STATE OF MINNESOTA
BEFORE THE
PUBLIC UTILITIES COMMISSION

Katie Sieben	Chair
Dan Lipschultz	Commissioner
Valerie Means	Commissioner
Matt Schuerger	Commissioner
John Tuma	Commissioner

In the Matter of Updating the Generic Standards for the Interconnection and Operation of Distributed Generation Facilities Established under Minn. Stat. § 216B.1611	DOCKET NO. E-999/CI-16-521

INITIAL COMMENTS OF THE INTERSTATE RENEWABLE ENERGY COUNCIL AND FRESH ENERGY ON THE DISTRIBUTED ENERGY RESOURCE TECHNICAL INTERCONNECTION AND INTEROPERABILITY REQUIREMENTS

The Interstate Renewable Energy Council, Inc. (IREC) and Fresh Energy appreciate the opportunity to provide these comments on the proposed Minnesota Distributed Energy Resource (DER) Technical Interconnection and Interoperability Requirements (TIIR). Both IREC and Fresh Energy were actively involved in the earlier phase of this docket to draft the Minnesota Distributed Energy Resources Interconnection Process (MN DIP) and Interconnection Agreement (MN DIA), and were members of the Distributed Generation Workgroup's Technical Subgroup (the "Workgroup" or DGWG) to draft the TIIR.

Our organizations greatly appreciate the Commission's commitment to this process of updating Minnesota's interconnection rules and requirements and also appreciate the hard work and collaboration of all of the Workgroup members through this process. In light of the substantial time and resources that went into developing the draft TIIR and the urgency to get updated technical standards in place, IREC and Fresh Energy support the Commission adopting

the TIIR as submitted, with two specific modifications identified below. However, while our organizations are able to accept the TIIR as drafted for purposes of expediency, there are a number of critical issues that were not completely or adequately addressed in the draft that we want to bring to the Commission's attention. We ask the Commission to establish a process to adequately resolve these issues as we believe portions of the TIIR are going to be problematic for DER customers if they are not resolved. In addition, we provide comments on the scope and proposed process for adopting the Technical Specification Manuals (TSM) and on the process for updating both the TIIR and TSMs going forward.

I. THE TECHNICAL INTERCONNECTION AND INTEROPERABILITY REQUIREMENTS SHOULD BE ADOPTED LARGELY AS SUBMITTED, BUT A CLEAR PROCESS SHOULD BE ESTABLISHED FOR FILING OF THE TECHNICAL SPECIFICATION MANUALS AND FOR FURTHER ALIGNING INDIVIDUAL UTILTY REQUIREMENTS.

Since the first TIIR was initially adopted in 2004, much has changed in the interconnection landscape in Minnesota, the market for distributed energy resources (DERs) has grown dramatically in size and there is a much more diverse set of technologies applying to interconnect. In addition, the primary technical standard that guides distribution interconnection, IEEE 1547, underwent a major update in 2018 that will enable DERs to assist with the management of power quality on the grid in ways that were previously prohibited. For these reasons it made sense to start with a fresh approach to the TIIR.

As has been the case since the technical requirements were first adopted in 2004,[1] we believe it was the Commission's intent that the technical requirements be consistent across the

[1] *See* Docket CI-01-1023, Order Establishing Standards, at 3 (Sept. 28, 2004) ("The Technical Work Group was charged with drafting documents and guidelines for tariffs so that a person interested in developing distributed generation could know what technical requirements to expect when applying for interconnection with *any electric utility in the state.*" (emphasis added)).

entire state of Minnesota. At the start of the Workgroup process, the utilities instead proposed that only some of the technical standards be established statewide in the TIIR, and that a separate set of documents, known as the Technical Specification Manuals (TSM), be prepared that could contain technical requirements specific and potentially unique to each utility.[2] As a result, the draft TIIR produced by the Workgroup is not as comprehensive as IREC and Fresh Energy would have liked. Very significant technical requirements that can impact project costs and timing are not in the TIIR and instead have been left to utility discretion to adopt in their TSMs. It is foreseeable that the existence of many different TSMs will complicate the interconnection process for DER customers, companies and installers. In addition, we are concerned that the process of creating multiple TSMs also means there will be less scrutiny and thorough justification of the technical requirements that are imbedded within.

Since there is an urgent need for some updated technical requirements to be in place, we recommend the draft TIIR be adopted now, with the two exceptions noted below. However, we urge the Commission to continue the effort of trying to establish consistent statewide technical standards and to ensure that the TSMs, if they exist at all,[3] contain only technical requirements that are truly justified based upon unique electrical circumstances in a utility's territory.

A. The TSMs Should be Filed with the Commission Along with a Clearly Defined Process for Objections and Updates.

The Commission should require that the TSMs be filed within 60-days of the Commission's Order. It is important to ensure there is a formal opportunity for the TSM's to be scrutinized and they should be properly lodged with the Commission. After the TSMs are filed,

[2] *See e.g.*, Dkt. E999/CI-16-521, Comments of Xcel Energy, at 2 (Jan. 17, 2018).

[3] As we noted during the Workgroup, it is also possible that exceptions could be included in the TIIR itself where unique conditions apply for a utility, rather than creating multiple different technical requirements documents.

there should be a 30-day period in which any stakeholder may file an objection with the Commission which documents their concerns with the provisions of any TSM. Any such objection should clearly identify what provisions are being objected to, why, and identify a preferred alternative approach if possible. If no such objections are received, the TSMs should go into effect automatically (i.e. 30 days after being filed). If objections are received, the Commission shall make a formal determination on the objections before the TSM can go into effect. If no objections are received and the TSM goes into effect after the 30-day period, the Commission should be explicit that this does not mean that all parties have waived rights to later object to a provision in a TSM, but only that a TSM with no filed objections will go into effect.

In addition to the designated period for filing objections after the TSM's are initially filed, any stakeholder should be able to petition the Commission for review of the TSMs if issues or concerns arise at a later date. It is often the case that it will not be obvious if there are issues with technical requirements until they are in effect and interconnection customers begin to operate under them, thus it is necessary that there be an opportunity to raise these concerns when they arise. This process will provide a streamlined pathway for TSMs to go into effect, allows for stakeholders to object to problematic provisions and does not foreclose later review of TSM provisions as circumstances change with technology and customer/industry experience with the process.

The utilities should be required to keep their TSM's up-to-date and to notify stakeholders and the Commission of any changes that are made. We also recommend that if a utility updates their TSM, that they be required to file a clean and a redlined version with the Commission, along with a letter explaining the changes and the proposed timing for when they would go into effect. The process described above for the filing of objections should apply for every update the

utility files and the changes should go into effect no sooner than 30-days after they are filed (or at a later date as identified in the filing). Changes should only apply to projects applying after the effective date (unless the applicant and utility mutually agree to follow the new requirements). In addition to filing the updated TSM with the Commission, each utility shall strive to notify interconnection customers and installers when changes are made.

B. The TSM Must be Subordinate to the TIIR and be Organized in a Consistent Manner.

In its Order, the Commission should clearly define the scope of the TSMs and their relationship with the TIIR. It must be clear that the TIIR is the controlling technical document for the state of Minnesota and preempts anything in an individual utility's TSM unless expressly noted in the TIIR. The TSMs must neither conflict with the TIIR's standards nor establish technical requirements that go beyond those in the TIIR.

