Keentel Engineering
An engineering company

DATA CENTER POWER ENGINEERING

Large Loads Are Now
studied like generation

Interconnection, campus electrical design and the modeling that gets a hyperscale or AI campus energized — for powered land developers, operators, EPCs and the utilities on the other side of the point of interconnection.

In two years the industry went from plugging in a load to defending it — with a dynamic model, a ride-through case and a curtailment commitment.

Every major market has now built, or is building, a study process for large loads. FERC has ordered all six RTOs to justify or reform their tariffs. NERC has issued a Level 3 Essential Action Alert on computational load modeling and is drafting the first reliability standards written specifically for these facilities. The engineering that used to sit inside a building is now on the transmission planner's desk — and it is power system engineering, which is what we do.

30+	1 GW	1.35 GW	4
YEARS ACROSS TRANSMISSION, SUBSTATIONS & INTERCONNECTION	ERCOT HYPERSCALE INTERCONNECTION DELIVERED	ELECTRICAL DESIGN ACROSS THREE ERCOT CAMPUSES	ISOS WITH DELIVERED LARGE-LOAD DYNAMIC MODELING

SCOPE | **Interconnection** | **Dynamic modeling** | **Ride-through** | **Campus substation** | **MV distribution** | **On-site generation**

WHERE WE WORK

01 Site screening
What a site can actually take, from which substation, and on what date.

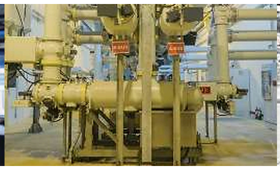
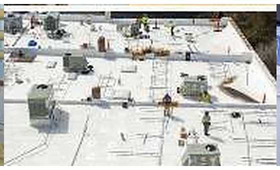
02 Interconnection
Study process entry, forms, allocation, and the utility relationship behind it.

03 Modeling
PSPD and EMT models, ride-through cases, harmonic spectra, ramp characterisation.

04 Campus design
POI substation, MV distribution, redundancy architecture, protection and metering.

05 Flexibility
Curtailable service, on-site generation and storage, and what they buy you in the queue.

06 Energization
Commissioning sequence, witness testing and the operating obligations that follow.


START A SCOPE ›› Tell us the site, the MW, the market and the date you need power — we will tell you what the study process actually requires and where the schedule risk sits.

NSPE | D·U·N·S REGISTERED | IEEE SENIOR MEMBER | BBB ACCREDITED A+

CONTACT 813-389-7871 · contact@keentelengineering.com · keentelengineering.com · Tampa · Austin · Sacramento · Baltimore

READ THIS BEFORE YOU PICK A SITE

What Changed, and Why It Changes Your Schedule

A large load used to be a service request. It is now a studied facility with a model, a performance obligation and, in most markets, a curtailment condition attached.

The four things that moved

- **A study process now exists.** ERCOT, SPP, PJM and MISO have each stood up a large-load process with a MW threshold, forms, a timeline and an allocation outcome. Entry is no longer a phone call to the utility.
- **The load has to be modeled.** Positive-sequence and EMT models, protection and control settings, ramp rates and harmonic spectra — the same package a generator submits.
- **The load has to ride through.** ERCOT and MISO have published voltage and frequency ride-through envelopes for large electronic load. Tripping offsite on a distant fault is now a compliance question, not just an availability one.
- **Flexibility buys speed.** Every market has built a faster path for load that will curtail or bring its own generation. That is now the principal schedule lever.

Why an outside power engineer

The people who design data center electrical systems and the people who model loads for transmission planners have historically been different professions. This work sits exactly on that seam, and it is the seam where projects lose cycles.

THE NUMBER THAT MATTERS MOST

Approved is not energized

ERCOT reported **8,926 MW** of large load approved to energize as of its June 2026 operational overview, against an observed non-simultaneous large-load peak of **3,966 MW** in the same month. Roughly half of what has cleared the process is not yet drawing power.

> ERCOT recorded **137 new large load interconnection submissions totalling around 140,000 MW through 2036** in its March 2026 report to the Technical Advisory Committee

> NERC's 2025 Long-Term Reliability Assessment notes that both ERCOT and PJM **revised forecasts downward** after the assessment — large loads add volatility to forecasts

> PJM's 2026 load forecast now requires **firm commitments** for near-term years and derates longer-term projects

What that means for you

- A queue position is not a load forecast, and a forecast is not a schedule
- Utilities and ISOs now discount unfirmed requests — demonstrating commitment moves you up the credibility order
- The projects that energize on time are the ones whose interconnection, modeling and equipment procurement were sequenced together from day one

If you are a developer

The interconnection process is now the critical path and the model is now a gating deliverable. Both need engineering attention months before you would historically have engaged an electrical firm.

