STATE OF MINNESOTA
BEFORE THE
PUBLIC UTILITIES COMMISSION

Nancy Lange	Chair
Dan Lipschultz	Commissioner
Matthew Schuerger	Commissioner
Katie Sieben	Commissioner
John Tuma	Commissioner

In the Matter of the Submittal of Northern State Power Company, doing business as Xcel Energy, of the 2017 Distribution System/Hosting Capacity Study	Docket No. E002/M-17-777

COMMENTS OF THE INTERSTATE RENEWABLE ENERGY COUNCIL, INC. ON XCEL'S 2017 DISTRIBUTION SYSTEM HOSTING CAPACITY REPORT

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I. INTRODUCTION

On November 1, 2017, Xcel Energy filed its Hosting Capacity Report in compliance with Minn. Stat. § 216B.2425 subd. 8 and the Commission's August 1, 2017 Order in Docket No. E002/M-15-962. On November 15, 2017, the Commission issued a Notice of Comment Period on Xcel's 2017 Distribution System Hosting Capacity Report. Accordingly, the Interstate Renewable Energy Council, Inc. (IREC) files these comments.

IREC is a 501(c)(3) non-partisan, non-profit organization working nationally to increase consumer access to sustainable energy and energy efficiency through independent fact-based policy leadership, quality workforce development, and consumer empowerment. In service of our mission, IREC works to increase the adoption of policies and regulatory reforms that expand access to and streamline grid integration of distributed energy resources (DER) to optimize their

widespread benefits. The scope of our work includes: developing and advancing regulatory policy innovations; generating and promoting national model rules, standards, and best practices; fostering collaborative partnerships with diverse stakeholders to build to consensus and achieve workable solutions; updating interconnection processes to facilitate deployment of DERs and remove constraints to their integration on the grid; and incorporating DER growth into utility distribution system planning and operations.

Through our work to support effective grid modernization throughout the United States—including in California and New York—IREC has emphasized hosting capacity as a key tool to harness DER benefits while helping to solve the challenges of interconnecting DERs in increasing quantities. In December 2017, IREC released a new report, *Optimizing the Grid: A Regulator's Guide to Hosting Capacity Analyses for Distributed Energy Resources*, which helps guide state regulators as they oversee utilities developing hosting capacity analyses to guide the integration of DERs on their distribution systems.[1] In Minnesota, IREC provided comments on Xcel's initial Hosting Capacity Report in Docket No. E002/M-15-962. IREC has also provided comments and been an active participant in Docket No. E999/CI-15-556, the Commission's investigation into grid modernization, where the Commission is exploring integrated distribution system planning, of which hosting capacity is a core component. Likewise, IREC is deeply engaged in the Commission's interconnection reform proceeding, Docket No. E-999/CI-16-521. IREC welcomes this opportunity to provide comments on Xcel's next iteration of its Hosting Capacity Report and associated hosting capacity map.

[1] Sky Stanfield & Stephanie Safdi, *Optimizing the Grid: A Regulator's Guide to Hosting Capacity Analyses for Distributed Energy* Resources, Interstate Renewable Energy Council, Inc. (Dec. 2017), available at https://irecusa.org/2017/12/tools-to-build-the-modern-grid ("*Optimizing the Grid*").

II. COMMENTS

IREC appreciates Xcel's efforts to continue to improve its hosting capacity analysis and believes this second iteration reflects many steps in the right direction. Xcel correctly recognizes that hosting capacity is a "key element in the future of distribution system planning," and IREC agrees with Xcel that hosting capacity "will have the potential to further enable Distributed Energy Resources (DER) integration by guiding future installations and identifying areas of constraint."[2] IREC further emphasizes that, in addition to guiding DERs to optimal grid locations—for example, via a map—hosting capacity analysis has the potential to streamline the interconnection process and to play a core role within utility distribution planning, including facilitating the use of DERs as non-wires alternatives. As Xcel acknowledges, the Commission and its consultant, ICF, have highlighted all of these goals as important hosting capacity use cases.[3] Although Xcel recognizes all of these goals in its latest report to some extent, it is not yet clear how Xcel will use its hosting capacity analysis to achieve them or that its chosen methodology is ultimately capable of doing so. Rather, Xcel seems focused at this time on using hosting capacity to "guide interconnections," via the published map and data set, and does not explain how it plans to use the analysis to inform planning or to streamline interconnection.[4]

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[2] Xcel Energy, Distribution System/Hosting Capacity Study, Docket No. E002-M-17-777, at 1 (Nov. 1, 2017) ("Xcel Hosting Capacity Report").

[3] *Id.* at 4-5; *see also, e.g.*, ICF International, *Integrated Distribution Planning*, at 8 (Aug. 2016) ("ICF Int'l Report"); Minn. Pub. Utils. Comm'n, Order Setting Additional Requirements for Xcel's 2017 Hosting Capacity Report, Dkt. E-002/M-15-962, at 5-6 (Aug. 1, 2017) ("Order Setting Additional Requirements") (ordering that the purpose of Xcel's hosting capacity report is "1) to inform and facilitate interconnection processes over time; and 2) to inform and facilitate distribution planning.").

[4] *See, e.g.*, Xcel Hosting Capacity Report at 8 ("The intent of this analysis is to guide interconnections while also informing the planning of the system. Combining this analysis with detailed interconnection is the most efficient way to bring DER onto the distribution system.").

Moreover, it is not yet clear that the map results, updated annually, are sufficiently accurate or updated frequently enough to provide meaningful guidance regarding interconnection locations.

IREC recognizes that Xcel's development of its hosting capacity analysis is an iterative and ongoing process, and appreciates Xcel's acknowledgment that "more work still needs to take place."[5] Nonetheless, it is essential that Xcel demonstrate in practical and concrete terms that its ongoing work and evolution of its analysis are moving it towards achievement of the ultimate interconnection and planning goals. Otherwise, IREC remains concerned that Xcel's investment in its current methodology may not ultimately provide the expected benefits to ratepayers, namely through improved interconnection and system planning, and ultimately the optimization of DERs on the grid.

As detailed in the following comments, IREC continues to have fundamental concerns with the transparency and accuracy of Xcel's hosting capacity methodology, the Electric Power Research Institute's (EPRI) DRIVE tool. IREC also questions Xcel's choice to update its results only annually and suggests that Xcel could improve the usefulness of its data files and map while also working toward deploying the tool to meet additional hosting capacity use cases, such as distribution system planning and interconnection streamlining. IREC finally raises several specific questions regarding technical elements and assumptions used in Xcel's Hosting Capacity Report.

Summary of Recommendations

Throughout our comments, IREC provides suggestions regarding ways to improve the usefulness of Xcel's hosting capacity analysis going forward. These suggestions include:

[5] *Id.* at 4.

- Conducting a more rigorous evaluation of hosting capacity results by comparing them to actual hosting capacity values derived from a power-flow based analysis on representative circuits.

- Holding workshop(s) or setting up a working group led by Commission staff or a third-party facilitator with Commission oversight to explore the full range of use cases for hosting capacity (including distribution system planning and interconnection streamlining) and methodological needs. This effort could also address more explicitly and concretely whether, how, and when Xcel's hosting capacity analysis could be used to streamline interconnection review and improve proactive distribution system planning.

