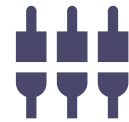

Flexible Loads: From Interconnection Commitments to Grid Operations

How flexible loads become dispatchable grid resources through interconnection design, operational controls, and reserve product qualification.



**Interconnection
Design**



**Operational
Controls**



**Reserve
Qualification**



Why Flexible Loads Matter

Grid Challenges

- Growing load growth and electrification
- Resource adequacy concerns
- Increasing renewable penetration
- Need for dispatchable capacity

Opportunity: Large Flexible Loads

Large flexible loads can serve as multi-functional grid assets:


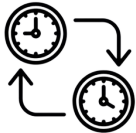

Controllable Demand & Capacity Resources

Reserve Resources & Grid Balancing Assets

Key Message

**Flexible loads should be planned as reliability assets from day one,
not after interconnection.**

Taxonomy of Load Flexibility

FLEXIBILITY TYPE	NET LOAD IMPACT	ASSET-DRIVEN EXAMPLES	PROCESS-DRIVEN EXAMPLES
 <p>Load Reduction</p>	<p><i>Temporarily reduces load and does not shift to another time or region</i></p>	<ul style="list-style-type: none"> • Onsite Generation • DERs • Increased water usage for cooling systems 	<ul style="list-style-type: none"> • Voluntary Curtailment: (dimming lights, turning off workloads/production lines)
 <p>Time Shifting</p>	<p><i>Loads shift to periods before or after time of constrained supply</i></p>	<ul style="list-style-type: none"> • Thermal Energy Storage (TES) • HVAC optimization • Onsite Energy Storage 	<ul style="list-style-type: none"> • Workload scheduling and coordination • Production line rescheduling
 <p>Location Shifting</p>	<p><i>Loads are relocated to a neighboring region where reserves are higher</i></p>	<p>N/A</p>	<ul style="list-style-type: none"> • Workload relocation

The Reliability Resource Framework

THREE CORE QUESTIONS

Planning

Can I count on this resource, long term?

Operations

Can I dispatch this resource?

Markets

Can I compensate this resource?

FLEXIBLE LOADS MUST DEMONSTRATE
Availability • Dispatchability • Verifiability • Performance

PLANNING RESERVE REQUIREMENTS

Objective & Requirements

Resource adequacy and peak reliability

- Contractual curtailment rights
- Capacity accreditation methodology
- Availability, Testing & Qualification

Utility Questions

- Can it be counted in IRPs?
- Can it support RA obligations?
- Is performance measurable?

From Interconnection Commitments to Grid Reliability Services

Operationalizing Flexible Load as a Planning and Operating Resource

THE OPPORTUNITY

As large flexible loads seek interconnection across North America, utilities and system operators are increasingly requiring operational flexibility commitments as part of the process.

This creates a rare opportunity to establish a common framework that converts interconnection flexibility commitments into dependable grid services.

For Utilities

- Reduce transmission and generation infrastructure requirements
- Improve resource adequacy planning
- Enhance system resilience during contingencies

For ISOs/RTOs

- Expand available reserve resources
- Improve operational flexibility
- Support reliability during rapid load growth

For Load Operators

- Monetize flexibility capabilities
- Improve project economics
- Provide measurable reliability value to the grid

KEY QUESTION

How should flexibility commitments be standardized, measured, and incorporated into planning and operating reserves?