If you are an operator

Your existing campus may be one of the facilities disconnecting on remote faults. Characterising that behaviour before your utility does it for you is a substantially better position to be in.

If you are a utility

You are receiving requests larger than anything in your planning history, with load models nobody has validated. Independent review of what is actually being asked for is the cheapest risk reduction available.

The two-year turn, in one sentence

In 2024 a large load was a service request handled by a utility account manager; in 2026 it is a studied facility with a submitted model, a published ride-through obligation, a curtailment condition and a registration category being written for it at NERC — and the engineering that satisfies all four is the same engineering a generator has been doing for twenty years.

MARKET BY MARKET

How Large Loads Actually Connect

Four processes, four thresholds, four sets of forms. A design that satisfies one market does not satisfy the next.

MARKET	PROCESS	THRESHOLD	WHAT IT ACTUALLY REQUIRES
ERCOT	Batch Zero, under PGRR145 and NPRR1325 — replaces the former PGRR115 process	75 MW	A single ERCOT-led, system-wide study that classifies each project as base, studied or excluded load, then runs a commitment gate and a refinement study. Requests of 100 MW or more must be allocated at least 100 MW to proceed. Notarised forms through the TSP or DSP.
SPP	High Impact Large Load study and HILL Generation Assessment, accepted by FERC 14 January 2026	—	Paired with Load Limited Resource Interconnection Service, which caps generator output at the forecast hourly load of nearby large loads so added load and added generation offset. FERC's order states it cuts timelines to less than half the typical SPP generator queue duration.
PJM	Critical Issue Fast Path on Large Load Additions — Board decision 16 January 2026	50 MW	Two routes. Bring Your Own New Generation offsets demand on an equivalent load carrying capability basis with an expedited pathway. Connect and Manage takes loads without offsetting generation, subject to curtailment ahead of pre-emergency demand response.
MISO	Large Load Interconnection Reliability Requirements Technical Compendium, draft to the Large Load Working Group June 2026	50 MW	Explicit voltage and frequency ride-through curves, a ramp-rate limit, and modeling obligations. Existing facilities are captured at 25 MW above their documented value as of 1 September 2026.
CAISO	No standalone large-load study process outside the Transmission Planning Process, per FERC's June 2026 finding	—	Under a FERC show cause order to justify or reform. Expect a process to emerge; plan on the current absence of one being temporary.

Texas adds a layer the tariff does not

Senate Bill 6 (2025) reaches loads of 75 MW or more with a competitively procured demand-reduction reliability service on 24 hours' notice; makes transmission-voltage loads interconnected after 31 December 2025 curtailable during firm load shed; lets ERCOT direct large loads with on-site backup generation sized at half their demand or more to deploy it or curtail; and requires a 120-day impact study and PUCT approval for netting and co-location arrangements. A Texas project is designed against the statute as well as the protocol.

Thresholds differ

75 MW in ERCOT, 50 MW in PJM and MISO, and a working definition of more than 20 MW in FERC's rulemaking. A campus phased below a threshold in one market is captured in another.

Windows are fixed

Batched processes run to published dates. Missing a submission window does not delay you by weeks — it delays you by a cycle, and cycles are measured in quarters.

Forms carry weight

Notarised attestations and declared operating intent are part of the submission. What you commit to on a form constrains how you can operate the facility afterward.

We work either side of the table — preparing and defending a submission for the load owner, or independently reviewing one for the utility or transmission planner receiving it

Non-ISO territory is not simpler — vertically integrated utilities set their own study conventions and interconnection requirements, and those are rarely published

THE FEDERAL LAYER

FERC, Co-Location and the Rules Being Written Now

Every RTO in the country is currently under an order to justify or reform how it connects large loads. Designing against today's tariff alone is a mistake.

The show cause orders — 18 June 2026

FERC issued tailored Federal Power Act section 206 orders to all six RTOs and ISOs, giving each 60 days to justify its tariff or file reforms, and 30 days to report on generation availability for existing and new large loads. Five reform categories:

- Transmission service study procedures for customers serving large loads
- Cost transparency and recovery, to prevent cost-shifting onto other customers
- Rates and terms for co-location arrangements
- Transmission services for flexible and curtailable load
- Interconnection customer standards for electrically proximate loads

FERC asserted exclusive authority over the study process on the basis that it directly affects jurisdictional transmission rates, and directed procedures that complete within 60 to 90 days of a request.

What we do with this

We track the dockets that govern your market and tell you which of your assumptions are resting on a rule that is under active reform. On a project with a 2028 or 2029 energization date, that is not academic — it decides whether your interconnection strategy still works when you get there.

