Mission Critical Microgrids:

Case Studies Review

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Outline

Introduction to Mission Critical Microgrids

Power Quality & Reliability – Grid vs Onsite Generation

Intro to Rotary Power Stabilizers

Case studies

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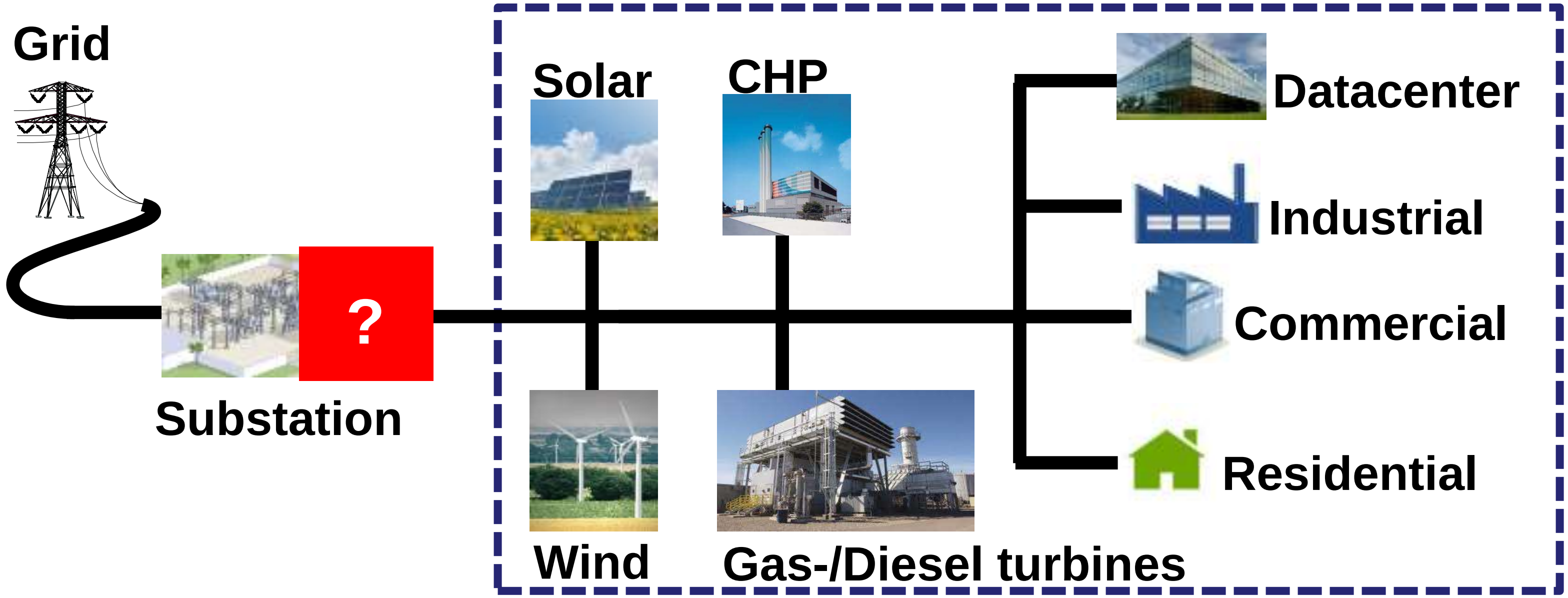
Definitions

What is a Microgrid?

An integrated energy system consisting of interconnected loads and distributed energy resources. Can operate in parallel with the grid or in an intentional island mode. - US DOE

What is a Mission Critical Microgrid?

A Microgrid system that can not tolerate a power quality disruption and is designed for 7 days a week, 24 hours a day, 365 days a year of uninterrupted operation.



Components of a Microgrid

- missing the key puzzle piece

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Major Components of Mission Critical Microgrids

- *Onsite power generation*
- *Utility grid connection (or an island network)*
- *Energy storage (usually chemical or kinetic)*
- *Power quality regulation*
- *Control system*
  - ✓ *Power balance*
  - ✓ *Coordinate demand response*
  - ✓ *Manage system sequence of operation*

