Revised Application
20235-195956-02

I. EXECUTIVE SUMMARY

A. Introduction

Northern States Power Company (NSP), a Minnesota corporation, doing business as Xcel Energy (Xcel Energy, the Company, or the Applicant), requests a Certificate of Need (CN) from the Minnesota Public Utilities Commission (Commission) to construct the Minnesota Energy Connection project. The project is proposed as an approximately 160- to 180-mile double circuit 345 kilovolt (kV) transmission line connecting the existing Sherburne County Generation Station Substation (Sherco Substation) in Becker, Minnesota, and a new substation in Lyon County, Minnesota, and other associated facilities, including intermediate and voltage support substations (Project).

The Project will support Xcel Energy's and the State's transition to clean energy by enabling the predictable and cost-effective interconnection and delivery of at least 1,996 megawatts (MW) of generation to the Sherco Substation point of interconnection (POI), providing necessary energy resources and optimizing the reuse of the Company's interconnection rights that will become available as the coal units at Sherco retire by the end of 2030. The Project will also enable the interconnection of more than 4,000 MW of generation overall that will support the recently enacted "100 percent by 2040" law that, generally, sets a standard for public utilities to generate or acquire 100% of the energy for retail sales from carbon-free resources. To minimize impacts to the human and natural environments, Xcel Energy proposes that both circuits be co-located on a double-circuited line.

Xcel Energy submits this Certificate of Need Application (Application) to the Commission pursuant to Minn. Stat. § 216B.243 and Minn. R. Ch. 7849. To facilitate review, a completeness checklist is included as Appendix A which identifies where in this Application information required by Minnesota statutes and rules can be found.

Xcel Energy will also apply for a Route Permit for the Project (Docket No. E002/TL-22-132), as required by Minn. Stat. § 216E.03. Xcel Energy anticipates submitting the Route Permit Application later in 2023. In the Route Permit proceeding, the Commission will evaluate the transmission line route and substation locations.

B. Xcel Energy's 2020-2034 Upper Midwest Integrated Resource Plan (IRP)

Xcel Energy is committed to delivering clean, reliable, and safe electricity service to customers. The Project was first proposed as part of Xcel Energy's recently approved IRP.[1]

[1] *In the matter of the 2020-2034 Upper Midwest Integrated Resource Plan of Northern States Power Company d/b/a Xcel Energy*, MPUC Docket No. E-002/RP-19-368, Order Approving Plan with Modifications and Establishing Requirements for Future Filings, at Ordering ¶ 2.A.6 (Apr. 15, 2022) (hereafter, the "IRP Order") (Appendix B).

In an IRP proceeding, the Commission evaluates a utility's need for resources to serve its customers. At the conclusion of an IRP proceeding, the Commission approves the size, type, and timing of needed resources on a generic basis.[2] A Certificate of Need proceeding "[s]tarts with a resource plan-determined size, type, and timing of a need, confirms a specific need exists, and evaluates the economic, environmental, and social consequences of the alternatives to fulfill the need."[3]

In its most recently concluded IRP, Xcel Energy proposed a plan (Alternate Plan) to reduce carbon emissions more than 85% from 2005 levels by 2030 and help Xcel Energy's deliver 100% carbon-free electricity by 2050. After careful consideration of Xcel Energy's proposal along with comments and analysis from numerous stakeholders, the Commission's Order provided this summary:

> In this Order, the Commission approves a modified version of Xcel's Alternate Plan that will guide investments through 2034. With the benefit of significant stakeholder engagement spanning more than two years, the Commission is able to approve a plan largely reflecting the positions taken jointly by Xcel, many environmental groups (the CEOs), and many labor groups (the Carpenters, IUOE, and LIUNA). The plan is designed to manage costs for households and businesses; reduce emissions that contribute to climate change; and ensure reliable electric service for Xcel customers. Most significantly, it provides for –
>
> - retiring all of Xcel's coal-powered generators,
> - adding substantial amounts of solar- and wind-powered generation,
> - reinforcing system reliability,
> - exploring options for adding new technology such as energy storage and hydrogen powered generation, and
> - pursuing the process of extending the life of Xcel's Monticello Nuclear Generating Plant (Monticello) in Monticello, Minnesota.

→ Transmission "solution" for Distribution deficiency

[2] In the Matter of the Application for a Certificate of Need for the Hollydale 115 kV Transmission Line Project in the Cities of Plymouth and Medina, MPUC Docket No. E002, ET2/CN-12-113, Attachment SSR 2 to the Direct Testimony of Dr. Steve Rakow.

[3] *Id.*

wasn't needed, Xcel is upgrading substation & distribution system.

the Terminal Substation and the Voltage Support Substation are expected to be complete by the September 30, 2031.

During the IRP, Xcel Energy estimated the net present value (NPV) of the gen-ties to deliver 1,996 MW to Sherco to be $528 to $713 million (2021$), assuming 140- to 175-mile lines.[29] (When updated for inflation and the passage of time, the NPV of this estimate in 2023 dollars is $596 million to $805 million.) In the IRP, Xcel Energy explained that the cost estimate: would be subject to further detailed design; assumed that CT capacity would provide reactive support in Lyon County; and would be modified based upon additional factors, including commodity costs and routing.[30] Updating the NPV of the high end estimate in the IRP for a 180-mile line results in an NPV (2023$) of $830 million.

For purposes of this Application, Xcel Energy prepared a Project cost estimate based on the Project components required to deliver at least 1,996 MW (2,200 MW/hour of energy) from the Lyon County area to the Sherco Substation. Based on these components and a double circuit transmission line approximately 180-miles long, the Project is estimated to cost $ 1.14 billion (2023$); with an NPV of $816 million (2023$ NPV). In other words, when updating for the passage of time, the current project estimate is in line with the cost assumptions from the IRP. Moreover, should other synergistic resource additions, also be approved, the cost of the line will likely decrease materially.

The Project will enable the predictable interconnection of energy for Xcel Energy customers. It is predictable because it does not require a multi-step and years-long MISO interconnection process. It is also cost-effective. Assuming the connection of 2,750 MWs a 2023 NPV of $816 million (NPV 2023$) the interconnected renewable generation cost is $297/kW. Interconnecting the same amount of renewable generation on a MISO system basis would cost substantially more, approximately $1.35 billion (NPV 2023$) through the MISO interconnection queue or $490/kW based on the assumptions of $564/kW wind and $225/kW of solar.

These estimates reflect recent impacts of inflation, supply chain issues, and a tight labor market, each of which contributes to increased costs of construction across the industry. Additional details regarding the Project costs are provided in **Chapter 2**.

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[29] *See In the Matter of the 2020-2034 Upper Midwest Integrated Resource Plan of Northern States Power Company d/b/a Xcel Energy*, MPUC Docket No. E-002/RP-19-368, Xcel Energy Reply Comments, at 151 (June 25, 2021).
[30] *See id.* at 104-06.

H. MISO Long Range Transmission Planning

The Project will complement the Long Range Transmission Planning (LRTP) projects portfolio MISO approved in July 2022. The $10.3 billion LRTP Tranche 1 portfolio of 18 projects will provide multiple benefits, including more reliable and resilient energy delivery; congestion and fuel savings, and reduced carbon emissions. The LRTP projects will also support the interconnection of approximately 53 GW of new generation resources throughout the upper Midwest. Three of the projects are located in Minnesota: Big Stone South – Alexandria – Big Oaks across the midsection of the State; Iron Range – Benton – Big Oaks, connecting the Iron Range and the western Metro area; and Wilmarth – North Rochester – Tremval, connecting Wilmarth, Minnesota with an expanded substation in eastern Wisconsin.[31] No LRTP Tranche 1 projects are located in southwestern Minnesota.

