Xcel Energy®

414 Nicollet Mall
Minneapolis, MN 55401

November 1, 2018

—Via Electronic Filing—

Daniel P. Wolf
Executive Secretary
Minnesota Public Utilities Commission
121 7th Place East, Suite 350
St. Paul, MN 55101

RE: DISTRIBUTION SYSTEM/HOSTING CAPACITY STUDY
DOCKET NO. E002/M-18-___

Dear Mr. Wolf:

Northern States Power Company, doing business as Xcel Energy, submits our Distribution System/Hosting Capacity Study in compliance with Minn. Stat. § 216B.2425, subd. 8, and the Commission's July 19, 2018 Order in Docket No. E002/M-17-777.

Pursuant to Minn. Stat. § 216.17, subd. 3, we have electronically filed this document with the Minnesota Public Utilities Commission, and copies have been served on all parties on the attached service lists. Please contact me at bria.e.shea@xcelenergy.com or 612-330-6064 if you have any questions regarding this filing.

Sincerely,

/s/

BRIA E. SHEA
DIRECTOR, REGULATORY & STRATEGIC ANALYSIS

Enclosures
c: Service Lists

STATE OF MINNESOTA
BEFORE THE
MINNESOTA PUBLIC UTILITIES COMMISSION

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

IN THE MATTER OF THE XCEL ENERGY
2018 HOSTING CAPACITY REPORT UNDER
MINN. STAT. § 216B.2425, SUBD. 8

DOCKET NO. E002/M-18-___

HOSTING CAPACITY REPORT

INTRODUCTION

Northern States Power Company, doing business as Xcel Energy, submits this Hosting Capacity Report in compliance with Minn. Stat. § 216B.2425 subd. 8, and the Commission's July 19, 2018 Order in Docket No. E002/M-17-777. Today we are also filing our Integrated Distribution Plan that includes our Grid Modernization Report in Docket No. E002/M-18-251.

Xcel Energy recognizes hosting capacity as a key element in the future of distribution system planning and anticipates it will have the potential to further enable Distributed Energy Resources (DER) integration by guiding future installations and aiding individuals and developers in identifying areas of constraint. We have made significant progress in our efforts to advance the value of this report in a meaningful way –in response to stakeholder feedback, learnings from other utilities, and our work with EPRI. Specifically, we have made the following improvements in this 2018 report:

- *Application of Reverse Power Flow Threshold.* An enhancement in the DRIVE tool allowed us to implement the "Reverse Power Flow" threshold. Unlike the functionality in previous versions of the tool, this version reports any reverse power flow at the head-end of the feeder (substation feeder breaker). If reverse power flow is seen at that location, a violation occurs and hosting capacity is limited. This enhancement allows our hosting capacity analysis (HCA) to better align with the criteria we use in the interconnection process.
- *Adjustment of Voltage Deviation Threshold.* In previous years, we used the default setting of three percent with an assumed 60 percent loss of aggregate generation for a given feeder. In our current analysis, we changed the

threshold to five percent with an assumed 100 percent loss of aggregate generation. This means that if a five percent voltage deviation occurs for a sudden loss of all generation on that feeder, hosting capacity is limited. This enhancement has minimal effect on the results, but better aligns with how we perform interconnection studies with multiple sources of distributed generation.[1]

- *Inclusion of fuses for thermal violations.* Another enhancement to the DRIVE tool included the addition of thermal violations on three phase fuses. In some instances, hosting capacity can be limited by the protective fuses used to serve a given area. These areas are usually small and serve a small number of customers. Consequently, this enhancement has only had a minimal impact on the hosting capacity for small portions of the system.
- *Regulator bandwidth adjustment.* As described in our 2017 analysis, we corrected the default bandwidth of our regulators, which aligns with the simplified IEEE 1453 approach. Our regulators now have a 4.8 Volt bandwidth with a trigger occurring at 50 percent of that (2.4 Volts).
- *Removal of solar gardens from the analysis that are not in-service.* In an attempt to make our analysis more forward looking we included any solar gardens with signed Interconnection Agreements into our models for our 2017 analysis. Due to issues with some of those projects not being built on time, not proceeding, or troubles with accurately accounting for how facilities were going to be constructed in the field we did not continue that practice this year. Instead, we are only including solar gardens that were in-service as of August 14, 2018. We believe this will provide more accurate results that can be used in conjunction with the publicly updated interconnection queue to better understand the remaining hosting capacity capabilities of a given feeder.

We think this report is an important step toward helping parties understand the process and gives additional insight as to potential feeder capacity. The determination of exactly where and how much DER can be added to our system will be determined through the interconnection process, and this analysis provides helpful insight as a starting point prior to an interconnection application being submitted.

We remind readers that this study presents the discreet hosting capacity of individual feeders without analysis of the cumulative effects of DER additions to substations or the transmission system. As DER penetration increases, system constraints are likely

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[1] The aggregate 5 percent threshold is one of three implemented as part of the Company's application of a simplified IEEE 1453 approach. While the DRIVE analysis separately addresses the second threshold– voltage regulator deviation – it is currently not capable of analyzing the individual DER 3 percent threshold.

to limit hosting capacity in various geographical areas. For instance, a substation may have three feeders with 3 MW of available capacity on each – but the substation or transmission systems may not have 9 MW of available capacity. As actual penetration increases, we will need to further analyze upstream ramifications. As a result, this study is not a holistic system view, but rather a snapshot of the capabilities of individual feeders as they are positioned today.

Industry experts suggest that a hosting capacity study should encompass six key requirements: (1) granular, (2) repeatable, (3) scalable, (4) transparent, (5) proven, and (6) available. We believe our hosting capacity report satisfies all six of the fundamental requirements suggested by industry experts, and meets the requirements of the underlying Minnesota statute and the Commission's Orders.

We present our study as follows:

A. Background
B. DER Defined
C. Hosting Capacity Tool – DRIVE
D. Methodology
E. Assumptions
F. Thresholds
G. Impacts and Mitigation
H. Accuracy
I. Results
J. Sensitivity
K. Non-Public Data

DISTRIBUTION SYSTEM STUDY

A. Background

Minn. Stat. § 216B.2425, subd. 8. requires that a utility operating under an approved multiyear rate plan:

> *Shall conduct a distribution study to identify interconnection points on its distribution system for small-scale distributed generation resources and shall identify necessary distribution upgrades to support the continued development of distributed generation resources, and shall include the study in its report required under subdivision 2.*

Subsequently, Order Point 3 of the Minnesota Public Utilities Commission's June 28, 2016 Order in the above-referenced docket required we submit the distribution study by December 1, 2016, which will:

a. *include the initial analysis of the hosting capacity of each feeder on the Xcel distribution system for small-scale distributed-generation resources, defined as resources that are 1 MW or less; and*
b. *identify potential distribution upgrades necessary to support expected distributed generation resource additions including, in aggregate, distributed-generation resources that are in the Company's integrated-resource-plan filings and those that are active in the Company's community-solar-garden process.*

The Commission's August 1, 2017 Order clarified the purpose of the hosting capacity report as: (1) to inform and facilitate interconnection processes over time; and (2) to inform and facilitate distribution planning. The Order also set-out guidance and requirements for our next Hosting Capacity Report.

The Commission's July 19, 2018 Order set additional requirements for our next Hosting Capacity Report as follows:

2. Xcel's 2018 Hosting Capacity Report must be detailed enough to provide developers with a reliable estimate of the available level of hosting capacity per feeder at the time of submittal of the report to the extent practicable. The information should be sufficient to provide developers with a starting point for interconnection applications.
3. Xcel's 2018 Hosting Capacity Report must be detailed enough to inform future distribution system planning efforts and upgrades necessary to facilitate the continued efficient integration of distributed generation.
4. Xcel must file a color-coded, map-based representation of the available Hosting Capacity down to the feeder level. This information should be provided to the extent it is consistent with what Xcel believes are legitimate security concerns. If security concerns arise, Xcel must explain in detail the basis for those concerns.
5. Xcel must provide the Hosting Capacity results in downloadable, MS-Excel or other spreadsheet file formats.
6. Xcel must provide information on the accuracy of the Hosting Capacity Report information; both estimates on the accuracy of the 2018 report and an analysis of the 2017 results compared to actual hosting capacity determined through any interconnection studies or other reasonable metric.
7. The Commission hereby requests that Xcel Energy address stakeholder recommendations in the Company's 2018 Hosting Capacity Report filing, including:

   a. consider the methodological options to both improve and measure accuracy of the HCA, including identification and analysis of industry best practices and an explanation of the Company's methodological choice;
   b. consider the feasibility and practicality of including the results of both the Small Distributed methodology and the Large Centralized methodology in future hosting capacity analyses;
   c. conduct a sensitivity analysis;
   d. explore a range of options for better presenting the public-facing results of the Hosting Capacity Analysis after consideration of, but not limited to, any security and privacy issues that may be implicated in providing more detailed information and what information might be useful to developers and stakeholders;
   e. provide an update in each report on the evolving capability of the EPRI DRIVE tool and whether it is capable of incorporating the technologies included in the broadened definition of DERs;
   f. file more detailed data on load profile assumptions used in the analysis, including peak load (kW) by substation and feeder; and
   g. file supplemental information that would result in a broader understanding of how to guide distribution upgrades for additional hosting capacity.

8. The hosting capacity report identified in Minn. Stat. § 216B.2425, subd. 8, may be filed separately from the Biennial Transmission Projects Report.
9. Xcel must file a Hosting Capacity Report on an annual basis by November 1 each year.

B. DER Defined

For purposes of our HCA, our definition of DER is aligned with IEEE 1547-2018 and the Minnesota Distributed Energy Resources DER Interconnection Process (MN DIP)[2] and is as follows:

> Sources and groups of sources of electric power that are not directly connected to a bulk electric system. DER includes both generators and energy storage technologies capable of exporting active power to an electric power system (EPS). An interconnection system or a supplemental DER device that is necessary for

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[2] The MN DIP definition has an additional sentence related to the process, but not necessary for hosting capacity: "For the purpose of the MN DIP and MN DIA, the DER includes the Customer's Interconnection Facilities but shall not include the Area EPS Operator's Interconnection Facilities."

compliance with this standard is part of a DER.

We note that the ability of DER to add or reduce capacity depends on the operating characteristics of the DER and the location on the system. DER that behaves primarily as an energy source (i.e. PV, wind, biomass) tends to only reduce hosting capacity. In contrast, battery storage has the potential to act as a load to reduce thermal and voltage impacts, effectively increasing the hosting capacity if properly sited and coordinated with DER output. It is possible for large amounts of energy storage acting as a load on a feeder to cause system constraints that appear like typical system loading limits managed by utilities for many years; this can occur at times of no DER generation or when the storage load greatly exceeds the DER generation.

Our analysis is relevant for DER that acts as an energy source on the distribution system. We did not take the *load characteristics* of DER devices such as energy storage into consideration in our analysis. Therefore, inclusion of an under-voltage threshold was not necessary. DER sources that create reverse power flow may cause high voltage conditions. A DER device such as a battery storage device acting as a large load could potentially create low voltage conditions. Future analysis aimed at understanding storage device load characteristic impacts on the distribution system would need to include both load and generation characteristics of DER. Due to the nascent nature of the energy storage market in Minnesota, we excluded energy storage load characteristics from our analysis. However, in the future we plan to monitor the ability of our hosting capacity tool with regard to energy storage, and maximize its capabilities where we can.

C. Hosting Capacity Tool – DRIVE

The Electric Power Research Institute (EPRI) has defined hosting capacity as the amount of DER that can be accommodated on the existing system without adversely impacting power quality or reliability. As a means to automate and streamline HCA, EPRI introduced the Distribution Resource Integration and Value Estimation (DRIVE) tool in 2016. The DRIVE tool is based on EPRI's streamlined hosting capacity method, which incorporates years of detailed HCA by EPRI in order to screen for voltage, thermal, and protection impacts from DER.

Due to EPRI's work in the field and our recognition of the value that a hosting capacity tool would bring, we sought out a partnership with EPRI in 2015 to assist in the development of the DRIVE tool. We believe that DRIVE, which has expanded its reach in the industry since we starting using it, continues to be a valuable tool to inform our HCA. Among others, the Joint Utilities of New York,[3] Salt River Project, Tennessee Valley Authority, and Southern Company are some of the other utilities currently using DRIVE. As DRIVE has expanded its reach, the level of industry and stakeholder collaboration around the tool has been beneficial in creating consistency with the application and methodologies.

Part of that collaboration has resulted in a technical report,[4] created by EPRI, which compares techniques and documents the status of the industry in regards to hosting capacity.

As we have done in past years, we have expanded and improved our 2018 report based on lessons-learned from our ongoing use of DRIVE, and updates EPRI has made to the DRIVE tool – confirming our confidence in the tool.

Enhancements that EPRI has made to the DRIVE tool since our last report include the ability to:

- Reverse Power Flow based on feeder head
- Unintentional Islanding dependent on switch locations (note: this still takes considerable manual effort to accommodate for a system wide analysis)
- Improved various usability issues (fixed bugs, updated code, etc.)
- Added the user variable for range of acceptable thermal limits
- Fuses now considered as limiting elements for thermal violations

As noted earlier, our analysis considers DER that acts as a generation source to the system. DRIVE does have the ability to output load capacity and future releases of the tool are expected to have added functionality to better address what certain distributions of load, like EV's or storage, might do to a feeder. However, we have not run the analysis to look at load additions, which we see as more of a traditional distribution planning function rather than a part of a HCA.

D. Methodology

1. Overview

In this year's HCA, we created 1,049 feeder models in Synergi Electric, which is the

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[3] Con Edison, National Grid, Central Hudson, Orange and Rockland, NYSEG/RGE

[4] https://www.epri.com/#/pages/product/3002011009/?lang=en-US

distribution load-flow program we use. The information for these models primarily came from our Geographic Information System (GIS). We supplemented the GIS information with data from our 2018 load forecast (prepared in 2017) and historic actual customer demand and energy data. To create the feeder models, we extracted asset data from GIS to Synergi – after which, we ran a series of "clean-up" scripts to provide model assumptions and address any common issues that may be present in the data.

This includes tasks such as setting the head-end voltage, setting the burial depths on underground cable, setting the height of overhead conductor above the ground, and placing equipment settings into capacitors, reclosers, and regulators, among other things. If errors persisted in the model, we dug deeper to find the source(s) of the issues, which included consulting other maps, performing visual inspections in the field, and calling Synergi to assist with unique occurrences.

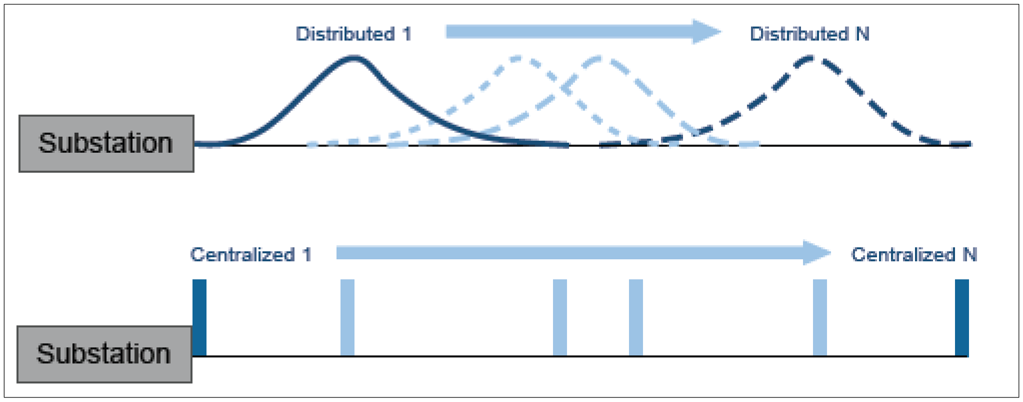
Once we addressed all identified errors in a particular model, we allocated the load to the feeder based on demand data and customer energy usage data. At this point, we ran a load-flow and performed a final check for any abnormalities on the feeder. After creating all of the feeder models, we analyzed them using DRIVE, which performed the hosting capacity technical analysis.

2. DER Allocation Method

Within the DRIVE tool there are three methods for allocating DER across a feeder, with each method intended to cover a different DER deployment scenario:

1. *Large Centralized:* Considers Large DER at a single location and does not consider DER at any other location on the feeder.
2. *Large Distributed:* Considers distribution of large DER at different feeder locations.
3. *Small Distributed:* Considers distribution of small DER at different feeder locations.

Figure 1: Difference Between the Distributed and Centralized DER Scenarios



Consistent with our most recent annual analysis, we used the Large Centralized method. The intent of using this method is to match the large amount of community solar gardens (CSG) being implemented in Minnesota. Use of the Large Centralized Method affects the hosting capacity results by generally showing a larger maximum hosting capacity and smaller minimum hosting capacity. The Large Centralized methodology only focuses on installations on three phase lines, which generally have more capacity and better align with the types of installations we are seeing on our system. The smaller minimum hosting capacity that results from this method is due to the concentration at specific locations, which has the tendency to affect the over-voltage and thermal thresholds a little more than distributing the load across the feeder. Consequently, that concentration also unmasks the potential to add more generation at ideal locations on the feeder (maximum hosting capacity).

Order Point No. 7b in the Commission's July 19, 2018 Order on our most recent hosting capacity report requested that we consider the feasibility and practicality of including the results of both the Small Distributed methodology and the Large Centralized methodology in future hosting capacity analyses. The Small Distributed method would be appropriate for a distribution system that was experiencing a lot of smaller scale PV installations, like roof-top, rather than the CSG we are experiencing in Minnesota.

Additionally, the accuracy of the results using the Small Distributed Method are dependent on the inclusion of secondary voltage equipment data in the modeling, because most violations for small scale installations occur on the secondary voltage level from the service transformer to the customer's meter. Since the Company does not maintain detailed secondary information beyond the transformer in its systems necessary for this analysis, this method would have limited usefulness. Further, our understanding of the intent of this analysis is that it is to provide realistic hosting capacity results at the primary voltage level for small scale installations up to 1 MW, rather than to inform small "roof top" style installations of available hosting capacity at the secondary voltage level. If there is available hosting capacity on a particular feeder, is it is not necessarily indicative of whether upgrades are required for small secondary connected DER. Likewise, if a particular feeder does not have hosting capacity available on a feeder it does not necessarily mean that a small secondary connected installation will be prohibited from interconnecting.

Analyzing hosting capacity is complex – and preparing two sets of results would further complicate and exacerbate the amount of work involved, particularly when one set of results would have questionable accuracy. While it is feasible to run the analysis with both the Large Centralized and Small Distributed Methods, there is significant extra work needed to process those results and map them. Furthermore, it would be necessary to include additional explanation to aid understanding and help stakeholders and report users recognize the differences and limitations, and to know how to best utilize the two sets of results. Before expanding the annual analysis, we believe it is important to help simplify the understanding of hosting capacity and not add further levels of analysis that might create confusion and provide limited value.

E. Assumptions

Below are the series of assumptions we applied to our HCA.

Data – We assumed the data from GIS was correct. In some instances however, we made modifications to the data after verification. The primary validation technique occurred while creating the feeder models within Synergi, which is our distribution load flow tool – and is used to model different scenarios that occur on the distribution system. As we manually allocate load to the feeder and run a load flow process, exceptions sometimes occur. Areas of the feeder are then highlighted due to overloading, high or low voltage, connectivity issues, etc. The engineer would then further investigate the feeder model for any obvious issues, such as field equipment turned off or a lack of connectivity. If that did not fix the issue, the engineer would then consult GIS or feeder maps that may have information different from what is in the model, or took other actions to verify or resolve the potential issues. When data modifications were necessary, they typically included conductor changes or various equipment updates.

Secondary Conductors – Secondary conductors connect from service transformers to the customer service entrance. The characteristics of secondary conductors combined with a high level of DER can lead to high voltage conditions on the customer premise. This has the potential to trigger conductor upgrades for interconnection of small residential or commercial DER systems. Since detailed secondary or low-voltage conductor information is not recorded in GIS, we are unable to account for the impacts beyond the medium-voltage (aka primary) distribution system. However, as discussed in our May 5, 2017 Reply Comments in Docket No. E002/M-15-962, we have traditionally assumed a three Volt drop across the secondary conductors and transformers to ensure compliance with ANSI C84.1. This means that when we model voltages on the primary system, we subtract three additional volts to better quantify the actual voltage at the customer level.

Conductor Spacing – Conductor spacing, or the distance between lines, impacts the electrical characteristics of distribution lines. In the Synergi impedance model, we assumed that the conductor spacing was the same for each voltage class. While we know this is not the case, the majority of our system is at 13.8 kV, and we used that standard as the default. While there are other configurations on our system, most of those were constructed more than 30 years ago, and we do not have good historical information regarding their conductor spacing.

Capacitors – For modeling purposes, it is important to know the state of every capacitor bank. However, at any point in time this is not known for the entire system, because the on/off status of each capacitor bank is not recorded along with load. Consequently, we assumed that each capacitor bank was switched on at peak, unless known to be offline. The state of the capacitor banks is driven by voltage and not by the peak hour. Even though our base assumption was that all capacitor banks were on at peak, if an over-voltage condition was witnessed, the capacitor would automatically switch off in the analysis just like it would do in the field. Therefore, the hour of the peak condition is irrelevant with regard to the capacitor status. For off-peak load analysis, we used a feature inside the DRIVE tool to switch off the capacitor banks where possible to more closely mimic that particular condition.

Feeder Topology – As a normal course of business, we regularly reconfigure feeders. For purposes of this analysis however, we assumed the configuration of the system is correct and static. Therefore, this analysis is a point-in-time snapshot of hosting capacity as of the date of our analysis – which is a reality of any analysis of the distribution system. However, we included future capacity projects that are scheduled to be completed by June 2019 into the feeder models. So while the feeder topology is generally a snapshot from the summer of 2018, we have included all known large capacity additions (such as conductor upgrades or new feeders) into the analysis to more accurately reflect future conditions.

Head-end Voltage – For the analysis, we set the voltage at the head-end of a feeder to 125 Volts on a 120 Volt base. This corresponds to 104 percent of whatever the nominal voltage is of a particular feeder. While the actual head-end voltage at different substations varies slightly, the 104 percent is intended to provide a realistic worst-case scenario in order to catch potential overvoltage impacts.

Distributed Generation Output – We assumed 100 percent of the allowed distributed generation output was flowing on the associated distribution feeders during the boundary conditions of Peak load and Daytime Minimum Loading .

