



Practical Guidance and Considerations for Large Load Interconnections

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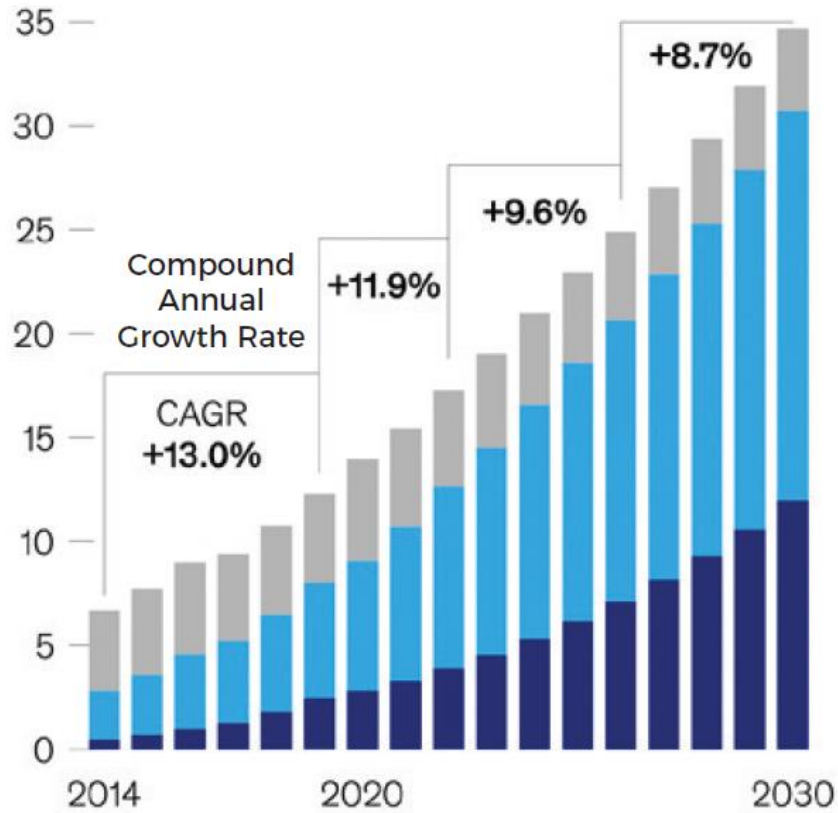
September 18, 2025

Background

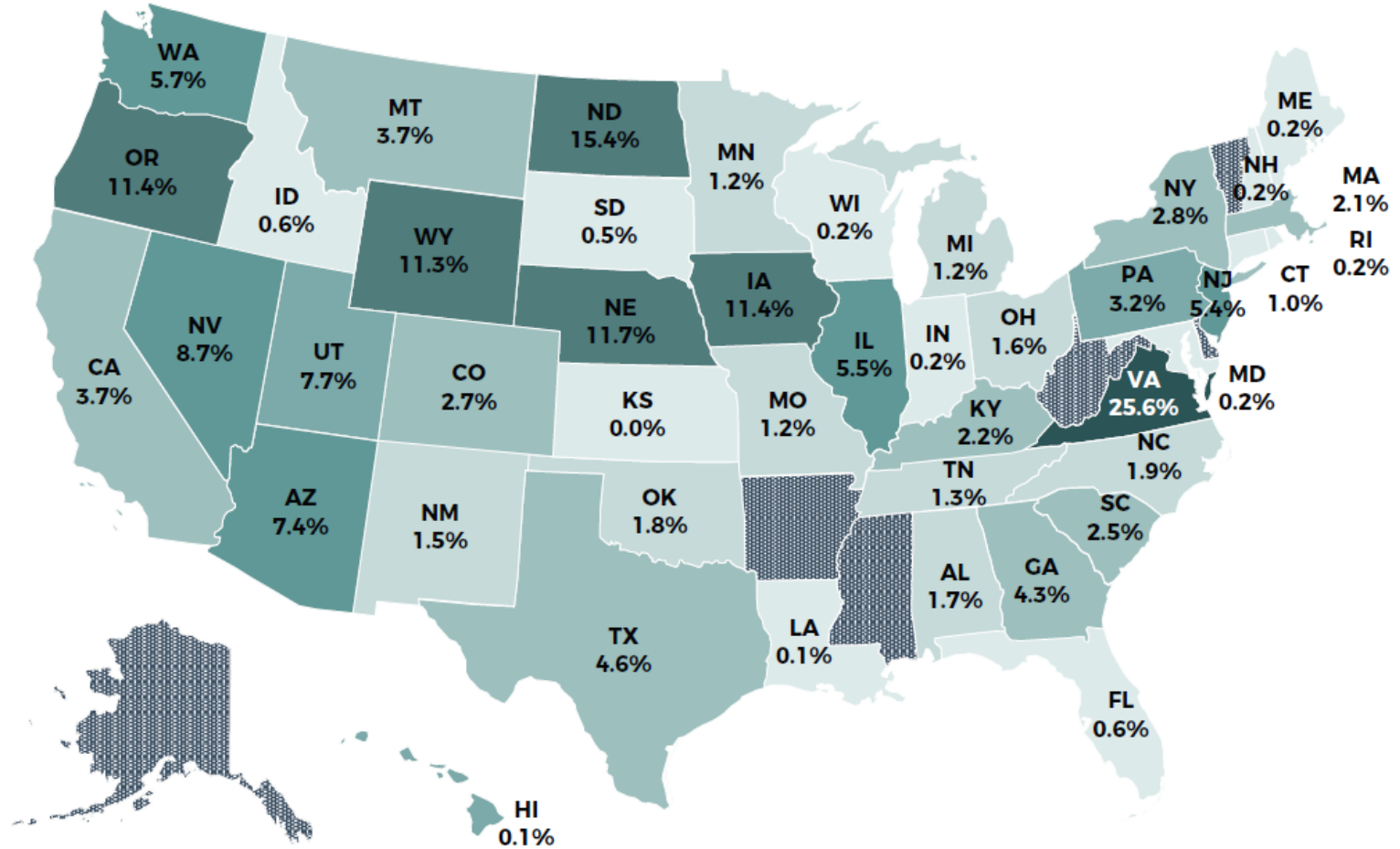


Backdrop: Significant Data Center Growth

Data center power consumption, by providers/enterprises* (gigawatts)



SOURCE: MCKINSEY & CO.