Since having both the TIIR and multiple different TSMs is likely to create some confusion and additional burden on interconnection customers, we recommend the Commission also order the utilities to adopt the TSMs using a consistent format and organization. At the August 9, 2019 Workgroup meeting the utilities presented a proposed outline for the TSM.[4] We support this outline and recommend the Commission require that it be followed by each utility.

C. The Commission Should Establish a Formal Review Process to Further Align the State's Technical Standards in the Future

In addition to the particular technical issues identified in the latter sections of these comments as requiring further work to achieve consistency and clarity, the Commission should commit to a comprehensive review and comparison of the TSMs within one year following their initial adoption. We recommend that Commission staff or another neutral party be tasked with

[4] *See* Slide 16 from the August 9, 2019 Workgroup meeting.

conducting a review of the TSMs to identify (1) what technical requirements are consistent across the utilities that could be moved into the TIIR and (2) what technical requirements are currently inconsistent but warrant evaluation as to whether the differences are truly justified based on actual technical distinctions with utility systems. Based on this review, a report would be submitted to the Distributed Generation Workgroup for discussion. The Commission should direct the Workgroup to continue to try to achieve a consistent set of technical requirements.

D. The Commission Should Establish a Convenient and Efficient Method to Collect Comments on Issues with the DIP, DIA, TSMs and TIIR for Discussion within the Distributed Generation Workgroup

In its August 13, 2018 Order the Commission delegated to the "Executive Secretary the authority to establish and maintain an ongoing Distributed Generation Workgroup to meet annually, or more frequently as needed, to review implementation and technical issues that arise with implementation of the MN DIP, MN DIA, or emerging DER technology. Updates to the MN DIP and/or MN DIA may be accomplished by Commission order in response to a petition."[5] IREC and Fresh Energy strongly support the idea of having a continuing formal Workgroup and have seen these used with some success in various states. In order to assist the Secretary in identifying when there are issues that need to be resolved that may require meetings on a more than annual basis, we ask that the Commission adopt the "Revision Request Form"[6] (included here as Attachment A) to standardize and facilitate the collection of requests for changes to future iterations of the DIP, DIA, TSMs and TIIR and to provide an appropriate path for public submission on an ongoing basis. Based on the urgency and volume of requests received from

[5] E-999/CI-01-1023 and E-999/CI-16-521, Order Establishing Updated Interconnection Process and Standard Interconnection Agreement, at 32 (Aug. 13, 2018).

[6] This form was developed with input from Dakota Electric and Star Energy Services.

stakeholders, the Commission can then appropriately reconvene the Workgroup to discuss and address the suggested changes.

Stakeholder conversations and collaboration prior to submission of the request form are encouraged, but not always practical and therefore should not be required. Providing a clear process for the many MN DIP, MN DIA, and TIIR stakeholders to participate in future improvements to the standards in a transparent and trackable manner will greatly benefit the few tasked with writing and approving the standards.

II. ENERGY STORAGE SYSTEMS ARE LIKELY TO BE AN IMPORTANT PART OF MINNESOTA'S ENERGY SYSTEM AND MORE NEEDS TO BE DONE TO ADDRESS THE PROCESS AND TECHNICAL REQUIREMENTS FOR THESE SYSTEMS IN THE NEAR FUTURE.

During Phase I of this proceeding IREC, Fresh Energy, the Energy Freedom Coalition of America and MnSEIA sought to clarify how energy storage systems (ESS) would be reviewed during the interconnection process. The Phase I Workgroup was unable to reach agreement on an approach to how the capacity from storage systems would be reviewed, and rather than deciding the issue last year, the Commission referred the issue to Phase II for "further development."[7] The Phase II Workgroup did attempt to further define the operating requirements and review standards for energy storage in Section 10 of the TIIR, but consensus was not achievable and IREC and Fresh Energy continue to believe that the effort is incomplete and that the Commission will need to revisit this issue again in the near future so that Minnesotans can take advantage of the flexible services that storage can provide without imposing unnecessary interconnection costs. At this point, the TIIR leaves too much to utility discretion and will require storage customers to individually negotiate with each utility about important features of their project

[7] *Id.* at 9.

which can slow down the interconnection process. Below we have identified for the Commission our particular areas of concern which we believe the Commission should look to resolve in the near future.

A. Control Modes for Energy Storage Systems

Section 10.2 of the draft TIIR addresses energy storage system control modes.[8] The controllable nature of energy storage is one of its most valuable features, enabling it to offer flexible services to customers and the grid. Utilities, however, are used to reviewing projects that typically operate with a set of fixed characteristics that are not easily changed. With storage systems, utilities need a sufficiently clear understanding of how the system will be operated to determine what effect it may have on the grid, but at the same time locking the storage system into one inflexible control mode may limit the usefulness of the storage system. In order to address this concern, Section 10.2 of the TIIR requires that energy storage system control modes be reviewed and approved by the utility and documented in the operating agreement.

IREC and Fresh Energy believe energy storage system control mode review, approval and security requirements proposed in the TIIR may be unduly restrictive in the long-term. While this conservative approach may appear prudent from an engineering perspective, we do not believe that this approach is necessary to protect the safety and reliability of the grid and believe it will impede customers' ability to operate their storage system in the most economical and/or grid beneficial manner. Thus, the draft TIIR's proposal, which may allow utilities to severely limit the flexibility of storage systems, should be considered a temporary measure that

[8] We have identified one specific editorial change that should be made to the TIIR. The definition for ESS Control Mode should be modified as follows: **"**The function that manages the real and reactive power flow from or to a ~~DER~~ESS in response to certain parameters~~,~~ (such as time, price signals, frequency or external signals, etc.)."

is re-evaluated in the near future. As more familiarity is gained about how storage systems operate and interact with the grid, interconnection requirements should allow for less restricted operation, with an eye towards incentivizing grid-supportive behavior. We recommend that the Commission order that this issue be addressed by utilities and stakeholders in the coming year and be incorporated into the TIIR soon thereafter.

B. Energy Storage System Operating Agreements

The TIIR states: "The ESS Control Mode(s) reviewed and approved should be documented in an operating agreement. The operating agreement should also list the ESS Control Mode(s) that is being utilized." The TIIR does not define, however, what this operating agreement language is and thus leaves open the possibility that each utility in Minnesota will impose varying requirements. We thus believe that the Commission should look to create standard operating agreement language for energy storage control modes in order to ensure consistent treatment of these systems across utilities.

Without standardization of the "control modes," which are broadly defined in the TIIR, potential confusion could arise due to individual utility interpretations as well as differences among storage vendors. Interconnection applicants should be able to understand what exactly is being agreed to and what is required to comply. The Commission should thus ensure that utilities and stakeholders work to harmonize the language and structure of these informational requirements in the operating agreements to the extent possible.

C. Defining Capacity for Systems Using Power Controls

As mentioned above, energy storage systems are unique in their ability to control both how much and when they export power to the grid. For example, storage systems can be designed to never export to the grid, to limit their export to a certain amount of capacity, or to limit the export to certain times of the year or day. For inverter based systems 20kW or less,

section 11.2 of the draft TIIR only allows DER AC capacity to be limited (for interconnection purposes) via the configuration settings. This requirement dovetails with the DIP section 5.14.3 allowance for limiting maximum capacity to less than a DER's nameplate rating.