Order Point No. 7f in the Commission's July 19, 2018 Order on our most recent hosting capacity report requested that we provide more detailed data on load profile assumptions used in the analysis, including peak load (kW) by substation and feeder, which we provide below:

Loading Levels – We populated each feeder model with non-coincident peak load information that was scaled down to 20 percent by the DRIVE tool to represent the Daytime Minimum Loading. These feeder peak loads could be for any time of the day and are not in relation to any type of load curve. The source of the peak load data was our SCADA system. If SCADA data was not available, we obtained the peak load from our manual monthly peak substation read process. Similar to our approach in the interconnection study process, we use 20 percent of peak demand for calculating daytime minimum load for feeders that do not have SCADA enabled, or other methods of determining the actual daytime minimum load. We initially relied on this value as a result of a National Renewable Energy Laboratory (NREL) paper.[5] Since that time, we have compared it to nearly 150 feeders where we have SCADA data on our system and where interconnection requests have been submitted, concluding that it is representative of our system.

Load Allocation – We allocated loads for the models on a section-by-section basis, which were based on the combination of appropriate load curves by customer type and customer energy usage. These are the only load curves used in our process. When available, we also used demand data from primary metered customers These factors are inputs to the Customer Management Module used within Synergi to allocate the peak load. Our load allocation methodology has evolved to this process from a process that only considered service transformer sizes. There is potential to further improve our load allocation method with Advanced Metering Infrastructure and the capabilities it has.

Finally, we note that we excluded from the study 49 feeders serving low voltage networks located in the downtown Minneapolis and St. Paul areas. We excluded these feeders because they are not detailed in the GIS system and have not previously been modeled. The special operating characteristics of secondary networks and processes

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[5] "Updating Interconnection Screens for PV System Integration." The file can be found online by navigating to: https://www.nrel.gov/docs/fy12osti/54063.pdf

to interconnect distributed generation is documented in "NSPM Network Connected PV Recommended Practice Based on Evaluation of Industry Practices, Standards and Experience" revision 2, dated June 17, 2014.[6] We also did not analyze a handful of other feeders that we serve, because we do not own them.

F. Thresholds

DRIVE has eleven criteria thresholds available to determine hosting capacity on a given piece of equipment. We use seven of those thresholds; the remaining four are either limited in its calculation capabilities or is not applicable to DER. In this year's report, we were able to use the Reverse Power Flow threshold to specify reverse flow at the feeder breaker instead of at any point on the feeder, due to DRIVE improvements. This improvement will more accurately reflect how we screen and study potential interconnections, so is a good fit for our HCA.[7]

Another threshold change in this year's analysis is the Primary Voltage Deviation percentage. In previous years we used the default setting of three percent and an assumed a 60 percent loss of aggregate generation for a given feeder. In the current analysis we updated this threshold to five percent with an assumed 100 percent loss of aggregate generation. This means that if a five percent voltage deviation occurs for a sudden loss of all generation on that feeder, hosting capacity is limited. This criteria directly aligns with how we perform interconnection studies with multiple sources of distributed generation using the Company's IEEE 1453 simplified approach. While the voltage regulator deviation is handled separately in DRIVE, which is consistent with the Company's study approach, DRIVE is not currently capable of performing the three percent *individual* threshold that we use in our detailed interconnection studies. We describe the Thresholds in more detail in Table 1 below.

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[6] System Planning and Strategy (NSPM) and Electric Distribution System Performance (EDSP) https://www.xcelenergy.com/staticfiles/xe/Corporate/Corporate%20PDFs/NSPM_PVNetwork_06_17_2014_Final_R2.pdf

[7] Screening flags reverse power flow as an early indicator of potential impacts. Studies use levels of reverse power flow at breaker locations to determine when additional protective measures (i.e. islanding protection) are needed.

Table 1: Hosting Capacity Thresholds

Criteria	Description	Threshold	Basis
Primary Over-Voltage	High voltage exceeds nominal voltage by threshold	105%	ANSI C84.1 Range A – Maintain quality of service to customers
Primary Voltage Deviation	Change in Voltage from no DER to full DER in aggregate	5%	MN Tariff Section 10, Sheet No. 146 – Maintain power quality for customers
Regulator Voltage Deviation	Change in bandwidth from no DER output to full DER output at a regulated node	50%	Prevent reliability and power quality issues by avoiding excessive regulator operations
Thermal for Discharging DER	Element rating	100%	Continue reliable customer service by staying within the normal ratings of existing elements
Additional Element Fault Current	Deviation in feeder fault currents	10%	Based on worst case scenarios from internal studies – maintain customer reliability
Breaker Relay Reduction of Reach	Deviation in breaker fault current	10%	Based on worst case scenarios from internal studies – maintain customer reliability
Reverse Power Flow	Element minimum loading	100%	Potential protection and thermal issues can occur with reverse power flow in to the substation
Sympathetic Breaker Tripping	*Breaker zero sequence current due to an upstream fault*	*Not used*	*For the analysis method used (Large Centralized) the criteria does not affect the hosting capacity*
Primary Under-Voltage	*Low voltage below nominal voltage threshold*	*Not used*	*Not a condition typically created by DER, unless considering the load aspects of energy storage*
Thermal for Charging DER	*Remaining element capacity at Peak Loading*	*Not used*	*Not a condition typically created by DER, unless considering the load aspects of energy storage*
Unintentional Islanding	*Element minimum loading*	*Not used*	*Criteria is applied on a section by section basis which lowers min hosting capacity to zero in all cases*

G. Impacts and Mitigations

Order Point No. 7g of the Commission's July 19, 2018 Order requests the Company to file supplemental information that would result in a broader understanding of how to guide distribution upgrades for additional hosting capacity. In this section, we discuss the more common potential distribution upgrades that may be necessary, and clarify that the most efficient and effective mitigation is dependent on the type(s) of constraints on each individual feeder in relation to a particular DER. Therefore, we generally discuss various constraint conditions and the type of mitigations that might be necessary to mitigate them.

To the extent a feeder has constraints, we identify the *primary* constraint in the tabular study results provided with this report as Attachment A.[8] Table 2 below shows the impacts we analyzed and the potential mitigations that could be implemented to increase hosting capacity. The specifics of each feeder and DER interconnection proposal are instrumental in determining the most appropriate and lowest cost mitigation for that specific situation. The mitigations can vary in degree from being fairly straightforward, to relatively complex. Therefore, a detailed study is needed to determine the optimal solution when DER is proposed on our feeders.

Table 2: Potential Mitigations of the Most Common Constraints

Category	Impacts	Mitigation
Voltage	Over-voltage	Adjust DER power factor setting, reconductor
	Voltage Deviation	Adjust DER power factor setting, reconductor
	Equipment Voltage Deviation	Adjust DER power factor setting, adjust voltage regulation equipment settings (if applicable), or reconductor
Loading	Thermal limits	Reconductor, replace equipment
Protection	Additional element fault current	Adjust relay settings, replace relays, replace protective equipment
	Breaker Relay Reduction of Reach	Adjust relay settings, replace relays, move or replace protective equipment
	Sympathetic Breaker Relay Tripping	Adjust relay settings, replace relays, move or replace protective equipment

In terms of mitigating constraints, our standard approach is to first study using low-cost options such as adjusting the DER power factor, before considering higher-cost options such as reconductoring. However, specific characteristics of the feeder determine the effectiveness of certain mitigations (such as using a non-unity fixed power factor for the DER) – and those mitigations may differ depending upon the location of the installation. Accordingly, attempting to pre-identify absolute mitigations that would increase the hosting capacity of each feeder will not always efficiently match the specific needs of a particular DER installation.

The National Renewable Energy Laboratory (NREL) has created a technical report[9] that further outlines costs and methods to increase hosting capacity on feeders in the

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[8] Some feeders may have additional constraints.

[9] See NREL's *The Cost of Distribution System Upgrades to Accommodate Increasing Penetrations of Distributed Photovoltaic Systems on Real Feeders in the United States* (April 2018) at https://www.nrel.gov/docs/fy18osti/70710.pdf

United States. Some of the key takeaways from that report include:

- Feeder characteristics, distribution of DER, and size of DER can all create significant variability in hosting capacity and distribution upgrade costs.
- In general, voltage constraints are lower cost to mitigate due to the ability to adjust inverter settings
- Thermal overloads are generally more expensive to mitigate.
- Upgrade costs can be minimized by guiding systems to better locations

These takeaways align with our potential mitigation strategies and further reiterate the difficulty in providing more detailed feeder specific mitigations due to the variabilities across the system.

H. Accuracy

Order Point No. 7a of the Commission's July 19, 2018 Order requests the Company to consider the methodological options to both improve and measure accuracy of the HCA, including identification and analysis of industry best practices and an explanation of the Company's methodological choice. In Section _ above, we explained that our use of the Large Centralized Method most closely matches the DER expansion occurring in Minnesota, and the limitations of the Small Distributed Method. Measuring accuracy is a time consuming and complex task. In this section, we discuss industry efforts to compare various methods and our approach to measuring the accuracy of our HCA.

1. *Industry Assessment of Hosting Capacity Methods*

In addition to accuracy of hosting capacity compared to other DG analyses, there is industry debate regarding differing methodologies and how they compare. Specifically, San Diego Gas and Electric (SDG&E) undertook a study to compare the hybrid method employed by the DRIVE tool with the Iterative Capacity Analysis (ICA) method that was employed by SDG&E to meet the California Hosting Capacity requirements.[10] The study found little difference between the results of two methods.

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[10] San Diego Gas and Electric's EPIC Final Report (December 31, 2017) https://www.sdge.com/sites/default/files/EPIC-1%20Project%204_Module%203_Final%20Report_0.pdf

Figure 2: Hybrid/DRIVE Results Compared to ICA

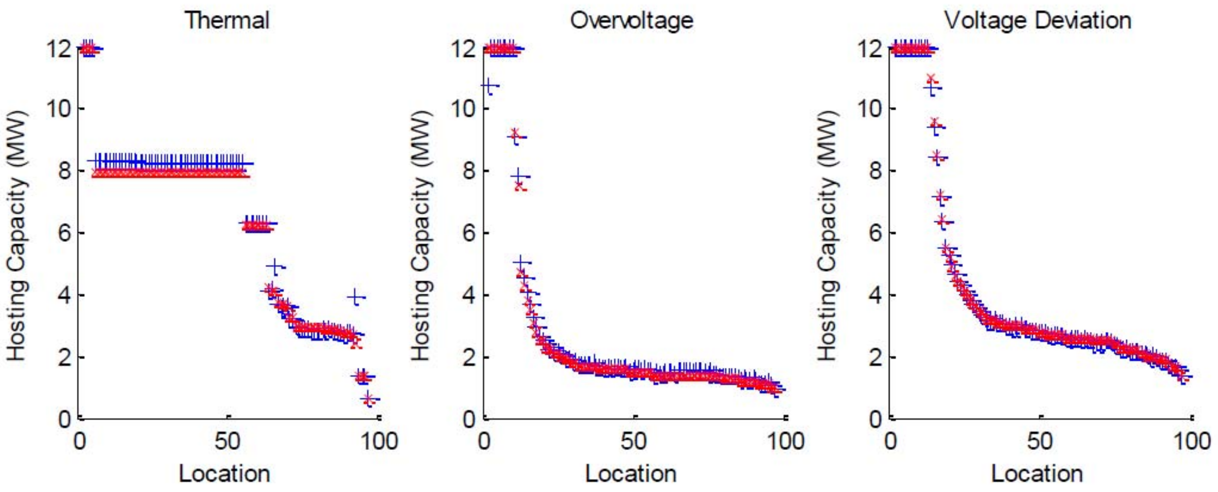


Figure 1. Comparative Results for One Feeder (Blue +: Iterative Analysis, Red x: DRIVE Analysis)

Source: San Diego Gas and Electric's EPIC Final Report, December 31, 2017, page iv.

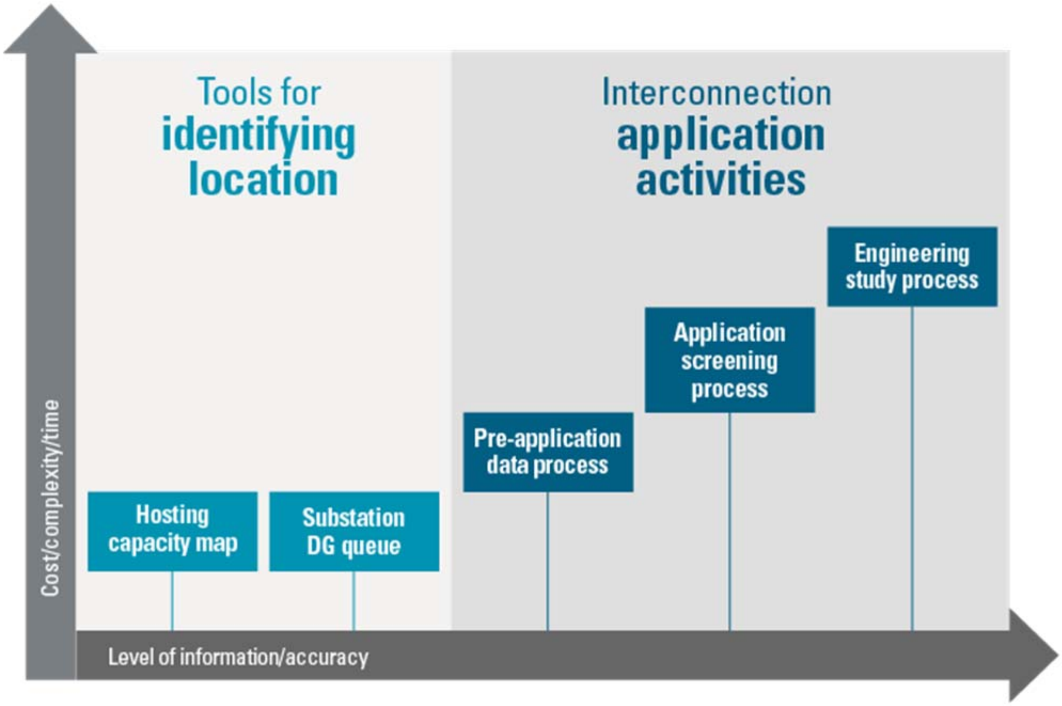
Key findings were that different hosting capacity methods can provide similar results; similar hosting capacity results can be derived more efficiently; hosting capacity methods will continue to evolve and improve. These findings demonstrate that the DRIVE hybrid method produces comparable results to one of the early leading industry approaches to hosting capacity that is significantly more labor intense to produce. We are confident that as DRIVE is refined through further improvements and modifications, the accuracy of the hybrid method will correspondingly also improve.

2. *Company Assessment of Hosting Capacity Accuracy*

In terms of gauging the accuracy of our hosting capacity results, we undertook an effort to compare them to our interconnection *screening* process results. In our 2017 report, we compared our hosting capacity results to interconnection *study* results; while a good correlation was seen between both, we noted a number of reasons why those two sets of results are not ideal in relation to one another (differing base models, power factor considerations, differing assumptions, etc.). Because there are fewer underlying differences between the HCA and interconnection screening, we believe this comparison provides a more fair assessment of hosting capacity accuracy. Also, there is discussion in the industry that hosting capacity has the potential to replace screens altogether, and make interconnection processes more streamlined; the comparison we undertook will therefore also aid this discussion.

As shown in Figure 3 below, the interconnection screening process is performed as a simplified technical analysis which may allow a project to avoid a detailed engineering impact study. The potential DER project needs to meet certain criteria (like size and voltage level) to qualify for the screen. In the screening process, the project is checked against several broad criteria – similar to hosting capacity. If the proposed project passes all screening checks, the request can bypass the full engineering study process and proceed directly to an interconnection agreement.

Figure 3: Xcel Energy DER Interconnection Tools and Processes



Our analysis first assessed the correlation of results between our 2017 and 2018 hosting capacity reports to determine whether the updated DRIVE tool used in this year's report produces results consistent with the previous version. We then correlated both our 2017 and 2018/current year hosting capacity results to the interconnection screen results.

a. 2018 Results are Consistent with 2017 Results

As of August 2018, we had performed 21 interconnection screens on large-scale DG projects. Four of those passed the screen and proceeded to interconnection agreements without further analysis; the remaining 17 proceeded to engineering study.[11] For the same points of interconnection, we recorded the corresponding hosting capacities from both of our 2017 and 2018 hosting capacity analyses. In first comparing the 2017 to 2018 hosting capacity results to each other, only three of those locations had results that differed by more than 100 kW. In all of these instances, the limiting factor for hosting capacity in the 2018 results was due to Reverse Power Flow, which as noted earlier in the report, was not utilized in the 2017 analysis. If it would have been possible to use this DRIVE Threshold in the 2017 analysis, we believe the results would have been nearly identical between the 2017 and 2018 analyses. This correlation gave us a high degree of confidence that the 2017 and 2018 results are consistent between the two versions of the DRIVE tool that we used.

b. 2017 and 2018 Results Reasonably Compare to Screen Results

When comparing both the 2017 and 2018 results to the 21 performed screens[12], we saw a similar level of accuracy. For the 21 locations, 18 of the screening results positively correlated with the 2017 hosting capacity results and 19 positively correlated with the 2018 results. This means that if the project passed the Screen for "X" amount of generation, there was at least that amount of hosting capacity at that location in our 2017/2018 reports. Based on the sizes of the projects in our sample, and the number of projects failing Screens, we believe the projects that passed Screens pushed the feeders to near their hosting capacity. In terms of accuracy, similar to projects passing the Screens, if a project failed the Screen for "X" amount, our hosting capacity reports indicated that amount of hosting capacity was not available at that location.

When digging deeper into the three locations where Screen results did not correlate with our 2017 HCA, we identified two reasons: (1) differences in Daytime Minimum Load (DML) values, and (2) potential islanding/reverse power flow issues. We discuss the specifics below.

The first and second sites that did not correlate were due to the differences in DML values. We found that the actual DML value used for the Screen was larger than the 20 percent value estimated in our HCA. When we applied the same/actual DML value from the Screen in the Synergi model and ran the results through the DRIVE software, a different hosting capacity value resulted that correlated with the Screen

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[11] The high failure rate of screens is often indication of new DER being proposed in with high levels of DER already installed.

[12] The screening performed on the large projects reviewed is similar to the Supplemental Review Screening process in the Minnesota Distributed Energy Resources Interconnection Process (MN DIP) in Docket E999/CI-16-521.

results.

The third site showed an opposite case of a failed Screen at a site that should have been capable of handling its desired 1 MW of solar generation. According to the Screen, the site failed due to potential islanding/reverse power flow issues. For this reason, the Screen flagged this project as unfit to proceed, whereas our 2017 HCA showed sufficient hosting capacity at that site. This lack of correlation was corrected with our 2018 HCA due to the inclusion of the new Threshold for Reverse Power Flow that we were able to use.

c. Summary

Based on this analysis, we believe our 2017 and 2018 HCA have produced reasonably accurate results. Our analysis also confirmed a measurable improvement in the quality of our 2018 hosting capacity results, due to the enhanced Reverse Power Flow Threshold within DRIVE. When comparing the 2018 results to the Screens performed in 2018, there was a 90 percent positive correlation rate. The only thing hindering a 100 percent correlation is estimating a default DML value as the percent of the peak feeder load.

It is not currently practical to use actual DML values in our HCA. We do not currently maintain this information for all feeders on our system. In addition, and separate from the significant effort involved in gathering actual DML values for every feeder, incorporating the actual values into our annual HCA would be a significant work effort. We would need to build a second set of feeder models containing these values, run them through DRIVE – and bring together both sets of results to determine the final values. Considering the incremental benefit portrayed by our 2018 HCA accuracy analysis, we believe a reasonable course of action is to identify and examine the feasibility and impact of other potential process improvements, and continue working with EPRI to potentially address this gap in a more efficient way.

I. 2018 HCA Results

The hosting capacity for a feeder is a range of values that depends on several variables including DER location, DER technology, feeder design, and feeder operation. Accordingly, the addition of new generation facilities on a feeder will reduce hosting capacity by an unknown value – predominately driven by the new DER location.

1. HCA is One Tool Among Several for Siting DER

We provide the results of our 2018 hosting capacity study in both tabular form and as an interactive visual representation, or heat map. The results are a snapshot in time as of August 2018. It is also important to note that DRIVE considers potential DG in increments of 100 kW on three phase sections during the HCA process. This means that if a feeder shows zero hosting capacity, there may actually be available hosting capacity of less than 100 kW. However, because the intent of the Large Centralized methodology is to examine locations for large DG installations, we did not take a more granular approach to ascertain specific values below the 100 kW threshold.

HCA results are not intended to be used for approving interconnection requests at this time.[13] Rather, they are intended to be an initial indication as to how much DER may be able to be placed on a given feeder. After consulting the HCA heat map or tabular results, we recommend customers utilize progressively more detailed tools to ascertain the viability of the site in which they are interested, as follows:

1. Review the publicly-available Solar*Rewards Community interconnection queue.[14] The queue is updated monthly, and may include additional generation that was proposed after the snapshot in time from which HCA data is drawn.
2. Request pre-application data for the interconnection location of interest, in order to further identify characteristics of the circuit that may impact hosting capacity.
3. Submit an interconnection application for the DER project to initiate the Screening and/or Study process. A completed interconnection application is the mechanism by which a project enters into the queue and begins the process for reserving hosting capacity. The outcome of Screening or Studies will identify allowable interconnection size and any mitigation costs.

2. *Specific 2018 HCA Results*

Our 2018 HCA results will differ in some instances from the 2017 HCA for a number of reasons, including the following:

- Changes in feeder forecasts (variations in load),
- New projects that result in changes to the configuration or capacity of a feeder,
- The addition of fuses as a limiting element for thermal violations,
- The addition of the DRIVE Reverse Power Flow Threshold,
- New CSG implemented on the system (connected DER),
- Only considering in-service CSG in the analysis (connected DER),[15] and

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[13] Our current Minnesota Electric Rate Book Sections 9 and 10 interconnection tariffs provide the applicable processes for DER interconnections.

