



Alberta Electric System Operator

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aeso.ca

Consolidated Written Feedback: Connection Requirements for Transmission-Connected Data Centres

(August 22 – September 19, 2025)

Please note: the development of any new ancillary services or demand management programs, or required participation in existing services or programs, is outside the scope of the connection requirements and will be included for consideration in Phase II of the Large Load Integration Program. See AESO Engage or more information.

Submissions (*alphabetical*)

1. AltaLink
2. Beacon AI Centers
3. Capital Power
4. IREN
5. Sovereign Digital Infrastructure/Cree Ative Datacenter GP
6. TransCanada Energy Ltd.
7. TransAlta Corporation
8. Utilities Consumer Advocate (UCA)
9. Voltus Energy Canada Ltd.

Written Feedback on Connection Requirements for Transmission-Connected Data Centres

Comment Period: August 22 to September 19, 2025

We value stakeholder input and invites all interested parties to provide their feedback on the draft Connection Requirements for Transmission-Connected Data Centres via the following stakeholder feedback form **by September 19, 2025, at 4:00 p.m. MT**. Please be as specific as possible with your responses. Thank you for your input.

Purpose

We have drafted the connection requirements for data centres in Alberta and are seeking stakeholder feedback to ensure there are clear expectations and that these requirements support the efficient advancement of projects while safeguarding system reliability.

Instructions

1. Please fill out the sections below as indicated
2. Only one completed feedback form will be accepted per organization
3. To upload your completed feedback form:
 - a. You will need to be registered and signed in on the AESO Engage platform
 - b. You will need to be on the [Connection Requirements for Transmission-Connected Data Centres page](#), which can be found on the AESO website at www.aeso.ca and follow the path: AESO Engage (found on very top navigation bar) > Connection Requirements for Transmission-Connected Data Centres > Written Feedback
 - c. Click on the "Submit Stakeholder Feedback" box below to upload your completed feedback form
4. All responses will be shared on AESO Engage in their original format
5. Responses due **by September 19, 2025, at 4:00 p.m. MT**

Comments From (Organization): AltaLink

Respondent Name (First and Last): Ryan MacMullin

Respondent Title: Principal Engineer- Energy Strategy

Connection Requirements for Transmission-Connected Data Centres

1. Are the requirements clear enough and provide enough detail to be followed by the Facility Owner? If no, specify which requirements and why.

☒ Yes ☐ No

The requirements that would apply to TFO facilities are clear. AltaLink is unable to comment if the requirements that would apply to the data centre facilities are sufficiently clear for the data centre owners.

2. Do you need further clarification on the requirements? If so, please specify which requirements could be clarified and how.

☒ Yes ☐ No

Yes, AltaLink would like to understand the rationale behind various requirements. See response to Q7.

3. Can the requirements be implemented by the Facility Owner without delaying a project's energization? If not, specify which requirements could delay a project and explain why.

☒ Yes ☐ No

Yes, the requirements that apply to TFO facilities would not be expected to delay TFO facility energization. AltaLink is unable to comment on the impact of requirements for the data centre owners on their facility energization.

4. Are there any requirements you believe could be challenging to comply with? If so, please specify which requirements and explain why.

☐ Yes ☒ No

The requirements that apply to TFO facilities do not present any extraordinary challenges. AltaLink is unable to comment on the requirements that apply to the data centre owners.

5. Are there any requirements you believe are not necessary for the reliable operation of the grid when connecting TCDCs? If so, please specify which requirements and explain why.

☐ Yes ☐ No

Rationale for requirements was not included in the document, AltaLink is unable to comment on the necessity for the requirements.

6. Are there any additional requirements you think should be considered for the reliable connection of TCDCs? Please provide detail on which requirements and why.

☐ Yes ☒ No

AltaLink has no comments at this time.

7. Are there any additional comments you would like to share?

AltaLink believes the AESO should define connection requirements for data centres in a manner which achieves the following objectives: 1) Attract data centre loads to Alberta; 2) Ensure data centres are integrated into the AES in a way that does not compromise grid reliability; 3) Promote economic efficiency and cost competitiveness; 4) Ensure fairness between data centre developers and other grid users. For the initial 1200 MW data centre allocation, AltaLink believes there is an additional objective of speed of connection to capture a near-term opportunity in the wider data centre market. To support this objective, these data centres have been allowed to initially connect without having to bring their own generation.

As the detailed rationale driving the various AESO requirements was not included with the connection requirements document, AltaLink is not able to assess if the AESO's proposal has struck the appropriate balance among the above-noted objectives.

To support the objectives of economic efficiency, cost competitiveness and fairness, AltaLink believes that there should be an opportunity for the AESO's framework to allow for alternative solutions (e.g. using R30 to address ramping concerns) to minimize costs, address power system needs and improve data centre economics. Where reliability functions are needed for data centre operation, the framework could allow for the option of services to be procured from the market or supplied from the bulk electric grid instead of asking each facility to build their own capability.

Comments From (Organization):	Beacon AI Centers
Respondent Name (First and Last):	Ed De Palezieux
Respondent Title:	VP Energy

Connection Requirements for Transmission-Connected Data Centres

1. Are the requirements clear enough and provide enough detail to be followed by the Facility Owner? If no, specify which requirements and why.

☐ Yes ☒ No

Beacon is fully aligned with the AESO that the reliability of the Alberta grid is paramount as large data centre loads are connected. Alberta must also maintain a competitive offering for data centres as the Hyperscalers evaluate building in Alberta versus other jurisdictions in North America. The Beacon feedback is provided within this context. The attached Appendix provides additional detail for the comments below.

The AESO's draft Transmission-Connected Data Centre Technical Requirements (July 2025) could impose some of the most restrictive ramping, reconnection, and contingency measures in North America as compared to standards currently in place in neighboring jurisdictions. While Beacon supports the intent of the draft requirements in maintaining grid stability and contingency management, the cumulative effect of these measures could create a competitive disadvantage for Alberta-based data centres.

In order for the AESO to implement a future version of technical standards for TCDC sites that meet commercial realities and project timelines, more discussion with developers is needed. The current draft standards, in Beacon's view, should establish the beginning of the technical standards development, which should consider both technical and commercial aspects during the upcoming phase 2 process.

The draft AESO requirements are not fully clear in many critical respects. AESO has established firm numerical thresholds for elements such as ramp rate limits, power factor (PF) operating range, and voltage/frequency ride-through envelopes. These are commendable because they provide Facility Owners with hard engineering values to design against. However, in parallel, the documents contain grey areas where Facility Owners cannot reasonably proceed without AESO interpretation or further specification. These gaps create uncertainty during the design and permitting phases and risk introducing late-stage rework or energization delays.

Examples of areas that require clarifications include:

- The exact **Most Severe Demand Contingency (MSDC)** value to be used for substation, transmission, and distribution design.

- AESO's decision-making **criteria for transmission redundancy** (e.g., whether multiple circuits or split right-of-way designs are required).
- What AESO considers **acceptable oscillation mitigation technologies**, and whether industry-standard approaches (e.g., STATCOMs, BESS, UPS controls) will be deemed sufficient.
- The expected **accuracy tolerance** for 7-day operational load forecasts, and how deviations will be managed operationally.
- Clear **acceptance metrics for model validation** (phasor domain and EMT), beyond generic references to ISO rules.
- The process governing **back-up generation parallel testing**, including whether short-duration synchronizations for commissioning are permissible.

Areas Where Requirements Are Ambiguous or Insufficiently Detailed

In several sections, the drafts set high-level principles but do not embed the practical implementation steps that Facility Owners require. Others defer to external AESO or ISO guidance documents without directly stating the compliance obligations.

Most Severe Demand Contingency (MSDC):

- The draft states that no single event can exceed the MSDC. However, Alberta's system-wide MSDC is **not formally defined in the draft**, with tables only presenting example values (e.g., 150 MW).
- Without a binding figure, Facility Owners cannot size transformers, configure breaker protection, or determine contingency designs. AESO clarification is essential before design lock-in.
- It is not clear how the MSDC will be set in alignment with existing AESO practices, such as those employed in establishing and maintaining the existing MSSC.

Transmission Line Redundancy:

- The document provides a formula and sample table linking TCDC size to the minimum number of circuits but also notes that the AESO may require additional redundancy based on "future planned projects."
- The absence of defined criteria leaves this to AESO discretion, creating uncertainty at early design stages when transmission planning and permitting must be finalized.

Oscillation and Control Stability:

- The draft sets explicit numerical thresholds (net load variability <16 kW per 100 ms; sub-synchronous oscillation amplitude ± 160 kW).
- However, it does not specify the **technologies or control strategies** that AESO will accept for compliance. Instead, it lists broad examples such as BESS or STATCOMs, without defining how a Facility Owner can prove adequacy or gain AESO approval. This risks leaving Facility Owners in a compliance limbo.

Operational Plan (7-Day Forecasts):

- Facility Owners must submit 7-day hourly load forecasts, yet the documents do not detail **accuracy margins nor do they provide information on deviations**.
- This omission is significant because IT workloads (AI, blockchain, rendering) are inherently volatile, and unrealistic forecast obligations may become unachievable. It is not clear how the AESO is aligning these requirements with the operations of impacted data centers.