- Considering exploration of alternative methodologies to meet the state's goals for hosting capacity, such as a methodology similar to the iterative approach selected by the California Public Utilities Commission for interconnection streamlining.

- Updating the hosting capacity results and map more frequently—ideally on a monthly basis, to start—or creating a phased approach through which Xcel will gradually move toward more real-time updating of the results.

- Providing additional details in Xcel's hosting capacity results, specifically maximum and minimum load data.

- Providing additional details on Xcel's hosting capacity map, including in particular pop-up windows that show the actual hosting capacity and other relevant data for feeders.

- Incorporating mitigations into Xcel's hosting capacity analysis as they become standardized.

- Providing further technical information on and refinements to assumptions in the methodology, including:

    - Explaining whether the DRIVE tool can be modified to analyze the actual mix of resources on Xcel's system rather than forcing a choice between, e.g., large centralized and small distributed resources;

    - Broadening the definition of DERs beyond generation and modifying the analysis to account for the load characteristics of resources, including in particular energy storage;

    - Evaluating feeders for which the analysis showed zero hosting capacity to determine whether these results stemmed from inaccuracies or limitations in the methodology;

- Explaining how and when load curves based on actual customer data will be incorporated into the analysis; and
- Evaluating DRIVE's ability to incorporate potential mitigations like a volt-var response.

A. The Accuracy and Transparency of Xcel's Hosting Capacity Methodology Remain Concerns and Require Further Evaluation.

1. Transparency Concerns

As emphasized in IREC's comments on Xcel's 2016 Hosting Capacity Report, transparency and accuracy are especially important characteristics of a hosting capacity analysis.[6] Transparency is necessary to allow the Commission and other stakeholders to understand, provide informed commentary on, and validate the details of the methodology, which in turn is essential to evaluating whether the chosen approach will return sufficiently accurate results to meet the underlying goals for hosting capacity. While it may vary depending on the use case, some degree of accuracy is necessary to make the hosting capacity analysis valuable in practice. Xcel acknowledges the importance of transparency and accuracy and takes steps to address these traits in its latest report,[7] but IREC remains concerned with respect to both.

IREC appreciates that Xcel's 2017 Hosting Capacity Report provides important details regarding its assumptions and approach. While this additional transparency is helpful in assessing Xcel's report, the lack of any comprehensive, publicly available information regarding

[6] *See* Comments of Interstate Renewable Energy Council Regarding Xcel Energy's Hosting Capacity Analysis and Supplemental Comments, Dkt. E002/M-15-962, at 14-15, 16-19 (April 20, 2017) ("IREC Comments, 15-962"); *see also Optimizing the Grid* at 6, 21, 29 (explaining the importance of transparency in hosting capacity methodology and assumptions to ensure accuracy and reliability); *id.* at 3 (explaining that accurate hosting capacity results are "needed to guide distribution-level decision-making" and to "inform the interconnection process.").

[7] Xcel Hosting Capacity Report at 17-20 (accuracy analysis).

EPRI's DRIVE tool continues to make it challenging to assess its details and application.[8] Although Xcel states that EPRI's methodology is "proven,"[9] IREC is not aware of any detailed, public information available about DRIVE, beyond what Xcel has been required to provide in this proceeding, or of comparisons of its results against those produced by other hosting capacity methodologies. IREC recognizes that other utilities are also relying on DRIVE and that there are some benefits associated with national consistency.[10] Nonetheless, this lack of transparency remains a critical issue because the Commission and stakeholders still do not have a complete picture of the underlying methodology, its assumptions, and its accuracy, and thus are challenged in assessing its application to the various use cases.

2. Accuracy Concerns and Suggestions for More Rigorous Evaluation of Hosting Capacity Results

Accuracy likewise remains a concern. IREC appreciates the Commission's recognition of its importance in requiring Xcel to assess the accuracy of its hosting capacity analysis.[11] While Xcel's initial assessment provides some interesting data points, IREC suggests that additional analysis is necessary, especially in light of the lack of transparency surrounding the underlying tool. Xcel notes that its approach to assessing accuracy—comparing hosting capacity results to interconnection study results—poses some problems, including in particular that most past interconnection studies did not necessarily calculate hosting capacity, but rather showed where violations occurred and upgrades are needed to interconnect a particular project.[12] Moreover,

[8] IREC understands that EPRI plans to release a report or reports, with details regarding the DRIVE tool and its methodology and assumptions. To IREC's knowledge, no such report is available yet. IREC looks forward to reviewing any DRIVE documentation that EPRI publishes.

[9] Xcel Hosting Capacity Report at 8.

[10] *See id.*.

[11] Order Setting Additional Requirements at 6.

[12] Xcel Hosting Capacity Report at 17-18.

because Xcel only had a limited number of interconnection studies that provided it with hosting capacity data, it ultimately compared results for only fifteen feeders for its accuracy analysis.[13] It is challenging to draw conclusions about the accuracy of Xcel's methodology from this small sample.

IREC agrees it could be helpful to calculate hosting capacity as part of the interconnection study process going forward, in order to facilitate more of these case-by-case accuracy comparisons.[14] However, because Xcel appears to be comparing the hosting capacity results for a specific project, the usefulness of this approach is necessarily limited. Moreover, relying on interconnection screens and studies seems likely to generate biased results, in that projects may be similar in nature (e.g., community solar gardens) and located in similar areas, and thus the circuits evaluated may be similar to each other, rather than a representative sample of Xcel's system.

Therefore, IREC further suggests that additional analysis beyond comparison with interconnection results may be required in order to get a clearer picture of the accuracy of Xcel's results. IREC requests that Xcel and the Commission consider a more comprehensive analysis that looks globally at Xcel's system and identifies representative circuits to test. Xcel could then run a power-flow based analysis to determine the actual hosting capacity of those circuits and compare those results to its DRIVE-based hosting capacity results. The California Commission recently ordered that State's three major investor-owned utilities to undertake precisely this sort of comparison to guide that Commission's selection of the hosting capacity methodology best

[13] *Id.* at 18-19.

[14] *See id.* at 17-18 (explaining that Xcel is "working to implement a standard interconnection study form that consultants fill that indicates the max capacity . . . going forward").

suited to the State's interconnection and distribution planning use cases.[15] Each utility analyzed representative portions of their distribution grid, as well as a single test circuit, using both a streamlined method (similar to EPRI's DRIVE tool)[16] and an iterative method,[17] which uses power flow simulations to identify a circuit's actual hosting capacity limitations.[18] The results showed the precise ways in which the streamlined method was inaccurate, as the extent of the deviation between the results depended, for instance, on the characteristics of the feeder and the type of power system limitation.[19] IREC suggests that undertaking a similar analysis in Minnesota would provide a more balanced picture than relying on interconnection studies as the comparator. IREC also suggests that the Commission or Xcel consider contracting with an independent third-party to undertake such an analysis.

Setting aside these issues with the analytical approach, the limited accuracy results that Xcel does provide raise initial concerns, which Xcel does not adequately address. IREC

[15] Cal. Pub. Utils. Comm'n, R. 14-08-013, Assigned Commissioner's Ruling (1) Refining Integration Capacity and Locational Net Benefits Analysis Methodologies and Requirements; and (2) Authorizing Demonstration Projects A and B (May 2, 2016).