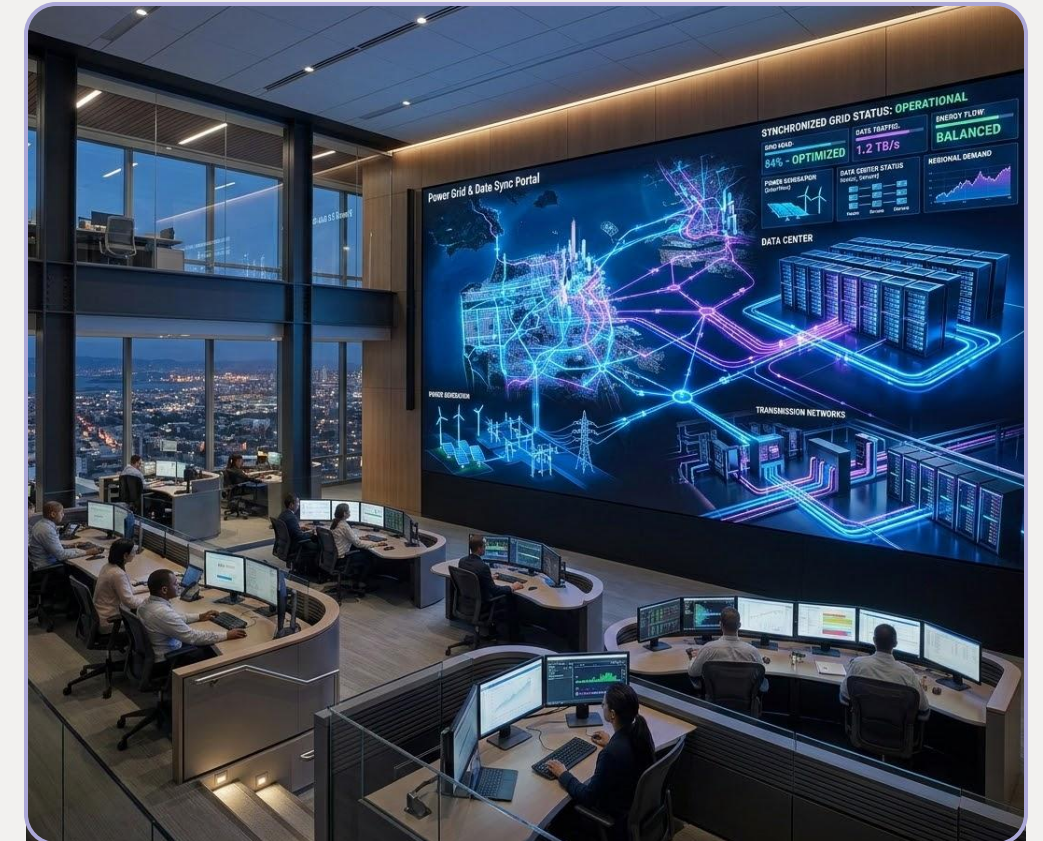
PROPOSED DISCUSSION FLOW

Interconnection Commitment → Qualification Standards → Operational Requirements → Reserve Product Participation → Verified Reliability Resource

Executive Summary: Infrastructure Redefined

The Evolution from Consumer to Grid Resource

- **Strategic Interconnection:** Planning loads as reliability assets from day one, using interconnection as a foundational planning tool.
- **Operational Excellence:** Implementing high-fidelity telemetry, SCADA integration, and EMS controls to ensure dispatchability.
- **Reliability Framework:** Qualifying flexible loads for NERC reserve products, including Spinning, Supplemental, and Contingency reserves.



Key Takeaway

Large flexible loads can be planned and operated as **dispatchable grid resources**, transforming energy consumption into a vital reliability asset.

Interconnection as the Foundation for Grid Services

Interconnection: More Than Just Connecting Load

Traditional View

Demonstrate the system's ability to serve the projected load reliably.

Emerging View

Demonstrate how the load itself acts as an active resource to support grid reliability.

Interconnection Becomes a Critical Planning Tool

- Capacity planning tool for long-term resource adequacy
- Reliability planning tool to ensure operational stability
- Mechanism for enabling and dispatching grid services

Discussion Point

Interconnection commitments increasingly influence resource adequacy planning.

Service Matrix for Grid Operators: Interconnection should Determine how a Flexible Large Load Serves as a Reliable & Dispatchable Grid Resource

Grid Service	NERC Reserve Definition	verrus™	Availability
Planning Reserve	Capacity planned to meet future peak demand, typically committed via IRPs or long-term contracts.	Contractual curtailment commitments can be incorporated in IRPs and RA plans as dependable load relief.	✓
Operating Reserve – Spinning	Online, synchronized capacity deliverable within 10 minutes to meet real-time system needs.	Sub-10-second response time; dispatchable in increments suitable for ISO ramping and reserve markets.	✓
Operating Reserve – Supplemental	Offline or non-synchronized reserve deliverable within 10 minutes.	Eligible for non-spin classifications in multiple ISO/RTO market structures.	✓
Contingency Reserve	Reserve to cover unexpected generation/load loss, deployable within 10 minutes.	Meets ramp rate and reliability obligations for N-1 single largest generation and transmission (MSSC) events. Biddable into contingency markets.	✓
Replacement Reserve	Resource used to restore contingency reserves within a 90-minute window.	4-hour duration enables backfilling and secondary reliability product participation.	✓
Other Online/Offline Reserves	Resources with dispatchability between 10–90 minutes (e.g., slow-start assets, pre-arranged demand response).	Suited for day-ahead commitment, reserve restoration, or emergency scheduling support.	✓
Regulating Reserve	Capacity under AGC control used to continuously balance ACE deviations.	Technically AGC-compatible. Targeting integration for real-time ancillary market participation.	Coming soon
Frequency Responsive Reserve (FRR)	Autonomous, droop-based response within seconds to stabilize frequency deviations.	Capable of inverter-based frequency response with configurable droop curves.	Coming soon

Operational Characteristics for Grid Services:

- **Fast Ramp:** Sub-10s response; meets or exceeds market performance requirements for spinning & contingency reserves
- **Duration:** 4 hours of discharge at 50% of data center facility load (customizable to meet utility operational needs)
- **Interoperability:** Designed for integration with utility SCADA + ISO telemetry systems for dispatch, measurement, verification
- **Market Eligibility:** Aligned with FERC 841 and ISO/RTO ancillary services tariffs
- **Future Capabilities:** FRR and Regulating Reserve products slated for market participation as part of roadmap

