TERRAFLOW ENERGY

Built for Volatility: Long - Duration UPS for Critical Infrastructure

DOE OE ENERGY STORAGE PEER REVIEW | JULY 29, 2026

THE POWER PROBLEM

Demand is Changing

The rapid load swings created by AI workloads are exposing a critical weakness in conventional power architectures, accelerating battery degradation, increasing generator wear, and reducing system reliability.

AI data centers can experience 50–60% load swings multiple times per minute

These rapid "heartbeat pattern type" load cycles accelerate lithium-ion degradation by up to 10x

Backup generators report material failure rates within 12 months due to load swing-driven overuse

FLEXIBILITY IS NO LONGER OPTIONAL.

Large AI loads must now coordinate with the grid

THREE MODELS OF FLEXIBILITY

Different Tradeoffs. Different Outcomes.

Workload Shifting

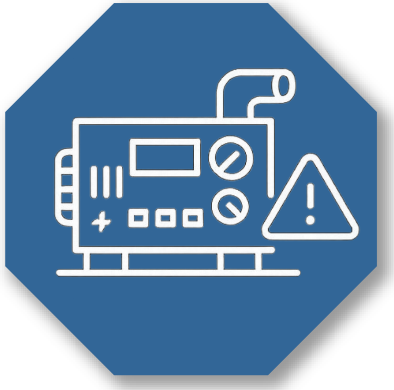
Move compute between campuses to reduce local grid stress.

Requires excess capacity elsewhere.

Compute Curtailment

Reduce active workloads during grid stress events or peak pricing periods.

Directly sacrifices monetizable compute.



Storage - Integrated Architecture

Use storage and on-site systems to reshape apparent grid demand.

Requires new infrastructure architecture.

SOLVING THE CHALLENGES OF AI POWER NEEDS

One Architecture, Four Critical Outcomes

1 SPEED TO POWER	2 GRID STABILITY	3 PROTECT EQUIPMENT	4 COMMUNITY BUY-IN
Conventional architectures can delay interconnection by 2–3 years	AI workloads create 50–60% load swings, 10x per minute	Load volatility degrades generators and critical infrastructure	Fire risk drives local opposition and permitting challenges
ACCELERATE	ABSORB	SHIELD	DE-RISK
Accelerates interconnection and reduces time to power	Instantly absorbs load swings and transforms volatility into a grid asset	Protects generators and critical infrastructure from damaging load volatility	Eliminates fire risk and improves permitting and community acceptance

FLOW BATTERIES

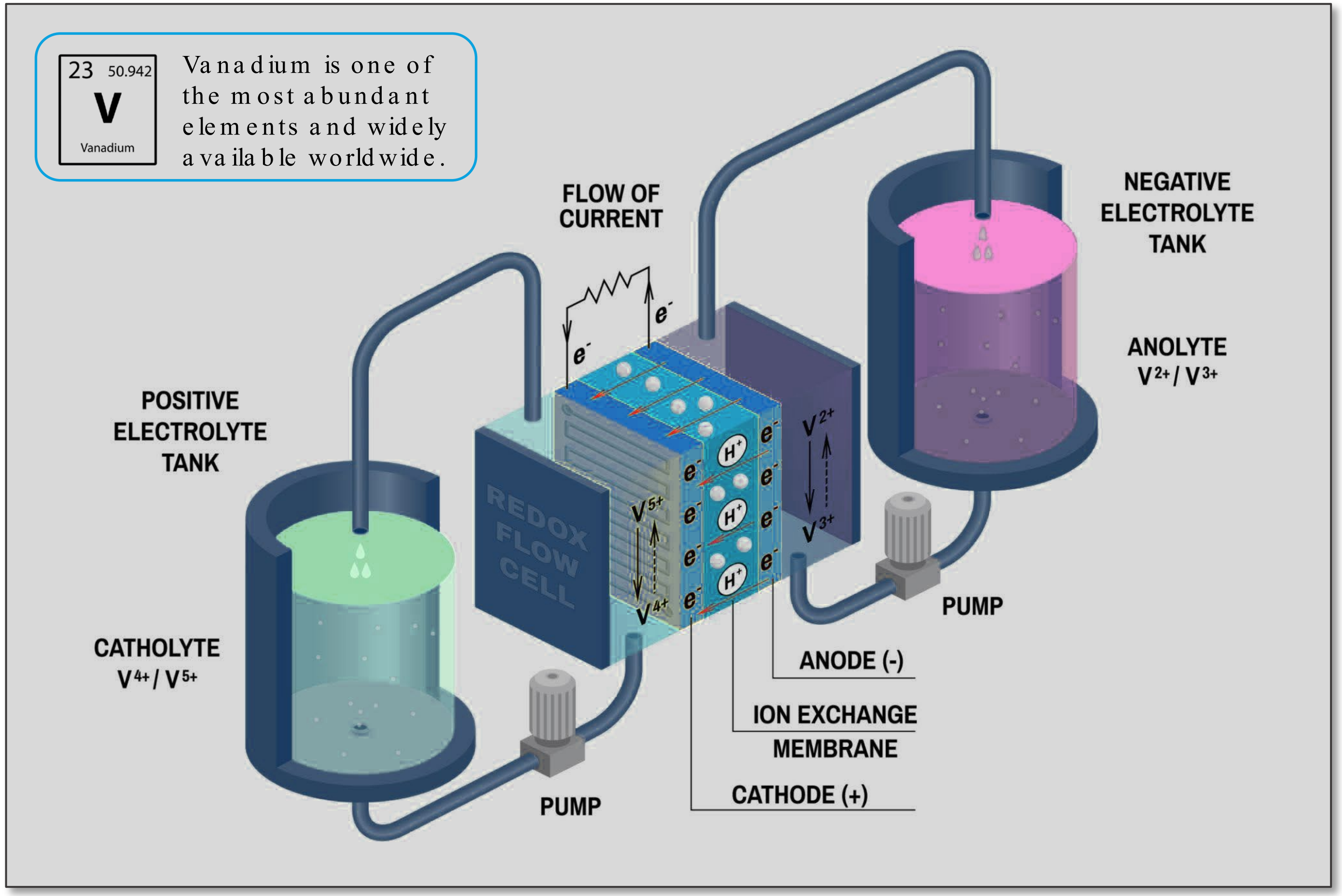
How LDUPS™ Powers Critical Loads

HOW IT WORKS:

1. **ENERGY STORED IN TANKS**
   Liquid electrolyte stores energy separately from power conversion
2. **POWER DELIVERED THROUGH CELL STACK**
   Electrolytes circulate through a central stack where energy is charged and discharged
3. **POWER AND DURATION SCALE SEPARATELY**
   Larger tanks increase duration without increasing power electronics
4. **DESIGNED FOR CONTINUOUS CYCLING**
   The chemistry supports frequent charging and discharging without performance degradation

WHY IT MATTERS:

- Long-Duration Operation
- Infrastructure Scale
- No Thermal Runaway
- Continuous Cycling



FLOW BATTERIES
Proven at Scale

Vanadium flow batteries have been deployed globally across utility, industrial, and microgrid applications for decades.

