Updating State Interconnection Standards

Grid Modernization Laboratory Consortium

March 8, 2023

MINNESOTA
PUBLIC UTILITIES COMMISSION

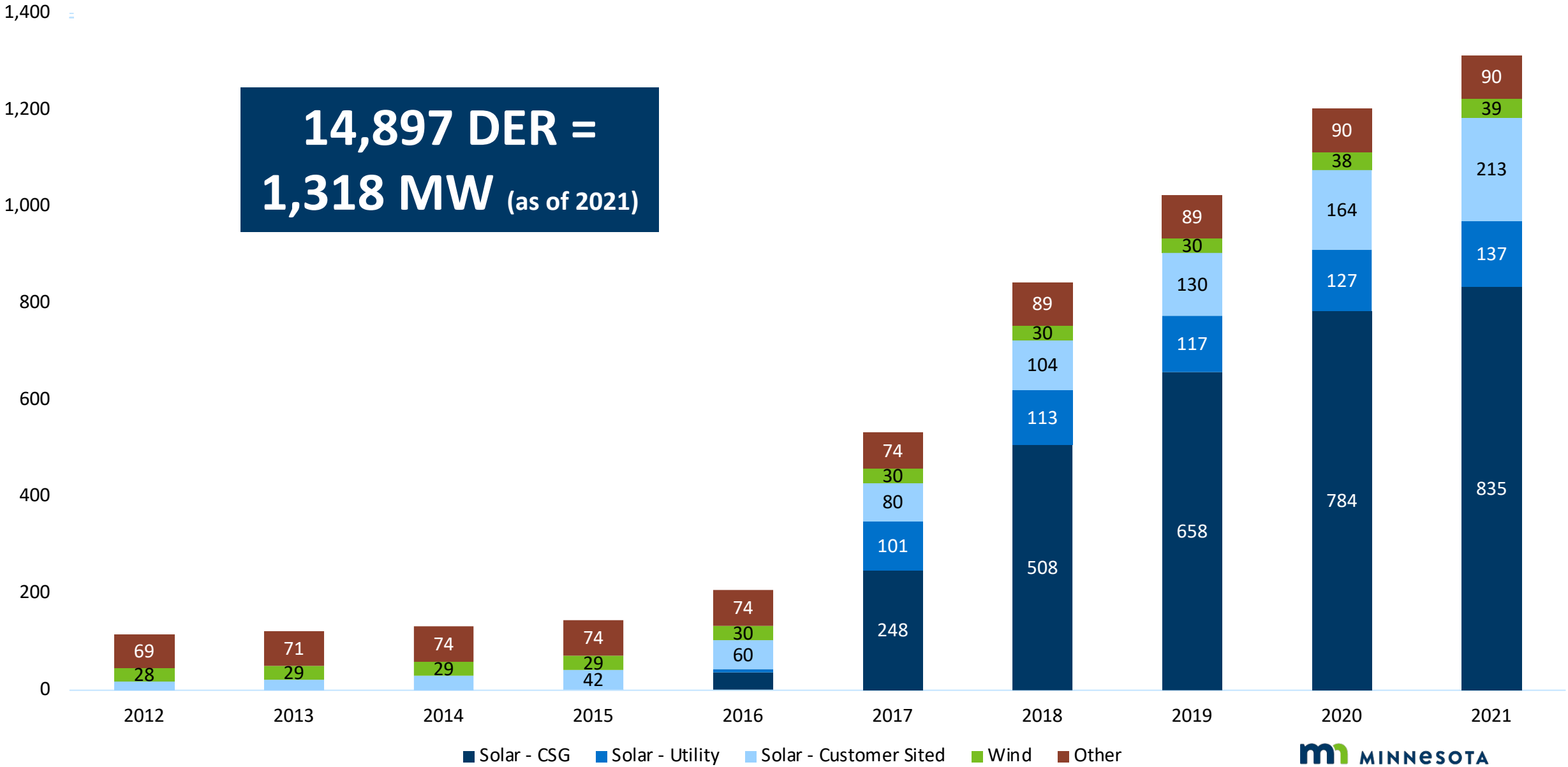
https://mn.gov/puc

Disclaimer

The ideas expressed are the views of the presenter(s), and not the Minnesota Public Utilities Commission.

Cumulative Intalled DER Capacity (MW)

14,897 DER = 1,318 MW (as of 2021)



*Other includes biogas, biomass, hydro, methane, municipal solid waste, storage, and natural gas