Share of State's Electricity Used by Data Centers in 2030

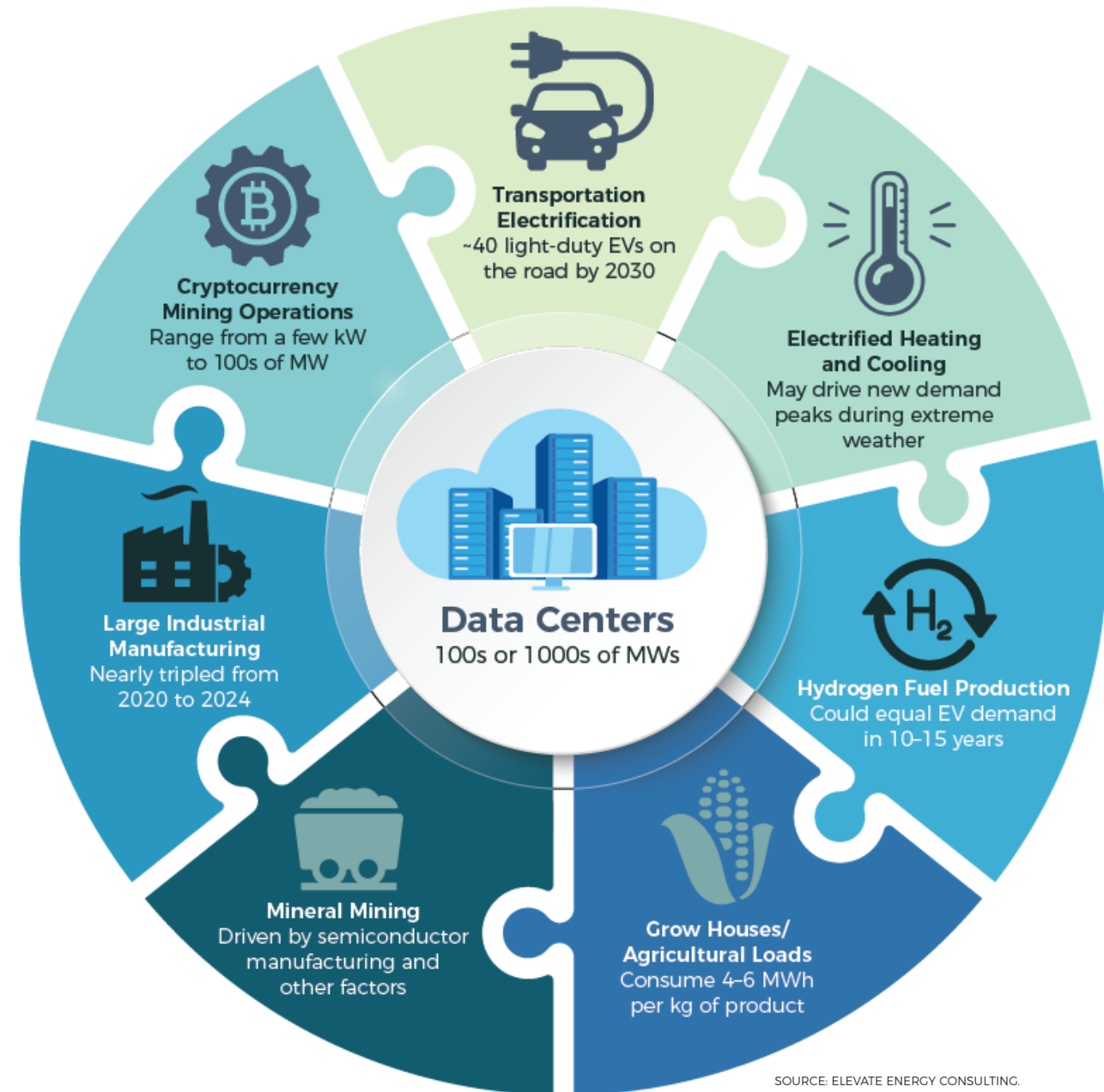
0.0% Lowest

Highest 25.6%

SOURCE: ADAPTED FROM EPRI.

Types of Large Loads

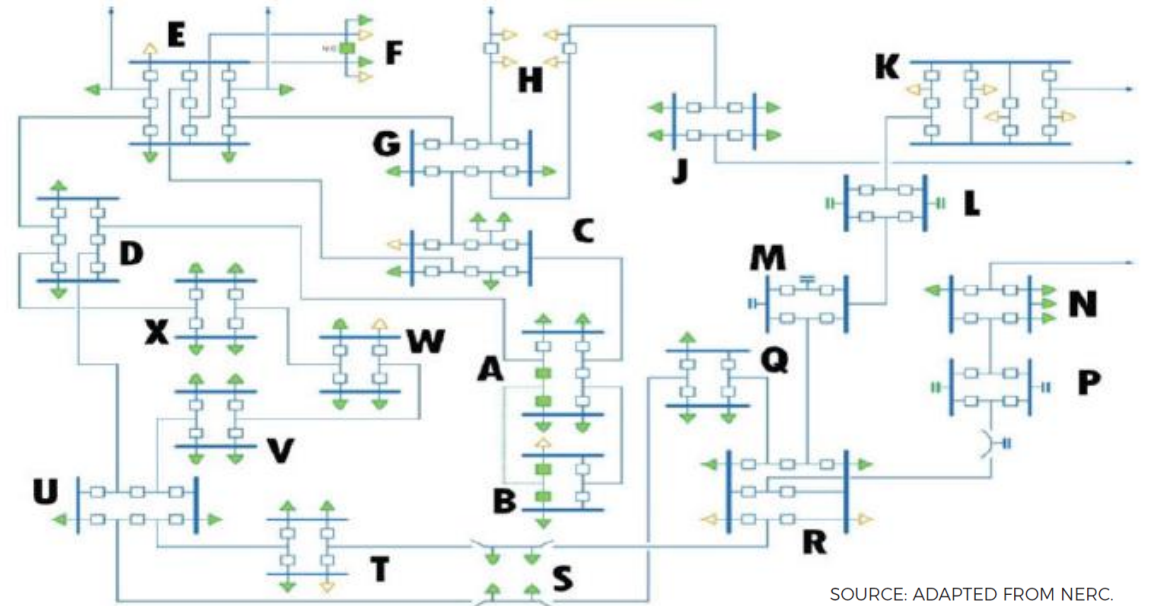
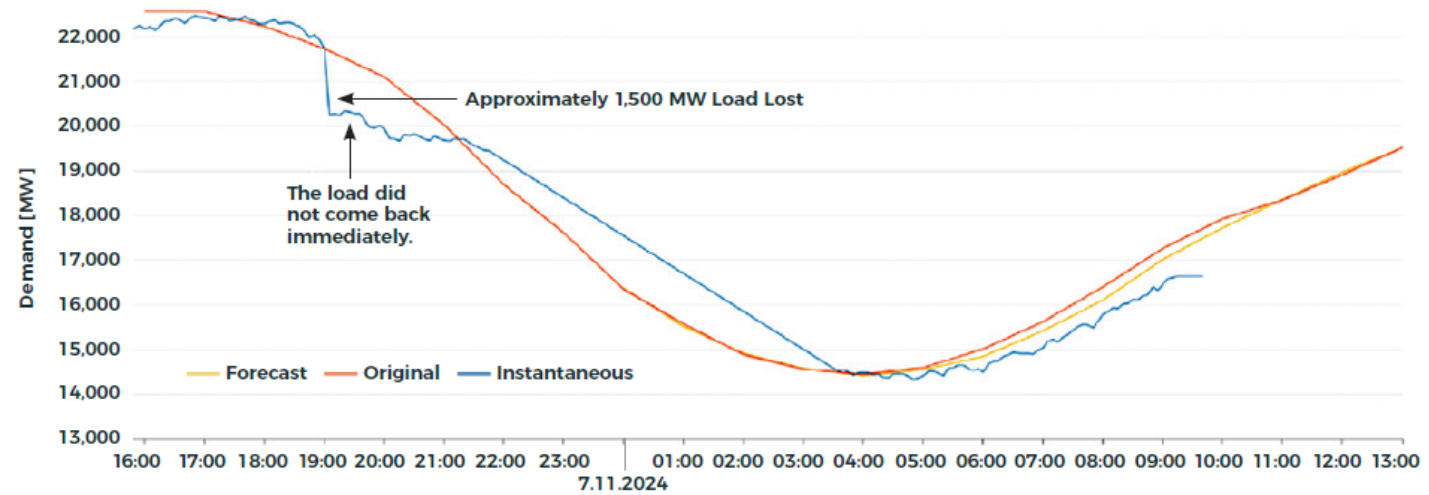
- Data center loads constitute 80+% of load growth across the Western Interconnection [\[WECC\]](#)
- 100s to 1000s of MWs per request
- Driven by largest corporations in the world
- Rather significant speculation
- Speed to construct and is key driver