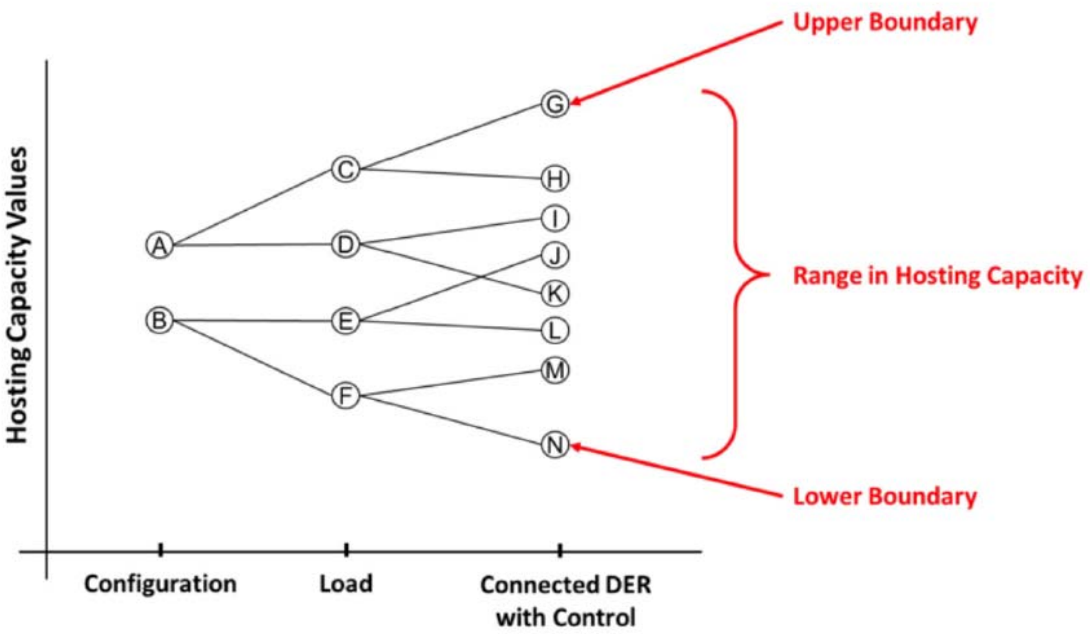
[14] Note that effective in June 2019, the public queue will include all DER interconnection applications.

[15] Our 2017 HCA attempted to predict CSG projects that would proceed to implementation.

- Remedying an issue where disabled generation in model was inadvertently turned on during analysis (connected DER).

We portray the impact that various factors have on HCA results in DRIVE in Figure 4 below.

Figure 4: Impact Factors and Recommended HCA Incorporation

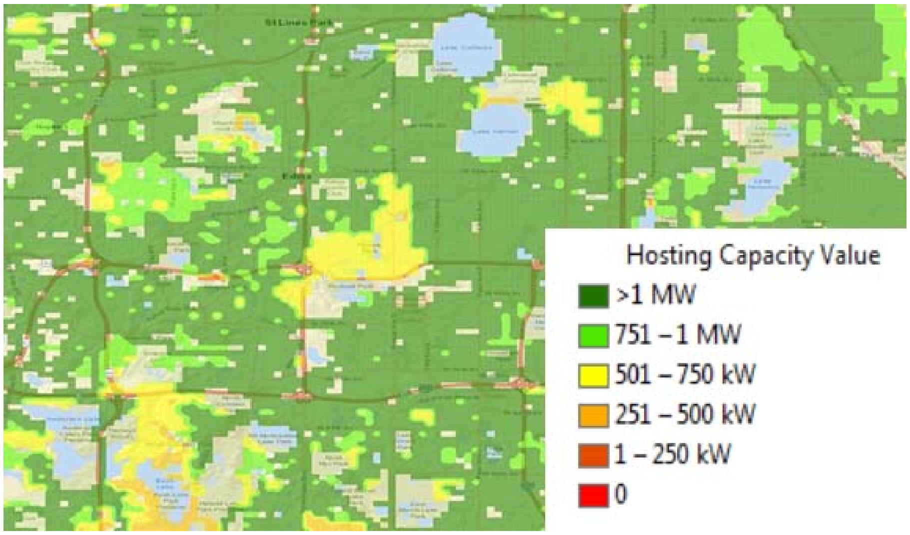


Source: EPRI – Impact Factors and Recommendations on How to Incorporate Them When Calculating Hosting Capacity. https://www.epri.com/#/pages/product/3002013381/

Our 2018 HCA results show 95 feeders that indicate zero maximum hosting capacity. In addition to the general note above regarding DRIVE's 100 kW incremental approach, 86 of these feeders have significant amounts of existing DG on them (83 of which have 1 MW or more). These existing DG installations have essentially "used-up" the hosting capacity on those feeders; in some cases, mitigations were completed on these feeders that added just enough capacity to the distribution system to accommodate a specific DG resource. The remaining nine feeders with zero hosting capacity either have no load on the feeder (reverse power flow violation) or have high voltage concerns for various reasons.

Figure 5 below is an example of the visual hosting capacity results that are available on our website at https://www.xcelenergy.com/working_with_us/how_to_interconnect. We note, the legend for the map is color-coded to indicate varying levels of available hosting capacity.

Figure 5: Example of Visual Hosting Capacity Results



Users are able to zoom in and zoom out – and have the option for a full-screen view. For feeders that are in close proximity to another feeder that has differing available hosting capacity, we have indicated the higher of the two capacities.

The heat map and tabular HCA results provide the amount of hosting capacity available without doing any mitigations. Therefore, while a location may show low hosting capacity, it is possible that mitigations could allow higher levels of DER to be interconnected; however, a study would need to be completed for that to be determined.

J. Sensitivity Analysis

We ran a sensitivity analysis for variations in substation bus voltage, as well as power factor for new generation. This is one of the requests in response to stakeholder feedback (Order Point No. 7c) the Commission included in its July 19, 2018 Order on our 2017 HCA.

For both of these analyses, we used the same five feeders, which we chose because they are broadly representative of differences we have on our system. One feeder was considered urban; two, suburban; and two, non-urban/rural. Each geographic category had one feeder with a primary voltage of 13.8kV and one with primary voltage of 34.5kV – with the exception of the urban feeder, which was at 13.8kV (we do not have 34.5kV serving urban areas).

1. *Power Factor Sensitivity Analysis*

For the power factor sensitivity analysis, we varied the power factor for all new DG added to each feeder from unity to 0.98 leading to 0.95 leading. The analysis assumed the additional reactive power support needed to increase the hosting capacity was available from the transmission system without adverse impacts. There is a limit to the amount of reactive power that can be adequately supplied to the distribution system and it will vary by location. Power flow studies are typically required for determining acceptable DER power factor settings beyond 0.98 leading. This is why we chose to use 0.98 leading exclusively for both the 2017 and 2018 analysis.

The table below illustrates the theoretical increases in hosting capacity that we observed, and the violations that limited them.

Table 3: Observed Theoretical Increases in Hosting Capacity – Power Factor Sensitivity Analysis

Feeder	Hosting Capacity Gained at 0.98 leading PF (kW)	Incremental Additional Hosting Capacity Gained at 0.95 leading PF (kW) over the 0.98 leading case	New Threshold Violated
A	600	800	Primary over voltage
B	300	40	Thermal for generation
C	0	0	Primary over voltage
D	100	100	Primary over voltage
E	200	0	Thermal for generation

The average hosting capacity gained by changing the power factor of new DER to 0.98 leading was 240 kW. If the power factor was changed to 0.95 leading, an average of 188 kW of additional hosting capacity was realizable beyond what was already accounted for with the 0.98 case. However, one feeder saw no gain in relation to either of the changes, and another saw no gain when going from 0.98 to 0.95. While three of the thresholds maintained over voltage as the limiting factor, two others changed to thermal for generation. As more reactive power is needed for the non-unity power factors, the hosting capacity that is limited by 'thermal for generation' will continue to decrease.

As noted above, there is a limit to the amount of reactive power support that can be supplied to the distribution system from the transmission system. We can, and have used a more leading power factor than 0.98 for some installations, but not without conducting a detailed impact study. Assuming a more leading power factor for all new potential installations in our HCA would definitely show more hosting capacity across our system. However, it would be less accurate, due to the limitations that exist.

2. *Bus Voltage Sensitivity Analysis*

For the bus voltage sensitivity analysis, each feeder's minimum hosting capacity was determined with the standard bus voltage of 104 percent and then re-determined with bus voltages at 102 percent and 100 percent. While it may not be possible to implement the lower bus voltage settings in the field, the conclusion we reached with this theoretical analysis was that hosting capacity can be increased for the Primary Over-Voltage threshold by reducing the bus voltage. However, it has negligible or no effect on the other threshold categories and they soon become the new limiting threshold.

It is important to understand that bus voltage is set higher to mitigate potential low voltage issues at the end of the feeder. If the bus voltage were to be lowered, it could lead to low voltage for customers during periods of high usage. It can also lead to the inability to switch load to a neighboring feeder during contingency or maintenance situations, because the neighboring feeder doesn't have enough voltage headroom to serve the additional load. Two of the five feeders began exhibiting low voltage issues at 102 percent and four of the five had them at 100 percent. This affirms the point that setting the bus voltage lower has other ramifications that would make a real-life implementation impractical without a significant investment in systems and equipment to enable a new level of feeder voltage regulation.

Table 4 below illustrates the theoretical increases in hosting capacity that were observed and the new violations that limited them. The average hosting capacity gained by reducing the voltage by two percent was 260 kW. If the hosting capacity was reduced by a full four percent no additional gains were seen beyond what was already accounted for with the two percent reduction. Low voltage during peak usage or thermal backflow overloads limited the gains that were realized in the over-voltage threshold.

Table 4: Observed Theoretical Increases in Hosting Capacity – Bus Voltage Sensitivity Analysis

Feeder	Hosting Capacity Gained at 102% (kW)	Hosting Capacity Gained at 100% (kW)	New Threshold Violated
A	0	0	Low voltage
B	400	0	Thermal for Generation
C	0	0	Low Voltage
D	700	0	Low Voltage
E	200	0	Thermal for Generation

3. *Conclusions*

When observing both variations in power factor and bus voltage, it is apparent that theoretical hosting capacity gains could be made. However, those gains are relatively small and lead to other system issues such as the need for reactive power support, potential low voltages for customers, and loss of resilience to alternatively serve load during contingency situations. Also, these potential changes really only have any positive impact in regards to the Primary Over-Voltage threshold. The other six Thresholds see virtually no change, with the exception of the Thermal for Generation Threshold, which actually decreases due to the extra amount of reactive power now on the system. While both of these analyses proved to have some significance, our conclusion is that the power factor and bus voltage decisions we have made to date are reasonable.

K. Presentation of HCA Results Considers Privacy and Security Interests

The Commission's July 19, 2018 Order requested that we explore a range of options for better presenting the public-facing results of the Hosting Capacity Analysis after consideration of, but not limited to, any security and privacy issues that may be implicated in providing more detailed information and what information might be useful to developers and stakeholders. In this section, we discuss our approach to stakeholder engagement on the topic of HCA, as well as the customer and Company privacy and security interests we have taken into account in the HCA results that we present.

1. *Stakeholder Engagement*

Stakeholder involvement in developing the HCA has occurred in several ways since our first HCA report in 2016. Most recently, we gathered feedback from the

Solar*Rewards Community (S*RC) Workgroup.[16] Approximately 20-30 solar developers and other stakeholders regularly participate in the S*RC Workgroup.

Workgroup meetings cover many program-related topics, including discussion surrounding how to make the interconnection process easier, for example, by providing more data to developers. The HCA is one of the tools to meet that need. As we began to develop the initial visual/heat map representation of the HCA in early 2017, we met with a small group of developers and other stakeholders to discuss the 2016 results and what they would want to see in the 2017 analysis – including a visual representation. Much of the feedback we received was in-line with the informal research we did on what other utilities were doing with their maps. In 2017, we published our first HCA map on the Xcel Energy website.

In an effort to continue to improve the use and usefulness of the HCA, we met with the Workgroup in mid-2018. Several members shared that they had not used the map – and others had visited our website and were aware of the HCA, but did not regularly use the HCA map. Others discussed ways they felt the map would be more useful – specifically, more frequent updates and more information surrounding the substation, feeder, and other equipment.[17] Currently the more detailed equipment information is available through the pre-application process, which can be requested at a cost.

From the discussion at the at the workgroup meeting, it was clear that the members did not have a strong understanding of HCA and how to apply it. As a result, we focused the balance of our time at that meeting on clarifying items in the HCA report – with a takeaway to update the interconnections information available on our website to better explain the various interconnection tools and processes. Our goal with this is to help stakeholders navigate as efficiently as possible the various processes – and get the information that they need, based on where they are with their potential/ proposed projects. However, at this time we are waiting on finalization of the new MN DIP before fully making changes to our website.

We note that we have looked at several different ways to update the HCA map more frequently – and initially thought we could do a streamlined update. However, as we have looked deeper into what would be involved, we found that we would need to undertake a complete HCA analysis each time. We believe the resources that would need to be dedicated to this effort would outweigh the benefit. That said, we have

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[16] Prior to the launch of our Solar*Rewards Community (S*RC) program, we started a Workgroup based on the Commission's April 7, 2014 Order in Docket No. E002/M-13-867.

[17] This feedback was consistent with many comments received by parties in response to our 2017 HCA filing.

improved our 2018 HCA analysis in several ways, some of which better align with our interconnection screening process. We are also continuing to look for ways to update the analysis more frequently without needing to complete the entire process with each update.

We are also working toward adding more data to the HCA map. While we believe we can provide more detailed equipment-related information for users, as desired, we have been unable at this time to overcome a usability issue for feeders that are close in proximity to another feeder. In this circumstance, the user would get information from multiple feeders, which we believe would be more frustrating than the current process of requesting specific information based on a location. Therefore, we did not implement this change with our 2018 HCA map. Like we are doing with the request for more frequent updates, we are continuing to examine options that would provide this information in a consistently usable format.

2. *Customer and Company Privacy and Security Considerations*

We note that we have removed certain feeders from the heat map in an effort to protect what we believe is private or confidential customer data, and/or critical distribution infrastructure information.

As we discussed in our September 21, 2017 Reply Comments in the Commission's grid modernization docket (Docket No. E999/CI-15-556), the issue of access and protection of distribution grid information is largely uncharted territory today. At the state level, the Commission has examined customer privacy and confidentiality in terms of Customer Energy Usage Data (CEUD) and customer Personally Identifiable Information (PII).[18] At a national level, we looked to guidance from the National Institute of Standards and Technology (NIST), North American Electric Reliability Corporation (NERC), and Federal Energy Regulatory Commission (FERC). We found that existing regulatory, legal, and industry frameworks provide little to no guidance with respect to data security protections and customer privacy and confidentiality considerations as it relates to distribution grid data.

We therefore considered these sources as advisory and developed criteria to apply to the visual hosting capacity results that would protect what we believe is sensitive and therefore non-public grid and customer information. We did this while also balancing public policy considerations that some may believe should result in full disclosure. In terms of customer privacy and confidentiality, we looked to the Commission's decisions on customer PII and CEUD. While grid and customer connection details

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[18] Docket No. E,G999/CI-12-1344.

are not a directly implicated in that proceeding, the Commission directed utilities to look to NIST principles for guidance with regard to collection and protection of customer PII – and required utilities to refrain from disclosing CEUD without the customer's consent unless the utility has adequately protected the customer's anonymity. In looking to NIST and other national standards that are generally applicable to the transmission grid, we found that they are broad and largely rely on utilities' judgement to apply them to their infrastructure.

We therefore applied our judgement within the broad guidance provided by these sources to develop criteria that we believe balances public policy objectives with the public interest, in terms of energy security – and our customers' interests, in terms of their privacy and confidentiality. We recognize that we are the first utility in Minnesota to encounter these privacy questions as they relate to hosting capacity, and look forward to Commission direction on the approach we have taken.

Specifically, we worked with our customer account management group to identify the customers and their associated feeder(s) that would fall into the following categories:

- Critical Energy Infrastructure on Distribution Feeder
- Critical Hospital - Level 1 or 2 Trauma Center on Distribution Feeder
- Critical Data Center on Distribution Feeder
- Critical Public Gathering Center on Distribution Feeder

We then identified feeders serving less than 15 premises, which we based on the threshold we apply to requests for aggregated CEUD – believing that feeders with such low density may provide insights into those customer locations that could compromise customer confidentiality and/or customer energy security.

We note that the Minnesota Government Data Practices Act (Minn. Stat. § 13.01 et seq.) addressing nonpublic data (Minn. Stat. § 13.02, subd. 9), private data on individuals (Minn. Stat. § 13.02, subd. 12), security information (Minn. Stat. § 13.37, subd. 1(a)), and trade secret information (Minn. Stat. § 13.37, subd. 1(b)), is not directly applicable here. The Minnesota Government Data Practices Act only addresses information held by state government. Here, the Hosting Capacity map developed by the Company has been publicly filed, and there is no Trade Secret or nonpublic version of this filed map on file with state government. Instead, in putting this map together, the Company has been sensitive to what could be considered to be nonpublic under this Act, and provided the heat map to reflect these concerns.

In light of these concerns, and the timing from the Commission's June 2017 hearing that set the requirement to provide the results of our study in a visual manner with submission of this report five months later, if there was a feeder with information we reasonably believed to be non-public, we excluded the entire feeder from the heat map by not providing any indicative color at all for that feeder. In total, we redacted 120 feeders out of a total of 1,049 in applying the criteria outlined above.

We believe the criteria we developed and applied to our heat map results are based on sound principles, and reasonably balance grid security, customer privacy, confidentiality, and energy security, and public policy objectives. For our next report, we will look into refining our methodology after also considering feedback we receive on this report.

CONCLUSION

Xcel Energy recognizes hosting capacity will become an important aspect of distribution system planning in the future. We believe it has the potential to further enable greater levels of DER integration by guiding future installations and identifying areas of constraint. We will continue to work closely with stakeholders and engage in the industry to identify and address other areas of opportunity that maximizes the value of this analysis.

Dated: November 1, 2018

Northern States Power Company

Substation	Feeder	Minimum Hosting Capacity (MW)	Min Limiting Factor	Maximum Hosting Capacity (MW)	Max Limiting Factor
Afton	AFT314	0.1	Primary Over-Voltage - min	2.14	Breaker Relay Reduction of Reach - max
Afton	AFT315	0.1	Primary Over-Voltage - min	1.77	Primary Over-Voltage - max
Afton	AFT321	0.07	Primary Over-Voltage - min	0.48	Primary Over-Voltage - max
Afton	AFT322	0.64	Thermal for Gen - min	3.49	Reverse Power Flow - max
Arden Hills	AHI021	0.3	Primary Over-Voltage - min	0.4	Primary Over-Voltage - max
Arden Hills	AHI022	0.3	Primary Over-Voltage - min	0.4	Primary Over-Voltage - max
Arden Hills	AHI024	0.3	Primary Over-Voltage - min	0.4	Primary Over-Voltage - max
Arden Hills	AHI025	0.4	Primary Over-Voltage - min	0.5	Primary Over-Voltage - max
Arden Hills	AHI063	0.49	Thermal for Gen - min	1.72	Reverse Power Flow - max
Airport	AIR060	0.3	Primary Over-Voltage - min	1.02	Breaker Relay Reduction of Reach - max
Airport	AIR061	0.96	Reverse Power Flow - min	0.96	Reverse Power Flow - max
Airport	AIR069	0.9	Primary Over-Voltage - min	1.08	Reverse Power Flow - max
Airport	AIR072	1.2	Primary Over-Voltage - min	1.3	Reverse Power Flow - max
Airport	AIR073	0.48	Thermal for Gen - min	0.7	Reverse Power Flow - max
Airport	AIR074	1.2	Thermal for Gen - min	1.36	Reverse Power Flow - max
Airport	AIR077	1.2	Primary Over-Voltage - min	1.7	Reverse Power Flow - max
Airport	AIR078	0.21	Reverse Power Flow - min	0.21	Reverse Power Flow - max
Airport	AIR079	1.23	Thermal for Gen - min	1.31	Reverse Power Flow - max
Airport	AIR62X	1.09	Reverse Power Flow - min	1.09	Reverse Power Flow - max
Airport	AIR62Y	0	Reverse Power Flow - min	0	Reverse Power Flow - max
Albany	ALB021	0.3	Primary Over-Voltage - min	1.35	Reverse Power Flow - max
Albany	ALB022	0.3	Primary Over-Voltage - min	0.8	Reverse Power Flow - max
Aldrich	ALD071	0.29	Thermal for Gen - min	0.65	Reverse Power Flow - max
Aldrich	ALD072	0.6	Thermal for Gen - min	1.42	Reverse Power Flow - max
Aldrich	ALD073	0.6	Thermal for Gen - min	1.22	Reverse Power Flow - max
Aldrich	ALD075	0.98	Reverse Power Flow - min	0.98	Reverse Power Flow - max
Aldrich	ALD076	0.2	Primary Over-Voltage - min	0.79	Breaker Relay Reduction of Reach - max
Aldrich	ALD081	0.66	Reverse Power Flow - min	0.66	Reverse Power Flow - max
Aldrich	ALD082	0.96	Thermal for Gen - min	1.6	Reverse Power Flow - max
Aldrich	ALD083	0.17	Thermal for Gen - min	0.57	Breaker Relay Reduction of Reach - max
Aldrich	ALD084	0.96	Thermal for Gen - min	1.3	Reverse Power Flow - max
Aldrich	ALD085	0.6	Thermal for Gen - min	1.92	Reverse Power Flow - max
Aldrich	ALD086	0.5	Primary Over-Voltage - min	1.96	Reverse Power Flow - max
Aldrich	ALD087	0.99	Reverse Power Flow - min	0.99	Reverse Power Flow - max