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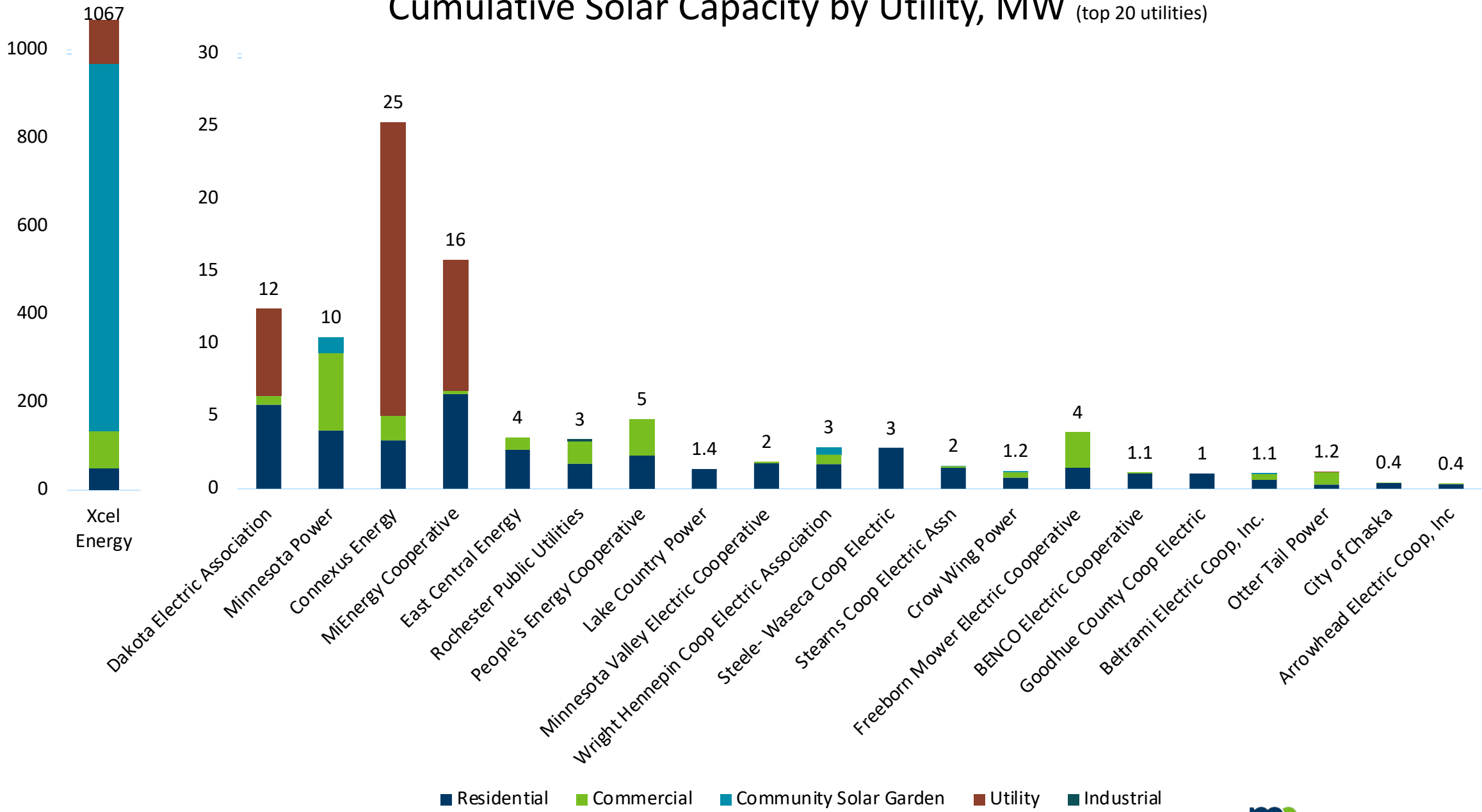
Cumulative Solar Capacity by Utility, MW (top 20 utilities)



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Minnesota Interconnection Update

Phase I: MN DIP/DIA

Interconnection Process, Applications, Agreements

(Effective June 17, 2019)

Phase II: TIIR

Technical Interconnection and Interoperability Requirements consistent with IEEE 1547-2018

(Interim Effective July 1, 2020)

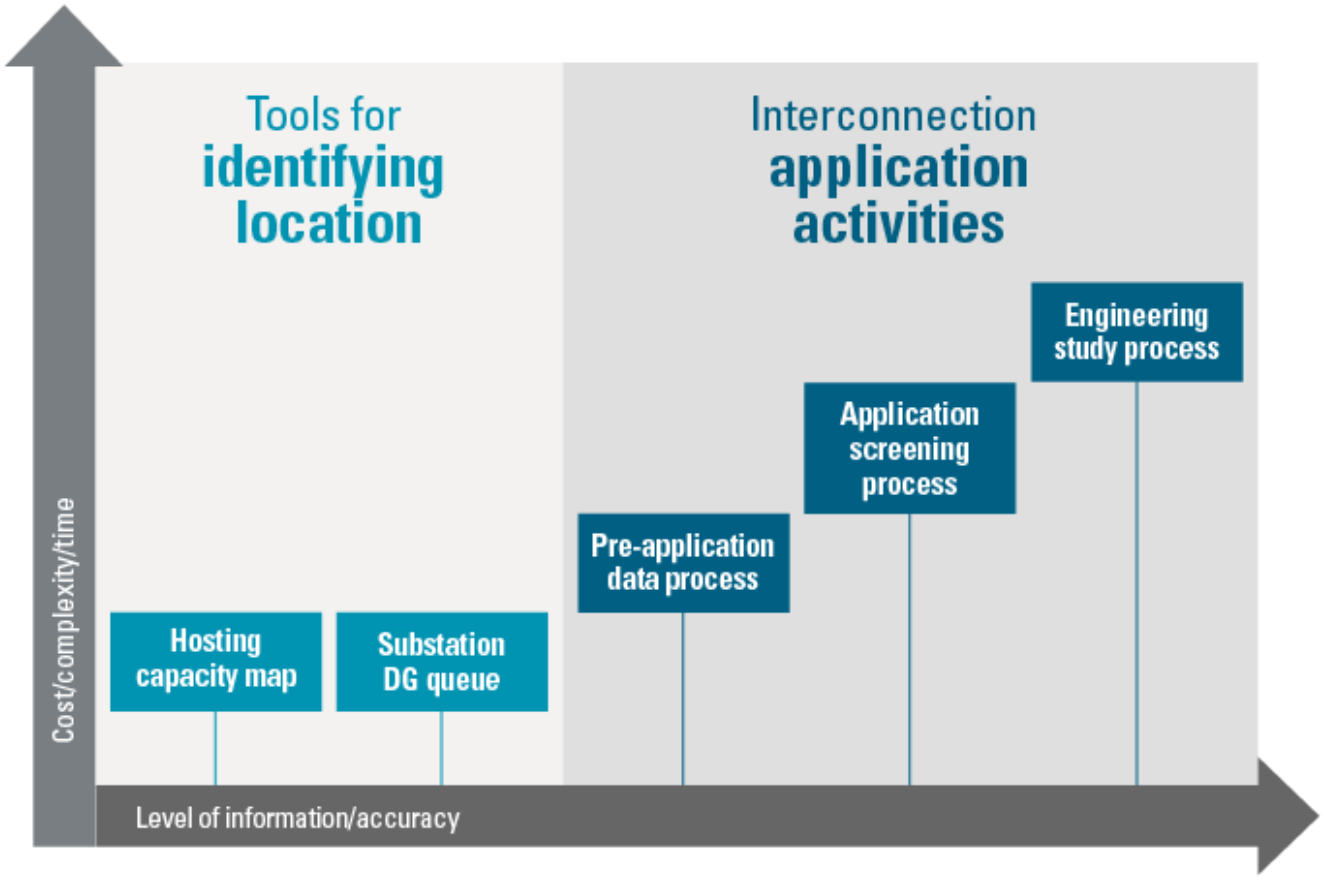
Full Effect pending Commission Notice of "Readily Available" IEEE 1547-2018 Certified Inverters – Anticipated Fall 2023