CO-LOCATION

Framework decided, detail pending

In December 2025 FERC found PJM's tariff provisions on co-locating generation with load unjust and unreasonable for lack of clarity on rates, terms and conditions, and directed PJM to file transparent rules. A compliance order followed in June 2026 establishing network service, firm contract demand and non-firm contract demand options with a 50 MW applicability threshold, while sending several elements back for further work.

> The **jurisdictional question** — whether interconnecting retail load through co-location is FERC-jurisdictional at all — was expressly left undecided

> ERCOT's **Withdrawal-Limited Private Use Network** and SPP's **LLRIS** are the equivalent mechanisms in those markets, and they work differently

The rulemaking

- Docket **RM26-4**, Interconnection of Large Loads to the Interstate Transmission System, opened with an advance notice of proposed rulemaking on 23 October 2025
- It uses **more than 20 MW** as its working definition of a large load
- It seeks comment on accelerated studies — potentially 60 days — for flexible loads willing to curtail, on cost allocation and crediting, and on reliability review where an existing plant partially shuts down to serve a new large customer
- As of August 2026 it remains at the advance notice stage. **No proposed or final rule has issued** — treat anyone telling you otherwise with care

Design for the rule that will apply at commercial operation, not the one in force at financial close — on a 2029 energization that is a different document

Co-location is not a way around interconnection. Every market now has an explicit mechanism with its own metering, protection and enforceable limits

Cost allocation is being actively reformed. Who pays for network upgrades, and whether other customers can be charged, is one of FERC's five named reform categories

Flexible service is the fast lane. Both FERC's rulemaking and every RTO process now reward load willing to curtail — the question is what that costs you operationally

THE RELIABILITY LAYER

NERC Is Writing Standards For Your Facility

Large computational load is becoming a registered function with its own reliability standards. The first drafts are out for comment now.

Level 3 Essential Action Alert — Computational Load Modeling, 4 May 2026

NERC's highest alert level, addressed to transmission planners, planning coordinators, transmission owners, balancing authorities, reliability coordinators and transmission operators. It reaches loads of **20 MW or more, connected at 60 kV, containing more than 1 MW of IT load** — which is to say, essentially every project in this market.

- Requires the **PERC1** power electronic reconnecting and ceasing model, or better
- Electrical size, power factor and dynamic characteristics including UPS settings
- **IT versus non-IT composition** of the load
- Maximum ramp rate in MW per minute
- Protective device models and reconnection parameters
- Corrective action so there is **no non-consequential loss of firm load for computational load from normally cleared non-bus faults**
- A prior Level 2 alert found entities generally lacked adequate processes to do any of this

Registration is coming

- NERC has proposed two new registered entity types — **Computational Load Owner** and **Computational Load Operator**
- Draft Rules of Procedure revisions were posted in April 2026; revised thresholds went out for comment in August 2026
- Registration brings audit exposure, evidence obligations and a compliance programme — the thing most data center organisations have never had to build

Project 2026-02 — Computational Loads

- Launched 16 March 2026. Three foundational standards drafted:
- **CLO-001** — interconnection, studies and modeling
- **CLO-002** — operational data and communications
- **CLO-003** — protection coordination
- Comment period running into September 2026

The guideline you can act on today

NERC's May 2026 Reliability Guideline, *Risk Mitigation for Emerging Large Loads*, is explicitly voluntary and non-binding — and it is the clearest available statement of what your ISO is about to ask for. Building to it now is the cheapest version of this work. Retrofitting a campus to it after energization is the expensive one.

What we produce

The model package, the load composition breakdown, the protection and reconnection parameter set, the ramp characterisation and the monitoring specification — in the form the alert and the guideline ask for.

Who we produce it for

Either side. For the load owner submitting it, or for the transmission planner who has received a submission and needs it independently reviewed before it enters a planning case.

What it is worth

A rejected or unusable model costs a study cycle. On a batched process that is measured in quarters, and it moves your energization date by more than the whole engineering fee.

SCOPE NOTE We produce the technical evidence — models, studies, settings, monitoring specifications. CIP cyber security is a separate discipline, coordinated with your own cyber team.

THE PROBLEM THAT CREATED THE RULES

Data Centers Are Disconnecting Too Early

A remote fault clears normally in a few cycles. Hundreds of megawatts of load transfers to backup and vanishes from the grid. That is now a documented, repeated reliability event.

NORTHERN VIRGINIA, 10 JULY 2024

~1,500 MW, on a lightning arrestor

A lightning arrestor failure on a 230 kV line triggered multiple system faults within 82 seconds. Voltage in the affected area dipped to between 0.25 and 0.40 per unit. Around 1,500 MW of load was lost and system frequency rose to 60.053 Hz, stabilising within four minutes.