Substation	Feeder	Minimum Hosting Capacity (MW)	Min Limiting Factor	Maximum Hosting Capacity (MW)	Max Limiting Factor
Aldrich	ALD088	0.96	Thermal for Gen - min	2.08	Reverse Power Flow - max
Aldrich	ALD091	0.75	Reverse Power Flow - min	0.75	Reverse Power Flow - max
Aldrich	ALD092	0.96	Thermal for Gen - min	2.65	Reverse Power Flow - max
Aldrich	ALD093	0.65	Reverse Power Flow - min	0.65	Reverse Power Flow - max
Aldrich	ALD094	0.26	Thermal for Gen - min	0.79	Reverse Power Flow - max
Aldrich	ALD095	0.96	Thermal for Gen - min	1.15	Reverse Power Flow - max
Aldrich	ALD096	0.5	Primary Over-Voltage - min	1.41	Reverse Power Flow - max
Aldrich	ALD097	0.96	Thermal for Gen - min	1.74	Reverse Power Flow - max
Aldrich	ALD098	0.6	Thermal for Gen - min	1.46	Reverse Power Flow - max
Air Lake	ALK063	0.8	Primary Over-Voltage - min	2.01	Reverse Power Flow - max
Air Lake	ALK064	0	Primary Over-Voltage - min	0	Primary Over-Voltage - max
Air Lake	ALK067	1.15	Thermal for Gen - min	1.5	Reverse Power Flow - max
Air Lake	ALK072	0.5	Primary Over-Voltage - min	2.05	Reverse Power Flow - max
Air Lake	ALK073	0.82	Thermal for Gen - min	1.89	Reverse Power Flow - max
Altura	ALT021	0	Primary Over-Voltage - min	0	Primary Over-Voltage - max
Annandale	ANN021	0.24	Thermal for Gen - min	2.17	Breaker Relay Reduction of Reach - max
Apache	APA061	0.94	Thermal for Gen - min	1.71	Reverse Power Flow - max
Apache	APA064	1.03	Thermal for Gen - min	1.4	Reverse Power Flow - max
Apache	APA065	0.47	Thermal for Gen - min	1.41	Reverse Power Flow - max
Apache	APA067	0.59	Thermal for Gen - min	1.51	Reverse Power Flow - max
Apache	APA068	0.64	Thermal for Gen - min	1.14	Reverse Power Flow - max
Apache	APA069	0.8	Reverse Power Flow - min	0.8	Reverse Power Flow - max
Apache	APA071	0.63	Thermal for Gen - min	1.52	Reverse Power Flow - max
Apache	APA072	0.7	Primary Over-Voltage - min	1.47	Reverse Power Flow - max
Apache	APA073	0.94	Thermal for Gen - min	1.49	Reverse Power Flow - max
Apache	APA074	1.03	Thermal for Gen - min	1.97	Reverse Power Flow - max
Apache	APA075	0.94	Thermal for Gen - min	1.81	Reverse Power Flow - max
Apache	APA076	0.85	Thermal for Gen - min	1.32	Reverse Power Flow - max
Apache	APA077	1.21	Thermal for Gen - min	1.32	Reverse Power Flow - max
Apache	APA078	0.26	Thermal for Gen - min	1.27	Reverse Power Flow - max
Atwater	ATW061	0	Primary Over-Voltage - min	0	Primary Over-Voltage - max
Atwater	ATW062	0.1	Primary Over-Voltage - min	0.97	Breaker Relay Reduction of Reach - max
Avon	AVN021	0	Primary Over-Voltage - min	0	Primary Over-Voltage - max
Averill	AVR081	0.12	Thermal for Gen - min	0.31	Reverse Power Flow - max

Substation	Feeder	Minimum Hosting Capacity (MW)	Min Limiting Factor	Maximum Hosting Capacity (MW)	Max Limiting Factor
Birch	BCH311	0.9	Primary Over-Voltage - min	1.45	Reverse Power Flow - max
Battle Creek	BCK061	3.01	Thermal for Gen - min	3.01	Thermal for Gen - max
Battle Creek	BCK062	0.93	Reverse Power Flow - min	0.93	Reverse Power Flow - max
Battle Creek	BCK071	0	Reverse Power Flow - min	0	Reverse Power Flow - max
Battle Creek	BCK072	0.59	Reverse Power Flow - min	0.59	Reverse Power Flow - max
Battle Creek	BCK073	0.9	Primary Over-Voltage - min	1.1	Reverse Power Flow - max
Battle Creek	BCK074	1.04	Reverse Power Flow - min	1.04	Reverse Power Flow - max
Bassett Creek	BCR061	0.95	Thermal for Gen - min	1.59	Reverse Power Flow - max
Bassett Creek	BCR062	0.98	Thermal for Gen - min	2.13	Reverse Power Flow - max
Bassett Creek	BCR063	0.94	Thermal for Gen - min	2.08	Reverse Power Flow - max
Bassett Creek	BCR081	1.14	Reverse Power Flow - min	1.14	Reverse Power Flow - max
Bassett Creek	BCR082	1.17	Thermal for Gen - min	1.45	Reverse Power Flow - max
Bassett Creek	BCR083	0.97	Thermal for Gen - min	1.2	Reverse Power Flow - max
Belgrade	BEG001	0.1	Primary Over-Voltage - min	0.2	Primary Over-Voltage - max
Becker	BEK021	0.2	Primary Over-Voltage - min	0.2	Primary Over-Voltage - max
Becker	BEK311	0.1	Primary Over-Voltage - min	0.94	Reverse Power Flow - max
Belle Plain	BEL061	0.1	Primary Over-Voltage - min	0.2	Primary Over-Voltage - max
Belle Plain	BEL062	0	Primary Over-Voltage - min	0	Primary Over-Voltage - max
Buffalo Lake	BFL021	0	Primary Over-Voltage - min	0	Primary Over-Voltage - max
Bird Island	BIS001	0.1	Primary Over-Voltage - min	0.5	Reverse Power Flow - max
Bluff Creek	BLC061	1.2	Primary Over-Voltage - min	1.24	Reverse Power Flow - max
Bluff Creek	BLC062	0.7	Primary Over-Voltage - min	2.19	Reverse Power Flow - max
Bluff Creek	BLC063	1	Primary Over-Voltage - min	1.94	Reverse Power Flow - max
Bluff Creek	BLC071	1.17	Thermal for Gen - min	2.02	Reverse Power Flow - max
Bluff Creek	BLC072	0.9	Primary Over-Voltage - min	1.27	Reverse Power Flow - max
Blue Herron	BLH061	0	Primary Over-Voltage - min	0	Primary Over-Voltage - max
Blue Herron	BLH062	0.2	Primary Over-Voltage - min	0.35	Reverse Power Flow - max
Blue Lake	BLL062	0.26	Thermal for Gen - min	1.03	Reverse Power Flow - max
Blue Lake	BLL063	0.24	Thermal for Gen - min	1.82	Reverse Power Flow - max
Blue Lake	BLL064	0.5	Reverse Power Flow - min	0.5	Reverse Power Flow - max
Blue Lake	BLL071	0.5	Primary Over-Voltage - min	2.31	Reverse Power Flow - max
Blue Lake	BLL072	0.96	Thermal for Gen - min	1.65	Reverse Power Flow - max
Brooten	BRO021	0	Primary Over-Voltage - min	0	Primary Over-Voltage - max
Brooklyn Park	BRP061	0.83	Reverse Power Flow - min	0.83	Reverse Power Flow - max

Substation	Feeder	Minimum Hosting Capacity (MW)	Min Limiting Factor	Maximum Hosting Capacity (MW)	Max Limiting Factor
Brooklyn Park	BRP062	0.8	Primary Over-Voltage - min	1.5	Reverse Power Flow - max
Brooklyn Park	BRP063	0.94	Thermal for Gen - min	1.23	Reverse Power Flow - max
Brooklyn Park	BRP071	0.9	Primary Over-Voltage - min	1.36	Reverse Power Flow - max
Brooklyn Park	BRP072	0.94	Thermal for Gen - min	1.38	Reverse Power Flow - max
Brooklyn Park	BRP073	0.94	Thermal for Gen - min	1.78	Reverse Power Flow - max
Brownton	BRW001	0.1	Reverse Power Flow - min	0.1	Reverse Power Flow - max
Butterfield	BTF001	0.07	Thermal for Gen - min	0.15	Reverse Power Flow - max
Burnside	BUR022	0.85	Thermal for Gen - min	1.08	Reverse Power Flow - max
Burnside	BUR023	0.4	Primary Over-Voltage - min	1	Reverse Power Flow - max
Burnside	BUR032	0	Primary Over-Voltage - min	0	Primary Over-Voltage - max
Baytown	BYT061	0.2	Primary Over-Voltage - min	0.37	Reverse Power Flow - max
Baytown	BYT071	0.35	Reverse Power Flow - min	0.35	Reverse Power Flow - max
Baytown	BYT072	0.63	Reverse Power Flow - min	0.63	Reverse Power Flow - max
Cannon Falls	CAF021	0.57	Reverse Power Flow - min	0.57	Reverse Power Flow - max
Cannon Falls	CAF022	0.32	Thermal for Gen - min	0.57	Reverse Power Flow - max
Cedarvale	CDV061	0.83	Reverse Power Flow - min	0.83	Reverse Power Flow - max
Cedarvale	CDV062	0.87	Reverse Power Flow - min	0.87	Reverse Power Flow - max
Cedarvale	CDV063	0.8	Primary Over-Voltage - min	0.84	Reverse Power Flow - max
Cedarvale	CDV071	0.97	Thermal for Gen - min	1.77	Reverse Power Flow - max
Cedarvale	CDV072	0.6	Thermal for Gen - min	1.93	Reverse Power Flow - max
Cedar Lake	CEL061	1.17	Thermal for Gen - min	1.39	Reverse Power Flow - max
Cedar Lake	CEL062	0.94	Thermal for Gen - min	1.12	Reverse Power Flow - max
Cedar Lake	CEL063	1.09	Reverse Power Flow - min	1.09	Reverse Power Flow - max
Cedar Lake	CEL064	0.9	Primary Over-Voltage - min	1.51	Reverse Power Flow - max
Cedar Lake	CEL066	0.94	Thermal for Gen - min	1.02	Reverse Power Flow - max
Cedar Lake	CEL071	1.29	Thermal for Gen - min	1.87	Reverse Power Flow - max
Cedar Lake	CEL072	0.95	Thermal for Gen - min	0.95	Reverse Power Flow - max
Cedar Lake	CEL075	1.06	Reverse Power Flow - min	1.06	Reverse Power Flow - max
Cottage Grove	CGR061	0.5	Primary Over-Voltage - min	2.71	Reverse Power Flow - max
Cottage Grove	CGR062	0.94	Thermal for Gen - min	2.62	Reverse Power Flow - max
Cottage Grove	CGR063	0	Primary Over-Voltage - min	0	Primary Over-Voltage - max
Cottage Grove	CGR064	1	Primary Over-Voltage - min	1.8	Reverse Power Flow - max
Cottage Grove	CGR071	0.58	Reverse Power Flow - min	0.58	Reverse Power Flow - max
Cottage Grove	CGR072	0.94	Thermal for Gen - min	2.21	Reverse Power Flow - max

Substation	Feeder	Minimum Hosting Capacity (MW)	Min Limiting Factor	Maximum Hosting Capacity (MW)	Max Limiting Factor
Cottage Grove	CGR073	2.26	Reverse Power Flow - min	2.26	Reverse Power Flow - max
Cottage Grove	CGR074	1	Primary Over-Voltage - min	1.41	Reverse Power Flow - max
Chemolite	CHE063	0.13	Thermal for Gen - min	1.81	Reverse Power Flow - max
Chemolite	CHE064	0.6	Thermal for Gen - min	1.27	Reverse Power Flow - max
Chemolite	CHE075	0.4	Primary Over-Voltage - min	1.44	Reverse Power Flow - max
Chemolite	CHE076	0.7	Primary Over-Voltage - min	1.78	Reverse Power Flow - max
Chisago County	CHI311	0.2	Primary Over-Voltage - min	1.24	Breaker Relay Reduction of Reach - max
Clarks Grove	CKG041	0.1	Primary Over-Voltage - min	0.39	Reverse Power Flow - max
Clara City	CLC022	0.4	Primary Over-Voltage - min	0.57	Primary Over-Voltage - max
Clara City	CLC221	0.2	Primary Over-Voltage - min	0.85	Primary Over-Voltage - max
Coon Creek	CNC061	0.6	Primary Over-Voltage - min	1	Reverse Power Flow - max
Coon Creek	CNC062	1.17	Thermal for Gen - min	1.59	Reverse Power Flow - max
Coon Creek	CNC063	0.94	Thermal for Gen - min	1.49	Reverse Power Flow - max
Coon Creek	CNC071	0.94	Thermal for Gen - min	1.03	Reverse Power Flow - max
Coon Creek	CNC072	1.17	Thermal for Gen - min	1.58	Reverse Power Flow - max
Coon Creek	CNC073	0.9	Primary Over-Voltage - min	1.94	Reverse Power Flow - max
Cokato	COK061	0	Primary Over-Voltage - min	0	Primary Over-Voltage - max
Crystal Foods	CRF061	0.28	Reverse Power Flow - min	0.28	Reverse Power Flow - max
Crystal Foods	CRF062	0.28	Thermal for Gen - min	1.81	Reverse Power Flow - max
Crooked Lake	CRL027	0.4	Primary Over-Voltage - min	1.8	Reverse Power Flow - max
Crooked Lake	CRL031	0.53	Thermal for Gen - min	1.23	Reverse Power Flow - max
Crooked Lake	CRL033	1.38	Thermal for Gen - min	1.82	Reverse Power Flow - max
Crooked Lake	CRL065	1.2	Primary Over-Voltage - min	1.24	Reverse Power Flow - max
Castle Rock	CSR001	0.1	Reverse Power Flow - min	0.1	Reverse Power Flow - max
nnon Falls Transmiss	CTF021	0.2	Primary Over-Voltage - min	0.92	Reverse Power Flow - max
nnon Falls Transmiss	CTF022	0.22	Thermal for Gen - min	1.25	Reverse Power Flow - max
Credit River	CTR021	0.85	Thermal for Gen - min	1	Reverse Power Flow - max
Credit River	CTR022	0.7	Reverse Power Flow - min	0.7	Reverse Power Flow - max
Credit River	CTR031	0.5	Primary Over-Voltage - min	2.29	Reverse Power Flow - max
Danube	DAN021	0.2	Primary Over-Voltage - min	0.5	Reverse Power Flow - max
Dassel	DAS061	0.2	Primary Over-Voltage - min	0.21	Reverse Power Flow - max
Dayton's Bluff	DBL060	0.3	Primary Over-Voltage - min	0.97	Breaker Relay Reduction of Reach - max
Dayton's Bluff	DBL061	0.27	Thermal for Gen - min	1.97	Reverse Power Flow - max
Dayton's Bluff	DBL062	1.07	Thermal for Gen - min	1.78	Reverse Power Flow - max

Substation	Feeder	Minimum Hosting Capacity (MW)	Min Limiting Factor	Maximum Hosting Capacity (MW)	Max Limiting Factor
Dayton's Bluff	DBL063	0.72	Thermal for Gen - min	1.44	Reverse Power Flow - max
Dayton's Bluff	DBL064	0.26	Thermal for Gen - min	1.21	Reverse Power Flow - max
Dayton's Bluff	DBL065	0.96	Thermal for Gen - min	1.44	Reverse Power Flow - max
Dayton's Bluff	DBL066	0.3	Primary Over-Voltage - min	0.66	Reverse Power Flow - max
Dayton's Bluff	DBL067	0.6	Thermal for Gen - min	1.7	Reverse Power Flow - max
Dayton's Bluff	DBL068	0.6	Primary Over-Voltage - min	1.7	Reverse Power Flow - max
Dayton's Bluff	DBL069	0.65	Thermal for Gen - min	2.11	Reverse Power Flow - max
Dayton's Bluff	DBL072	0.94	Reverse Power Flow - min	0.94	Reverse Power Flow - max
Dayton's Bluff	DBL073	0.6	Thermal for Gen - min	1.35	Reverse Power Flow - max
Dayton's Bluff	DBL074	0.92	Reverse Power Flow - min	0.92	Reverse Power Flow - max
Dayton's Bluff	DBL081	0.27	Thermal for Gen - min	1.1	Reverse Power Flow - max
Dayton's Bluff	DBL082	0.6	Reverse Power Flow - min	0.6	Reverse Power Flow - max
Douglas County	DGC061	0	Primary Over-Voltage - min	0	Primary Over-Voltage - max
Dahlgren	DHL061	0.36	Thermal for Gen - min	1.26	Reverse Power Flow - max
Delano	DLO021	0.15	Reverse Power Flow - min	0.15	Reverse Power Flow - max
Dundas	DND061	0.58	Thermal for Gen - min	0.9	Reverse Power Flow - max
Dundas	DND062	0.28	Thermal for Gen - min	0.98	Reverse Power Flow - max
Dundas	DND071	0.24	Thermal for Gen - min	1.9	Reverse Power Flow - max
Dundas	DND072	0	Primary Over-Voltage - min	0	Primary Over-Voltage - max
Dodge Center	DOC021	0.34	Thermal for Gen - min	1.7	Reverse Power Flow - max
Dodge Center	DOC031	0.2	Primary Over-Voltage - min	1.28	Reverse Power Flow - max
Dodge Center	DOC211	0.13	Thermal for Gen - min	0.82	Breaker Relay Reduction of Reach - max
Deephaven	DPN061	0.87	Reverse Power Flow - min	0.87	Reverse Power Flow - max
Deephaven	DPN062	1	Thermal for Gen - min	1.96	Reverse Power Flow - max
Deephaven	DPN063	0.94	Thermal for Gen - min	1.32	Reverse Power Flow - max
Deephaven	DPN071	0.95	Thermal for Gen - min	1.27	Reverse Power Flow - max
Deephaven	DPN072	0.94	Thermal for Gen - min	1.59	Reverse Power Flow - max
Deephaven	DPN073	0.9	Primary Over-Voltage - min	1.74	Reverse Power Flow - max
East Bloomington	EBL062	1.17	Thermal for Gen - min	1.6	Reverse Power Flow - max
East Bloomington	EBL063	0.48	Reverse Power Flow - min	0.48	Reverse Power Flow - max
East Bloomington	EBL064	1.09	Reverse Power Flow - min	1.09	Reverse Power Flow - max
East Bloomington	EBL065	0.87	Reverse Power Flow - min	0.87	Reverse Power Flow - max
East Bloomington	EBL066	1.01	Reverse Power Flow - min	1.01	Reverse Power Flow - max
East Bloomington	EBL067	0.87	Reverse Power Flow - min	0.87	Reverse Power Flow - max

Substation	Feeder	Minimum Hosting Capacity (MW)	Min Limiting Factor	Maximum Hosting Capacity (MW)	Max Limiting Factor
East Bloomington	EBL071	0.26	Thermal for Gen - min	0.85	Reverse Power Flow - max
East Bloomington	EBL072	1.17	Thermal for Gen - min	1.56	Reverse Power Flow - max
East Bloomington	EBL073	0.39	Reverse Power Flow - min	0.39	Reverse Power Flow - max
East Bloomington	EBL074	1.52	Reverse Power Flow - min	1.52	Reverse Power Flow - max
East Bloomington	EBL075	0.87	Reverse Power Flow - min	0.87	Reverse Power Flow - max
East Bloomington	EBL076	0.68	Reverse Power Flow - min	0.68	Reverse Power Flow - max
East Bloomington	EBL077	1.08	Reverse Power Flow - min	1.08	Reverse Power Flow - max
East Bloomington	EBL081	0.54	Reverse Power Flow - min	0.54	Reverse Power Flow - max
East Bloomington	EBL082	0.7	Primary Over-Voltage - min	0.84	Reverse Power Flow - max
East Bloomington	EBL083	0.41	Reverse Power Flow - min	0.41	Reverse Power Flow - max
East Bloomington	EBL084	0.6	Primary Over-Voltage - min	1.12	Reverse Power Flow - max
East Bloomington	EBL085	0.87	Reverse Power Flow - min	0.87	Reverse Power Flow - max
East Bloomington	EBL087	0.66	Reverse Power Flow - min	0.66	Reverse Power Flow - max
Elm Creek	ECK061	1	Primary Over-Voltage - min	1.57	Reverse Power Flow - max
Elm Creek	ECK062	1.2	Primary Over-Voltage - min	1.4	Reverse Power Flow - max
Elm Creek	ECK063	1	Primary Over-Voltage - min	2.34	Reverse Power Flow - max
Elm Creek	ECK081	0.62	Reverse Power Flow - min	0.62	Reverse Power Flow - max
Elm Creek	ECK082	0.9	Primary Over-Voltage - min	1.46	Reverse Power Flow - max
Elm Creek	ECK321	0.3	Primary Over-Voltage - min	4.56	Reverse Power Flow - max
Elm Creek	ECK322	0	Primary Over-Voltage - min	0	Primary Over-Voltage - max
Edina	EDA061	0.8	Primary Over-Voltage - min	1.07	Reverse Power Flow - max
Edina	EDA062	1.2	Thermal for Gen - min	2.05	Reverse Power Flow - max
Edina	EDA065	1.2	Primary Over-Voltage - min	1.42	Reverse Power Flow - max
Edina	EDA066	1.1	Primary Over-Voltage - min	1.22	Reverse Power Flow - max
Edina	EDA067	0.17	Thermal for Gen - min	0.52	Breaker Relay Reduction of Reach - max
Edina	EDA068	0.96	Thermal for Gen - min	1.28	Reverse Power Flow - max
Edina	EDA069	0.75	Reverse Power Flow - min	0.75	Reverse Power Flow - max
Edina	EDA071	1.04	Thermal for Gen - min	1.21	Reverse Power Flow - max
Edina	EDA072	1.2	Thermal for Gen - min	1.83	Reverse Power Flow - max
Edina	EDA073	0.6	Thermal for Gen - min	2.08	Reverse Power Flow - max
Edina	EDA074	1	Primary Over-Voltage - min	1.32	Reverse Power Flow - max
Edina	EDA075	1	Primary Over-Voltage - min	1.72	Reverse Power Flow - max
Edina	EDA076	0.65	Reverse Power Flow - min	0.65	Reverse Power Flow - max
Edina	EDA077	1.03	Reverse Power Flow - min	1.03	Reverse Power Flow - max