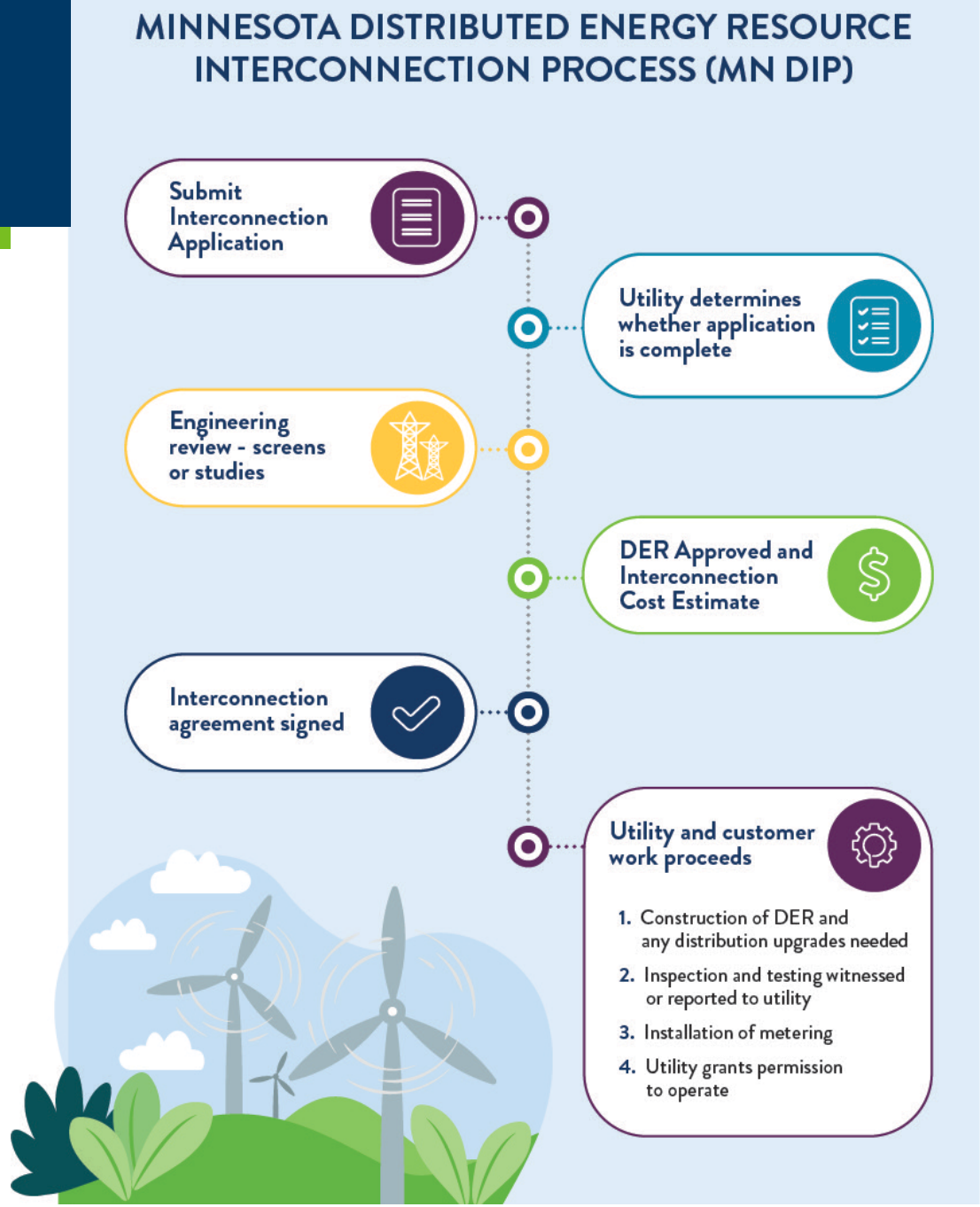
DG Rate Guidance

(Pending Commission hearing.)