> The load was **not disconnected by the utility**. Customer-side protection and controls transferred it to backup power — the facilities protected themselves, and the grid absorbed the consequence

And it keeps happening

- NERC's January 2026 incident review counted **26 large electronic load ride-through events** in ERCOT between January 2023 and September 2025, each shedding more than 100 MW indirectly
- Load loss ranged from **17% to 95%** of pre-disturbance consumption; line-to-ground faults averaged around a 65% reduction
- The critical threshold was single-phase voltage falling below roughly **0.7 per unit**
- Drive undervoltage settings were found **set as high as 0.96 per unit** — equipment configured to drop out on a voltage dip most of the grid would not even notice
- In July 2026 PJM and Dominion reviewed an event in which roughly 3,800 MW of data center load disconnected following a mechanical failure on a 230 kV line

ERCOT — Large Electronic Load ride-through

A facility with aggregate peak demand of 75 MW or more where half or more is power-electronic computational load.

VOLTAGE (P.U.)	MINIMUM RIDE-THROUGH
0.90 – 1.10	Continuous
0.80 – 0.90	2.0 s
0.50 – 0.80	0.5 s
0.20 – 0.50	0.25 s
1.10 – 1.20	2.0 s

- Active power held **within 10% of pre-disturbance** during required ride-through
- No more than **125% of maximum normal current** during voltage disturbances
- Protection must use filtered measurements or time delays — **instantaneous frequency measurement is prohibited**
- Frequency: continuous 58.8–61.2 Hz, with 299 s required in the bands either side
- Phased — proportional power reduction is allowed in the 0.8–0.5 p.u. band until 1 January 2028, after which the requirement tightens

MISO's curve is similar. It is not identical.

MISO's draft compendium requires 0.50 s between 0.50 and 0.80 p.u., 2.00 s between 0.80 and 0.90, and 0.15 s below 0.50 — with 0.50 s in the 1.10 to 1.20 band rather than ERCOT's 2.0 s. A multi-market developer cannot assume one facility design satisfies both.

Why this is an engineering problem, not a settings problem

The instinctive fix — loosen the undervoltage settings — trades a grid problem for an equipment problem, and nobody wants to be the engineer who allowed a transfer to fail. The real answer is a coordinated case across the UPS, the static transfer switch, the drives and the generator controls, demonstrated in a model rather than argued in a meeting. That is the work, and it usually shows that far more ride-through capability already exists than the settings currently allow.

THE DELIVERABLE THAT GATES THE PROJECT

The Model Is the Submission

Loads used to be a constant-power block in a planning case. They are now modelled facilities, with protection settings, ramp behaviour and a harmonic signature.

WHAT NERC'S GUIDELINE ASKS FOR

- **As-designed positive-sequence phasor-domain models** including protection and control settings, with OEM test reports sufficient to verify them
- An **as-designed breakdown of load makeup** — IT equipment, motor load, variable frequency drives, power electronics, lighting — with attestation that the model parameters map to it
- **Site-specific EMT models** developed with the OEM
- **Model verification by benchmarking** the positive-sequence model against the EMT model, with attestation that as-built parameters represent installed equipment rather than software defaults
- **Disconnection and real-power-reduction thresholds** — level and duration — for both voltage and frequency events, plus reconnection thresholds
- **Maximum and minimum ramp rates** for startup and shutdown, and any cyclical demand ramps, especially in the sub-synchronous frequency range
- **Expected harmonic injection spectrum**, at the facility and aggregated at the point of connection
- **Power quality monitoring installed before commissioning**, with fault recording, continuous dynamic disturbance recording and sequence-of-events recording at specifications similar to the PRC-002 and PRC-028 requirements placed on generators

WHY EMT, AND WHEN

Screening triggers

EMT study is triggered by non-convergence of the positive-sequence case, large power electronic devices, series capacitors, and weak grid conditions — the guideline offers a short-circuit ratio of two or less as an example, and is explicit that this is an example rather than settled guidance.

What the load actually does

- NERC documented a **50 MW block within a 200 MW AI training facility changing demand at 1.9 per unit per second for about 250 milliseconds**
- **Checkpoint cycling** — transitions between training and checkpoint-saving phases — occurring in under one second
- A conventional facility ramping **from about 450 MW to about 40 MW in 36 seconds**
- MISO's draft compendium derives a ramp-rate limit of **30 MW per minute**

None of this behaviour appears in a conventional load model. It is why the model, not the one-line, is now the thing your interconnection depends on.