For detailed specifications or to evaluate interconnection and product delivery pathways, please contact: inquiries@verrusdata.com

Critical Interconnection Data Requirements

Electrical Characteristics

- Peak demand
- Minimum demand
- Ramp rates
- Power factor

Operational Characteristics

- Curtailment speed
- Curtailment duration
- Frequency of dispatch
- Recovery profile

Grid Support Characteristics

- BESS integration
- Backup generation
- EMS capabilities
- Telemetry systems

Data Compliance

Accurate technical specifications ensure optimal grid integration and reliability assets planning.

Interconnection Commitments as Reliability Products

What Utilities Need to Know

To assess grid reliability, utilities ask: *Can the load...*

- Reduce demand?
- How fast?
- By how much?
- For how long?
- How often?
- With what confidence?

Outcome

Interconnection commitments become planning assumptions used by utilities and ISOs.

Key Takeaways

Interconnection & Value

Successful participation requires:

- Defined operational flexibility
- Verifiable performance
- Real-time visibility
- Dispatch capability
- Reserve product qualification

Final Message

Large flexible loads must be operated as **grid resources**—not merely as customers.

This structure ties directly to the broader thesis and naturally leads from interconnection requirements into the reserve-product matrix.

Strategic Summary

Interconnection is the foundation of future value, transforming consumption into a dispatchable reliability asset.

Converting Commitments into Grid Operations

Flexible Load Requirements Across NERC Reserve Products

PURPOSE

To enable flexible loads (e.g., data centers, industrial loads, EV charging, hydrogen, BESS-backed loads) to participate as reliable grid resources via standardized requirements.

COMMON REQUIREMENTS ACROSS ALL PRODUCTS

Resource Qualification

- Min. curtailable capacity (MW)
- Demonstrated load response
- Baseline methodology
- Performance testing
- Availability standards
- Seasonal accreditation

Visibility & Control

- Real-time telemetry
- SCADA integration
- Dispatch signal receipt
- Operator override
- Cybersecurity standards

Measurement & Verification

- Baseline load determination
- Event performance measurement
- Settlement methodology
- Compliance reporting
- Audit requirements

Reliability Requirements

- N-1 contingency support
- Resource availability
- Non-performance penalties
- Emergency procedures

Recommended Requirements by Category

1. Response Performance

- Response initiation time
- Full response deployment time
- Ramp rate (MW/min)
- Accuracy/tolerance band
- Sustained response duration

2. Dispatch & Communications

- SCADA telemetry rate
- Dispatch acknowledgement
- Fail-safe operating mode
- Communications redundancy

3. Availability

- Commitment periods
- Forced outage reporting
- Maintenance scheduling
- Seasonal qualification

4. Measurement & Verification

- Baseline methodology
- Event settlement calculations
- Performance scoring
- Post-event reporting

5. Reliability & Compliance

- Testing frequency
- NERC compliance alignment
- Market monitoring requirements
- Non-performance penalties

Key ESIG Discussion Point

Flexible Loads Require the Same Reliability Attributes as Generation

Qualification frameworks should define: **Visibility + Dispatchability + Verifiability + Performance Accountability** rather than prescribing the resource type. This expands reserve capacity and improves grid resilience.