Model Validation and Quality Testing:

- The draft requires submission of phasor domain and EMT models, including “model quality testing” reports.
- However, no **pass/fail criteria or tolerance thresholds** are specified. Facility Owners may produce extensive modeling, only for AESO to reject it based on internal or unpublished benchmarks. Clear standards are necessary to prevent late-stage disputes.

Back-Up Generation Parallel Operation:

- The draft specifies that back-up generators must not operate in parallel with the grid unless formally studied and approved.
- What is not addressed is **how Facility Owners trigger such a study**, or whether **short-duration parallel operation for commissioning tests** is permissible. Without this clarity, Facility Owners risk delay in energization and commissioning sign-off.

2. Do you need further clarification on the requirements? If so, please specify which requirements could be clarified and how.

☒ Yes ☐ No

Please see attached appendix document.

3. Can the requirements be implemented by the Facility Owner without delaying a project's energization? If not, specify which requirements could delay a project and explain why.

☐ Yes ☒ No

The same concerns levied during question (1) are representative of the information and systems required for all foundational design. Without further discussions with developers to clarify and improve around these concerns, the current draft requirements may interfere or halt a substantial amount of ongoing design for in flight projects. With that said, if engineering cues are taken from other preexisting TCDCs operating in other jurisdictions, there will be areas which AESO will have to compromise in order to maintain project timelines. To implement technical standards that are clear and that can be implemented reasonably within project timelines, we recommend that the AESO work with proponents to refine these standards during the phase 2 consultation process and delay the implementation of these technical standards until this consultation is complete.

4. Are there any requirements you believe could be challenging to comply with? Is so, please specify which requirements and explain why.

☒ Yes

☐ No

a) Ramp Rate & Reconnection

- **Requirement:** TCDCs must limit load ramping to **10 MW/min** up or down, both planned and unplanned, and must seek AESO approval before reconnection
- **Why This Is Challenging:**
 - For a 300–400 MW campus, IT load can change in step fashion if hall clusters or UPS systems cut in/out. Holding below 10 MW/min requires sophisticated load segmentation and ramp-control software.
 - Operational reconnection delays, dependent on AESO approval, could impact data centre SLAs, especially in Tier IV designs where uptime is contractually critical.
 - Beacon advises to not impose this ramping requirement at this time and to work with proponents in phase 2 to determine what technical solutions are reasonable and feasible to resolve concerns with ramping loads, and to ensure a fair implementation of technical standards. Among the necessary discussions will be to assess whether ramp restrictions or other technical solutions will appropriately address grid impacts, including further AS products or as-of-yet unconsidered technologies. This should involve discussions with the technical and markets groups at the AESO.

b) Most Severe Demand Contingency (MSDC)

- **Requirement:** No single event (breaker failure, stuck breaker, line loss) may cause load loss > MSDC
- **Why This Is Challenging:**
 - The MSDC number is not firmly fixed in the drafts (examples given are 150–200 MW).
 - Designing HV substations and MV distribution around an undefined cap is difficult and could force costly over-redundancy to hedge.
 - It's not clear how the hypothetical MSDC levels in the AESO's draft are aligned with the methodologies and grid management approaches that maintain the MSSC. It is unclear why the MSDC level would be different than the MSSC. We advise the AESO to discuss this element with project proponents and implement a fair approach during the phase 2 process, and to delay implementation of these standards at this time.

c) Oscillation & Control Stability

- **Requirement:** Net load variability must be **<16 kW per 100 ms**; oscillations within the sub-synchronous band limited to **±160 kW**

- **Why This Is Challenging:**

- Large data centres use power electronics (UPS, VFDs, cooling motors) that naturally introduce harmonics and fast load swings.
- Mitigating oscillations to this fine granularity likely requires **specialized STATCOMs, BESS, or custom UPS controls** — expensive and not widely field-proven at hyperscale scale.

d) Reactive Power Capability

- **Requirement:** Must operate within **± 0.95 PF**, in constant PF, voltage control, and reactive set-point modes; must respond to AESO within 10 minutes

- **Why This Is Challenging:**

- Data centres are load-heavy facilities, not generation assets — traditionally, PF correction is handled by utilities, not load customers.
- Designing enough reactive compensation (STATCOMs/capacitor banks) to cover the full DTS capacity continuously adds cost and complexity.

e) Ride-Through Obligations

- **Requirement:** Must remain connected through detailed LVRT/HVRT curves, frequency dips, RoCoF up to **5 Hz/s**, and voltage angle jumps up to **25°**

- **Why This Is Challenging:**

- IT loads and UPS systems are designed for protection-first, not grid support.
- Aligning vendor OEM trip curves with AESO's strict envelopes may require **custom UPS programming and warranty waivers** from OEMs.

f) Modeling and Validation

- **Requirement:** Must submit both **phasor domain (CMLD, UDM)** and **EMT models** (UPS, converters, static switches, motors) with quality testing and AESO approval
- **Why This Is Challenging:**
 - Many OEMs treat detailed UPS and VFD models as proprietary.
 - Facility Owners may struggle to obtain sufficient data granularity to satisfy AESO, especially for EMT modeling.

g) Operational Forecasting

- **Requirement:** Must submit 7-day operational plans with **hourly average net load forecasts**
- **Why This Is Challenging:**
 - IT workloads (AI training, blockchain, rendering) can cause unpredictable load swings.
 - Meeting strict forecast accuracy without tolerance guidance could be very difficult.
 - This requirement needs refinement in collaboration with industry and would be best to discuss in phase 2.

5. Are there any requirements you believe are not necessary for the reliable operation of the grid when connecting TCDCs? If so, please specify which requirements and explain why.

☒ Yes ☐ No

- Dual SCADA paths ≥ 300 MW (duplicative, high cost vs. low benefit).
- 7-day load forecasts (limited accuracy, little operational value vs. real-time telemetry).
- Transient overvoltage ride-through up to 1.8 p.u. (extreme, rare event unlikely to justify IT design burden).
- Reactive power control modes (all three required) (overextends load obligations).
- Sub-second oscillation suppression thresholds (may overshoot actual reliability needs).

6. Are there any additional requirements you think should be considered for the reliable connection of TCDCs? Please provide detail on which requirements and why.

☐ Yes

☒ No

Click or tap here to enter text.

7. Are there any additional comments you would like to share?

a) Demand Flexibility Programs

- **Proposed Requirement:** Large TCDCs should be capable of **participating in AESO demand response** (fast curtailment when triggered).
- **Why:** With loads in the 300–500+ MW class, integrating TCDCs into Alberta's demand response portfolio would significantly improve reliability. The draft mentions load shedding but not **structured demand participation**

b) Contingency SLAs for Load Reduction

- **Proposed Requirement:** Require Facility Owners to maintain internal SLAs for how fast load can be reduced (e.g., to MSDC in ≤ 30 min).
- **Why:** While the draft requires the ability to reduce load to MSDC after contingencies, it doesn't enforce operational accountability beyond design.

c) BESS / UPS Performance Standardization

- **Proposed Requirement:** Establish minimum performance criteria for UPS and BESS systems in TCDCs (e.g., ride-through duration, harmonic filtering response, oscillation damping).
- **Why:** UPS/BESS systems dominate the load profile of data centres and are often OEM-specific black boxes. Without standardization, AESO may face a wide variance in response quality. Current modeling requirements ask for detail but stop short of **minimum performance benchmarks**

Appendix A

Clarification Request – AESO Draft TCDC Technical Requirements

The Alberta Electric System Operator (AESO) has issued draft Transmission Connected Data Centre (TCDC) Technical Requirements (July 2025) and draft Connection Requirements for Transmission-Connected Data Centres (July 24, 2025). These documents are foundational in establishing a clear framework for how large-scale data centre loads will be integrated into the Alberta Interconnected Electric System (AIES).

While both drafts (ppt & draft regulation) provide substantial detail on ramp rates, ride-through obligations, reactive power support, contingency design, and modeling requirements; several requirements remain ambiguous from the perspective of Facility Owners. These ambiguities, if not resolved could lead to delays in design, uncertainty in permitting and potential misalignment with AESO's expectations during project execution.

This clarification request document highlights the specific areas where further guidance is needed. It is intended to support collaborative engagement between Facility Owners and AESO to ensure that the requirements are applied consistently, transparently and with enough precision to be actionable by design and engineering teams.

The following table provides a structured summary of the key requirement areas needing clarification. It identifies the ambiguity or gap, explains the impact on Facility Owners, and frames specific questions to AESO that, once answered, will significantly improve the ability to design and operate Transmission Connected Data Centres in compliance with AESO's intent.