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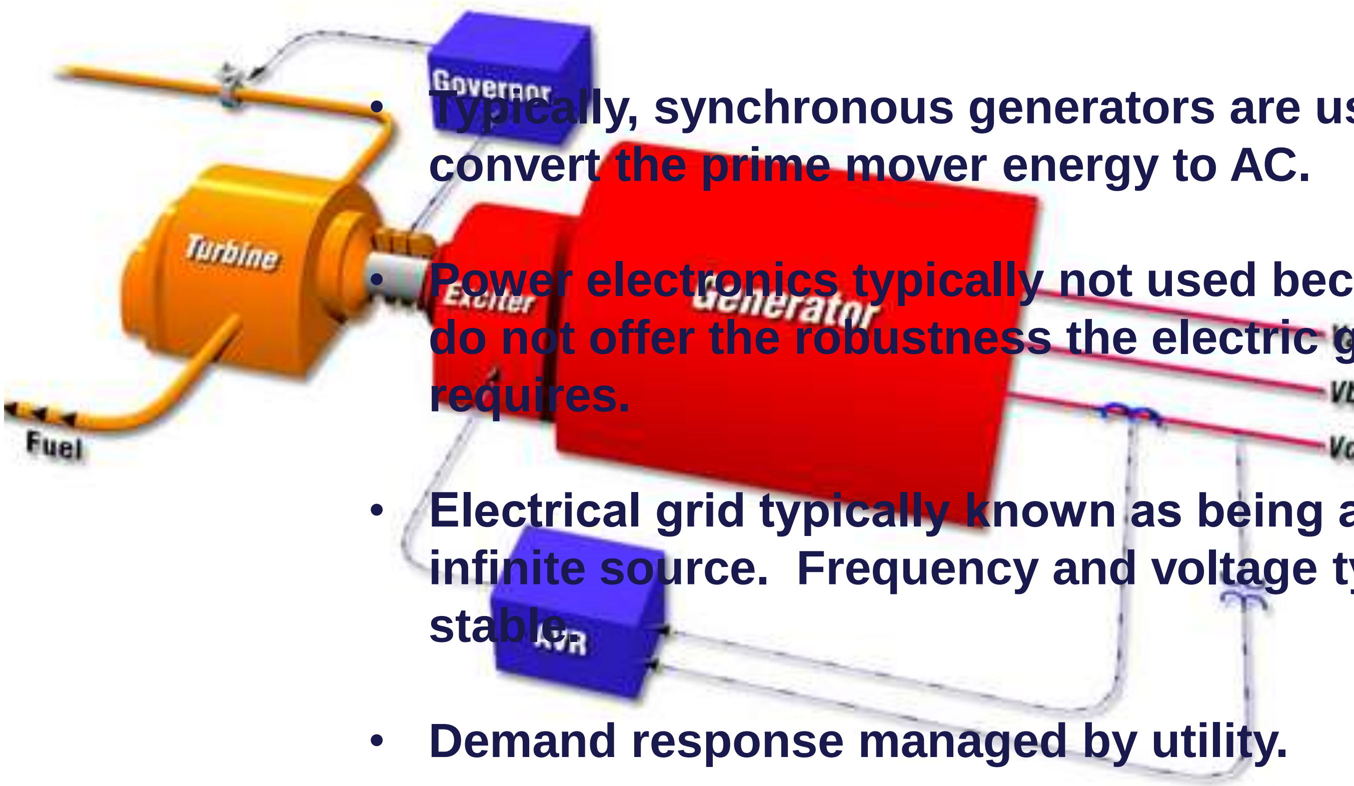
Conventional Grid Power Generation



- Typically, synchronous generators are used to convert the prime mover energy to AC.
- Power electronics typically not used because they do not offer the robustness the electric grid requires.
- Electrical grid typically known as being a ‘stiff’ infinite source. Frequency and voltage typically stable.
- Demand response managed by utility.
- Grid typically has an abundance of energy available for short circuit clearance.

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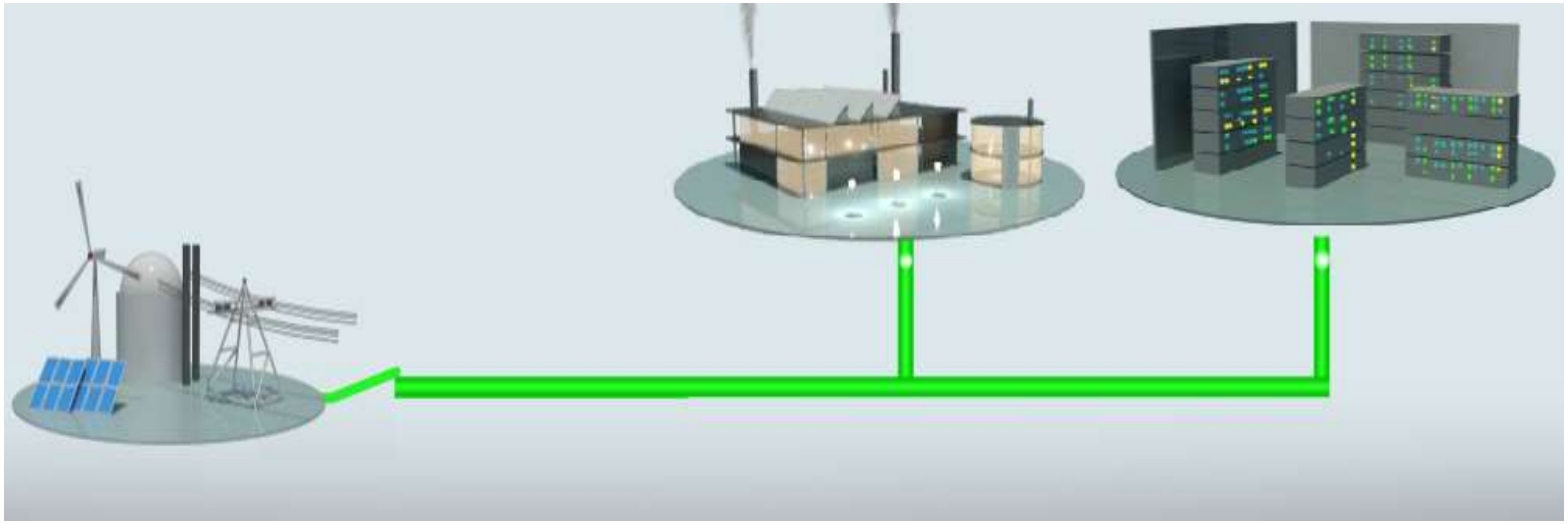
Conventional Grid Power Generation Con't