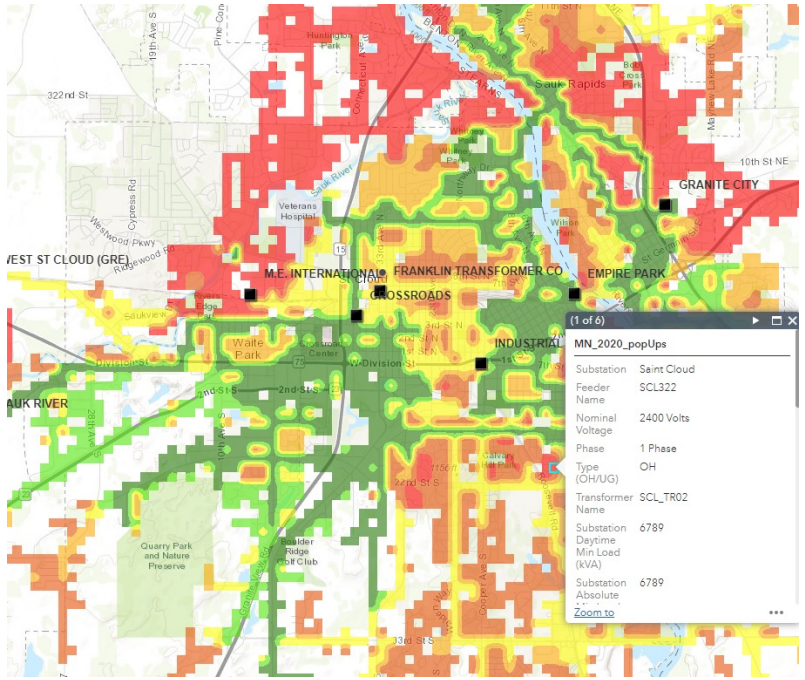
Commission "maintains an ongoing DG Workgroup to meet annually, or more frequently as needed, to review implementation and technical issues that arise with implementation of the MN DIP, Minnesota DER Interconnection Agreement (MN DIA), TIIR, or emerging DER technology."

Before/During Interconnection Process





Location Matters for Interconnection



Hosting Capacity Analysis – Public Map and Pop-Up Details

Substations with Capacity Constraints (≥90% XFMR Rating)	Feeders with Capacity Constraints (≥90% Feeder Rating)	Feeders with Aggregate DER ≥ DML	Feeders that have received Notices to date
Xfmr Rating: The maximum apparent power the substation transformer is capable of operating under. The summation of daytime minimum load and generation on the transformer cannot exceed this value	Feeder Rating: The maximum apparent power the feeder is capable of operating under at its origin point at the substation. The summation of daytime minimum load and generation on the feeder cannot	Any project connecting to feeders where the aggregate DER is greater than or equal to the Daytime Minimum Load (DML) will likely fail the initial review per MN DIP screen 3.2.1.2.	Types of Notices: Pre-MNDIP Substation or Specialized Study MNDIP System Impact Study Phase II Notice MNDIP Dedicated Feeder Notice
Capacity Constrained Substations: 63	**Capacity Constrained Feeders: 64**	**Feeders with Aggregate DER ≥ DML: 172**	**"No Capacity Notice" Feeders: 12**
% of Total Substations: 26.14%	**% of Total Feeders: 5.54%**	**% of Total Feeders: 14.88%**	**% of Total Feeders: 1.04%**
% Constrained Last Month: 25.31%	**% Constrained Last Month: 5.10%**	**% of Total Feeders Last Month: 14.97%**	**% Constrained Last Month: 0.87%**
ALB	ALB023	ALB021	BRO021
ALT	ALT021	ALB022	CHI311
ATW	AVR081	ALB023	CTF022
AVR	BIS001	ALT021	DGC061
BRO	BRO021	ANN021	DOC211
BUR	BUR032	ATW061	FAB063
CHI	CGR063	AVN021	LAF001
CKG	CHI311	AVR081	LCR311
CLC	CKG041	BEG001	LOW021
COK	CLC221	BEL061	MTW021
CTF	CTF021	BEL062	SCL322
DGC	DOC031	BFL021	WEF071

Public Interconnection Queue and Substation/Feeder Information

MN DIP Interconnection Review

Initial Review Screens

for Simplified and Fast Track Applications

Supplemental Review

when Application fails Initial Review screens

System Impact Study

for Applications that fail Supplemental Review or do not qualify or choose Fast Track Review

Affected System Study or Transmission Impact Study

if potential impacts extend beyond utility's distribution grid

Facilities Study may also be conducted.

Technical Interconnection and Interoperability Requirements

Interim Implementation	• Until IEEE 1547-2018 certified equipment is readily available, allows DER that meet IEEE 1547-2003. Utility and DER may agree to use UL 1741 SA settings.
IEEE 1547-2018	• Statewide TIIR addresses issues identified in IEEE 1547-2018: Performance categories, voltage and frequency ridethrough, advanced inverter voltage regulation modes enabled/disabled, interoperability capabilities. TIIR addresses issues not in IEEE 1547-2018; such as, metering, protection requirements, signage/labeling.
Utility Technical Specification Manuals	• Utilities' TSMs accessible to potential interconnection customers. Rate-regulated filed with Commission and published online.
Remaining Issues	• **Updated application templates with energy storage control modes**; Power control Systems (export); **Volt-Var regulation**; Volt-Watt regulation unintended curtailments; operating agreement details.