The configuration setting for power will generally limit output power at the inverter's terminals. In essence, it re-configures the inverter to a power value lower than nameplate. While this may be useful in some scenarios, it does not address the ability of Power Control Systems (PCS) to manage export while supporting local loads. A PCS would allow the inverter(s) on site to output full power when loads (possibly including energy storage) can consume the power. The PCS can, at the same time, ensure export to the grid remains below a certain power level. PCS are a low-cost option for managing PV system output, load and storage in order to meet export restrictions, though they can introduce inadvertent export.[9]

The PCS will be widely used in coming years to avoid assigning output ratings for PV plus storage systems that are higher than they would actually operate at in the real world. PCSs could also be used to avoid potential distribution system upgrades by keeping export below technical limits. Numerous states, including California, New York, Hawaii and California have started to address how storage systems with PCSs should be reviewed and are recognizing that it is possible to create clear and defined processes without having to default to extremely conservative assumptions. Thus, we believe the DIP and TIIR should be revised in the future to explicitly describe the treatment of DER using PCS for maximum capacity and export control.

III. THE IMPACT OF THE VOLTAGE REGULATION SETTINGS SHOULD BE CLOSELY MONITORED TO ENSURE INTERCONNECTION CUSTOMER IMPACTS ARE APPROPRIATE.

[9] Inadvertent export is the unscheduled export of active power from a generating facility, exceeding a specified magnitude and for a limited duration, generally due to fluctuations in load-following behavior.

One of the most significant and beneficial changes made in IEEE 1547-2018 is the ability for DERs to help manage system voltage. While IREC and Fresh Energy strongly support using DERs to help support the grid, and potentially manage the impacts from DERs, it is important to protect DER customers in that process. Below we identify some specific aspects of the proposed TIIR that could be improved in the future to better protect customers while enabling them to manage voltage on the system.

A. Voltage Regulation

Section 5.3 of the draft TIIR requires as the default voltage regulation mode that systems be operated at a constant power factor mode of 0.98. IEEE 1547-2018, on the other hand, has several potential modes, including volt-var. While constant power factor requires the same proportion of reactive power from all DER, volt-var would allow the DER to autonomously adjust reactive power production based on the grid's need. Autonomous volt-var can increase the ability of the grid to host DERs without upgrades and could potentially reduce var flow compared to constant power factor.[10] While a constant power factor, as proposed in the draft TIIR, is an acceptable "first step" into DER voltage regulation, IREC and Fresh Energy support utilizing the volt-var function in the future.

The MN utilities expressed some trepidation to using autonomous voltage regulation due to concerns that power quality issues could be caused by interactions between DER and/or interactions with other voltage regulating devices on the distribution system. Utilities in California and Hawaii have deployed volt-var as default on inverter-based DER for more than a year. In addition, as the 1547 certified equipment becomes available towards the end of next

[10] Var flow causes efficiency losses and reduces the ability of the grid to transmit real power, and thus is best minimized.

year, we expect there will be substantially more research and insight available that could help assuage utility concerns. Parties in Minnesota should look to the real-world experience of these utilities, as well as expanding literature, to help guide them while choosing the most beneficial default voltage regulation function and settings for future revisions of the TIIR. The Commission should require the Workgroup to fully evaluate volt-var within the next two years and should revisit and update the TIIR accordingly.

B. Voltage Regulation Agreements

The proposed TIIR incorporates the new reactive power capability in IEEE 1547. It does so by making the reactive power capability available to the utilities with no limits, allowing the utilities to require DERs to change their reactive power control modes upon utility request at any time. Section 5.2 of the TIIR states:

> The Area EPS Operator shall notify the DER Operator when a change in reactive power control modes is required to address Area EPS operating needs. Any implementation of functions shall adhere to applicable agreements.
>
> … When a communication channel exists from the Area EPS Operator's communication interface to the Local DER Communication Interface, the Area EPS Operator shall have the right to adjust the settings remotely in conformance with the Interconnection Agreement.

In certain scenarios,[11] control of DERs' voltage regulation settings may be beneficial for maintaining power quality, safety and reliability of the grid. However, the utility's changes to these settings may negatively affect the DER in terms of power production or ability to serve load. Some assurance that the DER customer is not unduly affected by the control is necessary. For example, the range or degree to which the utility can require changes in the voltage

[11] For instance, where there is high penetration of DER and certain voltage regulation schemes on the distribution system. These conditions are not always created by the individual DER itself, alone or in aggregate with other DERs.

regulation setting should be limited in the operating agreement so as to not create too much economic uncertainty for the project owner and/or impose too much of a logistical burden where no communications exist. Interconnection applicants should be able to understand what exactly is being agreed to and what is required to comply. The Commission should ensure that utilities and stakeholders work to harmonize the language and structure of these considerations in the operating agreements to the extent possible.

C. Reporting on Voltage Variations

The default activation of the volt-watt function in Section 5.4[12] of the TIIR raises the possibility that some customers' DER energy production could be curtailed enough to impact project economics. The volt-watt function triggers DER power reduction based on high voltage, regardless of the cause of the high voltage. However, due to the local nature of voltage, it is challenging to predict if or where DERs will be significantly impacted. Impacts can also change as distribution circuits change and/or utility voltage regulation practices change. Impacts could also be caused by poor installation practices.[13]

The draft TIIR directs DER operators to report voltage-related production concerns to the utility. In order to ascertain whether or not the volt-watt function is having a significant impact on customers, and whether utility voltage issues or DER issues are the cause, the Commission should require the utilities to report yearly (for a minimum of 5 years) on voltage-based energy production impacts reported by DER operators. Additionally, to determine that voltage is being well-maintained to the standards that DER are required to maintain, the Commission should

[12] We note that the title of this section should be changed from "Voltage and Reactive Power Control" to "Voltage and Active Power Control."

[13] Minimally, education of DER developers in this regard will be necessary to ensure consumers are not subject to sub-optimal installations.

require utilities to report on the voltage complaint process in general. To track whether developer negligence lead to DER caused voltage issues, the report could include information about systems that were deemed to be customer-side issues.

Possible elements of the report and a metric to determine maximum energy loss are given in Appendix B based on discussions in California as well as work done by NREL.[14] The recommendations for the metric are reliant on AMI voltage data, though inverter or DER-level data could be substituted. We recommend the Commission adopt a voltage reporting process, using Appendix B, in its order.

IV. COMMUNICATIONS OPERATING AGREEMENTS NEED TO BE FURTHER DEFINED

Similar to the language in section 5.2 which provides the utilities with unfettered discretion regarding use of reactive power capabilities, the draft TIIR also leaves the requirements regarding communications to operating agreements without clear limits on their terms. Section 9.2 of the TIIR states: "Writing of information by the Area EPS Operator through the Local DER Communication Interface, shall follow agreements governing Area EPS Operator control of the DER operating state control modes and parameters."