Global Deployment
5 Continents
Deployed across North America, Europe, Asia, Africa, and Australia

Utility Scale
200 MW/ 1GWh+
Individual projects now exceed 200 MW/ 1GWh of installed capacity

Long Duration
5 - 10+ Hours
Commercial systems delivering multi-hour energy storage

Growing Market
Multi GWh Pipeline
Multiple GWh-scale projects under development and manufacturing capacity expanding worldwide

INDUSTRY VALIDATION

RKP

3.5+ GWh
RONGKE POWER
Global utility-scale deployments

INVINITY ENERGY SYSTEMS

75+ MWh
INVINITY ENERGY SYSTEMS
Deployed across 70+ projects in 14 countries

SUMITOMO ELECTRIC

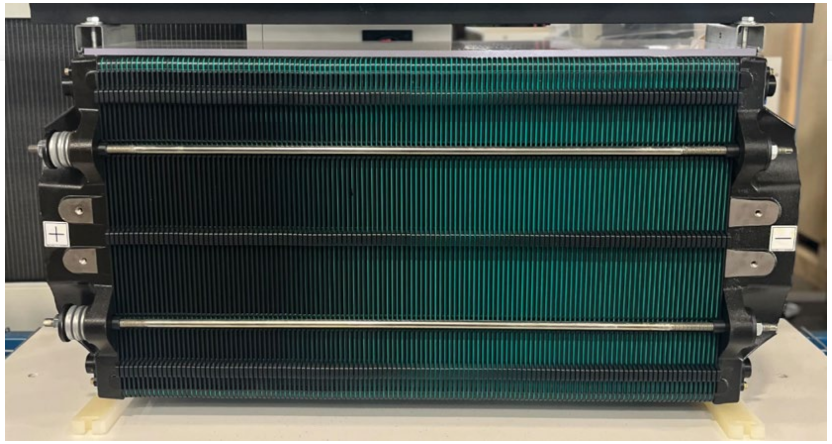
200+ GWh
SUMITOMO ELECTRIC
Installed VRFB capacity worldwide

A BETTER BATTERY
Stack Design Tailored for Critical Loads

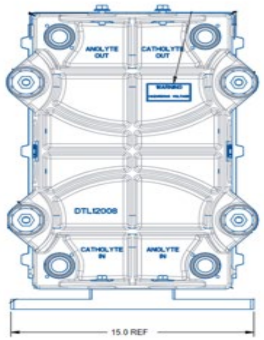
Advantages of the Stack Design:
- Open-frame configuration supports rapid maintenance, modular scalability, and manufacturability
- No dependence on restrictive shipping container dimensions
- Flexible design allows for higher-density installs and retrofit compatibility

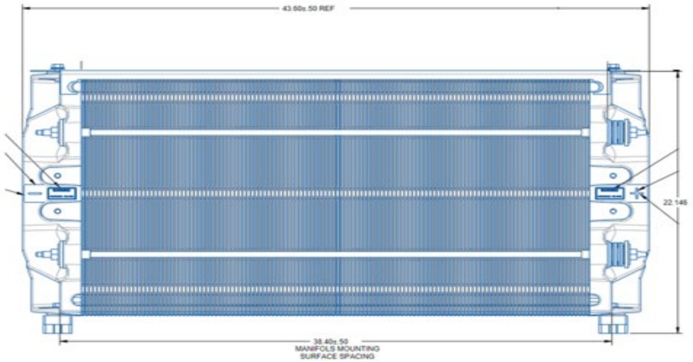
Enclosure & Infrastructure:
- System is fully housed in a temperature-controlled steel building
- Integrated power room for inverters, rectifiers, and controls