Although the LRTP projects are designed to provide substantial interconnection capacity, alleviate existing congestion, and enable additional renewable resource interconnections, they do not obviate the need for the Project. The LRTP projects are not located in the prime wind resource areas in southwestern Minnesota. The LRTP projects will also be networked lines, and any generator will be able to seek to interconnect using MISO's generator interconnection queue. The only way that Xcel Energy can retain its interconnection rights at Sherco is to directly connect Xcel Energy-owned generation to the Sherco Substation via a single-user generation tie line, like those proposed with this Project. The Project also helps ensure that Xcel Energy is able to acquire needed capacity and energy resources in a timely fashion without having to go through the interconnection queue and potentially face delays and relatively higher interconnection costs.

I. Potential Environmental Impacts

Chapter 8 of this Application provides a discussion of the natural environment and land use features in the area reviewed for the Project (Project Study Area), which is shown in Image 1.2 above. As discussed in further detail in Chapter 8, environmental and land use features vary moving from northeast to southwest portion in the Project Study Area. The primary land use within the Project Study Area is agriculture, with municipalities and rural homesteads scattered throughout the Project Study Area. The Mississippi River and the Minnesota River both cross the Project Study Area, and, to the extent there are sensitive or rare environmental features, they tend to be concentrated in the vicinity of these rivers. Many Project impacts can be avoided and minimized through prudent routing, consistent with the Commission's routing criteria. The Applicant will coordinate with applicable

[31] The expected in-service dates of these projects are, respectively: June 1, 2030; June 1, 2030; and June 1, 2028.

Applicant's proposal satisfies these four criteria as discussed below.

(A) *Probable result of denial of the Project would have an adverse effect upon the future adequacy, reliability, or efficiency of energy supply to the Applicant's customers*

Denial of a Certificate of Need for this Project would result in adverse effects upon the present and future efficiency of energy supply to the Minnesota electric customers and other end users. This Project is required to enable the full reutilization of Xcel Energy's interconnection rights at Sherco, enable Xcel Energy to acquire necessary capacity and energy resources, and interconnect thousands of megawatts of new renewable energy in southern and southwestern Minnesota. If the Project were delayed or denied, it could impact the availability of sufficient energy capacity to meet customer needs or the timing of the retirements of Sherco Unit 1 and Unit 3, or preclude Xcel Energy from retaining its interconnection rights.

(B) *A more reasonable and prudent alternative to the proposed facility has not been demonstrated by a preponderance of the evidence*

A more reasonable and prudent alternative to the Project has not been demonstrated. For example, as analyzed in the IRP proceeding, it is not as cost effective or as predictable and indeed may not be feasible, to instead interconnect the needed renewable generation to the regional transmission grid using the MISO queue process. This Application also demonstrates that lower and higher voltage lines are not feasible or reasonable alternatives to the Project.

(C) *The proposed transmission lines will provide benefits to society in a manner compatible with protecting the natural and socioeconomic environments*

The proposed Project will enable the interconnection of thousands of megawatts of new renewable energy, helping Xcel Energy to meet Minnesota's "100 percent by 2040" law which – in addition to requiring utilities to provide 100 percent clean energy by 2040 – expands the previous Renewable Energy Standard (RES) to require Xcel Energy to generate or procure 55 percent of its energy used to serve Minnesota customers from renewables by 2035.[33] The Project will be integral to meeting the new standards cost-effectively by enabling the reuse of our interconnection rights. Further, the Project is directly aligned with the law's requirement that utilities take "reasonable measures […] to develop and construct new transmission lines or upgrade existing transmission lines to transmit" renewable energy.[34] The addition of renewable resources will result in decreased emissions. The Company's approved Resource Plan including the Project achieves substantially more carbon reduction

[33] See Minn. Stat. § 216B.1691 as amended by Minnesota Session Laws 2023, Chapter 7.

[34] Minn. Stat. § 216B.1691 subd. 2b as amended by Minnesota Session Laws 2023, Chapter 7 (emphasis added).

than cases in which the Project is not included. The Project will also provide tax revenue for local units of government and 100 to 200 construction jobs. Pursuant to the Commission's routing criteria, the Project will be routed in a manner compatible with protecting the natural and socioeconomic environments.

(D) *The proposed transmission line will comply with relevant policies, rules, and regulations of other state and federal agencies and local governments*

Xcel Energy will secure all necessary permits and authorizations prior to commencing construction on the portions of the Project requiring such approvals.

L. Socioeconomic Considerations

Subpart 2 of Minnesota Rule 7849.0240 requires the applicant for a Certificate of Need to address the socially beneficial uses of the facility output, promotional activities that may have given rise to the demand, and effects of the facility in inducing future development. Following is a discussion of each consideration:

1. Socially Beneficial Uses of Facility Output

The Project will enable Xcel Energy to meet the demand for energy and, particularly, renewable energy economically because it will re-use Xcel Energy's existing interconnection rights, and will provide economic benefits in the form of property tax revenue and jobs—both from this Project and the new renewable generation which will ultimately interconnect via the Project.

2. Promotional Activities

Xcel Energy has not conducted any promotional activities or events that have triggered the need for the Project. In fact, Xcel Energy engages in significant demand-side management and conservation programs, as discussed further in Appendix E. Therefore, the Project is not needed due to growth in demand due to Xcel Energy's promotional activities. Rather, the Project is needed to meet energy needs and retain the interconnection rights connected to Sherco Units 1 and 3, and the benefits associated with reusing those existing and valuable interconnection rights.

3. Effect in Inducing Future Development

The Project will have a positive impact on the local communities and enables future development of wind and solar energy generation in the region. Notably, in the IRP Order, the Commission directed Xcel Energy to work with local governments and other stakeholders concerning the Project, including "to assess and account for local land use and

Table 2.1 summarizes the characteristics of the proposed double circuit 345 kV transmission line structures.

Table 2.1: Transmission Line Characteristics

Line Type	Structure Type	Structure Material	Typical Right-of-way Width (feet)	Typical Structure Height (feet)	Foundation Diameter (feet)	Average Span Between Structures (feet)
345 kV Double-Circuit & 345 kV Double-Circuit Angle and Dead-end*	Monopole w/ Davit Arms & Two-pole w/Davit Arms	Weathering Steel	150	90-160	7-12	1,000
	*Structure sizes may change based on site conditions and further analysis of proposed routes.					

A single circuit transmission line carries three phases (conductors) and shield wire(s). A double circuit transmission line carries six phases (conductors) and two shield wires. The 345 kV line will utilize bundled (twisted pair) 2x636 kcmil Aluminum Conductor Steel Reinforced (ACSR) or similar performance conductor. The 345 kV twisted pair conductors will have a capacity equal to or greater than 3,000 amps. per circuit!

This type of conductor is the preferred conductor in areas of wind generation due to its anti-galloping characteristics. - If the galloping action is significant, it can cause phase-to-phase and phase-to-ground faults The design of two twisted pair conductors in a bundled configuration reduces aeolian vibration and galloping due to its changing cross-section. X2?

The proposed transmission line will be designed to meet or surpass relevant local and state codes including NESC and Xcel Energy standards. Applicable standards will be met for construction and installation, and applicable safety procedures will be followed during design, construction, and after installation.