Substation	Feeder	Minimum Hosting Capacity (MW)	Min Limiting Factor	Maximum Hosting Capacity (MW)	Max Limiting Factor
Edina	EDA078	0.97	Thermal for Gen - min	1.19	Reverse Power Flow - max
Edina	EDA079	1.2	Thermal for Gen - min	1.26	Reverse Power Flow - max
Edina	EDA081	0.6	Thermal for Gen - min	0.88	Reverse Power Flow - max
Edina	EDA082	1.1	Primary Over-Voltage - min	1.25	Reverse Power Flow - max
Edina	EDA083	1.28	Reverse Power Flow - min	1.28	Reverse Power Flow - max
Edina	EDA084	1	Thermal for Gen - min	1.49	Reverse Power Flow - max
Edina	EDA085	0.26	Thermal for Gen - min	0.48	Reverse Power Flow - max
Edina	EDA087	0.99	Thermal for Gen - min	1.55	Reverse Power Flow - max
Edina	EDA088	1.1	Primary Over-Voltage - min	1.17	Reverse Power Flow - max
Edina	EDA089	0.7	Primary Over-Voltage - min	1.1	Reverse Power Flow - max
Eden Prarie	EDP062	1.3	Primary Over-Voltage - min	1.83	Reverse Power Flow - max
Eden Prarie	EDP063	1.2	Thermal for Gen - min	1.42	Reverse Power Flow - max
Eden Prarie	EDP071	1	Primary Over-Voltage - min	1.12	Reverse Power Flow - max
Eden Prarie	EDP072	0.65	Reverse Power Flow - min	0.65	Reverse Power Flow - max
Eden Prarie	EDP073	1	Primary Over-Voltage - min	1.85	Reverse Power Flow - max
Eden Prarie	EDP081	0.05	Reverse Power Flow - min	0.05	Reverse Power Flow - max
Eden Prarie	EDP082	1.1	Primary Over-Voltage - min	1.17	Reverse Power Flow - max
Eden Prarie	EDP083	1.2	Primary Over-Voltage - min	1.36	Reverse Power Flow - max
Eden Prarie	EDP084	0.47	Reverse Power Flow - min	0.47	Reverse Power Flow - max
Eden Prarie	EDP085	1.12	Reverse Power Flow - min	1.12	Reverse Power Flow - max
Eden Prarie	EDP091	0.6	Primary Over-Voltage - min	0.84	Reverse Power Flow - max
Eden Prarie	EDP092	1.1	Primary Over-Voltage - min	1.25	Reverse Power Flow - max
Eden Prarie	EDP093	1.2	Primary Over-Voltage - min	1.64	Reverse Power Flow - max
Eden Prarie	EDP094	1.2	Thermal for Gen - min	1.46	Reverse Power Flow - max
Eden Prarie	EDP095	1.2	Primary Over-Voltage - min	1.3	Reverse Power Flow - max
Eagle Lake	EGL021	0	Primary Over-Voltage - min	0	Primary Over-Voltage - max
Eagle Lake	EGL022	0.32	Thermal for Gen - min	0.54	Reverse Power Flow - max
Elko	EKO021	0.4	Primary Over-Voltage - min	0.86	Reverse Power Flow - max
Elliott Park	ELP061	0.94	Thermal for Gen - min	2.02	Reverse Power Flow - max
Elliott Park	ELP062	0.59	Thermal for Gen - min	1.65	Reverse Power Flow - max
Elliott Park	ELP063	0.94	Thermal for Gen - min	1.45	Reverse Power Flow - max
Elliott Park	ELP064	0.78	Thermal for Gen - min	0.99	Reverse Power Flow - max
Elliott Park	ELP071	0.94	Thermal for Gen - min	1.59	Reverse Power Flow - max
Elliott Park	ELP072	0.72	Reverse Power Flow - min	0.72	Reverse Power Flow - max

Substation	Feeder	Minimum Hosting Capacity (MW)	Min Limiting Factor	Maximum Hosting Capacity (MW)	Max Limiting Factor
Elliott Park	ELP073	0.64	Reverse Power Flow - min	0.64	Reverse Power Flow - max
Elliott Park	ELP074	0.93	Thermal for Gen - min	1.43	Reverse Power Flow - max
Elliott Park	ELP075	0.53	Reverse Power Flow - min	0.53	Reverse Power Flow - max
Elliott Park	ELP081	1.17	Thermal for Gen - min	1.76	Reverse Power Flow - max
Elliott Park	ELP082	0.59	Thermal for Gen - min	1.99	Reverse Power Flow - max
Elliott Park	ELP083	1.21	Reverse Power Flow - min	1.21	Reverse Power Flow - max
Elliott Park	ELP084	0.94	Thermal for Gen - min	1.98	Reverse Power Flow - max
Elliott Park	ELP085	0	Reverse Power Flow - min	0	Reverse Power Flow - max
Elliott Park	ELP086X	1.17	Thermal for Gen - min	1.4	Reverse Power Flow - max
Elliott Park	ELP086Y	0.26	Thermal for Gen - min	1	Reverse Power Flow - max
Essig	ESG001	0.05	Reverse Power Flow - min	0.05	Reverse Power Flow - max
Eastwood	ESW061	0.35	Thermal for Gen - min	2.07	Reverse Power Flow - max
Eastwood	ESW062	0.47	Thermal for Gen - min	2.17	Reverse Power Flow - max
Eastwood	ESW063	0.44	Reverse Power Flow - min	0.44	Reverse Power Flow - max
Eastwood	ESW071	0.94	Thermal for Gen - min	1.07	Reverse Power Flow - max
Eastwood	ESW072	0.26	Thermal for Gen - min	1.71	Reverse Power Flow - max
Eastwood	ESW073	0	Primary Over-Voltage - min	0	Primary Over-Voltage - max
Eastwood	ESW081	1.19	Thermal for Gen - min	1.53	Reverse Power Flow - max
Eastwood	ESW082	0.03	Additional Element Fault Current - min	0.34	Reverse Power Flow - max
East Winona	EWI022	0.42	Thermal for Gen - min	1.78	Reverse Power Flow - max
Excelsior	EXC061	0.96	Thermal for Gen - min	1.11	Reverse Power Flow - max
Excelsior	EXC062	0.58	Thermal for Gen - min	1.4	Reverse Power Flow - max
Faribault	FAB061	0.58	Thermal for Gen - min	1.18	Reverse Power Flow - max
Faribault	FAB063	0.2	Primary Over-Voltage - min	1.59	Reverse Power Flow - max
Faribault	FAB071	0.23	Thermal for Gen - min	1.49	Reverse Power Flow - max
Faribault	FAB073	0.28	Thermal for Gen - min	0.85	Reverse Power Flow - max
Fair Park	FAP061	0	Primary Over-Voltage - min	0	Primary Over-Voltage - max
Fair Park	FAP071	0.35	Thermal for Gen - min	3.25	Reverse Power Flow - max
Fiesta City	FIC021	0	Primary Over-Voltage - min	0	Primary Over-Voltage - max
Fiesta City	FIC022	0.64	Thermal for Gen - min	0.8	Reverse Power Flow - max
Fiesta City	FIC031	0.2	Primary Over-Voltage - min	1.12	Reverse Power Flow - max
Franklin	FRA001	0.1	Primary Over-Voltage - min	0.17	Reverse Power Flow - max
Franklin	FRA211	0.31	Reverse Power Flow - min	0.31	Reverse Power Flow - max
Farmington	FRM061	0.39	Reverse Power Flow - min	0.39	Reverse Power Flow - max

Substation	Feeder	Minimum Hosting Capacity (MW)	Min Limiting Factor	Maximum Hosting Capacity (MW)	Max Limiting Factor
Farmington	FRM062	0	Primary Over-Voltage - min	0	Primary Over-Voltage - max
Farmington	FRM071	0	Primary Over-Voltage - min	0	Primary Over-Voltage - max
Frontenac	FRO021	0.4	Primary Over-Voltage - min	0.64	Reverse Power Flow - max
First Lake	FSL311	0	Primary Over-Voltage - min	0	Primary Over-Voltage - max
First Lake	FSL312	0.1	Primary Over-Voltage - min	1.36	Breaker Relay Reduction of Reach - max
Fifth Street	FST067	0.91	Reverse Power Flow - min	0.91	Reverse Power Flow - max
Fifth Street	FST068	0.77	Reverse Power Flow - min	0.77	Reverse Power Flow - max
Fifth Street	FST077	0.85	Reverse Power Flow - min	0.85	Reverse Power Flow - max
Fifth Street	FST078	0.98	Reverse Power Flow - min	0.98	Reverse Power Flow - max
Fifth Street	FST085	0.7	Reverse Power Flow - min	0.7	Reverse Power Flow - max
Fifth Street	FST086	0.38	Reverse Power Flow - min	0.38	Reverse Power Flow - max
Fifth Street	FST087	1.17	Thermal for Gen - min	1.5	Reverse Power Flow - max
Fifth Street	FST088	0.58	Reverse Power Flow - min	0.58	Reverse Power Flow - max
Gaylord	GAY001	0.2	Primary Over-Voltage - min	0.26	Reverse Power Flow - max
Gaylord	GAY002	0.09	Thermal for Gen - min	0.43	Reverse Power Flow - max
Gaylord	GAY003	0.2	Primary Over-Voltage - min	0.32	Reverse Power Flow - max
Greenfield	GFD021	0	Primary Over-Voltage - min	0	Primary Over-Voltage - max
Greenfield	GFD022	0.32	Thermal for Gen - min	0.53	Reverse Power Flow - max
Gibbon	GIB021	0.33	Thermal for Gen - min	0.39	Reverse Power Flow - max
Glenwood	GLD021	0	Primary Over-Voltage - min	0	Primary Over-Voltage - max
Glenwood	GLD031	0.2	Primary Over-Voltage - min	1	Primary Over-Voltage - max
Goose Lake	GLK061	0.8	Primary Over-Voltage - min	2.34	Reverse Power Flow - max
Goose Lake	GLK062	0.9	Primary Over-Voltage - min	2.02	Reverse Power Flow - max
Goose Lake	GLK063	0.94	Thermal for Gen - min	1.47	Reverse Power Flow - max
Goose Lake	GLK064	0.94	Thermal for Gen - min	1.65	Reverse Power Flow - max
Goose Lake	GLK065	0.9	Primary Over-Voltage - min	1.19	Reverse Power Flow - max
Goose Lake	GLK071	0.94	Thermal for Gen - min	2.17	Reverse Power Flow - max
Goose Lake	GLK072	0.94	Thermal for Gen - min	1.72	Reverse Power Flow - max
Goose Lake	GLK073	0.62	Thermal for Gen - min	1.74	Reverse Power Flow - max
Goose Lake	GLK074	0.2	Primary Over-Voltage - min	1.59	Breaker Relay Reduction of Reach - max
Glen Lake	GNL061	1.08	Reverse Power Flow - min	1.08	Reverse Power Flow - max
Glen Lake	GNL062	0.8	Primary Over-Voltage - min	1.42	Reverse Power Flow - max
Glen Lake	GNL063	0.7	Primary Over-Voltage - min	1.23	Reverse Power Flow - max
Glen Lake	GNL071	0.59	Thermal for Gen - min	1.26	Reverse Power Flow - max

Substation	Feeder	Minimum Hosting Capacity (MW)	Min Limiting Factor	Maximum Hosting Capacity (MW)	Max Limiting Factor
Glen Lake	GNL072	0.94	Thermal for Gen - min	1.61	Reverse Power Flow - max
Glen Lake	GNL073	1.01	Reverse Power Flow - min	1.01	Reverse Power Flow - max
Gopher	GPH061	0.94	Thermal for Gen - min	1.28	Reverse Power Flow - max
Gopher	GPH062	0.94	Thermal for Gen - min	1.8	Reverse Power Flow - max
Gopher	GPH068	2.62	Reverse Power Flow - min	2.62	Reverse Power Flow - max
Gopher	GPH069	1.68	Reverse Power Flow - min	1.68	Reverse Power Flow - max
Gopher	GPH073	0.32	Thermal for Gen - min	1.16	Reverse Power Flow - max
Gopher	GPH074	1.35	Reverse Power Flow - min	1.35	Reverse Power Flow - max
Gopher	GPH075	1.87	Reverse Power Flow - min	1.87	Reverse Power Flow - max
Gopher	GPH079	1.62	Reverse Power Flow - min	1.62	Reverse Power Flow - max
Granite City	GRC062	0.9	Primary Over-Voltage - min	1.79	Reverse Power Flow - max
Granite City	GRC063	0.77	Thermal for Gen - min	1.78	Reverse Power Flow - max
Granite City	GRC073	0.2	Primary Over-Voltage - min	1.65	Reverse Power Flow - max
Granite City	GRC311	0	Reverse Power Flow - min	0	Reverse Power Flow - max
Granite City	GRC312	0	Primary Over-Voltage - min	0	Primary Over-Voltage - max
Granite City	GRC313	0.4	Primary Over-Voltage - min	1.4	Reverse Power Flow - max
Green Isle	GRI001	0.18	Thermal for Gen - min	0.21	Reverse Power Flow - max
Gleason Lake	GSL061	1.08	Reverse Power Flow - min	1.08	Reverse Power Flow - max
Gleason Lake	GSL064	0.6	Thermal for Gen - min	1.52	Reverse Power Flow - max
Gleason Lake	GSL065	0.5	Primary Over-Voltage - min	1.59	Breaker Relay Reduction of Reach - max
Gleason Lake	GSL074	0.6	Thermal for Gen - min	1.62	Reverse Power Flow - max
Gleason Lake	GSL075	0.96	Thermal for Gen - min	1.38	Reverse Power Flow - max
Gleason Lake	GSL076	1.1	Primary Over-Voltage - min	1.43	Reverse Power Flow - max
Gleason Lake	GSL079	0.96	Thermal for Gen - min	1.44	Reverse Power Flow - max
Gleason Lake	GSL341	0.2	Primary Over-Voltage - min	1.06	Breaker Relay Reduction of Reach - max
Gleason Lake	GSL342	1.5	Primary Over-Voltage - min	6.1	Reverse Power Flow - max
Goodview	GVW021	0.14	Thermal for Gen - min	1.57	Reverse Power Flow - max
Goodview	GVW022	0.26	Thermal for Gen - min	1.92	Reverse Power Flow - max
Goodview	GVW023	0.27	Thermal for Gen - min	1.82	Reverse Power Flow - max
Goodview	GVW031	0	Primary Over-Voltage - min	0	Primary Over-Voltage - max
Goodview	GVW032	0.22	Thermal for Gen - min	1.9	Reverse Power Flow - max
Hadley	HAD021	0.18	Reverse Power Flow - min	0.18	Reverse Power Flow - max
Hadley	HAD022	0.17	Reverse Power Flow - min	0.17	Reverse Power Flow - max
Hastings	HAS021	0	Primary Over-Voltage - min	0	Primary Over-Voltage - max

Substation	Feeder	Minimum Hosting Capacity (MW)	Min Limiting Factor	Maximum Hosting Capacity (MW)	Max Limiting Factor
Hastings	HAS022	0.34	Thermal for Gen - min	1.96	Reverse Power Flow - max
Hastings	HAS023	0.85	Thermal for Gen - min	1.63	Reverse Power Flow - max
Hastings	HAS031	0.58	Reverse Power Flow - min	0.58	Reverse Power Flow - max
Hastings	HAS032	0.7	Primary Over-Voltage - min	0.81	Reverse Power Flow - max
Hastings	HAS033	0.73	Reverse Power Flow - min	0.73	Reverse Power Flow - max
Hector	HEC001	0	Primary Over-Voltage - min	0	Primary Over-Voltage - max
Henderson	HEN021	0.21	Thermal for Gen - min	0.32	Reverse Power Flow - max
Hollydale	HOL061	0.7	Primary Over-Voltage - min	1.39	Reverse Power Flow - max
Hollydale	HOL062	0.7	Primary Over-Voltage - min	1.97	Reverse Power Flow - max
Howard Lake	HOW061	0.5	Primary Over-Voltage - min	1.32	Reverse Power Flow - max
Hassan	HSN311	0.3	Primary Over-Voltage - min	2.75	Breaker Relay Reduction of Reach - max
Hassan	HSN312	0.1	Primary Over-Voltage - min	3.31	Breaker Relay Reduction of Reach - max
Hassan	HSN321	0	Primary Over-Voltage - min	0	Primary Over-Voltage - max
Hassan	HSN322	1.4	Primary Over-Voltage - min	4.58	Reverse Power Flow - max
Hugo	HUG311	0.1	Primary Over-Voltage - min	0.89	Breaker Relay Reduction of Reach - max
Hugo	HUG312	0	Primary Over-Voltage - min	0	Primary Over-Voltage - max
Hugo	HUG321	0	Primary Over-Voltage - min	0	Primary Over-Voltage - max
Hugo	HUG322	1.5	Primary Over-Voltage - min	2.23	Primary Over-Voltage - max
Hiawatha West	HWW061	0.3	Primary Over-Voltage - min	0.56	Reverse Power Flow - max
Hiawatha West	HWW062	0.94	Thermal for Gen - min	1.45	Reverse Power Flow - max
Hiawatha West	HWW071	0.94	Thermal for Gen - min	2.57	Reverse Power Flow - max
Hiawatha West	HWW072	0.94	Thermal for Gen - min	1.37	Reverse Power Flow - max
Hiawatha West	HWW073	0.61	Thermal for Gen - min	0.86	Reverse Power Flow - max
Hiawatha West	HWW074	1	Thermal for Gen - min	1.39	Reverse Power Flow - max
Hiawatha West	HWW075	0.26	Thermal for Gen - min	2.18	Reverse Power Flow - max
Hyland Lake	HYL061	1.2	Primary Over-Voltage - min	1.81	Reverse Power Flow - max
Hyland Lake	HYL062	1.03	Thermal for Gen - min	1.49	Reverse Power Flow - max
Hyland Lake	HYL063	0.4	Primary Over-Voltage - min	1	Reverse Power Flow - max
Hyland Lake	HYL064	0.6	Primary Over-Voltage - min	2.65	Reverse Power Flow - max
Hyland Lake	HYL065	1.18	Thermal for Gen - min	2.25	Reverse Power Flow - max
Hyland Lake	HYL071	0.25	Reverse Power Flow - min	0.25	Reverse Power Flow - max
Hyland Lake	HYL072	0.9	Primary Over-Voltage - min	1.4	Reverse Power Flow - max
Hyland Lake	HYL073	0.94	Thermal for Gen - min	1.53	Reverse Power Flow - max
Hyland Lake	HYL074	0.61	Thermal for Gen - min	1.41	Reverse Power Flow - max

Substation	Feeder	Minimum Hosting Capacity (MW)	Min Limiting Factor	Maximum Hosting Capacity (MW)	Max Limiting Factor
Hyland Lake	HYL075	0.8	Primary Over-Voltage - min	1.32	Reverse Power Flow - max
Indiana	IDA061	0.58	Reverse Power Flow - min	0.58	Reverse Power Flow - max
Indiana	IDA062	0.9	Reverse Power Flow - min	0.9	Reverse Power Flow - max
Indiana	IDA063	1.17	Thermal for Gen - min	1.4	Reverse Power Flow - max
Indiana	IDA064	0.94	Thermal for Gen - min	1.6	Reverse Power Flow - max
Indiana	IDA071	1.06	Reverse Power Flow - min	1.06	Reverse Power Flow - max
Indiana	IDA072	0.95	Thermal for Gen - min	1.55	Reverse Power Flow - max
Indiana	IDA073	0.94	Thermal for Gen - min	1.22	Reverse Power Flow - max
Indiana	IDA074	0.94	Thermal for Gen - min	1.73	Reverse Power Flow - max
Jordan	JOR021	0	Primary Over-Voltage - min	0	Primary Over-Voltage - max
Jordan	JOR022	0	Primary Over-Voltage - min	0	Primary Over-Voltage - max
Kasson	KAN022	0	Primary Over-Voltage - min	0	Primary Over-Voltage - max
Kasson	KAN031	0	Primary Over-Voltage - min	0	Primary Over-Voltage - max
Kenyon	KEN021	0.1	Primary Over-Voltage - min	0.22	Reverse Power Flow - max
Kenyon	KEN022	0	Reverse Power Flow - min	0	Reverse Power Flow - max
Kimball	KIM021	0.47	Reverse Power Flow - min	0.47	Reverse Power Flow - max
Kegan Lake	KLK061	0.58	Thermal for Gen - min	1.03	Reverse Power Flow - max
Kohlman Lake	KOL061	0.59	Thermal for Gen - min	0.73	Reverse Power Flow - max
Kohlman Lake	KOL062	1.52	Thermal for Gen - min	1.76	Reverse Power Flow - max
Kohlman Lake	KOL063	0.76	Reverse Power Flow - min	0.76	Reverse Power Flow - max
Kohlman Lake	KOL064	1.32	Thermal for Gen - min	1.47	Reverse Power Flow - max
Kohlman Lake	KOL065	1.17	Thermal for Gen - min	1.6	Reverse Power Flow - max
Kohlman Lake	KOL071	0.92	Reverse Power Flow - min	0.92	Reverse Power Flow - max
Kohlman Lake	KOL073	0.5	Primary Over-Voltage - min	0.9	Primary Over-Voltage - max
Kohlman Lake	KOL074	0.94	Thermal for Gen - min	1.28	Reverse Power Flow - max
Lake Bavaria	LAB311	0.6	Primary Over-Voltage - min	1.94	Reverse Power Flow - max
Lake Bavaria	LAB312	0.37	Thermal for Gen - min	1.56	Breaker Relay Reduction of Reach - max
La Crescant	LAC062	0.16	Thermal for Gen - min	1.47	Reverse Power Flow - max
La Crescant	LAC063	0.14	Thermal for Gen - min	0.86	Reverse Power Flow - max
Lake Emily	LAE061	0	Primary Over-Voltage - min	0	Primary Over-Voltage - max
Lafayette	LAF001	0.1	Primary Over-Voltage - min	0.19	Reverse Power Flow - max
Lake City	LAK032	0.3	Primary Over-Voltage - min	0.34	Reverse Power Flow - max
Lake Pulaski	LAP311	0.1	Primary Over-Voltage - min	0.53	Breaker Relay Reduction of Reach - max
Lake Yankton	LAY061	0.2	Primary Over-Voltage - min	0.37	Reverse Power Flow - max

Substation	Feeder	Minimum Hosting Capacity (MW)	Min Limiting Factor	Maximum Hosting Capacity (MW)	Max Limiting Factor
Lawrence Creek	LCR311	0	Reverse Power Flow - min	0	Reverse Power Flow - max
Lexington	LEX061	0.96	Thermal for Gen - min	1.54	Reverse Power Flow - max
Lexington	LEX062	0.97	Reverse Power Flow - min	0.97	Reverse Power Flow - max
Lexington	LEX063	0.48	Thermal for Gen - min	1.66	Reverse Power Flow - max
Lexington	LEX064	0.96	Thermal for Gen - min	1.64	Reverse Power Flow - max
Lexington	LEX065	0.97	Thermal for Gen - min	1.12	Reverse Power Flow - max
Lexington	LEX071	1.33	Thermal for Gen - min	1.83	Reverse Power Flow - max
Lexington	LEX072	0.79	Reverse Power Flow - min	0.79	Reverse Power Flow - max
Lexington	LEX073	0.6	Reverse Power Flow - min	0.6	Reverse Power Flow - max
Lexington	LEX074	0.9	Primary Over-Voltage - min	1.6	Reverse Power Flow - max
Lexington	LEX075	0.96	Thermal for Gen - min	1.33	Reverse Power Flow - max
Lexington	LEX331	0.29	Thermal for Gen - min	0.83	Breaker Relay Reduction of Reach - max
Lexington	LEX332	1.49	Thermal for Gen - min	4.71	Reverse Power Flow - max
Lexington	LEX333	0.3	Primary Over-Voltage - min	1.68	Primary Over-Voltage - max
Lake Lillian	LIL021	0	Primary Over-Voltage - min	0	Primary Over-Voltage - max
Lindstrom	LIN022	0.53	Thermal for Gen - min	1.3	Reverse Power Flow - max
Lindstrom	LIN031	0.1	Primary Over-Voltage - min	2.24	Primary Over-Voltage - max
Long Lake	LLK061	0.96	Thermal for Gen - min	1.38	Reverse Power Flow - max
Long Lake	LLK063	0.94	Thermal for Gen - min	1.41	Reverse Power Flow - max
Long Lake	LLK071	0.26	Reverse Power Flow - min	1.96	Reverse Power Flow - max
Long Lake	LLK072	0.8	Primary Over-Voltage - min	1.82	Reverse Power Flow - max
Linn Street	LNS021	0.1	Primary Over-Voltage - min	0.74	Reverse Power Flow - max
Linn Street	LNS022	0.03	Reverse Power Flow - min	0.03	Reverse Power Flow - max
Linn Street	LNS032	0.61	Reverse Power Flow - min	0.61	Reverse Power Flow - max
Linn Street	LNS033	0.5	Primary Over-Voltage - min	0.61	Reverse Power Flow - max
Lone Oak	LOK061	1	Primary Over-Voltage - min	1.4	Reverse Power Flow - max
Lone Oak	LOK062	0.5	Primary Over-Voltage - min	2.48	Reverse Power Flow - max
Lone Oak	LOK063	0.42	Reverse Power Flow - min	0.42	Reverse Power Flow - max
Lone Oak	LOK081	0.96	Thermal for Gen - min	1.79	Reverse Power Flow - max
Lone Oak	LOK082	0.96	Thermal for Gen - min	1.11	Reverse Power Flow - max
Lone Oak	LOK083	1.1	Primary Over-Voltage - min	2.35	Reverse Power Flow - max
Lone Oak	LOK091	1.3	Primary Over-Voltage - min	1.53	Reverse Power Flow - max
Lone Oak	LOK092	1.48	Reverse Power Flow - min	1.48	Reverse Power Flow - max
Lone Oak	LOK093	0.48	Thermal for Gen - min	1.99	Reverse Power Flow - max

