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Alberta Utilities Commission
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RE: BULLETIN 2025-05 AND RULE 024: RULES RESPECTING MICRO-GENERATION CONSULTATION

This letter is provided in response to the inquiry made by the Alberta Utilities Commission (the Commission) regarding Rule 024. CVs were not requested as part of the submission, but I provide the below explanation of my experience and background in making this submission. My responses to specific questions follow.

I am an electrical engineer specializing in generator interconnections, from large micro-generation up to transmission-connected, within Alberta and other jurisdictions, predominantly in solar, wind, battery, and gas in the aggregated generating facility topology (i.e. I am usually not involved in very large single-generator projects at transmission). I am a member of the standards working groups for IEEE 1547 and CSA C22.3 No. 9, which are standards adopted by Albertan utilities for application of distributed energy resources (DER) and which are key inputs to the product standards for inverters and other generation technologies. I am often a key contact on behalf of generator owners and constructors in interfacing with utilities and the AESO. I am often a provider of key inputs to Micro-generation Form A, including development of generator designs, on behalf of owners and constructors.

In the micro-generation space, I most often work with constructors, while in the large distributed generation space and transmission space, I most often work with generator owners directly. As a result, I have been a participant from a few stakeholder perspectives in connecting generation to the Alberta Interconnected Electric System.

In addition, I am a trainer and certified Commissioning Conformity Evaluator[1] to IEEE 1547-2018. As a result, in addition to my work designing, building, and commissioning distributed DER, I also regularly audit installations of DER for conformity to the interconnection standards. I am also a Safety Codes Officer (Electrical, Groups A and B), and have regard for concerns of authorities having jurisdiction[2].

[1] See IEEE's ICAP DER program page at https://standards.ieee.org/products-programs/icap/programs/der/.

[2] My remarks are based on my own professional concerns when acting in that role. I do not claim to speak for all inspectors.

Conversely, I do very little work on the load side of micro-generation facilities; this limitation shows up in my comments below.

Where possible, my responses to the questions reference publicly available information. Unfortunately, I cannot make available specific client information for actual sites.

My response is my own, and does not represent the position of Hawk's Aerial and Technical Solutions Inc., nor of our clients.

Sincerely,

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QUESTIONS:

1. ***Should there be a standardized methodology or minimum information requirements for utilities' calculation of the estimated annual consumption at a customer's existing or new site and the calculation of the micro-generation unit's output? Please provide an explanation.***

   A standardized methodology would be advisable for both load and generation analyses; however, care must be taken to address fair estimations of specific generation technologies.

   Specifically in respect of micro-generating unit output for solar, as an example, several assumptions are made including selection of weather data that can have a significant effect on the outcome of any studies. In larger scale solar plants, agreements on weather data as the basis of design are critical in forecasting performance.

   Some tools available for estimating make assumptions regarding key parameters in a way where an unfamiliar user could be making an assumption that was not understood, nor intended. For example, the National Renewable Energy Laboratory's PVWatts[3] software makes assumptions which are not conveyed directly on the software's interface and may not be appropriate to the application under consideration [1].

   If a modeling guide were prepared by a working group, there are open-source software tools that could form a basis that all parties could have access to, such as the National Renewable Energy Laboratory's System Advisor Model[4].

[3] See https://pvwatts.nrel.gov/.

[4] See https://sam.nrel.gov/. It should be noted that large-scale solar sites typically make use of PVsyst (https://www.pvsyst.com/), and Helioscope (https://helioscope.aurorasolar.com/) is another common commercial-scale (i.e. large micro-generation) software for solar estimating. No specific software is advocated for at this time; a modeling group would have to establish specific needs in respect of modeling and accuracy to determine which software is appropriate.

For load analysis where new data is not available, building systems professionals may have access to ANSI/ASHRAE 140-compliant software[5] to accurately estimate loads. Likewise, industrial process professionals often have means of estimating load demands in their facilities' designs using process design software.