TSG Recommendations – Interim to Full

- Aligned with ISO/RTO Guidance ☑
- Encouraging use of Volt-Var but still allows for Constant Power Factor if utility chooses ☑
- Advanced Inverter Settings and Utility Required Profiles - *workgroup*
- Updated Utility Technical Specification Manuals - *upcoming*
- Training for Utility and DER Developers - *ongoing*
- Tracking inverter certification and modifications - *ongoing*
- Expectations for legacy equipment upgrades - *ongoing*

High Penetration Challenges and Trials

- March 31, 2022 Order Modifying Practices for Xcel Energy
  - Expanded **parallel processing** of fast track and system impact study in areas with no known capacity constraints. Attempt to expedite the queue from serial processing practice which waited until signed IA.
  - Piloting mandatory **Group Studies** for areas with 3 or more applications greater than 40kW that cannot be reviewed in parallel
  - Established a **Cost Sharing program** for under 40kW systems. Customer pays $200 with application submission and is eligible for up to $15,000 in distribution upgrades and supplemental review costs. Low-income customers are exempt from the fee but can participate in the program.
  - Requests the DGWG propose an **independent, unbiased technical review process and a queue or policy review process** with the goal of reducing appeals to the Commission
- March 2, 2023 Decision – *Order forthcoming*
  - TIIR allows **interim use of advanced inverters** with mutual agreement. Xcel announced plans to start in April 2023 and recommends customer identify in advance of SIS; restudy with advanced inverters as a mitigation would be at cost of customer.

Ongoing TIIR Issues for DGWG

11. The Commission recommends the following items for discussion and eventual resolution through the DG Workgroup:

a. **Energy storage control modes** and harmonization of the language and structure of the energy storage requirements in the operating agreements;

b. Determination of explicit treatment of distributed energy resources (DER) using **Power Control Systems for maximum capacity and export control** in the Minnesota Distributed Energy Resources Interconnection Process (MN DIP) and the TIIR document;

c. Evaluation of **Voltage-Reactive Power Regulation** in the TIIR;

d. Harmonization of the language and structure of **voltage regulation** considerations in the operating agreements to the extent possible;

e. Harmonization of the language and structure of the **communications operating agreements** so as to not unduly burden DER operators; and

f. Plan to reduce and/or track **unintended curtailments due to Voltage – Active Power Control** prior to implementation.

See Commission's January 22, 2020 Order

Resources

https://mn.gov/puc/energy/distributed-energy/interconnection

Materials from the Technical Subgroup's update of statewide TIIR (Phase II):

https://mn.gov/puc/utilities/interconnection/

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Thank You!

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Background Slides

Commission Order

January 24, 2017

- The Commission hereby delegates authority to the Executive Secretary to issue Notice(s), set schedules, and designate comment periods for the scope outlined in paragraphs 2 – 3 below. The Executive Secretary will, in cooperation with the Department of Commerce, **convene a work group of appropriate size and composition, and may select a facilitator, to develop the record more fully.**
- **The Commission will transition the Minnesota Interconnection Process to one based on the FERC SGIP and SGIA**. The Executive Secretary will set schedules and take comments. It is anticipated that the Commission will consider the record and comments within 18 months of this order, to replace Attachments 1, 3, 4, and 5 to its 2004 Interconnection Standards in this Docket. The Executive Secretary will use the Joint Movants' May 12, 2016 filing, generally, as the starting point for comments**.**
- In the longer-term (nine to twenty-two months), the Executive Secretary will set schedules and take comments on updating the Minnesota interconnection technical standards. It is anticipated that the Commission will consider the record and comments within 24 months of this Order, to replace Attachment 2 to the Commission's 2004 Interconnection Standards. **This stage of work would incorporate newly revised national technical standards, and other issues identified as areas in need of updating.**
- The Commission hereby designates Commissioner Matthew Schuerger as lead commissioner pursuant to Minn. Stat. § 216A.03, Subd. 9, with authority to help develop the record necessary for resolution of the issues, and to develop recommendations to the Commission in this docket.

MN PUC Process Details

Phase I	Phase II
3 initial documents (FERC SGIP/SGIA, Joint Movants' Red-line of FERC; Dakota Electric Red-line of MN existing stds)	1 initial document (Regulated Utilities' Technical Interconnection and Interoperability Requirements Proposal)
15 organizations (engineers, regulatory staff, lawyers, advocates)	9 organizations (engineers, technical experts)
5 full day In Person meetings – 1 year	8 half day web meetings – 7 months; 3 full day In Person mtgs
Draft staff recommendations (4 rounds of comments)	Edits as we go (~2 rounds of comments)

Workgroup Topics & Timeline

2017	PHASE I In-Person Topics
June 2	Pre-app report; Application requirements; Queue type & process; Material Modification Definition; Fast Track; Site Control
July 28	Definitions; Transmission Provider's role; Engineering screens; Study process; process timelines/extensions; dispute resolution
Sept 15	Insurance; Disconnect Switch; metering; Commissioning/inspection, testing, authorization; Design, procure, install, construct facilities/upgrades; advanced inverters
Nov 3	Interconnection Agreement; process for updating; Transition issues; any outstanding issues
Dec 1	Webinar for feedback on some of the draft staff recommendations and descriptions of outstanding issues

