# Technical Considerations for Co-located Resources – Grid Integration and Reliability Studies

ESIG Conference
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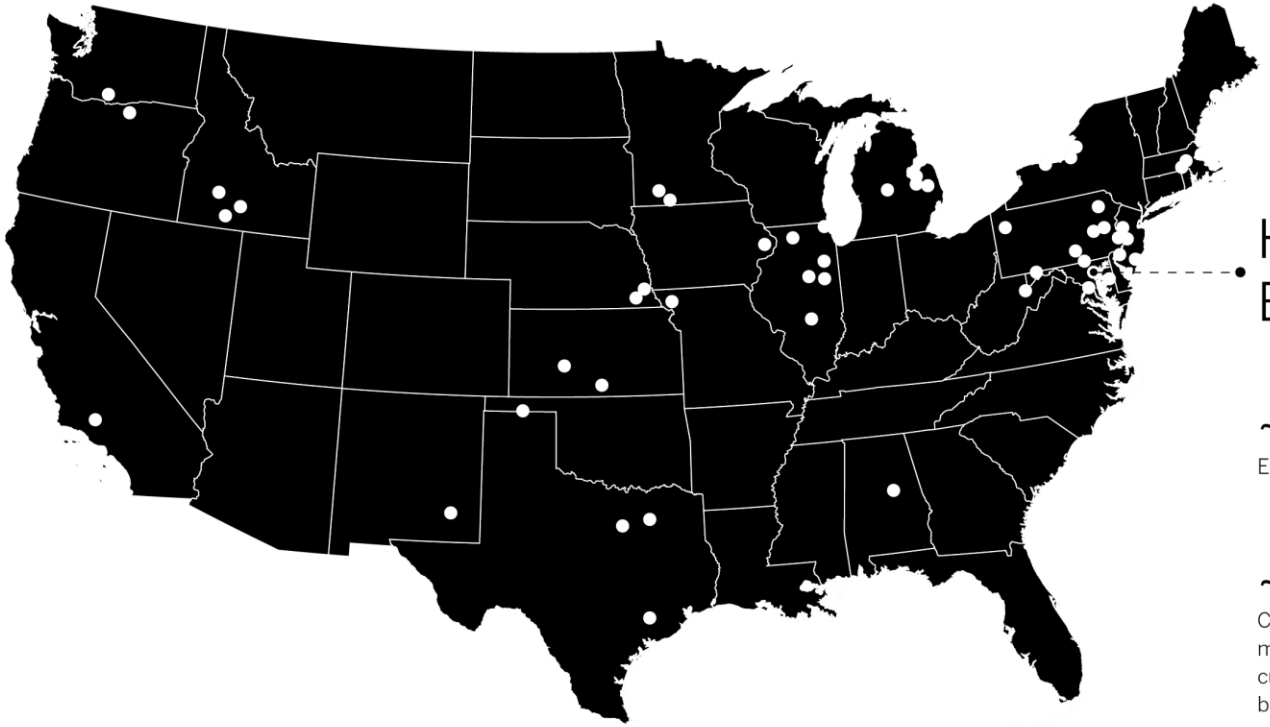
# Constellation At A Glance

## *Our Business*

*Constellation is the nations largest producer of clean, carbon-free energy and a leading supplier of energy products and services, including sustainable energy solutions.*



### 48 states

Operates in 48 U.S. states, the District of Columbia, Canada and the United Kingdom.

### >33,000 MWs

Constellation has a generating capacity of more than 33,000 MWs and an annual output that is nearly 90 percent carbon-free, generating enough clean, carbon-free energy to power the equivalent of 16 million homes.

### ~10%

Constellation produces approximately 10 percent of the carbon-free energy in the U.S.

### Headquartered in Baltimore

### ~14,000

Employs almost 14,000 people.

### ~2 million

Constellation serves approximately two million residential, public sector and business customers through our family of retail businesses.

### 75%

Constellation supplies energy products and services, including sustainability solutions, to 75 percent of Fortune 100 companies.