Table 2

Computation of SAC Overhead Conductor Ampacities (Steady State)

Per ANSI/IEEE Standard 738-1986

	mi/hr	ft/s
Wind speed	1.36	2.00
Coefficient of emissivity		0.5
Coefficient of solar absorption		0.5

	Temperature C	Temperature F
Ambient air temp	40	104
Conductor surface temp	200	392

Latitude	45 degrees N
Azimuth of line	90 degrees
Elev above msl	1000 ft

Air viscosity @ T ave	0.05463	lb/h ft
Air density	0.05403	lb/ft³
Air thermal conductivity	0.0101	W/ft C
Altitude of sun	68.1	degrees
Azimuth of sun	180	degrees
Heat rec'd by a surface	94.84	W/ft²
Elevation correction factor	1.0340	

Conductor			Resistance, Ohm/mi			Ohm/kft	Conductor heat transfer, W/ft					Ampacity	MVA rating @ nominal voltage							
			50	100	200	200	Forced convection heat loss			Radiated	Solar	kV:	69	115	138	161	230	345	500	
kcm	strand	diam,in	deg C	deg C	deg C	deg C	qc1	qc2	max	heat loss	heat gain	cond/ph:	1	1	1	1	1	2	3	kcm
4/0	6/1	0.563	0.5920	0.6979	0.9097	0.17229	46.46	39.77	46.46	15.72	2.30	590	70	117	141	164				4/0
266	6/7	0.633	0.5520	0.6507	0.8481	0.16063	49.28	42.67	49.28	17.67	2.56	633	76	126	151	177				266
336	18/1	0.684	0.3059	0.3606	0.4700	0.08902	51.24	44.70	51.24	19.09	2.79	871	104	174	208	243				336
336	26/7	0.721	0.3072	0.3623	0.4725	0.08949	52.62	46.14	52.62	20.13	2.94	883	106	176	211	246				336
477	26/7	0.858	0.2169	0.2557	0.3333	0.06313	57.44	51.21	57.44	23.95	3.50	1111	133	221	266	310				477
477	24/7	0.846	0.2168	0.2556	0.3332	0.06311	57.04	50.78	57.04	23.62	3.45	1106	132	220	264	308				477
556	26/7	0.927	0.1860	0.2192	0.2856	0.05409	59.73	53.65	59.73	25.88	3.78	1230	147	245	294	343				556
636	24/7	0.977	0.1631	0.1922	0.2504	0.04742	61.34	55.37	61.34	27.27	3.98	1336	160	266	319	373	532			636
795	26/7	1.108	0.1306	0.1536	0.2002	0.03792	65.38	59.71	65.38	30.93	4.52	1556	186	310	372	434	620	1860	4042	795
795	45/7	1.115	0.1313	0.1644	0.2008	0.03799	65.59	59.93	65.59	31.13	4.55	1558	186	310	372	434	620	1861	4047	795
795	30/19	1.140	0.1307	0.1540	0.2006	0.03799	66.33	60.74	66.33	31.82	4.65	1569	187	312	375	437	625	1875	4076	795
954	45/7	1.165	0.1089	0.1291	0.1676	0.03172	67.06	61.53	67.06	32.52	4.75	1729	207	344	413	482	689	2066	4492	954
954	54/7	1.196	0.1094	0.1287	0.1673	0.03169	67.96	62.51	67.96	33.39	4.86	1745	209	348	417	487	695	2085	4533	954
1192	54/19	1.338	0.0863	0.1013	0.1313	0.02487	71.95	66.86	71.95	37.35	5.46	2044	244	407	488	570	814	2442	5309	1192
1272	54/19	1.382	0.0851	0.0996	0.1286	0.02436	73.14	68.17	73.14	38.58	5.63	2087	249	416	499	582	831	2494	5422	1272
1590	54/19	1.545	0.0657	0.0787	0.0987	0.01869	77.41	72.69	77.41	43.13	6.30	1472	295	492	591	689	985	2954	6423	1590
2312	76/19	1.602	0.0505	0.0584	0.0742	0.01405	83.72	79.94	83.72	50.30	7.35	3002	359	598	718	837	1196	3588	7800	2312

Notes:
Sun computations based on noon local sun time
Solar absorption based on "Clear atmosphere"
Azimuth of line: N-S = 0, E-W = 90

Xcel Energy
Delivery System Planning & Engineering

Revised App p.73

Project uses 636 Grosbeak ACSR

3002 amps

* two twisted bundled pair conductors in a bundled configuration App. p.26 2+2!

Ex 35, Application, Appendix 7
SW MN 345kV - 01-1958

2. Associated Facilities

The Project will include modifications to the Sherco Substation and three new substations: the Terminal Substation in Lyon County; the Intermediate Substation approximately 20 miles to the northeast of the new Lyon County substation, and a Voltage Support Substation at the approximate Project mid-point. Each substation will be constructed on a 40- to 80-acre parcel.

a. Sherco Substation Modifications

The existing Sherco Substation, owned by Xcel Energy, is the northeastern endpoint of the proposed double circuit 345 kV transmission line. This substation is located on Xcel Energy property near the Sherburne County Generating Plant in Becker, Minnesota. New substation equipment necessary to accommodate the proposed 345 kV transmission line is proposed to be installed at the Sherco Substation.[36]

b. Terminal Substation in Lyon County

Xcel Energy proposes to construct a new 345 kV substation. The substation will include the installation of two 116/-58 MVAR synchronous condensers.[37] The Terminal Substation will facilitate the interconnection of renewable resources in the vicinity of that substation.

A control building and road access will also be constructed at the site.

c. Voltage Support (Series Compensation) Substation

Xcel Energy proposes to construct a new 345 kV voltage support substation. This substation is currently proposed to include a Series Capacitor and one 150 MVAR STATCOM system per line. Selection of voltage support equipment will be dependent on the technologies available at the time of construction and the resources selected to interconnect to the line. A control building and road access will also be constructed at the site.

d. Intermediate Substation

Xcel Energy proposes to construct an intermediate substation near the Terminal Substation. The Intermediate Substation will facilitate the interconnection of renewable resources in the vicinity of that substation.

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[36] The Project may interconnect with a Sherco Solar Project substation. The final determination will be made in the routing process for the Project.

[37] The attributes provided by these synchronous condensers could also be fulfilled by a CT, as discussed elsewhere in this Application.

Xcel Energy estimates that construction of the Project, including substation construction and all substation equipment, including STATCOMs and series compensation, will cost $1.14 billion, representing the sum of the expenditures over the life of the Project using 2023$ dollars. These costs include all transmission line costs (including materials, associated construction, permitting and design costs, and risk assessment contingencies), two new substations and a series compensation substation, Sherco Substation modification costs (including materials, construction, permitting and design costs, and risk contingencies), AFUDC, and right-of-way/land acquisition costs.

Table 2.2 provides a breakdown of the Project costs.

Table 2.2: Project Capital Cost Estimates (2023$)

Project Components	2023$
Transmission line (Gen-tie ($3.8 million /mile))	$689 million
Sherburne County Substation (Sherco) Modifications	$9 million
Terminal Substation (Lyon County) Costs	$164 million
Intermediate Substation	$24 million
Voltage Support Substation	$253 million
Project Total	$1.139 billion

The transmission line only is approximately $3.8 million per mile. These estimated costs are generally consistent with the $3.5 million per-mile transmission line cost estimates Xcel Energy provided during the IRP proceeding. The estimates have been updated to account for cost pressures occurring more generally, as well as changed assumptions regarding Project components. More specifically, for example, the Project as proposed in this Application would include synchronous condensers at the Terminal Substation; those facilities were not included in the IRP cost estimate because, at that time, the attributes provided by the synchronous condensers were planned to be fulfilled via CT capacity with a clutch feature. Separately, too, the cost estimate in this Application incorporates changes since 2021 as a result of inflation, supply chain issues, rising material costs, and a tight labor market.

To enable a comparison between the IRP estimate and the current Project estimate, the IRP estimate was converted to an NPV in 2023$ dollars. The observed inflation rate in 2022 was 9.41% and the inflation in 2023 is estimated at 3.18%. These are weighted inflation costs

A control building and road access will also be constructed at the site.

B. Project Costs

The Project will cross a large section of southwest and central Minnesota and is expected to be approximately 160- to 180-miles long. Although Xcel Energy has identified a Project Study Area and potential route corridors, the route development process has just begun and the final route will not be identified until the Route Permit process concludes. As a result, Xcel Energy developed a Project cost based on an estimated route length, plus substation costs.