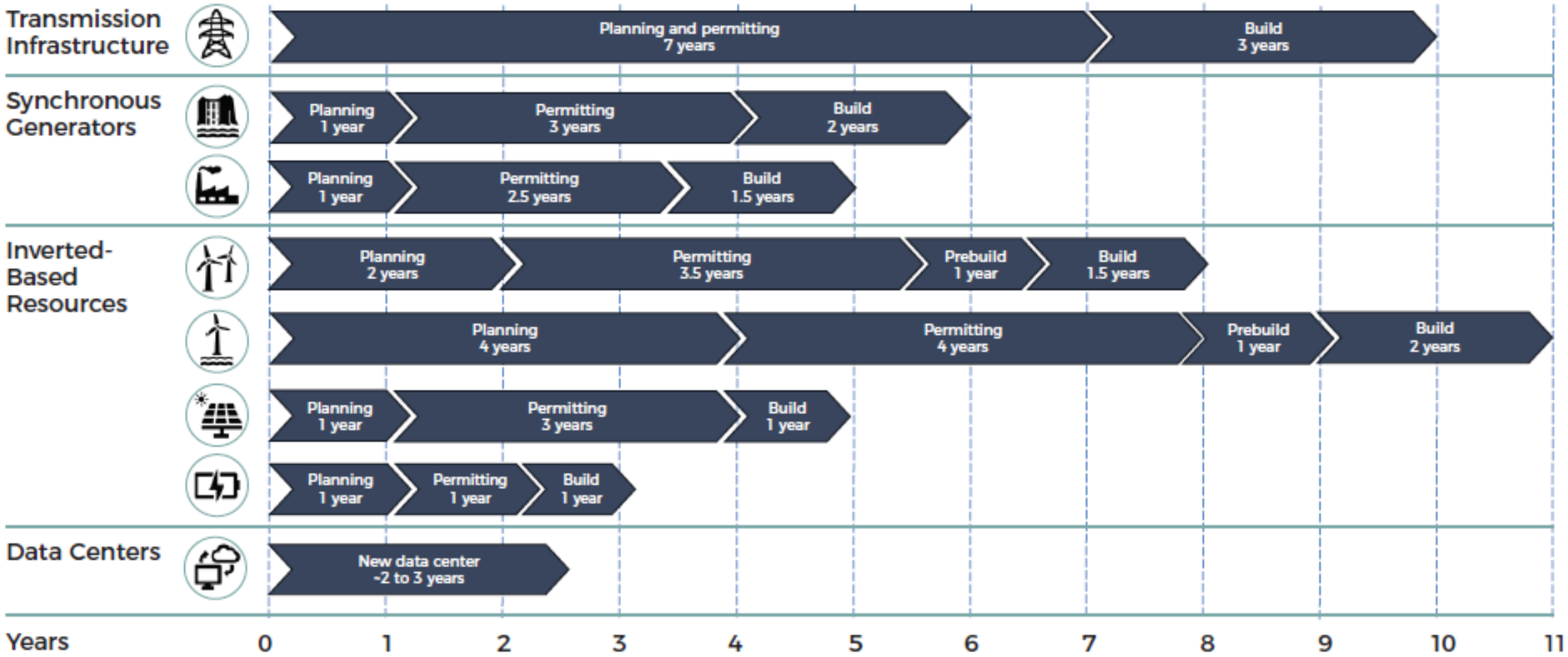
SOURCE: ELEVATE ENERGY CONSULTING.

Faint Signals: Reliability and Stability Risks

- Two large data center disconnection events in Northern Virginia
 - 1,500 MW reduction in July 2024
 - 1,800 MW reduction in Feb 2025
- Dozens of individual data centers disconnecting
- Caused by unknown and uncoordinated load-side protections within facilities



Timelines for Grid Infrastructure vs. Data Centers



Grid Reliability Challenges



The Balancing Act: Speed vs. Reliability

ECONOMICS

- Significant long-term, predictable revenue streams for utilities
- Transmission expansion and development
- Enhanced infrastructure utilization
- Potential for demand flexibility
- New service models
- Tax breaks, incentives, and economic development packages
- Local jobs creation

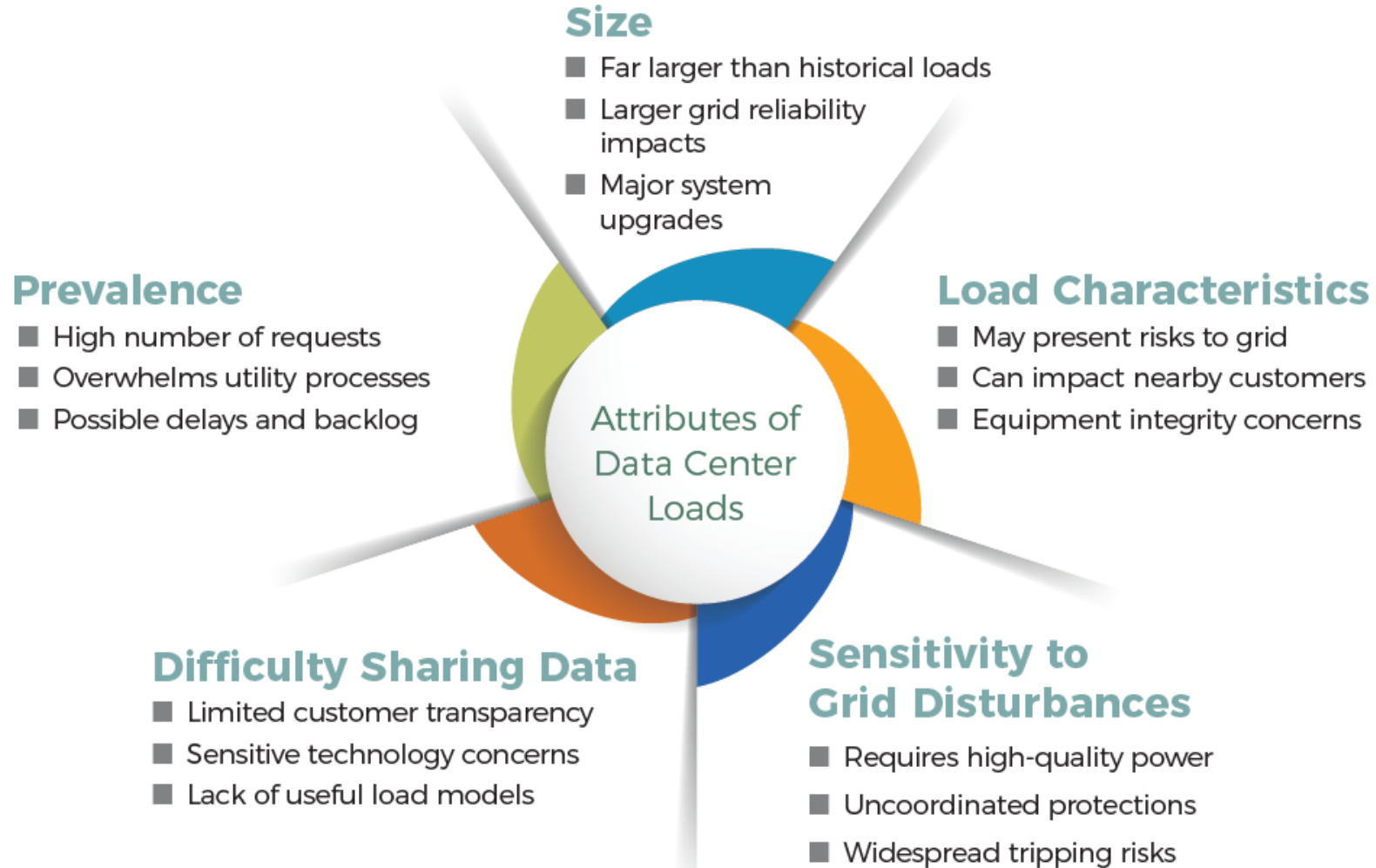


GRID RELIABILITY

- Overloaded or congested transmission infrastructure
- Voltage and frequency stability issues
- Interconnection backlog inundation
- Regulatory risks and hurdles
- Uncertain operating characteristics
- Reliance on baseload generation to serve loads

SOURCE: ELEVATE ENERGY CONSULTING.