2018	PHASE II Web Meeting Topics
March 23	Scope/Overview; Inventory of Definitions to Discuss
April 13	Performance Categories; Response in Normal and Abnormal Conditions; MISO Bulk Power System
May 18	Reactive Power and Voltage/Power Control Performance; Protection Requirements
June 8	Energy Storage; Non-export; Inadvertent export; Limited export
Aug 24	Interoperability (Monitor and Control Criteria); Metering; Cyber security
Sept 14	Test and Verification; Witness Test Protocol
Sept 21	Full Day In Person to Revisit and Reconcile Edits
Oct 3	References; Definitions; 1-line diagram requirements; Agreements

Utilization of Capabilities – Impact Considerations

- Capabilities and functions which utilization/provision of may **impact DER owners**:
  - Reactive power exchange
  - Active power curtailment
  - Head-room to provide frequency response
- Capabilities and functions which utilization/provision of may **impact distribution utilities**:
  - Voltage Ride-Through with extended voltage trip settings
  - Frequency Ride-Through with extended frequency trip settings
- Utilizing interoperability and communication enabled may require additional equipment and investment in areas outside IEEE 1547's scope **impacting utility and/or DER customer/operator.**

Scope of Interoperability in IEEE 1547-2018

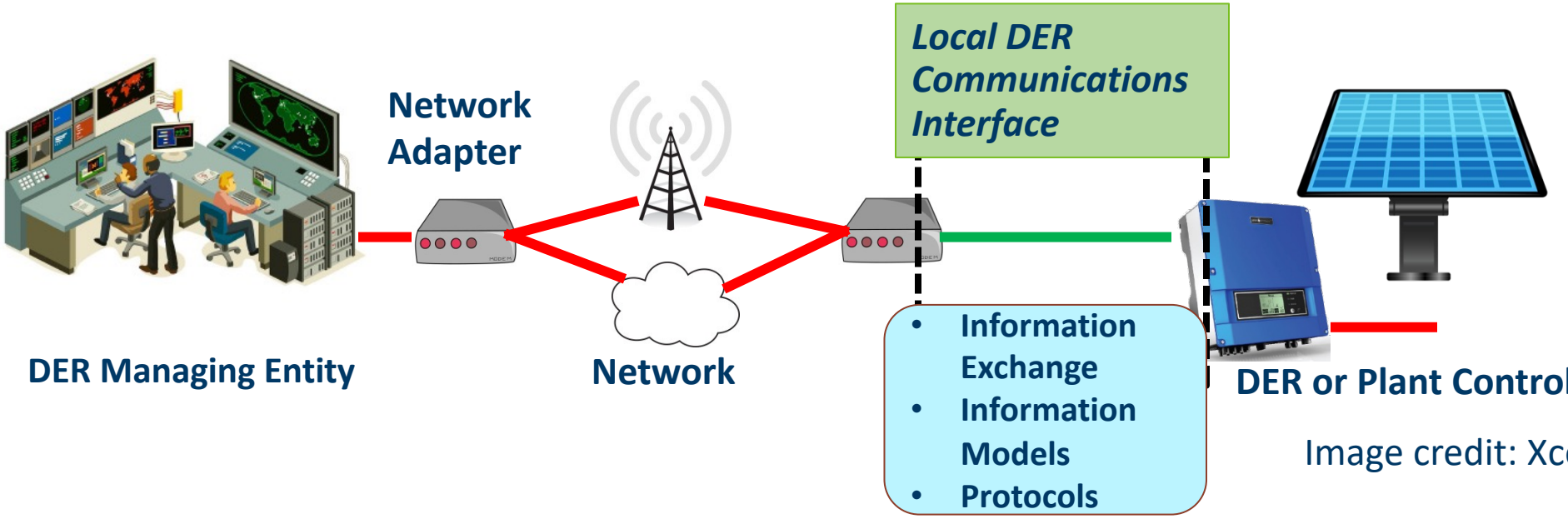
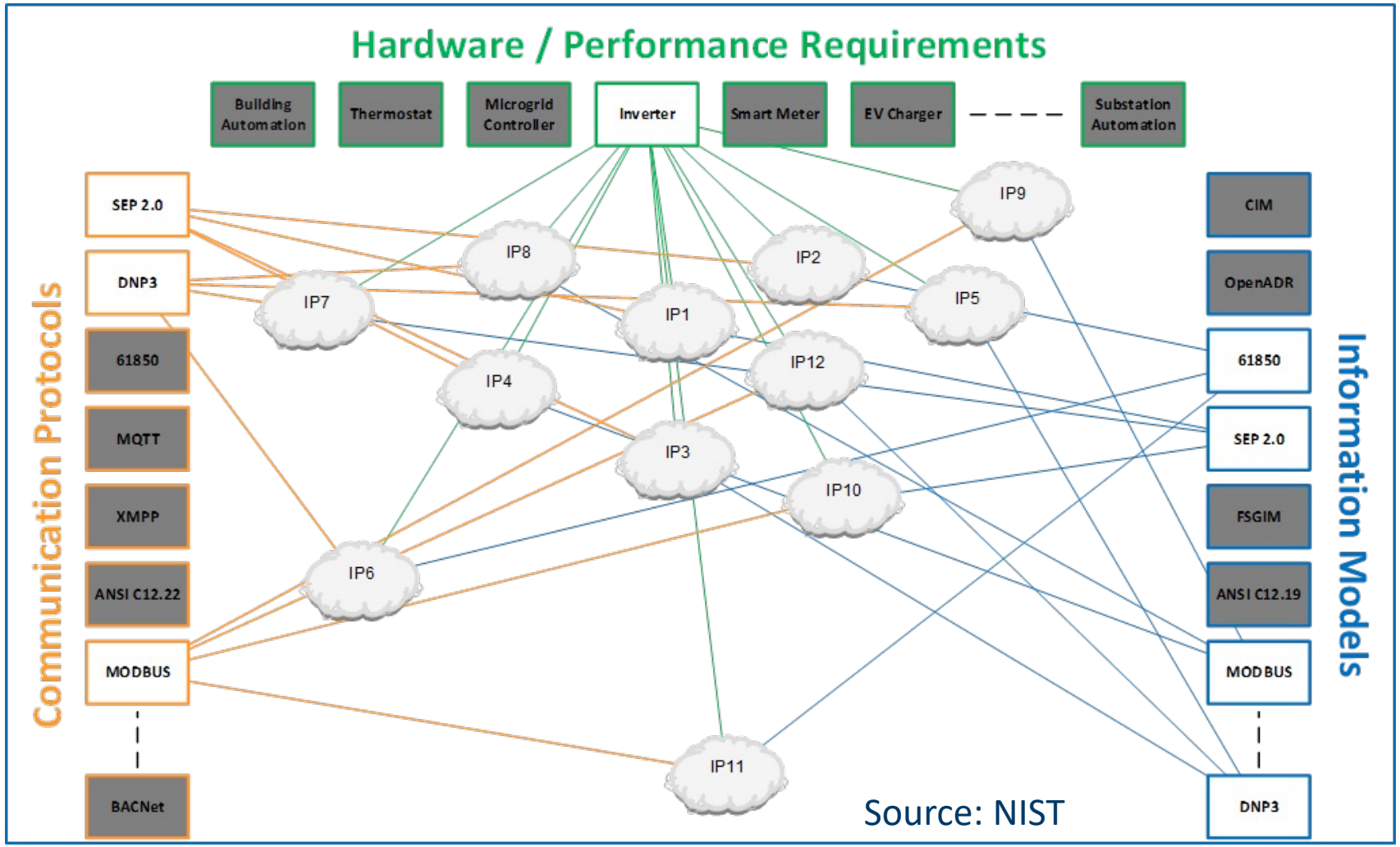