Regardless of modeling standards chosen, care should be taken to provide standard assumptions or require engineering involvement to establish appropriate assumptions and modeling requirements. The Canadian Electrical Code [1], for example, bases its cable ampacity tables on standard assumptions[6] to allow for sizing of cable without an engineering degree. A similar strategy for defined modeling guidelines could be used here. Requiring engineering involvement for small micro-generation may be cost prohibitive, and unnecessary if common acceptable solutions can be provided in the same manner as provided for by Code.

a. ***Please identify and justify the best historical timespan for accurately assessing a customer's historical energy usage (for existing sites).***

   I have no comment on this, and defer to load-side professionals.

b. ***Please identify and justify the best way for accurately projecting a customer's future energy usage (for new sites).***

   I have no comment on this, and defer to load-side professionals.

c. ***Please specify and justify the minimum level of proof that utilities should accept if a customer explains that they intend to increase their electricity consumption shortly after installing a micro-generation system (such as electric vehicle proof of purchase, etc.)***

   Proof of purchase of a product still makes very broad assumptions about usage. An individual who does not often commute may not use as much power even with an electric vehicle.

   A better approach to this might be to allow interconnection of the full generator size subject to reverse power protection and/or an actively monitored load restriction using IEEE 1547 limit active power controls via supervisory control and data acquisition (SCADA), until such time that the load is demonstrated.

   Alternatively, other non-technical compliance means could be used (e.g. comparing net meter results after 1 year).

d. ***Please explain how a new micro-generation unit's yearly energy output should be calculated, including accommodation for any partial shading or coverage of a rooftop solar photovoltaic system.***

[5] See Natural Resources Canada note on the retirement of its CAN-QUEST modeling software at https://natural-resources.canada.ca/energy-efficiency/building-energy-efficiency/energy-management-data-fact-sheets-guides.
[6] See Alberta Municipal Affairs Electrical STANDATA bulletin 24-ECB-004 [9] regarding rule 4-004, for example.

For all generation types, the Commission should consider establishing a modeling working group to publish an acceptable modeling guideline. This guideline should establish acceptable / proven software and specified assumptions that are considered acceptable for use in this application. Not all estimating methods are fair or equal. Such a guideline could also help standardize submissions to utilities and review criteria, which can streamline the review process and get reviews completed more quickly.

Modern software such as System Advisor Model[7], PVsyst, or Helioscope have methodologies for analyzing near-shading using 3D models. Near-shading should be directly modeled where possible. As mentioned above, specific assumptions such as input weather data and shading, can have a profound impact on the output calculations. As a result, to maintain a fair playing field, it is advisable that some of these assumptions either be controlled, or supported by analysis authenticated by an engineering professional[8], to ensure they are conducted in a fair manner for all parties that reduces the likelihood of a later non-compliance with the regulation.

2. ***There are currently no specified mechanisms for monitoring compliance of micro-generation systems with the Micro-Generation Regulation (i.e., the micro-generation system generates all or a part of, but not more than, the customer's yearly electricity consumption) after the system is approved. How important is post-approval compliance monitoring to ensure micro-generators are remaining aligned with the Micro-Generation Regulation? Please provide an explanation.***

   I do not hold an opinion on the importance of compliance monitoring. That is a financial consideration when taken over an annual period.

   a. ***Please identify and justify the best way to structure mechanisms for post-approval compliance monitoring, particularly regarding which party (or parties) should assume primary responsibility (such as the AUC, the AESO, the utilities, etc.).***

      One operational feature of the micro-generation approach is the simplicity offered in addressing the Albertan power market, which is a unique power market. The micro-generator need not be a specialist in ISO rules, Alberta Reliability Standards, and financial settlement with the AESO (all of which are required for large distribution-connected generators and transmission generation), precisely because the mechanisms offered by micro-generation allow the wires owner and retailer to manage the relationship with the market using their specific competencies. As a result, most micro-generators are not specialized in these regulatory / compliance aspects as fully participating large generators might be.