The gap nobody talks about

Device-level immunity references — the ITI curve, SEMI F47, IEEE Std 1668 sag ride-through testing — were written for equipment rated below 1000 V. Neither NERC's guideline nor ERCOT's ride-through rules reference them. Your obligation is now measured at the campus boundary, and there is no published method for aggregating device curves to a 300 MW facility. Bridging that gap is engineering work, and it is where we spend most of our time on these projects.

- Positive-sequence model and case set
- Load composition breakdown and attestation
- Ramp rate characterisation
- Site-specific EMT model
- Ride-through case against the applicable curve
- Monitoring and recording specification
- Benchmarking and verification report
- Harmonic injection spectrum
- Protection and reconnection parameters

SITE SELECTION & DILIGENCE

What Makes Land Actually Powered

"Powered land" is a real-estate term. It has no standard, tariff or regulatory definition — which means the buyer has to supply the engineering one.

Our test — four things, all of them checkable

- **An executed agreement.** An interconnection or electric service agreement in hand, not a letter of intent and not a utility saying capacity looks available.
- **An allocated MW quantity with a study-confirmed date.** Not a request, not a queue position — an allocation, with the study that supports it.
- **Identified and funded network upgrades.** Someone knows what has to be built, what it costs, and who is paying. An unfunded upgrade is a schedule, not a cost.
- **Secured long-lead equipment slots.** A confirmed manufacturing slot for the transformers, not a quoted lead time.

This is our definition, not anybody's standard. We state it that way because there is no authority to cite, and a firm that pretends otherwise is selling you something.

Technical diligence for buyers and lenders

We review the interconnection position, the study record, the upgrade scope and cost allocation, the equipment procurement status and the electrical design maturity — and we report what is actually secured against what is asserted. The findings are usually about dates, not megawatts.

SITE SCREENING — WHAT WE LOOK AT

Source capability. Which substations can reach the site, at what voltage, with what existing loading and what thermal headroom under contingency

Contingency performance. What the voltage at the point of interconnection does under the bounding transmission contingency — because that is what your ride-through obligation is measured against

Short circuit strength. Available fault current and short-circuit ratio, which decide protection design and whether EMT study is triggered

Upgrade exposure. What the utility will require, in what sequence, and whether any of it lands on a long-lead item

Queue and process position. Which process the site enters, at which threshold, against which submission window

Flexibility value. What curtailable service or on-site generation is worth here, in months saved and megawatts released

Route and land. The line or tap that reaches the site, its constraints, and the terminal arrangement at both ends

What comes back

- A ranked view of candidate points of interconnection with the MW each can realistically carry and by when
- The upgrade scope and rough order of magnitude behind each
- A recommendation on process entry and on whether flexibility is worth committing to
- The specific reasons a site we do not recommend fails — stated plainly

The most common finding

It is rarely that a site cannot be powered. It is that the date is wrong — usually by one to three years, and usually because an upgrade or a transformer that nobody sequenced sits between the agreement and the energization. Finding that in diligence is cheap. Finding it after a land purchase and a construction commitment is not.

INSIDE THE FENCE

Campus Substation and Distribution

From the point of interconnection to the medium-voltage bus feeding each hall — the part of a data center that is a substation, designed by people who design substations.

What we design

- **The POI substation** — configuration, main transformers, high-side and low-side arrangement, metering and the utility interface
- **Medium-voltage campus distribution** — radial, loop and dual-feed architectures, cable and duct bank design, ampacity and derating
- **Unit substations and hall transformers**, sizing, impedance and tap selection
- **Protection and coordination** across the campus, with arc flash analysis and label schedules
- **Grounding** — ground grid design to IEEE Std 80 with step and touch potential, and the interface between yard grid, building steel and the IT ground reference
- **Standby and emergency systems** — generator plant arrangement, transfer schemes and their classification under NFPA 110
- **Power quality** — harmonic analysis to IEEE Std 519, filter design where needed, and the reactive behaviour of cooling plant

Where we stop

We design to the medium-voltage and low-voltage distribution serving the halls. White-space electrical, rack-level power distribution, cooling design and the IT fit-out belong to specialists in that work, and we coordinate with them rather than claim their scope.