While control of the DER's various settings may be beneficial for maintaining power quality, safety and reliability of the grid, the utility's changes to these settings may negatively affect the DER in terms of power production or ability to serve load. Some assurance that the DER customer is not unduly affected by the control is necessary. Interconnection applicants should be able to understand what exactly is being agreed to and what is required to comply. It

[14] A. Hoke, P. Gotseff et al. NREL (May 9, 2019). *Estimating Customer Impact of Volt-Watt Using Only Smart Meter Voltage Data* [PowerPoint slides]. https://www.nrel.gov/docs/fy19osti/74146.pdf

would have been strongly preferable to define these parameters in the TIIR, but due to time and resource constraints, it was not resolved by the Workgroup. IREC and Fresh Energy believe the Commission should make it a priority to ensure that utilities and stakeholders work to harmonize the language and structure of these considerations in the operating agreements. The potential for conflict will most likely arise when the IEEE 1547-2018 functions are actually in place and operational, which gives the parties until about mid-2021 to work on more concrete language for the operating agreements.

V. TIMELINE

While IEEE 1547-2018 was published in April of 2018, there are a number of additional steps that need to be taken before it is possible to require equipment using these new functionalities to be installed. In particular, IEEE 1547.1, which will guide manufacturers as they test and certify their procedures to the new IEEE 1547-2018 standard, is expected to be published in the first quarter of 2020. After it is published, Underwriters Laboratories (UL) will then update its certification standard for inverters, known as UL 1741 (it is expected that this can happen within a few weeks of the publication of 1547.1). After that, it will likely take roughly 18 months, or until mid-2021, for products to be readily available on the market that are certified to comply with the updated requirements.

Since the draft TIIR is proposing to utilize various different functionalities of these newly-certified devices, and they are not yet available on the market, it is necessary for the Commission to clearly define what requirements will go into place immediately upon adoption, and which will only go into place when the appropriate UL 1741 certified equipment is available on the market. Unfortunately this issue was not fully appreciated until the tail end of the Workgroup process and the TIIR was drafted without an express vision for what would be applicable immediately and what would need to wait until the newly certified equipment

becomes available. The Workgroup discussed this issue at its final meeting and developed the following language in Section 1.6 of the draft TIIR:

> All requirements of the TIIR are immediately applicable unless requiring equipment that conforms with IEEE 1547-2018 advanced functionalities.
>
> Area EPS Operators cannot require the use of certified equipment that meets the requirements of IEEE 1547-2018 until such time the equipment is readily available. At such time certified equipment first becomes available, the Area EPS Operator and DER Owner may mutually agree to utilize the certified equipment and functionalities in conformance with the requirements of IEEE 1547-2018. At such time when certified equipment is readily available, the entire TIIR shall be applicable.

While this language provides some clarity, ultimately it is overly vague on two important points and we recommend that the Commission craft more explicit direction.

First, it is not clear that everyone is likely to agree on what constitutes "readily available" or that interconnection customers will know when that threshold has supposedly been crossed. While we hope that this will not be a point of controversy, we recommend the Commission be more explicit by defining a concrete date. In particular, we recommend "readily available" be replaced with "three months after the UL 1741 future effective date." The future effective date is likely to be 18 months after UL 1741 is adopted, and adding three months provides a buffer which allows a little room for error. We believe this should provide sufficient time for manufacturers and sales channels to make the products available and reduce confusion about old equipment.

The second issue is admittedly more difficult to resolve. It is not necessarily clear to interconnection customers, or even utilities, which sections of the TIIR require "equipment that conforms with IEEE 1547-2018 advanced functionalities." This short description in the TIIR is an imperfect way of establishing the requirements that apply in the interim, and may confuse the reader as to what requires conforming equipment. For example, does the voltage regulation provision of 0.98 power factor take effect since equipment can today be certified for that

operation (even if it is not tested per 1547.1's constant power factor mode test procedure)? Ideally the following sections would only become applicable three months after the UL 1741 future effective date: sections 4 (Performance Categories), 5 (Reactive Power Capability and Voltage/Power Control Performance), 6 (Response to Abnormal Conditions), 9 (Interoperability), 12 (Enter Service and Synchronization)[15] and 14 (Test and Verification Requirements).[16] However, if that approach is taken then the old Distributed Generation Interconnection Requirements would also not apply and there would be a gap in the Minnesota technical requirements for an extended period of time. At this point IREC and Fresh Energy do not have a clear recommendation for the Commission on how to resolve this issue. We are reaching out to parties to see if there is a clearer interim approach that could be developed and hope to be able to provide more detail in reply comments.

VI. CONCLUSION

IREC and Fresh Energy are proud to have been part of this first-ever effort to incorporate the new IEEE 1547-2018 standards into a state's technical requirements for interconnection. In order to ensure that the efforts of the Commission best serve the citizens of Minnesota and can act as a model for other states, we recommend the Commission adopt the TIIR as proposed, but consider the issues and changes recommended above to Section 1.6 regarding the timeline for implementation. In addition, we urge the Commission to recognize that while the TIIR is an admirable effort, it does not achieve the goal of establishing statewide technical requirements so long as the TSMs contain numerous important, and disparate, technical requirements. Therefore,

[15] The limits established in this section are different from IEEE Std 1547-2003 and could possibly be implemented, but may cause unnecessary confusion to do so.

[16] Many of the concepts included in this section could be put to use immediately, but IEEE Std 1547-2018 specific concepts and requirements may need to be singled out for exclusion until full implementation with certified equipment.

the Commission should establish a process to ensure that the content of the TSMs is brought within the TIIR, as appropriate, in the near future.

We also ask the Commission to pay particular attention to the inadequacies of the energy storage technical requirements and to remedy those in the near future so that energy storage growth is not stymied in the state. Finally, the Commission should ensure that customers are protected and get the clarity they need as the voltage regulation and communication requirements in the TIIR are implemented.

DATED: September 24, 2019

By: /s/ Sky Stanfield

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ATTACHMENT A

REVISION REQUEST FORM

For consideration in future revisions of the State of Minnesota Distributed Energy Resources Interconnection Process (MN DIP), Interconnection Agreement (MN DIA), and Technical Interconnection and Interoperability Requirements (TIIR)*

*All sections of the Revision Request Form must be filled out to be considered.

Submitted by: _____
Organization: _____
Phone: _____
Email: _____

Request to modify: □ MN DIP □ MN DIA □ TIIR
Page number: _____ Paragraph number: _____

Reason for Request:

Revision Urgency: □ Low □ Medium □ High

Explanation of Urgency:

Proposed Revision (exact text required):

Consensus from stakeholders is not required to submit this form, but stakeholder conversations are strongly encouraged. Please provide a summary of stakeholder involvement and dialogue:

ATTACHMENT B

Reporting on Volt-watt Issues

The following will be reported by the utility as required by the Minnesota PUC:
Worst-case customer Maximum Energy Loss from voltage complaint process with DER with volt-watt activated:

- Time in hours when system is curtailing
  - Will exclude no/low production hours (e.g. 3pm – 9am for PV since PV systems in the night will not curtail regardless of voltage)
- Sum of Maximum Energy Loss (kWh) over 1 year
- Average voltage when system is curtailing
- % of hours in Range A
- % of hours outside ANSI Range A

All customers from voltage complaint process with volt-watt activated:

- # of customers with Maximum Energy Loss ≤ 1% over 1 year
- # of customer in range: 1% < Maximum Energy loss ≤ 2% over 1 year
- # of customer with Maximum Energy loss >2% over 1 year
- % average of hours for all reporting customers in ANSI Range A

For customer-side issues:

- # customers reported (up to 20 per year to limit burden on the utility)
- # of customers with Maximum Energy Loss ≤ 1%
- # of customer with Maximum Energy Loss in range: 1% < Estimated Energy Loss ≤ 2%
- # of customer with Maximum Energy loss >2%

For all cases above, when a generating facility owner/operator provides loss information, the IOUs will compare the data provided with the Maximum Energy Loss estimation methodology and will report its results.