      Any compliance mechanism should make use of data with one of the participants in micro-generation that not only has access to the data, but also has the competency to analyze it – the utilities or the retailers. Any kind of compliance monitoring which places burden on, for example, a homeowner is unlikely to be successful and will likely lead to

[7] For example, see https://samrepo.nrelcloud.org/help/pv_shading.html.

[8] P.Eng., P.L.(Eng), or P.Tech., with the latter two acting within their scopes of practice authorized by APEGA or the ASET / APEGA Joint Board of Examiners as applicable. I will use terms like "engineering involvement" in this response, and I refer equally to all my colleagues holding the mentioned designations for brevity.

process non-compliances (in addition to any actual generation non-compliances). Due to the expected market experience level of a micro-generator, the concept of compliance and self-reports, such as one might find when dealing with the AESO and the MSA, is not appropriate.

With bidirectional meters, it should be possible to assess annually the compliance based on meter data for the utilities or retailers.

3. ***What type of inverter de-rating, and associated evidence of this de-rating, would ensure that a micro-generation facility will not later increase its system capacity beyond the micro-generation system size approved by the utility? Please provide an explanation.***

   First, I would remark that inverter de-rating should not be the focus of consideration. The issue of <u>generator</u> derating is one that applies to all generation technologies, including synchronous machines (e.g. combined heat and power) and inverters. Inverter derating is held out by installers and manufacturers as a method of achieving a reduced production rating which is easy to use because it is software-based; however, it carries risks which must be considered. There are controls-related methods to inhibit production from synchronous machines as well, and they suffer from similar risks. See my response to sub-item ‘a’, below.

   a. ***Should micro-generators be permitted to derate their inverters, subject to the previously described limitations? Please provide an explanation.***

      Derating of inverters is a more challenging topic than it may first appear. While a solar PV facility may be expected to last 25+ years, a solar project can reasonably be expected to have inverter failures during the life of the project[9]. In the event that a replacement occurs, it is difficult to guarantee that special modifications made to the specific inverter will be complied with in the replacement (assuming a replacement of that specific make / model is even available). It would require sufficient technical knowledge on the part of the micro-generator owner and the installer at the time of replacement, to ensure that the inverter was again appropriately derated. It must be noted that the owner and/or the installer at the time of replacement may not be the original owner or installer who installed the system.

      The Canadian Electrical Code, and Safety Codes Officers by extension, are not well equipped to address this requirement on behalf of utilities, even if a maintenance permit is pulled, as section 84 of the Code broadly requires conformity with the utility (“supply authority”) requirements[10], but has no terms specifically respecting export limitation [1].

      As a result, the only assurance for the utility is likely to have would be a requirement, broadly speaking, that all replacements be reviewed with the utility to ensure compliance; otherwise the risk of an error is unreasonably high in my view. This assumes that DER owners and their installers are knowledgeable of the risks,

[9] NREL discusses typical failure rate assumptions in 3.4 of [7] for large-scale facilities, but micro-generators typically do not use large central inverters common to utility plants. As a result, failure rates will be different in micro-generators. Nonetheless, it is not reasonable to imply that no failures will occur.
[10] See rules 84-002 and 84-014 in the Code [2] as an example.

responsible, prompt, and provide advanced warning with their disclosures of replacements – and this may be true in most cases (or the owner / installer may not even think about it or realize it). Unfortunately, however, a non-compliant DER owner or installer could put their neighbours at risk in terms of voltage and power quality among other hazards.

In addition, the Canadian Electrical Code and the Electrical Code Regulation together require that equipment be "approved for the specific purpose for which it is to be employed"[11]. To provide a level of certainty for utilities and electrical authorities having jurisdiction, it would be prudent for any such derating to be approved by the approval body (certifying body or inspection body), rather than being an aftermarket modification of an existing model of generator (i.e. to align with C22.1-24 2-024), even if by the manufacturer. In addition, special marking provisions should be provided (or alternative nameplates) to ensure the correct replacement inverter is selected (i.e. that is similarly derated).