Redundancy — and what the standards actually say

- The **Uptime Institute Tier Classification System** runs Tier I basic capacity, Tier II redundant capacity components, Tier III concurrently maintainable, Tier IV fault tolerant. It is deliberately **outcome-based** and is not expressed in N+1 or 2N terms — anyone equating a Tier to a topology is quoting a convention, not the standard
- Only Uptime certifies to it, through design document, constructed facility and operational sustainability certifications
- **ANSI/TIA-942-C**, announced May 2024, covers architecture, telecommunications infrastructure, power, cooling, fire protection, physical security and monitoring
- **ANSI/BICSI 002-2024** is the current data center design and implementation best practices document
- N, N+1, 2N, 2N+1, distributed-redundant and block-redundant are **engineering usage**, not standard definitions. In Uptime's 2025 survey of 835 operators, 42% reported 2N and 41% N+1 as their primary redundant power topology

DENSITY, HONESTLY

The installed base and the design case have separated

Uptime's 2025 survey puts the average of modal rack densities at almost 9 kW, with more than 80% of operators reporting no racks above 30 kW and only 9% reporting a maximum at or above 50 kW. New AI halls are being designed at multiples of that. The engineering story is not a single density number — it is that the same campus often has to carry both, and the distribution design has to survive the transition.

- POI substation drawing package
- Campus MV one-line and layout
- Load flow and voltage regulation
- Short circuit and equipment duty
- Protection settings and coordination
- Arc flash study and label schedule
- Ground grid analysis to IEEE 80
- Harmonic and power quality study
- Cable ampacity and duct bank design

THE SCHEDULE LEVER

Flexibility, On-Site Generation and Storage

Every market has now built a faster path for load that will curtail or bring its own generation. Deciding whether to take it is an engineering and commercial question together.

MECHANISM	MARKET	WHAT IT IS, AND WHAT IT COSTS YOU
Provisional Controllable Load Resource	ERCOT	Embeds controllable load directly into security-constrained economic dispatch and allows partial firm service ahead of full transmission build-out. Intent is declared on a notarised form. Exempt from the minimum-allocation rules that otherwise apply.
Withdrawal-Limited Private Use Network	ERCOT	Co-located generation and load operating behind an enforceable maximum MW withdrawal limit. The limit has to be real, metered and enforceable — which is a controls and protection design problem, not a contract clause.
Bring Your Own New Generation	PJM	Voluntary. Offsets demand on an equivalent load carrying capability basis, with an expedited interconnection pathway. The ELCC accounting is where the value is won or lost.
Connect and Manage	PJM	For load without offsetting generation. Faster, but curtailable ahead of pre-emergency demand response, with the transmission owner and load-serving entity selecting who curtails.
Load Limited Resource Interconnection Service	SPP	Caps generator output at the forecast hourly load of nearby large loads so that added load and added generation offset one another. Paired with the HILL study.
SB6 demand reduction	Texas	Statutory rather than tariff. Loads of 75 MW or more face a competitively procured demand-reduction service on 24 hours' notice, and ERCOT may direct deployment of on-site backup generation sized at half the load or more.

The engineering behind a flexibility commitment

- What the facility can actually shed, how fast, and without damaging a training run or an SLA
- The controls and telemetry path that makes the commitment verifiable to the ISO
- Protection and interlocks that enforce a withdrawal limit rather than merely document it
- Generator or storage sizing against the committed reduction, with fuel and runtime reality
- The metering and settlement arrangement, because the value depends on how it is measured

On-site generation and storage

- Generator plant arrangement, paralleling, and classification under **NFPA 110**
- Battery storage under **NFPA 855** — which since its 2026 edition makes a hazard mitigation analysis the default for essentially all systems other than lead-acid and aqueous nickel, and requires large-scale fire testing alongside UL 9540A listing
- Bridging power and the transfer scheme, which is where most ride-through failures actually originate
- Interconnection of the generation itself, which in most markets is a second study process

A commitment you cannot deliver is worse than no commitment

Curtailment obligations are enforceable, metered and increasingly statutory. Before we recommend one we establish what the facility can actually shed without breaking an SLA or a training run, and what the controls path is that makes it verifiable. A flexibility commitment made on a spreadsheet and discovered to be undeliverable in operation is a materially worse outcome than a longer queue wait.

NOTE Flexibility is worth taking when it converts an unfundable upgrade or a multi-year wait into an energization date — and worth refusing when it does not

THE CONSTRAINT THAT GOVERNS

Transformers Decide Your Energization Date

On most campuses the binding constraint is not engineering hours or even the interconnection study. It is a manufacturing slot.

THE DEPARTMENT OF ENERGY'S OWN NUMBERS

36 months typical, up to 60

DOE's Large Power Transformer Resilience Report puts commonly quoted lead times at **36 months**, with a maximum of as much as **60 months**. Domestic capacity sits at roughly 343 units a year at around 40% utilisation, against US demand rising toward roughly 900 units a year by 2027 — and manufacturers reported demand jumps of as much as 70% year over year.

> Grain-oriented electrical steel and copper each account for roughly a quarter of large power transformer production cost — which is why a purchase order does not solve the queue

What belongs on your schedule

A confirmed manufacturing slot, not a quoted lead time. The two are different documents and only one of them survives contact with a delayed project. We ask for it in week one, because the answer determines whether the design should avoid a new transformer entirely.