- **The average US power plant (natural gas, coal, etc) is only 35% efficient while the remaining 65% is lost in the form of waste heat .**
- **In addition, transmission losses typically average an additional 2 – 4%.**
- **End user has limited energy security, and reliant on the reliability of their electrical service from the grid.**

Onsite Power Generation

- As a stand alone solution, loads will see an interruption upon a grid outage.
- Loads may see voltage and frequency excursions in island operation due to either change in load demand or change in power generation.
- Narrow input voltage windows; may disconnect when exposed to grid voltage deviations. - These technologies typically synchronize to the grid's voltage and frequency.
- May de-rate for peak load management.
- May not be able to supply enough reactive power to support the load in island operation. In grid connected operation, may result in a poor power factor reflected back to the grid.
- Those that utilize inverters to convert their energy produced to AC have paralleling limitations due to inherent paralleling challenges with inverter technology.
- Unable to deliver fault current to clear a load side short circuit.

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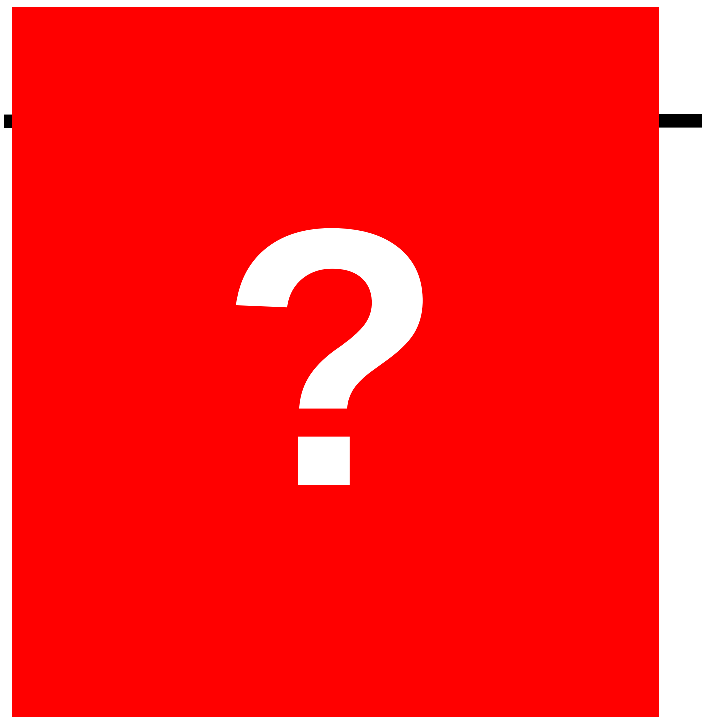
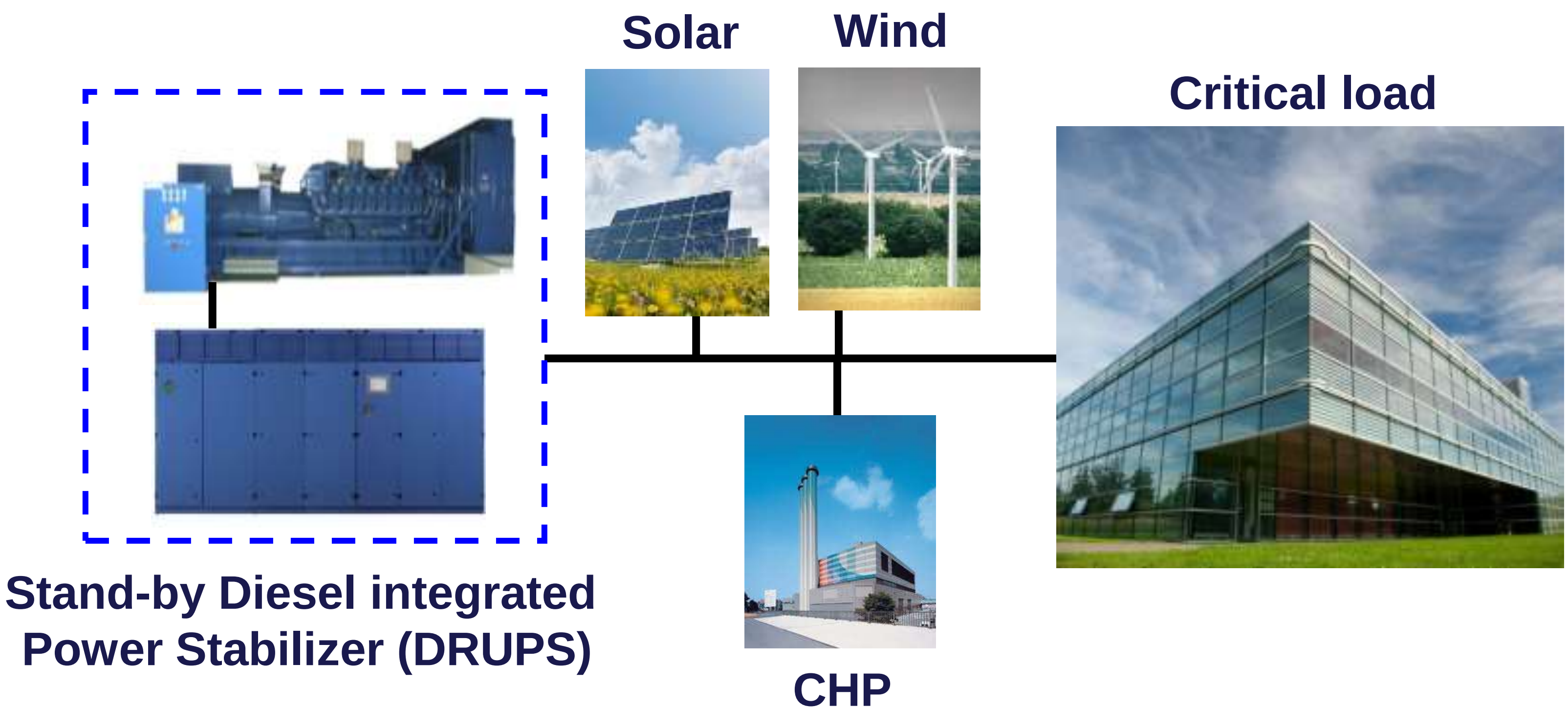
Rotary Power Stabilizers
Grid Connected Microgrids