Image credit: Xcel Energy

Interoperability Consideration	IEEE 1547-2018
Clear price signals for participation or contributions.	Not in scope.
Interface between the DER and the Utility can exchange and use information securely and effectively.	In scope.
DER's "grid services" and utility operations are in sync throughout the entire system.	Not in scope.

NIST on IEEE 1547-2018 Optionality



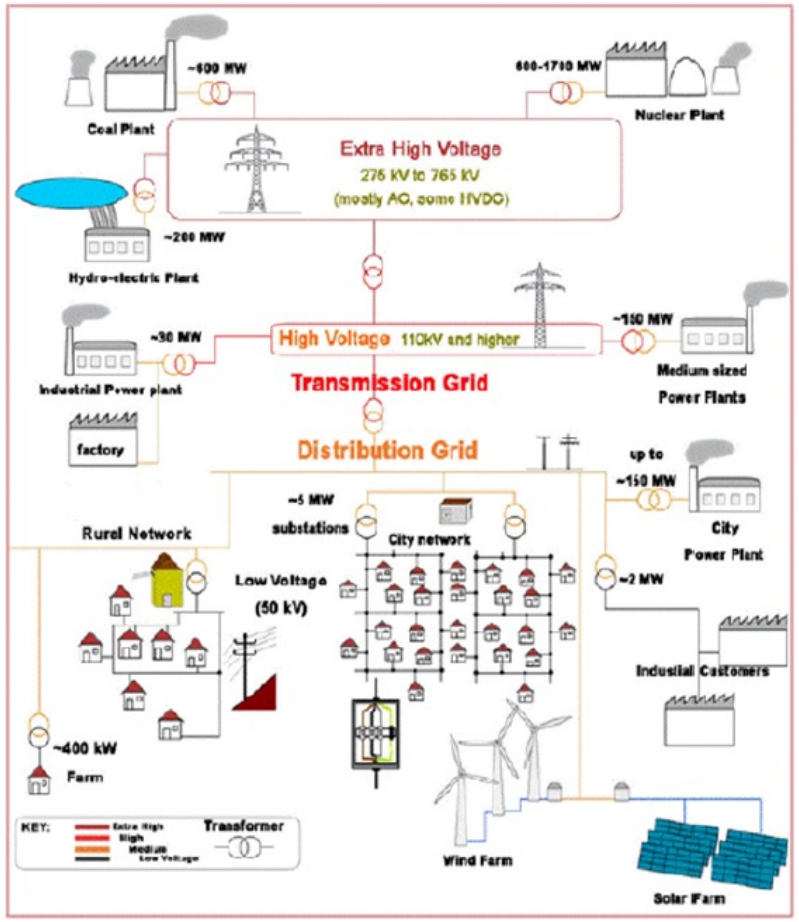
MN Utility Summary of Pros/Cons (2018)

- Upside: The ***simplicity*** leads to better chances of success with implementing true interoperability and effective information exchange between all applicable DER and Utilities in the state.
  - Potential to streamline integration for Developers, Installers, and Utilities
- Downside: The ***timing*** of the MN update means that market forces have not begun to converge on one of the protocols
  - The IEEE 1547 working group had anticipated some consolidation over time.
  - Expectation is that many manufacturers will offer just one of the three protocols. This aligns with standard requirements

Working hypothesis: Standardizing under a single protocol may be practical in the longer term, and assists in effective interoperability, but we need to better understand vendors offerings and back-end system integrations for all affected parties before making this a statewide requirement.