Key Attributes of Data Center Loads

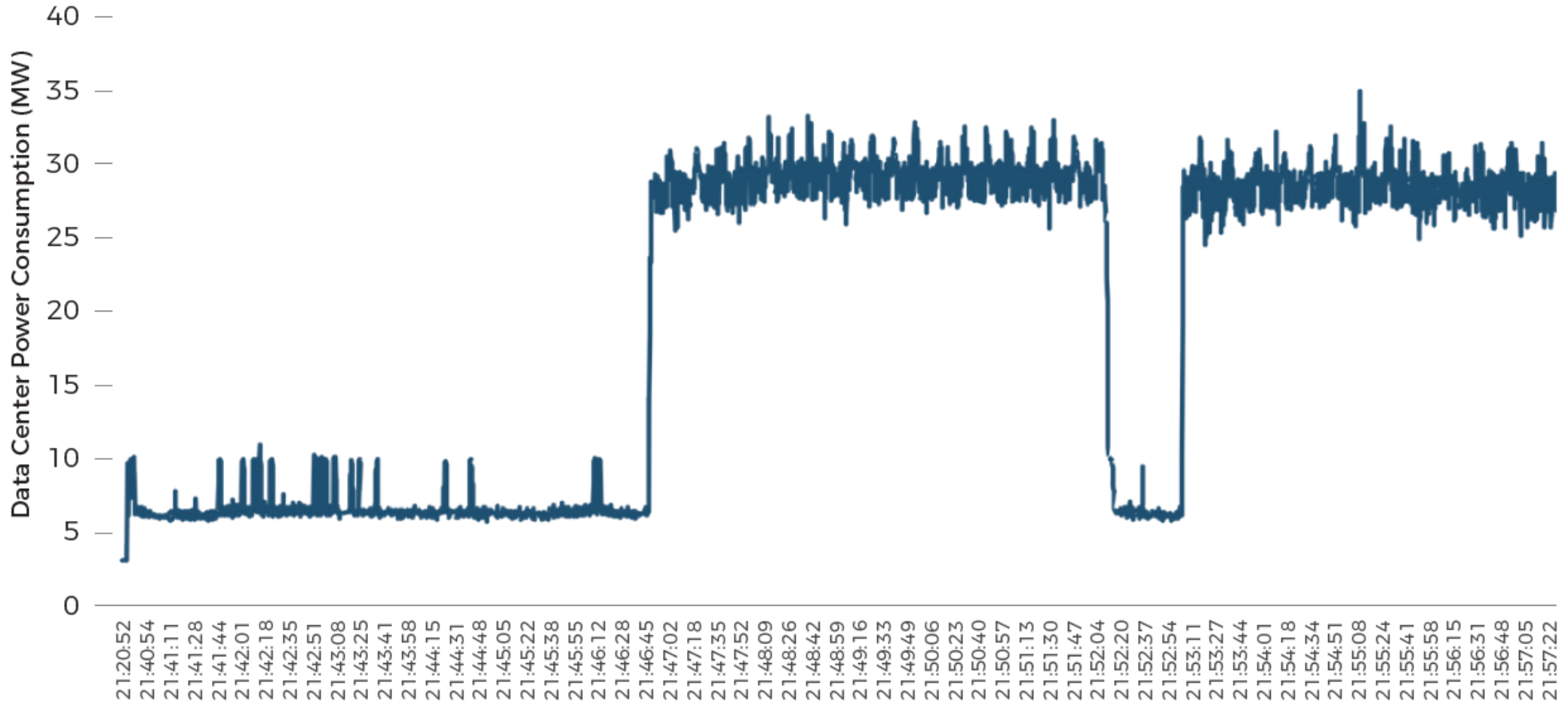


SOURCE: ELEVATE ENERGY CONSULTING.

Key Reliability Challenges with Data Centers

- Ramping, variability, and uncertainty
- Impacts on frequency response and voltage control
- Generator cycling and strain
- Transmission utilization constraints
- Ride-through performance and dynamic response
- Power quality issues
- Transient stability impacts
- Subsynchronous oscillations
- Protection system impacts

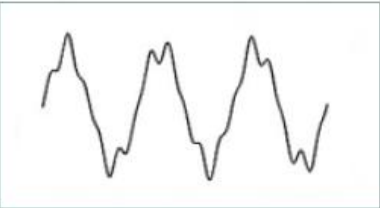
The Shakes, Spikes, and Fuzz



SOURCE: EDGETUNEPower, INC.

