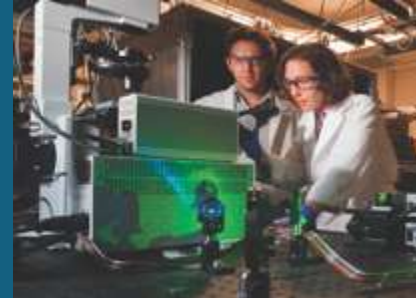


# Introduction to Microgrids



PRESENTED BY

Ben Schenkman

October 14, 2020

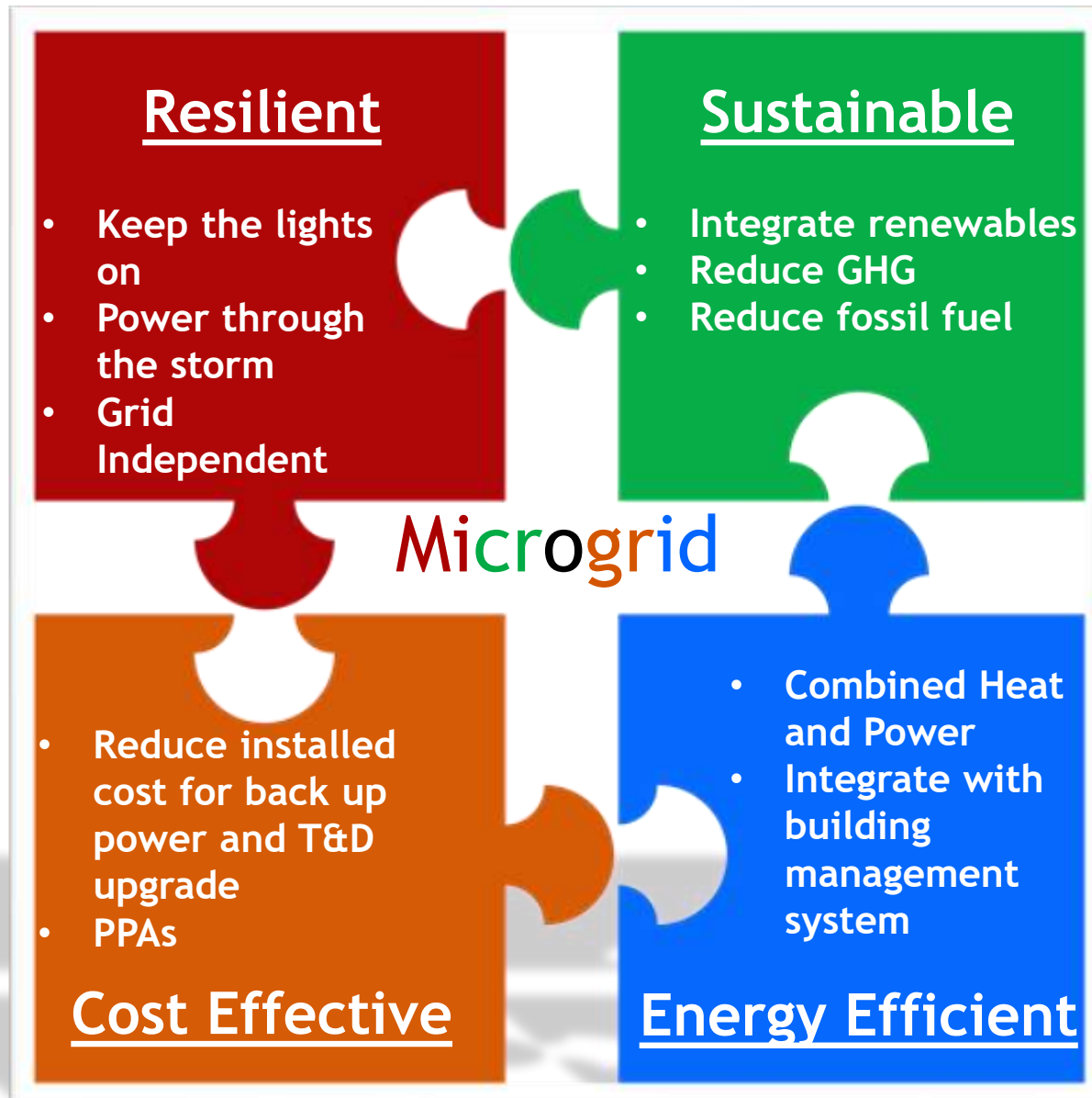
SAND2020/10717C



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- What is a Microgrid
- Microgrid Operation
- Project Process
- Costs and Case Study





# What is a Microgrid?

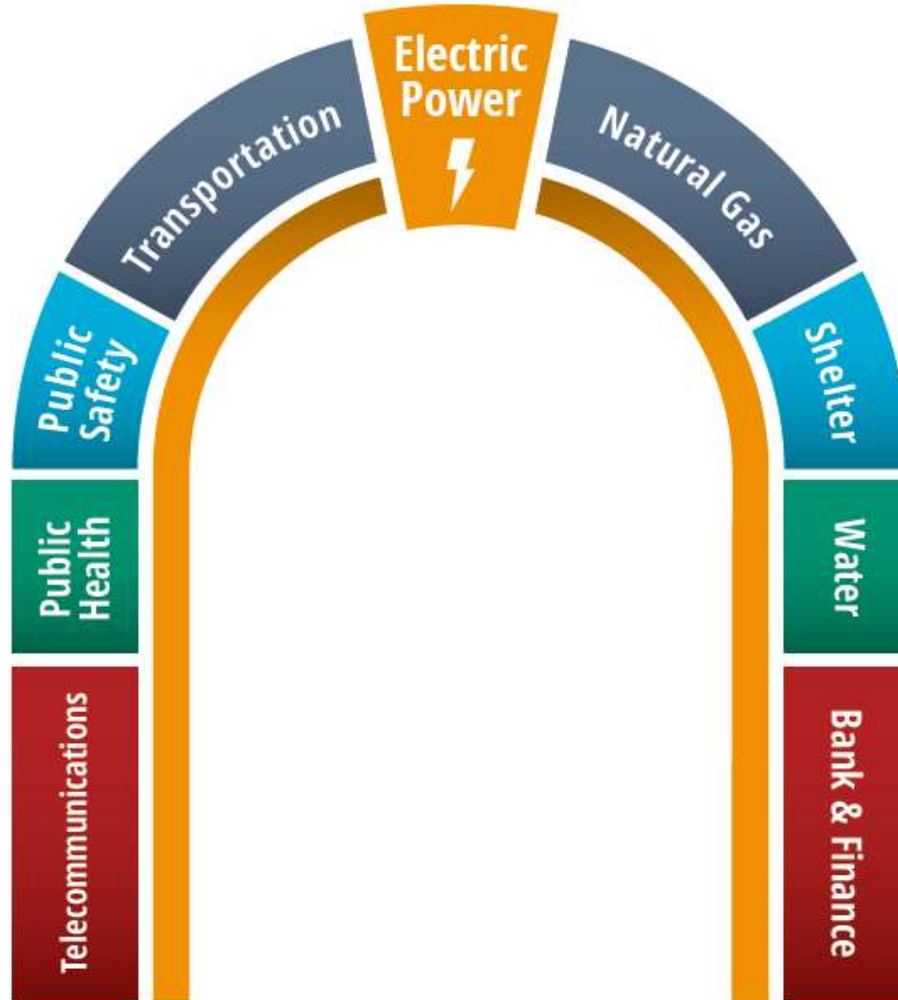




### Department of Energy Microgrid Definition

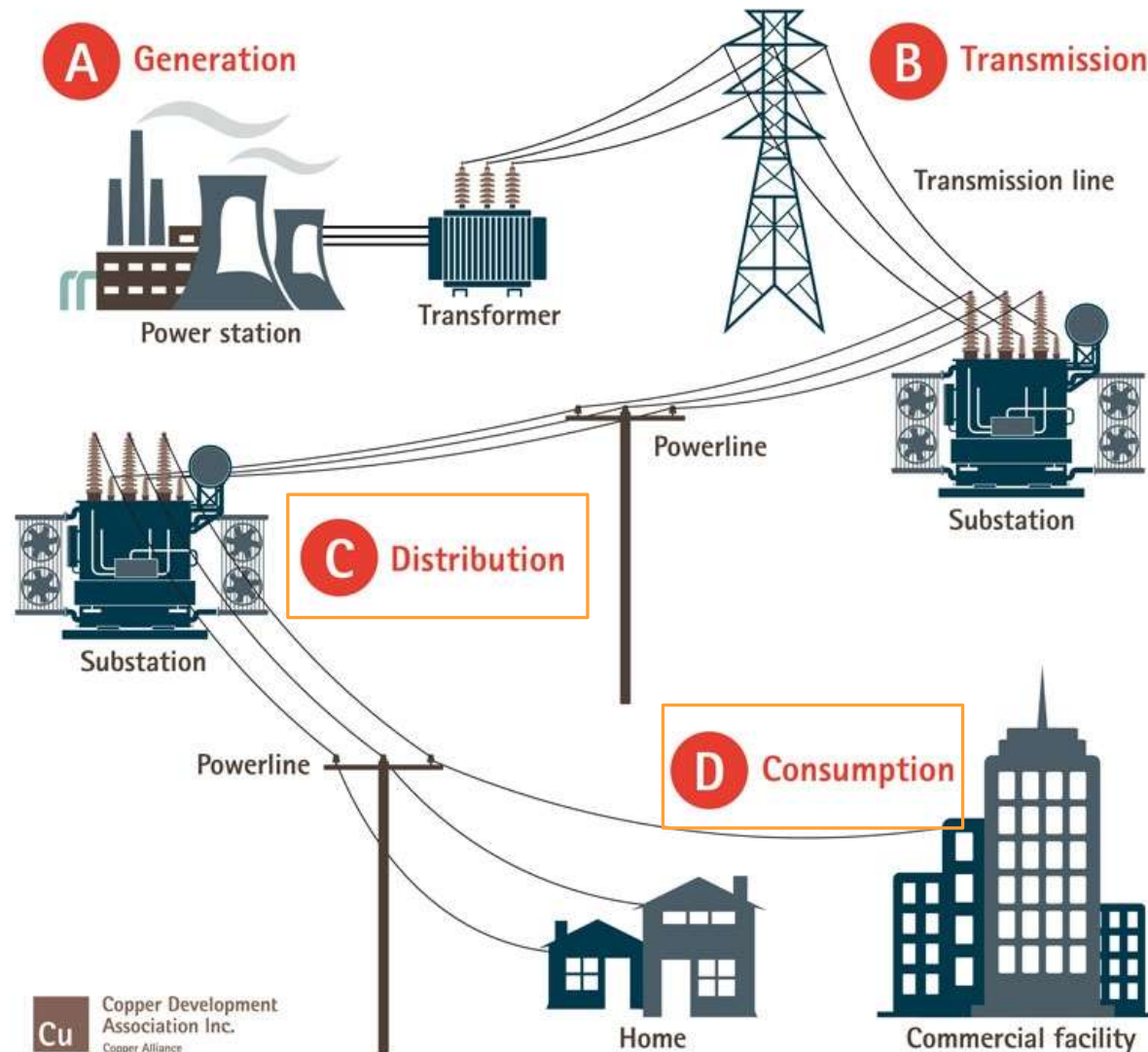
*“A **microgrid** is a group of interconnected **loads** and **distributed energy resources** within clearly defined electrical boundaries that acts as a **single controllable entity** with respect to the grid. A microgrid can connect and disconnect from the grid to enable it to operate in both grid-connected or island mode.”*