How we design around it

- **Rate before you buy.** Confirm what existing utility and site equipment will carry under the new duty before specifying a replacement — on brownfield and expansion projects this is the highest-value study available
- **Configuration options that avoid a purchase.** Tap changes, impedance selection, loading redistribution and staged energization traded against capital
- **Phased energization.** Design a campus that can take partial service on the first transformer and grow, rather than waiting for the full build
- **Specification quality.** Getting the specification right the first time, because a change after release to manufacture restarts a queue position rather than a task
- **Spare and mobile strategy** on a critical single-transformer configuration

Sequence the three tracks together

- **Interconnection** — submission windows are fixed dates, and missing one costs a full cycle
- **Procurement** — the slot has to be reserved before the study concludes, which means committing under uncertainty
- **Design** — has to be far enough along to specify the equipment, and flexible enough to absorb the study outcome
- Running these in series is the most common avoidable cause of a missed energization date on a data center project

Ask on day one — nameplate and test data for existing transformers, the switchyard arrangement as operated today, and the utility's upgrade list with its own procurement position

Ask the utility too — their long-lead exposure is often the binding constraint on your project, and it is rarely volunteered early

The study that pays for itself

On brownfield sites, expansions and utility-side upgrades, a rerating study that establishes what the existing transformer, bus or line will actually carry under the new duty is worth a large multiple of its own cost — because the alternative it avoids is not a cheaper transformer, it is a three-year wait for one.

THE GOVERNING BASIS

Rules, Standards and Where They Bind

Some of these are enforceable today, some are voluntary guidance, and some are drafts. Knowing which is which is most of the value.

DOCUMENT	STATUS	WHAT IT GOVERNS
ERCOT PGRR145 / NPRR1325	In effect	Batch Zero large load interconnection process, 75 MW threshold, classification and allocation
ERCOT NOGRR282 / NPRR1308	Phased	Large Electronic Load voltage and frequency ride-through, current limits and protection measurement requirements
MISO Large Load Technical Compendium	Draft, June 2026	Ride-through curves, ramp-rate limit and modeling obligations at a 50 MW threshold
PJM CIFP Board decision	Jan 2026	Large load additions — BYONG and Connect and Manage pathways at 50 MW
SPP HILL / HILLGA / LLRIS	FERC-accepted Jan 2026	High impact large load study, generation assessment and load-limited interconnection service
FERC dockets EL26-67 to EL26-72	Open	Show cause orders to all six RTOs on large load and co-located load tariffs
FERC docket RM26-4	ANOPR only	Interconnection of large loads to the interstate transmission system — no proposed or final rule as of August 2026
NERC Level 3 Alert — Computational Load Modeling	Reporting closed Aug 2026	Model, protection and ramp data for loads of 20 MW or more at 60 kV with over 1 MW of IT load
NERC Reliability Guideline — Emerging Large Loads	Voluntary	Modeling, monitoring, ride-through and operating practice — the clearest preview of what is coming
NERC Project 2026-02, CLO-001 / 002 / 003	Drafting	Interconnection and modeling, operational data and communications, protection coordination
IEEE Std 80	Current	Substation grounding, step and touch potential
IEEE Std 519	Current	Harmonic limits at the point of common coupling
IEEE Std 1584 / 1584.1	Current	Arc flash incident energy calculation, and what an arc flash study must deliver
IEEE Std 1668	Current	Voltage sag and short interruption ride-through testing for equipment rated below 1000 V
ANSI/TIA-942-C · ANSI/BICSI 002-2024	Current	Data center infrastructure and design best practice
Uptime Institute Tier Standard: Topology	Current	Outcome-based Tier classification — certified only by Uptime Institute
NFPA 855 (2026) · NFPA 110 (2025) · NFPA 70	Current	Stationary energy storage, emergency and standby power, and the electrical installation code as adopted by your AHJ

Enforceable, voluntary, or draft

Tariff and protocol provisions bind you today. NERC's guideline is voluntary but is the clearest available preview of the standards being drafted. The CLO standards and the FERC rulemaking are neither yet — and a design that assumes any of the three is one of the others is how projects acquire expensive surprises. We label which is which in every deliverable.

SCOPE NOTE We produce the technical evidence. NERC CIP cyber security is a separate discipline, coordinated with your own cyber team rather than performed by us.