Expanded Clarification Request Table – AESO Draft TCDC Technical Requirements

Requirement Area	Ambiguity / Gap	Impact on Facility Owner	Proposed Clarifying Question to AESO
Most Severe Demand Contingency (MSDC)	Draft references MSDC but only provides illustrative values (e.g., 150 MW, 200 MW). No binding system-wide MSDC value is defined.	Facility Owners cannot size transformers, breakers, or MV feeders with confidence. Overdesigning adds major cost, under designing risks rejection at later AESO stages.	<i>What is the binding MSDC value for Alberta TCDCs, and will this threshold be standardized across projects or determined through project-specific studies?</i>
Transmission Line Redundancy	Draft regulations outline circuit minimums but allows AESO to impose extra redundancy “based on future system development.” No transparent criteria are given.	Early design uncertainty makes ROW acquisition, permitting, and EPC pricing unstable. A design for 2 circuits may later be invalidated if AESO mandates 3 or 4, causing major delays.	<i>What objective criteria (system strength, N-1/N-2 security, local load density) will AESO use to decide redundancy requirements, and at what stage will these decisions be confirmed?</i>
Oscillation / Control Stability	Numerical thresholds provided (<16 kW/100 ms, ±160 kW in sub-synchronous band), but no accepted mitigation technologies are defined.	Owners may invest in solutions (e.g., STATCOMs, UPS tuning, BESS damping) that AESO later deems inadequate. This risks stranded capital and compliance disputes.	<i>Which specific mitigation technologies or methods will AESO accept to demonstrate oscillation compliance, and will AESO publish a formal testing protocol for validation?</i>
Operational Plan (7-Day Forecasts)	Owners must submit hourly 7-day load forecasts, but no tolerance or error margin is defined.	Workloads (AI, rendering, blockchain) are inherently volatile. Without clear ±% error bands, forecasts may always appear non-compliant, exposing Owners to penalties or repeated disputes.	<i>What forecast accuracy threshold does AESO require (e.g., ±5%, ±10%), and how will deviations be managed in practice?</i>

Requirement Area	Ambiguity / Gap	Impact on Facility Owner	Proposed Clarifying Question to AESO
Model Validation / Quality Testing	Requirement to submit phasor and EMT models with “quality testing,” but no definition of pass/fail criteria or acceptable error margins.	Without defined thresholds, Owners risk model rejection after costly studies. Vendors may also withhold proprietary data, making compliance uncertain.	<i>What measurable standards will AESO apply to model validation (e.g., tolerances in voltage/frequency response, acceptable harmonics deviation), and will AESO provide a template or reference model?</i>
Back-up Generation Parallel Operation	Draft states no parallel operation unless “studied and approved,” but does not describe the approval process or exceptions for commissioning synchronizations.	Commissioning normally requires short parallel runs for relay testing and synchronization. If prohibited, energization could be delayed until AESO creates a study path.	<i>What is the procedure for obtaining approval for parallel operation of back-up generators, and will AESO permit limited-duration synchronization tests during commissioning?</i>
Voltage & Frequency Ride-Through Settings	Draft requires protection settings based on OEM curves but also compliance with AESO ride-through envelopes. No guidance on how to resolve conflicts.	Vendor warranties may prohibit operation outside OEM curves. Owners may face contractual conflicts if AESO demands stricter envelopes than the OEM guarantees.	<i>If OEM trip curves differ from AESO envelopes, which takes precedence, and how should Owners document alignment or request exemptions?</i>
Reconnection After Trip	Reconnection requires AESO approval, but no SLA or timeline is defined for AESO response.	Delays in reconnection could jeopardize Tier III/IV SLA commitments. Owners need predictability for how long AESO will take to authorize reconnection.	<i>What service level or maximum response time does AESO commit to for reconnection approvals after a breaker trip or contingency</i>

Comments From (Organization):	Capital Power
Respondent Name (First and Last):	Matthew Davis Wil Danek
Respondent Title:	VP – Regulatory, Policy & Government Relations Sr. Lead, Commercial

Connection Requirements for Transmission-Connected Data Centres

Capital Power appreciates that the AESO is needing to address the integration of a new class of large loads to ensure that the grid remains reliable but is concerned that the AESO is placing new, onerous connection requirements solely targeted at data centres. These requirements while generally clear are inconsistent with the treatment of other market participants. We know and appreciate that there is a need to move with speed on this issue given the competitive nature of the opportunity to attract data centres to the province, but we are concerned that the AESO may be getting ahead of industry-wide standards that are being developed at the NERC large load task force. At this stage, and for gigawatt scale projects we would suggest that a more targeted project-by-project approach be adopted. There are different types of data centres, having different operating characteristics, and requirements have to be accommodating enough to balance the AESO's reliability requirements with how these loads perform.

Overall, Capital Power is concerned that the AESO's requirements create excessive burden on the developer, adding costs and requiring investments that will delay development. Additionally, the AESO's approach to project capabilities such as backup generation may limit data centre projects from providing solutions to grid challenges. The AESO's approach appears to be based on overly conservative views of the capabilities of the grid, particularly generator response – for example, the AESO's 10 MW/min ramping requirement would limit projects to ramp 200 MW over a 20 minute period whereas the AESO's practices on the intertie can allow for export schedules go from 935 MW to 0 MW over the same 20 minute period (or a load ramp of just over 45 MW/minute). Finally, for some of the requirements, Capital Power questions if the AESO is requiring some of these investments at the project level when there would be a more efficient approach through system-wide investments.

The AESO's requirements document may outline the AESO's suggested requirements, but the AESO provides little to no rationale for its positions. For industry to be able to collaborate with the AESO and provide solutions, the AESO must provide more transparency as to its specific concerns related to data centre connections. Industry is willing and able to bring solutions to the discussion, but the AESO needs to specifically indicate what risks it is trying to mitigate and provide industry the opportunity to propose solutions that are both cost effective and appropriate relative to the issues.

Capital Power's detailed response to the AESO's questions follows.

Are the requirements clear enough and provide enough detail to be followed by the Facility Owner?
If no, specify which requirements and why.

☐

Yes

☒

No

The requirements document is generally clear and detailed, however, several areas lack sufficient clarity for practical implementation:

- **Oscillation Limits:** The thresholds (e.g., 16 kW per 100 ms; ± 160 kW sub-synchronous band) appear non-scalable and likely infeasible at TCDC scale; Capital Power requests that the AESO please confirm intended scaling (e.g., did the AESO intend this to be on a per-MW basis, not per facility) and where/how compliance is measured.
- **Responsibility for Studies:** The AESO document lists required studies, but Capital Power notes that it does not specify which stakeholder is responsible for each. Clarification is needed on which studies are to be completed by the AESO/TFO versus the facility owner. Specify which entity is responsible for each required study in Section 7.2. The coordination role of the AESO in studies like Sub-synchronous Oscillation (SSO) Assessment needs to be specified.
- **Transmission Line and Substation Requirements:** Capital Power notes that:
 - Terms such as “close proximity,” “separate diameters,” and “Next Contingency Loading (MW)” are not clearly defined. Clarification is needed on how these apply to different ownership structures and physical layouts.
 - The rationale for applying the MSDC limit (200 MW) to determine transmission line and transformer configurations needs further explanation, particularly considering the requirements already include separate provisions regarding the impact of single contingencies.
 - The requirements for interconnection configurations for data centres of varying sizes need to be more specific.
- **Voltage Ride-Through:** The requirement to restore output after voltage ride-through needs clarification. Specifically, Capital Power requests the AESO to clarify if it mandatory to restore active power consumption to 100% of the pre-disturbance level, or is it optional?

Do you need further clarification on the requirements? If so, please specify which requirements could be clarified and how.

☒ Yes☐ No

- **Technology Specific Treatment:** Capital Power requests that the AESO provide further, more detailed rationale as to why data centres are being subjected to more stringent requirements compared to other large loads, which may pose equal risks to the transmission system? Providing rationale for each of the targeted requirements and explaining how they align with broader grid reliability goals will help industry collaborate with the AESO on reasonable, efficient and effective solutions.

- **Backup Generation:** The AESO requires backup generation to be strictly for emergency use, Capital Power is concerned that this approach is overly restrictive as data centres can be willing and capable of providing services such as emergency demand response. Consultation, along with clarification, is necessary on whether backup generation can be used for other purposes if it complies with connection requirements. Additionally, Capital Power requests that the AESO clarify whether backup generation can be used to meet ride-through and restore output requirements and whether such a use will require SAS contracts.
- **Contingency Definitions:** Capital Power requests that the AESO clarify whether N-1 and N-2 contingency requirements apply only to the data centre facility or to the transmission system more broadly.
- **Medium Voltage Distribution:** Capital Power requests clarification as our view is that the requirement that no single event can result in load loss greater than MSDC should be genericized to refer to net load at the point of connection, rather than load loss.

Can the requirements be implemented by the Facility Owner without delaying a project's energization? If not, specify which requirements could delay a project and explain why.