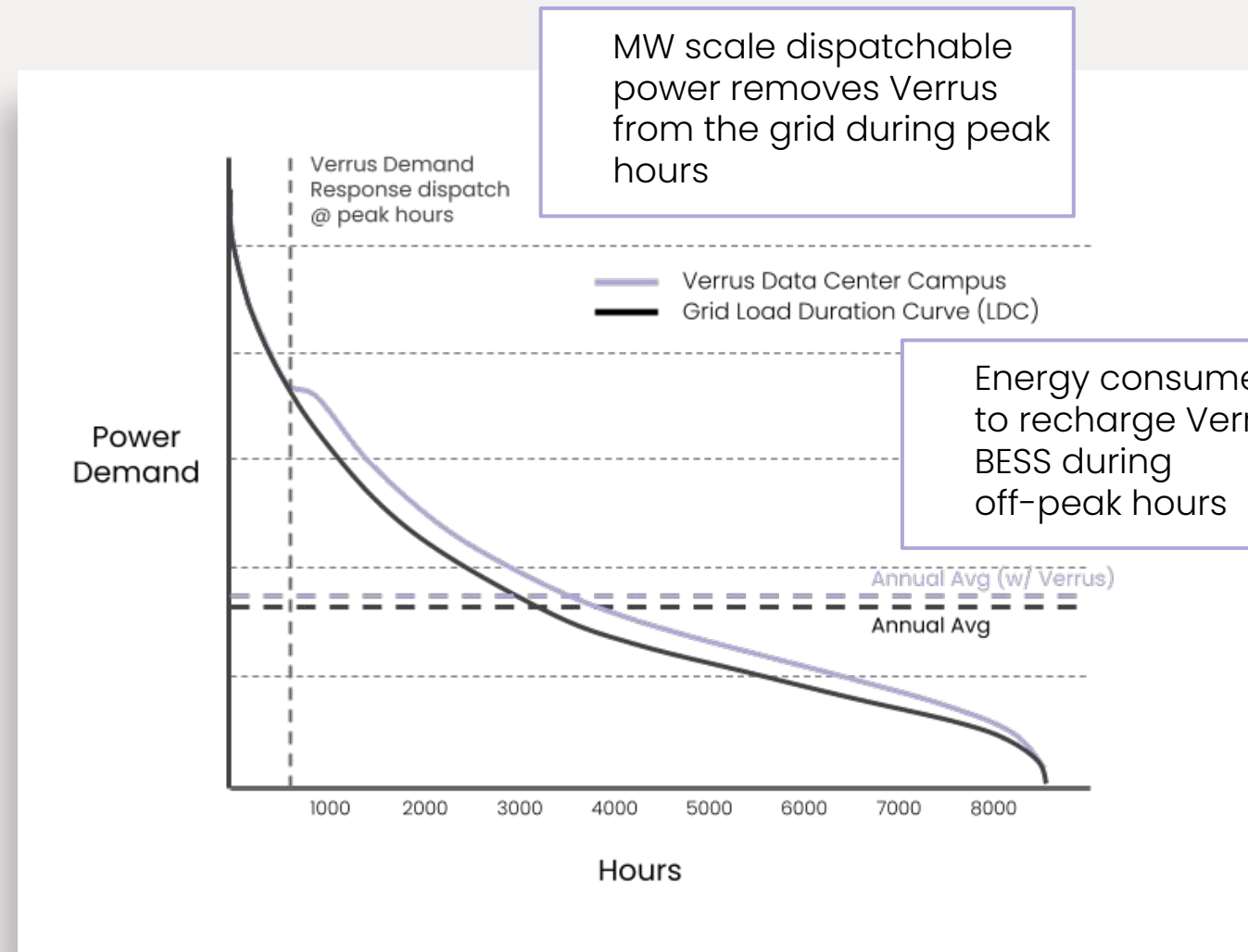
Planning Reserve Requirements

Objective

Resource adequacy and peak reliability

Requirements

- Contractual curtailment rights
- Capacity accreditation methodology
- Availability commitments
- Performance testing
- Seasonal qualification



Representative utility Load Duration Curve (LDC)

Utility Questions

- Can it be counted in IRPs?
- Can it support RA obligations?
- Is performance measurable?

Operating & Contingency Reserve Requirements

Spinning Reserve

Requirements:

- Response ≤ 10 minutes
- Online visibility
- Continuous telemetry
- Dispatch capability

Supplemental Reserve

Requirements:

- Response ≤ 10 minutes
- Standby capability
- Verified load reduction

Contingency Reserve

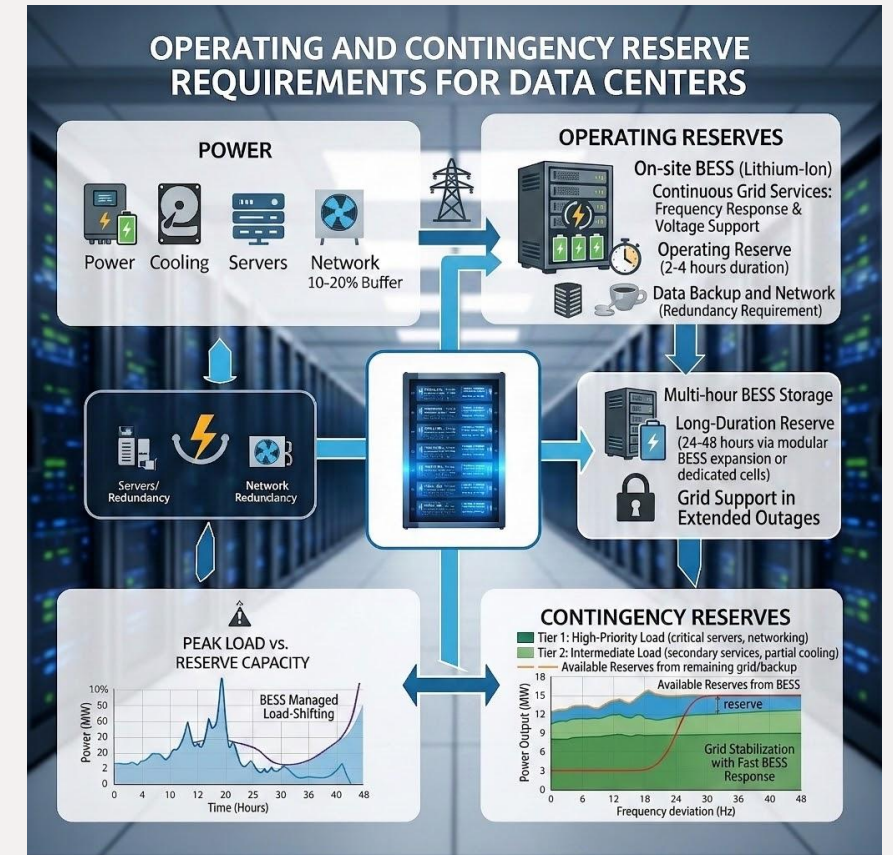
Requirements:

- Reliable emergency response
- Firm curtailment commitment
- Event performance verification

Key Enablers

Infrastructure and Systems

- EMS integration
- Automated controls
- Communications infrastructure



Key Operational Insight

Load provides high-fidelity contingency and operating reserves through advanced automation and real-time telemetry integration.

Reserves & Frequency Response

Replacement Reserves

Requirements:

- Multi-hour duration
- Sustained curtailment
- Restoration planning

Other Operating Reserves:

- Day-ahead commitment
- Reserve restoration support

Regulation Reserve

Requirements:

- AGC integration
- Continuous modulation
- High-speed telemetry
- Accuracy scoring

Frequency Response

Requirements:

- Autonomous response
- Frequency sensing
- Droop controls
- Sub-second performance

Flexible Load Advantage

Long-duration demand reduction can outperform traditional reserve resources.

Future State

Data centers with advanced controls and BESS become frequency-responsive assets.

Current State: **Most flexible loads are not yet fully qualified.**



Operational Requirements & Compliance

Control Systems & Telemetry

Control Systems

- EMS
- SCADA
- Site controller
- Automated dispatch

Telemetry

- MW consumption
- Curtailment status
- BESS state of charge
- Availability status

Communications & Metrics

Communications

- Utility
- ISO/RTO
- Aggregator

Performance Metrics

- Response time
- Ramp rate
- Accuracy
- Availability
- Duration

Compliance Functions

- Event logging
- Settlement support
- Baseline calculation
- Auditability

Key Principle

"If it cannot be measured, it cannot be counted."

Operational Integration Insight

Seamless integration of control systems and high-fidelity telemetry is essential for meeting rigorous performance and compliance standards.

Flexible Data Centers as Reliability Assets

Example Architecture

 Data Center Load

+

 Battery Storage

+

 Microgrid Controls

= **Dispatchable Resource**

Services Enabled

- ✓ Planning Reserve
- ✓ Spinning Reserve
- ✓ Supplemental Reserve
- ✓ Contingency Reserve
- ✓ Replacement Reserve

Future?

- Regulation Reserve
- Frequency Response

Market Evolution

Emerging Trends

- Flexible interconnection agreements
- Grid-enhancing load participation
- Resource adequacy accreditation
- Co-optimized load and storage dispatch

Future State

Flexible loads become capacity, reliability, and market resources rather than passive consumers.

Operational Integration Insight

Data centers with advanced controls and BESS evolve from power consumers into grid-stabilizing assets.

Key Takeaways

Interconnection & Value

Successful participation requires:

- Defined operational flexibility
- Verifiable performance
- Real-time visibility
- Dispatch capability
- Reserve product qualification