There are several main components of these cost estimates, (1) transmission line structures and materials; (2) transmission line construction and restoration; (3) transmission line permitting and design; (4) transmission line and substation right-of-way acquisition; and (5) substation materials, permitting, design, and construction. Each of these components also includes a risk contingency and financing expenses, Allowance of Funds Used During Construction (AFUDC).

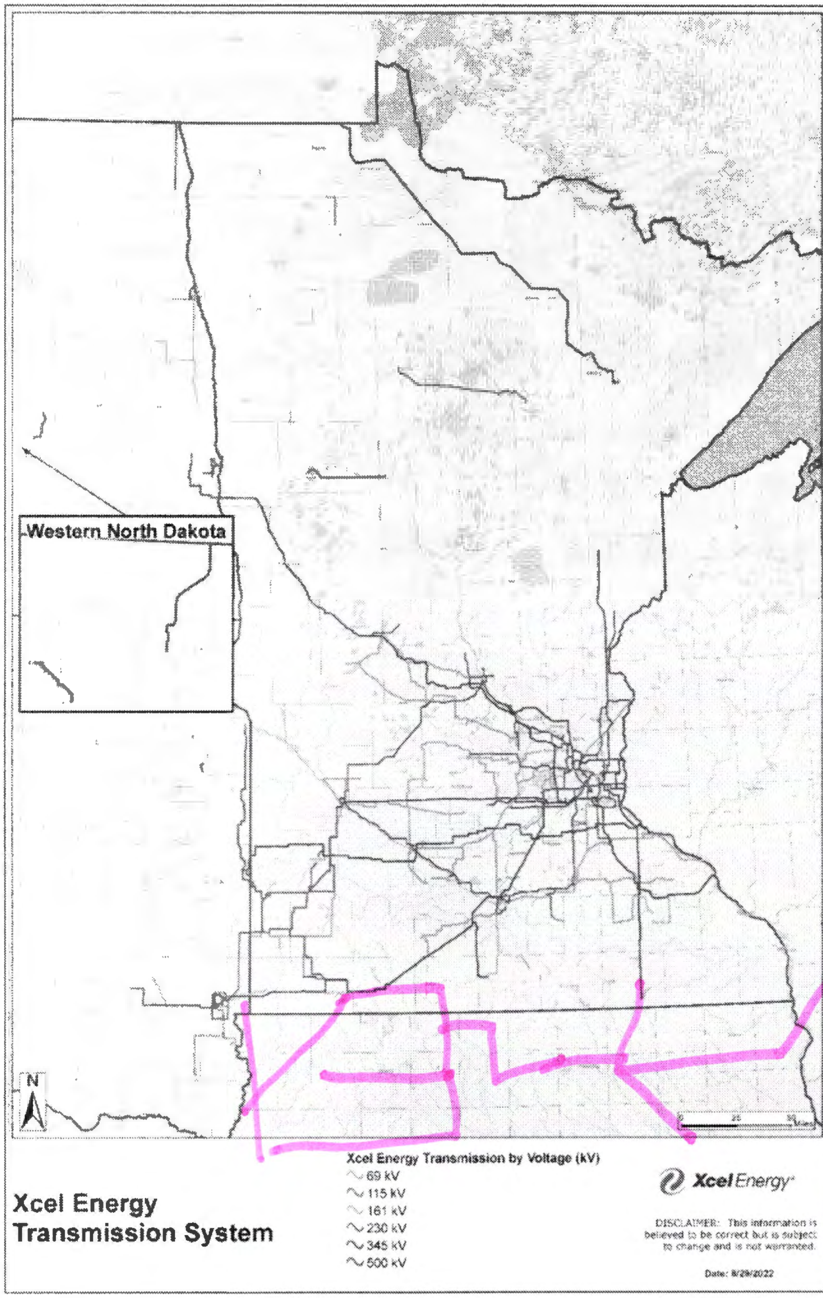
To prepare a cost estimate for the transmission line portions of the Project, Xcel Energy relied in part upon the actual costs incurred for constructing the Huntley-Wilmarth 345 kV Project, construction of which was completed in October 2021. Xcel Energy updated this data based on current market conditions and included a contingency factor. The estimate values are based on long straight alignments. The introduction of many corner structures and/or an alignment that jumps across features will have a cost increase. Right-of-way cost estimates for the transmission line and substations were based on a 150-foot right-of-way for the transmission line and 40 to 80 acres for each substation. Xcel Energy considered actual costs from prior project acquisitions and approximated the number of easements required to estimate the overall land acquisition costs.

? Includes ? + Buy the Farm MN St. 216E.12, Subd 4

To estimate substation construction costs, Xcel Energy identified the necessary components for each substation. Xcel Energy then estimated material, construction, design, and permitting costs based on cost estimates for these items from prior substation improvement projects.

To calculate an appropriate risk contingency, Xcel Energy identified potential risks that could result in additional costs. These risks include unexpected weather conditions, poor soil conditions in areas where no soil data was obtained, transmission line outage constraints, potential shallow rock, river crossings, labor shortages, and market fluctuations in material pricing and labor costs. Xcel Energy then developed an appropriate cost contingency for each of these risks and applied them to each of the cost categories above.

Image 3.2: Xcel Energy's Transmission System in Minnesota, North Dakota, and South Dakota[38]



Xcel Xmsn does not exist in vacuum See MVP Portfolio, in particular MVP 3&4 from SW MN into Iowa & WI & beyond — Takes energy out of SW MN - just not up to Xcel

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[38] Portions of the lines depicted above are transmission facilities that Xcel Energy owns with other utilities.

Proposed MVP portfolio

The proposed MVP portfolio is the culmination of more than eight years of transmission planning solutions, as transmission projects identified in MTEP03 through MTEP10 were brought together to form a cohesive, regional plan. Approximately 11 months of intensive studies were performed on the candidate portfolio, with heavy stakeholder involvement and review. At the end of the study, MISO recommends a proposed MVP portfolio for review and approval by the Board of Directors.