[16] EPRI characterizes the DRIVE tool as a version of a streamlined method. *See* Smith, Jeff and Matthew Rylander, PhD, *Overview of Hosting Capacity Methods: Detailed and Streamlined Methods*, Electric Power Research Institute, presented to the California Integration Capacity Analysis Workgroup, slides 9-10 (June 9, 2016), http://drpwg.org/wp-content/uploads/2016/06/EPRI_Hosting-Capacity-Methods_Smith.pdf.

[17] *See Optimizing the Grid* at 19 (explaining that the "iterative method directly models DERs on the distribution grid to identify hosting capacity limitations" by running power flow simulations iteratively at each node until a power system limitation is violated).

[18] *Id.* at 32-35 (reviewing the demonstration project and results).

[19] *Id.* at 33; *see also, e.g.,* Southern California Edison. R. 14-08-013, Southern California Edison Company's (U 338-E) Update Demonstration Projects A and B Final Reports, at 45, 47, 80 (Jan. 4, 2017) (explaining that the results were particularly far apart for steady state voltage and protection criterion, for nodes close to the substation, and for complex feeders, such as those with high numbers of voltage regulation devices).

disagrees with Xcel that DRIVE's results have been "proven to be reasonably accurate,"[20] either by Xcel's assessment or elsewhere. In the two instances where Xcel's hosting capacity results were shown to be excessively conservative (or "unfavorable," as Xcel characterizes them), the deviations (300 kW and 700 kW) were significant, especially considered in light of the size of an average residential solar system (10 kW or less). It is not clear why these relatively significant discrepancies exist, and it would be especially interesting to know if the discrepancies are due to a particular assumption or other methodological parameter that could be adjusted in the future. It is also not evident how large the error actually is, given that only the proposed installation size was evaluated, which seems to be a limitation to conducting the analysis in this manner.

In addition, Xcel's analysis does not provide information on the extent of the deviation in cases where the hosting capacity results were "favorable." Such accuracy information is important, since deviations of the DRIVE-based results in either direction (more or less conservative) reveal accuracy issues and limit the usefulness of the hosting capacity analysis, especially in applications beyond the map use case. Going forward, IREC suggests that the Commission require it to identify deviations of any kind from actual hosting capacity, so that parties may understand their frequency and magnitude. To the extent this is a limitation of the approach Xcel has taken to date (comparing to existing interconnection screening and study results), a more comprehensive analytical approach, as suggested above, may be required.

3. Alternative Hosting Capacity Methodologies, Such as an Iterative Approach, to Meet Identified Use Cases

Undertaking a more robust assessment of Xcel's hosting capacity analysis should also help it determine whether and how it may need to modify its approach to address any issues. IREC would be pleased if the DRIVE tool, in which Xcel has already invested considerable time

[20] Xcel Hosting Capacity Report at 8.

and resources, were able to achieve all identified hosting capacity use cases, including interconnection streamlining and improved planning. If Xcel is unable to demonstrate that this is the case, however, IREC encourages the Commission to consider implementation of other, more accurate methodologies. IREC notes that Xcel recognizes that an additional tool may be needed for the interconnection streamlining use case.[21]

For example, in our prior comments, IREC noted that, in California, the "iterative approach" to hosting capacity was shown to be more accurate than a streamlined approach (again, similar to the DRIVE tool), and has therefore adopted been adopted by that State's Commission and utilities for the identified interconnection use cases. While Xcel is correct that the iterative approach is more computationally intensive and time-consuming to run relative to a streamlined approach like DRIVE, Xcel exaggerates the extent of this efficiency gap. Run times, for instance, depend not just on the methodology but also on hardware and software choices. The San Diego Gas and Electric (SDG&E) data that Xcel provides reflects the fact that "[the] streamlined simulation was performed on a server based computer, while the iterative was performed on office laptop computers."[22] By contrast, Pacific Gas & Electric was able to reduce run times by using a combination of local machines and servers, and the use of cloud computing could decrease run times even further.[23] The California utilities were also able to reduce run times without compromising accuracy by strategically reducing the number of hours and nodes analyzed.[24] Additional efficiencies are likely possible and are being explored in California.

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[21] *Id.* at 9.

[22] San Diego Gas & Electric Co., R. 14-08-013, Demonstration Projects A & B Final Reports of San Diego Gas & Electric Company (U 902-E), Demonstration A—Enhanced Integration Capacity Analysis, p. 43 (Dec. 22, 2016) ("SDG&E Report").

[23] Optimizing the Grid at 33.

[24] *Id.*

Furthermore, even though the iterative approach is more computational intensive, SDG&E nonetheless supported using it for the interconnection use case.[25]

Since the Commission has also acknowledged interconnection streamlining as a goal of hosting capacity analysis, IREC believes that the accuracy issue, and California's determination regarding iterative versus streamlined methodologies, remain important topics for the Commission to address. IREC notes that the iterative methodology is one alternative to the DRIVE tool, which has received detailed review in California, but there are others offered by other companies as well as methods developed by other utilities, all of which may also warrant attention. IREC suggests that a workshop(s) or working group led by Commission staff or a neutral, third-party facilitator with Staff oversight may present an appropriate vehicle for exploring the interconnection streamlining use case and methodological needs further, to inform further exploration of alternative methodologies as needed.[26]

B. Xcel's Hosting Capacity Analysis Should Be Updated More Frequently to Make It More Useful.

Currently it appears that Xcel updates its hosting capacity results on an annual basis, when it files its updated report with the Commission. As a result, over the course of the year, its hosting capacity data and map become increasingly less useful, as grid conditions change and the results become out-of-date. To address this issue, IREC urges the Commission to require Xcel to update its results more frequently, ideally on a monthly basis to start. The Commission could also consider somewhat less frequent updates for the entire grid, coupled with incremental updating of particular grid segments each time the hosting capacity of a feeder is assessed as part

[25] SDG&E Report at 9 ("SDG&E continues to believe that only the results of the iterative analysis are accurate enough to use for interconnection purposes.").

[26] *See* Optimizing the Grid at 25-27 (reviewing best practices for stakeholder engagement in hosting capacity analysis).

of the interconnection process.[27] Or it could consider a phased approach, requiring Xcel to gradually increase the frequency of its updating as it refines its methodology and works improves on software and hardware constraints. Ultimately, the frequency of updates should align with the Commission's goals and use cases for the hosting capacity: in particular, the closer to real-time, the more useful the results will be to streamline interconnection.

IREC notes that Xcel highlights the speed of the DRIVE tool as one of its benefits over more accurate but computationally intensive methodologies like the iterative approach used in California.[28] If Xcel is exchanging speed for accuracy, at least in the near-term, it seems important that it take advantage of this attribute of its methodology to provide more frequent updates to its data files and map.

C. Xcel Should Improve Its Data Files and Map, and Should Work Toward Deploying Hosting Capacity for Other Use Cases.

1. Hosting Capacity Data

IREC appreciates Xcel's provision of hosting capacity data in a spreadsheet. To make the results more useful (for instance, to help customers design DERs to avoid hosting capacity limits), IREC suggests that in the future the spreadsheet should contain greater detail. For instance, it should contain the maximum and minimum load data used for the feeder, to facilitate comparison with the hosting capacity results. While additional data beyond maximum and minimum load data would also be useful, IREC believes these additional data are good starting points.[29]

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[27] *See id.* at 20 (discussing options to increase the frequency of updating).

[28] Xcel Hosting Capacity Report at 7-10.