Substation	Feeder	Minimum Hosting Capacity (MW)	Min Limiting Factor	Maximum Hosting Capacity (MW)	Max Limiting Factor
Lowry	LOW021	0	Primary Over-Voltage - min	0	Primary Over-Voltage - max
Lester Prarie	LSP021	0.24	Thermal for Gen - min	1.08	Breaker Relay Reduction of Reach - max
Lester Prarie	LSP022	0.2	Primary Over-Voltage - min	0.59	Reverse Power Flow - max
Maple Lake	MAP061	0.1	Primary Over-Voltage - min	0.82	Primary Over-Voltage - max
Mazeppa	MAZ021	0.1	Primary Over-Voltage - min	0.48	Reverse Power Flow - max
Medford Junction	MDF021	0	Primary Over-Voltage - min	0	Primary Over-Voltage - max
Midtown	MDT061	0.94	Thermal for Gen - min	1.46	Reverse Power Flow - max
Midtown	MDT062	0.94	Thermal for Gen - min	1.43	Reverse Power Flow - max
Midtown	MDT067	0.94	Thermal for Gen - min	1.74	Reverse Power Flow - max
Midtown	MDT071	0.65	Reverse Power Flow - min	0.65	Reverse Power Flow - max
Midtown	MDT073	0.94	Thermal for Gen - min	1.4	Reverse Power Flow - max
Midtown	MDT074	0.96	Thermal for Gen - min	1.03	Reverse Power Flow - max
Midtown	MDT077	1.17	Thermal for Gen - min	1.52	Reverse Power Flow - max
Meire Grove	MEI021	0.1	Primary Over-Voltage - min	0.22	Reverse Power Flow - max
Meeker	MEK021	0.1	Reverse Power Flow - min	0.1	Reverse Power Flow - min
Medicine Lake	MEL061	0.85	Reverse Power Flow - min	0.85	Reverse Power Flow - max
Medicine Lake	MEL062	0.9	Primary Over-Voltage - min	1.07	Reverse Power Flow - max
Medicine Lake	MEL063	0.3	Reverse Power Flow - min	0.3	Reverse Power Flow - max
Medicine Lake	MEL064	0.94	Thermal for Gen - min	1.62	Reverse Power Flow - max
Medicine Lake	MEL065	0.54	Reverse Power Flow - min	0.54	Reverse Power Flow - max
Medicine Lake	MEL066	0.43	Reverse Power Flow - min	0.43	Reverse Power Flow - max
Medicine Lake	MEL067	0.94	Thermal for Gen - min	1.14	Reverse Power Flow - max
Medicine Lake	MEL068	0.94	Thermal for Gen - min	1.6	Reverse Power Flow - max
Medicine Lake	MEL069	1.07	Thermal for Gen - min	1.87	Reverse Power Flow - max
Medicine Lake	MEL071	0.98	Thermal for Gen - min	1.29	Reverse Power Flow - max
Medicine Lake	MEL072	0.59	Thermal for Gen - min	1.52	Reverse Power Flow - max
Medicine Lake	MEL073	0.36	Thermal for Gen - min	1.88	Reverse Power Flow - max
Medicine Lake	MEL074	0.94	Thermal for Gen - min	1.51	Reverse Power Flow - max
Medicine Lake	MEL075	0.94	Thermal for Gen - min	2.13	Reverse Power Flow - max
Medicine Lake	MEL076	1.01	Reverse Power Flow - min	1.01	Reverse Power Flow - max
Medicine Lake	MEL077	0.94	Thermal for Gen - min	1.42	Reverse Power Flow - max
Medicine Lake	MEL078	0.94	Thermal for Gen - min	1.28	Reverse Power Flow - max
Medicine Lake	MEL079	1.08	Reverse Power Flow - min	1.08	Reverse Power Flow - max
Medicine Lake	MEL081	0.26	Thermal for Gen - min	1.33	Reverse Power Flow - max

Substation	Feeder	Minimum Hosting Capacity (MW)	Min Limiting Factor	Maximum Hosting Capacity (MW)	Max Limiting Factor
Medicine Lake	MEL082	0.94	Thermal for Gen - min	1.34	Reverse Power Flow - max
Medicine Lake	MEL083	0.94	Thermal for Gen - min	1.57	Reverse Power Flow - max
Medicine Lake	MEL087	0.67	Reverse Power Flow - min	0.67	Reverse Power Flow - max
Medicine Lake	MEL088	1	Primary Over-Voltage - min	1.44	Reverse Power Flow - max
Medicine Lake	MEL089	1.2	Primary Over-Voltage - min	1.53	Reverse Power Flow - max
Morgan	MGN211	0	Primary Over-Voltage - min	0	Primary Over-Voltage - max
Mayhew Lake	MHW311	0	Primary Over-Voltage - min	0	Primary Over-Voltage - max
Mayhew Lake	MHW312	0	Reverse Power Flow - min	0	Reverse Power Flow - max
Mound	MND061	0.59	Thermal for Gen - min	0.97	Reverse Power Flow - max
Mound	MND062	0.68	Thermal for Gen - min	2.1	Reverse Power Flow - max
Mound	MND063	0	Primary Over-Voltage - min	0	Primary Over-Voltage - max
Mound	MND071	0.3	Primary Over-Voltage - min	1.4	Reverse Power Flow - max
Mound	MND072	0.39	Thermal for Gen - min	1.99	Reverse Power Flow - max
Minnesota Lake	MNL001	0.08	Thermal for Gen - min	0.27	Reverse Power Flow - max
Minnesota Valley	MNV211	0	Primary Over-Voltage - min	0	Primary Over-Voltage - max
Moore Lake	MOL061	0.59	Thermal for Gen - min	1.57	Reverse Power Flow - max
Moore Lake	MOL062	1.52	Thermal for Gen - min	2.38	Reverse Power Flow - max
Moore Lake	MOL063	0.6	Thermal for Gen - min	1.8	Reverse Power Flow - max
Moore Lake	MOL064	0.94	Thermal for Gen - min	1.64	Reverse Power Flow - max
Moore Lake	MOL065	0.94	Thermal for Gen - min	1.54	Reverse Power Flow - max
Moore Lake	MOL066	0.94	Thermal for Gen - min	1.91	Reverse Power Flow - max
Moore Lake	MOL067	0.63	Thermal for Gen - min	1.2	Reverse Power Flow - max
Moore Lake	MOL068	0.3	Primary Over-Voltage - min	1.27	Reverse Power Flow - max
Moore Lake	MOL069	0.6	Reverse Power Flow - min	0.6	Reverse Power Flow - max
Moore Lake	MOL071	0.94	Thermal for Gen - min	1.2	Reverse Power Flow - max
Moore Lake	MOL072	0.94	Thermal for Gen - min	1.38	Reverse Power Flow - max
Moore Lake	MOL073	0.9	Primary Over-Voltage - min	1.76	Reverse Power Flow - max
Moore Lake	MOL074	0.87	Reverse Power Flow - min	0.87	Reverse Power Flow - max
Moore Lake	MOL076	0.95	Thermal for Gen - min	1.79	Reverse Power Flow - max
Moore Lake	MOL077	0.82	Reverse Power Flow - min	0.82	Reverse Power Flow - max
Moore Lake	MOL078	0.8	Primary Over-Voltage - min	1.8	Reverse Power Flow - max
Moore Lake	MOL079	0.95	Thermal for Gen - min	1.1	Reverse Power Flow - max
Merriam Park	MPK061	2.07	Reverse Power Flow - min	2.07	Reverse Power Flow - max
Merriam Park	MPK062	0.96	Thermal for Gen - min	1.07	Reverse Power Flow - max

Substation	Feeder	Minimum Hosting Capacity (MW)	Min Limiting Factor	Maximum Hosting Capacity (MW)	Max Limiting Factor
Merriam Park	MPK063	0.6	Thermal for Gen - min	2.14	Reverse Power Flow - max
Merriam Park	MPK064	0	Reverse Power Flow - min	0	Reverse Power Flow - min
Merriam Park	MPK065	0.65	Thermal for Gen - min	1.54	Reverse Power Flow - max
Merriam Park	MPK066	0.69	Reverse Power Flow - min	0.69	Reverse Power Flow - max
Merriam Park	MPK067	0.96	Thermal for Gen - min	2.01	Reverse Power Flow - max
Merriam Park	MPK068	0.3	Primary Over-Voltage - min	1.86	Reverse Power Flow - max
Merriam Park	MPK071	0	Reverse Power Flow - min	0	Reverse Power Flow - min
Merriam Park	MPK072	1.62	Reverse Power Flow - min	1.62	Reverse Power Flow - max
Merriam Park	MPK073	0.73	Reverse Power Flow - min	0.73	Reverse Power Flow - max
Merriam Park	MPK074	1.06	Primary Over-Voltage - min	1.11	Reverse Power Flow - max
Merriam Park	MPK075	0.96	Thermal for Gen - min	1.41	Reverse Power Flow - max
Merriam Park	MPK076	1.33	Reverse Power Flow - min	1.33	Reverse Power Flow - max
Merriam Park	MPK077	1.43	Reverse Power Flow - min	1.43	Reverse Power Flow - max
Merriam Park	MPK078	0.2	Primary Over-Voltage - min	0.79	Breaker Relay Reduction of Reach - max
Merriam Park	MPK081	1.38	Reverse Power Flow - min	1.38	Reverse Power Flow - max
Merriam Park	MPK082	0.3	Primary Over-Voltage - min	1.3	Breaker Relay Reduction of Reach - max
Merriam Park	MPK083	0.2	Primary Over-Voltage - min	1.15	Breaker Relay Reduction of Reach - max
Merriam Park	MPK084	0.3	Primary Over-Voltage - min	1.02	Breaker Relay Reduction of Reach - max
Merriam Park	MPK085	0.96	Thermal for Gen - min	1.49	Reverse Power Flow - max
Merriam Park	MPK086	0.73	Reverse Power Flow - min	0.73	Reverse Power Flow - max
Merriam Park	MPK087	0.96	Thermal for Gen - min	1.94	Reverse Power Flow - max
Mapleton	MPN081	0	Primary Over-Voltage - min	0	Primary Over-Voltage - max
Meridian	MRN021	0	Primary Over-Voltage - min	0	Primary Over-Voltage - max
Main Street	MST063	1.76	Reverse Power Flow - min	1.76	Reverse Power Flow - max
Main Street	MST064	0.35	Reverse Power Flow - min	0.35	Reverse Power Flow - max
Main Street	MST066	0.97	Thermal for Gen - min	1.5	Reverse Power Flow - max
Main Street	MST068	0.94	Thermal for Gen - min	1.26	Reverse Power Flow - max
Main Street	MST069	0.94	Thermal for Gen - min	1.13	Reverse Power Flow - max
Main Street	MST070	0.94	Thermal for Gen - min	1.79	Reverse Power Flow - max
Main Street	MST071	1	Thermal for Gen - min	1.72	Reverse Power Flow - max
Main Street	MST074	0.19	Reverse Power Flow - min	0.19	Reverse Power Flow - max
Main Street	MST075	0.94	Thermal for Gen - min	2.22	Reverse Power Flow - max
Main Street	MST076	0.48	Thermal for Gen - min	1.28	Reverse Power Flow - max
Main Street	MST080	0.1	Primary Over-Voltage - min	0.84	Breaker Relay Reduction of Reach - max

Substation	Feeder	Minimum Hosting Capacity (MW)	Min Limiting Factor	Maximum Hosting Capacity (MW)	Max Limiting Factor
Main Street	MST082	1.04	Reverse Power Flow - min	1.04	Reverse Power Flow - max
Montrose	MTR021	0	Primary Over-Voltage - min	0	Primary Over-Voltage - max
Montevideo	MTV001	0.1	Primary Over-Voltage - min	0.23	Reverse Power Flow - max
Montevideo	MTV002	0.3	Primary Over-Voltage - min	0.3	Reverse Power Flow - max
Montevideo	MTV003	0.44	Reverse Power Flow - min	0.44	Reverse Power Flow - max
Montevideo	MTV021	0.2	Primary Over-Voltage - min	0.57	Reverse Power Flow - max
Montevideo	MTV022	0.3	Primary Over-Voltage - min	0.6	Reverse Power Flow - max
Morristown	MTW021	0	Primary Over-Voltage - min	0	Primary Over-Voltage - max
Maynard	MYN021	0.4	Primary Over-Voltage - min	0.44	Reverse Power Flow - max
Nerstrand	NER021	0	Primary Over-Voltage - min	0	Primary Over-Voltage - max
Nine Mile Creek	NMC063	1.51	Reverse Power Flow - min	1.51	Reverse Power Flow - max
Nine Mile Creek	NMC064	1.59	Reverse Power Flow - min	1.59	Reverse Power Flow - max
Nine Mile Creek	NMC082	0.94	Thermal for Gen - min	1.72	Reverse Power Flow - max
Nine Mile Creek	NMC083	0.99	Thermal for Gen - min	1.77	Reverse Power Flow - max
Nine Mile Creek	NMC092	0.95	Thermal for Gen - min	1.88	Reverse Power Flow - max
Nine Mile Creek	NMC093	0.94	Thermal for Gen - min	1.84	Reverse Power Flow - max
Northfield	NOF061	0	Primary Over-Voltage - min	0	Primary Over-Voltage - max
Northfield	NOF062	0.81	Thermal for Gen - min	2.06	Reverse Power Flow - max
Northfield	NOF071	0	Primary Over-Voltage - min	0	Primary Over-Voltage - max
Northfield	NOF072	0.23	Thermal for Gen - min	1.95	Reverse Power Flow - max
Northfield	NOF073	1.14	Reverse Power Flow - min	1.14	Reverse Power Flow - max
Oakdale	OAD061	0.95	Thermal for Gen - min	1.69	Reverse Power Flow - max
Oakdale	OAD062	0.75	Reverse Power Flow - min	0.75	Reverse Power Flow - max
Oakdale	OAD063	0.94	Thermal for Gen - min	1.6	Reverse Power Flow - max
Oakdale	OAD064	0.73	Reverse Power Flow - min	0.73	Reverse Power Flow - max
Oakdale	OAD065	0.94	Thermal for Gen - min	1.44	Reverse Power Flow - max
Oakdale	OAD071	0.58	Thermal for Gen - min	1.51	Reverse Power Flow - max
Oakdale	OAD072	0.78	Thermal for Gen - min	1.62	Reverse Power Flow - max
Oakdale	OAD073	0.94	Thermal for Gen - min	1.47	Reverse Power Flow - max
Oakdale	OAD074	0.94	Thermal for Gen - min	1.38	Reverse Power Flow - max
Oakdale	OAD075	1	Primary Over-Voltage - min	2.33	Reverse Power Flow - max
Oak Park	OPK065	0.4	Primary Over-Voltage - min	1.72	Reverse Power Flow - max
Oak Park	OPK066	0.52	Reverse Power Flow - min	0.52	Reverse Power Flow - max
Oak Park	OPK067	0.3	Primary Over-Voltage - min	1.55	Reverse Power Flow - max

Substation	Feeder	Minimum Hosting Capacity (MW)	Min Limiting Factor	Maximum Hosting Capacity (MW)	Max Limiting Factor
Oak Park	OPK071	0.7	Reverse Power Flow - min	0.7	Reverse Power Flow - max
Oak Park	OPK072	0.94	Thermal for Gen - min	1.2	Reverse Power Flow - max
Oak Park	OPK073	0.3	Primary Over-Voltage - min	1.46	Reverse Power Flow - max
Oak Park	OPK074	1.56	Reverse Power Flow - min	1.56	Reverse Power Flow - max
Oak Park	OPK075	0.79	Reverse Power Flow - min	0.79	Reverse Power Flow - max
Oak Park	OPK077	0	Reverse Power Flow - min	2.23	Reverse Power Flow - max
Orono	ORO061	0.5	Primary Over-Voltage - min	1.56	Reverse Power Flow - max
Orono	ORO062	0.7	Primary Over-Voltage - min	2	Reverse Power Flow - max
Osseo	OSS061	0.94	Thermal for Gen - min	1.8	Reverse Power Flow - max
Osseo	OSS062	0.94	Thermal for Gen - min	1.72	Reverse Power Flow - max
Osseo	OSS063	0.7	Primary Over-Voltage - min	1.3	Reverse Power Flow - max
Osseo	OSS064	0.33	Thermal for Gen - min	1.77	Reverse Power Flow - max
Osseo	OSS065	0.94	Thermal for Gen - min	1.64	Reverse Power Flow - max
Osseo	OSS066	1.17	Thermal for Gen - min	1.55	Reverse Power Flow - max
Osseo	OSS071	0.94	Thermal for Gen - min	1.4	Reverse Power Flow - max
Osseo	OSS072	0.86	Reverse Power Flow - min	0.86	Reverse Power Flow - max
Osseo	OSS073	0.6	Primary Over-Voltage - min	1.56	Reverse Power Flow - max
Osseo	OSS074	0.71	Reverse Power Flow - min	0.71	Reverse Power Flow - max
Osseo	OSS075	1.46	Reverse Power Flow - min	1.46	Reverse Power Flow - max
Osseo	OSS076	1.17	Thermal for Gen - min	1.26	Reverse Power Flow - max
Osseo	OSS077	0.94	Thermal for Gen - min	1.61	Reverse Power Flow - max
aynesville Transmissio	PAT312	0	Primary Over-Voltage - min	0	Primary Over-Voltage - max
aynesville Transmissio	PAT313	0	Primary Over-Voltage - min	0	Primary Over-Voltage - max
aynesville Transmissio	PAT314	0.1	Primary Over-Voltage - min	0.49	Reverse Power Flow - max
Pine Bend	PBE061	0.58	Thermal for Gen - min	0.81	Reverse Power Flow - max
Pine Island	PIL021	0	Primary Over-Voltage - min	0	Primary Over-Voltage - max
Pine Island	PIL022	0.2	Primary Over-Voltage - min	1.18	Reverse Power Flow - max
Pipestone	PIP061	0.35	Reverse Power Flow - min	0.35	Reverse Power Flow - max
Pipestone	PIP062	0.59	Thermal for Gen - min	0.89	Reverse Power Flow - max
Pipestone	PIP090	0	Primary Over-Voltage - min	0	Primary Over-Voltage - max
Parkers Lake	PKL061	1.11	Thermal for Gen - min	1.82	Reverse Power Flow - max
Parkers Lake	PKL062	1.17	Thermal for Gen - min	1.61	Reverse Power Flow - max
Parkers Lake	PKL063	0.9	Primary Over-Voltage - min	1.22	Reverse Power Flow - max
Parkers Lake	PKL064	1.19	Thermal for Gen - min	1.66	Reverse Power Flow - max

Substation	Feeder	Minimum Hosting Capacity (MW)	Min Limiting Factor	Maximum Hosting Capacity (MW)	Max Limiting Factor
Parkers Lake	PKL065	1.18	Thermal for Gen - min	1.43	Reverse Power Flow - max
Parkers Lake	PKL066	0.98	Reverse Power Flow - min	0.98	Reverse Power Flow - max
Parkers Lake	PKL071	0.94	Thermal for Gen - min	2.08	Reverse Power Flow - max
Parkers Lake	PKL072	1	Thermal for Gen - min	1.43	Reverse Power Flow - max
Parkers Lake	PKL073	0.73	Reverse Power Flow - min	0.73	Reverse Power Flow - max
Parkers Lake	PKL074	0.5	Primary Over-Voltage - min	1.8	Reverse Power Flow - max
Parkers Lake	PKL075	1	Primary Over-Voltage - min	1.65	Reverse Power Flow - max
Parkers Lake	PKL081	0.9	Primary Over-Voltage - min	1.13	Reverse Power Flow - max
Parkers Lake	PKL082	0	Thermal for Gen - min	1.08	Reverse Power Flow - max
Parkers Lake	PKL083	1.45	Thermal for Gen - min	1.75	Reverse Power Flow - max
Parkers Lake	PKL084	1.17	Thermal for Gen - min	5.74	Reverse Power Flow - max
Parkers Lake	PKL085	0.9	Primary Over-Voltage - min	1.89	Reverse Power Flow - max
Plato	PLA022	0.1	Primary Over-Voltage - min	0.47	Reverse Power Flow - max
Plato	PLA023	1.25	Reverse Power Flow - min	1.25	Reverse Power Flow - max
Prior	PRR061	0.36	Thermal for Gen - min	1.87	Reverse Power Flow - max
Prior	PRR062	0.59	Thermal for Gen - min	1.36	Reverse Power Flow - max
Prior	PRR063	0.94	Thermal for Gen - min	1.05	Reverse Power Flow - max
Ramsey	RAM061	1.02	Thermal for Gen - min	1.05	Reverse Power Flow - max
Ramsey	RAM062	0.94	Thermal for Gen - min	1.26	Reverse Power Flow - max
Ramsey	RAM063	0.94	Thermal for Gen - min	1.53	Reverse Power Flow - max
Ramsey	RAM064	0.94	Thermal for Gen - min	1.63	Reverse Power Flow - max
Ramsey	RAM071	1	Primary Over-Voltage - min	1.92	Reverse Power Flow - max
Ramsey	RAM072	0.9	Primary Over-Voltage - min	1.15	Reverse Power Flow - max
Ramsey	RAM073	0.8	Primary Over-Voltage - min	0.93	Reverse Power Flow - max
Ramsey	RAM077	0.35	Thermal for Gen - min	1.47	Reverse Power Flow - max
Rapidan	RAP081	0.1	Primary Over-Voltage - min	0.29	Breaker Relay Reduction of Reach - max
Richmond	RCH061	0.4	Primary Over-Voltage - min	0.66	Reverse Power Flow - max
Red River	RED091	0.1	Primary Over-Voltage - min	0.71	Breaker Relay Reduction of Reach - max
Red Wing	REW021	0.4	Primary Over-Voltage - min	1.02	Reverse Power Flow - max
Red Wing	REW022	0.85	Thermal for Gen - min	1.32	Reverse Power Flow - max
Red Wing	REW023	0	Primary Over-Voltage - min	0	Primary Over-Voltage - max
Red Wing	REW031	0.3	Primary Over-Voltage - min	1.04	Reverse Power Flow - max
Red Wing	REW032	0.71	Reverse Power Flow - min	0.71	Reverse Power Flow - max
Red Wing	REW033	0.8	Primary Over-Voltage - min	1.35	Reverse Power Flow - max