End View



Side View



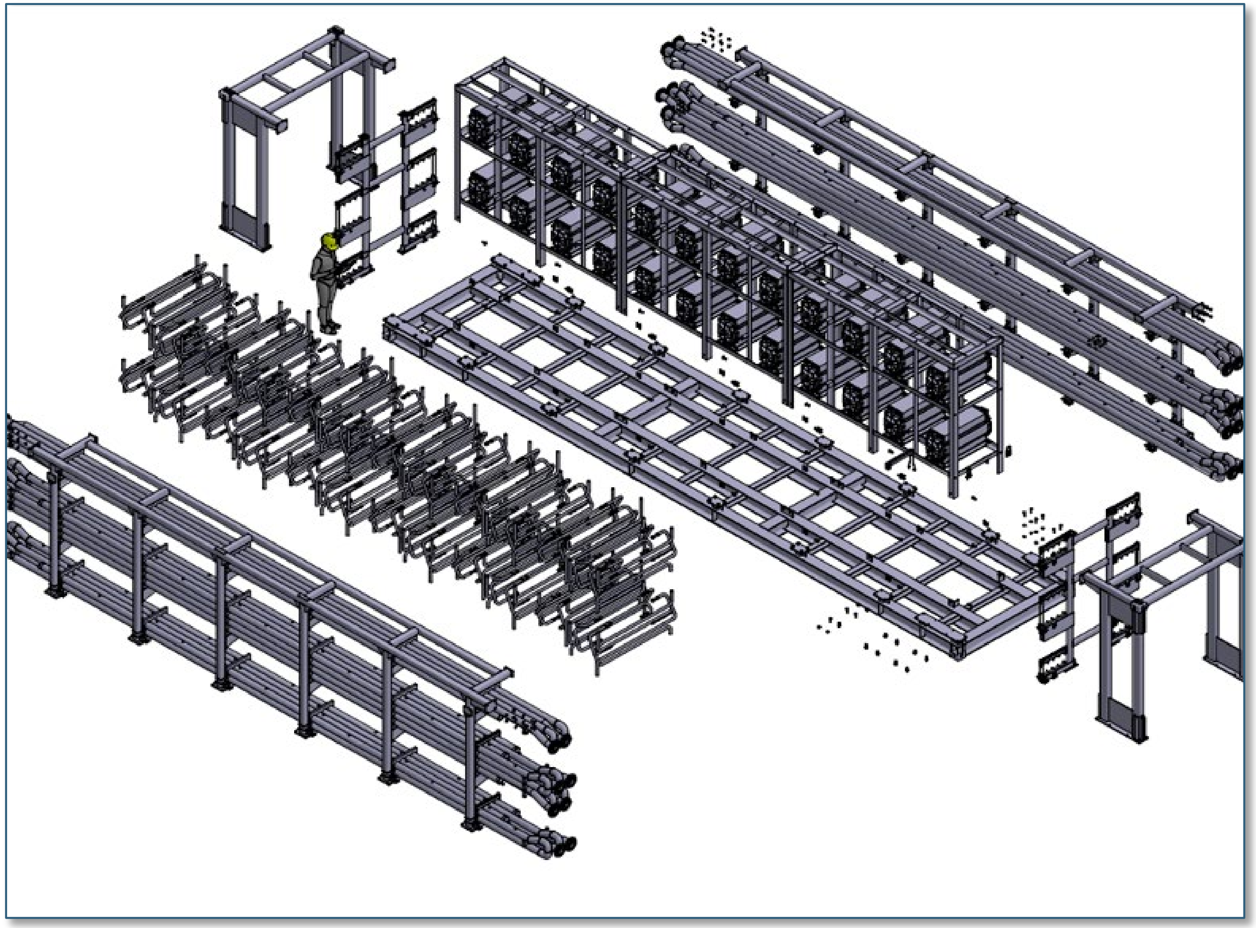


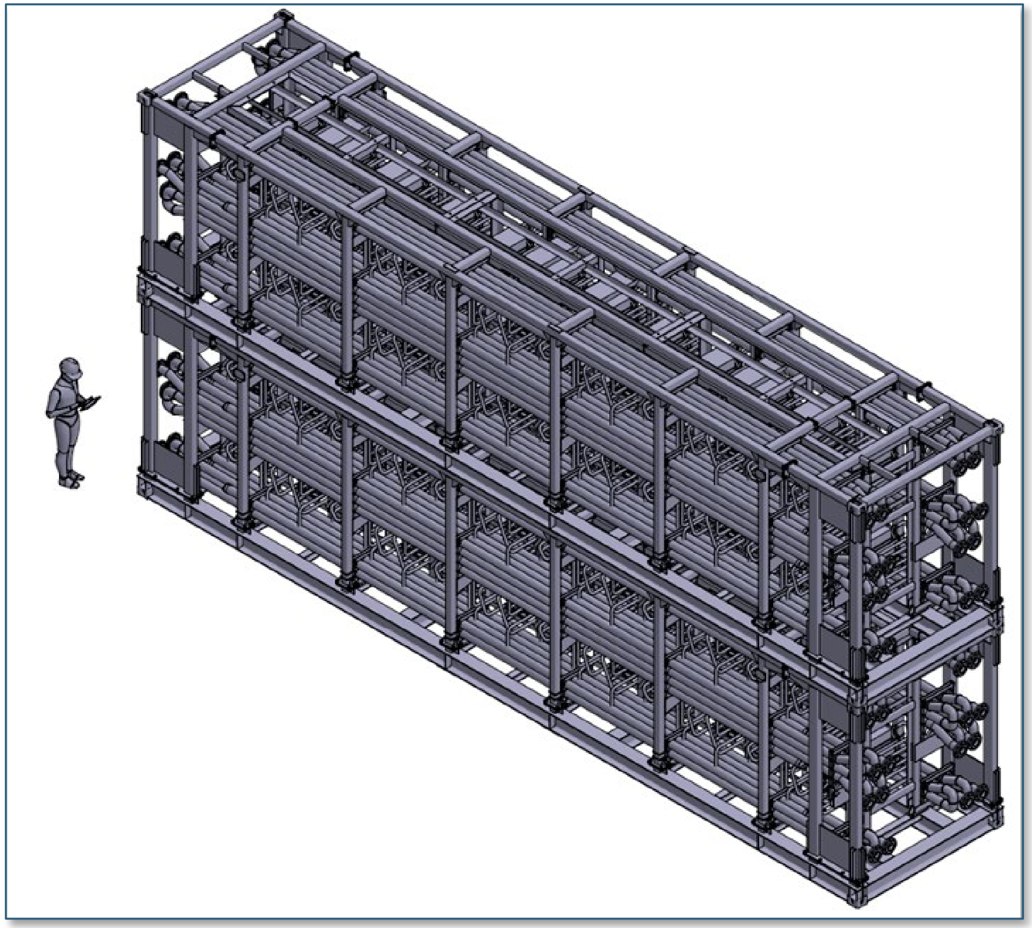
WHY IT MATTERS:

Terra Flow's architecture is purpose-built for hyperscale operators: easy to service, fast to scale, and resilient in mission-critical environments.

A BETTER BATTERY

Open Skid Modular Architecture





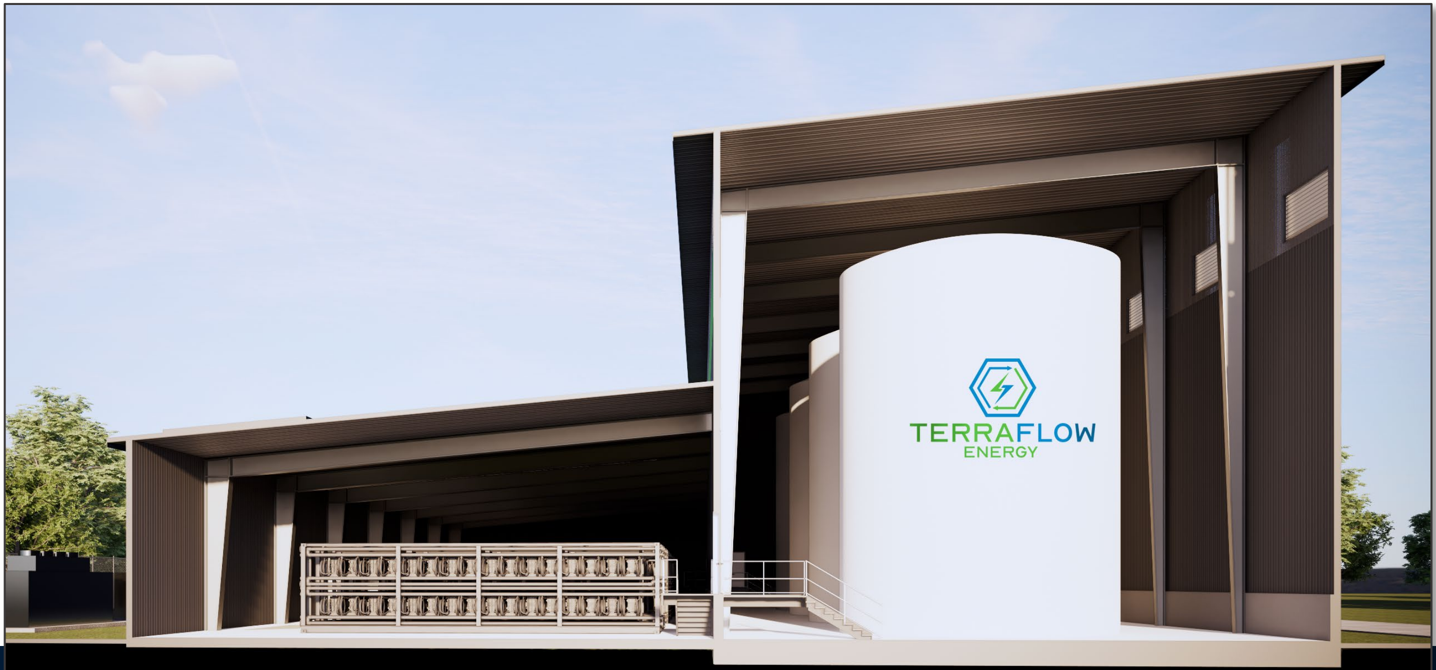
BATTERY-BUILDING
Energy Storage Where It Is Needed