IEEE 1547 and P2800

- IEEE 1547 is applicable to DERs “not directly connected to the bulk power system” e.g. connected at typical primary or secondary distribution voltage levels.
  - Removed the 10 MVA limit from previous versions.
  - **<u>BUT:</u> IEEE P2800 Standards is needed because IEEE 1547 and NERC Reliability Standards do not directly apply to transmission or networked sub-transmission connected inverter-based resources.**
  - Does not address planning, designing, operating, or maintaining the utility grid (“Area EPS”) with DER.
  - **May be addressed in DER interconnection practices, incl. <u>screening</u>.**

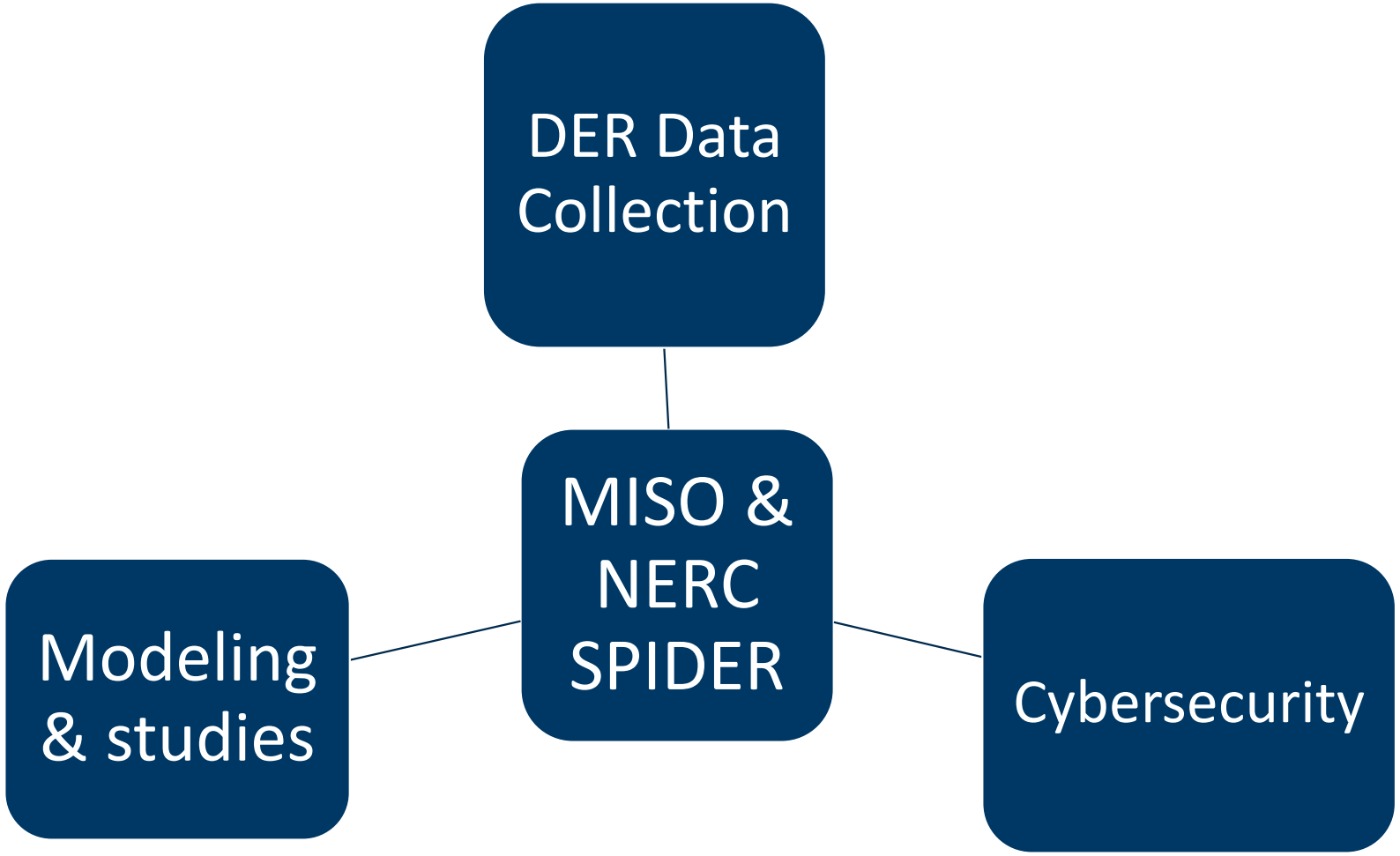


Bulk System Guidelines
NERC, FERC
IEEE, ANSI, IEC
NESC

Technical and jurisdictional overlap

Distribution System Guidelines
IEEE 1547, PUC/PRC
IEEE, ANSI, IEC
NEC

Bulk Power System reliability topics



Resources for Interconnection Customers