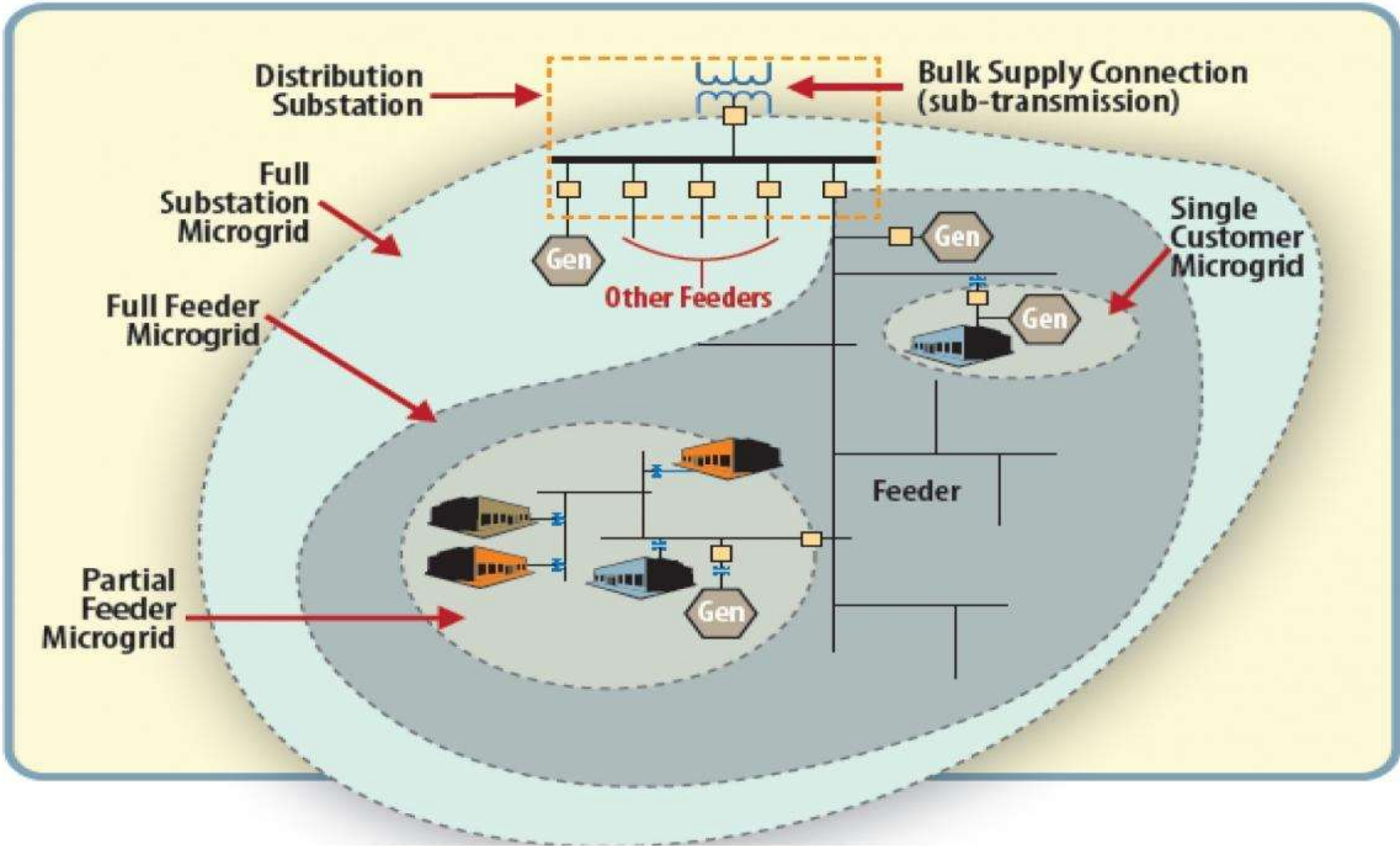




The grid is the keystone infrastructure – central to the web of interconnected systems that support life as we know it

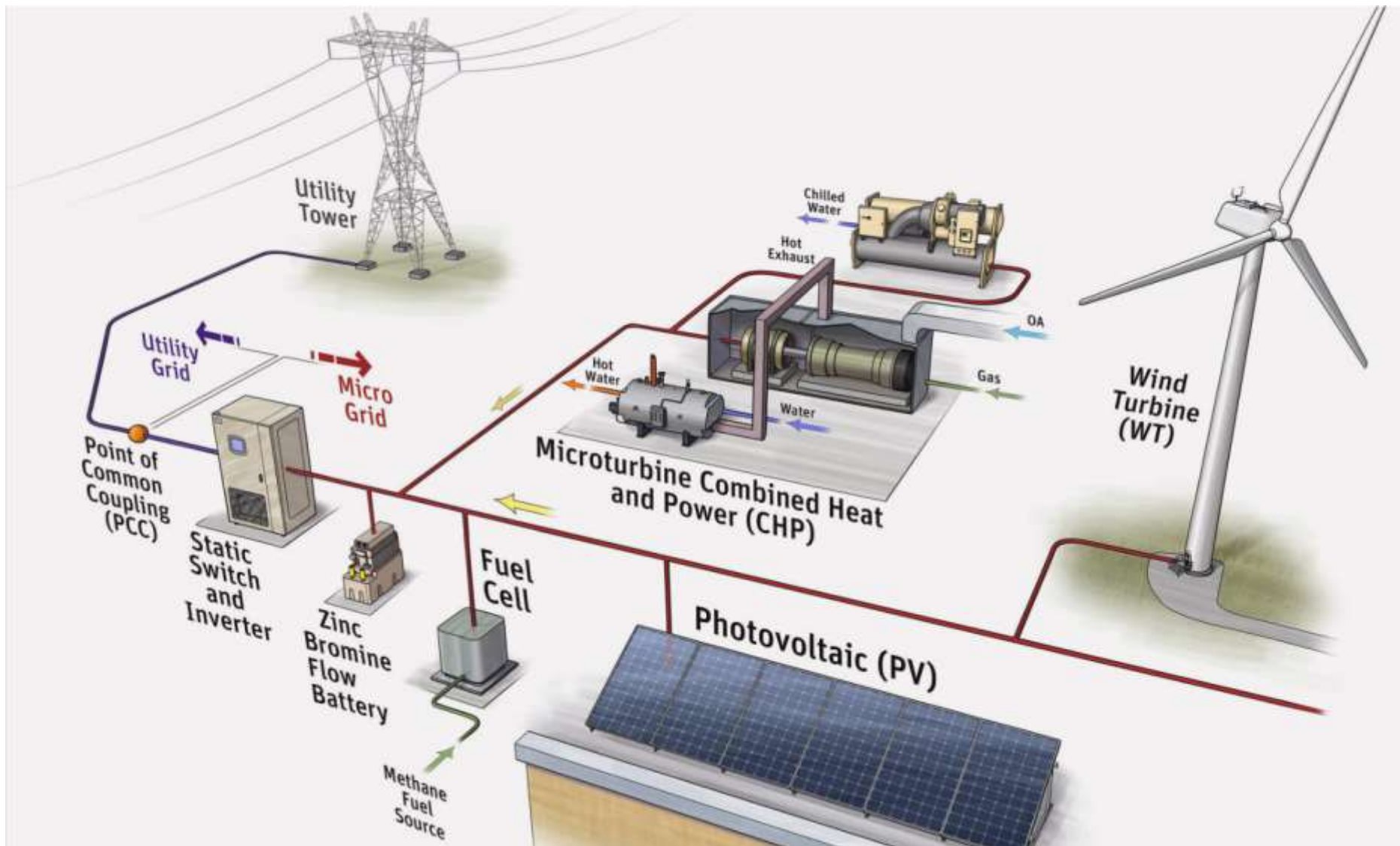
# Traditional Electric Grid and Microgrid