Examples of Power Quality Issues

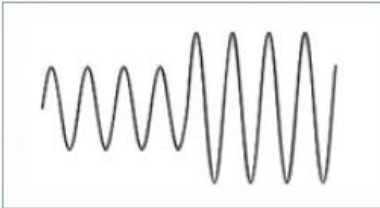
Flickers



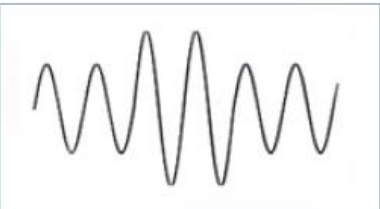
Harmonics



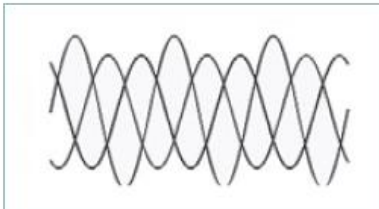
Over/Undervoltages



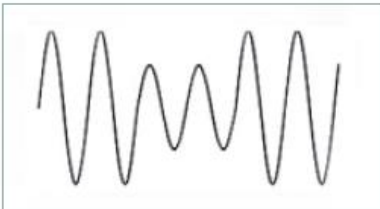
Swells



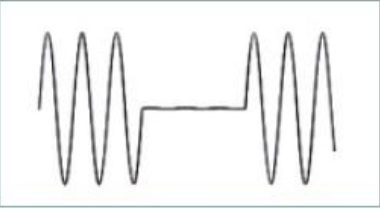
Unbalance



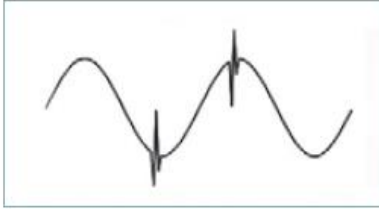
Sags



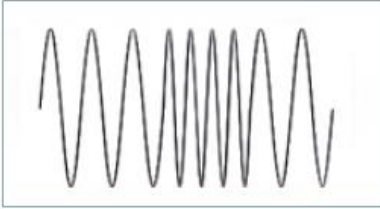
Interruptions



Transients



Frequency Deviations

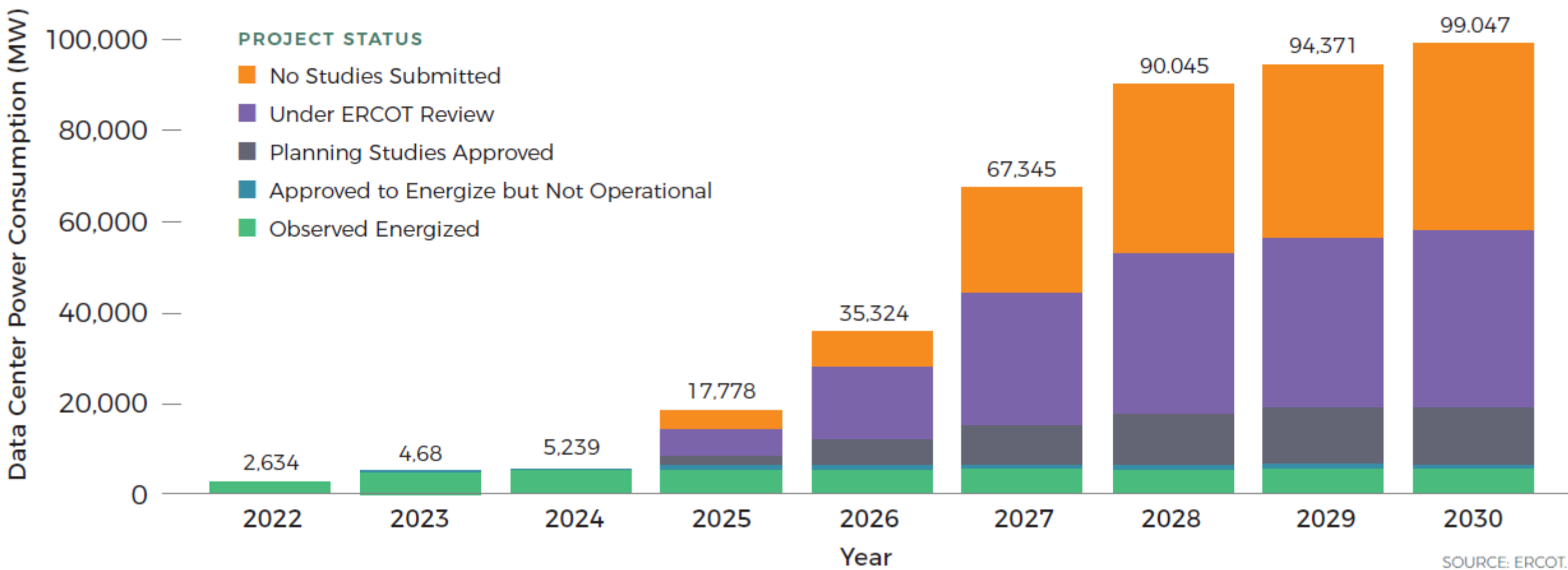


SOURCE: ELEVATE ENERGY CONSULTING. ADAPTED FROM FS, INC. (WWW.FS.COM).



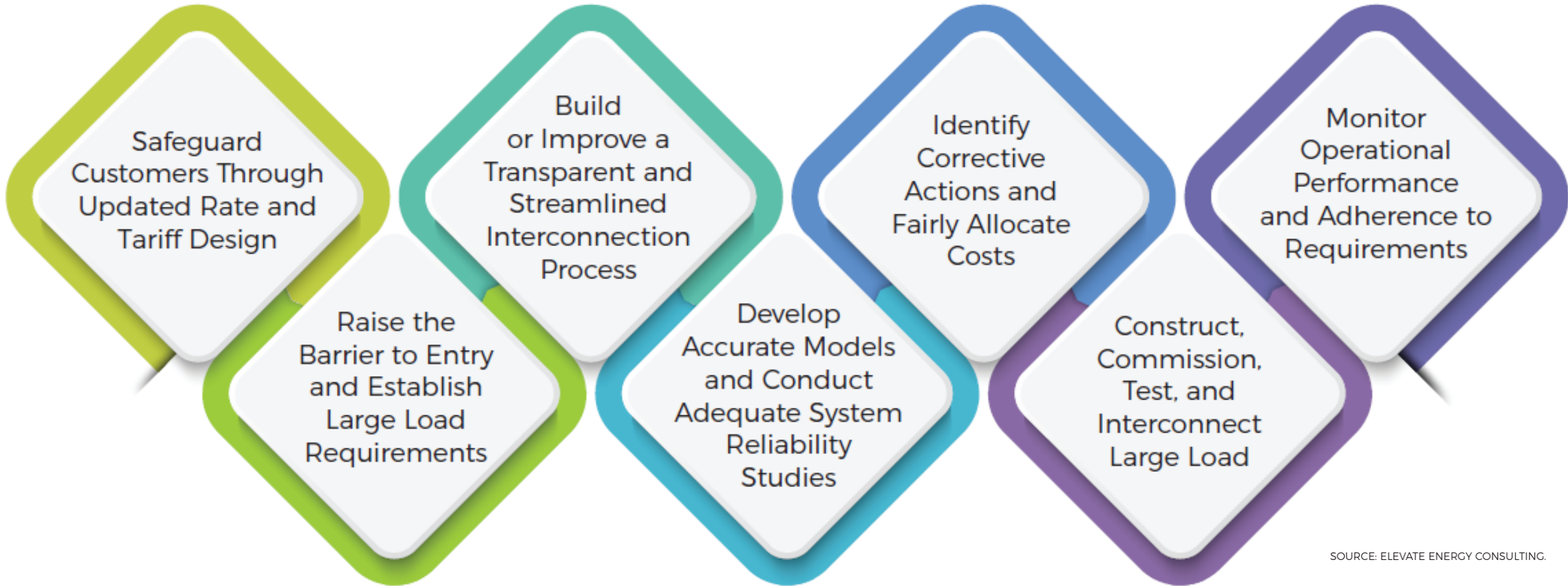
Large Load Interconnection Process

ERCOT Large Load Interconnection Queue



SOURCE: ERCOT.