- **Power Stabilizer decouples utility & microgrid.**
- **Microgrid sees regulated power source.**
- **Grid interconnection simplified.**
- **Grid sees rotary power stabilizer instead of downstream onsite power generation**

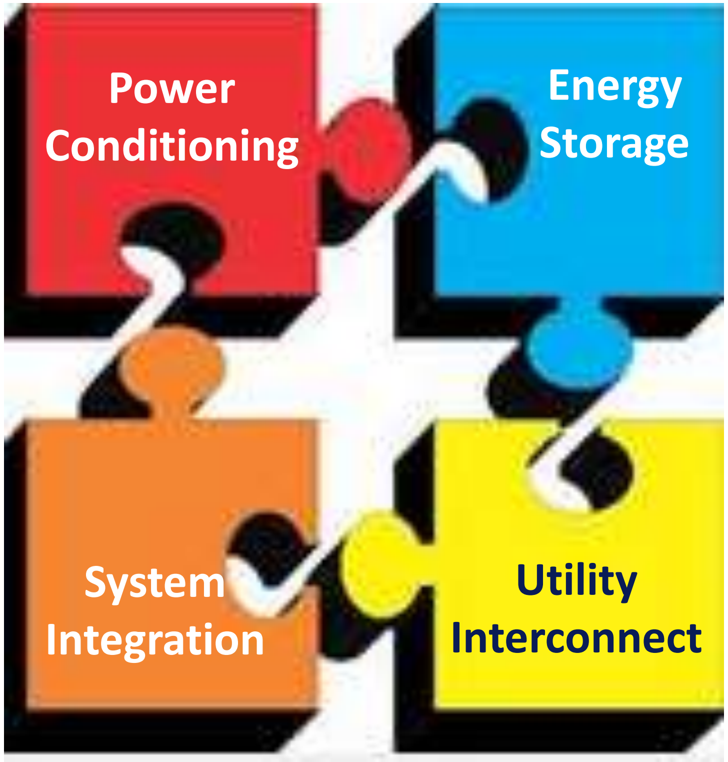
  ->Simplified utility interconnection

Rotary Power Stabilizers
Island Grids



- Island configuration of power stabilizer solution with optional stand-by diesel generator
- Utility interconnection avoided.
- Stand-by diesel source available should a prime mover be down for maintenance.

