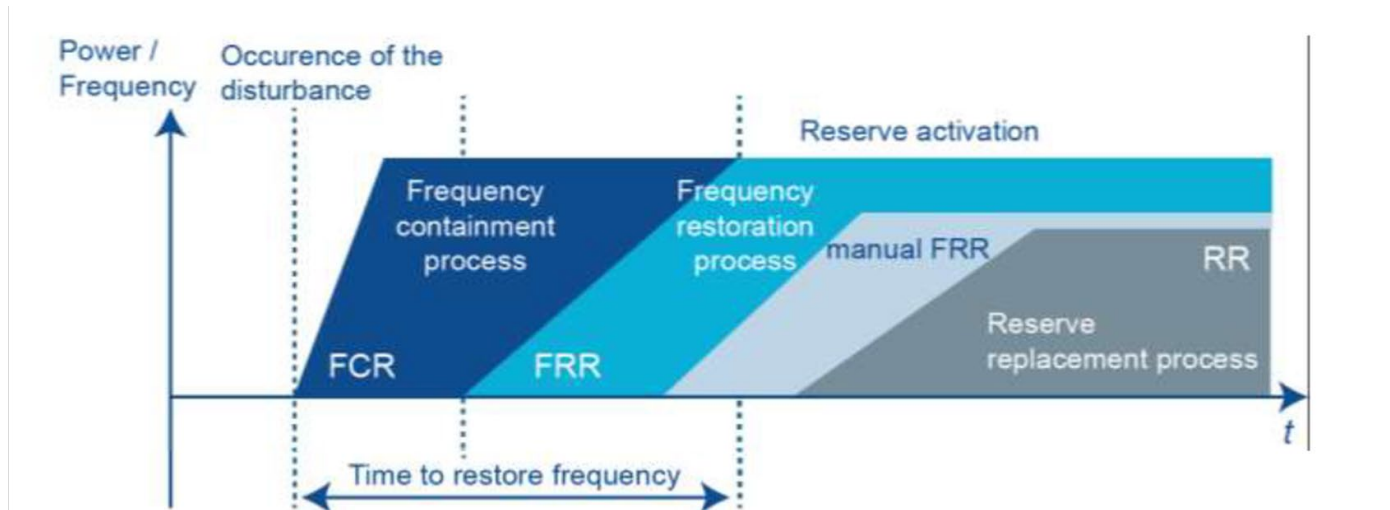


## Why Microgrids?

- 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

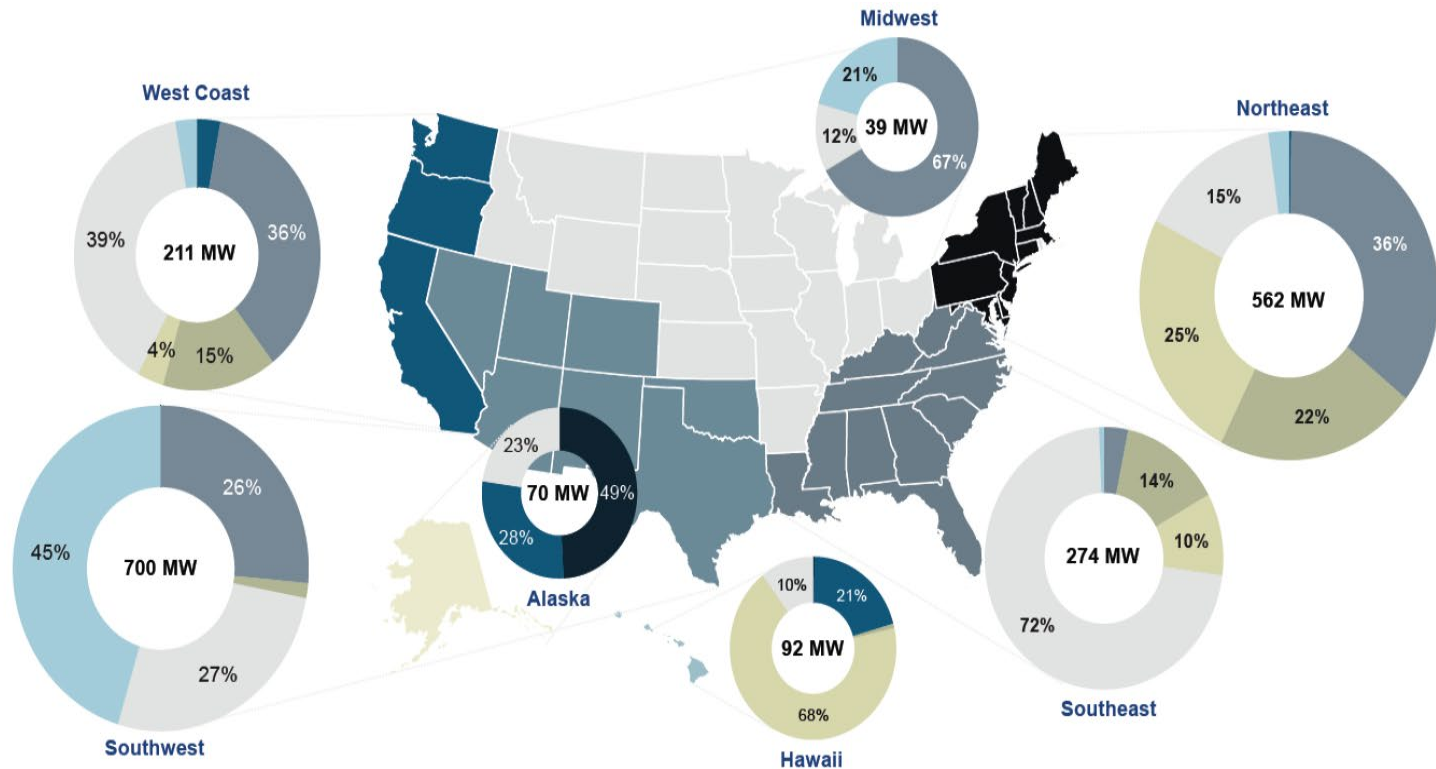
Running Reciprocating Engines can handle 10% step loads and ramp power ~1%/sec