☐ Yes

☒ No

Capital Power is very concerned that several provisions will materially extend development timelines unless made scalable and risk-based. These include:

- **Stage Requirements:** Requiring detailed information in early stages may result in additional costs and effort, as project specifics are often not finalized until later stages. The proposed level of detail in Stages 0, 1 and 2 assume commercial and equipment decisions that have not yet been fixed as these configurations are often not finalized until later stages of the project. Capital Power is concerned that requiring early assessments will most likely result in additional costs and effort on both the project and the AESO during early development as changes later in the development cycle will likely occur.
- **Auxiliary Equipment:** Capital Power's review of the requirements for reactive power capability, ramping, and ride-through indicate that to achieve the prescriptive performance suggested, the installation of auxiliary equipment (STATCOM, BESS) may be necessary, increasing cost and lead time. It is our estimation that to meet the current requirements, a BESS equal to or greater than the size of the load will need to be developed and constructed, adding significant cost to projects.
- **Testing and Validation:** Capital Power would note that hardware-in-the-loop testing and model validation requirements may introduce delays, especially if triggered late in the process.
- **Operational Readiness:** The AESO's 24/7 requirements imply the need for a control centre adding additional requirements (e.g. ARS compliance including CIP costs). The AESO should consider at what level this is required as this scale of monitoring may add significant costs to smaller projects, and may still impede development timelines for other projects.

Are there any requirements you believe could be challenging to comply with? Is so, please specify which requirements and explain why.

☒ Yes

☐ No

Capital Power is very concerned that several of the AESO's proposed requirements will be challenging to comply with or will add cost and complexity to projects. These include:

- **Reactive Power Capability:** Data centres do not inherently have reactive power capability; meeting ± 0.95 PF may require significant auxiliary equipment.
- **Voltage Ride-Through:** Off-the-shelf equipment may not meet the AESO's voltage ride-through requirements, necessitating additional investment in UPS or BESS. Over voltage ride-through requirements could also be very challenging to meet – at 20% (1.2 pu), a 240kV breaker may be required to upgrade to 300kV, and 500kV breaker required to upgrade to 765 or 800kV class, with availability, lead time and cost implications.
- **Ramping Rate:** The fixed ramp rate of 10 MW/min is slow and does not scale with facility size. For larger data centres, this may be impractical and require battery energy storage to manage ramping. A percentage-based ramp rate tied to facility size and regional system strength would be more appropriate.
- **Load-Induced Forced Oscillation:** The requirement to limit net load variability to less than 16 kW per 100 ms is extremely stringent and is likely not be feasible for data centres, even with on-site BESS.
- **Medium Voltage Distribution:** The requirement that no single event on the medium voltage distribution system can result in load loss greater than the MSDC is overly prescriptive. It should focus on net load at the point of connection rather than load loss.
- **Underfrequency/Undervoltage Load Shedding:** High-reliability data centres (Tier II/IV) may not be able to comply with load shedding requirements without significant operational and commercial impacts.

Are there any requirements you believe are not necessary for the reliable operation of the grid when connecting TCDCs? If so, please specify which requirements and explain why.

☒ Yes

☐ No

Capital Power views some requirements as unnecessarily stringent, including:

- **Backup Generation:** The proposed “emergency only” restriction on backup generation (prohibiting controlled, non-export parallel operation) eliminates effective options to leverage the investment in backup generation. Allowing non-export use of backup generation is allowed for other loads and may further facilitate participation in reliability services such as emergency demand response.
- **Reactive Power Capability:** Traditionally, loads have not been required to control voltage on the transmission system. The requirement for data centres to provide voltage support in tight bandwidth may be excessive. Data centres operate close to unity Power Factor, unlike

other loads. While a data centre does have mechanical loads (building HVAC for instance), this is relatively low portion of the overall facility load (small compared to the IT load).

- **Underfrequency/Undervoltage Load Shedding:** Mandating participation in load shedding programs for high-reliability data centres may not be appropriate; voluntary participation should be considered instead.
- **Ramping Rate:** As mentioned above, the proposed ramp rate is slow and does not reflect that the energy market can ramp much faster. Acknowledging and leveraging flexibility is required as data centres have many types of loading, with some more stable than others.
- **Number of Transmission Line Connections:** The example transmission line and transformer configurations with the minimum number of circuits are extremely robust and present a significant cost – including N-2 design, necessitating three (3) to four (4) separate transmission lines for sizes equal to or greater than 800 MW. Some data centres (lower tier applications) do not require this level of reliability and doing so just for system needs likely would present a barrier to economic returns.

Are there any additional requirements you think should be considered for the reliable connection of TCDCs? Please provide detail on which requirements and why.

☒ Yes

☐ No

- **Project-by-Project Approach:** Given the diversity of data centre types and operating characteristics, Capital Power views that a more targeted, project-specific approach may be more effective than blanket requirements – particularly while there is still broad industry evolution underway.
- **System-Wide Investments:** Capital Power views that some reliability requirements may be more efficiently addressed through system-wide investments rather than at the project level. Rather than burdening each data centre project (while not having the same requirements for other large load customers), we recommend AESO consider a centralized means of dealing with frequency issues regardless of the source: specifically an expanded scope/mandate of the current FFR+ initiative.
- **Manufacturer Data Sheets:** Capital Power recommends gathering and reviewing detailed manufacturer data sheets and capability curves for data centre equipment to inform compliance strategies.
- **Generator RAS:** Capital Power believes that the AESO should consider using a GRAS scheme, as has been used to protect sudden loss of the BC Tie Line while under load. This is a viable option that could negate the need for more than 2 transmission connections to a data centre.

Are there any additional comments you would like to share?

Capital Power has serious concerns with the technical requirements as they are currently presented. The stringent criteria contained within the document will be difficult for large scale loads to meet, let alone in a cost-effective manner. While we are aware that NERC is progressing broader

industry standards – until those standards are clear, we believe the requirements are acting at a level of detail beyond, and not aligned with other ISO jurisdictions. This presents a large challenge in attracting data centre investment to the Alberta market and risks significant capital outlay. We recommend re-framing the standard around performance outcomes, scalable metrics, and case-specific mitigations – while permitting controlled, non-export use of on-site backup generators to meet grid needs by allowing data centre to participate in services such as emergency demand response. This will better safeguard reliability and maintain Alberta's competitiveness in attracting data centre investment.

While Capital Power appreciates the AESO providing clarity on the most severe demand contingency limit (MSDC) of 200 MW, we would suggest the AESO accelerate efforts to increase this limit through the use of fast net demand response (FNDR). The limits the AESO have imposed on generators with the Most Severe Single Contingency (MSSC) equally needs to be addressed and while the AESO has started to explore fast frequency services, the pace of development of ancillary service products to address these issues needs to increase. Primary frequency response concerns have been an urgent issue since 2021, but we have not even seen the AESO develop a pilot for FNDR yet – only referring to the potential as part of its reliability work.

Comments From (Organization): IREN

Respondent Name (First and Last): Gavin O'Herlihy

Respondent Title: Commercial Associate

Connection Requirements for Transmission-Connected Data Centres

1. Are the requirements clear enough and provide enough detail to be followed by the Facility Owner? If no, specify which requirements and why.

☐ Yes

☐ No

Click or tap here to enter text.

2. Do you need further clarification on the requirements? If so, please specify which requirements could be clarified and how.

☒ Yes

☐ No

Reactive Power Requirement

The requirement to “respond to AESO set-points” is unclear. In particular, it raises questions about whether this implies staged capacitor banks must be installed to adjust available MVAR, or whether it refers to changes in load itself. Greater clarity is needed on the intent and practical application of this requirement.

Load Shedding Requirement

The requirement for under-frequency and under-voltage load shedding is typical in many jurisdictions and is generally implemented as an automated, last-resort protection measure. Typically, this is performed through relays that detect frequency collapse in real-time and send a trip signal to breakers to prevent cascading failures. The reference to “if directed by AESO” introduces uncertainty, as it suggests the possibility of discretionary, non-technical commands rather than purely protection-driven actions. Greater clarity is needed on how this requirement would be applied in practice.

3. Can the requirements be implemented by the Facility Owner without delaying a project's energization? If not, specify which requirements could delay a project and explain why.

☐ Yes

☐ No

Click or tap here to enter text.

4. Are there any requirements you believe could be challenging to comply with? Is so, please specify which requirements and explain why.

☒ Yes

☐ No

Voltage Ride-Through Thresholds

The proposed voltage ride-through thresholds are extremely challenging to meet. In particular, the requirement of maintaining operation at $V < 0.45$ for 9 cycles is especially difficult. While these thresholds appear similar to those being proposed in ERCOT, it is important to note that this same requirement is receiving significant pushback in the ERCOT market. The majority of the thresholds proposed are also quite stringent and may present compliance challenges for operators.

Ramping Requirements

The proposed maximum ramping limit of 10 MW per minute is considerably restrictive compared to operating practices in Texas. While this slower ramp rate may not create significant issues for smaller data centers, it poses material challenges when considering facilities above 600 MW. For large-scale facilities, ramping up from curtailment or a trip at this limit would take over an hour, which could materially impact operational flexibility and system responsiveness.

Reliability Design Requirement

The requirement that facilities must be designed so no single failure results in more load loss than the Most Severe Demand Contingency (MSDC) could impose significant additional redundancy requirements. This may limit the ability to use single transformers at bulk or primary substations, or radial configurations instead of ring or breaker-and-a-half designs.