Maximum Energy Loss Metric

Without detailed irradiance and weather data, it is challenging to estimate potential power output of a PV system, and estimations for other DER would have specific challenges as well. An energy loss metric can show the maximum amount of possible energy loss, which assumes the PV or other DER would otherwise have been at full output power at the time the volt-watt function was triggered. This is useful to understand the possible impact of the function and whether or not the impact is "significant." From NREL's PowerPoint *Estimating Customer Impact of Volt-Watt Using Only Smart Meter Voltage Data:*
Expressing it in math:

$$E_{curtailed} = P_{PV} \times t_{AMI} \times \sum_{v_{AMI}} max\left(\frac{v_{AMI} - 1.06}{1.1 - 1.06}, 0\right)$$

$E_{curtailed}$ is the maximum possible curtailment due to volt-watt, in kWh, over the time period of interest
P_{PV} is the rated AC power of the PV system, in kW
t_{AMI} is the period of the AMI measurements, in hours (so for 15-minute readings, t_{AMI} is 0.25)
v_{AMI} is the set of AMI voltage readings for the time period between 9am and 3pm, in per unit (pu)

This method could be expanded to non-PV systems as needed.

Reporting Information for Voltage Complaint Process

In addition to the above methodology for reporting DER-customer issues, reports will be filed by the utilities on the voltage complaint process. These reports will contain the following information:

- # complaints (DER and non-DER)
- Was complaint from customer or 3rd party
- Duration to resolve (days between complaint call and resolution)
- Utility or customer issue
- Method for resolving issue
    - Utility action (identify: tap change, replace secondary, transformer upgrade, VR settings adjustment, change capacitor type or settings, transfer customer, ...)
    - Customer issue action (coordinate with developer or inverter manufacturer)
    - DER functional settings change
    - No action (insignificant issue)
    - Utility resolved issues caused by other DER
    - "Contingent systems[17]" – one of the above
    - "Contingent systems" – no action required
- Cost of resolution
    - Utility: Cost to perform work
    - Customer: customer provided information

[17] A "contingent system" is one where the DER operator accepted non-default regulation settings to avoid potential system upgrades identified in the interconnection process.

CERTIFICATE OF SERVICE

Docket No. E-999/CI-16-521 and E-999/CI-01-1023

I, the undersigned, state that I am a citizen of the United States and am employed in the City and County of San Francisco; that I am over the age of eighteen (18) years and not a party to the within cause; and that my business address is 396 Hayes Street, San Francisco, CA 94102.

On September 24, 2019, I served a true and correct copy of

INITIAL COMMENTS OF THE INTERSTATE RENEWABLE ENERGY COUNCIL AND FRESH ENERGY ON THE DISTRIBUTED ENERGY RESOURCE TECHNICAL INTERCONNECTION AND INTEROPERABILITY REQUIREMENTS

on the parties in this action as follows:

SEE ATTACHED SERVICE LIST

BY ELECTRONIC FILING: I caused a copy of the document(s) to be sent to the e-mail addresses of the persons designated as accepting electronic service on the Official Service List by using the eService feature of the eFiling application of the Minnesota Public Utilities Commission.

I declare under penalty of perjury under the laws of the State of California that the foregoing is true and correct.

Executed in San Francisco, California on September 24, 2019.

/s/ Jennifer Miao
Jennifer Miao

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Alan	Miller	N/A		2210 20th St NE Stewartville, MN 55976	Paper Service	No	OFF_SL_16-521_Official Service List PUC

First Name	Last Name	Email	Company Name	Address	Delivery Method	View Trade Secret	Service List Name
Darrick	Moe	darrick@mrea.org	Minnesota Rural Electric Association	11640 73rd Ave N Maple Grove, MN 55369	Electronic Service	No	OFF_SL_16-521_Official Service List PUC
David	Moeller	dmoeller@allete.com	Minnesota Power	30 W Superior St Duluth, MN 558022093	Electronic Service	No	OFF_SL_16-521_Official Service List PUC
Dalene	Monsebroten	dalene.monsebroten@nmpagency.com	Northern Municipal Power Agency	123 2nd St W Thief River Falls, MN 56701	Electronic Service	No	OFF_SL_16-521_Official Service List PUC
Andrew	Moratzka	andrew.moratzka@stoel.com	Stoel Rives LLP	33 South Sixth St Ste 4200 Minneapolis, MN 55402	Electronic Service	No	OFF_SL_16-521_Official Service List PUC
Michael	Murtaugh	mmurtaugh@fmcs.coop	Freeborn-Mower Cooperative Services	2501 Main Street East Albert Lea, MN 56007	Electronic Service	No	OFF_SL_16-521_Official Service List PUC
Ben	Nelson	benn@cmpasgroup.org	CMMPA	459 South Grove Street Blue Earth, MN 56013	Electronic Service	No	OFF_SL_16-521_Official Service List PUC
Tony	Nelson	tnelson@itasca-mantrap.com	Itasca-Mantrap Coop. Electric Assn.	PO Box 192 Park Rapids, MN 56470	Electronic Service	No	OFF_SL_16-521_Official Service List PUC
David	Niles	david.niles@avantenergy.com	Minnesota Municipal Power Agency	220 South Sixth Street Suite 1300 Minneapolis, Minnesota 55402	Electronic Service	No	OFF_SL_16-521_Official Service List PUC
Michael	Noble	noble@fresh-energy.org	Fresh Energy	Hamm Bldg., Suite 220 408 St. Peter Street St. Paul, MN 55102	Electronic Service	No	OFF_SL_16-521_Official Service List PUC
Rolf	Nordstrom	rnordstrom@gpisd.net	Great Plains Institute	2801 21ST AVE S STE 220 Minneapolis, MN 55407-1229	Electronic Service	No	OFF_SL_16-521_Official Service List PUC