Safe, non-flammable energy storage designed for deployment alongside critical infrastructure.

Deploy Near Load
Designed for installation alongside AI data centers and critical facilities

Large-Tank Architecture
Enables infrastructure-scale deployment with fewer components and simplified operation

Simplified Siting
Reduced setback requirements and greater location flexibility



Terra Flow Energy Standalone Power System

WHY IT MATTERS:

Infrastructure must be designed for real-world deployment, not ideal conditions.

BATTERY-BUILDING

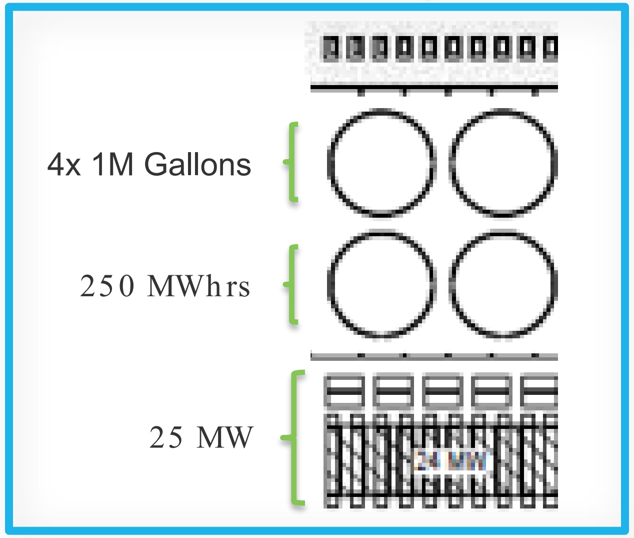
AI Data Center with LDUPS™ Architecture

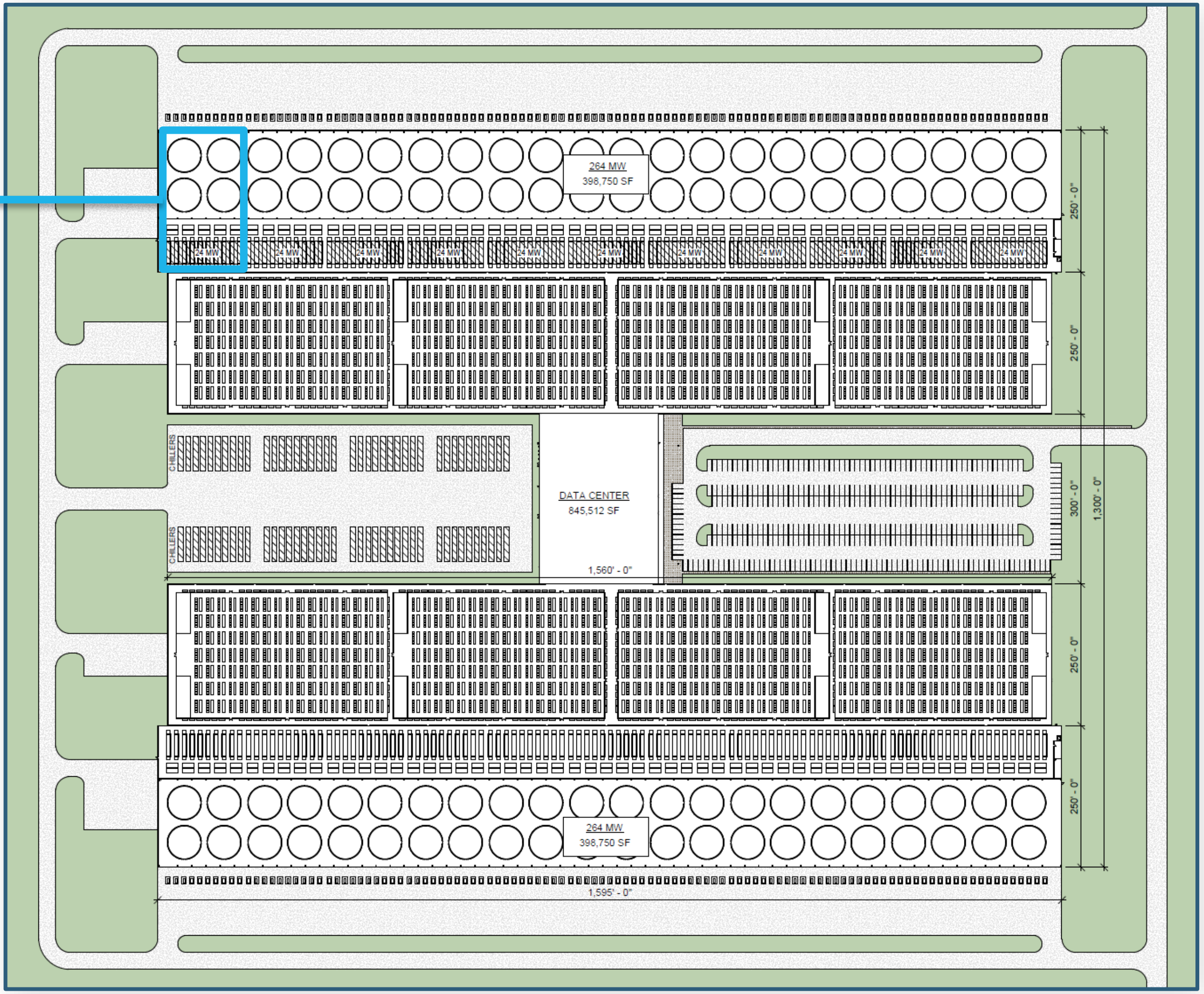
COMPLETE TERRAFLOW SYSTEM ARCHITE

Open Skid + Dual Conversion Power Path

BUILDING

TYPE	AREA
DATA CENTER	845,512 SF
	845,512 SF
BATTERY BUILDING	
264 MW	398,750 SF
264 MW	398,750 SF
	797,500 SF
TOTAL BUILDING AREA	1,643,013 SF