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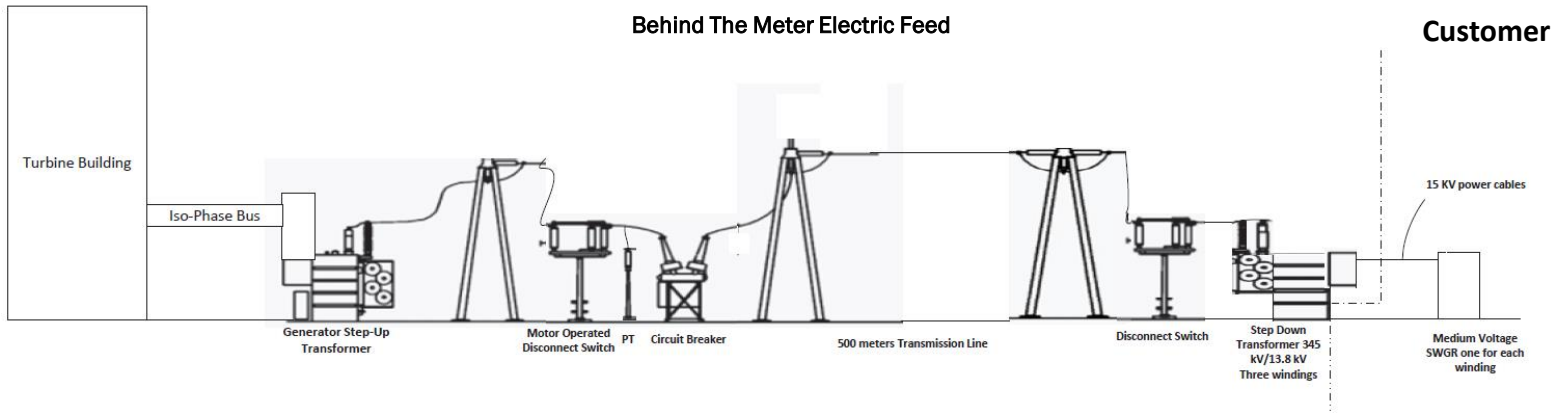
# Why / What Is Behind The Meter (BTM) All About?

- Opportunity to stabilize generation revenue by co-locating customers at the nuclear site, with pricing that recognizes the carbon-free and reliable attributes of our power.  Customers obtain direct access to highly reliable carbon-free power, potentially avoiding some grid-related charges.
- Speed to market – generally can build and interconnect customer 2+ years faster than local Utility
- Useful attributes at most nuclear plants: large land, clean highly reliable electric power, water and rail access, heat
- Top co-location customer interests: Data Centers, H2 production, Sustainable Aviation and Diesel Fuel production, Direct Air CO2 Capture



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# Data Center Land & Power Requirements and Realities

**Must Have**

- Land capable of a data center build (generally less than 15 degree slope)
- Outside of 500 year flood zone
- Limited wetlands
- Limited impacts from endangered species and historical artifacts
- Clear path to land entitlement: zoning and permitting
- Access to power

**Nice-to-Haves**

- 300+ contiguous acres
- Known utility capacity and approvals
- Direct access to high voltage power
- Redundant power feeds
- Fast-track site readiness to build
- Permitted, Zoned and Entitled land
- Local and state tax incentives
- Carbon Free energy source
- Competitive power prices
- Water for cooling

**Nirvana**

- 300+ contiguous acres
- No flood, wetlands or other risk elements
- Fully entitled, zoned, permitted
- Direct substation access
- 50+MWE on day 1
- 300+ MWE by year 3
- Full local and state tax incentives
- Carbon Free energy source
- Competitive power prices