First Name	Last Name	Email	Company Name	Address	Delivery Method	View Trade Secret	Service List Name
Samantha	Norris	samanthanorris@alliantenergy.com	Interstate Power and Light Company	200 1st Street SE PO Box 351 Cedar Rapids, IA 524060351	Electronic Service	No	OFF_SL_16-521_Official Service List PUC
Timothy	O'Leary	toleary@llec.coop	Lyon-Lincoln Electric Cooperative, Inc	P.O. Box 639 Tyler, MN 561780639	Electronic Service	No	OFF_SL_16-521_Official Service List PUC
Jeff	O'Neill	jeff.oneill@ci.monticello.mn.us	City of Monticello	505 Walnut Street Suite 1 Monticelllo, Minnesota 55362	Electronic Service	No	OFF_SL_16-521_Official Service List PUC
Wendi	Olson	wolson@otpco.com	Otter Tail Power Company	215 South Cascade Fergus Falls, MN 56537	Electronic Service	No	OFF_SL_16-521_Official Service List PUC
Russell	Olson	rolson@hcpd.com	Heartland Consumers Power District	PO Box 248 Madison, SD 570420248	Electronic Service	No	OFF_SL_16-521_Official Service List PUC
Bethany	Owen	bowen@mnpower.com	Minnesota Power	30 West Superior Street Duluth, MN 55802	Electronic Service	No	OFF_SL_16-521_Official Service List PUC
Dan	Patry	dpatry@sunedison.com	SunEdison	600 Clipper Drive Belmont, CA 94002	Electronic Service	No	OFF_SL_16-521_Official Service List PUC
Jeffrey C	Paulson	jeff.jcplaw@comcast.net	Paulson Law Office, Ltd.	4445 W 77th Street Suite 224 Edina, MN 55435	Electronic Service	No	OFF_SL_16-521_Official Service List PUC
Dean	Pawlowski	dpawlowski@otpco.com	Otter Tail Power Company	PO Box 496 215 S. Cascade St. Fergus Falls, MN 565370496	Electronic Service	No	OFF_SL_16-521_Official Service List PUC
Susan	Peirce	Susan.Peirce@state.mn.us	Department of Commerce	85 Seventh Place East St. Paul, MN 55101	Electronic Service	No	OFF_SL_16-521_Official Service List PUC

First Name	Last Name	Email	Company Name	Address	Delivery Method	View Trade Secret	Service List Name
Joyce	Peppin	joyce@mrea.org	Minnesota Rural Electric Association	11640 73rd Ave N Maple Grove, MN 55369	Electronic Service	No	OFF_SL_16-521_Official Service List PUC
Mary Beth	Peranteau	mperanteau@wheelerlaw.com	Wheeler Van Sickle & Anderson SC	44 E. Mifflin Street, 10th Floor Madison, WI 53703	Electronic Service	No	OFF_SL_16-521_Official Service List PUC
Jeff M	Peters	jeff.peters@mrenergy.com	Missouri River Energy Services	3724 W Avera Dr PO Box 88920 Sioux Falls, MN 57109-8920	Electronic Service	No	OFF_SL_16-521_Official Service List PUC
Donna	Pickard	dpickardgsss@gmail.com	Genie Solar Support Services	1215 Lilac Lane Excelsior, MN 55331	Electronic Service	No	OFF_SL_16-521_Official Service List PUC
David G.	Prazak	dprazak@otpco.com	Otter Tail Power Company	P.O. Box 496 215 South Cascade Street Fergus Falls, MN 565380496	Electronic Service	No	OFF_SL_16-521_Official Service List PUC
Gregory	Randa	granda@lakecountrypower.com	Lake Country Power	2810 Elida Drive Grand Rapids, MN 55744	Electronic Service	No	OFF_SL_16-521_Official Service List PUC
Mark	Rathbun	mrathbun@grenergy.com	Great River Energy	12300 Elm Creek Blvd Maple Grove, MN 55369	Electronic Service	No	OFF_SL_16-521_Official Service List PUC
Michael	Reinertson	michael.reinertson@avantenergy.com	Avant Energy	220 S. Sixth St. Ste 1300 Minneapolis, Minnesota 55402	Electronic Service	No	OFF_SL_16-521_Official Service List PUC
John C.	Reinhardt		Laura A. Reinhardt	3552 26Th Avenue South Minneapolis, MN 55406	Paper Service	No	OFF_SL_16-521_Official Service List PUC
Generic Notice	Residential Utilities Division	residential.utilities@ag.state.mn.us	Office of the Attorney General-RUD	1400 BRM Tower 445 Minnesota St St. Paul, MN 551012131	Electronic Service	Yes	OFF_SL_16-521_Official Service List PUC

First Name	Last Name	Email	Company Name	Address	Delivery Method	View Trade Secret	Service List Name
Kevin	Reuther	kreuther@mncenter.org	MN Center for Environmental Advocacy	26 E Exchange St, Ste 206 St. Paul, MN 551011667	Electronic Service	No	OFF_SL_16-521_Official Service List PUC
Darla	Ruschen	d.ruschen@bcrea.coop	Brown County Rural Electric Assn.	PO Box 529 24386 State Highway 4 Sleepy Eye, MN 56085	Electronic Service	No	OFF_SL_16-521_Official Service List PUC
Robert K.	Sahr	bsahr@eastriver.coop	East River Electric Power Cooperative	P.O. Box 227 Madison, SD 57042	Electronic Service	No	OFF_SL_16-521_Official Service List PUC
Richard	Savelkoul	rsavelkoul@martinsquires.com	Martin & Squires, P.A.	332 Minnesota Street Ste W2750 St. Paul, MN 55101	Electronic Service	No	OFF_SL_16-521_Official Service List PUC
Larry L.	Schedin	Larry@LLSResources.com	LLS Resources, LLC	332 Minnesota St, Ste W1390 St. Paul, MN 55101	Electronic Service	No	OFF_SL_16-521_Official Service List PUC
Kenric	Scheevel	Kenric.scheevel@dairylandpower.com	Dairyland Power Cooperative	3200 East Ave S PO Box 817 La Crosse, Wisconsin 54602	Electronic Service	No	OFF_SL_16-521_Official Service List PUC
Jacob J.	Schlesinger	jschlesinger@keyesfox.com	Keyes & Fox LLP	1580 Lincoln St Ste 880 Denver, CO 80203	Electronic Service	No	OFF_SL_16-521_Official Service List PUC
Jeff	Schoenecker	jschoenecker@dakotaelectric.com	Dakota Electric Association	4300 220th Street W Farmington, MN 55024	Electronic Service	No	OFF_SL_16-521_Official Service List PUC
Christopher	Schoenherr	cp.schoenherr@smmpa.org	SMMPA	500 First Ave SW Rochester, MN 55902-3303	Electronic Service	No	OFF_SL_16-521_Official Service List PUC

First Name	Last Name	Email	Company Name	Address	Delivery Method	View Trade Secret	Service List Name
Kay	Schraeder	kschraeder@minnkota.com	Minnkota Power	5301 32nd Ave S Grand Forks, ND 58201	Electronic Service	No	OFF_SL_16-521_Official Service List PUC
Ronald J.	Schwartau	rschwartau@noblesce.com	Nobles Cooperative Electric	22636 U.S. Hwy. 59 Worthington, MN 56187	Electronic Service	No	OFF_SL_16-521_Official Service List PUC
Rob	Scott Hovland	rob.scott-hovland@mrenergy.com	Missouri River Energy Services	3724 W Avera Dr PO Box 88920 Sioux Falls, SD 571098920	Electronic Service	No	OFF_SL_16-521_Official Service List PUC
Dean	Sedgwick	Sedgwick@Itascapower.com	Itasca Power Company	PO Box 455 Spring Lake, MN 56680	Electronic Service	No	OFF_SL_16-521_Official Service List PUC
David	Shaffer	shaff081@gmail.com	Minnesota Solar Energy Industries Project	1005 Fairmount Ave Saint Paul, MN 55105	Electronic Service	No	OFF_SL_16-521_Official Service List PUC
Doug	Shoemaker	dougs@charter.net	Minnesota Renewable Energy	2928 5th Ave S Minneapolis, MN 55408	Electronic Service	No	OFF_SL_16-521_Official Service List PUC
Felicia	Skaggs	fskaggs@meeker.coop	Meeker Cooperative Light & Power	1725 US Highway 12 E Suite 100 Litchfield, MN 55355	Electronic Service	No	OFF_SL_16-521_Official Service List PUC
Glen	Skarbakka	glen@s-pllc.com	Skarbakka PLLC	5411 Bartlett Blvd Mound, MN 55364	Electronic Service	No	OFF_SL_16-521_Official Service List PUC
Trevor	Smith	trevor.smith@avantenergy.com	Avant Energy, Inc.	220 South Sixth Street Suite 1300 Minneapolis, Minnesota 55402	Electronic Service	No	OFF_SL_16-521_Official Service List PUC
Rafi	Sohail	rafi.sohail@centerpointenergy.com	CenterPoint Energy	800 LaSalle Avenue P.O. Box 59038 Minneapolis, MN 554590038	Electronic Service	No	OFF_SL_16-521_Official Service List PUC