Large Load Interconnection Enhancements



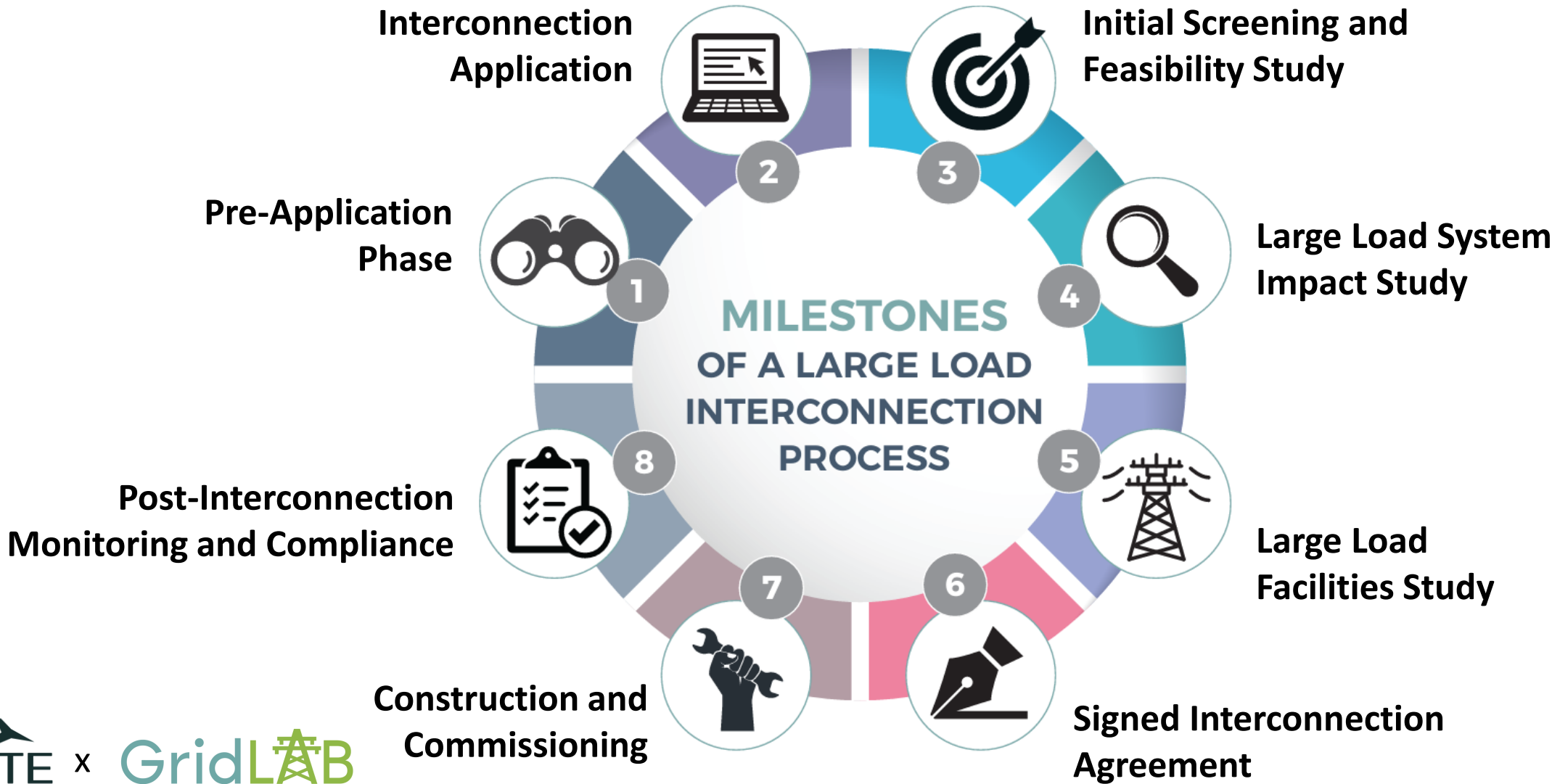
SOURCE: ELEVATE ENERGY CONSULTING.

Raise the Bar: Technical Requirements

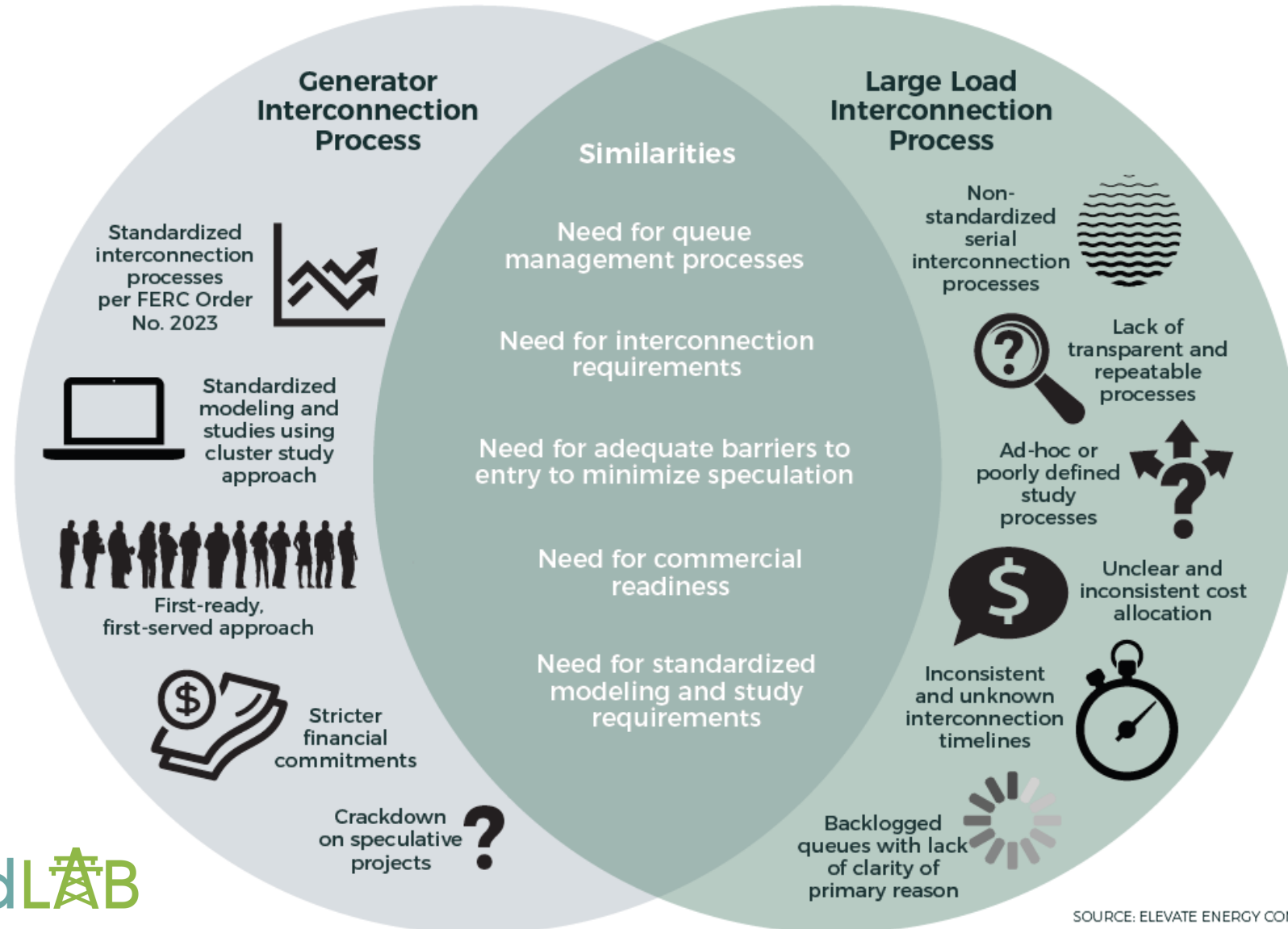
- Load size limits
- Data and model sharing
- Data recording and monitoring
- Ride-through performance
- Power factor/reactive power
- Power quality
- Oscillation Damping
- Short-circuit and protection
- Operational control and communications
- Emergency response
- Operations and maintenance
- Demand response
- Utility right to monitor and enforce requirements