Substation	Feeder	Minimum Hosting Capacity (MW)	Min Limiting Factor	Maximum Hosting Capacity (MW)	Max Limiting Factor
Riverside	RIV061	0.96	Thermal for Gen - min	1.01	Reverse Power Flow - max
Riverside	RIV062	0.96	Thermal for Gen - min	1.16	Reverse Power Flow - max
Riverside	RIV063	0.6	Thermal for Gen - min	1.31	Reverse Power Flow - max
Riverside	RIV064	0.96	Thermal for Gen - min	1.3	Reverse Power Flow - max
Riverside	RIV065	1.86	Reverse Power Flow - min	1.86	Reverse Power Flow - max
Riverside	RIV066	0.75	Reverse Power Flow - min	0.75	Reverse Power Flow - max
Riverside	RIV071	0.93	Reverse Power Flow - min	0.93	Reverse Power Flow - max
Riverside	RIV072	0.77	Reverse Power Flow - min	0.77	Reverse Power Flow - max
Riverside	RIV073	0.96	Thermal for Gen - min	1.07	Reverse Power Flow - max
Riverside	RIV074	0.63	Reverse Power Flow - min	0.63	Reverse Power Flow - max
Riverside	RIV075	0.92	Thermal for Gen - min	1.05	Reverse Power Flow - max
Riverside	RIV076	0.96	Thermal for Gen - min	1.18	Reverse Power Flow - max
Rogers Lake	RLK064	0.7	Primary Over-Voltage - min	6.1	Breaker Relay Reduction of Reach - max
Rogers Lake	RLK065	0.94	Thermal for Gen - min	5.69	Breaker Relay Reduction of Reach - max
Rogers Lake	RLK066	0.98	Primary Over-Voltage - min	1.86	Primary Over-Voltage - max
Rogers Lake	RLK068	1.2	Thermal for Gen - min	7.75	Breaker Relay Reduction of Reach - max
Rogers Lake	RLK069	0.26	Thermal for Gen - min	5.03	Breaker Relay Reduction of Reach - max
Rogers Lake	RLK071	0.58	Thermal for Gen - min	6.83	Breaker Relay Reduction of Reach - max
Rogers Lake	RLK072	0.94	Thermal for Gen - min	9.85	Breaker Relay Reduction of Reach - max
Rogers Lake	RLK073	0.94	Thermal for Gen - min	7.54	Breaker Relay Reduction of Reach - max
Rogers Lake	RLK079	0.62	Thermal for Gen - min	5.83	Breaker Relay Reduction of Reach - max
Rosemount	RMT311	0.2	Primary Over-Voltage - min	0.72	Breaker Relay Reduction of Reach - max
Rosemount	RMT312	0.05	Thermal for Gen - min	0.15	Breaker Relay Reduction of Reach - max
Renville	RNV021	0	Reverse Power Flow - min	0	Reverse Power Flow - max
Rock River	ROC090	0	Thermal for Gen - min	0	Thermal for Gen - max
Rock River	ROC091	0	Reverse Power Flow - min	0	Reverse Power Flow - max
Rose Place	RPL061	0.97	Thermal for Gen - min	1.71	Reverse Power Flow - max
Rose Place	RPL062	1.04	Reverse Power Flow - min	1.04	Reverse Power Flow - max
Rose Place	RPL063	1	Thermal for Gen - min	1.29	Reverse Power Flow - max
Rose Place	RPL064	0.94	Thermal for Gen - min	1.43	Reverse Power Flow - max
Rose Place	RPL071	0.94	Thermal for Gen - min	1.93	Reverse Power Flow - max
Rose Place	RPL072	0.95	Thermal for Gen - min	1.13	Reverse Power Flow - max
Rose Place	RPL073	0.94	Thermal for Gen - min	1.13	Reverse Power Flow - max
Rose Place	RPL074	0.94	Thermal for Gen - min	1.49	Reverse Power Flow - max

Substation	Feeder	Minimum Hosting Capacity (MW)	Min Limiting Factor	Maximum Hosting Capacity (MW)	Max Limiting Factor
Rose Place	RPL075	0.94	Thermal for Gen - min	0.97	Reverse Power Flow - max
Red Rock	RRK061	1.52	Thermal for Gen - min	1.78	Reverse Power Flow - max
Red Rock	RRK062	1.75	Thermal for Gen - min	1.95	Reverse Power Flow - max
Red Rock	RRK063	0.8	Primary Over-Voltage - min	1.63	Reverse Power Flow - max
Red Rock	RRK064	0.7	Primary Over-Voltage - min	2.67	Reverse Power Flow - max
Red Rock	RRK071	1.52	Thermal for Gen - min	1.57	Reverse Power Flow - max
Red Rock	RRK072	1.49	Thermal for Gen - min	1.89	Reverse Power Flow - max
Red Rock	RRK081	1.56	Reverse Power Flow - min	1.56	Reverse Power Flow - max
Red Rock	RRK082	0.7	Primary Over-Voltage - min	0.87	Reverse Power Flow - max
Red Rock	RRK083	0.4	Thermal for Gen - min	2	Reverse Power Flow - max
Rich Spring	RSP061	1.12	Reverse Power Flow - min	1.12	Reverse Power Flow - max
Rich Valley	RVA061	0.5	Primary Over-Voltage - min	3.05	Reverse Power Flow - max
Rich Valley	RVA062	0.1	Primary Over-Voltage - min	1.27	Breaker Relay Reduction of Reach - max
Rich Valley	RVA063	0	Primary Over-Voltage - min	0	Primary Over-Voltage - max
Riverwood	RWD061	0.59	Thermal for Gen - min	0.94	Reverse Power Flow - max
Riverwood	RWD062	0.94	Thermal for Gen - min	1.79	Reverse Power Flow - max
Riverwood	RWD063	1.1	Primary Over-Voltage - min	1.39	Reverse Power Flow - max
Riverwood	RWD081	0.85	Reverse Power Flow - min	0.85	Reverse Power Flow - max
Riverwood	RWD082	0.59	Thermal for Gen - min	1.12	Reverse Power Flow - max
Sauk River	SAK311	0	Primary Over-Voltage - min	0	Primary Over-Voltage - max
Sauk River	SAK312	0.1	Primary Over-Voltage - min	1.74	Breaker Relay Reduction of Reach - max
Sauk River	SAK321	0	Primary Over-Voltage - min	0	Primary Over-Voltage - max
Savage	SAV063	0.7	Primary Over-Voltage - min	1.78	Reverse Power Flow - max
Savage	SAV067	0.6	Primary Over-Voltage - min	2.06	Reverse Power Flow - max
Savage	SAV069	0.28	Thermal for Gen - min	1.11	Reverse Power Flow - max
Savage	SAV071	0.94	Thermal for Gen - min	1.69	Reverse Power Flow - max
Savage	SAV072	0.51	Reverse Power Flow - min	0.51	Reverse Power Flow - max
Savage	SAV073	0.85	Reverse Power Flow - min	0.85	Reverse Power Flow - max
Scandia	SCA021	0	Primary Over-Voltage - min	0	Primary Over-Voltage - max
Sacred Heart	SCH001	0.15	Reverse Power Flow - min	0.15	Reverse Power Flow - max
Sacred Heart	SCH211	0.01	Reverse Power Flow - min	0.34	Reverse Power Flow - max
Saint Cloud	SCL311	0.3	Primary Over-Voltage - min	2.25	Reverse Power Flow - max
Saint Cloud	SCL312	0.1	Primary Over-Voltage - min	0.9	Breaker Relay Reduction of Reach - max
Saint Cloud	SCL313	0.1	Primary Over-Voltage - min	1.97	Breaker Relay Reduction of Reach - max

Substation	Feeder	Minimum Hosting Capacity (MW)	Min Limiting Factor	Maximum Hosting Capacity (MW)	Max Limiting Factor
Saint Cloud	SCL322	0	Primary Over-Voltage - min	0	Primary Over-Voltage - max
Saint Cloud	SCL323	0	Primary Over-Voltage - min	0	Primary Over-Voltage - max
Salida Crossing	SDX061	3.09	Reverse Power Flow - min	3.09	Reverse Power Flow - max
Sedan	SED061	0.04	Reverse Power Flow - min	0.04	Reverse Power Flow - max
Shepard	SHP061	0.91	Reverse Power Flow - min	0.91	Reverse Power Flow - max
Shepard	SHP062	0.6	Thermal for Gen - min	1.9	Reverse Power Flow - max
Shepard	SHP063	0.9	Reverse Power Flow - min	0.9	Reverse Power Flow - max
Shepard	SHP071	0.96	Thermal for Gen - min	1.43	Reverse Power Flow - max
Shepard	SHP072	0.36	Thermal for Gen - min	1.32	Reverse Power Flow - max
Sibley Park	SIP061	0.7	Primary Over-Voltage - min	1.86	Reverse Power Flow - max
Sibley Park	SIP062	1.87	Reverse Power Flow - min	1.87	Reverse Power Flow - max
Sibley Park	SIP063	0.6	Thermal for Gen - min	1.39	Reverse Power Flow - max
Sibley Park	SIP071	0.28	Thermal for Gen - min	1.54	Reverse Power Flow - max
Sibley Park	SIP072	0.3	Primary Over-Voltage - min	1.31	Reverse Power Flow - max
Sibley Park	SIP073	0.35	Thermal for Gen - min	1.3	Reverse Power Flow - max
Saint John's	SJO001	0	Primary Over-Voltage - min	0	Primary Over-Voltage - max
Saint Louis Park	SLP071	0.6	Thermal for Gen - min	1.77	Reverse Power Flow - max
Saint Louis Park	SLP072	0.29	Thermal for Gen - min	2.02	Reverse Power Flow - max
Saint Louis Park	SLP073	0.36	Thermal for Gen - min	1.85	Reverse Power Flow - max
Saint Louis Park	SLP074	0.4	Primary Over-Voltage - min	1.13	Breaker Relay Reduction of Reach - max
Saint Louis Park	SLP075	0.6	Thermal for Gen - min	1.81	Reverse Power Flow - max
Saint Louis Park	SLP076	0.96	Thermal for Gen - min	1.62	Reverse Power Flow - max
Saint Louis Park	SLP077	0.96	Thermal for Gen - min	1.83	Reverse Power Flow - max
Saint Louis Park	SLP081	0.9	Primary Over-Voltage - min	1.43	Reverse Power Flow - max
Saint Louis Park	SLP082	0.96	Thermal for Gen - min	2.13	Reverse Power Flow - max
Saint Louis Park	SLP083	0.96	Thermal for Gen - min	1.7	Reverse Power Flow - max
Saint Louis Park	SLP084	0.96	Thermal for Gen - min	1.73	Reverse Power Flow - max
Saint Louis Park	SLP085	0.96	Thermal for Gen - min	1.58	Reverse Power Flow - max
Saint Louis Park	SLP086	1.01	Thermal for Gen - min	1.42	Reverse Power Flow - max
Saint Louis Park	SLP087	0.96	Thermal for Gen - min	1.31	Reverse Power Flow - max
Saint Louis Park	SLP091	0.86	Reverse Power Flow - min	0.86	Reverse Power Flow - max
Saint Louis Park	SLP092	0.96	Thermal for Gen - min	1.72	Reverse Power Flow - max
Saint Louis Park	SLP093	0.9	Primary Over-Voltage - min	2.05	Reverse Power Flow - max
Saint Louis Park	SLP094	0.96	Thermal for Gen - min	1.11	Reverse Power Flow - max

Substation	Feeder	Minimum Hosting Capacity (MW)	Min Limiting Factor	Maximum Hosting Capacity (MW)	Max Limiting Factor
Saint Louis Park	SLP095	0.96	Reverse Power Flow - min	0.96	Reverse Power Flow - max
Saint Louis Park	SLP096	0.96	Thermal for Gen - min	1.98	Reverse Power Flow - max
Saint Louis Park	SLP097	0.96	Thermal for Gen - min	1.24	Reverse Power Flow - max
Saint Louis Park	SLP321	0.3	Primary Over-Voltage - min	1.12	Breaker Relay Reduction of Reach - max
Saint Louis Park	SLP322	0.5	Primary Over-Voltage - min	1.8	Breaker Relay Reduction of Reach - max
Slayton West	SLW061	0.61	Reverse Power Flow - min	0.61	Reverse Power Flow - max
Slayton West	SLW062	0.58	Reverse Power Flow - min	0.58	Reverse Power Flow - max
Summit Ave	SMT061	0.72	Thermal for Gen - min	1.06	Reverse Power Flow - max
Summit Ave	SMT062	0.1	Primary Over-Voltage - min	0.86	Breaker Relay Reduction of Reach - max
Summit Ave	SMT063	0.59	Thermal for Gen - min	1.11	Reverse Power Flow - max
Summit Ave	SMT071	1.53	Thermal for Gen - min	2.22	Reverse Power Flow - max
Summit Ave	SMT072	0	Primary Over-Voltage - min	0	Primary Over-Voltage - max
Summit Ave	SMT081	0.96	Thermal for Gen - min	1.92	Reverse Power Flow - max
Summit Ave	SMT082	0.2	Primary Over-Voltage - min	1.08	Breaker Relay Reduction of Reach - max
Summit Ave	SMT091	0.49	Thermal for Gen - min	1.98	Reverse Power Flow - max
Summit Ave	SMT092	0	Primary Over-Voltage - min	0	Primary Over-Voltage - max
South Haven	SOH001	0.1	Reverse Power Flow - min	0.1	Reverse Power Flow - max
Southtown	SOU061	0.47	Thermal for Gen - min	1.56	Reverse Power Flow - max
Southtown	SOU063	1.07	Thermal for Gen - min	1.77	Reverse Power Flow - max
Southtown	SOU064	0.23	Thermal for Gen - min	2.2	Reverse Power Flow - max
Southtown	SOU065	1.3	Primary Over-Voltage - min	1.53	Reverse Power Flow - max
Southtown	SOU066	0.94	Reverse Power Flow - min	0.94	Reverse Power Flow - max
Southtown	SOU069	0.9	Reverse Power Flow - min	0.9	Reverse Power Flow - max
Southtown	SOU072	0.94	Thermal for Gen - min	1.85	Reverse Power Flow - max
Southtown	SOU073	0.82	Reverse Power Flow - min	0.82	Reverse Power Flow - max
Southtown	SOU075	0.47	Thermal for Gen - min	1.94	Reverse Power Flow - max
Southtown	SOU076	0.47	Thermal for Gen - min	1.15	Reverse Power Flow - max
Southtown	SOU077	0.94	Thermal for Gen - min	2.42	Reverse Power Flow - max
Southtown	SOU078	0.2	Primary Over-Voltage - min	0.93	Reverse Power Flow - max
Southtown	SOU079	0.47	Thermal for Gen - min	1.59	Reverse Power Flow - max
Southtown	SOU081	0.92	Reverse Power Flow - min	0.92	Reverse Power Flow - max
Southtown	SOU082	0.47	Thermal for Gen - min	1.99	Reverse Power Flow - max
Southtown	SOU083	0.47	Thermal for Gen - min	1.31	Reverse Power Flow - max
Southtown	SOU084	0.4	Reverse Power Flow - min	0.4	Reverse Power Flow - max

Substation	Feeder	Minimum Hosting Capacity (MW)	Min Limiting Factor	Maximum Hosting Capacity (MW)	Max Limiting Factor
Southtown	SOU085	0.94	Thermal for Gen - min	1.5	Reverse Power Flow - max
Southtown	SOU086	0.47	Thermal for Gen - min	1.64	Reverse Power Flow - max
Southtown	SOU087	0.47	Thermal for Gen - min	0.65	Reverse Power Flow - max
Southtown	SOU088	0.25	Thermal for Gen - min	1.25	Reverse Power Flow - max
South Ridge	SRD211	0	Primary Over-Voltage - min	0	Primary Over-Voltage - max
Saint Joseph	STO001	0.65	Reverse Power Flow - min	0.65	Reverse Power Flow - max
Saint Joseph	STO002	0.2	Primary Over-Voltage - min	0.56	Reverse Power Flow - max
Stewart	STW021	0.1	Primary Over-Voltage - min	0.1	Primary Over-Voltage - max
Stockyards	STY061	0.1	Primary Over-Voltage - min	1.95	Reverse Power Flow - max
Stockyards	STY062	0.5	Primary Over-Voltage - min	1.61	Reverse Power Flow - max
Stockyards	STY063	0.4	Primary Over-Voltage - min	1.1	Primary Over-Voltage - max
Stockyards	STY065	0.5	Primary Over-Voltage - min	1.91	Reverse Power Flow - max
Stockyards	STY071	0.8	Primary Over-Voltage - min	2.38	Reverse Power Flow - max
Stockyards	STY072	0.94	Thermal for Gen - min	1.4	Reverse Power Flow - max
Stockyards	STY073	0.59	Thermal for Gen - min	1.6	Reverse Power Flow - max
Stockyards	STY075	0	Primary Over-Voltage - min	0	Primary Over-Voltage - max
Swan Lake	SWN021	0.25	Reverse Power Flow - min	0.25	Reverse Power Flow - max
Swan Lake	SWN022	0	Primary Over-Voltage - min	0	Primary Over-Voltage - max
Terminal	TER061	0.96	Thermal for Gen - min	1.49	Reverse Power Flow - max
Terminal	TER062	0.96	Thermal for Gen - min	1.54	Reverse Power Flow - max
Terminal	TER063	0.96	Thermal for Gen - min	1.75	Reverse Power Flow - max
Terminal	TER064	0.96	Thermal for Gen - min	1.33	Reverse Power Flow - max
Terminal	TER065	0.48	Thermal for Gen - min	2.24	Reverse Power Flow - max
Terminal	TER066	0.96	Thermal for Gen - min	2.22	Reverse Power Flow - max
Terminal	TER071	0.96	Thermal for Gen - min	1.51	Reverse Power Flow - max
Terminal	TER072	1.2	Reverse Power Flow - min	1.2	Reverse Power Flow - max
Terminal	TER073	0.17	Thermal for Gen - min	0.53	Breaker Relay Reduction of Reach - max
Terminal	TER074	1.25	Reverse Power Flow - min	1.25	Reverse Power Flow - max
Terminal	TER075	0.96	Thermal for Gen - min	1.3	Reverse Power Flow - max
Terminal	TER076	0.73	Reverse Power Flow - min	0.73	Reverse Power Flow - max
Terminal	TER081	0.26	Thermal for Gen - min	1.78	Reverse Power Flow - max
Terminal	TER082	1	Thermal for Gen - min	1.66	Reverse Power Flow - max
Terminal	TER083	0.6	Thermal for Gen - min	1.36	Reverse Power Flow - max
Terminal	TER084	1.76	Reverse Power Flow - min	1.76	Reverse Power Flow - max

Substation	Feeder	Minimum Hosting Capacity (MW)	Min Limiting Factor	Maximum Hosting Capacity (MW)	Max Limiting Factor
Terminal	TER085	0.73	Reverse Power Flow - min	0.73	Reverse Power Flow - max
Terminal	TER086	1.13	Reverse Power Flow - min	1.13	Reverse Power Flow - max
Tanner's Lake	TLK023	2.08	Reverse Power Flow - min	2.08	Reverse Power Flow - max
Tanner's Lake	TLK032	2.08	Reverse Power Flow - min	2.08	Reverse Power Flow - max
Tanner's Lake	TLK034	1.45	Reverse Power Flow - min	1.45	Reverse Power Flow - max
Tanner's Lake	TLK061	0.9	Primary Over-Voltage - min	1.93	Reverse Power Flow - max
Tanner's Lake	TLK062	0.9	Primary Over-Voltage - min	1.59	Reverse Power Flow - max
Tanner's Lake	TLK064	0.96	Thermal for Gen - min	1.14	Reverse Power Flow - max
Tanner's Lake	TLK065	0.62	Reverse Power Flow - min	0.62	Reverse Power Flow - max
Tanner's Lake	TLK066	0.7	Thermal for Gen - min	1.59	Reverse Power Flow - max
Tanner's Lake	TLK067	0.6	Thermal for Gen - min	1.51	Reverse Power Flow - max
Tanner's Lake	TLK071	0.88	Reverse Power Flow - min	0.88	Reverse Power Flow - max
Tanner's Lake	TLK073	1.06	Thermal for Gen - min	1.08	Reverse Power Flow - max
Tanner's Lake	TLK075	0.96	Thermal for Gen - min	1.39	Reverse Power Flow - max
Tanner's Lake	TLK076	0.94	Reverse Power Flow - min	0.94	Reverse Power Flow - max
Tanner's Lake	TLK077	0.8	Primary Over-Voltage - min	2.04	Reverse Power Flow - max
Tracy	TRA001	0.23	Reverse Power Flow - min	0.23	Reverse Power Flow - max
Tracy	TRA002	0.2	Primary Over-Voltage - min	0.24	Reverse Power Flow - max
Tracy Switching Statio	TSS061	0	Primary Over-Voltage - min	0	Primary Over-Voltage - max
Twin Lake	TWL061	0.76	Thermal for Gen - min	1.03	Reverse Power Flow - max
Twin Lake	TWL062	0.5	Primary Over-Voltage - min	1.29	Reverse Power Flow - max
Twin Lake	TWL063	1.3	Primary Over-Voltage - min	1.36	Reverse Power Flow - max
Twin Lake	TWL064	0.5	Primary Over-Voltage - min	1.23	Reverse Power Flow - max
Twin Lake	TWL065	0.94	Thermal for Gen - min	1.65	Reverse Power Flow - max
Twin Lake	TWL066	0.96	Thermal for Gen - min	1.33	Reverse Power Flow - max
Twin Lake	TWL067	0.94	Thermal for Gen - min	1	Reverse Power Flow - max
Twin Lake	TWL068	0.58	Thermal for Gen - min	1.4	Reverse Power Flow - max
Twin Lake	TWL069	0.94	Thermal for Gen - min	1.3	Reverse Power Flow - max
Twin Lake	TWL071	0.94	Thermal for Gen - min	1.97	Reverse Power Flow - max
Twin Lake	TWL072	0.94	Thermal for Gen - min	1.92	Reverse Power Flow - max
Twin Lake	TWL073	0.64	Reverse Power Flow - min	0.64	Reverse Power Flow - max
Twin Lake	TWL074	0.91	Thermal for Gen - min	1.14	Reverse Power Flow - max
Twin Lake	TWL075	0	Primary Over-Voltage - min	0	Primary Over-Voltage - max
Twin Lake	TWL076	0.94	Thermal for Gen - min	1.66	Reverse Power Flow - max