Protection & Control Requirement

The requirement to include synchrophasors and digital fault recorders appears to transfer typical utility practices onto load facilities. Our facilities generally do not implement these systems in full, though we have partial capabilities in this regard.

Operational Plans Requirement

The requirement to provide near-term operating plans, such as hourly load forecasts and ramp profiles, appears more aligned with utility practices than with large load facilities. While relatively straightforward if operating with steady, constant-like loads, this would still create an administrative burden as such forecasting is not a standard practice for our facilities and we do not currently dedicate resources to it.

Communications Requirement

The requirement for dual SCADA/telecom paths at ≥ 300 MW and physical telecom diversity at ≥ 500 MW appears to apply utility-level standards directly to customers. These measures should

reasonably be the responsibility of the utility substation owner at the Point of Interconnection (POI), rather than being imposed on the customer substation.

5. Are there any requirements you believe are not necessary for the reliable operation of the grid when connecting TCDCs? If so, please specify which requirements and explain why.

☐ Yes

☐ No

Click or tap here to enter text.

6. Are there any additional requirements you think should be considered for the reliable connection of TCDCs? Please provide detail on which requirements and why.

☐ Yes

☐ No

Click or tap here to enter text.

7. Are there any additional comments you would like to share?

Click or tap here to enter text.

Comments From (Organization):	Sovereign Digital Infrastructure/Cree Ative Datacenter GP
Respondent Name (First and Last):	Darin Watson, P.Eng.
Respondent Title:	CTO & VP Engineering and Construction

Connection Requirements for Transmission-Connected Data Centres

1. Are the requirements clear enough and provide enough detail to be followed by the Facility Owner? If no, specify which requirements and why.

☐ Yes ☒ No

We think they are clear, but problematic and recommend some clarification and review. Please see attached document for specifics

2. Do you need further clarification on the requirements? If so, please specify which requirements could be clarified and how.

☒ Yes ☐ No

Because much of the power flow management happens in times scales that are far less than 10 minutes and any control response entails some amount of latency further refinement and clarification is required and recommended. Please see attached document for specifics.

3. Can the requirements be implemented by the Facility Owner without delaying a project's energization? If not, specify which requirements could delay a project and explain why.

☒ Yes ☐ No

If the requirements are amended as recommended, then there should be no delay. As currently written, or at least our interpretation of what is written, cannot be complied with given the know technology of today, in any reasonably cost-effective manner and would likely make Alberta a non-competitive jurisdiction.

If the requirements are modified as recommended, cost competitive solutions are available, and the grid will remain reliable and minimally impacted. Please see attached document for specifics.

4. Are there any requirements you believe could be challenging to comply with? If so, please specify which requirements and explain why.

☒ Yes

☐ No

We believe as written, there likely is not a way to comply, or not without a massive BESS that could make AB uncompetitive. Please see attached document for specifics

5. Are there any requirements you believe are not necessary for the reliable operation of the grid when connecting TCDCs? If so, please specify which requirements and explain why.

☐ Yes

☒ No

We agree there is a requirement, without doubt, we just believe that we need an adjustment to keep Alberta cost competitive w/o jeopardizing the grid reliability.

6. Are there any additional requirements you think should be considered for the reliable connection of TCDCs? Please provide detail on which requirements and why.

☒ Yes

☐ No

Please see attached document for specifics.

7. Are there any additional comments you would like to share?

Should the AESO wish to follow up with SDI and our engineers and providers, we would be open to a clarification meeting based upon the information provided.



Response to AESO TCDC Guidance

**STAKEHOLDER INPUT
SOVEREIGN DIGITAL**

**PREPARED BY:
ATLAS POWER TECHNOLOGIES INC.**

SEPTEMBER 19, 2025

Section 6.4

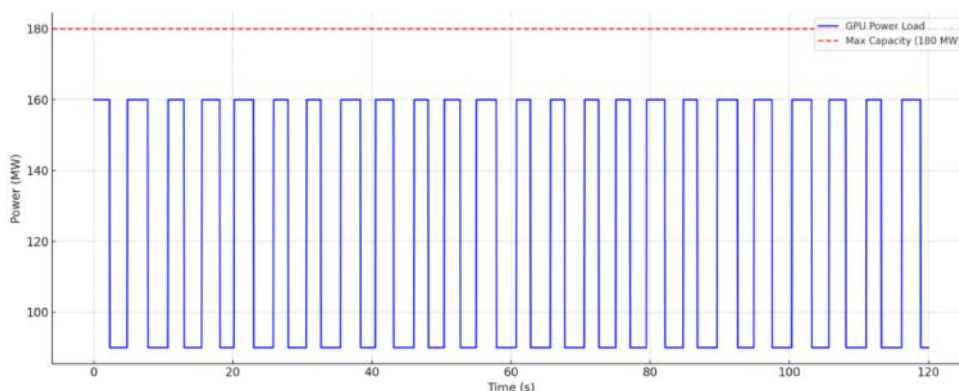
The TCDC must limit load ramping to maximum ramp rate of 10 MW/min.

Atlas' feedback on the proposed requirement that Transmission-Connected Data Centers (TCDCs) limit load ramping to a maximum of 10 MW per minute.

We wish to emphasize that ramping is a facility-wide operational issue, and it must be understood in terms of two distinct areas of power usage:

1. Facility Support Systems – This includes heating, ventilation, and cooling equipment, as well as lighting, pumps, fans, and other infrastructure needed to keep the data center operating safely. Load changes here typically occur when additional cooling capacity is brought online to handle rising thermal output, or when systems are cycled down as demand falls. While these shifts are significant, they usually occur on slower timescales and can be anticipated based on environmental and operating conditions.
2. Computational Load (GPU Processing) – The most dynamic component of a modern AI data center is the large-scale deployment of GPUs. Unlike support systems, GPUs consume power in direct proportion to computational demand. During AI workloads, GPU ramping occurs on a second-to-second basis.

Typically, GPUs sustain high power output for several seconds while performing heavy computation, then experience a sharp drop in power draw for several seconds during communication, synchronization, or code recompilation stages. This results in massive power swings—often in the range of 40–60% of total GPU load—occurring within a matter of seconds. These fluctuations are inherent to AI training and inference processes and can occur repeatedly throughout the day as jobs scale up, down, or shift between clusters.



Both types of ramping must be carefully managed, but it is the fast, frequent, and bidirectional ramping of GPU clusters that presents the greatest challenge for system stability. If either facility support loads or computational loads are allowed to change too abruptly, they can create undesirable disturbances to the transmission grid.

While the proposed threshold of 10 MW/minute provides a clear upper bound, Atlas recommends that AESO also recognize that grid operations and data center control systems function at a much finer resolution than whole minutes. We would like to ensure that the AESO is providing rules that address these two issues independently, one being the prevailing average over a one-minute period, and the second for the abrupt changes caused by GPU processing changes.

Suggested amendment to section 6.4:

The TCDC must limit the prevailing average for the facility to maximum change of 10 MW over a 1-minute period.

Section 6.5

To limit the risk of power oscillations, the TCDC's net load variability must be limited to less than 16 kW per 100 milliseconds.

Atlas' feedback on the proposed requirement that "to limit the risk of power oscillations, the TCDC's net load variability must be limited to less than 16 kW per 100 milliseconds."

While we support the underlying objective of reducing net load oscillations, we are concerned that the way this requirement is currently phrased does not account for the realities of AI Data Center system operation. As written, it would effectively prevent AI-focused data centers from connecting to the Alberta grid, as no facility could practically comply with a 100 ms variability limit. Also, the phrase "net load oscillations" considers the effect differently from load demand ramping (increasing/ decreasing), which in practice more accurately describes the activities at an AI data center where the GPU's are ramping up and down based on the computational process the GPU's are engaged in.

1. Alignment with Real-World Response Times

In practice, system response times and control latencies are closer to 300 ms, consistent with established requirements such as Fast Frequency Response (FFR) that the AESO has established through the FFR market frameworks and public consultation periods. Atlas recommends that AESO revise the language to reflect these practical limits. A standard that recognizes real-world latency constraints will enable compliance while still meeting reliability objectives.

Fast Frequency Response

Fast Frequency Response (FFR) is a fast-acting transmission reliability service that facilitates the arrest of, and recovery from, frequency decay caused by events such as the sudden loss of imports from the Alberta-B.C. Intertie and the Montana-Alberta Tie Line and/or internal generation. This service is currently provided through Load Shed Service for imports (LSSI), whereby load customers are under contract to be quickly taken offline following the sudden loss of imports coming across the interties.

2. Basis of Monitoring and Control

We further recommend that the requirement specify that variability management (load ramping) be based on monitoring of facility load and the local power system of the facility, rather than grid frequency.

Frequency-based controls are appropriate for the broader grid reliability through technologies such as Battery Energy Storage Systems (BESS), but not for severe load driven changes that occur on the electrical grid due to frequent large load swings at facilities such as data centers.

This is because in order for frequency response type systems to respond to a frequency event the governor control settings of the system must be set to respond after an impact to the grid has taken place, i.e. the frequency of the grid has been impacted by a major event, such as a loss of generation or a significant load change event at an AI Data Center (which typically happens second to second) causing the grid frequency to leave the acceptable deadband and then frequency response services such as a BESS, or other system such as generator through governor control initiate and provide a response.