As an alternative, IEEE 1547-2018 and CSA C22.3 No. 9 (and by extension UL 1741 SB and CSA C22.2 No. 107.1) require the existence of a "capability to limit active power" (see [1] clause 4.6.2 or [2] clause 7.2.3.4.1). This method was intended to give the utility access via interoperability requirements[12] to control the active power of the facility [3].

Use of the limit active power capability in active control when monitored by the utility's SCADA system would be an appropriate way to address the challenges involved with derating a system, including disclosure to the utility. It also permits compliance monitoring by the utility for protection of its assets. The drawback is that it requires an active connection to the utility's SCADA system[13]. In addition, to ensure protection of the upstream system, it may be appropriate to apply protections to ensure excessive production cannot flow back onto the system and cause unintended harm. Examples may include reverse power relaying (32R) or directional overcurrent elements (67 / 67N).

4. ***The City of Medicine Hat's micro-generation application process includes an initial step to determine a potential micro-generation system's maximum permissible size, which has been found to reduce the number of full applications received. Would it be useful for the micro-generation application process to include an initial sizing determination phase, where a utility first determines a customer's maximum permissible micro-generation system size before the customer makes a decision to proceed to a full application? Please provide an explanation.***

   A key reason for my submission to this inquiry is to recommend a two-stage process. Any larger generator will go through multiple stages of study at progressively higher costs appropriate to progressively higher detail. This allows a generator to determine if capacity exists before spending money on detailed engineering and construction. To be required to make a full

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[11] See CE Code rule 2-024 [2].

[12] Interoperability requirements in IEEE 1547 are the "SCADA interface" intended for use with inverter settings and monitoring for DER Management Systems (DERMS) by utilities.

[13] EPCOR, ENMAX, and FortisAlberta all require SCADA connections for large micro-generators exceeding various thresholds – typically 500 kVA, but may be as low as 250 kVA. As a result, the drawback largely applies to small micro-generators which would not have otherwise had such a connection.

application, with the full associated design and other application costs, puts an unreasonable burden on the micro-generator to pay for engineering on a project and on the utility to fully consider an application that may go nowhere due to system constraints. It is inefficient for all parties.

In larger distribution-connected generators, it is customary to study the generator in multiple stages, to avoid putting full engineering resources (either for the generator or the utility) to work on a site that cannot pass screening checks.

For perspective, consider a 5 MW micro-generator using solar photovoltaic modules with a 1.2 DC to AC ratio (i.e. 6 MW_{DC}). NREL indicates a cost of 0.289 $\$/W_{DC}$ CAD[14] for "office work", which translates into a cost of $1.7m; while engineering will be only a portion of the "office work" described by NREL, nonetheless significant cost is associated with getting to a full Form A application with larger micro-generators. Keep in mind that good due diligence associated with a Form A application could include:

- noise studies by specialists[15] (e.g. to claim that a project has "met the requirements stated in AUC Rule 012 Noise Control),
- environmental impact assessments and associated field work (e.g. to claim that a project has "met all applicable environmental requirements"), and
- consultation with neighbours (e.g. Rule 007 Participant Involvement Program, to claim that a project is not "aware of any outstanding objections from any person regarding your project").

Spend on these activities is completely unnecessary if a quick screening test can confirm no such installation is possible due to grid constraints.

As noted by Medicine Hat (as per the question), this saves effort for the utilities and as I have noted, also for the micro-generation customer. It seems like a good source of reduced risks and costs for everyone.

5. ***The AUC has heard from stakeholders that inverter standards for micro-generation often change, creating temporary misalignment with some AUC guidance documents and contributing to some confusion among micro-generation applicants. Would it be helpful for the AUC to facilitate a working group of relevant parties that reviews technical standards (for inverters, etc.)? Please provide an explanation.***

I cannot provide perspective on whether it would be helpful for the AUC to facilitate a working group regarding technical standards, since I am involved with the standards anyways. However, in consideration of the question, I provide the following information for the Commission to consider:

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[14] Based on $223 USD / kW for "Officework" as per NREL [8], Figure 10, with $1.30 CAD to $1.00 USD exchange rate.
[15] As the Commission is well aware, solar also needs noise studies. Large central inverters can be loud, as can any forced-air-cooled equipment such as transformers.

