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STANDARDS ASSOCIATION

# DATA CENTERS: SUMMARY OF STANDARDS PRIORITIES AND RECOMMENDATIONS

## INDUSTRY CONNECTIONS ACTIVITY UPDATE

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# DATA CENTERS: STANDARDS NEEDS ANALYSIS AND RECOMMENDATIONS

- Industry Connection Activity approved in June 2025
  - https://standards.ieee.org/industry-connections/activities/data-centers-standards-needs-analysis-and-recommendations/
- Objectives
  - Identify the current state of standards relevant to data centers
  - Assess anticipated future needs for such standards, and
  - Define a path for the standards community to help assure reliable operations of both data centers and the supporting infrastructure
- Current state of the Industry Connection Activity
  - The ***Review of Industry Efforts and Standards of Grid Readiness For Data Center Deployment*** white paper was published in January 2026.
  - The white paper on the protection of data center IT systems is in progress.
  - The industry connection activity will continue working on the further development of standards with the relevant IEEE committees, and on additional work products.
- This presentation provides initial comments and feedback on the recommendations made in the whitepaper. This feedback focused on two things: how should the recommendations be prioritized, and overall comments on the recommendations.

# TOPIC PRIORITY TIERS

The first set of feedback focused on how the papers recommendations should be prioritized. Standardization and early communication were raised as important key themes. When considering all the responses the following priority list emerged with the Tier One items being recommended as to be addressed first.

**TIER ONE**

- A common set of definitions, scope, and terminology
  - Should be included in the following standards as much as possible.
- Standard for Data Center Performance Requirements and Interoperability
- Near parallel workstreams:
  - Standard for Data Center Interconnection Process and Data Requirements
  - Standard for Data Center Modeling in Power System Studies

**TIER TWO**

- Certification and Testing Framework for Validating Data Center Performance
- Standard for the Coordination of Co-Located Generation Facilities and Data Center Facilities
- Data center flexibility requirements and definitions

**TIER THREE**

- A Chips-to-Grid Framework and Strategy for Considering Grid Requirements in All Aspects of Data Center Design

# OVERALL FEEDBACK AND DEFINITIONS

Data centers in many locations and are seeing disparate requirements emerge.  Values will be different but even major concepts like the evaluation of risk to generators, risks grid stability, etc. are not consistent across different entities.  Standardization and early communication are musts.

Standards should include definitions for common terms like, “data center load,” POI/PCC measurement, load categories, and applicability thresholds.

For example, there is are no agreed-upon definitions of data center sizes, often referred to as "capacity" in MW. It is not always clear whether MW threshold represents the connected load demand or peak demand or average (annual?) demand, or some other quantity.

The MW rating both reflects the rated MW capacity of an industrial load - it is calculated on the basis of IT load size (e.g. 300 MW) times a PUE (typically 1.3 to 1.4 factor), and the MW is also a rating that correspond to the HV / MV switchgear and transformer sizing. The PUE of a data center may vary by its type.

# TOPIC DETAILS

The second part of the feedback focused on suggestions and comments as to the individual recommendations. This section details the feedback that was provided on individual topics.

## Performance Requirements

- **Voltage and Frequency Ride-Through Requirements**
  - Harmonize voltage/frequency ride-through to avoid uncoordinated loss-of-load during disturbances.
- **Ramp Rate limits**
  - Include clear expectations for ramp rate and delay; how load returns materially affects post-fault stability.
  - Specify both continuous ramp limits and discrete step-change limits (block size and time window) for realistic operational behavior
- **Oscillation Control (Magnitude and Frequency Spectrum)**
  - Explicitly call out avoidance of inter-area mode, SSTI and SSCI excitation (or damping expectations), given potential cyclicity of AI workloads.
  - Might be more specifically called AI / ML cycling control or suppression. The reason is because extreme loss of load events and fatiguing of T-G mechanical shafts can be so catastrophic. Even provocation of electromechanical oscillatory swing modes is extremely undesirable.
- **Power Factor and Voltage Control**
- **Power Quality**
- **Post-Fault Active Power Recovery Expectations**