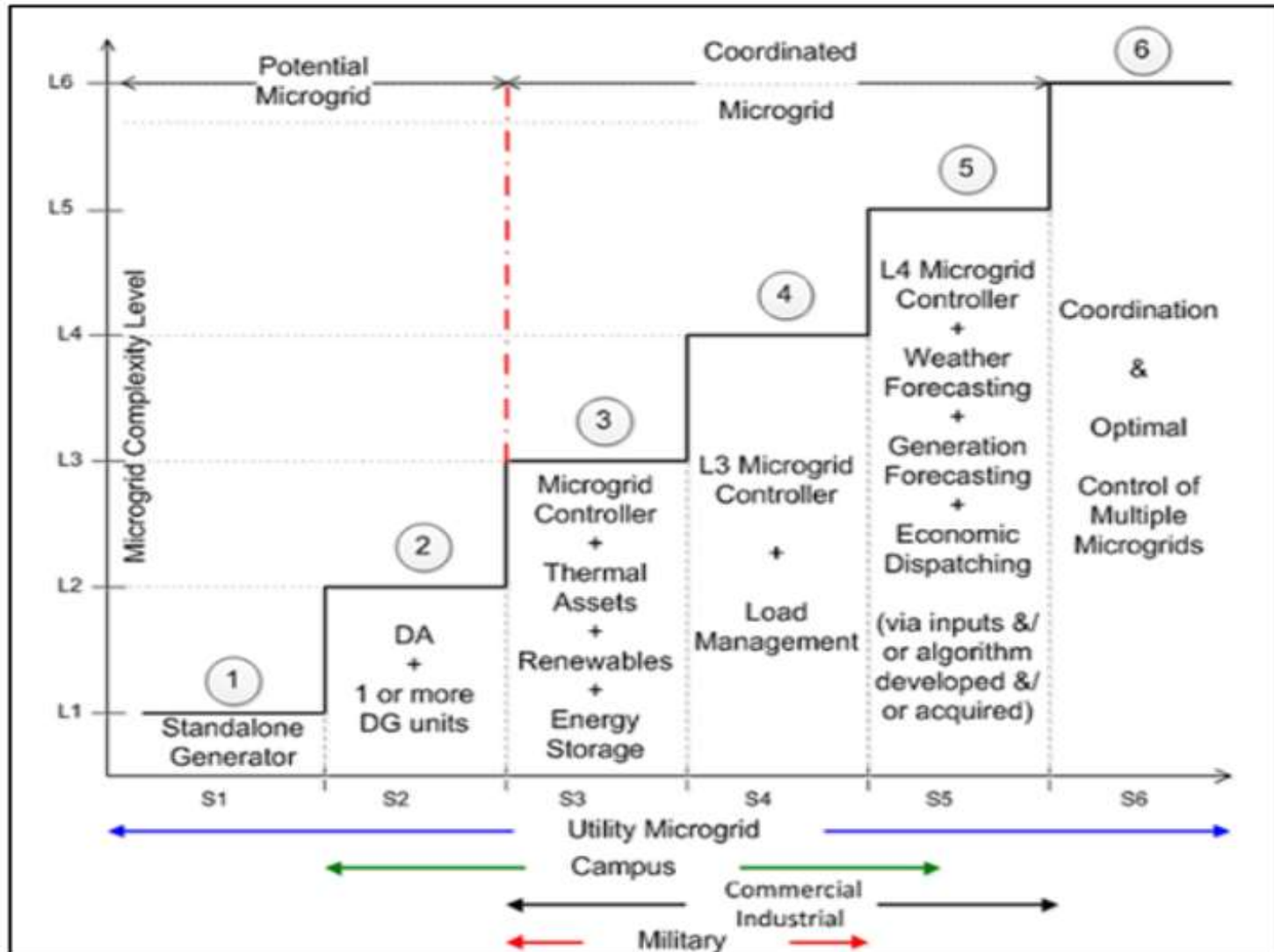




# Microgrid Illustration



# Microgrid Complexities

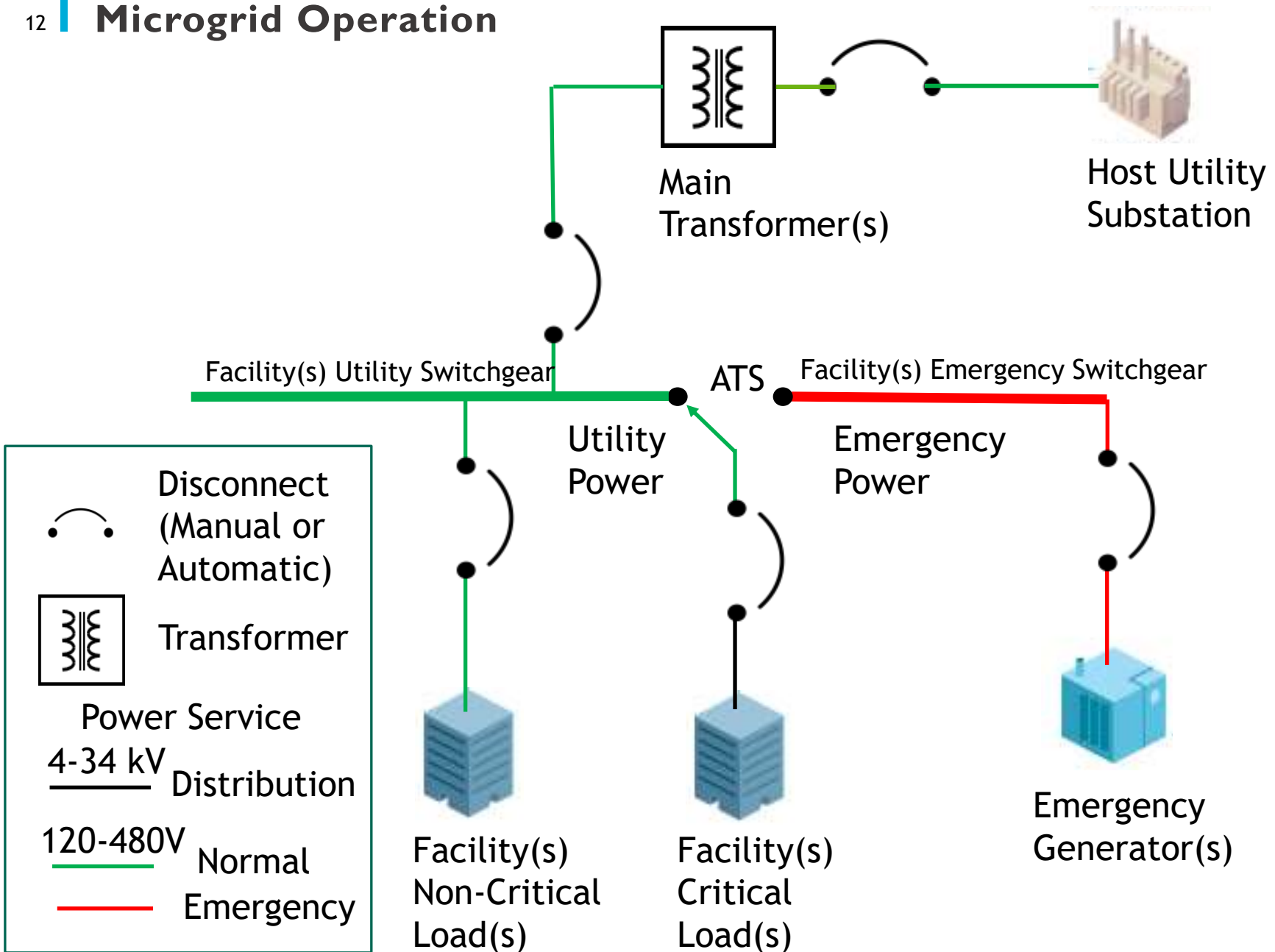




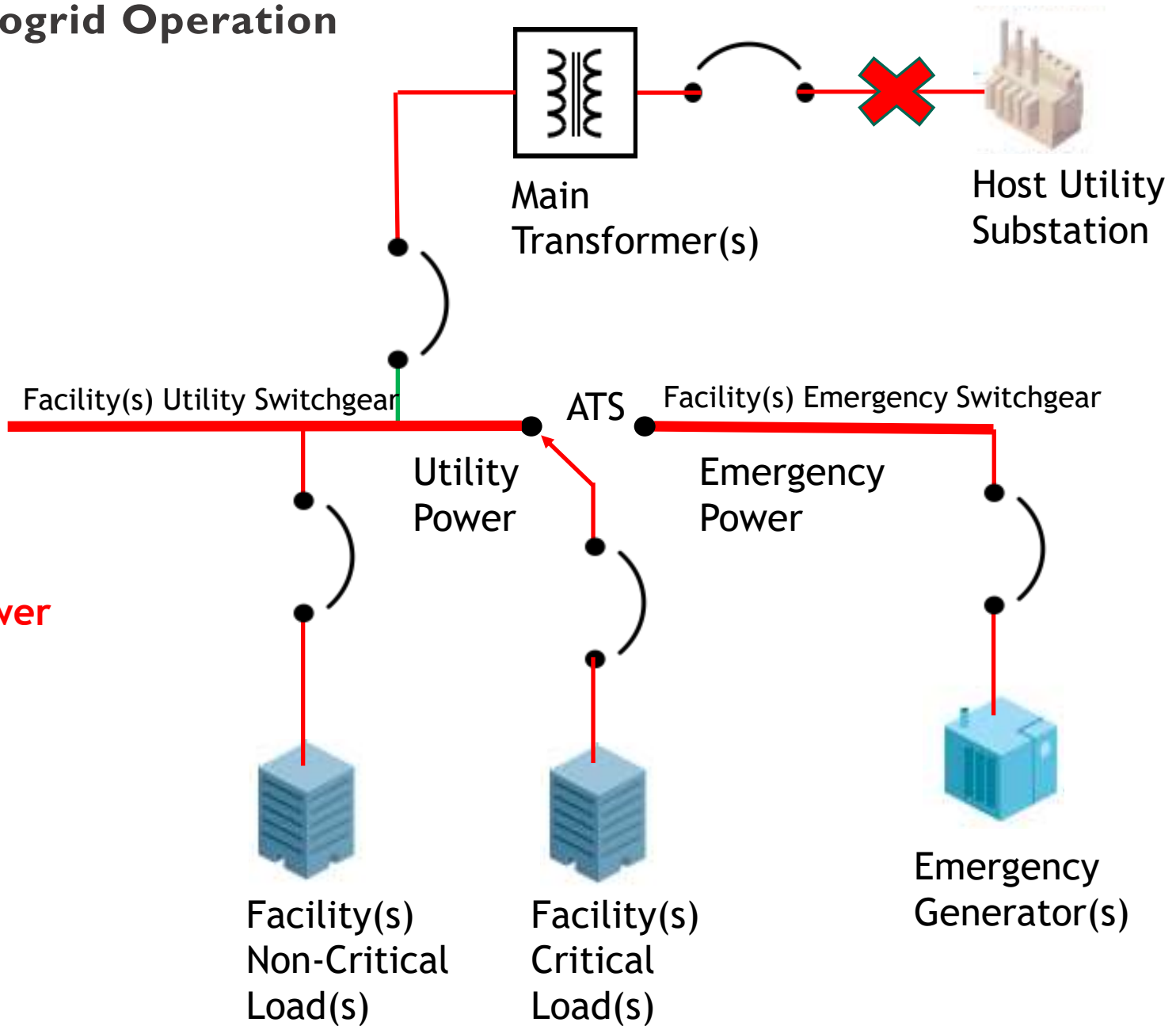
# Microgrid Architecture



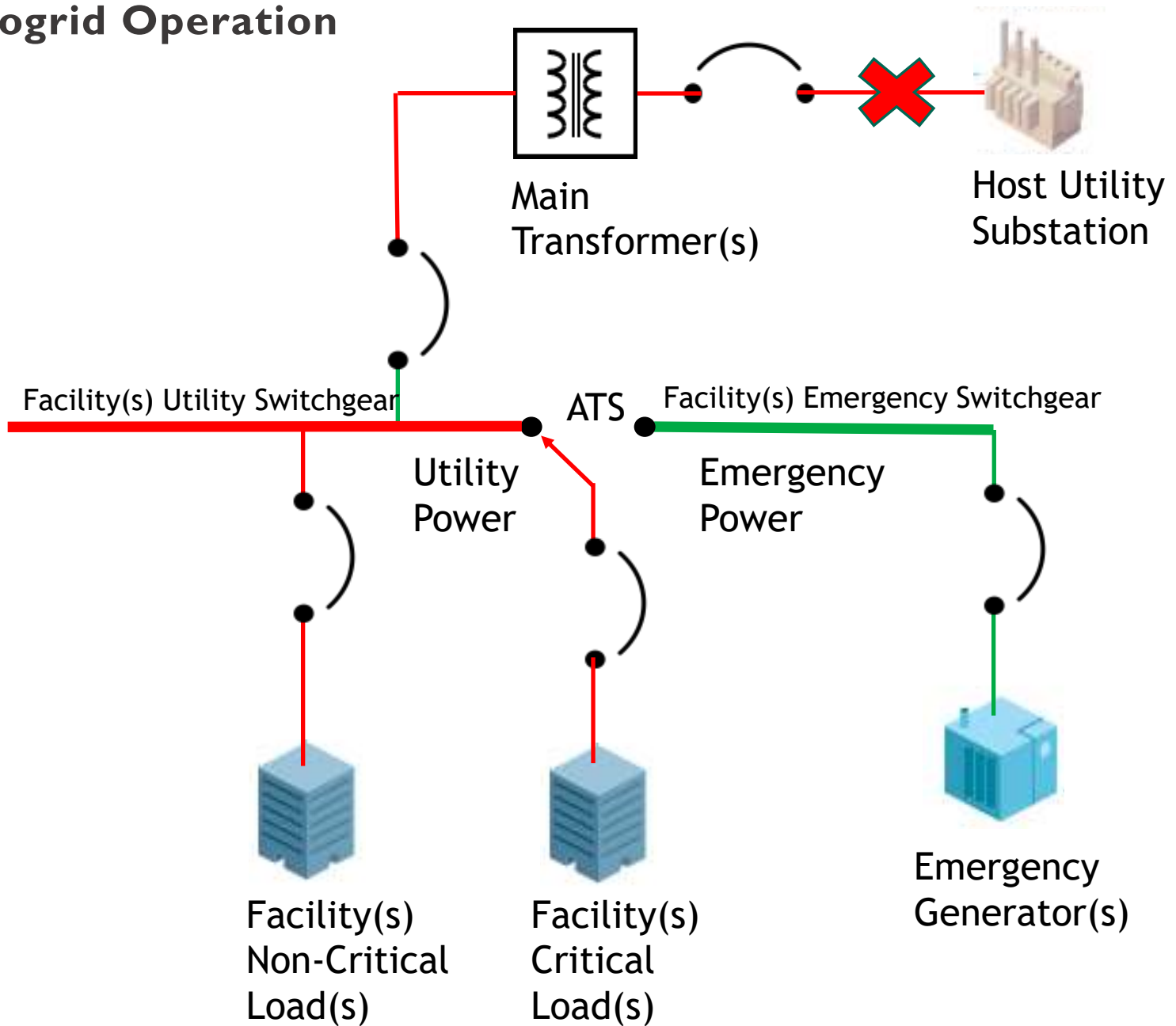
# Microgrid Operation



# Microgrid Operation

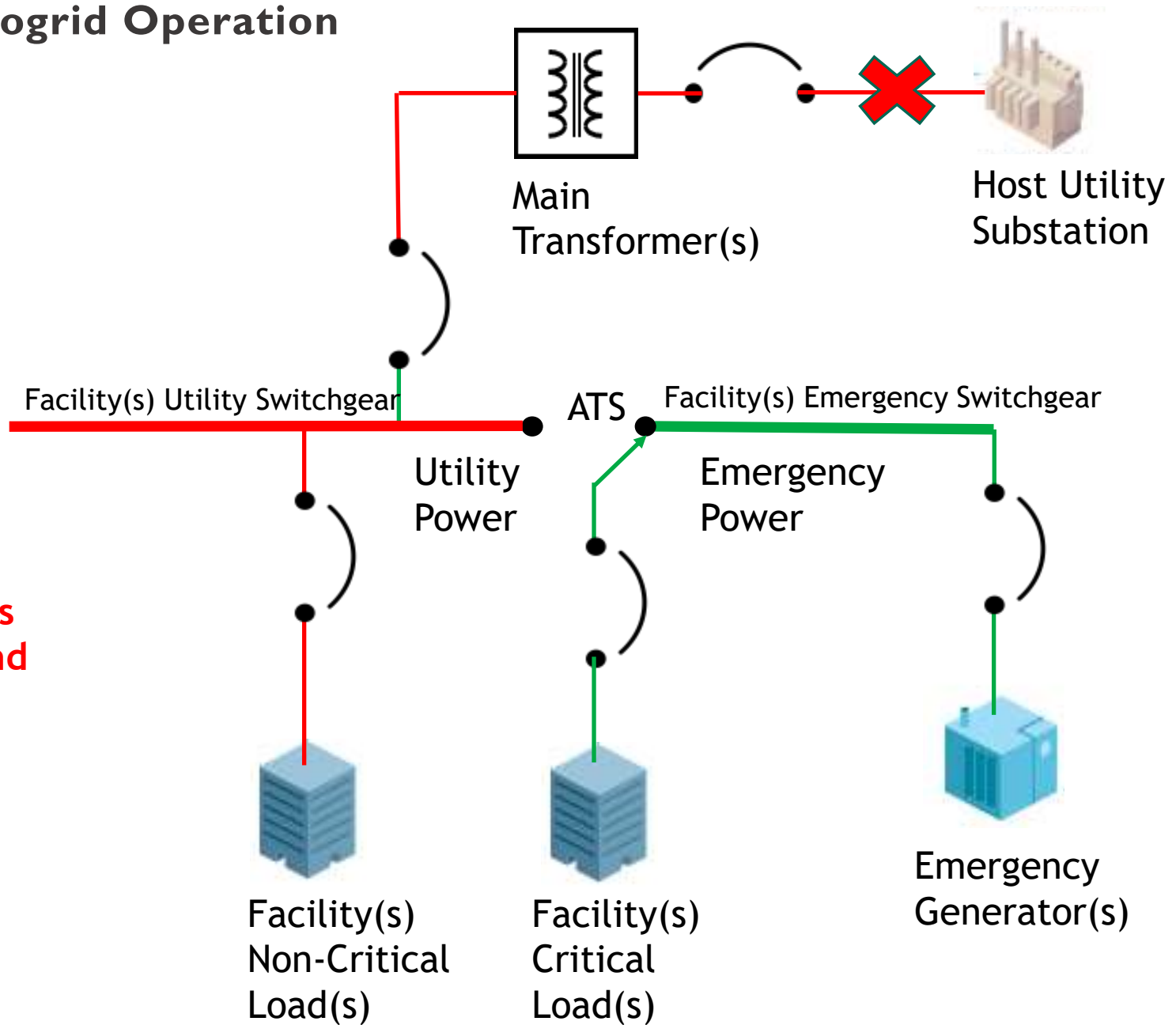