[29] Pacific Gas & Electric's data files, for instance, set out the minimum and maximum hosting capacity values for each of four limiting criteria. *See* Pacific Gas & Electric Co., R. 14-08-013, Pacific Gas & Electric Company's (U 39 E) Demonstration Projects A & B Final Reports, Appendix A (Demonstration Project A—Enhanced Integration Capacity Analysis), at

2. Hosting Capacity Map

IREC appreciates Xcel's provision of a hosting capacity map. The map is an important step towards improved system data transparency, and IREC hopes it will be useful in guiding interconnections and serve "to provide developers with a starting point for interconnection applications."[30] Since the hosting capacity map is currently the only concrete application of Xcel's hosting capacity analysis, IREC encourages the Commission to ensure that it is as useful as possible by improving the accuracy and frequency of updating of the data that underlies the map. As indicated above, IREC continues to have concerns regarding the accuracy of the underlying data, and we urge the Commission to require Xcel to continue to evaluate and improve accuracy. In addition, as discussed above, we suggest more frequent updates to the data and the maps, such that the results do not become overly outdated and thus less useful.

Additionally, IREC suggests that the level of data provided in the map should be improved to make it more valuable to users. Specifically, the map does not currently show the data associated with individual feeders, for example in a pop-up window when a user clicks on the feeder, but rather relies exclusively on colors indicating ranges of hosting capacity values. While a user may be able to cross-reference the map with the hosting capacity results spreadsheet, providing the data in the map would make it much more user-friendly. IREC suggests that the map should include, via pop-ups or a comparable mechanism, all of the data contained in the results spreadsheet, as well as the voltage of the feeder and the existing and queued projects, at least to start. Although it is true that queued projects may not ultimately be

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172 (Dec. 27, 2016). Voltage level, number of voltage regulators, circuit length, number of customers, and percent of customer type could be other future data points to consider.

[30] Order Setting Additional Requirements at 5.

built,[31] providing the data on the map is still useful to users looking to understand the level of congestion and potential upgrades at a particular point of interconnection. IREC notes that the New York utilities, which also currently rely on the EPRI DRIVE tool, have produced map with such pop-up boxes with detailed information.[32]

Xcel also notes that, if feeders are close together, and have different hosting capacities, it applied the color associated with the higher hosting capacity.[33] This approach seems to decrease the value of the map. For example, if a red (low hosting capacity) feeder is in close proximity to a green (higher hosting capacity) feeder, they entire area would seem to be misrepresented as green. While pop-ups with detailed information would be ideal, IREC suggests that the map should at least show the appropriate colors for each individual feeder, once a user has zoomed in sufficiently. In addition, since the EPRI DRIVE tool generates a hosting capacity range, it should be made clear on the map which end of the range Xcel is incorporating.[34]

Finally, while IREC finds it reasonable to have the map, at present, provide the amount of hosting capacity available without any mitigations,[35] IREC emphasizes that this approach may need to change as smart inverter standards are approved or other mitigations are standardized in

[31] Xcel's disclaimer associated with the map states: "Information on other projects in the interconnection queue for various feeders, but not yet interconnected, may have an impact on hosting capacity. This information is not reflected in the maps because we lack certainty on whether the projects will proceed. You may use this information in conjunction with the maps and with the Capacity Screen below. This interconnection queue information is available on-line under the Substation DG Queue prompt on this page [link to project queue]."

[32] Links to all of the utilities' maps are on the Joint Utilities of New York web site: http://jointutilitiesofny.org/utility-specific-pages/hosting-capacity.

[33] Xcel Hosting Capacity Report at 22.

[34] Xcel states in its report that the map results are "color coded based on the minimum available hosting capacity," however IREC did not find any clear indication of this choice on the map itself. Xcel Hosting Capacity Report at 1.

[35] Xcel Hosting Capacity Report at 21.

a way that allows them to be consistently incorporated. Specifically, IREC notes that the map data relies on an assumed Power Factor of 0.98; modifying that value or incorporating other standardized voltage regulation functions could be appropriate mitigations to incorporate.

3. Additional Use Cases—Interconnection Streamlining and Improved Distribution System Planning

IREC suggests that, in the next iteration of Xcel's Hosting Capacity Report, the Commission require it to move beyond a discussion focused nearly exclusively on the map application of its analysis. Instead, Xcel should address more explicitly and concretely whether its hosting capacity analysis can or will be useful in (1) streamlining interconnection review, including through complementing or supplanting the current screening process, and (2) improving distribution planning to better integrate DERs. If the analysis cannot be used for these applications in its current iteration, IREC suggests that the Commission require Xcel to explain what specifically it lacks, and either when it expects these gaps to be addressed or when it anticipates implementing a different tool or methodology to achieve the particular goal. IREC further suggests that Xcel explain what practical steps would be required to deploy hosting capacity in these applications and expected timelines for each deployment. Xcel's development of this information could be aided through the workshops or working group process suggested above. With this information, the Commission can assess how best to proceed towards these goals and consider appropriate timelines to do so. Ultimately, with more concrete steps guiding the implementation of hosting capacity for the various use cases, the Commission should begin to see more practical benefits of Xcel's efforts beyond the production of an annual report and map.

Interconnection Streamlining. In its latest report, despite recognizing interconnection streamlining as a possible goal,[36] Xcel seems to dismiss its importance. Specifically, Xcel states that interconnection is necessarily a "detailed process" and hosting capacity is performed "at a higher system level."[37] According to Xcel, while hosting capacity may "guide interconnections," a "detailed interconnection study is the most efficient way to bring DER onto the distribution system."[38] IREC encourages the Commission to reject this view. While it may be true today, with the approach to hosting capacity analysis that Xcel has chosen, it does not take into account that other analytic approaches, such as the iterative methodology discussed above, can be used to help streamline interconnection review, in particular to complement and potentially supplant the current, conservative screening process. IREC urges the Commission to consider directing Xcel to assess whether its current approach can eventually achieve this goal, or whether it needs to investigate other methodologies to do so. As indicated above, IREC also suggests that a workshop or working group process may be a productive venue in which to explore these concepts.

Distribution System Planning. IREC notes that the Commission explicitly required that Xcel's analysis "be detailed enough to inform future distribution system planning efforts and upgrades necessary to facilitate the continued efficient integration of distributed generation."[39] IREC supports this objective. However Xcel has not yet provided concrete information as to whether its analysis possesses the requisite level of detail for this purpose, and, importantly, how it will employ hosting capacity within its distribution system planning efforts to facilitate the

[36] *Id.* at 4.

[37] *Id.* at 18.

[38] *Id.*at 8.

[39] Order Setting Additional Requirements at 5.

integration of distributed generation (DG) and other types of DER. IREC suggests that the Commission require Xcel to articulate its practical plans to do so either in its next hosting capacity filing or in a filing in Docket No. E999/CI-15-556. If its methodology as currently deployed cannot achieve this use case, then IREC suggests that the Commission require Xcel to indicate with specificity what improvements would be required in order to do so.