“Often” should be carefully stated in respect of standards change timelines. IEEE 1547 [2] was last published 7 years ago. IEEE 1547.1 [5] and CSA C22.3 No. 9 [3] were published 5 years ago. Both are in progress to be revised[16], and neither are expected to be published before 2026. For IEEE, it will take another few years to update IEEE 1547.1 (the testing standard) to allow for certifications to be updated. Another few years after that, UL 1741 and CSA C22.2 No. 107.1[17] will be updated.

The time lag from publishing of the interconnection standard until equipment is available that supports it is the same pattern observed when IEEE 1547 was published in 2018. It took until about 2022 to get sufficient product on the market for utilities to be able to safely adopt UL 1741 SB and CSA C22.2 No. 107.1 updates as product requirements in interconnection standards.

Contrast this with the Canadian Electrical Code, which has updates every 3 years. This begs the question: exactly what is meant by often in respect of inverter standards.

It would be an accurate statement by stakeholders that interconnection standards have been updated by utilities more frequently than Code. I would remark that “inverter standards for micro-generation often change” is likely not an accurate statement. The product standards may be changing more regularly than the interconnection standards due to other features of the products (e.g. DC arc-fault protection or other non-grid-facing requirements), but this should have less impact on the utilities / grid, and thus on a micro-generation interconnection.

In regards to a working group, it could be advantageous for the Commission to be aware of the activities of standards in addition to sharing information with stakeholders. In the distribution generation context, standards such as IEEE 1547 and CSA C22.3 No. 9 serve a similar purpose to the myriad of ISO rules and Alberta Reliability Standards in terms of technical performance of generators. Several Albertans are involved in the interconnection standards IEEE 1547 and CSA C22.3 No. 9, and some are likely[18] involved in the product standards, such as CSA C22.2 No. 107.1. No doubt, the perspective of a utility commission would be unique on the interconnection standards (public utility commissions are often discussed, but not often involved, in these standards).

a. ***If yes, how often should the working group meet? (e.g. monthly, quarterly, bi-annually). Please provide examples of technical requirements, other than inverters, that should be included in the discussions.***

   Given the standards timelines I have outlined above, annually seems like it would be appropriate to address micro-generator connections (i.e. in respect of the grid requirements), and that is still probably aggressive. If review of specific utility changes

[16] The author participates in both IEEE 1547 and CSA C22.3 No. 9 standards updates, so the remark is from first-hand experience with the ongoing revision processes.

[17] A CSA C22.2 No. 107.1 revision is currently in progress; however, it is not clear that this is due to grid standards changes, since the grid standards revisions are in progress.

[18] I can confirm involvement of myself and other Albertans in the interconnection standards, but I am not on the product standards and cannot confirm Albertan involvement.

were a target of the working group, then a more frequent schedule (bi-annual) may be appropriate.

b. ***If no, please suggest a different way that the AUC can keep abreast of changing technical standards.***

It may be possible for the AUC's technical personnel to join some of the standards as an observer if so desired. IEEE 1547, for example, permits attendance to working groups of individuals who are not voting members on the standards.

I would be happy to connect Commission personnel with appropriate contacts in the interconnection standards community.

6. ***Please identify, and provide justification and details for, any other high priority micro-generation issues that should be addressed to ensure the effective and efficient functioning of the micro-generation landscape.***

Effects of Aggregate Generation on Distribution and Transmission Upgrades

Aggregate generation within a specific transmission substation can saturate the feeder equipment and/or transformers of that station. In addition, upgrades for live-line-reclose block and other changes may be necessary to ensure the safety of the system with DER present. These upgrades are difficult to address on a first come, first serve basis for micro-generators, partly because of financial limitations of the scale of typical project versus the costs of substation upgrades and partly because they are technical utility topics.