This type of frequency response is not an acceptable way to manage an AI Data Center load change as it is a lagging response, which has already subjected the grid, connected generators, and connected loads, to stresses including mechanical stresses, from the causation load change event.

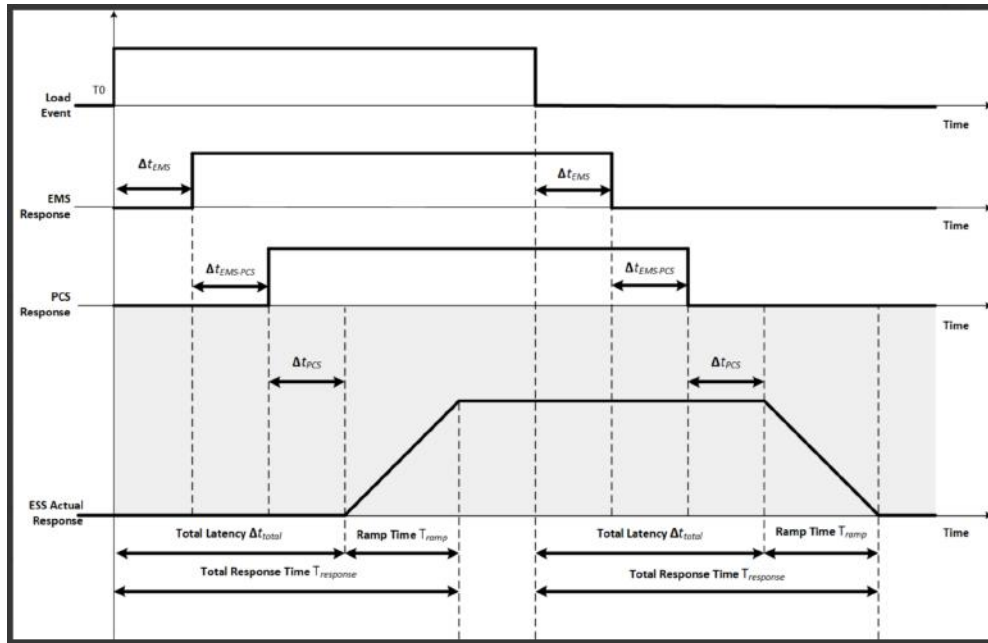
Ensuring clarity here will avoid mismatches in interpretation, technical expectations, system design, as well as prevent cascading events that could exacerbate the problem leading to a more severe system failure.

Consideration of Latencies in Control Systems

Any control solution involves multiple sources of latency, including:

- Sampling rate of the power meter,
- Computation time to detect and quantify changes,
- Communication latency when dispatching signals to the Power Conversion System (PCS), and
- PCS ramping latency itself.

As a result, no system can achieve “instant” response. Instead, the response is inherently step-like, producing a staircase effect where measured power change and actual power response are offset by these latencies.



Practical Objective: Minimization, Not Elimination

Given these realities, the requirement should focus not on eliminating all variability within 100 ms, but on minimizing the difference between actual load and supply while smoothing the load profile as much as possible.

The key goal should be to reduce the “sawtooth” effect in the net load profile, thereby minimizing the disturbance seen by the grid.

Considerations should include:

- The acceptable latency response time limit should reflect achievable timeperiods, such as <300ms response constraint. This would be consistent and comparable to current FFR requirements.
- Consideration in MW for the initial mismatch in power change from a load change event, and the response, factoring latency, by the supporting power response systems to arrest this power change, both during an increasing or decreasing load.
- Load & local power system based power measurement and response, versus lagging frequency response.

Additionally, consideration for the size of the AI Data Center should factor into power change limits. This is because the initial change in load will be proportional to the size of the data center, and the non-instantaneous response of a power response dampening system will only be to inject or absorb power after its latency period creating an initial shortfall in power change response. These factors need to be considered or data centers will simply not be able to connect to the Alberta transmission system.

Other considerations should include:

- The size AI Data Centers are gravitating towards,
- the size is appropriate to handle a single feed from the transmission system,
- net impact based on the size of the data center (i.e. a larger data center will have a larger net impact),
- the grids overall ability to handle the short duration load change event,
- consideration to the fact that AI data centers load changes are typically brief and cyclical, and are typically not prolonged durations of power change, which would be case in the event of a loss of generation on the system.

Suggested amendment to section Load-Induced Forced Oscillation 6.5:

To limit the risk of power oscillations the TCDC must:

- Implement load and power system measurement and control methodology (not exclusively frequency based control),
- limit the average load variance for the facility to maximum change of 1% of the facility rating (2.5 MW maximum) over any 500-millisecond period.

Section 6.5

Forced power oscillation amplitude within sub-synchronous frequency band must be limited to less than ± 160 KW.

Our comments above should also be incorporated into this section that discusses sub-synchronous frequency band.



Sincerely,
Mitchell Miller, CEO
Atlas Power Technologies Inc.

Comments From (Organization): TransCanada Energy Ltd.

Respondent Name (First and Last): Joanne Tatham

Respondent Title: Manager, Regulatory Services

Power and Energy Solutions

Connection Requirements for Transmission-Connected Data Centres

1. Are the requirements clear enough and provide enough detail to be followed by the Facility Owner? If no, specify which requirements and why.

☐ Yes

☐ No

Click or tap here to enter text.

2. Do you need further clarification on the requirements? If so, please specify which requirements could be clarified and how.

☒ Yes

☐ No

Further clarity is needed on how the AESO will contemplate behind the fence generation, and how the AESO intends to integrate those assets with the grid. The requirements should contemplate how data center load and behind the fence generation could be utilized to support grid reliability.

The emergency power requirements are too restrictive, and considerations should be given to leveraging these units differently during operating periods outside of an emergency.

3. Can the requirements be implemented by the Facility Owner without delaying a project's energization? If not, specify which requirements could delay a project and explain why.

☐ Yes

☒ No

Design elements such as low voltage ride through and fast frequency response will be challenging to incorporate into the facility design and will present delays and increased cost.

Consideration should be given to managing frequency at a system level rather than a facility level. The FFR+ procurement that is currently being contemplated by the AESO could be leveraged to manage the fast-ramping needs of data centers.

4. Are there any requirements you believe could be challenging to comply with? If so, please specify which requirements and explain why.

☒ Yes

☐ No

See response to 3.

5. Are there any requirements you believe are not necessary for the reliable operation of the grid when connecting TCDCs? If so, please specify which requirements and explain why.

☐ Yes

☐ No

As noted above, the AESO should explore opportunities to address ramping requirements at a system level through products that it is already contemplating.

6. Are there any additional requirements you think should be considered for the reliable connection of TCDCs? Please provide detail on which requirements and why.

☐ Yes

☐ No

[Click or tap here to enter text.](#)

7. Are there any additional comments you would like to share?

The *AESO Connection Requirements for Transmission Connected Data Centres* should allow opportunities for developers to propose feasible alternatives or allow flexibility within on-site configurations to address the reliability concerns. For example, it may be possible to address some of the ramping concerns identified by the AESO with the utilization of an on-site power source, however, the requirements impose strict restrictions on the use of back-up power sources. Also, where appropriate, the AESO should manage the reliability concern at a system wide level instead of imposing potentially expensive and onerous requirements on specific projects. For example, it is unclear why the AESO is unable to leverage the resources that will be procured through the fast-frequency response procurement to address the frequency and ramping concerns that the frequency ride-through and ramping limits within these specifications are intended to address.

TCE would encourage further consultation on the Connection Requirements with both data center developers and potential behind the fence generators to ensure that the requirements support the achievement of Alberta's goals around data centers development while maintaining grid reliability in the most cost effective and efficient manner.

Comments From (Organization):	TransAlta Corporation
Respondent Name (First and Last):	Akira Yamamoto
Respondent Title:	Director, Regulatory & Market Policy

Connection Requirements for Transmission-Connected Data Centres

1. Are the requirements clear enough and provide enough detail to be followed by the Facility Owner? If no, specify which requirements and why.

☐ Yes ☒ No

The requirements poorly consider behind-the-fence configurations, on-site supply, and TCDC demand response

The requirements do not sufficiently contemplate arrangements included behind-the-fence data centre and generation or battery configurations given that these forms of on-site supply can ameliorate or mitigate the grid facing impacts that serving a data centre load could have on the Alberta interconnected electric system (“**AIES**”). The only level of contemplation of this is in the definition of the Transmission-Connected Data Centres (“**TCDC**”) and the emergency back-up power – and the emergency back-up power is only imposing a restriction on that type of on-site supply.

Additionally, TCDCs may be willing to provide demand response to help address system reliability. This goes beyond just mitigating the TCDCs impacts to the system and includes demand response that could enhance the capabilities of the AIES to manage broader system reliability issues and concerns. In this respect, the AESO’s proposed requirements approaches TCDCs as if they will always create issues for the system rather than as a type of resource that could also include controllable load characteristics that improve the AIES.