Related to both the interconnection and planning use cases, IREC supports Xcel's efforts to investigate areas of low hosting capacity.[40] We appreciate that its initial investigation of these areas allowed Xcel to update its analysis with more accurate results[41] and further suggest that areas of zero hosting capacity specifically warrant additional attention, as discussed further below. IREC also suggests that identifying areas with low hosting capacity may lead to innovative interconnection and distribution planning possibilities, especially if these low-capacity areas occur correspond with high DER growth and/or if it would not possible for a single DER project to accommodate the upgrades needed to expand the hosting capacity at those sites. Such areas may be ripe for testing emerging concepts such as solicitation of non-wires alternatives for upgrades, application of DER-based mitigations such as smart inverter settings to avoid or defer upgrades, cost-sharing and group study of projects attempting to interconnect in that area, and proactive planning for upgrades where DER growth is anticipated. IREC encourages the Commission to consider these opportunities, and to require Xcel to consider and explore them as well, beyond simply targeting them to improve hosting capacity accuracy.

[40] *Id.* at 21-22.

[41] *Id.*

D. The Technical Information Provided in the 2017 Report Is Helpful, but Questions Persist Regarding Xcel's Approach and Assumptions, Which May Impact the Accuracy of Its Results.

IREC has several specific questions regarding the technical assumptions and other components used in Xcel's Hosting Capacity Report. IREC recognizes that some assumptions are necessary, and that it is not always possible or practicable to rely on actual data. In each case, we are interested to know whether and to what extent the assumption or other element affects the accuracy of Xcel's hosting capacity analysis. Such information will assist the Commission and stakeholders in better understanding the underlying methodology and any modifications needed to make it suitable to all the use cases identified by the Commission. IREC requests that the Commission direct Xcel to respond to these questions, ideally in a separate filing prior to its next Hosting Capacity Report, or at least in its next report.

1. Choice of Methodology Within the DRIVE Tool

In its most recent report, Xcel relied on the "large centralized" instead of the "small distributed" methodology "based on feedback from stakeholders" and "to more accurately reflect[] characteristics of DER deployment associated with programs such as Solar*Rewards Community."[42] IREC remains concerned that the DRIVE tool forces Xcel to make such a choice and questions the impact it has on the usefulness of Xcel's study results.[43] IREC understands that, in reality, Xcel's distribution system has a mix of "small distributed" DG (such as rooftop solar) and "large centralized" DG (such as community solar gardens), and this mix will likely change over time, especially as more distributed storage comes online. Assuming all DER will

[42] *Id.*at 2, 10-12.

[43] *See* IREC Comments, 15-962, at 19-21.

be large, centralized DG (or small, distributed DG) will necessarily make the results of the analysis inaccurate, which in turn impacts their practical utility, as discussed above.[44]

IREC urges the Commission to require Xcel to explain whether the DRIVE tool can be modified to analyze the actual mix of DERs on Xcel's system, or at least a closer approximation of that mix, and if so, when that modification will be made. As discussed further below regarding evaluating the tool's accuracy, IREC also suggests that Xcel indicate how choosing a methodology impacts the accuracy of the results with respect to the actual hosting capacity of a circuit.

2. Definition of DER and Incorporation of Energy Storage

IREC is concerned by Xcel's narrow definition of DER and view of the behavior these technologies exhibit on the distribution system. Xcel defines DER as only including "sources of electric power," and states that it "did not take the load characteristics of DER devices such as energy storage into consideration" in its analysis.[45] This is in contrast to common definitions of DER, which include both supply and demand side resources.[46] Xcel's narrow analytic framework

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[44] *See* Xcel Hosting Capacity Report at 11 (explaining that the use of the large centralized method "*does affect the results* by generally showing a larger maximum hosting capacity and a smaller minimum hosting capacity").

[45] *Id.* at 6-7; *see* also *id.* at 3 (stating that report results were extended to energy storage "that is acting as a source of power" and that analysis does not consider load aspects because "[s]tandards do not currently fully define the requirements or characteristics of storage operating as a load").

[46] *See, e.g.*, ICF Int'l Report at 1 (defining DER as "supply and demand side resources that can be used throughout an electric distribution system to meet energy and reliability needs of customers," including distribution generation and "distributed flexibilty and storage" such as "demand response, electric vehicles, thermal storage, [and] battery storage"); Cal. Pub. Utils. Code § 769(a) (defining "distributed resources" as "distributed renewable generation resources, energy efficiency, energy storage, electric vehicles, and demand response technologies"); Minn. Commerce Dep't, Distributed Energy Resources, https://mn.gov/commerce/industries/energy/distributed-energy/ (last visited Jan. 30, 2018) (defining distributed energy resources as "utility or customer-sited resources on the distribution

fails to account for the actual operating characteristics of energy storage—which frequently act only or primarily as a source of load—and consequently significantly limits how instructive the results are regarding the grid's capacity to host storage technologies.[47]

Related to this concern, IREC disagrees with Xcel's assertion that DER "tend[] only to reduce hosting capacity" when it "behaves primarily as an energy source."[48] To the contrary, DERs' effects on hosting capacity depend on how and for what hosting capacity is being evaluated. For example, distributed solar may *increase* the hosting capacity for energy storage, at least when the full functionality of storage acting as load is considered. Similarly, energy storage or load control could *increase* the hosting capacity for distributed solar. IREC appreciates that the energy storage market is nascent in Minnesota and that a hosting capacity analysis that fully incorporates energy storage may not be immediately useful. Nonetheless, IREC urges the Commission to request more detail from Xcel regarding how and when its tool will fully incorporate energy storage, including its load characteristics. In the meantime, IREC suggests that Xcel should not define DER in such a narrow manner, even if its chosen hosting capacity approach may not yet be able to address the full spectrum of DER.

3. Minimum and Maximum Hosting Capacity Values

The EPRI DRIVE tool produces both a minimum hosting capacity value, which IREC understands to correlate with the least optimal location on the feeder (likely often to be the most downstream node from the substation), and a maximum hosting capacity value, which IREC

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grid that can include combined heat and power, solar photovoltaic, wind, batter storage, thermal storage, and demand-response technologies").

[47] *See* Optimizing the Grid at 1 n.1 (explaining that hosting capacity varies greatly depending on the extent to which DER technologies act as a source of load, generation, or a combination of the two); *id.* at 21 (explaining the benefits of making hosting capacity agnostic to DER type).

[48] Xcel Hosting Capacity Report at 7.

understands to correlate with most optimal location on the feeder (likely often to be the closest node to the substation). While IREC appreciates that this range can provide a rough sense of the hosting capacity at any given node on the feeder, in many cases this range is very wide. The majority of differentials appear to exceed 5 MW (e.g., 2 MW minimum hosting capacity, 7 MW maximum hosting capacity). IREC questions the usefulness of these wide ranges for a project seeking to interconnect at a particular node. IREC suggests the Commission require Xcel to explore whether or not the DRIVE tool can or will be able to produce more granular values, ideally down to the nodal level, as such results would be ultimately be more valuable, particularly to interconnection applicants, both for the purposes of the map as well as interconnection streamlining.

4. Feeders with Zero Hosting Capacity

IREC notes that there are many instances in Xcel's hosting capacity data in which both minimum and maximum hosting capacities are determined to be 0 MW (by our count, 174 instances). IREC questions the accuracy of these results, especially in light of the relatively low penetrations of DERs in Minnesota. IREC suggests that further analysis of these zero-capacity areas would be instructive: it may, for instance, reveal some of the limitations of Xcel's hosting capacity methodology. IREC urges the Commission to require Xcel to evaluate and address these zero-capacity results. If they are reflective of existing violations on Xcel's system, IREC encourages the Commission to require Xcel to explore ways in which such existing violations could be identified.