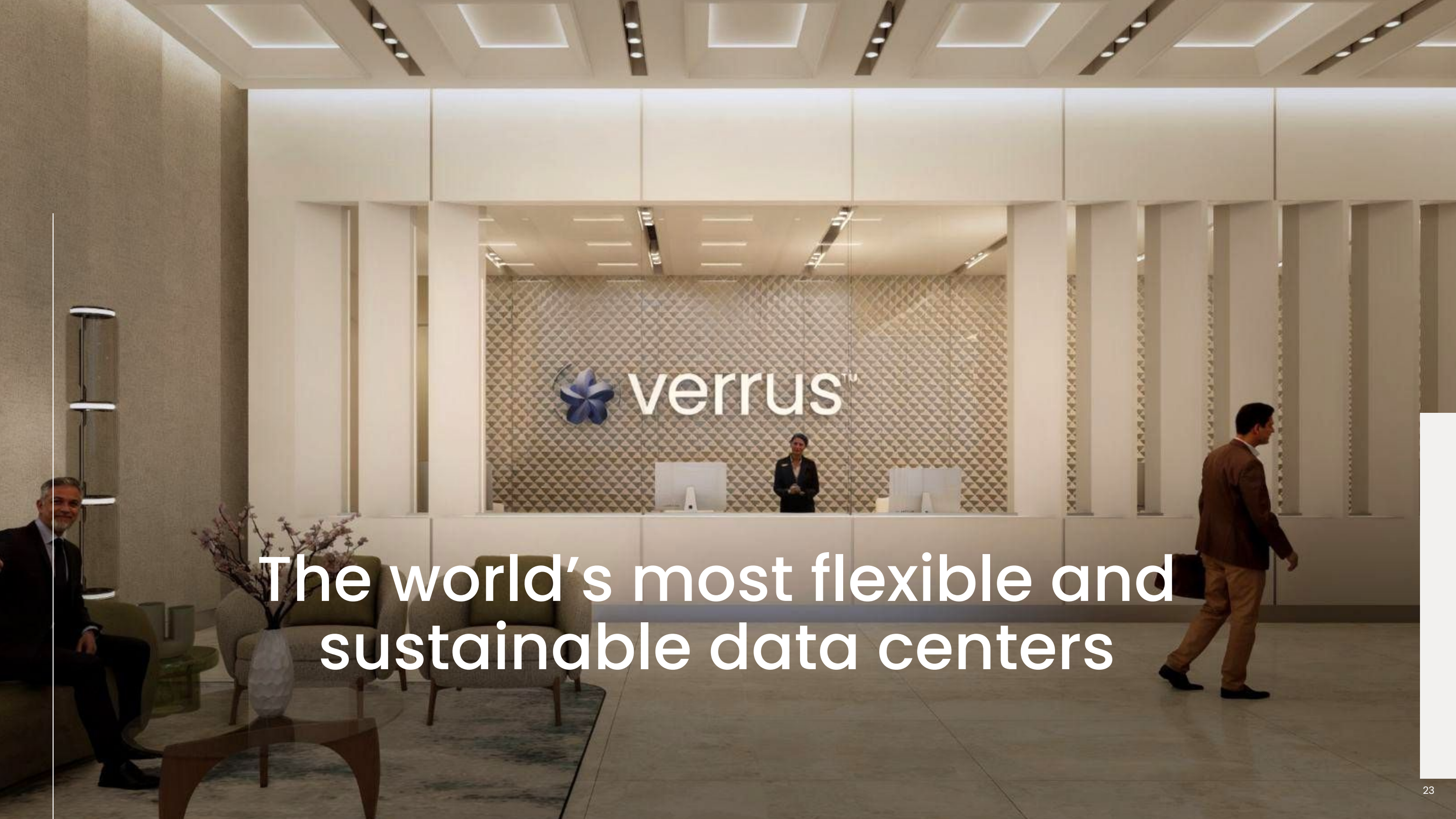
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Interconnection is the foundation of future value, transforming consumption into a dispatchable reliability asset.



The world's most flexible and sustainable data centers

Built by Veterans. Engineered for the Future.

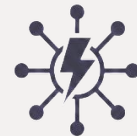


The Verrus team has led infrastructure, power, and design for the world's most sophisticated hyperscalers and utilities.



Hyperscale DNA

We built the first generation of cloud infrastructure from inside the hyperscalers. At Verrus, we're carrying that experience forward to create the next generation of data centers - engineered to be flexible, efficient, and purpose-built for the future.



Grid & Utility Insight

Deep expertise in energy procurement and grid stabilization allow us to unlock capacity and help the grid where others see constraints.



Operational Excellence

Decades of experience with a proven track record of managing multi-billion dollar portfolios and delivering complex infrastructure on schedule.

We aren't just building another data center. We are building the industry's new standard.

The Grid Is Now Demanding Flexibility. We Purpose-Built It.

Verrus was purpose-built on the principle that the data center must be a flexible grid asset. While the industry races to adapt to new regulatory and energy demands, we are primed to execute, leveraging decades of experience and years of dedicated engineering that have made our foresight the industry's emerging standard.

One way data centers can help the grid? By being flexible
Data centers could help slash costs and grid-upgrade times by easing off of utility grids during peak hours and finding ways to provide their own power.

By Jeff St. John
27 February 2025

Rethinking Load Growth
Assessing the Potential for Integration of Large Flexible Loads in US Power Systems

"This architecture redefines data centers from static power loads to dynamic, grid-supporting assets."
[<Full Article>](#)

Latitude Energy NEWS

Verrus demonstrates flexible data center technology

In a first-of-its-kind real-world pilot, the start-up dropped all power from a 70 MW data center in less than a minute using utility-scale batteries

By Jeff St. John
23 April 2024

DATA CENTER RICHNESS

Verrus is rethinking data centers

[Full Episode](#)

VOLTS

Can Data Centers Be Good Grid Citizens?

"Meet the data center that gives back to the grid."
[<Full Episode>](#)

LATITUDE MEDIA | COVERING THE NEW FRONTIERS OF THE ENERGY TRANSITION

TECH | MARKETS | DEALS | PODCASTS | EVENTS | RESEARCH | RESOURCES

NEWS | GRID EDGE | REGULATION

Wright directs FERC to fast track large load interconnection

In a notice of proposed rulemaking, the Energy Secretary endorsed accelerating interconnection for flexible loads like data centers.