WHO WE WORK FOR AND HOW

Engagement & Capability

WHO COMMISSIONS THIS WORK

Hyperscale operators	AI campus developers	Powered land developers	Colocation providers
Utilities & TSPs	EPC contractors	IPPs co-locating generation	Industrial & crypto load
Lenders & technical diligence	Real estate & asset managers	OEMs & equipment suppliers	Public power & cooperatives

ENGAGEMENT MODELS

Site screening

A ranked view of candidate points of interconnection with the MW each can carry, by when, and at what upgrade exposure — before a deposit is committed.

Named deliverable

A model package, a ride-through case, a POI substation design, an arc flash study — fixed fee, defined inputs, stated assumptions.

Programme support

Task-order or retained engineering across a portfolio of sites, carrying one standards basis and one model library rather than rebuilding both per project.

ENGINEERING PLATFORMS

OUR CLIENTS

Delivered — 1 GW ERCOT hyperscale interconnection; 1.35 GW of electrical design across three ERCOT campuses at 250, 500 and 600 MW

Dynamic modeling — engagements in SPP (245 MW), PJM (220 MVA), ERCOT (160 MW) and CAISO (99 MW). Clients confidential; references available under NDA

START HERE

Four Things and We Can Scope It

01	02	03	04
The site	**The MW**	**The market**	**The date**
Location, candidate substations, land position.	Total, phased, and how much is IT load.	ERCOT, PJM, MISO, SPP, CAISO or a non-ISO utility.	When you need first power, and how firm that is.

WHY KEENTEL ENGINEERING

01
We came from the transmission side
The interconnection, modeling and protection work on a data center is transmission engineering — our core practice, not a new line of business.

02
Delivered at this scale
1 GW of ERCOT hyperscale interconnection, 1.35 GW of design across three ERCOT campuses, and dynamic modeling in four ISOs.

03
We track the dockets
Every market here is under active reform. We tell you which assumptions rest on a rule being rewritten.

04
Honest about the boundary
We design to the MV distribution serving the halls. White space, cooling and IT fit-out belong to specialists.

05
The model is yours
Native model files, case lists and a change log ship with the report, documented well enough to re-run.

06
P.E.-sealed and defensible
Florida-registered firm, Reg. No. 36853. Written to survive utility review, ISO scrutiny and lender diligence.

PRIMARY AUTHORITIES BEHIND THIS FLYER

Market rules and filings. ERCOT large load integration materials, PGRR145 and NPRR1325, NOGRR282 and NPRR1308, the March 2026 report to the Technical Advisory Committee and the June 2026 Monthly Operational Overview; PJM's January 2026 Board decision letter on the Critical Issue Fast Path for large load additions and the 2026 Load Forecast Report; MISO's June 2026 Large Load Interconnection Reliability Requirements Technical Compendium; SPP's HILL, HILLGA and LLRIS filings.

Federal. FERC orders in dockets EL25-49 on co-location, EL26-67 through EL26-72 show cause orders to the six RTOs, ER26-247 accepting SPP's HILL process, and the advance notice of proposed rulemaking in RM26-4. Texas Senate Bill 6 (2025) and the PUCT implementation record.

Reliability. NERC's Level 3 Essential Action Alert on computational load modeling; the Reliability Guideline *Risk Mitigation for Emerging Large Loads*; *Characteristics and Risks of Emerging Large Loads*; the incident review of voltage-sensitive load reductions; Project 2026-02 drafts; and the 2025 Long-Term Reliability Assessment.

Standards and market data. IEEE Std 80, 519, 1584 and 1584.1, and 1668; ANSI/TIA-942-C; ANSI/BICSI 002-2024; the Uptime Institute Tier Standard: Topology and 2025 global survey; NFPA 70, 110 and 855; the Lawrence Berkeley National Laboratory 2024 United States Data Center Energy Usage Report; the Department of Energy Large Power Transformer Resilience Report; and EIA Annual Energy Outlook 2026.

Market processes, docket statuses, standard editions and figures are current as of August 2026 and provided for orientation only. Nothing here is legal or regulatory advice. The applicable tariff, protocol and interconnection agreement control.

START A SCOPE ›› contact@keentelengineering.com · 813-389-7871 · keentelengineering.com

NSPE | D·U·N·S REGISTERED | IEEE SENIOR MEMBER | BBB ACCREDITED A+

TAMPA — HQ
400 N Ashley Dr, Ste 2600
Tampa, FL 33602
813-389-7871

AUSTIN
5900 Balcones Dr, Ste 100
Austin, TX 78731
512-591-0752

SACRAMENTO
1401 21st St, Ste R
Sacramento, CA 95811
916-913-4524

BALTIMORE
306 W Redwood St, Ste 200
Baltimore, MD 21201
410-225-2181

contact@keentelengineering.com · keentelengineering.com · 813-389-7871 · Florida Firm Reg. No. 36853 · NAICS 541330