Implement a Clear Interconnection Process

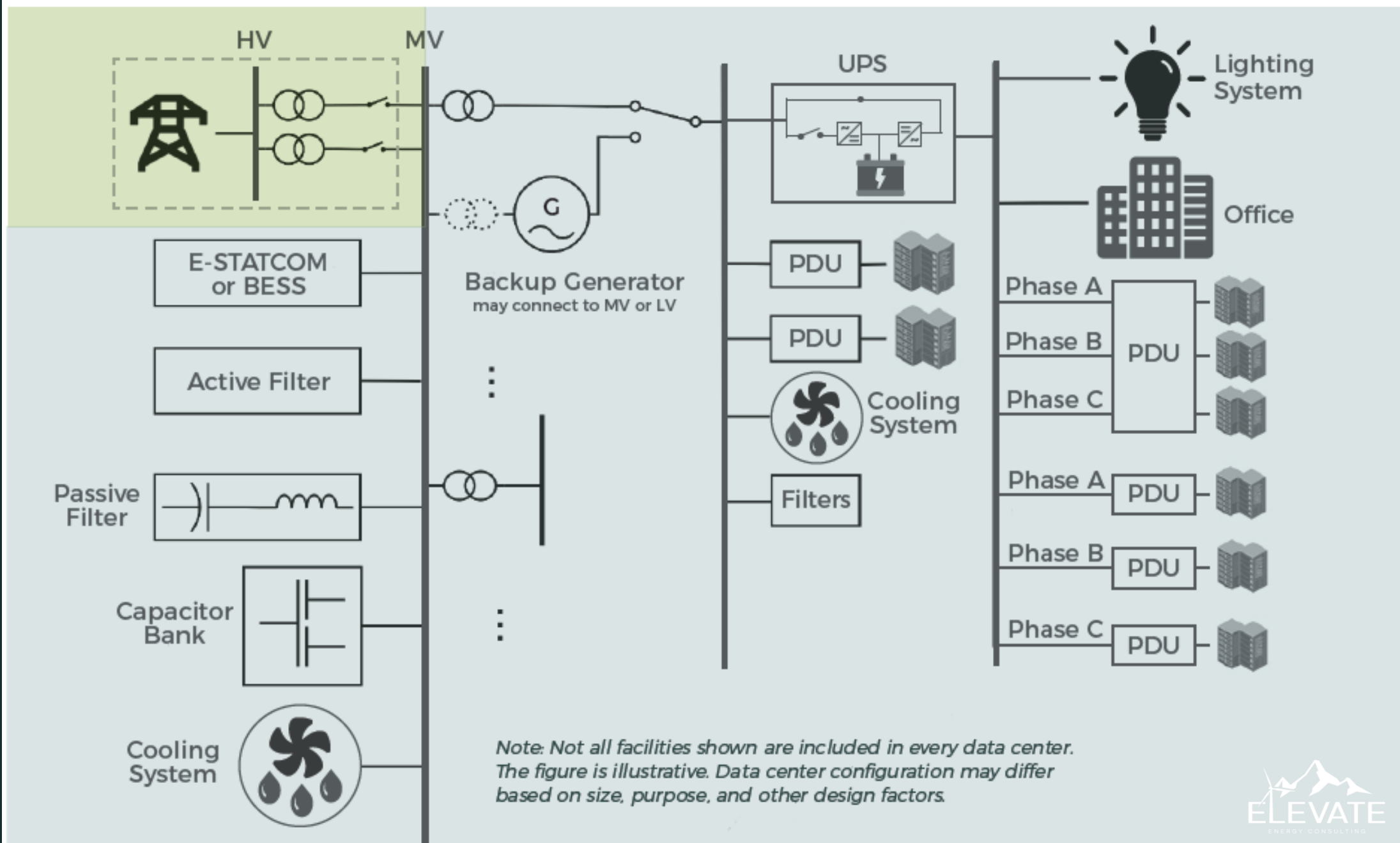


IBRs and Data Centers: More Common Than Not?





Data Center Modeling and Studies



Note: Not all facilities shown are included in every data center. The figure is illustrative. Data center configuration may differ based on size, purpose, and other design factors.

Powerflow Studies

- Thermal overloads and voltage violations
- Congestion and available transmission services

Transient Stability Studies

- Angular stability and electro-mechanical oscillation
- Voltage stability, ride-through performance, etc.