"Meanwhile, others like the startup **Verrus** are proposing redesigning data centers to better serve as flexible grid assets."

The Verrus™ blueprint



Ultra-low water consumption

Consumes significantly less water than legacy design data centers through closed-loop cooling and seasonal adiabatic spray misters.



Advanced BESS Backup Power

Uses battery energy storage systems (BESS) rather than diesel generators for a safer, cleaner, quieter approach.



Verrus PowerFlow™

Enables optimal use of available energy from the grid, helping tenants and utilities maximize revenue.



Load Flexibility

Data centers utilize BESS flexibility to reduce power import during grid stress, decreasing the need for new generation and infrastructure investments while increasing system revenue, thus creating **downward pressure on electricity rates** for all customers.



StabiliGrid™

Data center BESS acts as an automatic grid "**shock absorber**," **improving voltage event ride-through** via StabiliGrid™ architecture to help utilities stay more resilient and ensure reliable power for all.



Rendering of a Verrus data center campus under development.

Verrus: Reimagining the Data Center as a Grid Asset

Transforming static IT load into a dispatchable, grid-responsive resource with Verrus **Powerflow™**



Innovative Design

- **Integrated Powerflow™ Platform:** A grid-aware "operating system" that synchronizes electrical hardware, server workloads, and onsite battery storage throughout the facility.
- **Dynamic Load Balancing:** Moves beyond internal power management to actively balance energy flow across the interconnect with utility-scale, asset-backed load flexibility.
- **The "Grid Shock Absorber":** Megawatt-scale optimization that improves grid asset utilization for both utilities (upstream) and AI customers (down-stream), while strengthening resiliency and reliability for both.

What sets Verrus apart for **utilities**?

Verrus makes the power grid more efficient and affordable for everyone

1

Firm Demand Response at MW scale

Verrus data centers are purpose-built to deliver megawatt scale load flexibility via bespoke utility products, including **demand response and ancillary services, that are 100% committable** due to our dispatchable, grid-tied battery energy storage capacity.

2

Lower Energy Prices

Utilities can factor Verrus' dependable Demand Response commitment into their rate plans leading to a higher system capacity factor and more energy revenue without the need to invest in new peak generation and transmission assets - thus resulting in **lower energy prices for ratepayers**.

3

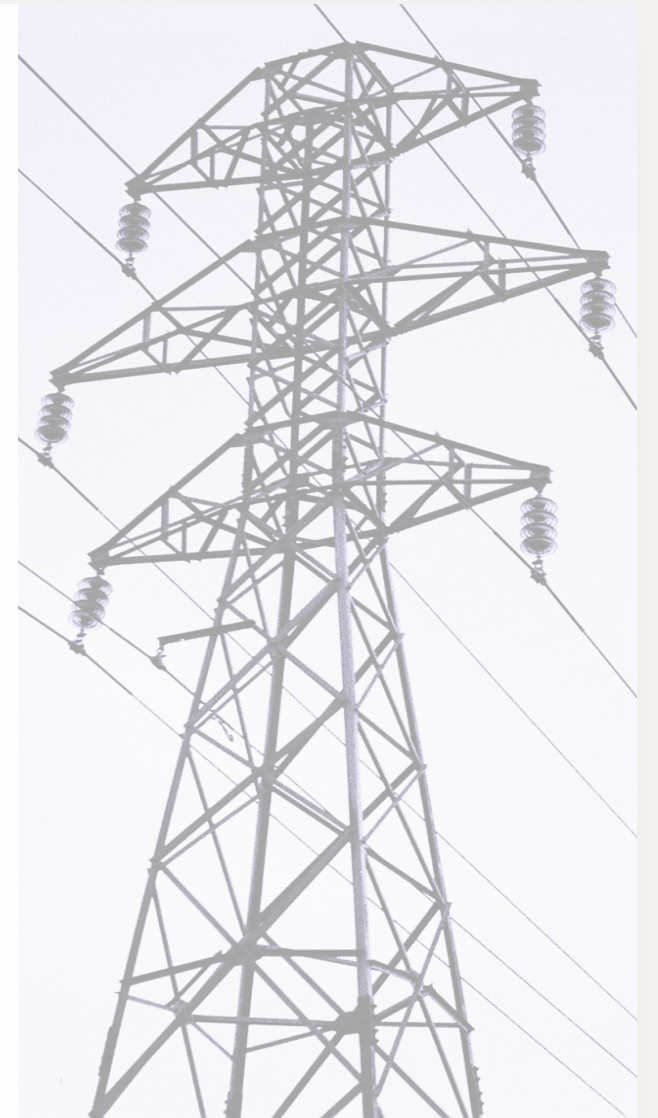
Stable power interconnection

Utilities are becoming increasingly concerned about the effects of large, abrupt workloads swings in AI training data centers. Verrus' grid-following BESS design **acts as a "shock absorber", helping to mitigate the effects** of such swings as perceived by the utility at the point of interconnection.