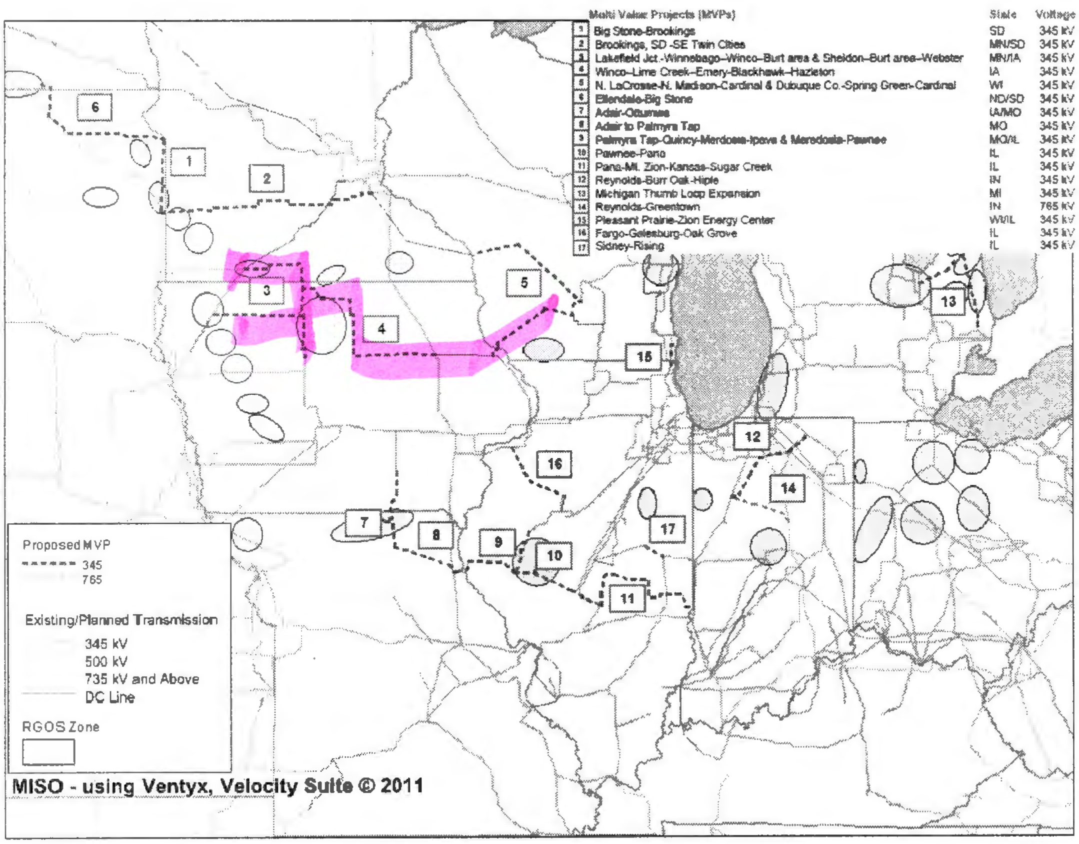

Figure 1-3: Proposed MVP portfolio

The proposed MVP portfolio combines reliability, economic and public policy drivers to provide a transmission solution that provides benefits in excess of its costs throughout the MISO footprint. This portfolio, when integrated into the existing and planned transmission network, resolves about 650 reliability violations for more than 6,700 system conditions, enabling the delivery of 41 million MWh of renewable energy annually to load. The portfolio also provides strong economic benefits; all zones[8] within the MISO footprint see benefits of at least 1.6 to 2.8 times their cost.

[8] Benefits were calculated based on the MISO proposed Local Resource Zones for Resource Adequacy

power grid, reusing important connections near retiring coal plants, which will help maintain reliability.

This Project is a critical part of the new transmission infrastructure identified in the IRP. Xcel Energy is a national leader in wind energy and has steadily expanded its wind portfolio since 2005. Xcel Energy also continues to increase solar and wind capacity. At the end of 2022 Xcel Energy had approximately 1,200 MW of large and distributed-scale solar and over 4,500 MW of wind. Wind and solar will be integral to Xcel Energy's plan to reduce carbon emissions 85% by 2030 from 2005 levels, produce more than 50 percent of Xcel Energy's customers' electricity by 2030, and meet Minnesota's new "100 % by 2040" standard. As discussed in the following section, by re-using Xcel Energy's existing interconnection rights, the Project will enable the interconnection of additional renewable energy generation in a timely and cost-effective manner.

4. Re-using Interconnection Rights to Interconnect Renewable Generation

Large power plants, such as the coal units at Sherco, interconnect to the regional transmission grid, and the incumbent generation owner owns the associated transmission interconnection rights. Those rights cannot be bought or sold as standalone assets.[46] The closure of the Sherco coal units will open up approximately 2,000 MW of transmission interconnection rights to Xcel Energy (the incumbent transmission owner). MISO rules require replacement generation to achieve commercial operation within three years of the closure date of the existing facility.[47]

Value? • Cost to acquire? (replacement elsewhere?) • Value of xmsn service provided over time?

Interconnection rights are a valuable asset in part because the regional transmission grid is congested: there is not currently enough transmission capacity on the regional system to accommodate all the renewable energy projects that wish to interconnect. Although additional infrastructure is planned, interconnection delays and high estimated upgrade costs are expected to persist. Therefore, reusing available, existing interconnection rights can speed the addition of renewable energy resources, in this case, replace retiring thermal generation.

In Minnesota, the most productive wind resources are in the southwest portion of the state, as shown in Image 3.3 below. The majority of the state's installed wind capacity is also located in southwest Minnesota.[48] In addition, the state's highest solar irradiance is located in southwest Minnesota where limited tree cover and expansive non-forested lands result in

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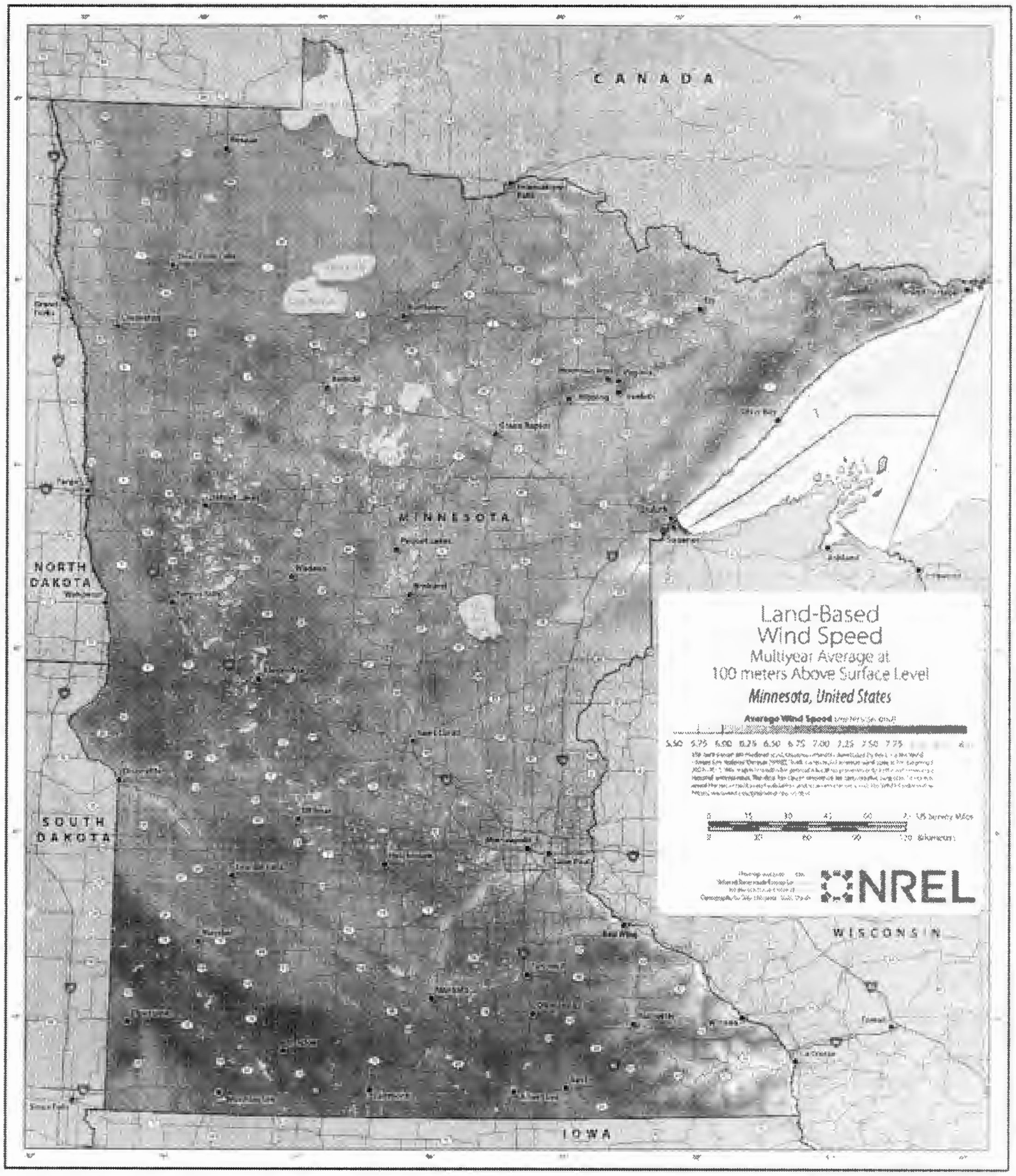
[46] *See* MISO Tariff, Attachment X, § 16.

[47] *See* MISO Tariff, Attachment X, § 3.3.1.

[48] *See* USGS, *The U.S. Wind Turbine Database*, available at https://eerscmap.usgs.gov/uswtdb/ (last accessed Feb. 23, 2023).

ample sun exposure at ground level.[49] A solar suitability Minnesota map is shown in Image 3.4.