5. Customer Load Assumptions and Allocation

Xcel states that it allocated load to the feeder based on "a combination of appropriate load curves by customer type and customer energy usage."[49] It also used demand data from primary-metered customers "when available."[50] IREC would appreciate additional detail regarding the load curves that Xcel uses in its hosting capacity analysis. Specifically, does it employ one load curve by customer class (e.g., one residential load curve, one commercial load curve, etc.) or does it employ multiple curves that incorporate customers' particular traits, based, for instance, on meter data (e.g., residential customer type A, residential customer type B, etc.)? Although Xcel states that it is using demand data when available, it does not specify whether it is using that data to build tailored load curves, to distribute load to different sections of a circuit, or for some other purposes. IREC notes that the extent to which load curves reflect averages across broad customer classes, and are not specific to individual customers or even groups of similar customers, is likely to negatively impact hosting capacity accuracy. If Xcel is relying on generic curves by customer class, IREC requests additional information regarding how and when more specific curves based on customer data will be incorporated into its analysis.

6. Loading Levels and Use of Minimum Load

Xcel appears to take the same approach with respect to loading levels as it did in its prior Hosting Capacity Report, and IREC continues to have the same concerns with this approach.[51] Specifically, IREC is concerned by Xcel's use of the conservative 20-percent of peak load parameter, which Xcel does not sufficiently justify, rather than actual minimum load data from its SCADA system. If this is a constraint of the DRIVE tool, IREC suggests that the Commission

[49] *Id.* at 13-14.

[50] *Id.*

[51] *Id.* at 13; IREC Comments, 15-962, at 23-24.

require Xcel to indicate when the tool will be able to accommodate use of actual minimum load data.

7. Criteria Thresholds

IREC has the following questions and suggestions regarding Xcel's six chosen criteria thresholds:[52]

- Primary Voltage Deviation (3%) – IREC questions why 3% is the threshold used here when Xcel's current Section 10 Tariff specifies 4%.[53] Moreover, given that Xcel has indicated that the majority of its system is 13.8 kV, IREC suggests that a 5-6% change, at a minimum, would be more appropriate. IREC requests that Xcel further justify its use of 3% in this instance. Furthermore, the assumption that all DER on a feeder trips offline at the same time[54] would likely lead to overestimation of voltage deviation. The conditions where this phenomenon would occur are only major system disturbances where general power quality is affected. Generally, it would require that voltage or frequency tripping limits which are far outside the normal range are reached. IREC requests that Xcel describe the conditions under which the voltage deviation should be evaluated (e.g., steady state or abnormal) and justify the use of the related assumptions.
- Additional Element Fault Current (10%) – IREC notes that this criterion affects minimum and maximum hosting capacity in about 100 (or about 10%) of feeders.

[52] Xcel Hosting Capacity Report at 14-15.

[53] Minnesota Electric Rate Book: Section 10, Distributed Generation Interconnection Requirements § 4(B)(iii) (Flicker), Sheet No. 10-146.

[54] Xcel Supplemental Comments, Dkt. No. E002/M-15-962 (Mar. 20, 2017) (Q: For primary voltage deviation, please explain if Xcel assumed that all DER on a feeder would trip off-line at the same time? A: Yes, the DRIVE tool analysis assumes all DER tripping off at the same time.).

While the chosen threshold of 10% seems reasonable to IREC at this time, IREC suggests it requires further evaluation given the current lack of understanding of how inverter-based fault currents present themselves to downstream or upstream breakers. IREC suggests that the Commission require Xcel to provide any additional learnings on this issue in future Hosting Capacity Reports.

- Breaker Relay Reduction of Reach (10%) – Xcel indicates that it shifted its threshold for this parameter from 5 percent to 10 percent.[55] Similar to the threshold for additional element fault current discussed above, IREC finds this change reasonable at this point, but nonetheless flags it as requiring further evaluation over time given the lack of understanding of how inverter fault currents present themselves at upstream breakers. Again, IREC suggests that the Commission require Xcel to provide any additional learnings on this issue in future Hosting Capacity Reports.

8. Potential Mitigations and Advanced Inverter Settings

Xcel notes that currently interconnection studies typically determine mitigations on a case-by-case basis and IREC appreciates Xcel's emphasis on low-cost mitigation options such as adjusting DER power factor.[56] Xcel indicates that its hosting capacity analysis assumes a fixed power factor of 0.98 leading for all new DER "to approximate the hosting capacity gains associated with the use of non-unity power factor values."[57] While IREC finds this assumption reasonable at this time, IREC notes that Xcel recognizes that it is unknown what power factor is optimal for new DER, and that 0.98 leading reflects "approximately the middle of the range of

[55] Xcel Hosting Capacity Report at 3-4.

[56] *Id.* at 15-16.

[57] *Id.* at 3.

anticipated non-unity power factor values."[58] Xcel has not yet provided information regarding DRIVE's capabilities to include a volt-var response. If that ability is indeed lacking, IREC suggests that Xcel could instead assume a power factor of 0.975, which, at 105% voltage, aligns with the new IEEE 1547-2018 defaults for volt-var.

Going forward, IREC notes that Xcel may need to refine its approach to assume certain, standardized mitigations such as those associated with smart inverters. IREC also emphasizes that, while the table of potential mitigations provided in the Report is a helpful sample,[59] it is not comprehensive. For example, in addition to adjusting DER power factor, the utility may use (or at least will soon be able to use) smart inverter voltage regulation functions. In addition, adjusting voltage regulation equipment and/or utility operational practices could be appropriate mitigations for over-voltage.

9. Distributed Generation Output

Xcel indicates that it assumed that 100 percent of allowed DG output was flowing on associated feeders during the boundary conditions of peak load and daytime minimum loading, which were used for the analysis. While IREC recognizes these as generally accepted assumptions, we note that ultimately their accuracy depends on the peak and minimum load times, and the extent to which they comport with the actual generation profile of the DER. IREC suggests that Xcel should explore improvements to more accurately distribute generation at the appropriate time of day, based on actual data.

In addition, IREC finds it unclear whether these assumptions were applied to existing DG, new DG, or both. IREC would appreciate additional detail on this point.

[58] *Id.* at 3.

[59] *Id.* at 16.

10. Secondary Conductors

Xcel states that, since secondary conductor information is not recorded in its GIS, it was unable to account for the impacts beyond the primary distribution system.[60] It assumes a three-volt drop across secondary conductors and transformers, such that when it modeled voltages on the primary system, it subtracts three additional volts to better quantify the actual voltage at the customer level. IREC appreciates this additional detail regarding Xcel's assumptions. But IREC finds it unclear whether the three volts are subtracted for all scenarios, even for backfeed through the transformer. IREC agrees that it is a reasonable approach at this time, although it does result in some uncertainty. Also, while IREC understands the current limitation regarding secondary conductor information, we emphasize that the ultimate goal should be to incorporate secondary conductors into the hosting capacity analysis, especially if the hosting capacity analysis is to be used for interconnection purposes.[61]

11. Conductor Spacing

Xcel states that it assumed that conductor spacing was the same for each voltage class, since the majority of its system is at 13.8 kV.[62] IREC again requests a more detailed description than "majority," since that term could mean anywhere from 51-percent to 99-percent of Xcel's system, with differing implications for the accuracy of its analysis.[63] In particular, IREC suggests that the effectiveness of modeling non-unity power factor or other reactive power functions could be affected by this assumption. It is likely that higher-voltage circuits would have larger

[60] *Id.* at 12.