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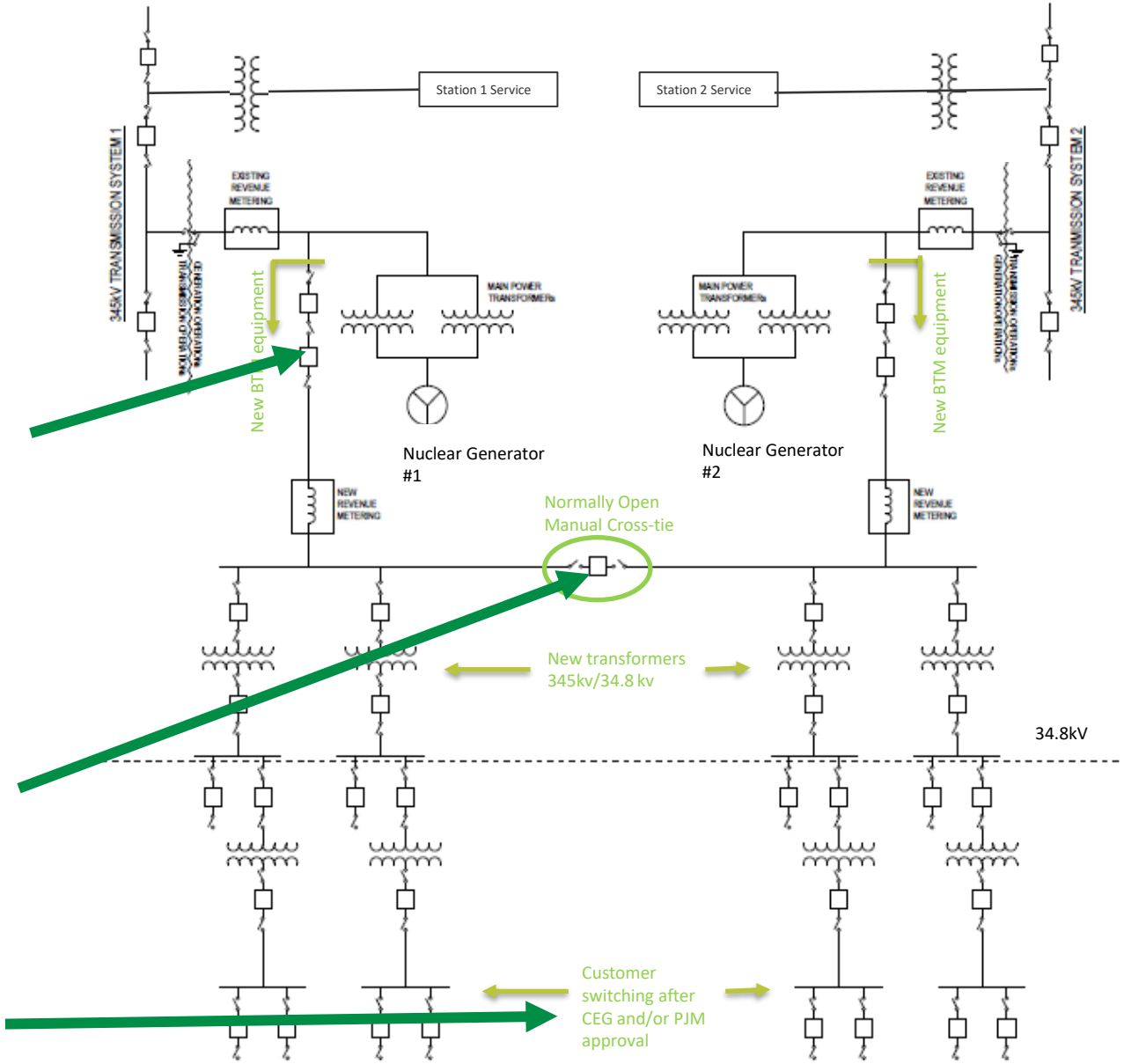
# Isolating Dual Unit Supply & High Side Manual Cross-Tie

The CEG Behind the Meter (BTM) design does not allow grid power or services to flow back to the customer. This design has been approved by PJM and the local TO.

- Automated circuit breakers open preventing the customer taking grid power in less than 3 cycles (60 cycles/sec) should customer load exceed the unit generation. This ensures that all BTM load, including any fluctuations in demand, is served entirely and solely by the generator's output. The generator's net production after serving BTM load is delivered into the PJM market, measured by the revenue meter.
- A normally open manual high side breaker can be closed (with CEG/PJM permission) to allow the customer to power from either unit. Breaker closure takes about 12 hours after a forced unit outage.
- Customer can switch unit connection with CEG/PJM permission at low side voltage based on unit contingency arrangements in the ISA. Customer switching is nearly instantaneous once approved.