Image 3.3: Minnesota Average Annual Wind Speeds at 80 meters



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[49] *See* e.g., University of Minnesota, *Minnesota Solar Suitability Analysis*, available at https://solar.maps.umn.edu/index.php (last accessed Feb. 28, 2023).

The Project is needed to connect resources like these in wind- and solar-rich western Minnesota to an available point of interconnection at the Sherco Substation. The results of Xcel Energy's 2022 RFI on renewable projects between the Sherco Substation and Lyon County confirm that renewable development is planned in this area in the latter half of this decade. Specifically, Xcel Energy issued an RFI on June 3, 2022 (with responses provided by July 1, 2022), to collect information about potential generation assets in development that may be candidates for interconnection to the Project. The RFI indicated that the information collected would be used in future planning processes to inform the need, and specific routing, for the Project. In 2022, Xcel Energy issued its first RFP to meet capacity needs approved in the IRP, and plans to issue another RFP later in 2023 to begin sourcing renewable capacity that can interconnect to the Project. The 2022 RFP yielded a shortlist of 464 MW of solar projects – out of a targeted 900 – including capacity that would reutilize the first tranche of open interconnection at the Sherco site. The results of the RFP and other external benchmarks show that it is currently challenging to bring on new renewable resources cost effectively; and while some of these market conditions are transitory, the current significant constraints in the broader grid are a key contributor to this challenging environment. As such the Project is an important component of the Company's ability to achieve its clean energy goals and the newly enacted state clean energy requirements. As discussed in Chapter 4, these resources continue to be needed to meet both customer needs, as well as carbon reduction goals.

extended incentives to accelerate and advance the clean energy transition which will likely lead to increased renewables development on the Company's system. The 100 by 2040 law will also increase the need for additional renewable resource for all utilities in the state, including Xcel Energy. Given the current oversubscribed state of the MISO queue, both these factors only increase the importance of, and the value provided by, the Project to the Xcel Energy system.

This chapter discusses the resource and capacity needs identified in Xcel Energy's IRP, as well as major changes to the MISO RA construct and load forecasts prepared in Spring 2022.

1. Determining Customer Needs

The Company's internally developed customer needs forecast is derived from customer demand and energy forecasts and adjustments for the effects of energy efficiency (EE) resources, distributed energy resources (DER), and electric vehicle (EV) adoption. To this, Xcel Energy adds a reserve margin that is prescribed by MISO. Then Xcel Energy subtracts the capacity accreditation of the energy resources the Company has, or expects to have, on the system, to determine the net surplus or need.

Forecasting the Company's customers' energy needs starts with a peak-hour demand forecast (in MW) and a forecast of customers' total energy needs (in MWh) for each year of the planning period.

a. Forecast for Peak Demand Requirements

Xcel Energy uses econometric analysis and historical actual coincident net peak demand data to determine forecasted system demand, which forms the basis of the Company's capacity requirements for each planning year. From these corporate forecasts, Xcel Energy makes adjustments that add back in the effect of anticipated future EE achievements and distributed solar generation, so that Xcel Energy can model EE and distributed solar as competing with supply-side resources in the modeling process. This was a change the Company first implemented with the Company's July 2019 initial Resource Plan filing and is further discussed below.

The methodology used to develop the Spring 2022 Forecast has not changed from the initial Resource Plan filing, though the inputs used to develop the forecast have been updated.

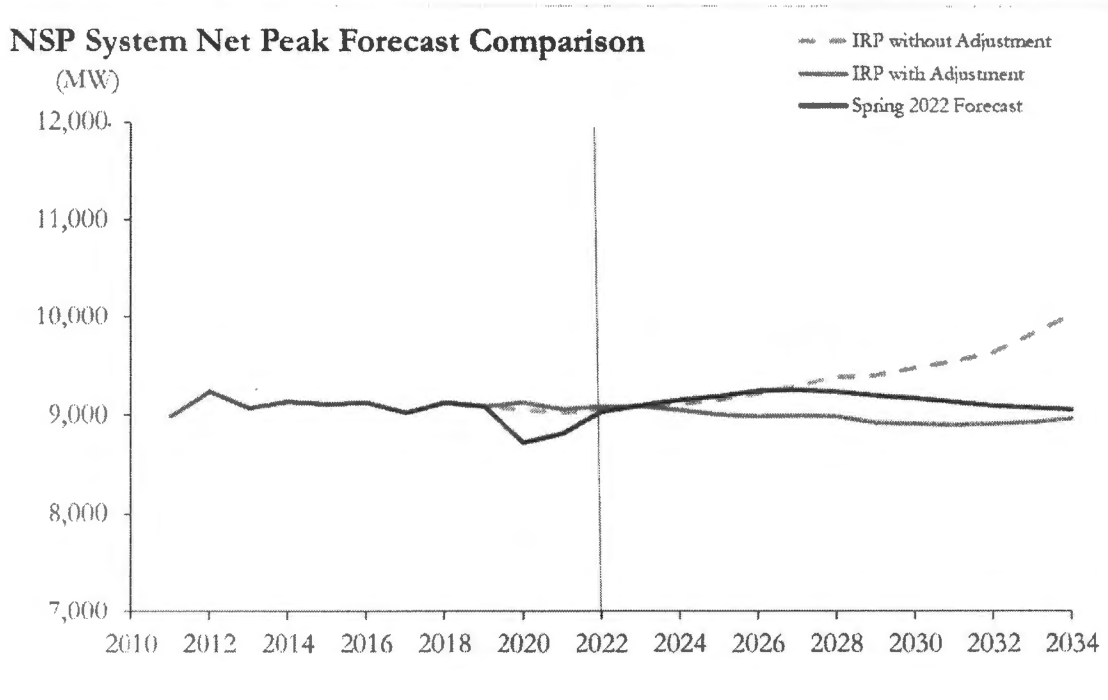
The Spring 2022 peak corporate demand forecast for this update shows an average annual growth rate of 0.02% from 2022 through 2034. Image 4.1 below shows the updated

Now that's more realistic!! But see p. 47 - it's -0.29%, even more realistic corporate net load forecast – called "Spring 2022 Forecast" in the Image 4.1 in relation to the forecast from the IRP Fall 2019 Forecast referred to as "IRP without Adjustments". In addition, Image 4.1 includes an "IRP with Adjustments" series where the Future Demand Side Management (DSM) adjustment used in the IRP forecast is updated with the Future DSM adjustment from the Spring 2022 forecast. The "IRP with Adjustments" series provides an "apples-to-apples" comparison for the Spring 2022 forecast with the IRP forecast that eliminates the differences in DSM forecasts. After accounting for the differences in the IRP and Spring 2022 forecasts in the "IRP with Adjustments" forecast, the Spring 2022 peak demand forecast exceeds the "IRP with Adjustments" peak demand forecast through the 2034 horizon. Xcel Energy undertook additional steps in the course of resource plan modeling, for incremental new EE to be modeled as a supply-side resource. This required that the Company adjust the base energy forecast (discussed in Part 1 above) to remove the embedded EE adjustment that projects the effects of new 2022-2034 program year EE achievements.[52]

In other words, after accounting for increased levels of DSM that were approved in the IRP, the updated 2022 load forecast result in a larger incremental resource need than the Company had anticipated in the IRP. This higher peak forecast is driven by a higher energy forecast which includes stronger than expected actual energy demand in 2021 and a higher level of EV adoptions over the forecast horizon. While a higher EV adoption rate results in more energy needed to support charging, a change in the EV charging profile results in lower peak impact per vehicle during the system peak hour.

[52] Xcel Energy also disaggregated DG Solar resources, as discussed previously. This included incremental potential EE savings amounts from the 2022-2034 program years in Strategist and Encompass modeling processes as "Bundles," which compete on an economic basis with supply-side resources. In effect, this allows Xcel Energy to treat projected additions of DG solar and portfolios of new EE measures, at a given average cost, like generic supply-side resources.