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





# Why Microgrids?



■ Remote Community ■ Island ■ University/Research Facility ■ City/Community ■ Public Institution ■ Military Installation ■ Commercial

Industry

Island Utilities

Military Bases

Remote Mines

Remote Villages





# Why Microgrids?

## Industry

- Load management to avoid peak demands and additional charges
- Backup power for critical consumers

## Small Commercial

- Increase in energy economics, lowering the energy cost
- Backup power
- Integration of RE (e.g. rooftop PV)

## Renewable Energy

- Integration of fluctuating energy generation into grid, buffer for intermittent loads, smoothening the renewable generation
- Utilization of renewable energy in peak demand times
- Output and ramp control to avoid rapid voltage and power swings on the grid
- Hybrid power plants (e.g. on islands)

## Microgrids

- Balancing renewable generation and demand (e.g. hybrid energy systems)
- Increasing the utilization of renewable energy and overall system efficiency, with possibility of reduction in carbon emissions and use of fossil fuels

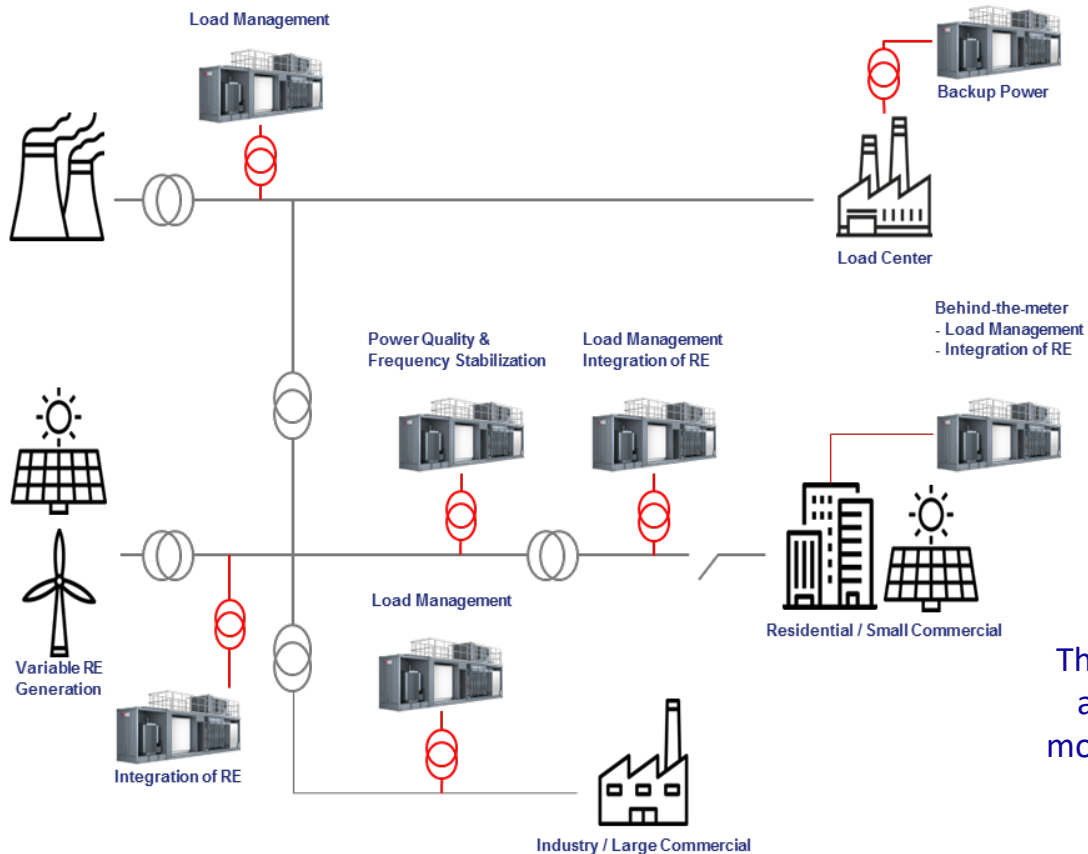
## Distribution Grids

- Managing peaks and loads to avoid capacity problems in grids
- Integration of larger RE shares
- Participation in capacity and balancing energy markets (positive & negative)

## E-Mobility Infrastructure

- Battery power for charging stations to reduce impact on grid infrastructure
- Fast charge options for vehicles and electrical trains
- High power availability

# Why Microgrids?



CENTRALIZED

TRANSMISSION

DISTRIBUTION

BEHIND THE METER

DISTRIBUTED

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

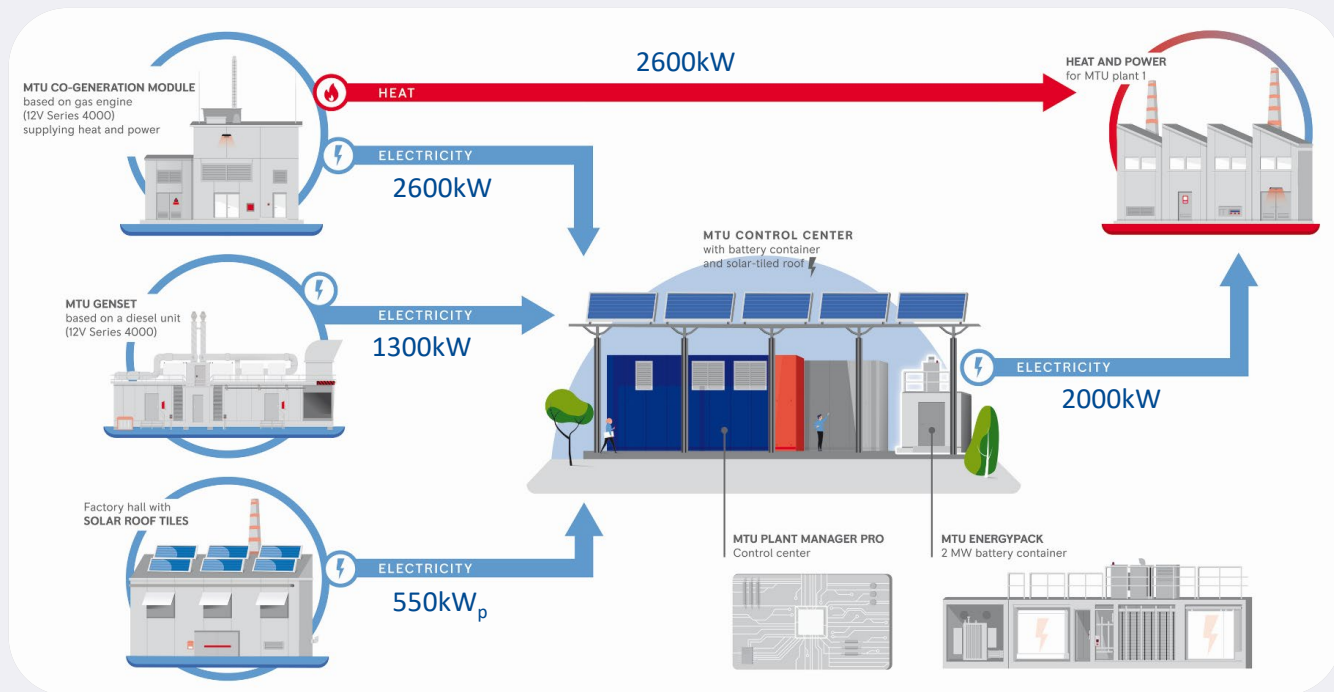
- Demonstration of our competence as a solution provider in energy sector
- Development and validation of new algorithms and technologies
- Simulation of customer defined requirements in a real environment