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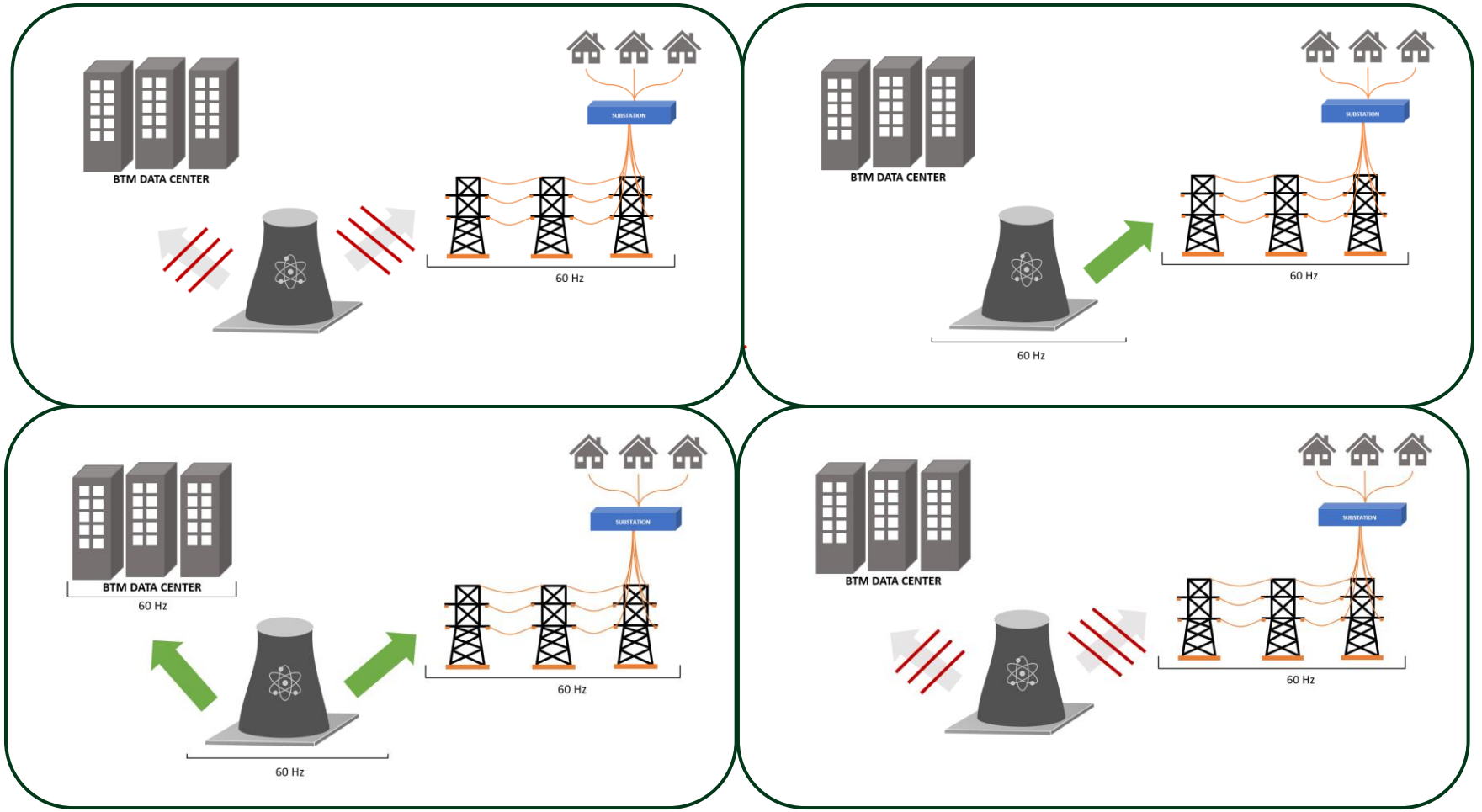
# Isolating Grid Services Provided by Nuclear Unit to Co-located Load

- BTM load is automatically disconnected when nuclear unit is out of service.
- Nuclear unit connects to the grid then BTM load connects to the nuclear unit - all maintain the same frequency of 60Hz.
- Nuclear unit provides services directly to the load:
  - Real power (MWe) from the generator at actual load including fluctuations
  - Reactive power (VARs) by D-curve or Cap Banks
  - Voltage control and frequency support by voltage regulator
  - Black start by the power plant being on line