[61] *See* IREC Comments, 15-962, at 25.

[62] Xcel Hosting Capacity Report at 13.

[63] *See* IREC Comments, 15-962 at 24-25.

than modeled inductance, while lower-voltage circuits would have lower than modeled inductance.

12. Capacitors

Xcel indicates that it assumed that each capacitor bank was switched on at peak, unless known to be offline.[64] IREC finds this approach generally reasonable but requests that Xcel confirm that no primary overvoltage limitation to hosting capacity would occur with a capacitor switched on. IREC believes that this outcome is suggested by the report, but it is not clear.

13. Head-End Voltage

Xcel states that it set the voltage at the head-end of a feeder to 125 Volts on a 120 Volt base, which corresponds to 104 percent of whatever the nominal voltage is of a particular feeder, in order to provide a "realistic worst-case scenario" to catch potential overvoltage impacts.[65] IREC suggests that it may be more appropriate to determine an *actual* worst-case value using SCADA data, to avoid relying on overly conservative values. IREC would appreciate additional information on whether SCADA data could be used in this instance and, if not, then why not.

III. CONCLUSION

IREC appreciates the opportunity to submit these comments on Xcel's Hosting Capacity Report. We look forward to reviewing other parties' comments and continuing our participation in this proceeding.

[64] Xcel Hosting Capacity Report at 13.

[65] *Id.* at 14.

DATED: February 2, 2018 SHUTE, MIHALY & WEINBERGER LLP

By: /s/ Erica S. McConnell

ERICA S. McCONNELL
STEPHANIE SAFDI
396 Hayes Street
San Francisco, California 94102
Telephone: (415) 552-7272
Facsimile: (415) 552-5816
mcconnell@smwlaw.com
safdi@smwlaw.com

Attorneys for Interstate Renewable Energy Council, Inc.

CERTIFICATE OF SERVICE

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 February 2, 2018, I served a true and correct copy of

COMMENTS OF THE INTERSTATE RENEWABLE ENERGY COUNCIL, INC. ON XCEL'S 2017 DISTRIBUTION SYSTEM HOSTING CAPACITY REPORT

on all parties 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.

BY MAIL: I enclosed the document(s) in a sealed envelope addressed to the persons designated as requiring paper service on the Official Service List. I am readily familiar with Shute, Mihaly & Weinberger LLP's practice for collecting and processing correspondence for mailing. On the same day that the correspondence is placed for collection and mailing, it is deposited in the ordinary course of business with the United States Postal Service, in a sealed envelope with postage fully prepaid.

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 February 2, 2018.

/s/Amy Zehring
Amy Zehring

First Name	Last Name	Email	Company Name	Address	Delivery Method	View Trade Secret	Service List Name
David	Aafedt	daafedt@winthrop.com	Winthrop & Weinstine, P.A.	Suite 3500, 225 South Sixth Street Minneapolis, MN 554024629	Electronic Service	No	OFF_SL_17-777_M-17-777
Christopher	Anderson	canderson@allete.com	Minnesota Power	30 W Superior St Duluth, MN 558022191	Electronic Service	No	OFF_SL_17-777_M-17-777
Alison C	Archer	aarcher@misoenergy.org	MISO	2985 Ames Crossing Rd Eagan, MN 55121	Electronic Service	No	OFF_SL_17-777_M-17-777
Ryan	Barlow	Ryan.Barlow@ag.state.mn.us	Office of the Attorney General-RUD	445 Minnesota Street Bremer Tower, Suite 1400 St. Paul, Minnesota 55101	Electronic Service	No	OFF_SL_17-777_M-17-777
James J.	Bertrand	james.bertrand@stinson.com	Stinson Leonard Street LLP	50 S 6th St Ste 2600 Minneapolis, MN 55402	Electronic Service	No	OFF_SL_17-777_M-17-777
William A.	Blazar	bblazar@mnchamber.com	Minnesota Chamber Of Commerce	Suite 1500 400 Robert Street North St. Paul, MN 55101	Electronic Service	No	OFF_SL_17-777_M-17-777
James	Canaday	james.canaday@ag.state.mn.us	Office of the Attorney General-RUD	Suite 1400 445 Minnesota St. St. Paul, MN 55101	Electronic Service	No	OFF_SL_17-777_M-17-777
Jeanne	Cochran	Jeanne.Cochran@state.mn.us	Office of Administrative Hearings	P.O. Box 64620 St. Paul, MN 55164-0620	Electronic Service	No	OFF_SL_17-777_M-17-777
John	Coffman	john@johncoffman.net	AARP	871 Tuxedo Blvd. St, Louis, MO 63119-2044	Electronic Service	No	OFF_SL_17-777_M-17-777
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	Yes	OFF_SL_17-777_M-17-777

First Name	Last Name	Email	Company Name	Address	Delivery Method	View Trade Secret	Service List Name
Corey	Conover	corey.conover@minneapolismn.gov	Minneapolis City Attorney	350 S. Fifth Street City Hall, Room 210 Minneapolis, MN 554022453	Electronic Service	No	OFF_SL_17-777_M-17-777
Carl	Cronin	Regulatory.records@xcelenergy.com	Xcel Energy	414 Nicollet Mall FL 7 Minneapolis, MN 554011993	Electronic Service	No	OFF_SL_17-777_M-17-777
Joseph	Dammel	joseph.dammel@ag.state.mn.us	Office of the Attorney General-RUD	Bremer Tower, Suite 1400 445 Minnesota Street St. Paul, MN 55101-2131	Electronic Service	No	OFF_SL_17-777_M-17-777
Ian	Dobson	residential.utilities@ag.state.mn.us	Office of the Attorney General-RUD	1400 BRM Tower 445 Minnesota St St. Paul, MN 551012130	Electronic Service	Yes	OFF_SL_17-777_M-17-777
John	Farrell	jfarrell@ilsr.org	Institute for Local Self-Reliance	1313 5th St SE #303 Minneapolis, MN 55414	Electronic Service	No	OFF_SL_17-777_M-17-777
Sharon	Ferguson	sharon.ferguson@state.mn.us	Department of Commerce	85 7th Place E Ste 280 Saint Paul, MN 551012198	Electronic Service	No	OFF_SL_17-777_M-17-777
Edward	Garvey	edward.garvey@AESLconsulting.com	AESL Consulting	32 Lawton St Saint Paul, MN 55102-2617	Electronic Service	No	OFF_SL_17-777_M-17-777
Janet	Gonzalez	Janet.gonzalez@state.mn.us	Public Utilities Commission	Suite 350 121 7th Place East St. Paul, MN 55101	Electronic Service	No	OFF_SL_17-777_M-17-777
Kimberly	Hellwig	kimberly.hellwig@stoel.com	Stoel Rives LLP	33 South Sixth Street Suite 4200 Minneapolis, MN 55402	Electronic Service	No	OFF_SL_17-777_M-17-777
Michael	Hoppe	il23@mtn.org	Local Union 23, I.B.E.W.	932 Payne Avenue St. Paul, MN 55130	Electronic Service	No	OFF_SL_17-777_M-17-777