First Name	Last Name	Email	Company Name	Address	Delivery Method	View Trade Secret	Service List Name
Beth H.	Soholt	bsoholt@windonthewires.org	Wind on the Wires	570 Asbury Street Suite 201 St. Paul, MN 55104	Electronic Service	No	OFF_SL_16-521_Official Service List PUC
Marcia	Solie	m.solie@bcrea.coop	Brown County Rural Electric Assn.	24386 State Hwy. 4, PO Box 529 Sleepy Eye, Minnesota 56085	Electronic Service	No	OFF_SL_16-521_Official Service List PUC
Robyn	Sonstegard	robynnsec@wiktel.com	North Star Electric Cooperative, Inc.	PO Box 719 441 State Hwy 172 NW Baudette, MN 56623	Electronic Service	No	OFF_SL_16-521_Official Service List PUC
Sky	Stanfield	stanfield@smwlaw.com	Shute, Mihaly & Weinberger	396 Hayes Street San Francisco, CA 94102	Electronic Service	No	OFF_SL_16-521_Official Service List PUC
Mike	Steckelberg	msteckelberg@grenergy.com	Great River Energy	12300 Elm Creek Boulevard Maple Grove, MN 553694718	Electronic Service	No	OFF_SL_16-521_Official Service List PUC
Sherry	Swanson	sswanson@noblesce.com	Nobles Cooperative Electric	22636 US Highway 59 PO Box 788 Worthington, MN 56187	Electronic Service	No	OFF_SL_16-521_Official Service List PUC
Eric	Swanson	eswanson@winthrop.com	Winthrop & Weinstine	225 S 6th St Ste 3500 Capella Tower Minneapolis, MN 554024629	Electronic Service	No	OFF_SL_16-521_Official Service List PUC
Thomas P.	Sweeney III	tom.sweeney@easycleanenergy.com	Clean Energy Collective	P O Box 1828 Boulder, CO 80306-1828	Electronic Service	No	OFF_SL_16-521_Official Service List PUC
Lynnette	Sweet	Regulatory.records@xcelenergy.com	Xcel Energy	414 Nicollet Mall FL 7 Minneapolis, MN 554011993	Electronic Service	No	OFF_SL_16-521_Official Service List PUC

First Name	Last Name	Email	Company Name	Address	Delivery Method	View Trade Secret	Service List Name
Bryant	Tauer	btauer@whe.org	Wright-Hennepin	6800 Electric Dr Rockford, MN 55373	Electronic Service	No	OFF_SL_16-521_Official Service List PUC
Pat	Treseler	pat.jcplaw@comcast.net	Paulson Law Office LTD	4445 W 77th Street Suite 224 Edina, MN 55435	Electronic Service	No	OFF_SL_16-521_Official Service List PUC
Jeff	Triplett	triplettj@powersystem.org	MREA	10710 Town Square Dr NW St 201 Minneapolis, MN 55449	Electronic Service	No	OFF_SL_16-521_Official Service List PUC
Adam	Tromblay	atromblay@noblesce.com	Nobles Cooperative Electric	22636 US Hwy. 59 P.O. Box 788 Worthington, MN 56187-0788	Electronic Service	No	OFF_SL_16-521_Official Service List PUC
Lise	Trudeau	lise.trudeau@state.mn.us	Department of Commerce	85 7th Place East Suite 500 Saint Paul, MN 55101	Electronic Service	No	OFF_SL_16-521_Official Service List PUC
Craig	Turner	cturner@dakotaelectric.com	Dakota Electric Association	4300 - 220th Street West Farmington, MN 550249583	Electronic Service	No	OFF_SL_16-521_Official Service List PUC
Alan	Urban	alan.m.urban@xcelenergy.com	Xcel Energy	N/A	Electronic Service	No	OFF_SL_16-521_Official Service List PUC
Sam	Villella	sdvillella@gmail.com		10534 Alamo Street NE Blaine, MN 55449	Electronic Service	No	OFF_SL_16-521_Official Service List PUC
Sarah	Walinga	swalinga@solarcity.com	Energy Freedom Coalition	3055 Clearview Way San Mateo, MN 94402	Electronic Service	No	OFF_SL_16-521_Official Service List PUC
Robert	Walsh	bwalsh@mnvalleyrec.com	Minnesota Valley Coop Light and Power	PO Box 248 501 S 1st St Montevideo, MN 56265	Electronic Service	No	OFF_SL_16-521_Official Service List PUC

First Name	Last Name	Email	Company Name	Address	Delivery Method	View Trade Secret	Service List Name
Roger	Warehime	warehimer@owatonnautilities.com	Owatonna Public Utilities	208 South WalnutPO Box 800 Owatonna, MN 55060	Electronic Service	No	OFF_SL_16-521_Official Service List PUC
Jenna	Warmuth	jwarmuth@mnpower.com	Minnesota Power	30 W Superior St Duluth, MN 55802-2093	Electronic Service	No	OFF_SL_16-521_Official Service List PUC
Elizabeth	Wefel	eawefel@flaherty-hood.com	Flaherty & Hood, P.A.	525 Park St Ste 470 Saint Paul, MN 55103	Electronic Service	No	OFF_SL_16-521_Official Service List PUC
John	Williamson	John.Williamson@state.mn.us	Minnesota Department of Labor and Industry	443 Lafayette Rd N St. Paul, MN 55155-4341	Electronic Service	No	OFF_SL_16-521_Official Service List PUC
Danielle	Winner	danielle.winner@state.mn.us	Department of Commerce	85 7th Place East Suite 500 Saint Paul, MN 55101	Electronic Service	No	OFF_SL_16-521_Official Service List PUC
Robyn	Woeste	robynwoeste@alliantenergy.com	Interstate Power and Light Company	200 First St SE Cedar Rapids, IA 52401	Electronic Service	No	OFF_SL_16-521_Official Service List PUC
Terry	Wolf	terry.wolf@mrenergy.com	Missouri River Energy Services	3724 W Avera Dr PO Box Sioux Falls, SD 571098920	Electronic Service	No	OFF_SL_16-521_Official Service List PUC
Daniel P	Wolf	dan.wolf@state.mn.us	Public Utilities Commission	121 7th Place East Suite 350 St. Paul, MN 551012147	Electronic Service	Yes	OFF_SL_16-521_Official Service List PUC
Thomas J.	Zaremba	TZaremba@wheelerlaw.com	WHEELER, VAN SICKLE & ANDERSON	44 E. Mifflin Street, 10th Floor Madison, WI 53703	Electronic Service	No	OFF_SL_16-521_Official Service List PUC