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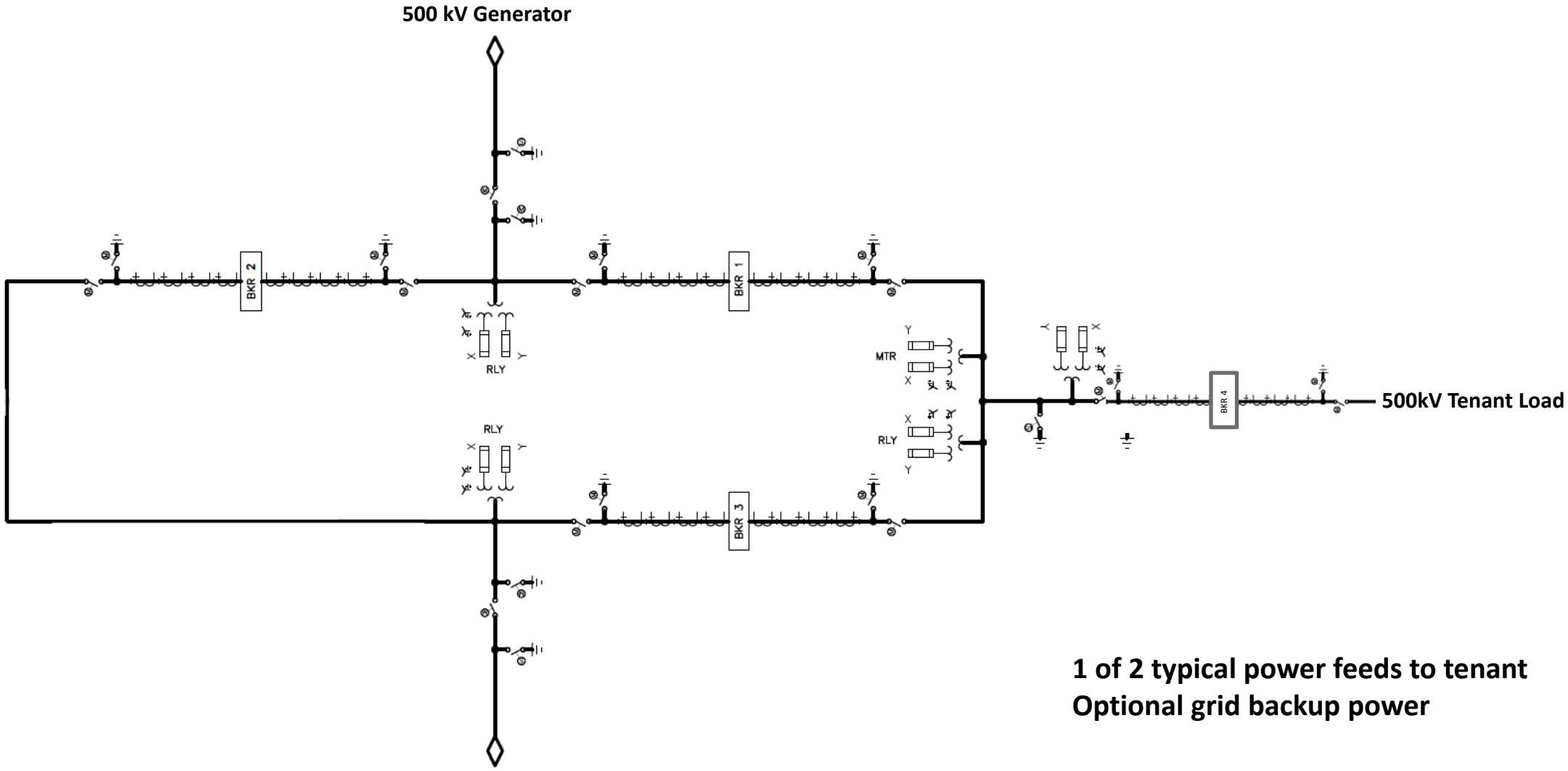
# Alternate BTM Interconnection 4-Breaker Configuration