A methodology for sharing these exceptional costs beyond the first project to meet a constraint should be available; or ideally the upgrades simply become built into the transmission planning program and the capital programs of the relevant utilities (with associated impact on transmission and distribution rates). Micro-generators are not large competitive generators, so providing advantage of this kind to them seems unlikely to affect the market broadly. For comparison, consider the reported total capacity of micro-generators of 367 MW[19], and contrast this with the current total internal load reported by AESO at 10,462 MW[20]. Even if all the micro-generators are operating at full capacity, their capability represents only about 3% of the total production in the province.

Due to the increasing saturation of some distribution substations with generation (micro-generators or DG), this is becoming a higher priority issue in southern Alberta.

Note that for the purposes of this observation, I am communicating second-hand reports from project colleagues who have been presented with large cost estimates for station upgrades that caused project cancellations.

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[19] https://www.aeso.ca/market/market-and-system-reporting/micro-and-small-distributed-generation-reporting, June 9, 2025 report.

[20] Observed at June 26, 14:48, on the AESO's Current Supply Demand Report at http://ets.aeso.ca/.

Inter-Utility Applications and Associated Rules

Inter-utility conditions involving DER, especially where small municipal systems and/or REAs connect to larger utilities should be addressed in fair and balanced technical requirements from an external, impartial body. Power generation has a specific ability to affect upstream utilities, who often want to be involved in the interconnection process.

For DERs (micro-generators or DGs) which are connecting to a utility with direct access to transmission (either as the transmission owner or directly connecting to the transmission owner) there is a benefit of certainty of expectations, due to the ISO Rules and Alberta Reliability Standards providing some guidance as to expectations.

For micro-generators attempting to connect to utilities that do not have direct access to transmission, there is an uphill battle to deal with competing utility requirements. The initial connecting utility may take one position on the requirements, while the upstream utility may get involved and take a different position. Providing guidance on navigating these matters for micro-generators and utilities could be beneficial to all parties involved. There are public safety issues should the utilities not cooperate, as generators are inherently sources of potentially hazardous energy.

An Albertan policy / standard addressing these inter-utility issues would be appropriate to mitigate technical and regulatory uncertainty for micro-generation. This could be developed by AESO as an ISO rule specifically dealing with these small systems, or it could be dealt with in partnership with Safety Codes Council and the Alberta Electric Utility Code. As there are market effects (e.g. pool registration), and not exclusively safety issues, the former may be most appropriate.

While this issue may affect a small portion of customers, it can have safety and economic impacts to the grid. As a result, notwithstanding the smaller customer base, it is a high priority issue in my opinion, due to what appears to be a gap in the requirements.

REFERENCES

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[2] Committee on Canadian Electrical Code, Part I, "CSA C22.1-24, Canadian Electrical Code, Part I (25th Edition), Safety Standard for Electrical Installations," CSA Group, Toronto, ON, 2024.

[3] "IEEE 1547-2018 IEEE Standard for Interconnection and Interoperability of Distributed Energy Resources with Associated Electric Power System Interfaces," IEEE SA, 2018.

[4] Subcommittee on Interconnection of Distributed Energy Resources to Electricity Supply Systems, "CSA C22.3 NO. 9:20, Interconnection of distributed energy resources and electricity supply systems," CSA Group, Toronto, ON, 2020.

[5] DR Interconnection Application Guide Procedures Working Group, "IEEE 1547.2-2023, IEEE Application Guide for IEEE Std 1547-2018, IEEE Standard for Interconnection and Interoperability of

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[6] P1547.1 Working Group, "IEEE 1547.1-2020, IEEE Standard Conformance Test Procedures for Equipment Interconnecting Distributed Energy Resources with Electric Power Systems and Associated Interfaces," IEEE SA, New York, NY, 2020.

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[9] K. Glubrecht, "STANDATA bulletin 24-ECB-004, Electrical, 2024 Canadian Electrical Code, Part 1 Section 4 – Conductors," Government of Alberta, Edmonton, AB, 2025.