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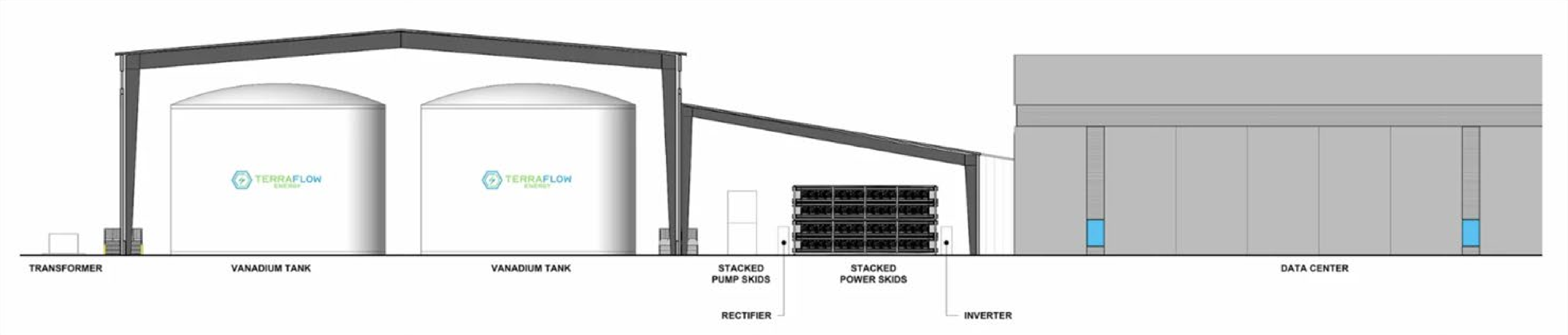
How LDUPS™ Works

LDUPS™ is an in-series energy solution designed to continuously power your facility – not just kick in when something fails.



- Filters out harmonic distortion at the source
- Absorbs and releases energy in real time
- Interfaces with your generation system and grid
- Maintains uptime with no switching delays

TerraFlowenergy.com/ldups

DATACENTER
Grid Disruption

HOME > NEWS > THE CRITICAL POWER CHANNEL

AI data centers causing "distortions" in US power grid - Bloomberg

Shows a strong link between data center proximity and quality of power for consumers

January 06, 2025 By: Zachary Skidmore Have your say

New evidence suggests that artificial intelligence (AI) data centers are distorting the quality of electricity delivered to homes, heightening the risks of appliance damage and fire.

A Bloomberg report, using data from Whisker Labs and DC Byte, has shown that the proliferation of data centers supporting AI applications is putting unparalleled strain on US grid infrastructure and impacting the quality of power delivered to millions of consumers, especially in large data center markets like North Virginia.

'There's a strong link between proximity to AI data centers and higher levels of distorted power in residential areas.'

– Bloomberg

Chapter 3: Risks to the Bulk Power System

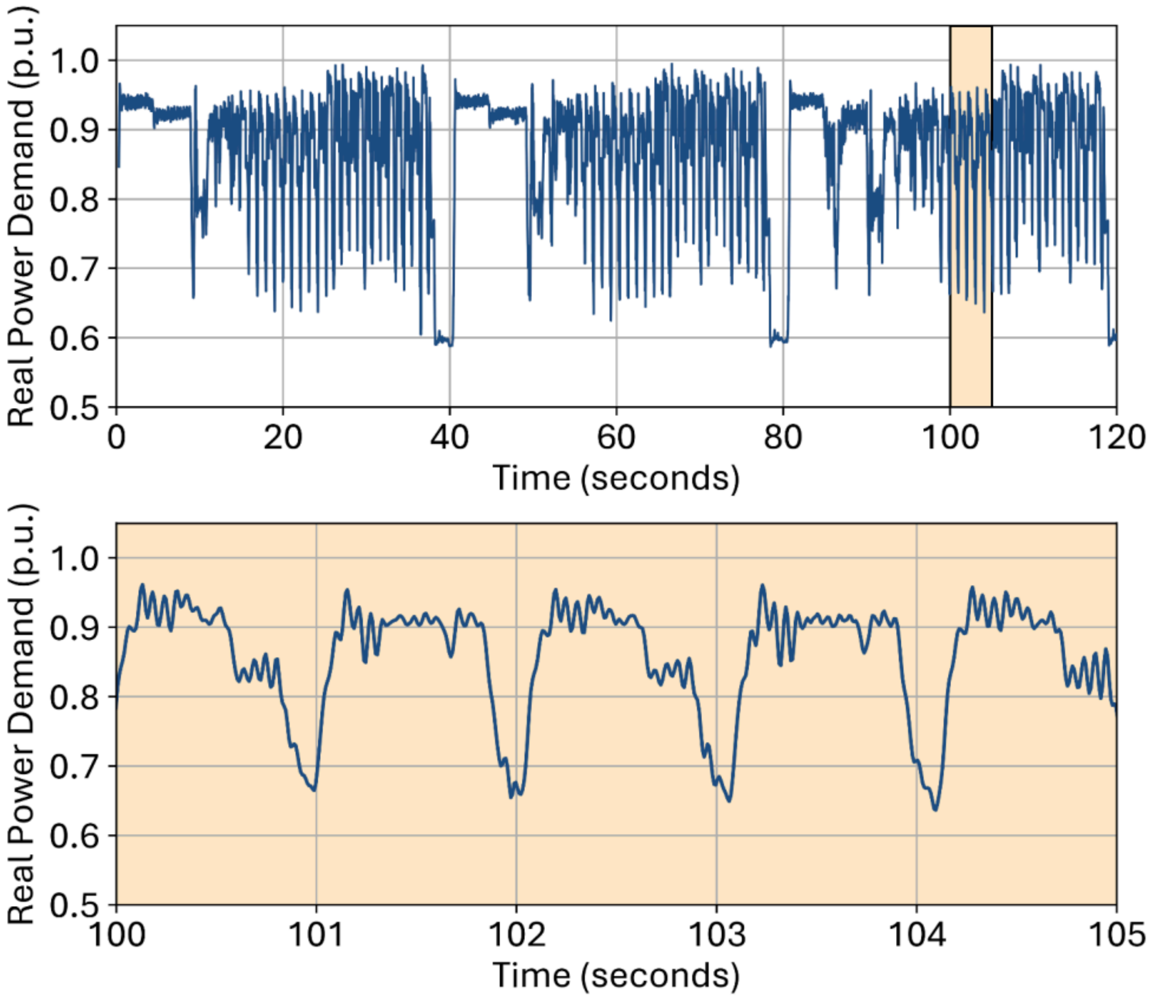


Figure 3.8: Example AI Data Center Load Profile During Training Over Two Minutes (Top) and in a Five-Second Period (Bottom)