First Name	Last Name	Email	Company Name	Address	Delivery Method	View Trade Secret	Service List Name
Christopher	Anderson	canderson@allete.com	Minnesota Power	30 W Superior St Duluth, MN 558022191	Electronic Service	No	OFF_SL_1-1023_1
Janet	Anderson	jainstp@q.com	-	1799 Sargent St. Paul, MN 55105	Electronic Service	No	OFF_SL_1-1023_1
John	Bailey	bailey@ilsr.org	Institute For Local Self-Reliance	1313 5th St SE Ste 303 Minneapolis, MN 55414	Electronic Service	No	OFF_SL_1-1023_1
Peter	Beithon	pbeithon@otpco.com	Otter Tail Power Company	P.O. Box 496 215 South Cascade Street Fergus Falls, MN 565380496	Electronic Service	No	OFF_SL_1-1023_1
Jon	Brekke	jbrekke@grenergy.com	Great River Energy	12300 Elm Creek Boulevard Maple Grove, MN 553694718	Electronic Service	No	OFF_SL_1-1023_1
Generic Notice	Commerce Attorneys	commerce.attorneys@ag.state.mn.us	Office of the Attorney General-DOC	445 Minnesota Street Suite 1800 St. Paul, MN 55101	Electronic Service	No	OFF_SL_1-1023_1
George	Crocker	gwillc@nawo.org	North American Water Office	PO Box 174 Lake Elmo, MN 55042	Electronic Service	No	OFF_SL_1-1023_1
Lisa	Daniels	lisadaniels@windustry.org	Windustry	201 Ridgewood Ave Minneapolis, MN 55403	Electronic Service	No	OFF_SL_1-1023_1
Steve	Downer	sdowner@mmua.org	MMUA	3025 Harbor Ln N Ste 400 Plymouth, MN 554475142	Electronic Service	No	OFF_SL_1-1023_1
Renee	Doyle		Doyle Electric Inc.	PO Box 295 Amboy, MN 56010	Paper Service	No	OFF_SL_1-1023_1

First Name	Last Name	Email	Company Name	Address	Delivery Method	View Trade Secret	Service List Name
R. Neal	Elliot		American Council for an Energy-Efficient Economy	529 14th Street, NW, Suite 600 Washington, DC 20045	Paper Service	No	OFF_SL_1-1023_1
Sharon	Ferguson	sharon.ferguson@state.mn.us	Department of Commerce	85 7th Place E Ste 280 Saint Paul, MN 551012198	Electronic Service	Yes	OFF_SL_1-1023_1
Tony	Hainault	anthony.hainault@co.hennepin.mn.us	Hennepin County DES	701 4th Ave S Ste 700 Minneapolis, MN 55415-1842	Electronic Service	No	OFF_SL_1-1023_1
John S.	Jaffray	jjaffray@jjrpower.com	JJR Power	350 Highway 7 Suite 236 Excelsior, MN 55331	Electronic Service	No	OFF_SL_1-1023_1
Steve	Korstad	swkorstad@comcast.net	Korridor Capital LLC	20 Red Fox Road St. Paul, MN 551276331	Electronic Service	No	OFF_SL_1-1023_1
Michael	Krikava	mkrikava@briggs.com	Briggs And Morgan, P.A.	2200 IDS Center 80 S 8th St Minneapolis, MN 55402	Electronic Service	No	OFF_SL_1-1023_1
Douglas	Larson	dlarson@dakotaelectric.com	Dakota Electric Association	4300 220th St W Farmington, MN 55024	Electronic Service	No	OFF_SL_1-1023_1
Michael	Loeffler	mike.loeffler@nngco.com	Northern Natural Gas Co.	CORP HQ, 714 1111 So. 103rd Street Omaha, NE 681241000	Electronic Service	No	OFF_SL_1-1023_1
Richard	Macke	macker@powersystem.org	Power System Engineering, Inc.	10710 Town Square Dr NE Ste 201 Minneapolis, MN 55449	Electronic Service	No	OFF_SL_1-1023_1

First Name	Last Name	Email	Company Name	Address	Delivery Method	View Trade Secret	Service List Name
Pam	Marshall	pam@energycents.org	Energy CENTS Coalition	823 7th St E St. Paul, MN 55106	Electronic Service	No	OFF_SL_1-1023_1
Michael	Noble	noble@fresh-energy.org	Fresh Energy	Hamm Bldg., Suite 220 408 St. Peter Street St. Paul, MN 55102	Electronic Service	No	OFF_SL_1-1023_1
Bethany	Owen	bowen@mnpower.com	Minnesota Power	30 West Superior Street Duluth, MN 55802	Electronic Service	No	OFF_SL_1-1023_1
David G.	Prazak	dprazak@otpco.com	Otter Tail Power Company	P.O. Box 496 215 South Cascade Street Fergus Falls, MN 565380496	Electronic Service	No	OFF_SL_1-1023_1
Generic Notice	Residential Utilities Division	residential.utilities@ag.state.mn.us	Office of the Attorney General-RUD	1400 BRM Tower 445 Minnesota St St. Paul, MN 551012131	Electronic Service	No	OFF_SL_1-1023_1
Richard	Savelkoul	rsavelkoul@martinsquires.com	Martin & Squires, P.A.	332 Minnesota Street Ste W2750 St. Paul, MN 55101	Electronic Service	No	OFF_SL_1-1023_1
Larry L.	Schedin	Larry@LLSResources.com	LLS Resources, LLC	332 Minnesota St, Ste W1390 St. Paul, MN 55101	Electronic Service	No	OFF_SL_1-1023_1
Rafi	Sohail	rafi.sohail@centerpointenergy.com	CenterPoint Energy	800 LaSalle Avenue P.O. Box 59038 Minneapolis, MN 554590038	Electronic Service	No	OFF_SL_1-1023_1
Lynnette	Sweet	Regulatory.records@xcelenergy.com	Xcel Energy	414 Nicollet Mall FL 7 Minneapolis, MN 554011993	Electronic Service	No	OFF_SL_1-1023_1

First Name	Last Name	Email	Company Name	Address	Delivery Method	View Trade Secret	Service List Name
Craig	Turner	cturner@dakotaelectric.com	Dakota Electric Association	4300 - 220th Street West Farmington, MN 550249583	Electronic Service	No	OFF_SL_1-1023_1
Robyn	Woeste	robynwoeste@alliantenergy.com	Interstate Power and Light Company	200 First St SE Cedar Rapids, IA 52401	Electronic Service	No	OFF_SL_1-1023_1
Daniel P	Wolf	dan.wolf@state.mn.us	Public Utilities Commission	121 7th Place East Suite 350 St. Paul, MN 551012147	Electronic Service	Yes	OFF_SL_1-1023_1