Image 4.1: Corporate Forecast of Peak Load by Vintage



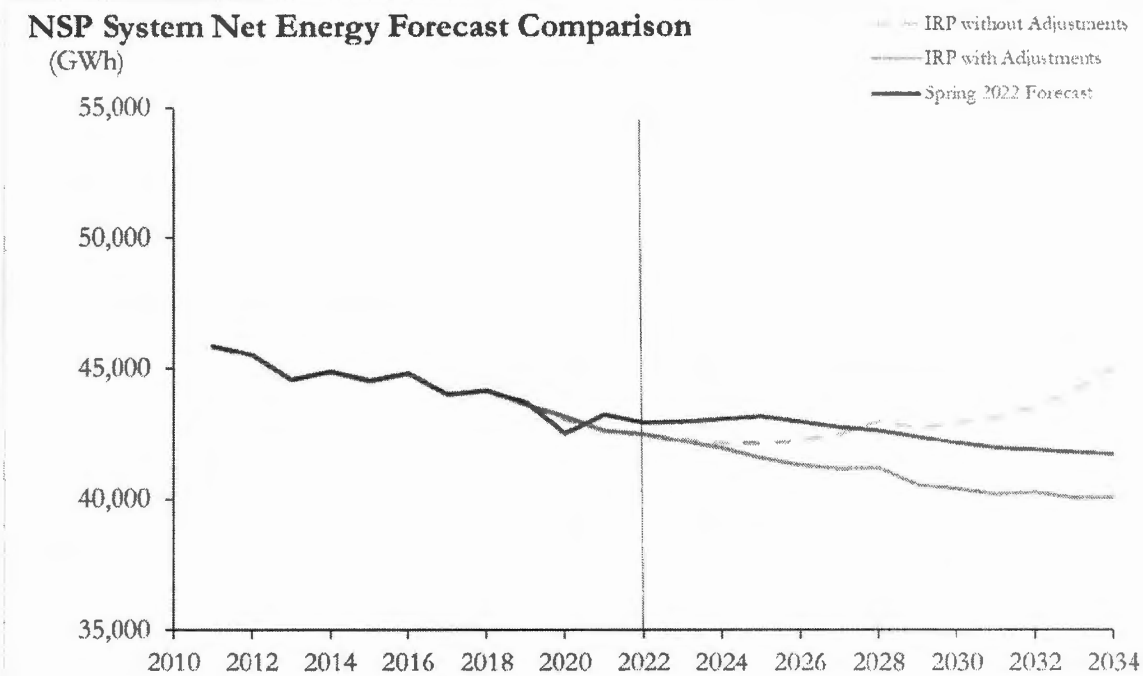
b. Forecast for Energy Requirements

In addition to forecasting peak demand, Xcel Energy also forecasts customers' energy requirements. Xcel Energy expects net energy requirements to remain above the forecasts used to determine the need for new supply side resources in the IRP filing. The Spring 2022 forecast is calling for approximately -0.2% growth over the full 2022-2034 planning period. Image 4.2 below portrays the net energy from the Spring 2022 forecast, as compared to the IRP Fall 2019 forecast referred to as "IRP without Adjustments". Image 4.2 also includes an "IRP with Adjustments" series where the Future DSM adjustment used in the IRP forecast is updated with the Future DSM adjustment from the Spring 2022 forecast. The "IRP with Adjustments" series provides an "apples-to-apples" comparison for the Spring 2022 forecast with the IRP forecast that eliminates any differences in DSM forecasts. Changes from the Company's Fall 2019 forecast vintage to the Spring 2022 forecast are attributable to higher than previously expected historical energy consumption, the long-term impact of the COVID-19 pandemic on customer sales, and additional sales from higher EV adoption.

-0.2% Flat demand continues

2006 peak 9,859
has not reached that level since!
Remember CapX 2020 based on
2.49% annual increase!

Image 4.2: Corporate Forecasted Net Energy Requirements by Vintage



c. Forecast Adjustments for Anticipated Customer Trends

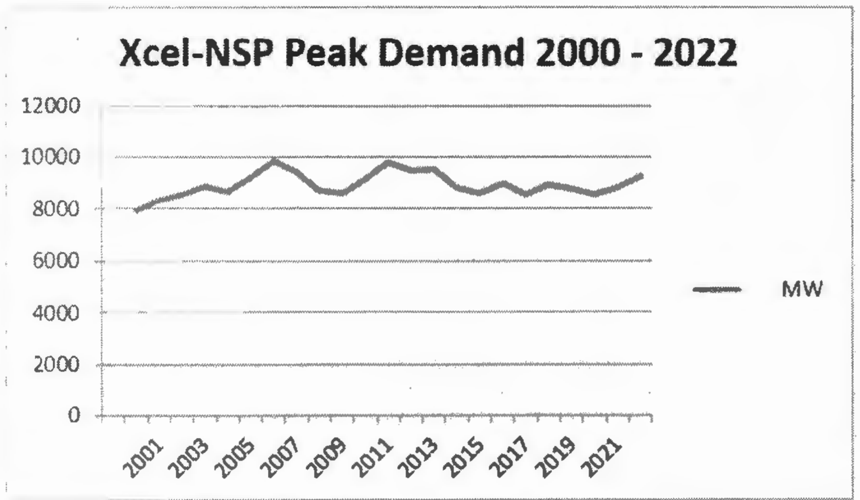
After determining the base peak capacity and energy demand forecasts, Xcel Energy makes adjustments to account for the impact of events or trends reasonably expect to occur in the planning period. The forecast has been exogenously adjusted for trends in DER and adoption of EVs. DER in the form of behind-the-meter rooftop solar results in a reduction to the forecast while EV charging results in an increase to the forecast. The forecast also made certain adjustments to overall demand for large customer changes expected in future years.

d. Adjustments to Model Certain Load-Modifying Resources as Competing with Supply-Side Resource Options

There are no changes to the methodology used in the IRP filing to account for load-modifying resources – such as energy efficiency, demand response, and distributed generation – as competing with supply-side resources in the Company's modeling process.

Xcel's Peak Demand from SEC 10-K filings

Legalectric post: Xcel Energy Peak Demand = 9,245 MW February 23rd, 2023
https://legalectric.org/weblog/24749/



Xcel P	MW
2000	7,936
2001	8,344
2002	8,529
2003	8,868
2004	8,665
2005	9,212
2006	9,859
2007	9,427
2008	8,697
2009	8,615
2010	9,131
2011	9,792
2012	9,475
2013	9,524
2014	8,848
2015	8,621
2016	9,002
2017	8,546
2018	8,927
2019	8,774
2020	8,571
2021	8,837
2022	9,245

a. Annual MISO Reserve Margin Requirements Applied to the NSP System in the IRP

Historically, MISO based its PRM requirements on an annual analysis of the amount of reserve capacity required to avoid loss of load events, evaluated based on the system's summer peak. Based on the needs indicated in MISO's 2020-2021 Loss of Load Expectation Study (LOLE Study) – which Xcel Energy used to develop the Company's approved IRP – the Company calculated its effective reserve margin to be 3.46%. Below is a discussion on how Xcel Energy's reserve margin obligation (2022) was derived in the IRP.

For the 2020-21 planning year, MISO had indicated an unforced capacity (UCAP) PRM of 8.9%, and this requirement was expected to remain relatively constant at 8.8-8.9% over the full MISO planning period, to 2029. The Company determined the NSP-specific reserve margin based on this information, and the coincident peak demand factor of the Company's own peak load in relation to the MISO peak. The Company assumed this coincident factor to be 95%; meaning that NSP expects to experience load levels that are approximately 95% of the peak load during times when the total MISO system load is peaking. Considering the overall MISO PRM and the Company's own coincident peak factor together, the Company's NSP-system effective reserve margin declined from the 8.9% MISO-wide PRM to 3.46%.