The ramping restrictions are unreasonable and the rationale for the stringency is unclear

The ramping limitation is overly broad and does not explain if the restriction applies to both ramping up and down, planned or unplanned events, and the TCDC or Most Severe Demand Contingency (“**MSDC**”) level.

Appendix B: Transmission Line and Transformer Examples does not provide sufficient detail to understand how they are applied

The current table lacks sufficient clarity and adaptability to accommodate alternative connection configurations. More specifically, it is unclear how to interpret the table for data center loads that fall

between the specified example sizes (e.g., if the data centre loads are higher are lower than the transformer sizes list in the table). Additionally, it does not address whether the presence of other loads on the same circuits influences the minimum circuit requirements. Finally, the treatment of configurations that involve multiple circuits that have different voltage levels, and therefore differing circuit capacities, is not explained.

The need for multiple circuits is overly broad and could result in inefficient TCDC development

The AESO's requirements in paragraph 5.3.2 also provide poor specificity and raises too much uncertainty. Under these requirements, the AESO could impose costly configurations choices at any time in the interconnection process that could ultimately make a TCDC uneconomic. For example, the AESO states that the minimum circuit capacity may consider future planned projects in the area without any clarification if that is only with respect to transmission system modifications or upgrades or also relates to other load projects including TCDCs or generation - development projects can be speculative and never come to fruition. This could force a TCDC to design a configuration that is more costly with unnecessary circuits that are not needed to serve the TCDC but rather in contemplation of future projects that don't ever get built. The AESO also leaves itself full discretion with limited transparency to the TCDC in terms of the decision criteria that is applied as well as the timing of when the need to split circuits to address future planned projects and double circuit tower failure cascade risk are identified. This could lead inefficient TCDC development and siting and inconsistent configuration decisions that ultimately thwart Alberta's ability to attract data centre economic development.

2. Do you need further clarification on the requirements? If so, please specify which requirements could be clarified and how.

☒ Yes

☐ No

Please see our responses to Question 1, 5 and 7.

3. Can the requirements be implemented by the Facility Owner without delaying a project's energization? If not, specify which requirements could delay a project and explain why.

☐ Yes

☒ No

There have been minimal requirements for any load connections to date including large load industrial sites. The AESO's release of these draft *Connection Requirement for Transmission-Connected Data Centres* comes as a poorly timed surprise during the allocation process for Phase 1 when commercial negotiations are still occurring for the projects in that process.

We anticipate that these new requirements will hinder TCDC projects and could delay projects. For example, projects may require additional equipment and infrastructure that has not been contemplated in the current designs of TCDCs and the additional costs to comply and limitations could materially impact the commercial opportunities for TCDCs beyond what has been contemplated by the parties involved in TCDC development. Additionally, some of the equipment that could need to be modify such as transformers and breakers already have two-to-three year lead times and at least some project proponents have already advanced procurements of this equipment based upon the specifications and requirements that are contained in the current ISO Rules.

4. Are there any requirements you believe could be challenging to comply with? If so, please specify which requirements and explain why.

☒ Yes

☐ No

Please see our responses to Question 5 below.

5. Are there any requirements you believe are not necessary for the reliable operation of the grid when connecting TCDCs? If so, please specify which requirements and explain why.

☒ Yes

☐ No

MSDC should be set at the same value as Most Severe Single Contingency (“MSSC”)

The AESO’s proposal for MSDC is unnecessarily restrictive and inconsistent with the MSSC. The MSSC is currently set at 466 MW which is in stark contrast to the AESO’s proposal for an MSDC of 200 MW. Both are single contingency impacts but are inversely related: the loss of a single generator is addressed by directing contingency reserves whereas MSDC is addressed by reducing generation. The significant difference between the two is unjustifiable in that both the loss of generation or load can be triggered instantaneously but it is likely easier or just as easy for the AIES to respond to an MSDC given that a response to a loss of load is to reduce online generation whereas a loss of generation requires generation and contingency reserves to ramp up. Turning down generation is faster and easier to accomplish than ramping up generation.

Furthermore, an MSDC set as low as the AESO has set it requires more equipment and infrastructure such as transformers and breakers significantly increases interconnection costs and complicates the electrical configuration of these sites. TransAlta recommends that the MSDC and MSSC should be aligned and the MSDC should be set at 466 MW or a level close to that level (e.g. 425 MW, which was also a level that was applied in the recent past).

No ramping requirement should be imposed in alignment with other system loads and data centres < 75 MW

The AESO’s load ramping restriction of 10 MW/min is too restrictive. Notably, no other industrial or other loads connected to the AIES have such a restriction. Furthermore, the ramping restriction is not applied to data centres that fall below the 75 MW threshold – it is conceivable that high ramping data centres could strategically size below this threshold to avoid capture from this regulatory requirement despite the impacts being similar. Additionally, it is even discriminatory and unfair to the TCDCs that it applies because it implies drastically different ramping limitations based on the size of TCDC. A 75 MW TCDC can ramp 13% of its total maximum demand whereas a 1,000 MW TCDC has a ramping allowance of 1% of its total maximum demand. The only thing that is clear from the AESO’s approach is that the requirements are selectively applied, create different requirements for different data centre sizes, and ignore excluded loads whose ramping profiles can have the same impacts as large loads to system reliability.

Beyond being unfair, the requirement does not provide reasonable latitude to find solutions to allow the system to meet higher ramping needs. For instance, a TCDC upon which the ramping requirement is applied is divorced from concept of the MSDC (a TCDC could be comprised of several MSDCs). Moreover, a TCDC that includes any on-site generation that could be used to manage its grid-facing ramping impacts, the restriction using emergency back up generation for only emergency back-up power use would not allow that generation to be used for this purpose. While TransAlta views a procurement of resources on a system-wide basis is the most efficient way to handle large load ramping requirements, the AESO's requirements do not allow a data centre to consider how it could address a higher ramping requirement through the use of other technology solutions such as on-site generation including battery storage.

TransAlta recommends that the AESO not impose any ramping requirement for Phase 1 given that the AESO determined that the total amount of data centres that could be reliably served was 1,200 MW and the Phase 1 data centres will be sized in accordance with this allocation limit. Any requirement that is considered be in a consultation on Phase 2 requirements.

FFR+ should be used to address large load ramping requirements

Additionally, the AESO is currently planning to procure up to 750 MW of high availability Fast Frequency Response+ ("FFR+") service to support import flows that the AESO has also stated would be directed on/utilized very infrequently. Alternatively, or as a compliment, the Fast Regulating Reserve ("FRR") service that the AESO was/is considering for mitigating excessive tolerance excursion in area control error could also be used to address data centre ramping. The capabilities of FFR and FRR are well aligned to addressing potential higher ramping from data centres particularly given the significant amount of high availability FFR that will be procured and the relatively modest level of Phase 1 data centre load.¹ In addition, the cost of FFR+ is proposed to be recovered from load customers, which would include the large loads being proposed in Phase 1.

Ring bus configurations should be permitted

The AESO stipulation in subsection 5.3.3 that ring bus configurations should not be permitted is overly restrictive, forces TCDC to design higher cost high voltage substation configurations and could be less reliable for arrangements with lower numbers of circuits (6 or less) than breaker-and-a-half configurations.

Both ring bus and breaker-and-a-half configurations address the risk of a loss of multiple transmission lines or multiple transformers in a single bus fault or breaker failure event. However, mandating a requirement for a breaker and a half configuration requires the installation of 2 extra breakers for any arrangement with 6 or less feeders, which drives up interconnection costs without an associated reliability benefit. Rather than increasing reliability, the addition of more breakers increases the potential risk of a breaker failure and could increase rather than decrease reliability risks.

TransAlta acknowledges that for configurations with more than 6 feeders a breaker-and-a-half configuration could be justifiable over a ring bus configuration. However, an outright prohibition from considering a ring bus configuration is unjustifiably restrictive particularly when both configurations

¹ Using FFR+ for large load ramping requirements is vastly superior to the other types of ancillary services such as black start and transmission must run that the AESO is considering for FFR+.

can provide similar up times and reliability. TransAlta recommends that the AESO eliminate this restriction and permit ring bus configurations for data centres to be used on a case-by-case basis.

Two SCADA telecommunication paths should only be required for facilities with TCDC (or combined load and generation) greater than 1,000 MW

Section 5.10 of the AESO's proposal states "TCDC facilities with load greater than or equal to 300 MW must have two SCADA telecommunication paths to the AESO". This is an overly restrictive requirement and is more stringent than the requirement currently contained in *Section 503.16: SCADA* (paragraph 5(8) that only requires 2 communications circuits when a facility has a capability of combined load and generation greater than 1,000 MW. The AESO should maintain consistency with its ISO Rules and only impose a requirement of two SCADA telecommunications paths under the same criteria for other loads, generating units, or combined load and generation facilities (cogeneration industrial systems).