# Microgrid Operation

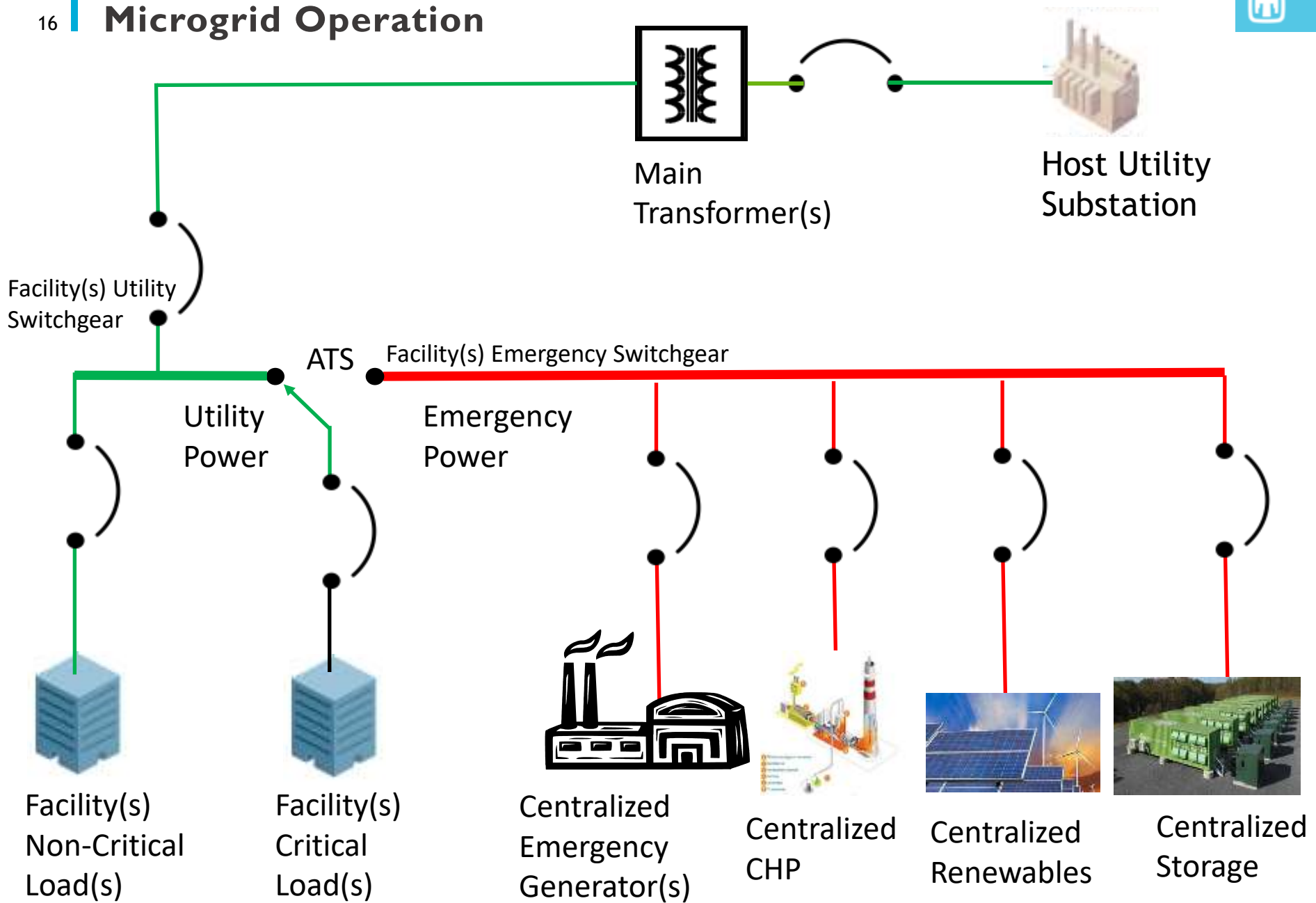


**Back-Up  
Generator  
Starts**

# Microgrid Operation

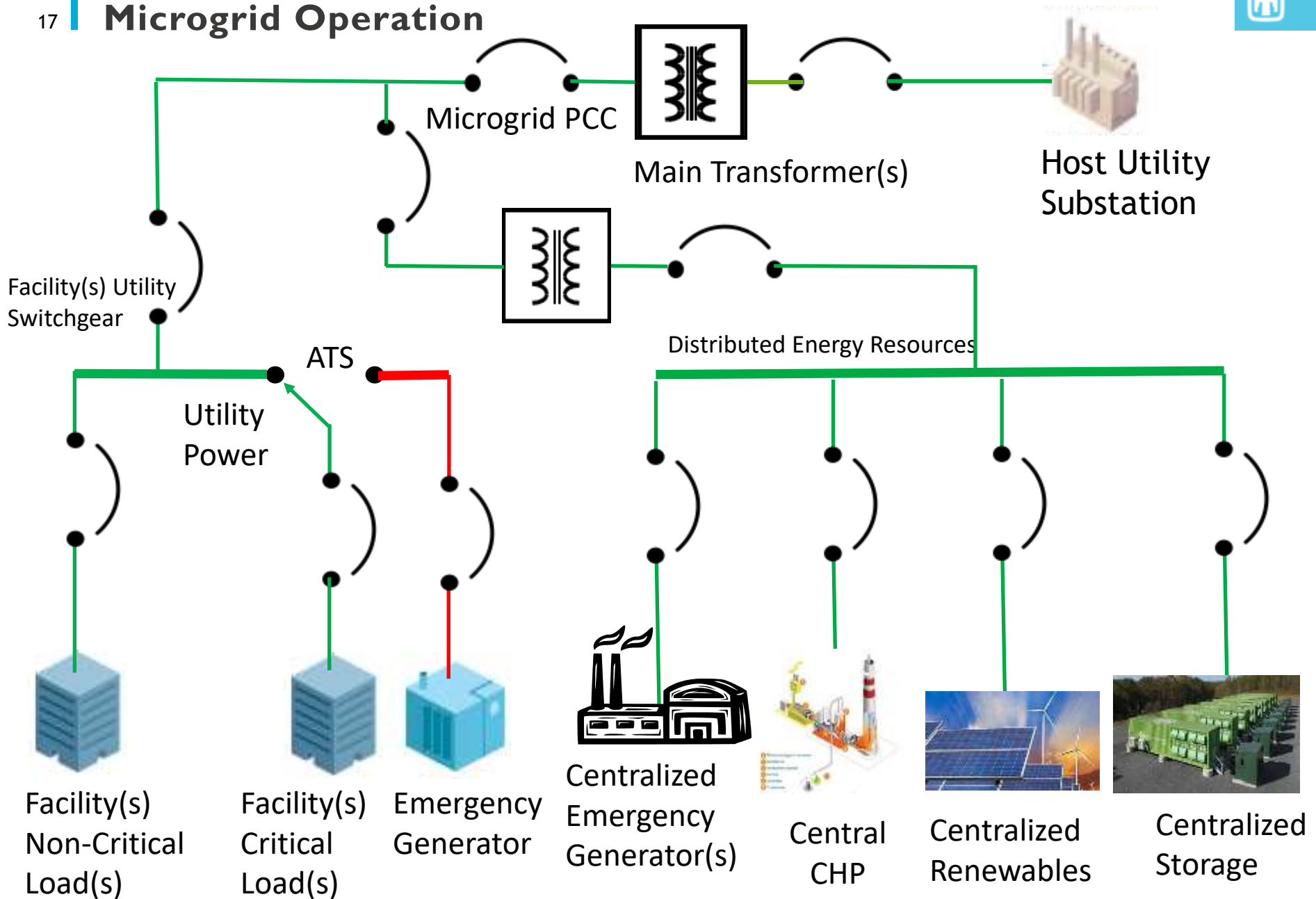


# Microgrid Operation

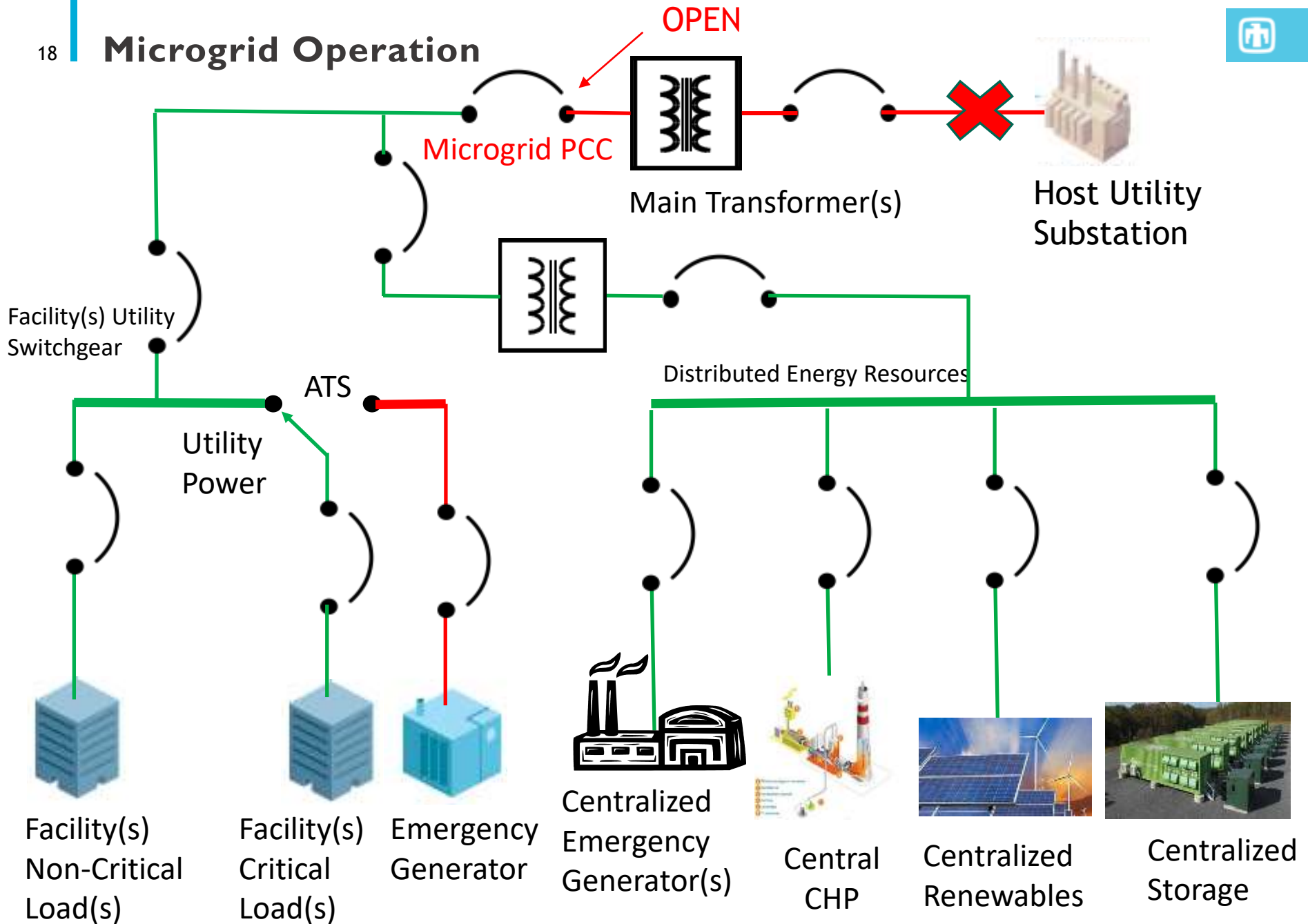




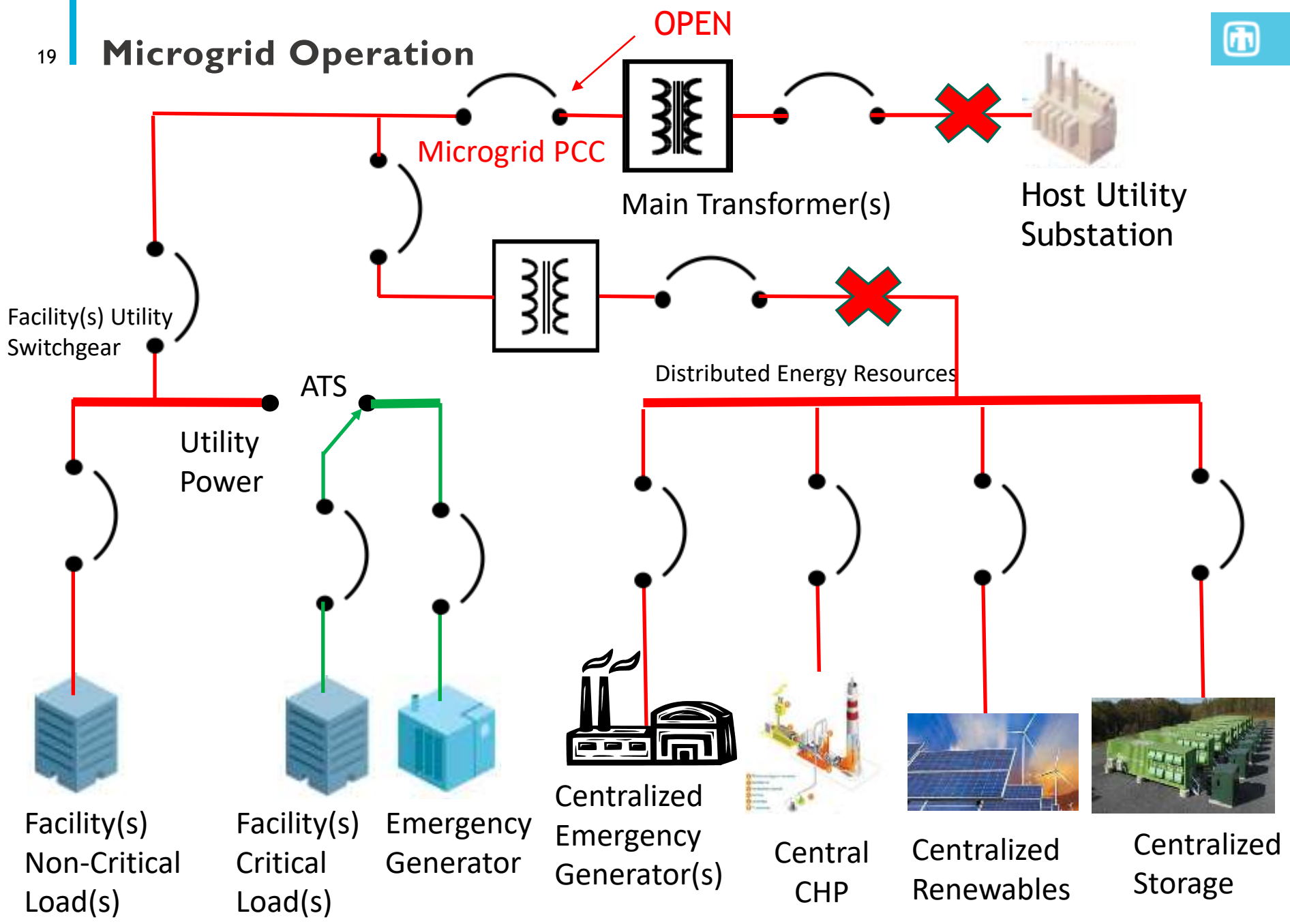
# Microgrid Operation



# Microgrid Operation



# Microgrid Operation





- **Distributed or Central Electrical Generation**
  - Generators (Diesel, Natural Gas, Propane, Hydrogen, etc)
  - Renewable Energy (Wind, Solar, Hydro, Geothermal, etc.)
  - Energy Storage (Batteries, Flywheels, Hydrogen, etc.)
  - Fuel Cells



Diesel Generator

- **Isolation, Switching and Protection**
  - Reclosers
  - Automatic Transfer Switches (Building, 15kV, etc.)
  - Breakers (Manual, Automatic, Shunt Trip)
  - Relays (Configurable)



15kV Pad Mount Switch

- **Controls and Communication**
  - Microgrid Controller (Central, De-centralized, etc.)
  - Generation Controller (BMS, Diesel Control, et.)
  - Building Controller (Building Management System, etc.)
  - Communication Medium (Fiber, Copper, Radio, Cell, etc.)