Requirements of a Power Stabilizer



- Capable of bi-directional power flow that allows both power injection and absorption while tightly regulating voltage and frequency.
- Maintain power quality during transient events.
- Energy storage and controls integration further enabling load follow support and power balancing.
- Decoupling the microgrid from utility
- Seamless transition between different operating states (act as a shock absorber)

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Energy Storage

Minutes/hours

- High energy density –longer runtime possible.
- DC bus restricts stabilizer capacities to 1600kW or less per module.
- Re-charge / absorption of energy limited by charging circuit

Seconds

- High power density - 16.5MWs or 21MWs (or MegaJoules)
- Available in stabilizer capacities up to 2.7MW per module.
- Bi-directional power flow – Stabilisation action.
- Very Fast re-charge
- Can be infinitely power cycled without degrading
- Very small footprint
- No hazardous materials

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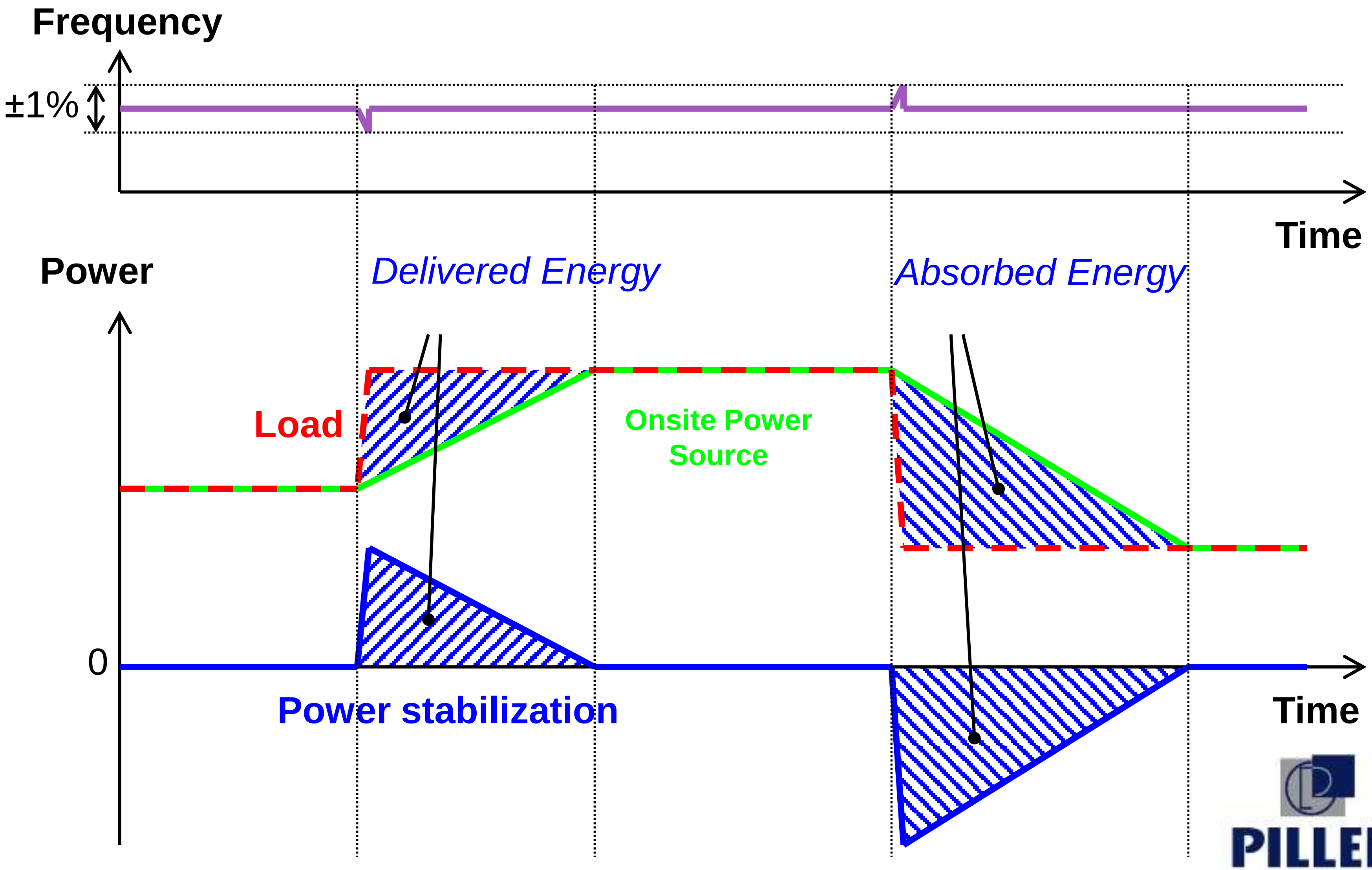
Frequency Stabilization & Power Distribution