The load-induced forced oscillation and control stability requirements are not requirements for any other loads, increase the cost of TCDC, and may not align with a broader system benefit

Subsections 6.5 and 6.6 specify strict requirements that must be adhered to by TCDC. Notably, these are not requirements that apply to any other load including data centres that are not classified as TCDCs but are connected to the AIES. Furthermore, the AESO has provide no rationale as to why these specific values (e.g., net load variability of < 16 kW per 100 ms, sub-synchronous frequency band < 160 kW) are reasonable or necessary. Indeed, the AESO additional commentary shows that these values are subject to change which undermines the notion that these should be set at these levels at all, the AESO states: "these indicative values may be refined based on system-specific electromagnet [sic] transient (EMT) studies, accounting for local grid strength, connection configuration, and facility control behaviour".² We are concerned that the AESO is imposing asymmetrically applied requirements on TCDC that require these facilities to incorporate expensive equipment and solutions like battery energy storage systems, E-Statcoms, and other controls that are unnecessary for the TCDC and could be more efficiently deployed and utilized at the regional or bulk system levels to address weaknesses in the AIES. Moreover, deploying this equipment to operate only to modulate the behaviour of the TCDC could result in poor use/utilization of this equipment and systems that could provide broader benefits to enhance AIES reliability.

The transient overvoltage ride-through requirement is onerous given the unlikelihood of an issue

Subsection 5.14.6 specify minimum ride-through requirements for various phase-to-phase or phase-to-ground instantaneous voltages. The AESO does not provide any rationale for these requirements or any information about the assessment of risk that has driven it to specify such stringent requirements. Our understanding is that these types of overvoltage events are extremely rare and unlikely to occur; however, the complexity, cost and effort to design systems to comply with these requirements are very real and could be significant. The AESO should remove these requirements as they are unnecessary and not required of any other load connected to the AIES.

² Subsection 6.5: Load-Induced Forced Oscillation, Page 18.

6. Are there any additional requirements you think should be considered for the reliable connection of TCDCs? Please provide detail on which requirements and why.

☐ Yes

☒ No

TransAlta does not see the need for additional requirements and asks the AESO to further review the reasonableness of the requirements that it has incorporated into its draft *Connection Requirement for Transmission-Connected Data Centres*.

7. Are there any additional comments you would like to share?

The requirements need further and better consultation and should be worked on to applied to Phase 2+

The AESO's approach needs to be more flexible and accommodating for Phase 1 data centre development to appropriately allow Alberta to prove out the opportunity for data centres to locate in the province. The AESO's timing in terms of developing these requirements were issued in midst of the allocation process for Phase 1 hosting capacity when the focus for developers is on the commercial agreements for these data centres. The untimely release of these entirely new and restrictive requirements on transmission-connected large loads is inconsistent with the treatment of other loads (no other loads are subject to stringent requirements like these), unfriendly to business – creating a unpredictable regulatory environment, and undermines Alberta's ability to compete against other jurisdictions to attract and serve these types of data centre customers in the competitive global industry for technology investment.

The *AESO Connection Requirements for Transmission-Connected Data Centres* require more time to be developed and consulted on and should occur after the Phase 1 data centres have more certainty and have completed the allocation process. This is necessary because the load profiles and the requirements for data centre clients can be different from customer-to-customer and site-to-site and the ability to manage system impacts may differ by from connection location. TransAlta recommends that the AESO work closely with the Phase 1 data centres through the interconnection process and the development of functional specification for their facilities as an alternative that more practically aligns with the current circumstances of data centre development.

By leveraging the approach TransAlta recommends, the AESO will be in better positioned to develop more reasonable requirements with real-life data centre deployments in way that is more practical given the rapid pace of data centre evolution while still achieving system reliability. In this regard, TransAlta recommends that the *AESO Connection Requirements for Transmission-Connected Data Centres* be applied to data centres in subsequent phases (Phase 2+) after that more meaningful and timely engagement can occur.

Comments From (Organization): Utilities Consumer Advocate (UCA)

Respondent Name (First and Last): Steven Wilson

Respondent Title: Senior Market Analyst

Connection Requirements for Transmission-Connected Data Centres

1. Are the requirements clear enough and provide enough detail to be followed by the Facility Owner? If no, specify which requirements and why.

☒ Yes ☐ No

Overall, the AESO's connection requirements for transmission-connected data centres are simple and straightforward enough for facility owners to follow. The UCA does have some concerns that the document's usage of discretionary language – such as “the AESO may require hardware in the loop (HIL) testing” (Section 5.5) or “the AESO will assess the cascade risk” (Section 5.3.2) – may reduce predictability across applications, or lead to inconsistent enforcement. In the absence of adequate safeguards, shortcoming in these areas risk exposing ratepayers to reliability risks and/or increased costs.

2. Do you need further clarification on the requirements? If so, please specify which requirements could be clarified and how.

☐ Yes ☒ No

Click or tap here to enter text.

3. Can the requirements be implemented by the Facility Owner without delaying a project's energization? If not, specify which requirements could delay a project and explain why.

☒ Yes ☐ No

Yes, in general the connection requirements should not be an impediment to timely project energization. However, as contemplated in question 1, any process steps subject to the

AESO's discretion may introduce delays if triggered late in the process or applied inconsistently. From the UCA's perspective, the concern is not with the feasibility of implementation, but with ensuring that discretionary requirements are enforced transparently and predictably to avoid unnecessary cost or schedule impacts.

4. Are there any requirements you believe could be challenging to comply with? If so, please specify which requirements and explain why.

☐ Yes

☒ No

No, from the UCA's perspective, there are no specific requirements in the AESO's connection document that appear inherently challenging to comply with. The technical expectations are appropriate for the scale and sophistication of transmission-connected data centres, and facility owners are expected to have the necessary expertise or support to meet them.

5. Are there any requirements you believe are not necessary for the reliable operation of the grid when connecting TCDCs? If so, please specify which requirements and explain why.

☐ Yes

☒ No

The UCA maintains that all requirements outlined in the AESO's connection document are necessary for the reliable operation of the grid when connecting transmission-connected data centres. The technical expectations are appropriate given the scale, complexity, and potential system impacts of these facilities.

6. Are there any additional requirements you think should be considered for the reliable connection of TCDCs? Please provide detail on which requirements and why.

☐ Yes

☒ No

The UCA generally defers to the AESO and industry experts on technical and engineering matters and their role in supporting grid reliability. That said, recent best practices from other jurisdictions suggest that additional measures—such as requiring grid-aware scheduling, demand flexibility, and transparency around energy use—may help ensure that transmission-connected data centres operate efficiently and do not impose unnecessary costs on consumers. Any decisions to incorporate such practices are particularly relevant given the risk of overbuilding infrastructure and/or stranded assets posed by the integration of these facilities.

7. Are there any additional comments you would like to share?

Not at this time.

Comments From (Organization): Voltus Energy Canada Ltd.

Respondent Name (First and Last): Anneliese Gallagher

Respondent Title: Energy Markets Manager

Connection Requirements for Transmission-Connected Data Centres

1. Are the requirements clear enough and provide enough detail to be followed by the Facility Owner? If no, specify which requirements and why.

☒ Yes ☐ No

Click or tap here to enter text.

2. Do you need further clarification on the requirements? If so, please specify which requirements could be clarified and how.

☒ Yes ☐ No

The requirement that TCDCs have the capability to participate in both Underfrequency Load Shedding (UFLS) and Undervoltage Load Shedding (UVLS) programs is unclear today. More guidance is needed from the AESO on the parameters of these programs, the metering requirements necessary, and the ability to aggregate loads. Voltus also asks that the AESO clarify whether large loads will be compensated for UVLS/UFLS, and if so what the proposed payment rate is.

3. Can the requirements be implemented by the Facility Owner without delaying a project's energization? If not, specify which requirements could delay a project and explain why.

☐ Yes ☒ No

The requirement that facilities over 300 MW have two physically diverse SCADA communication paths to the AESO will delay large TCDCs' time to launch. Setting up this second SCADA pathway could delay the largest data centers looking to interconnect.

4. Are there any requirements you believe could be challenging to comply with? If so, please specify which requirements and explain why.

☐ Yes

☒ No

5. Are there any requirements you believe are not necessary for the reliable operation of the grid when connecting TCDCs? If so, please specify which requirements and explain why.

☐ Yes

☒ No

Click or tap here to enter text.

6. Are there any additional requirements you think should be considered for the reliable connection of TCDCs? Please provide detail on which requirements and why.

☐ Yes

☒ No

Click or tap here to enter text.

7. Are there any additional comments you would like to share?

Voltus understands the need for TCDCs in balancing voltage and frequency on Alberta's relatively small 12 GW system. However, the stringent requirements to interconnect may deter data center construction and lead these projects to build in other jurisdictions. This would reduce overall investment and economic growth in Alberta. Voltus recommends that the AESO design additional demand response programs, such as structured price response or capacity programs, to serve as a positive incentive to these loads rather than a barrier to entry.

Voltus also recommends that the AESO look to other jurisdictions like PJM for best practices on data center growth. In PJM, data center owners and developers can fund virtual power plants to offset the load growth they are bringing. For example, a 100 MW data center in Ohio could purchase a 100 MW VPP from Voltus, which Voltus then brings to the PJM market in that same location.