Substation	Feeder	Minimum Hosting Capacity (MW)	Min Limiting Factor	Maximum Hosting Capacity (MW)	Max Limiting Factor
Twin Lake	TWL077	0.55	Reverse Power Flow - min	0.55	Reverse Power Flow - max
Twin Lake	TWL078	0	Primary Over-Voltage - min	0	Primary Over-Voltage - max
Twin Lake	TWL079	0.94	Thermal for Gen - min	2.2	Reverse Power Flow - max
Twin Lake	TWL081	0.8	Primary Over-Voltage - min	1.68	Reverse Power Flow - max
Twin Lake	TWL082	0.59	Thermal for Gen - min	1.44	Reverse Power Flow - max
Twin Lake	TWL083	0.99	Thermal for Gen - min	1.5	Reverse Power Flow - max
Twin Lake	TWL089	0.94	Thermal for Gen - min	1.31	Reverse Power Flow - max
Upper Levee	UPP061	0.96	Thermal for Gen - min	1.62	Reverse Power Flow - max
Upper Levee	UPP062	0.96	Thermal for Gen - min	1.88	Reverse Power Flow - max
Upper Levee	UPP063	0.5	Primary Over-Voltage - min	1.7	Reverse Power Flow - max
Upper Levee	UPP064	0.96	Thermal for Gen - min	2.01	Reverse Power Flow - max
Upper Levee	UPP065	1.63	Thermal for Gen - min	1.68	Reverse Power Flow - max
Upper Levee	UPP066	0.36	Thermal for Gen - min	1.46	Reverse Power Flow - max
Upper Levee	UPP067	1.3	Reverse Power Flow - min	1.3	Reverse Power Flow - max
Upper Levee	UPP068	0.99	Thermal for Gen - min	1.25	Reverse Power Flow - max
Upper Levee	UPP069	1.12	Reverse Power Flow - min	1.12	Reverse Power Flow - max
Upper Levee	UPP081	0.96	Thermal for Gen - min	2.06	Reverse Power Flow - max
Upper Levee	UPP082	0.6	Thermal for Gen - min	1.69	Reverse Power Flow - max
Upper Levee	UPP083	1.23	Reverse Power Flow - min	1.23	Reverse Power Flow - max
Upper Levee	UPP084	0.74	Thermal for Gen - min	2.15	Reverse Power Flow - max
Upper Levee	UPP085	0.96	Thermal for Gen - min	1.43	Reverse Power Flow - max
Upper Levee	UPP086	0.96	Thermal for Gen - min	1.83	Reverse Power Flow - max
Upper Levee	UPP088	2.03	Reverse Power Flow - min	2.03	Reverse Power Flow - max
Upper Levee	UPP089	0.43	Reverse Power Flow - min	0.43	Reverse Power Flow - max
Vesili	VES021	0	Primary Over-Voltage - min	0	Primary Over-Voltage - max
Villard	VIL021	0.2	Reverse Power Flow - min	0.2	Reverse Power Flow - max
Viking	VKG061	0.58	Reverse Power Flow - min	0.58	Reverse Power Flow - max
Viking	VKG065	0.94	Thermal for Gen - min	1.45	Reverse Power Flow - max
Viking	VKG071	1	Reverse Power Flow - min	1	Reverse Power Flow - max
Viking	VKG072	1.2	Primary Over-Voltage - min	1.65	Reverse Power Flow - max
Vermillion	VMR061	0.26	Thermal for Gen - min	0.48	Reverse Power Flow - max
Vermillion	VMR062	0.96	Thermal for Gen - min	1	Reverse Power Flow - max
Vermillion	VMR063	0.28	Thermal for Gen - min	0.36	Reverse Power Flow - max
Wabasha	WAB021	0.35	Thermal for Gen - min	0.77	Reverse Power Flow - max

Substation	Feeder	Minimum Hosting Capacity (MW)	Min Limiting Factor	Maximum Hosting Capacity (MW)	Max Limiting Factor
Wabasha	WAB031	0	Primary Over-Voltage - min	0	Primary Over-Voltage - max
Wakefield	WAK321	0	Primary Over-Voltage - min	0	Primary Over-Voltage - max
Waseca	WAS081	0	Reverse Power Flow - min	0	Reverse Power Flow - max
Waseca	WAS091	1.22	Thermal for Gen - min	2.54	Reverse Power Flow - max
Waseca	WAS092	0	Primary Over-Voltage - min	0	Primary Over-Voltage - max
Waseca	WAS231	2.18	Reverse Power Flow - min	2.18	Reverse Power Flow - max
Waterville	WAT021	0.2	Primary Over-Voltage - min	0.61	Reverse Power Flow - max
Waterville	WAT081	0.3	Primary Over-Voltage - min	0.6	Breaker Relay Reduction of Reach - max
Waterville	WAT221	0.36	Thermal for Gen - min	0.66	Reverse Power Flow - max
Waverly	WAV021	0	Primary Over-Voltage - min	0	Primary Over-Voltage - max
lliams Brothers Prop	WBP061	0.94	Thermal for Gen - min	1.37	Reverse Power Flow - max
lliams Brothers Prop	WBP062	0	Thermal for Gen - min	1.27	Reverse Power Flow - max
West Coon Rapids	WCR061	0.7	Primary Over-Voltage - min	1.1	Primary Over-Voltage - max
West Coon Rapids	WCR062	0.6	Primary Over-Voltage - min	1.62	Reverse Power Flow - max
West Coon Rapids	WCR063	0.6	Primary Over-Voltage - min	1.38	Reverse Power Flow - max
West Coon Rapids	WCR311	0.26	Primary Over-Voltage - min	2.06	Primary Over-Voltage - max
West Coon Rapids	WCR321	0.19	Primary Over-Voltage - min	0.73	Breaker Relay Reduction of Reach - max
West Coon Rapids	WCR322	0.5	Primary Over-Voltage - min	3.81	Reverse Power Flow - max
Waconia	WCS061	1	Reverse Power Flow - min	1	Reverse Power Flow - max
Waconia	WCS064	0.3	Primary Over-Voltage - min	1.21	Reverse Power Flow - max
Waconia	WCS071	0.96	Thermal for Gen - min	1.42	Reverse Power Flow - max
Waconia	WCS072	0.26	Thermal for Gen - min	1.23	Reverse Power Flow - max
Woodbury	WDY311	0.1	Primary Over-Voltage - min	1.73	Breaker Relay Reduction of Reach - max
Woodbury	WDY312	1.52	Thermal for Gen - min	3.73	Reverse Power Flow - max
Woodbury	WDY321	0.94	Thermal for Gen - min	2.67	Reverse Power Flow - max
Woodbury	WDY322	2.6	Primary Over-Voltage - min	3.94	Reverse Power Flow - max
West Byron	WEB021	0.31	Thermal for Gen - min	1.95	Reverse Power Flow - max
West Faribault	WEF061	0.23	Thermal for Gen - min	1.28	Reverse Power Flow - max
West Faribault	WEF071	0.4	Primary Over-Voltage - min	1.57	Reverse Power Flow - max
West Hastings	WEH021	0.5	Primary Over-Voltage - min	1.34	Reverse Power Flow - max
West Hastings	WEH022	0.85	Thermal for Gen - min	1.43	Reverse Power Flow - max
Wells Creek	WEL021	0	Primary Over-Voltage - min	0	Primary Over-Voltage - max
Western	WES061	0.67	Thermal for Gen - min	1.72	Reverse Power Flow - max
Western	WES062	0.7	Primary Over-Voltage - min	1.59	Reverse Power Flow - max

Substation	Feeder	Minimum Hosting Capacity (MW)	Min Limiting Factor	Maximum Hosting Capacity (MW)	Max Limiting Factor
Western	WES063	0.4	Primary Over-Voltage - min	1.39	Reverse Power Flow - max
Western	WES064	0.96	Thermal for Gen - min	2.11	Reverse Power Flow - max
Western	WES065	0.3	Primary Over-Voltage - min	1.51	Reverse Power Flow - max
Western	WES071	0.97	Thermal for Gen - min	1.57	Reverse Power Flow - max
Western	WES072	1	Thermal for Gen - min	1.64	Reverse Power Flow - max
Western	WES073	0.3	Primary Over-Voltage - min	0.71	Breaker Relay Reduction of Reach - max
Western	WES074	0.63	Thermal for Gen - min	1.86	Reverse Power Flow - max
Western	WES075	0.96	Thermal for Gen - min	1.4	Reverse Power Flow - max
Western	WES076	1.03	Thermal for Gen - min	1.82	Reverse Power Flow - max
Wilson	WIL071	0.95	Thermal for Gen - min	1.68	Reverse Power Flow - max
Wilson	WIL072	0.71	Thermal for Gen - min	1.57	Reverse Power Flow - max
Wilson	WIL073	0.95	Thermal for Gen - min	1.65	Reverse Power Flow - max
Wilson	WIL074	0.95	Thermal for Gen - min	1.28	Reverse Power Flow - max
Wilson	WIL075	0.94	Thermal for Gen - min	0.97	Reverse Power Flow - max
Wilson	WIL076	0.94	Thermal for Gen - min	1.45	Reverse Power Flow - max
Wilson	WIL077	0.94	Thermal for Gen - min	1.26	Reverse Power Flow - max
Wilson	WIL078	0.94	Thermal for Gen - min	1.22	Reverse Power Flow - max
Wilson	WIL079	1.17	Thermal for Gen - min	1.54	Reverse Power Flow - max
Wilson	WIL081	1.04	Thermal for Gen - min	1.67	Reverse Power Flow - max
Wilson	WIL082	0.74	Thermal for Gen - min	1.7	Reverse Power Flow - max
Wilson	WIL083	0.66	Thermal for Gen - min	0.85	Reverse Power Flow - max
Wilson	WIL084	0.6	Thermal for Gen - min	1.44	Reverse Power Flow - max
Wilson	WIL085	0.61	Thermal for Gen - min	1.99	Reverse Power Flow - max
Wilson	WIL086	0.26	Thermal for Gen - min	1.66	Reverse Power Flow - max
Wilson	WIL087	0.96	Thermal for Gen - min	1.96	Reverse Power Flow - max
Wilson	WIL088	0.59	Thermal for Gen - min	0.59	Reverse Power Flow - max
Wilson	WIL089	0.96	Thermal for Gen - min	1.83	Reverse Power Flow - max
Wilson	WIL091	0.95	Thermal for Gen - min	1.26	Reverse Power Flow - max
Wilson	WIL092	0.94	Thermal for Gen - min	1.31	Reverse Power Flow - max
Wilson	WIL093	0.94	Thermal for Gen - min	1.33	Reverse Power Flow - max
Wilson	WIL094	1.17	Thermal for Gen - min	1.44	Reverse Power Flow - max
Wilson	WIL095	0.94	Thermal for Gen - min	1.58	Reverse Power Flow - max
Wilson	WIL096	0.99	Thermal for Gen - min	1.4	Reverse Power Flow - max
Wilson	WIL097	0.59	Thermal for Gen - min	1.6	Reverse Power Flow - max

Substation	Feeder	Minimum Hosting Capacity (MW)	Min Limiting Factor	Maximum Hosting Capacity (MW)	Max Limiting Factor
Wilson	WIL098	0.6	Thermal for Gen - min	1.67	Reverse Power Flow - max
Winona	WIN021	0.05	Thermal for Gen - min	0.8	Reverse Power Flow - max
Winona	WIN022	0.13	Thermal for Gen - min	0.28	Reverse Power Flow - max
Winona	WIN023	0.21	Thermal for Gen - min	0.29	Reverse Power Flow - max
Winona	WIN032	0.85	Thermal for Gen - min	1.17	Reverse Power Flow - max
Winona	WIN033	0.17	Thermal for Gen - min	1.76	Reverse Power Flow - max
Winona	WIN034	0.49	Reverse Power Flow - min	0.49	Reverse Power Flow - max
Winona	WIN041	0.68	Reverse Power Flow - min	0.68	Reverse Power Flow - max
Winona	WIN042	0.17	Thermal for Gen - min	0.53	Reverse Power Flow - max
Winona	WIN043	0.13	Thermal for Gen - min	0.87	Breaker Relay Reduction of Reach - max
Watkins	WKN001	0.1	Primary Over-Voltage - min	0.33	Reverse Power Flow - max
Wobegon Trail	WOB021	0	Primary Over-Voltage - min	0	Primary Over-Voltage - max
Wobegon Trail	WOB022	0.19	Thermal for Gen - min	0.46	Reverse Power Flow - max
West River Road	WRR061	1.01	Thermal for Gen - min	1.35	Reverse Power Flow - max
West River Road	WRR064	0.95	Thermal for Gen - min	1.94	Reverse Power Flow - max
West River Road	WRR065	2.15	Reverse Power Flow - min	2.15	Reverse Power Flow - max
West River Road	WRR074	1.17	Thermal for Gen - min	1.7	Reverse Power Flow - max
West River Road	WRR075	0.94	Thermal for Gen - min	1.78	Reverse Power Flow - max
West River Road	WRR081	1.24	Thermal for Gen - min	1.38	Reverse Power Flow - max
West River Road	WRR084	0.94	Thermal for Gen - min	1.73	Reverse Power Flow - max
West River Road	WRR085	0.8	Reverse Power Flow - min	0.8	Reverse Power Flow - max
Winsted	WSD061	0.59	Thermal for Gen - min	1.12	Reverse Power Flow - max
Westgate	WSG061	1.55	Thermal for Gen - min	1.93	Reverse Power Flow - max
Westgate	WSG062	1.3	Primary Over-Voltage - min	1.43	Reverse Power Flow - max
Westgate	WSG063	1.1	Primary Over-Voltage - min	1.62	Reverse Power Flow - max
Westgate	WSG064	1.1	Primary Over-Voltage - min	1.54	Reverse Power Flow - max
Westgate	WSG065	0.8	Primary Over-Voltage - min	1.45	Reverse Power Flow - max
Westgate	WSG066	0.9	Primary Over-Voltage - min	1.98	Reverse Power Flow - max
Westgate	WSG071	1.1	Primary Over-Voltage - min	1.79	Reverse Power Flow - max
Westgate	WSG072	0.89	Reverse Power Flow - min	0.89	Reverse Power Flow - max
Westgate	WSG073	0.57	Reverse Power Flow - min	0.57	Reverse Power Flow - max
Westgate	WSG074	1	Primary Over-Voltage - min	2.09	Reverse Power Flow - max
Westgate	WSG075	1.23	Thermal for Gen - min	1.59	Reverse Power Flow - max
Westgate	WSG076	0.5	Primary Over-Voltage - min	1.22	Reverse Power Flow - max

Substation	Feeder	Minimum Hosting Capacity (MW)	Min Limiting Factor	Maximum Hosting Capacity (MW)	Max Limiting Factor
Westgate	WSG351	0.6	Thermal for Gen - min	1.13	Reverse Power Flow - max
Westgate	WSG352	0.6	Primary Over-Voltage - min	2.48	Breaker Relay Reduction of Reach - max
Westgate	WSG361	0.38	Thermal for Gen - min	1.75	Breaker Relay Reduction of Reach - max
Westgate	WSG362	0.5	Primary Over-Voltage - min	2.97	Reverse Power Flow - max
Westport	WSP021	0.06	Reverse Power Flow - min	0.06	Reverse Power Flow - max
West Union	WSU021	0.03	Reverse Power Flow - min	0.03	Reverse Power Flow - max
Watab River	WTB021	0	Primary Over-Voltage - min	0	Primary Over-Voltage - max
Watertown	WTN061	0.5	Primary Over-Voltage - min	0.55	Reverse Power Flow - max
Watertown	WTN062	0.3	Primary Over-Voltage - min	0.79	Reverse Power Flow - max
West Waconia	WWK311	0.15	Thermal for Gen - min	0.56	Breaker Relay Reduction of Reach - max
West Waconia	WWK321	0.2	Primary Over-Voltage - min	1.64	Breaker Relay Reduction of Reach - max
Wyoming	WYO021	0.8	Primary Over-Voltage - min	1.84	Reverse Power Flow - max
Wyoming	WYO022	0	Primary Over-Voltage - min	0	Primary Over-Voltage - max
Wyoming	WYO031	0.7	Primary Over-Voltage - min	1.43	Reverse Power Flow - max
Wyoming	WYO032	0.4	Primary Over-Voltage - min	1.26	Reverse Power Flow - max
Wyoming	WYO033	0.85	Thermal for Gen - min	1.5	Reverse Power Flow - max
Crossroads	XRD061	0.81	Reverse Power Flow - min	0.81	Reverse Power Flow - max
Crossroads	XRD062	1.02	Thermal for Gen - min	1.44	Reverse Power Flow - max
Crossroads	XRD063	0.94	Thermal for Gen - min	1.75	Reverse Power Flow - max
Crossroads	XRD075	0.94	Thermal for Gen - min	1.19	Reverse Power Flow - max
Crossroads	XRD076	0.2	Primary Over-Voltage - min	1.23	Breaker Relay Reduction of Reach - max
Crossroads	XRD077	0.96	Thermal for Gen - min	1.36	Reverse Power Flow - max
Young America	YAM021	0	Primary Over-Voltage - min	0	Primary Over-Voltage - max
Young America	YAM031	0.2	Primary Over-Voltage - min	0.83	Reverse Power Flow - max
Yellow Medicine	YLM211	0.1	Primary Over-Voltage - min	0.69	Breaker Relay Reduction of Reach - max
Yellow Medicine	YLM212	0.1	Primary Over-Voltage - min	0.48	Reverse Power Flow - max
Zumbro Falls	ZUF021	0	Primary Over-Voltage - min	0	Primary Over-Voltage - max
Zumbrota	ZUM021	0	Primary Over-Voltage - min	0	Primary Over-Voltage - max
Zumbrota	ZUM022	0	Primary Over-Voltage - min	0	Primary Over-Voltage - max

Source	Requirement	Location Response is Addressed
Docket 17-777 7/9/18 Order	2. Xcel's 2018 Hosting Capacity Report must be detailed enough to provide developers with a reliable estimate of the available level of hosting capacity per feeder at the time of submittal of the report to the extent practicable. The information should be sufficient to provide developers with a starting point for interconnection applications.	Attachment A - Hosting Capacity Results
Docket 17-777 7/9/18 Order	3. Xcel's 2018 Hosting Capacity Report must be detailed enough to inform future distribution system planning efforts and upgrades necessary to facilitate the continued efficient integration of distributed generation.	2018 Report: Section G - Impacts and Mitigations
Docket 17-777 7/9/18 Order	4. Xcel must file a color-coded, map-based representation of the available Hosting Capacity down to the feeder level. This information should be provided to the extent it is consistent with what Xcel believes are legitimate security concerns. If security concerns arise, Xcel must explain in detail the basis for those concerns.	Page 22 provides link to: https://www.xcelenergy.com/working_with_us/how_to_interconnect
Docket 17-777 7/9/18 Order	5. Xcel must provide the Hosting Capacity results in downloadable, MS-Excel or other spreadshe	Attachment A - Hosting Capacity Results
Docket 17-777 7/9/18 Order	6. Xcel must provide information on the accuracy of the Hosting Capacity Report information; both estimates on the accuracy of the 2018 report and an analysis of the 2017 results compared to actual hosting capacity determined through any interconnection studies or other reasonable metric.	2018 Report: Section H - Accuracy
Docket 17-777 7/9/18 Order	7. The Commission hereby requests that Xcel Energy address stakeholder recommendations in the Company's 2018 Hosting Capacity Report filing, including: a. consider the methodological options to both improve and measure accuracy of the hosting capacity analysis, including identification and analysis of industry best practices and an explanation of the Company's methodological choice;	2018 Report: Section H - Accuracy
Docket 17-777 7/9/18 Order	b. consider the feasibility and practicality of including the results of both the Small Distributed methodology and the Large Centralized methodology in future hosting capacity analyses;	2018 Report: Section D - Methodology, 2. DER Allocation Method
Docket 17-777 7/9/18 Order	c. conduct a sensitivity analysis;	2018 Report: Section J - Sensitivity Analysis
Docket 17-777 7/9/18 Order	d. explore a range of options for better presenting the public-facing results of the Hosting Capacity Analysis after consideration of, but not limited to, any security and privacy issues that may be implicated in providing more detailed information and what information might be useful to developers and stakeholders;	2018 Report: Section K - Presentation of HCA Results Considers Privacy and Security Interests
Docket 17-777 7/9/18 Order	e. provide an update in each report on the evolving capability of the EPRI DRIVE tool and whether it is capable of incorporating the technologies included in the broadened definition of DERs;	2018 Report: Section C - Hosting Capacity Tool -DRIVE
Docket 17-777 7/9/18 Order	f. file more detailed data on load profile assumptions used in the analysis, including peak load (kW) by substation and feeder; and	2018 Report: Section E - Assumptions
Docket 17-777 7/9/18 Order	g. file supplemental information that would result in a broader understanding of how to guide distribution upgrades for additional hosting capacity.	2018 Report: Section G - Impacts and Mitigations

CERTIFICATE OF SERVICE

I, Jim Erickson, hereby certify that I have this day served copies of the foregoing document on the attached list of persons.

<u>xx</u> by depositing a true and correct copy thereof, properly enveloped with postage paid in the United States mail at Minneapolis, Minnesota

<u>xx</u> electronic filing

Docket Nos. **E002/M-17-777**
Xcel Energy's Miscellaneous Electric Service List

Dated this 1st day of November 2018

/s/
____
Jim Erickson
Regulatory Administrator

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