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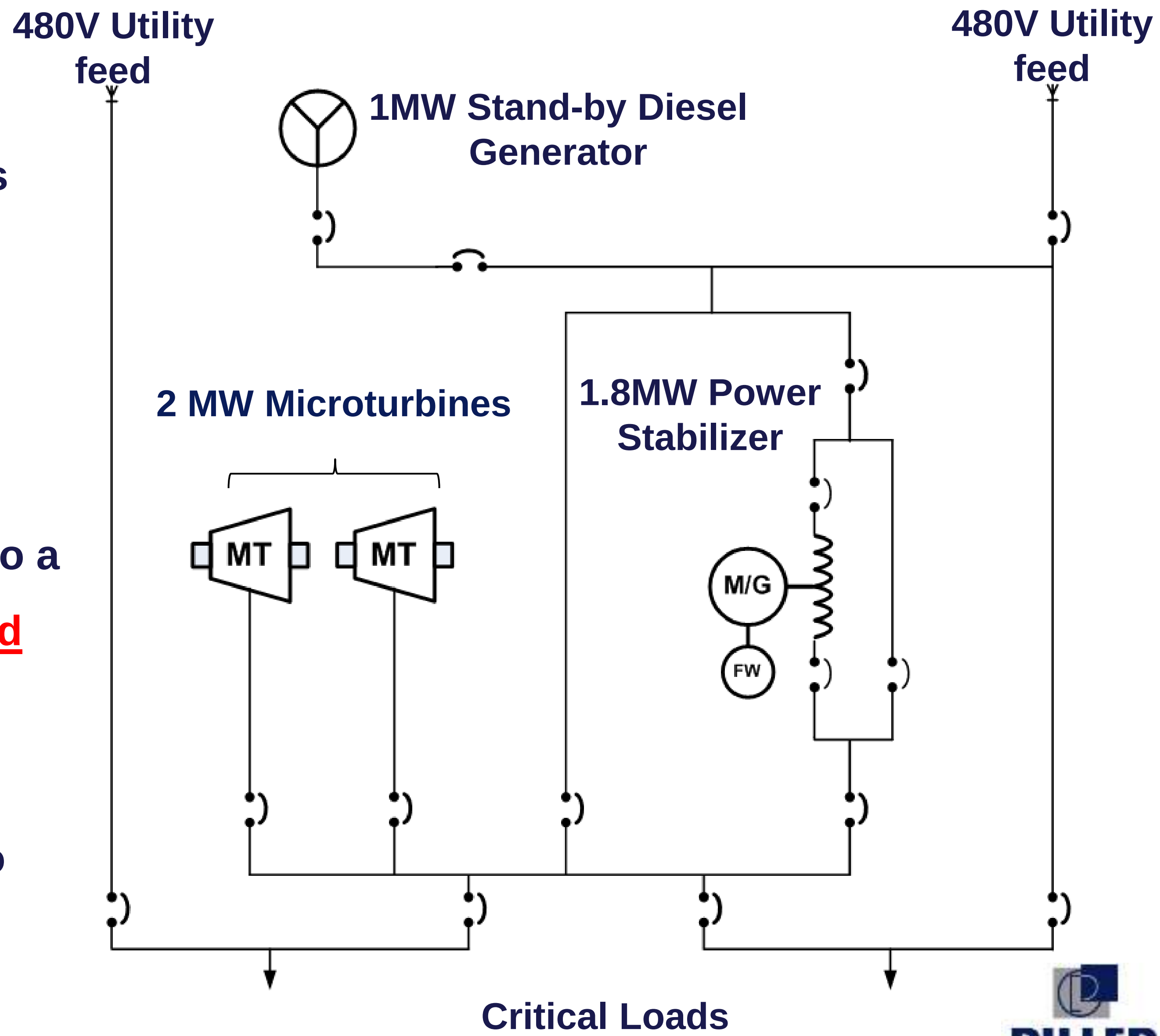
Case Study – Biotech Manufacturer

- (2) 1MW Microturbines
- Annual base loads typically < 1.8MW
- System fault tolerant to a 1MW micro turbine <u>and</u> utility failure.
- Seamless transition to island operation.