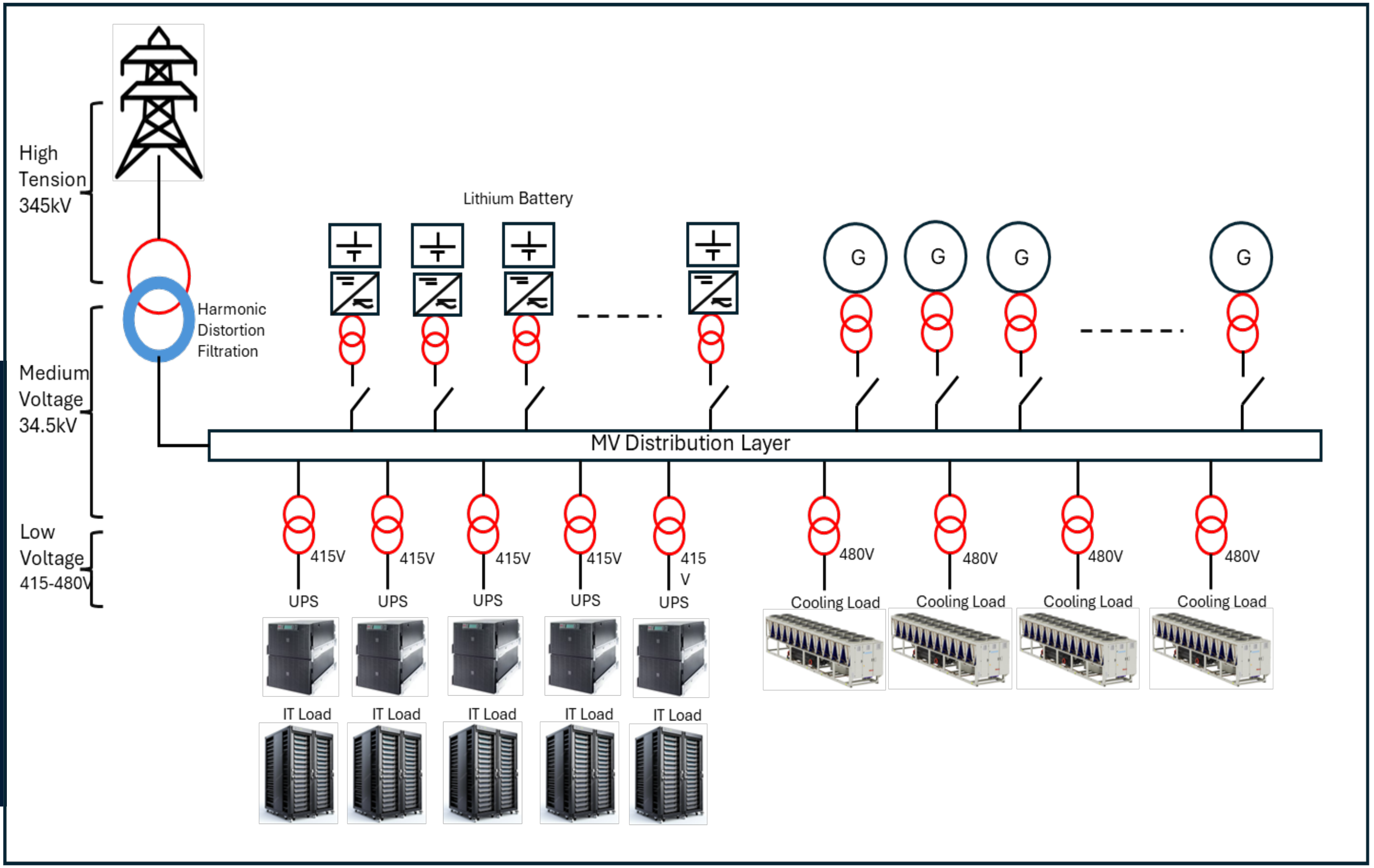
Characteristics and Risks of Emerging Large Loads Large Loads Task Force White Paper

TRADITIONAL POWER ARCHITECTURE

Conventional Power Systems Limit Reliability and Scale

Transformer inertia and layered AC – DC conversion limit ramp - rate response in traditional architectures. These delays increase losses and harmonic distortion and create stability issues under high - variability critical loads such as AI data centers.

- Slow Dynamic Response / No Load Volatility Management
- Conversion Losses
- Harmonic Distortion Management
- Scaling Constraints