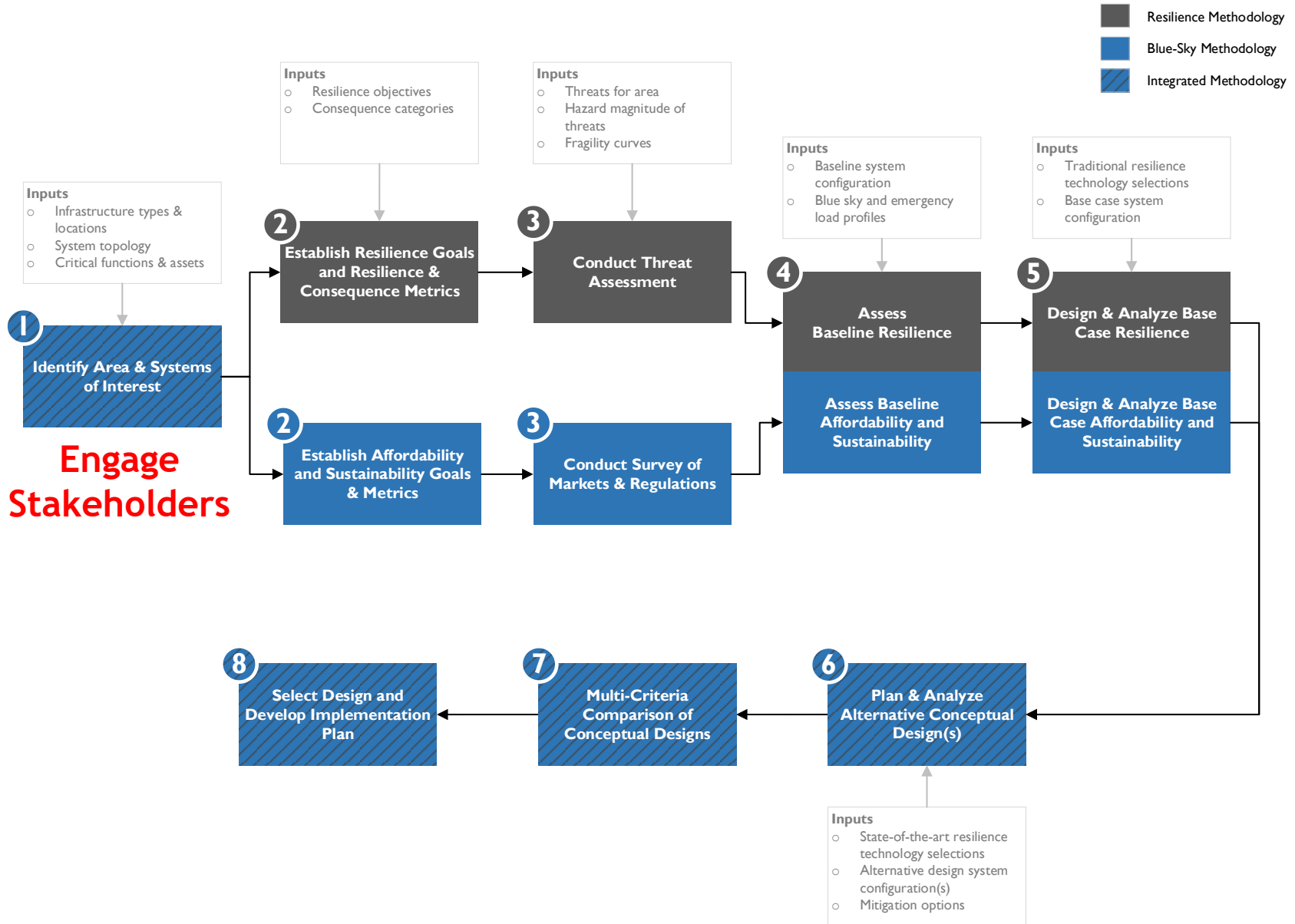
Microgrid Controller

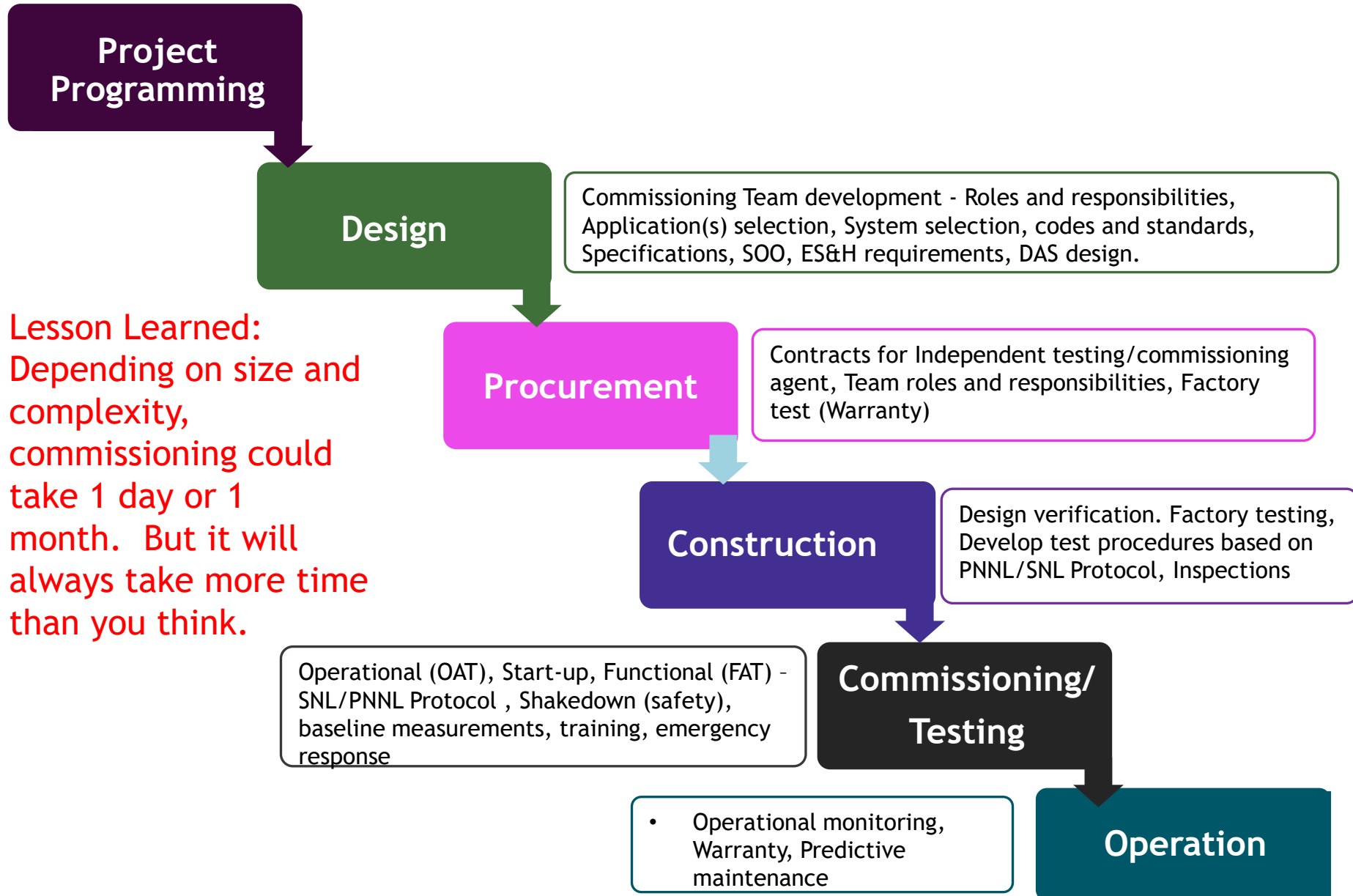
- **OTHER**
  - Balance of Plant (Enclosures, Foundations, Transformers, etc)
  - Physical Security (Fences, Locks, etc.)



# Project Process









# Case Study

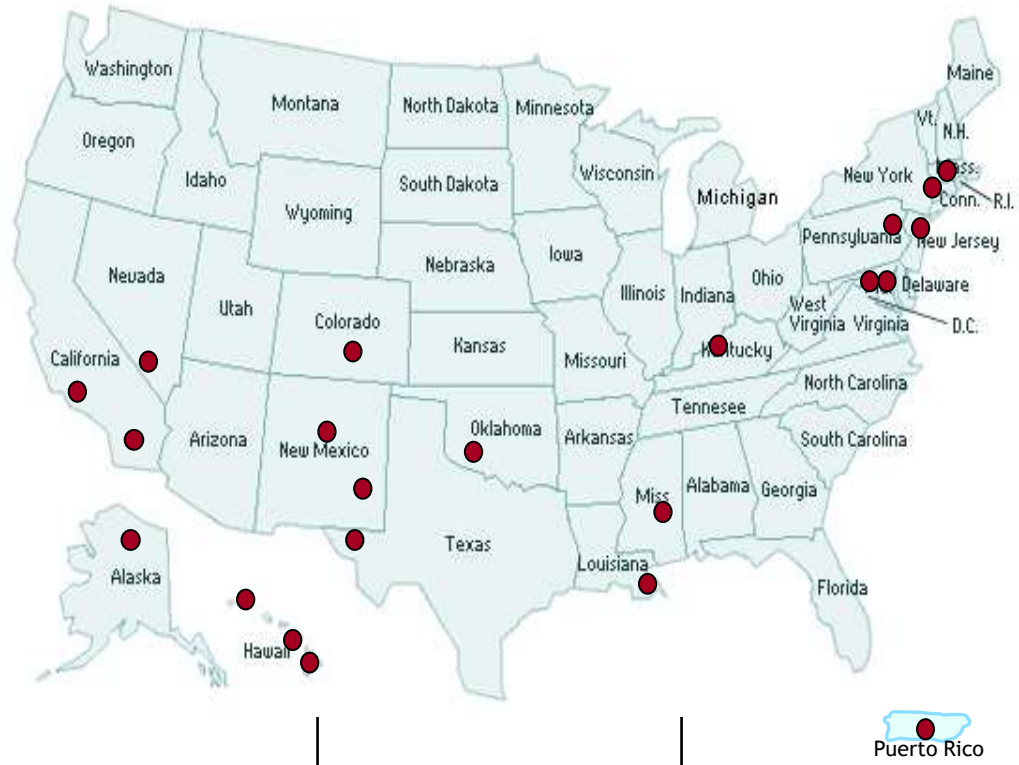




# Sandia Energy Surety Microgrid Efforts



Conceptual Designs/Assessments	Small Scale Microgrid Demos	Large Scale Microgrid Demos	Operational Prototypes
<ul style="list-style-type: none"> <li>• Creech AFB – FY12 DoD</li> <li>• <b>Soto Cano – FY12 DoD</b></li> <li>• West Point FY12, DoD/DOE</li> <li>• <b>Osan AFB, FY 12, DoD</b></li> <li>• Philadelphia Navy Yard – FY11, DOE OE/PIDC</li> <li>• Camp Smith – FY10, DOE FEMP</li> <li>• Indian Head NWC – FY09, DOE OE/DoD</li> <li>• Ft. Sill – FY08, Sandia LDRD</li> <li>• Ft. Bliss – FY10, DOE FEMP</li> <li>• Ft. Carson – FY10, DOE FEMP</li> <li>• Ft. Devens (99<sup>th</sup> ANG) – FY09, DOE OE/DoD</li> <li>• Ft. Belvoir – FY09 DOE OE/FEMP</li> <li>• Cannon AFB – FY11, DOE OE/DoD</li> <li>• Vandenberg AFB – FY11, DOE FEMP</li> <li>• Kirtland AFB – FY10, DOE OE/DoD</li> <li>• Maxwell AFB – FY09, DoD/DOE</li> <li>• Alaska Villages– FY12, DOE</li> <li>• <b>Bagram – FY13, DoD</b></li> <li>• <b>Kuwait – FY15, DoD</b></li> <li>• 29 Palms – FY14, DoD</li> <li>• <b>Korea Naval Academy – FY16, DoD</b></li> <li>• Kauai – FY15, DOE</li> <li>• Northhampton, MA – FY14, DOE</li> <li>• Hoboken, NJ – FY16 DOE</li> <li>• New Orleans – FY17, DOE</li> <li>• NJ Transit – FY17, DOE</li> <li>• UPS in KY – FY17, DOE</li> <li>• Puerto Rico – FY19, DOE</li> <li>• Kirtland – FY20, DOE</li> </ul>	<ul style="list-style-type: none"> <li>• Maxwell AFB – FY09, DoD</li> <li>• Ft. Sill – FY09, DoD w/ SNL serving as advisor</li> <li>• Kirtland DC Microgrid – FY19, DoD</li> </ul>	<ul style="list-style-type: none"> <li>• SPIDERS JCTD – FY11, DOE/DoD                             <ul style="list-style-type: none"> <li>• Camp Smith</li> <li>• Ft Carson</li> <li>• Hickam AFB</li> </ul> </li> <li>• Cordova – FY19, DOE</li> </ul>	<ul style="list-style-type: none"> <li>• H.R. 5136 National Defense Authorization Act</li> </ul>