# TOPIC DETAILS

## Performance Requirements (cont.)

- **Communication Protocols and Real-time Data Requirements**
  - Standard signals, telemetry, response expectations, fallback behavior.
- **Measurement and Verification Methods for Compliance Assessment**
  - Consider a two-stage compliance approach: (1) factory/design qualification of key subsystems and (2) site commissioning and periodic verification using POI measurements and disturbance/event capture
- **Minimum Interoperability Requirements (Across Multi-Vendor Systems)**
  - The minimum interoperability requirements (across multi-vendor systems) are an important addition. Coordination between UPS settings, VFDs for cooling, and backup generation/protection is often where unexpected interactions occur.
  - With multi-vendor sites, some set of standards (much like harmonic content) should apply universally to large loads. An example would be the capability of any UPS to operate its rectifier in constant current mode and ramp load from zero to 100% in some small time (say 20 cycles) to support LVRT.
  - Nearly all data centers lack the ability to connect the typical reciprocating diesel engine powered generators to the utility or export power from the UPS or PSU battery storage. We have a handful of sites with generator synch capability and some grid forming capabilities in a few UPS units in Europe but it is certainly not the norm.

# TOPIC DETAILS

## Modeling

- **Data Needs for Steady, Positive Sequence Phasor, and Electromagnetic Transient Studies**
  - Modeling standard (steady-state + phasor dynamics + EMT) + model quality including required model forms, bandwidth expectations, aggregation rules, and model validation/benchmarking procedures.
- **Model Quality and Performance Assessment**
  - Require benchmarking against standardized test cases and acceptance criteria (pass/fail envelopes), not only narrative validation reports.

# TOPIC DETAILS

## Interconnection

- **Interconnection Processes and Milestones**
  - Non-proprietary models are needed for planning/operations and connection assessments.
  - Encourage generic/"grey-box" representations so studies aren't bottlenecked by proprietary models.
  - Data center interconnection standards should be coordinated with the requirements that apply to generation or storage that may be behind the same point of interconnection or point of common coupling.
- **Data Requirements for Interconnection**

# TOPIC DETAILS

## Co-Located Load and Generation (preliminary draft)

The terms “behind the meter” and “off the grid” need to be better defined.  Any time a site with co-located generation which will be connected to the utility is at issue, standards must apply but sites which truly are “off the grid” and/or will never operated site located generation paralleled to the grid are not subject to these specific requirements.  A definition of that here would be useful as a reference if nothing else. The standards should also define minimum interoperability requirements that ensure consistent behavior across multi-vendor systems for load and generation, and to ensure coordination between the resources.

It should also include controls/protection/islanding/transfer coordination for hybrid sites.

# TOPIC DETAILS

## Flexibility

- **Defining load flexibility in power systems**
- **Flexibility mechanisms beyond curtailment**
  - Define flexibility mechanisms beyond curtailment (e.g., bounded ramping, controlled block shedding, scheduled load shaping, restoration coordination), including verification via telemetry and measurement
- **Communication standardization and requirements for utilities and data centers**

# TOPIC DETAILS

## Chip to Grid

The initial and preceding set of requirements related to interconnection, interoperability, and flexibility build on each other and are supportive. They are essentially prerequisites to understanding the “ask” in the AC domain. The capabilities of compute and the component limits of semiconductor classes will to a certain extent define the landscape of what is possible in direct current (DC). Long-term evolution path as hardware/control architectures change

- **Software Integration and Increasing Power Density—Limitations with Chip Design, Software Controlled Power Consumption**
- **Power Distribution—Compute/GPU Racks, Data Center Power Distribution Networks, Grid Interface, and Converter Designs for DC Distribution**
- **Energy Efficiency—Software Based Efficiencies, Improved Facility Design, and Power Distribution**
- **Considerations for Chips, Racks, Facilities with Respect to Grid Code Requirements**

# NEXT STEPS

## ROADMAP

- In light of the rapid evolution of AI technology a roadmap for update of these standards will be needed.
- There must be a clearly defined periodic evaluation of these standards as GPUs and the surrounding technologies are evolving extremely fast.