First Name	Last Name	Email	Company Name	Address	Delivery Method	View Trade Secret	Service List Name
Julia	Jazynka	jjazynka@energyfreedomcoalition.com	Energy Freedom Coalition of America	101 Constitution Ave NW Ste 525 East Washington, DC 20001	Electronic Service	No	OFF_SL_17-777_M-17-777
Alan	Jenkins	aj@jenkinsatlaw.com	Jenkins at Law	2265 Roswell Road Suite 100 Marietta, GA 30062	Electronic Service	No	OFF_SL_17-777_M-17-777
Linda	Jensen	linda.s.jensen@ag.state.mn.us	Office of the Attorney General-DOC	1800 BRM Tower 445 Minnesota Street St. Paul, MN 551012134	Electronic Service	No	OFF_SL_17-777_M-17-777
Richard	Johnson	Rick.Johnson@lawmoss.com	Moss & Barnett	150 S. 5th Street Suite 1200 Minneapolis, MN 55402	Electronic Service	No	OFF_SL_17-777_M-17-777
Sarah	Johnson Phillips	sarah.phillips@stoel.com	Stoel Rives LLP	33 South Sixth Street Suite 4200 Minneapolis, MN 55402	Electronic Service	No	OFF_SL_17-777_M-17-777
Mark J.	Kaufman	mkaufman@ibewlocal949.org	IBEW Local Union 949	12908 Nicollet Avenue South Burnsville, MN 55337	Electronic Service	No	OFF_SL_17-777_M-17-777
Thomas	Koehler	TGK@IBEW160.org	Local Union #160, IBEW	2909 Anthony Ln St Anthony Village, MN 55418-3238	Electronic Service	No	OFF_SL_17-777_M-17-777
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_17-777_M-17-777
Douglas	Larson	dlarson@dakotaelectric.com	Dakota Electric Association	4300 220th St W Farmington, MN 55024	Electronic Service	No	OFF_SL_17-777_M-17-777

First Name	Last Name	Email	Company Name	Address	Delivery Method	View Trade Secret	Service List Name
Peder	Larson	plarson@larkinhoffman.com	Larkin Hoffman Daly & Lindgren, Ltd.	8300 Norman Center Drive Suite 1000 Bloomington, MN 55437	Electronic Service	No	OFF_SL_17-777_M-17-777
Paula	Maccabee	Pmaccabee@justchangelaw.com	Just Change Law Offices	1961 Selby Ave Saint Paul, MN 55104	Electronic Service	No	OFF_SL_17-777_M-17-777
Peter	Madsen	peter.madsen@ag.state.mn.us	Office of the Attorney General-DOC	Bremer Tower, Suite 1800 445 Minnesota Street St. Paul, Minnesota 55101	Electronic Service	No	OFF_SL_17-777_M-17-777
Kavita	Maini	kmaini@wi.rr.com	KM Energy Consulting LLC	961 N Lost Woods Rd Oconomowoc, WI 53066	Electronic Service	No	OFF_SL_17-777_M-17-777
Pam	Marshall	pam@energycents.org	Energy CENTS Coalition	823 7th St E St. Paul, MN 55106	Electronic Service	No	OFF_SL_17-777_M-17-777
Joseph	Meyer	joseph.meyer@ag.state.mn.us	Office of the Attorney General-RUD	Bremer Tower, Suite 1400 445 Minnesota Street St Paul, MN 55101-2131	Electronic Service	No	OFF_SL_17-777_M-17-777
David	Moeller	dmoeller@allete.com	Minnesota Power	30 W Superior St Duluth, MN 558022093	Electronic Service	No	OFF_SL_17-777_M-17-777
Andrew	Moratzka	andrew.moratzka@stoel.com	Stoel Rives LLP	33 South Sixth St Ste 4200 Minneapolis, MN 55402	Electronic Service	No	OFF_SL_17-777_M-17-777
David	Niles	david.niles@avantenergy.com	Minnesota Municipal Power Agency	220 South Sixth Street Suite 1300 Minneapolis, Minnesota 55402	Electronic Service	No	OFF_SL_17-777_M-17-777
Carol A.	Overland	overland@legalectric.org	Legalectric - Overland Law Office	1110 West Avenue Red Wing, MN 55066	Electronic Service	No	OFF_SL_17-777_M-17-777

First Name	Last Name	Email	Company Name	Address	Delivery Method	View Trade Secret	Service List Name
Jeff	Oxley	jeff.oxley@state.mn.us	Office of Administrative Hearings	600 North Robert Street St. Paul, MN 55101	Electronic Service	No	OFF_SL_17-777_M-17-777
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_17-777_M-17-777
Richard	Savelkoul	rsavelkoul@martinsquires.com	Martin & Squires, P.A.	332 Minnesota Street Ste W2750 St. Paul, MN 55101	Electronic Service	No	OFF_SL_17-777_M-17-777
Inga	Schuchard	ischuchard@larkinhoffman.com	Larkin Hoffman	8300 Norman Center Drive Suite 1000 Minneapolis, MN 55437	Electronic Service	No	OFF_SL_17-777_M-17-777
Zeviel	Simpser	zsimpser@briggs.com	Briggs and Morgan PA	2200 IDS Center80 South Eighth Street Minneapolis, MN 554022157	Electronic Service	No	OFF_SL_17-777_M-17-777
Ken	Smith	ken.smith@districtenergy.com	District Energy St. Paul Inc.	76 W Kellogg Blvd St. Paul, MN 55102	Electronic Service	No	OFF_SL_17-777_M-17-777
Byron E.	Starns	byron.starns@stinson.com	Stinson Leonard Street LLP	50 S 6th St Ste 2600 Minneapolis, MN 55402	Electronic Service	No	OFF_SL_17-777_M-17-777
James M.	Strommen	jstrommen@kennedy-graven.com	Kennedy & Graven, Chartered	470 U.S. Bank Plaza 200 South Sixth Street Minneapolis, MN 55402	Electronic Service	No	OFF_SL_17-777_M-17-777
Eric	Swanson	eswanson@winthrop.com	Winthrop & Weinstine	225 S 6th St Ste 3500 Capella Tower Minneapolis, MN 554024629	Electronic Service	No	OFF_SL_17-777_M-17-777

First Name	Last Name	Email	Company Name	Address	Delivery Method	View Trade Secret	Service List Name
Lisa	Veith	lisa.veith@ci.stpaul.mn.us	City of St. Paul	400 City Hall and Courthouse 15 West Kellogg Blvd. St. Paul, MN 55102	Electronic Service	No	OFF_SL_17-777_M-17-777
Joseph	Windler	jwindler@winthrop.com	Winthrop & Weinstine	225 South Sixth Street, Suite 3500 Minneapolis, MN 55402	Electronic Service	No	OFF_SL_17-777_M-17-777
Cam	Winton	cwinton@mnchamber.com	Minnesota Chamber of Commerce	400 Robert Street North Suite 1500 St. Paul, Minnesota 55101	Electronic Service	No	OFF_SL_17-777_M-17-777
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_17-777_M-17-777
Patrick	Zomer	Patrick.Zomer@lawmoss.com	Moss & Barnett a Professional Association	150 S. 5th Street, #1200 Minneapolis, MN 55402	Electronic Service	No	OFF_SL_17-777_M-17-777