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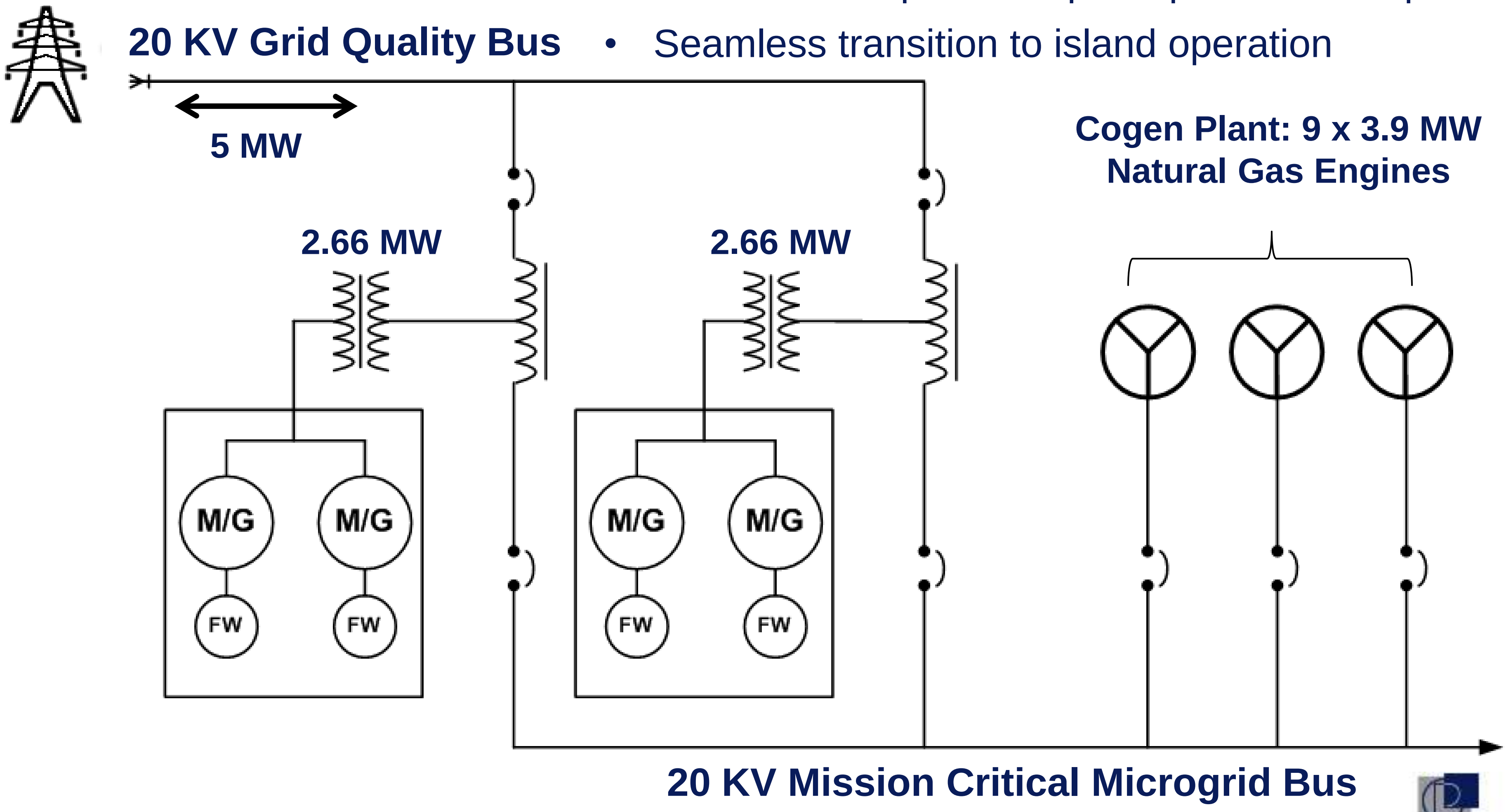
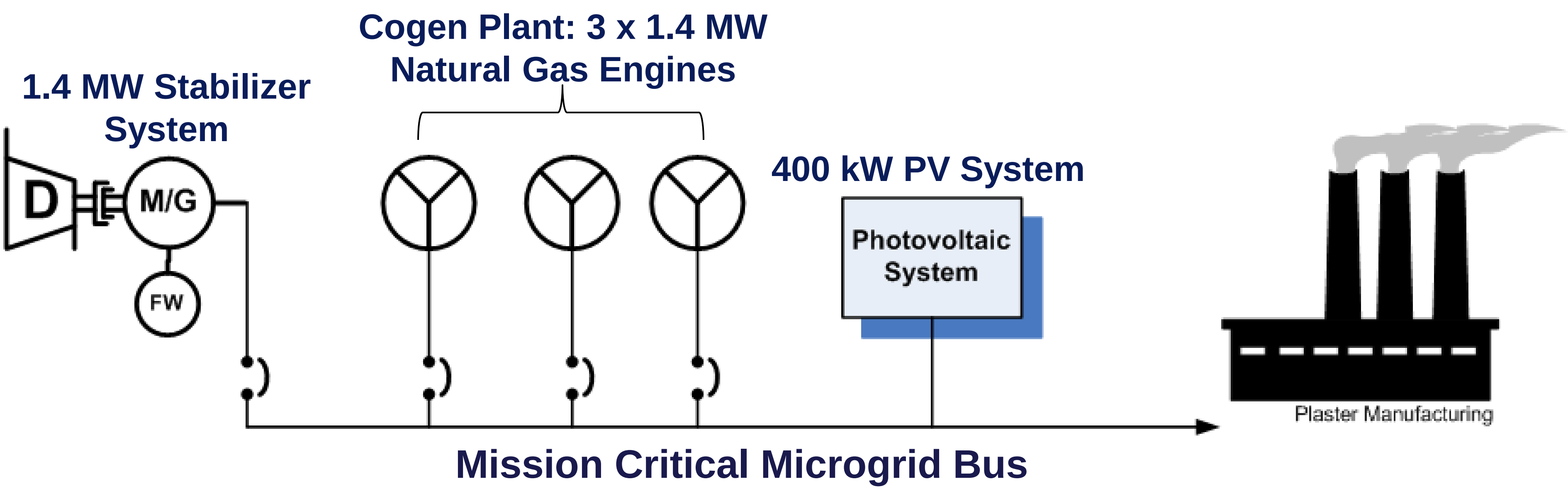
Case Study – Semiconductor Plant