EMT Studies

- Complex stability phenomena
- Power electronic interactions and oscillations

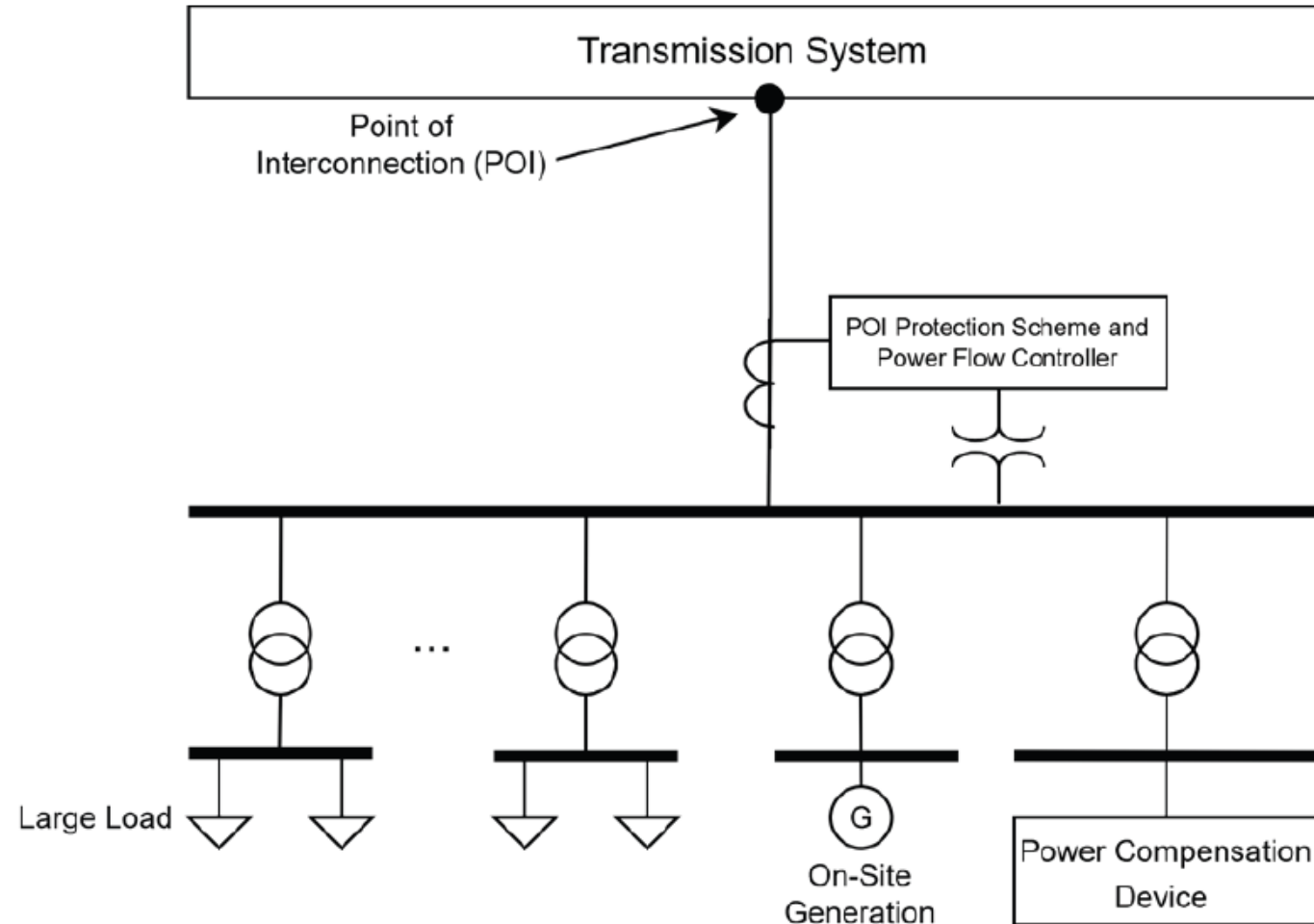
Short-Circuit Studies

- Breaker duty, protection coordination, co-located generation

Complex Solutions Require Complex Studies

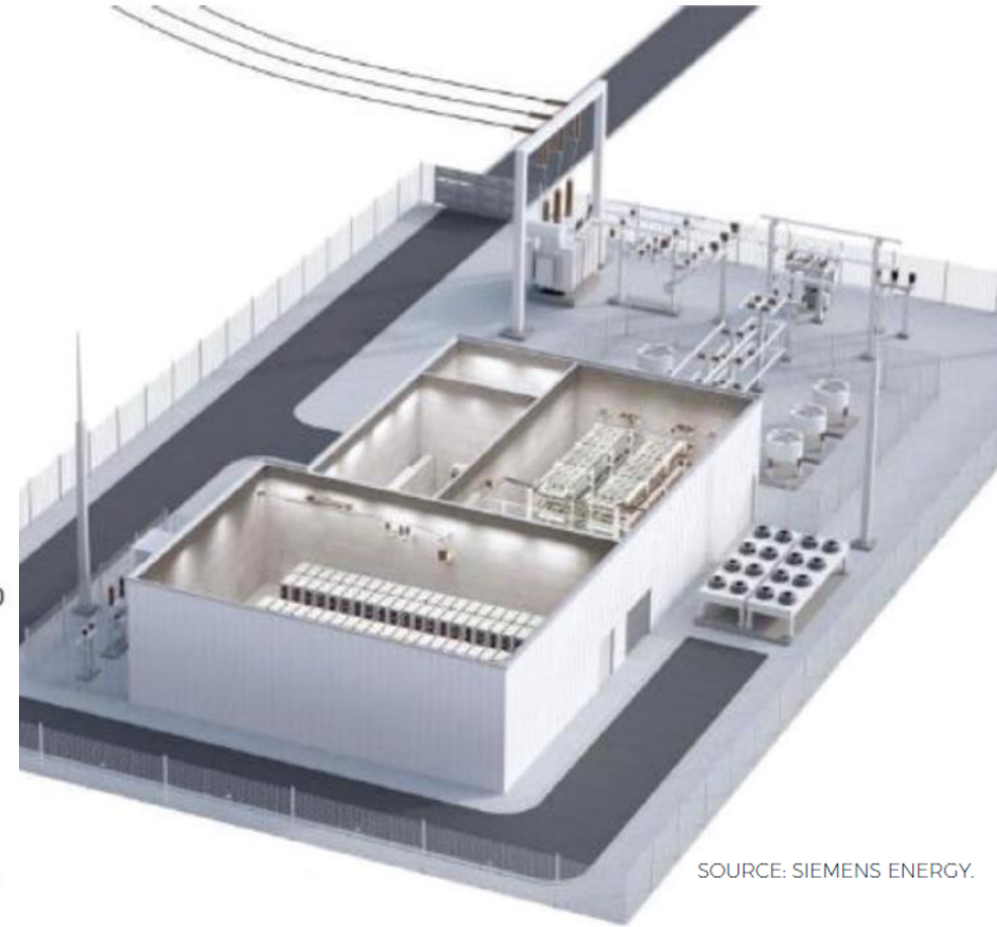
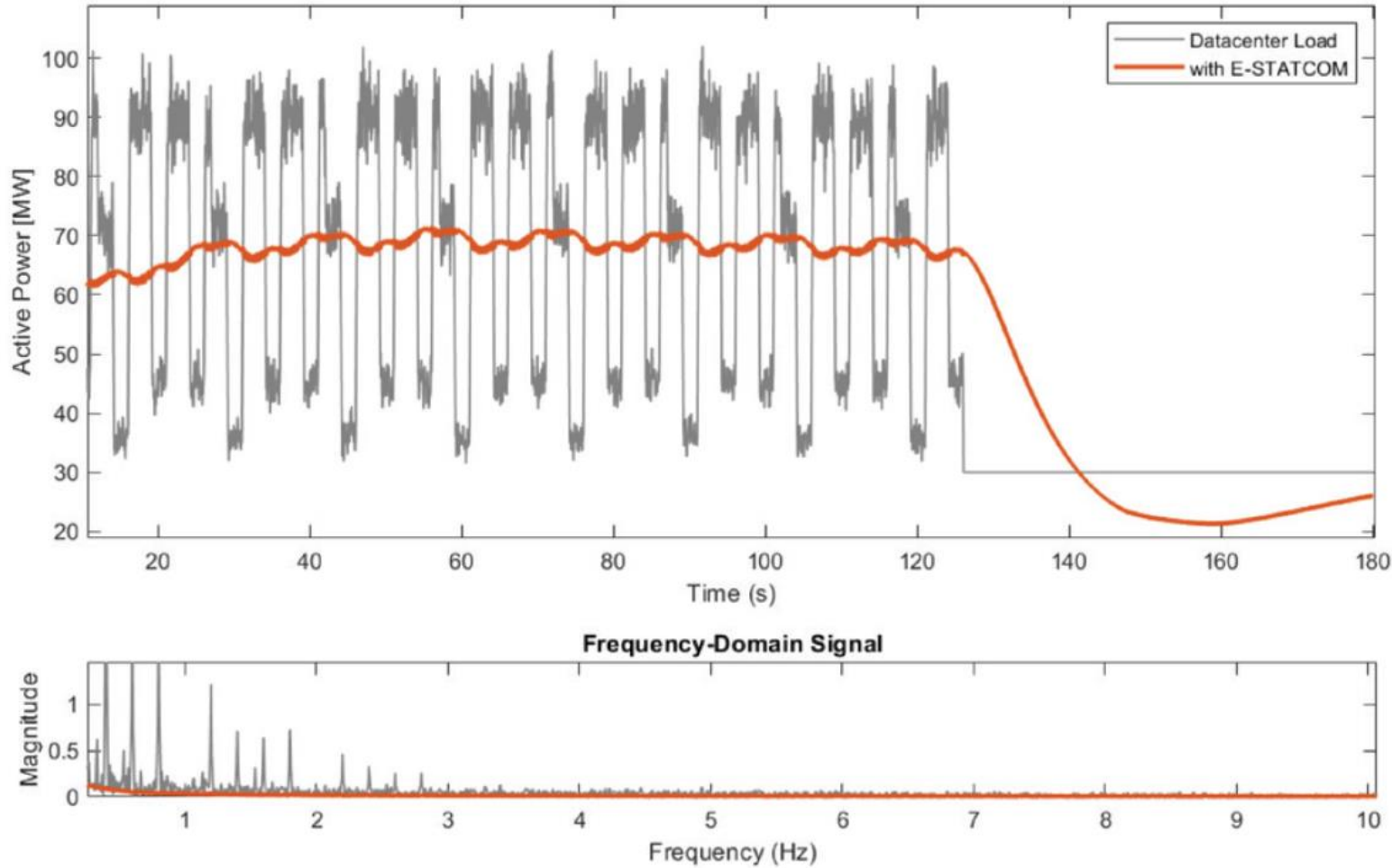


Source: SMA



SOURCE: ELEVATE ENERGY CONSULTING.

Solution Example: E-STATCOM





Regulatory Considerations

Regulator Questions

- Protecting existing customers
- Jurisdictional issues
- Application process
- Interconnection requirements
- Queue management
- Operations and performance
- Load forecasting
- Load modeling and studies
- Financial and other terms of service





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