**1 of 2 typical power feeds to tenant**
**Optional grid backup power**



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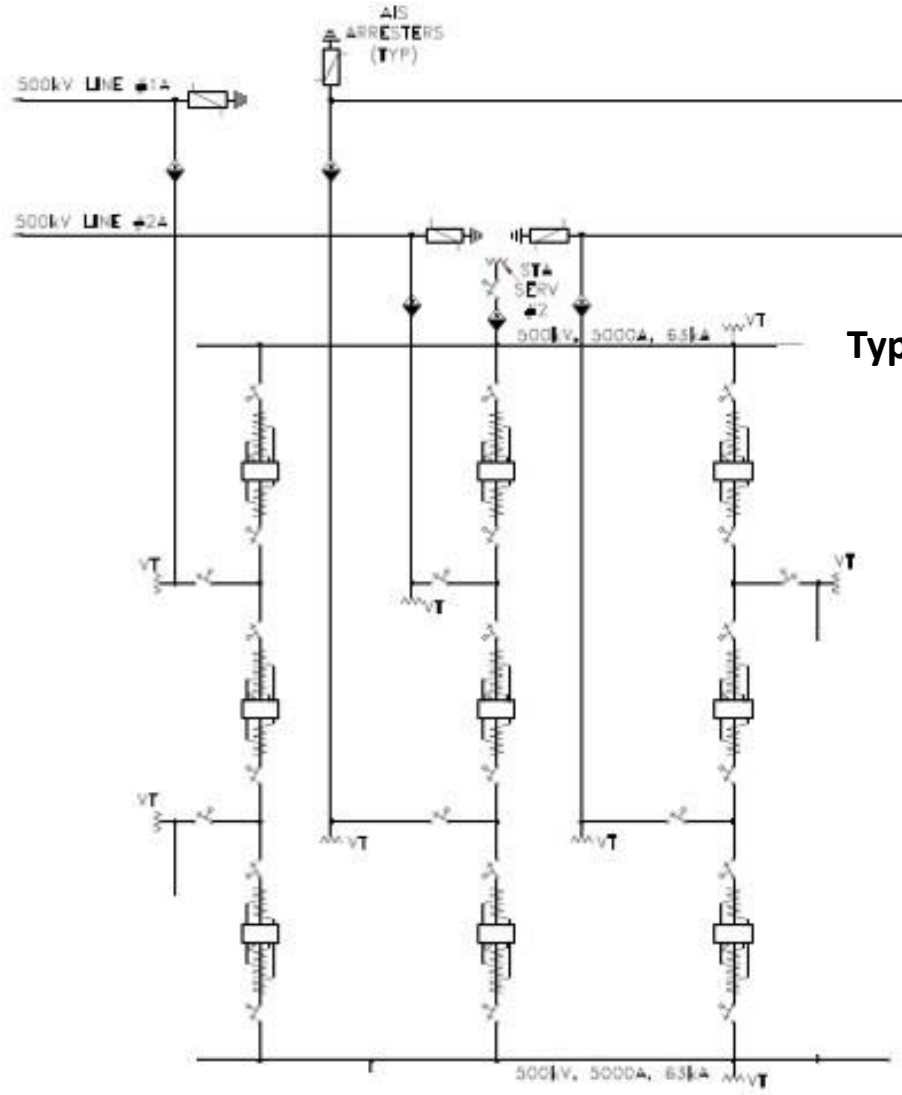
# Front of The Meter Interconnection – Breaker and a Half




500 kV Grid

Typical power feeds to tenant

Typical power feeds to tenant



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# Electrical Studies and Other Considerations For Large Load Co-location

- Steady state and Transient stability analysis
- Short circuit, fault currents and harmonics – both grid and generator
- Zones of protection, Protection schemes
  - Generator and Grid protection coordination
  - NERC protection requirements
- Necessary and/or Load Deliverability studies
  - Grid support could involve VARs, thermal overloads
- Operation and Maintenance isolation
- Capacity derating - for Behind The Meter / Private Use Network configurations
- Best Practices:
  - IEEE 519 – Harmonic Control in Electrical Power Systems
  - Parallel or advanced independent grid studies
  - EPRI – BTM Large Electric Load analysis

# Questions?