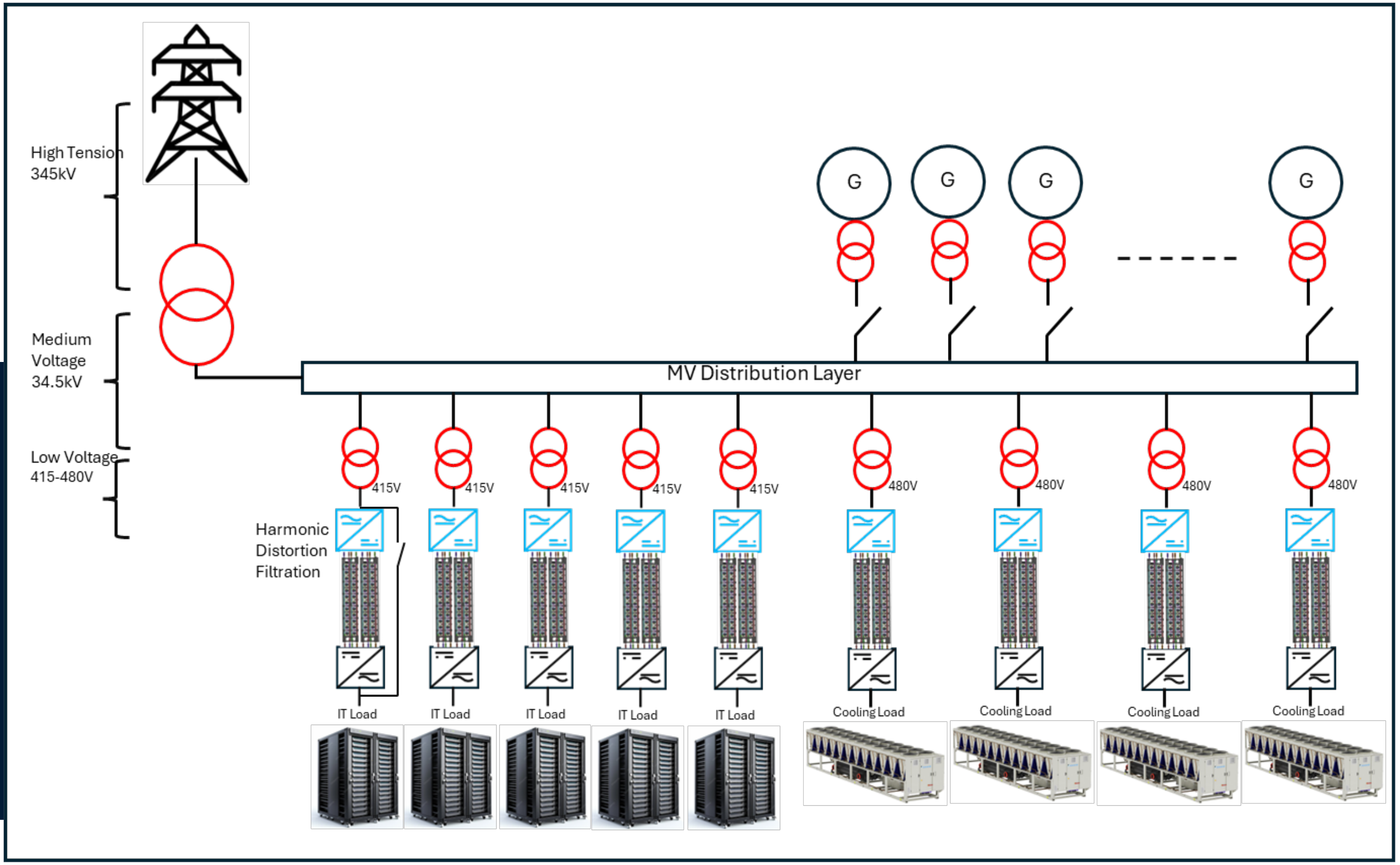


TERRAFLOW ENERGY POWER ARCHITECTURE

Coordinated Large Load Architecture Improves Reliability

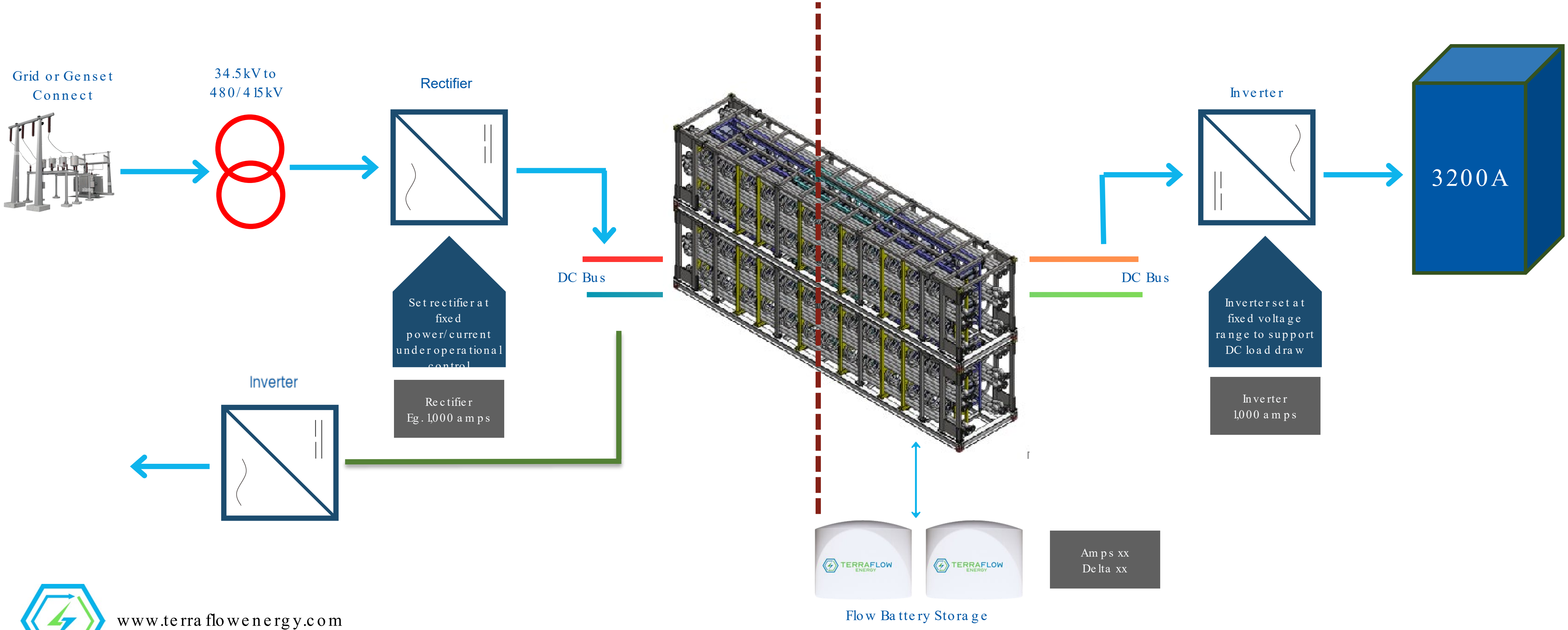
Low- voltage system implementation reduces delays, losses, and harmonic distortion while improving stability under high - variability large loads such as AI data centers. Designed to protect medium - voltage infrastructure and support continuous coordination with the grid.