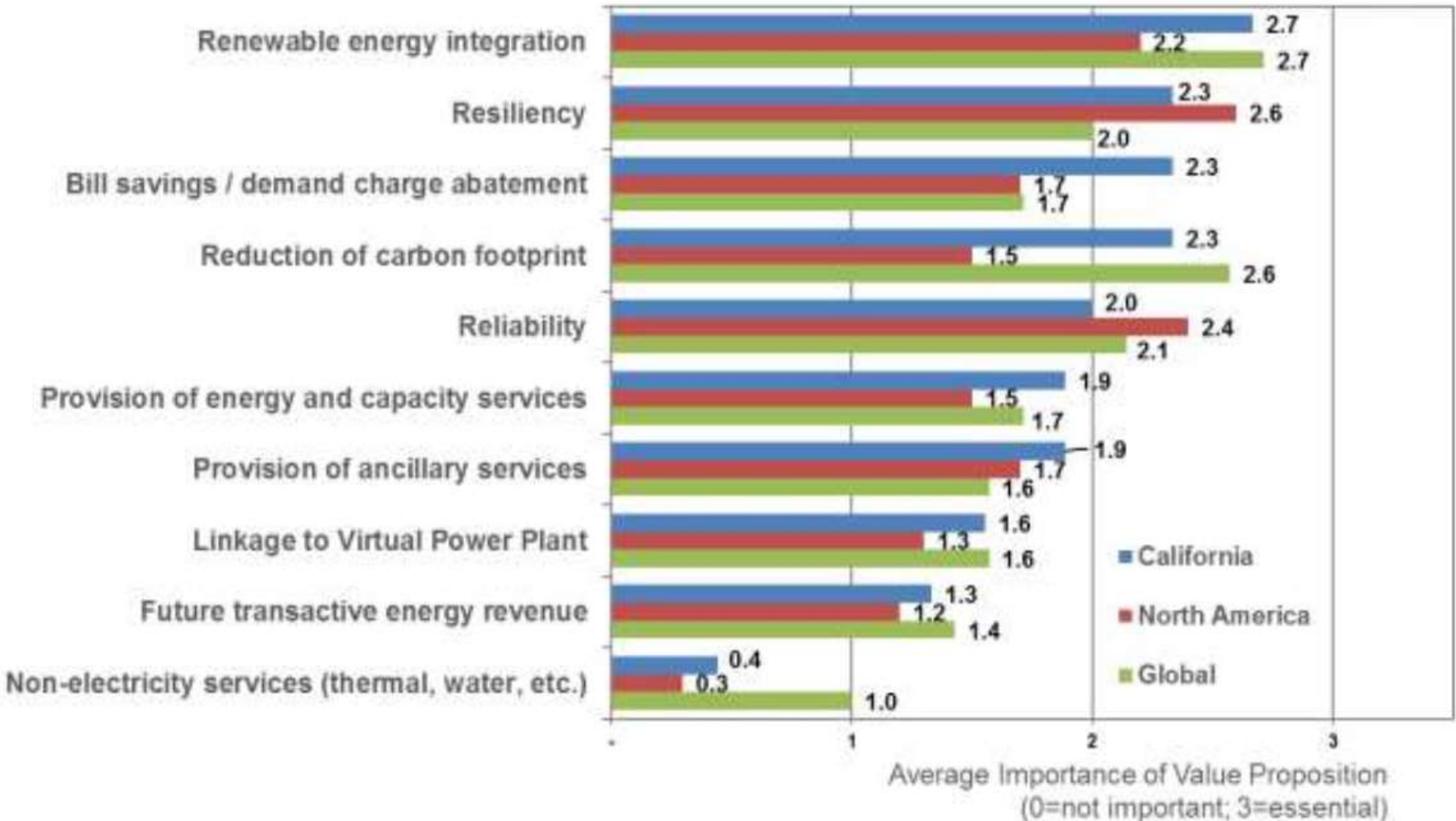


## Case Studies: California Energy Commission

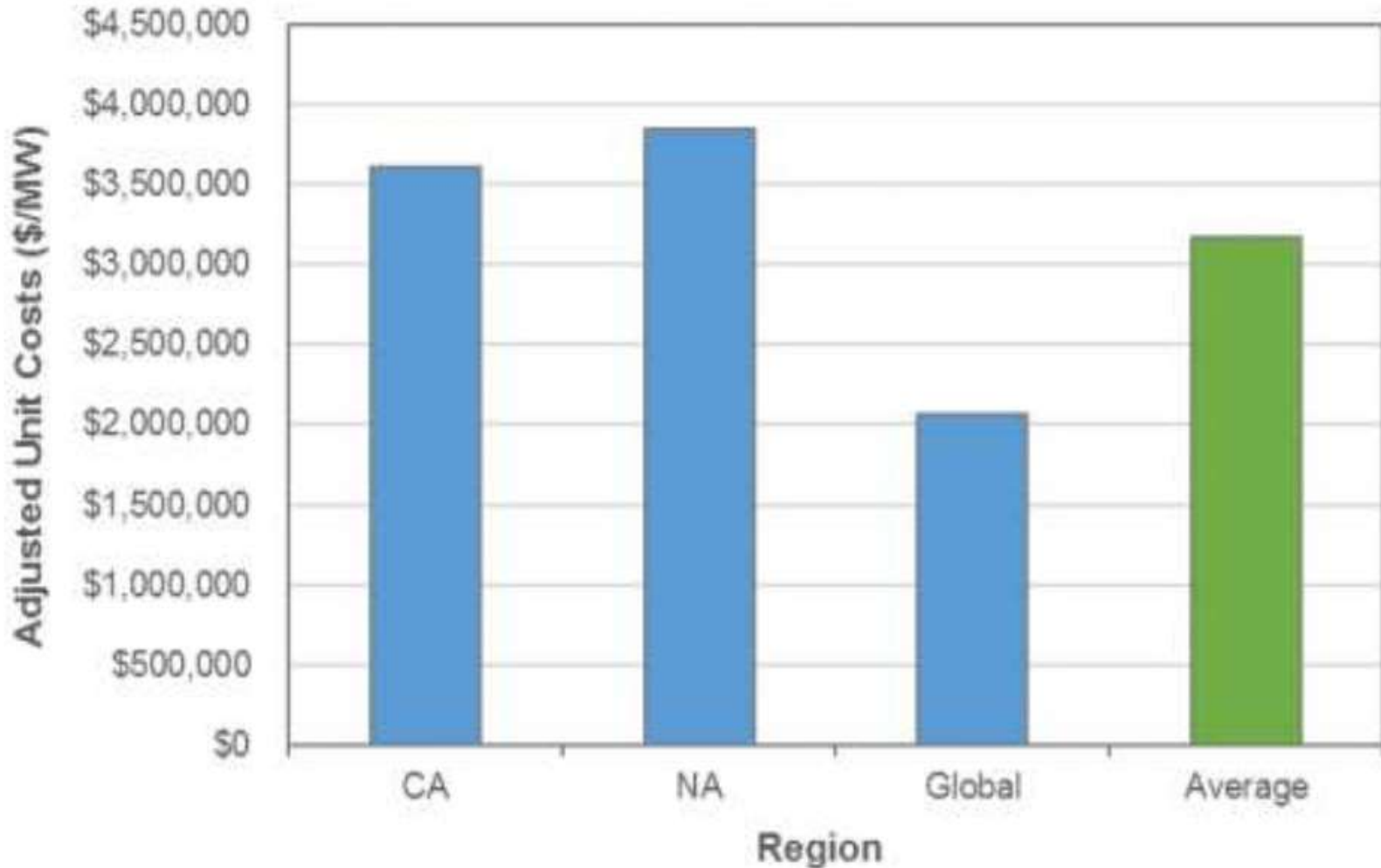


- 2018 - Navigant performed a review on 9 microgrids within the California Energy Commission
- Microgrids range from 153kW to 13.5MW
- All 9 microgrids consisted of solar plus storage
- Generation mix was 88% Clean Energy and 12% Fossil Fuel
- Types of Economic Mechanisms
  - Energy Management Services Agreement: Contractor supplies demand response to SCE (cost savings split between owner and contractor) and owner pays monthly maintenance fees
  - Power Purchase Agreement
  - Service Contract: Contractor provides reduction to demand charges and splits savings with owner
  - Arbitrage for residential: Research purposes not economical
  - Utility Owned: Peak shaving mitigation
  - Lease to Own: 7 year contract which lease is based on monthly electric savings (Freeze monthly electric bill)
  - Private Investment: Reduce GHG and resiliency
  - Government Investment: Military Construction (MILCON)

# Value Proposition



# Microgrid Costs



Source: Navigant Research, "Microgrid Analysis and Case Studies Report", CEC-500-2018-022, August 2018

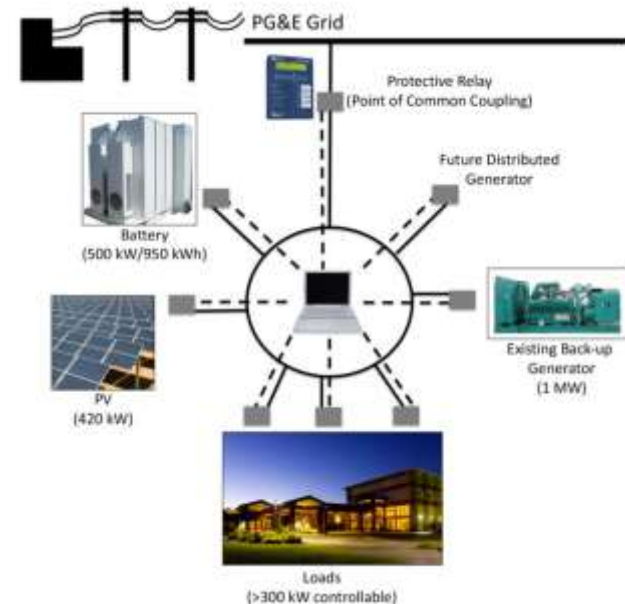
# Microgrid Case Study: Blue Lake Rancheria



<https://schatzcenter.org/blrmicrogrid/>

- **Location:** California
- **Application:** Energy demand reduction, resiliency, reduce GHG
- **Cost:** \$6.3M
- **R&D Cost:** 20%
- **Expected Revenue:** \$200k
- **NPV:** positive at ~20-25 years

- **Project Timeline:** 24 Months
- **Unplanned Outages:** 4 in 2017
- **Carbon Reduction:** 175 tons CO<sub>2</sub>
- **PV:** 15% of load demand



<https://schatzcenter.org/blrmicrogrid/>

## Contact Information

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