Our first building block to becoming a global leader in Microgrids



- Highly flexible test environment, modular set-up
- Flexibility to integrate renewable energy sources
- Sophisticated MTU control system

## System Architecture of Validation Centre



# Winkelmann, Automotive Components Supplier

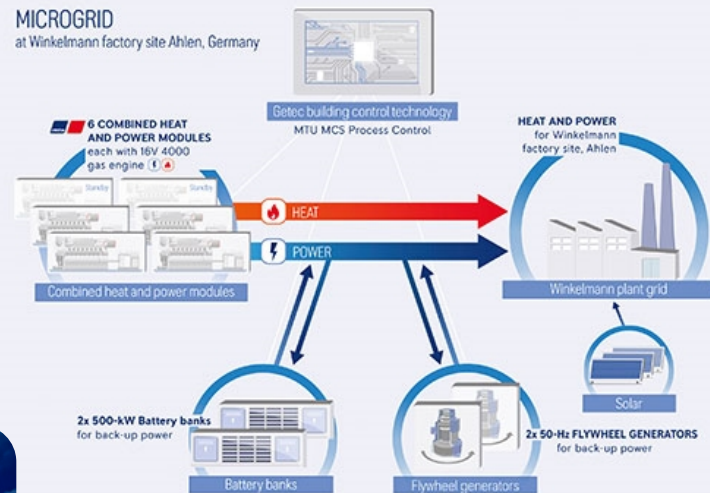
## Ahlen, Germany, Europe

### Reference: Winkelmann

#### 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)



# 02

## Case Study Pork Processing Facility



## Microgrid Case Study

- 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 Pork Processing Facility Granjas Carroll - Pueblo, Mexico







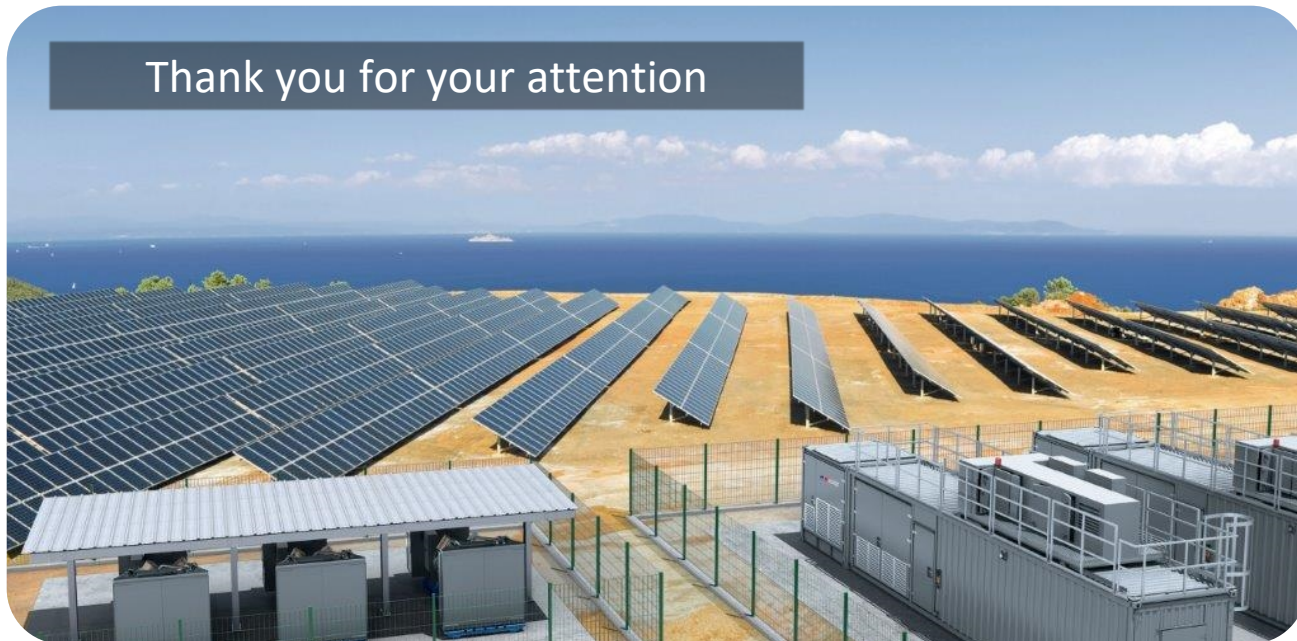


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Thank you for your attention



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