- Fast Dynamic Response
- Low Conversion Losses
- Improved Harmonic Distortion Management
- Modular Scaling



COMPLETE TERRAFLOW SYSTEM ARCHITECTU

Open Skid + Dual Conversion Power Path



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A CATEGORY OF ONE
Instant Power Response Critical Loads

	TERRAFLOW LDUPS™	Lithium (Tesla Megapack)	XL Batteries	Form Energy Batteries	Energy Dome	EOS
Cycle Life	UNLIMITED (No degradation)	3–7K cycles (3-5x+ faster burnout)	20 Yrs Claimed	1,000 – 1,300 Cycles	UNLIMITED No degradation	5,000-6,000 Cycles Claimed
Fire Risk	ZERO	Thermal runaway	Zero	Zero	Low	Zero
Duration	10+ HOURS	1–4 HOURS	10+ HOURS	Multi-Day	4-24 HOURS	4-16 HOURS
Switching	NONE	Yes	Yes	Yes	Yes	Yes
Response Time	<5 MILLISECOND (Automatic)	Control-dependent	Fast Claimed	Seconds to Minutes	Minutes	< 5 Millisecond
Efficiencies	>90% (in LDUPS Mode)	~90%	~70%	30 – 50%	~75%	~75%
Supply Chain	U.S. Domestic	Lithium bottlenecks	U.S. Domestic	U.S. Domestic	Global	U.S. Domestic
Footprint / Energy Density	67.5 kWh / M^2	50 kWh / M^2	5 – 15 kWh / M^2	49 - 74 kWh / M^2	4 – 5 kWh / M^2	33 kWh / M^2
Chemistry	Vanadium	Lithium	Organic Flow	Iron - Air	Compressed CO^2	Zinc - Bromine

TERRAFLOW ENERGY

Grid - Ready By Design

RESPONSIVE LOAD IS NO LONGER OPTIONAL. IT'S THE FUTURE OF AI INFRASTRUCTUR

100% Site Curtailment	Enables full load response during grid events.
Behind - the - Meter Dispatch	Uses on - site generation without disrupting operations.
Ancillary Service Participation	Unlocks frequency response, reserves, and future market participation.
TX SB6 & Responsive Load Ready	Designed for Texas' evolving large - load requirements.
LVRT Compliant	Supports ride - through performance during grid disturbances.

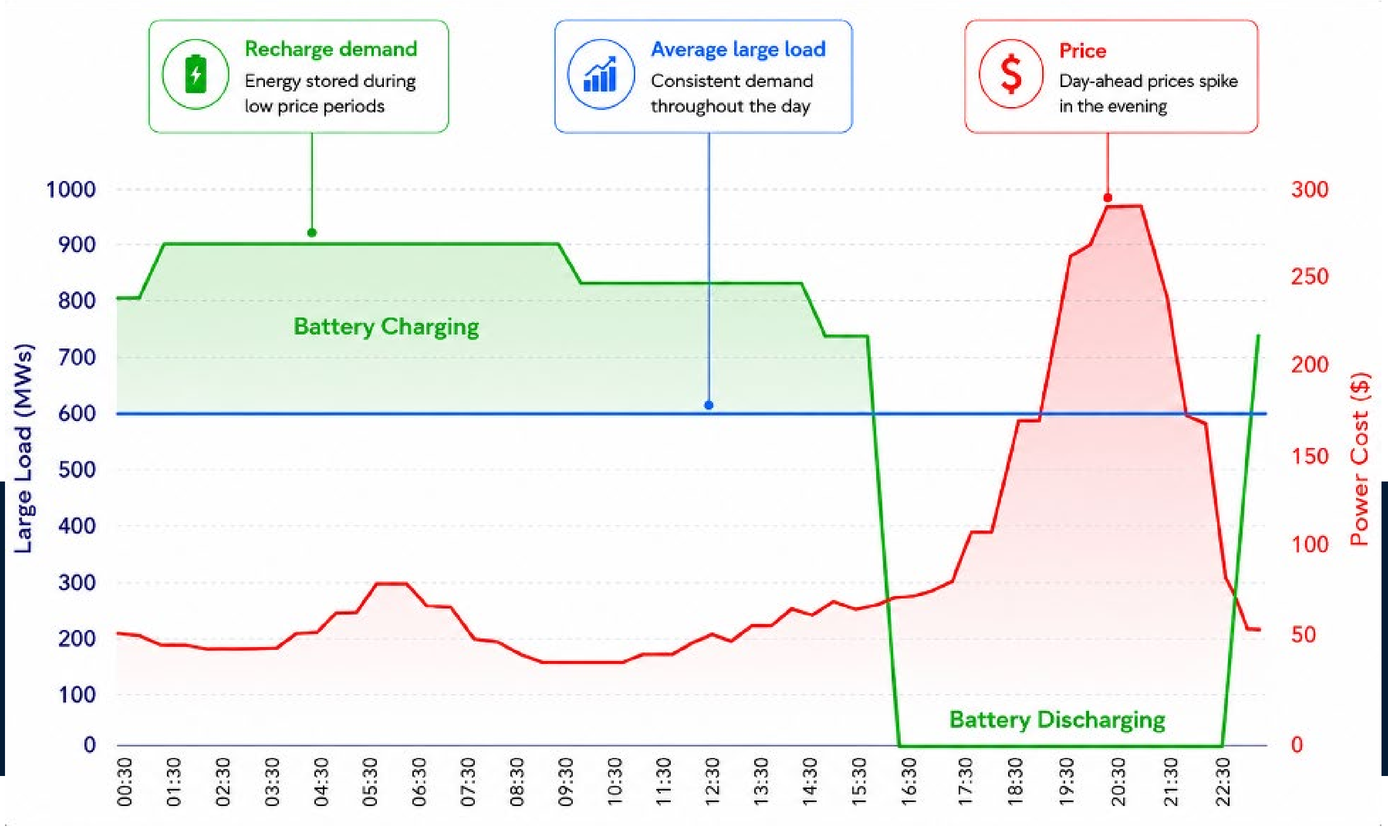
Instead of simply consuming electricity, LDUPS ™ enables critical loads such as AI data centers to support grid reliability, reduce operating costs, and help lower electricity costs for the communities they serve.

TURNING POWER INTO PROFIT
Optimizing Energy Use for Maximum Return

Economic effects of TerraFlow Energy solutions

- Reduces peak power costs through load shaping
- Enables participation in grid services markets
- Reduces total cost of ownership through improved asset utilization
- Improves cost predictability by smoothing demand and reducing peak exposure
- Converts energy infrastructure from fixed cost to operational asset
- Reduces exposure to energy price volatility and peak pricing events

Load Shifting Value | Summer Day Example



WHY IT MATTERS:

Infrastructure-scale energy storage changes how power is procured, used, and valued, enabling lower costs, improved system performance, and new operational flexibility.

TERRAFLOW ENERGY

Infrastructure Measured Over Decades

TRUE COST IS MEASURED ACROSS THE ENTIRE ASSET LIFE

	Conventional Lithium	LDUPS™
Initial CAPEX	Lower	Higher
Replacement Batteries	Every 8-12 years	None
Cycling Degradation	Yes	Minimal
UPS + Harmonic Filters	Separate systems	Integrated
Useful Asset Life	~10 years	25-30 years
Lifetime Cost per Delivered MWh	Increases over time	Declines per delivered MWh

TERRAFLOW ENERGY

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