- 35 MW Natural Gas Engine generators (N+1)
- Possible to import or export up to 5 MW of power
- Seamless transition to island operation

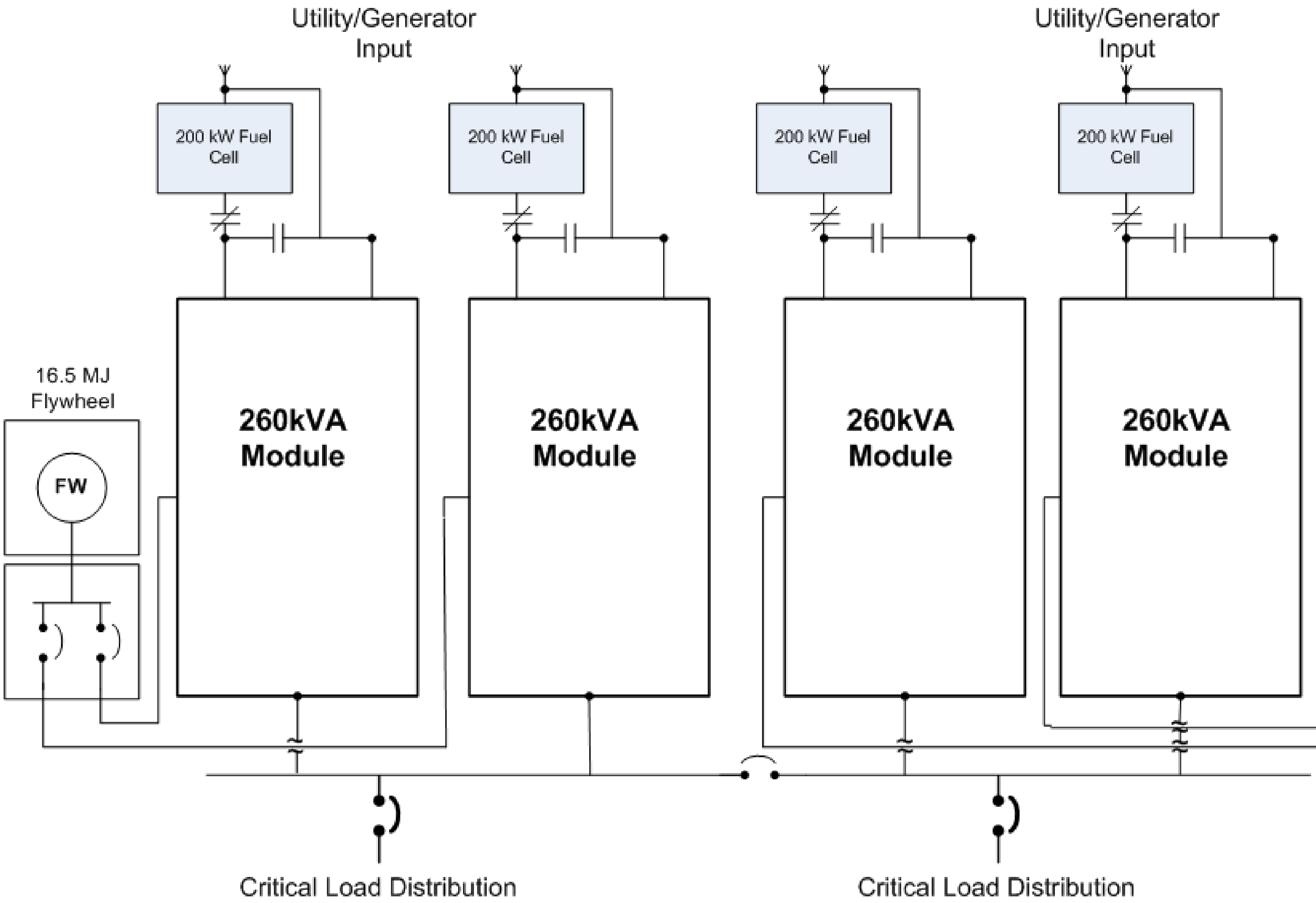


Case Study – Industrial Plant

- 3.5 MW of critical load provided by onsite generation
- (3) 1400 kW natural gas engine gensets
- 400 kW Photovoltaic power plant



Case Study - Datacenter



Case Studies Summary

- **Power Stabilizer Solution simplified utility interconnection.**
- **Microgrids became robust with addition of utility grade power stabilizer**
  - **Fault clearing capability, even in island operation.**
  - **Over current capability**
  - **Loads and alternative energy generation downstream of Power Stabilizer no longer exposed to raw utility including black and brown outs.**
  - **Power Stabilizer provides system kVAR.**
- **Simplifies and consolidates control system.**
  - **Prime mover output power controls**
  - **Power balancing between energy store and onsite power generation**
  - **Switchgear transfer controls, load shedding, etc.**
- **Sites have never seen any unplanned downtime!!!**

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Thank You!!!

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