4

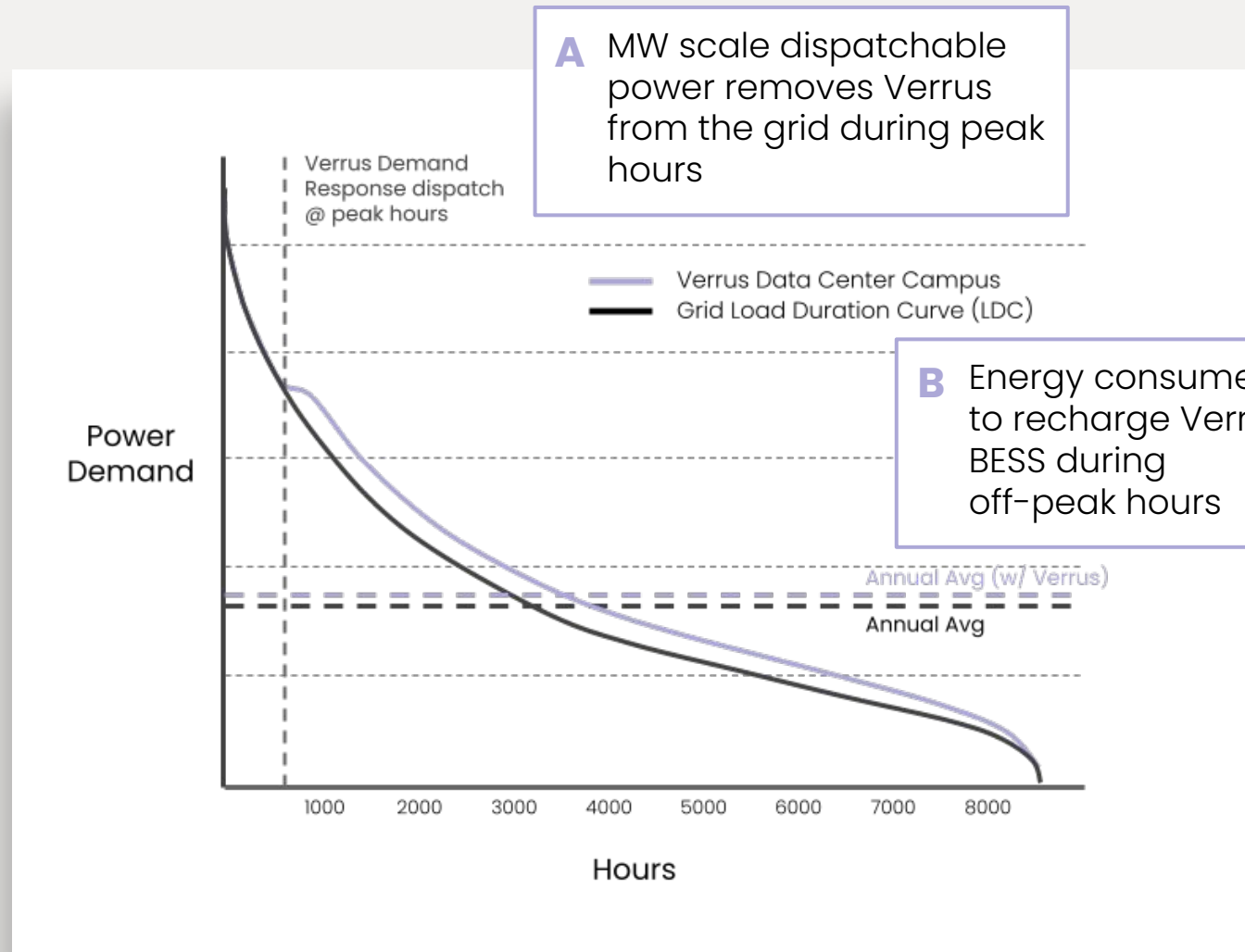
Ability to add renewable generation

In regions where renewable generation is capped by demand during peak periods, Verrus' battery storage can serve as a high capacity curtailment asset, **raising the ceiling for renewable generation on the grid**.



Utilities: How Verrus helps the grid & its customers

Large load flexibility that can be dependably dispatched when the grid is stressed.



Representative utility Load Duration Curve (LDC)

A By committing firm, dispatchable power during peak [n] hours of the year, a Verrus data center campus can be added to a utility demand curve without contributing toward net new required generation and minimizing infrastructure upgrades.

B Verrus data center campuses utilize megawatt-scale BESS as the sole dispatchable energy resource - which means they discharge during a utility event with **100% of required energy consumed during off-peak periods.**



That translates to a higher system-level capacity factor and **higher utility returns + downward pressure on energy prices for ratepayers.**

Thank You

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