Image 4.3: MISO Planning Reserve Margin Calculation – NSP System

Planning Year June 1, 2021 to May 31, 2022

$$(95\ percent\ coincidence\ factor) x\ (1 + 8.9\ percent) - 1$$
$$= 3.46\ percent\ effective\ reserve\ margin\ for\ NSP$$

Applying the Company's effective reserve margin to the Company's annual load forecast over the planning period determined the capacity obligation the Company needed to meet in the Company's IRP. This calculation for 2022 is illustrated below.

Table 4.1: Capacity Obligation Calculation under IRP Assumptions – 2022 Example

Total Capacity Obligation Component	Value
Forecasted NSP Peak Load	9,101 MW
NSP Effective Reserve Margin	x (1+ 3.46%)
NSP Obligation	**= 9,416 MW**

b. NSP Resources Capacity Accreditation in the IRP

After the Company determined this MISO obligation level, the Company considered the types of resources suitable to meet the requirement. MISO's tariff and business practices, at the time, set forth procedures to enable various types of resources to be used to achieve the Company's RA requirements: (1) capacity resources,[54] (2) load modifying resources,[55] and (3) energy efficiency resources.[56]

Resource accreditation represents a measure of a resource's reliable contribution to System RA needs. A generator's operation, maintenance, and utilization directly impact the portion of nameplate capacity rating currently recognized as an accredited resource. Therefore, for a resource's expected contribution to RA, MISO has historically used UCAP rather than installed capacity (ICAP). This is a measure that estimates the amount of capacity that can be counted on to contribute to customer needs in peak hours. UCAP is calculated differently

[54] Physical Generation Resources (i.e., physical assets and purchase agreements), External Resources if located outside of MISO's footprint, and DR Resources participating in MISO's energy and operating reserves market, available during emergencies.

[55] Behind-the-Meter Generation and DR available during emergencies, which reduces the demand for energy supplies coming from the LSE.

[56] Energy Efficiency Resources: Installed measures on retail customer facilities designed and tested to achieve a permanent reduction in electric energy usage while maintaining a comparable quality of service.

Table 4.2: 2020-2034 System Net Accredited Capacity Surplus/Deficit Prior to Expansion Planning (MW, resource values measured in terms of UCAP)

Year	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032
Obligation with Reserves, less Existing EE	9,655	9,695	9,748	9,770	9,761	9,767	9,758	9,685	9,669	9,624	9,604
Existing Fossil Thermal	6,154	6,154	5,320	5,011	4,603	3,448	3,448	2,965	2,454	2,340	2,064
Existing Nuclear	1,642	1,642	1,642	1,642	1,642	1,642	1,642	1,642	1,642	1,642	1,642
Existing Large Hydro	831	831	831	0	0	0	0	0	0	0	0
Existing Renewables	1,625	1,581	1,641	1,522	1,497	1,474	1,417	1,373	1,349	1,300	1,267
Existing Demand Response	1,041	1,055	1,066	1,072	1,077	1,078	1,077	1,071	1,059	1,048	1,037
Net Surplus/(Deficit) before New Resources Added	1,637	1,567	753	(523)	(944)	(2,126)	(2,175)	(2,635)	(3,166)	(3,295)	(3,595)

Misleading - Should include NERC LTRA report (2022) projected additions - with proposed generation, excess capacity

V. NEED ANALYSIS

Xcel Energy conducted an engineering analysis to evaluate potential alternatives for meeting the need to deliver at least 1,996 MW of energy to Sherco, which will maximize the cost-effective delivery of energy from resources on the line to the rest of the grid. The report of that analysis is presented in this chapter rather than as an appendix. The headings and acronyms have been updated to conform to the Application format.

A. Executive Summary

Xcel Energy plans to retire its coal-powered generators at Sherco. There are three Xcel Energy units currently in operation with a combined capacity of 1,996 MW[61] as shown in Table 5.1:

Table 5.1: Xcel Energy Sherco Generating Capacity

	Unit 1	Unit 2	Unit 3
Capacity	720 MW	710 MW	566.4 MW
Retirement Date	2026	2023	2030

The Commission approved Xcel Energy's plans to retire all three units and to add significant amounts of renewable generation resources. In Xcel Energy's most recent IRP proceeding,[62] the Commission concluded that Xcel Energy had demonstrated that between 2027 and 2032, it will need approximately 2,150 MW more wind-powered generation and 600 MW more solar-powered generation, or an equivalent amount of energy and capacity from a combination of wind, solar and/or storage.[63] The Commission authorized Xcel Energy to own approximately 1,300 MW of this energy which would re-use the 1,286 MW of interconnection rights associated with Unit 1 and Unit 3. The Commission directed Xcel Energy to begin CN and route permit proceedings for 345 kV transmission facilities extending from Sherco to enable new energy resources to connect to the MISO transmission grid.

The maximum generation that could be delivered to the Sherco POI (which currently connects Sherco Units 1, 2, and 3) at any one time is 1,996 MW due to MISO requirements

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[61] This amount represents Xcel Energy's 59 percent ownership of Sherco Unit 3 (876 MW). Southern Minnesota Municipal Power Agency owns 393.6 MW, or 41% of Sherco Unit 3, and thus holds those interconnection rights.

[62] *See generally*, IRP Order.

[63] *Id.* at Ordering ¶ 2.A.8.

and limitations. The amount of generation interconnected, however, could be substantially greater (in the Company's Plan, approximately 4,000 MW) if the generation is a combination of resources, wind, solar, combustion turbine, and/or batteries because these types of resources are often complementary, not often generating at their full output at the same time. In the event the total amount of generated resources exceeded 1,996 MW, operational controls would be used to limit the amount of energy delivered to the POI to 1,996 MW.

Given the Commission's determinations regarding Sherco retirements, this study evaluates the transmission facilities needed to deliver at least 1,996 MW of energy to the Sherco POI from energy resources located in and around Lyon County, Minnesota.

This stability assessment studied the power system's ability to experience a fault or sudden change in the system without prolonged loss of synchronism. For modeling, the generation was assumed to be all wind turbine generation and 10 transmission line options and two sub-options were evaluated, as discussed in more detail in Section 5.3 of this Chapter. Wind generation was assumed in the study because it is the most likely resource in Southeastern Minnesota and because both solar and wind are inverter-based generation. Consequently, the study results could be generalized to any mix of wind and solar resources, with some variation in substation equipment depending on the final composition of resources.

The best-performing option consists of two 345 kV circuits between Lyon County and the Sherco POI. Option 9 would enable the delivery of at least 1,996 MW and up to 2,396 MW of energy to the Sherco POI (referred to as Option 9 below). The 345 kV line facilities in Option 9 could be co-located on the same structures as a double circuit 345 kV line and meet transmission system planning criteria. Option 9 was also stress-tested for a longer transmission route length of 180 miles and continued to enable the delivery of 1,996 MW at the Sherco POI. Option 9 includes a substation in Lyon County, an Intermediate Substation approximately 20 miles from the endpoint and a Voltage Support Substation at the midpoint along the line.

This study also details Xcel Energy's evaluation of alternatives to Option 9, as required by Minnesota Certificate of Need statutes and rules. These alternatives included: (i) size alternatives (different voltages or conductor arrays, AC/DC, and double circuiting); (ii) type alternatives, including alternative terminals/substations, double circuiting with existing transmission lines; generation alternatives; and underground transmission lines; and (iii) the no build alternative.

B. Background and Study Assumptions

The Commission approved Xcel Energy's IRP on April 15, 2022. In its IRP Order, the Commission approved Xcel Energy's acquisition of approximately 600 MW of solar and 2,150 MW of wind, or an equivalent amount of energy and capacity from a combination of wind, solar and/or storage between 2027 and 2032, which will maximize the use of the generation rights associated with Sherco using a radial gen-tie line. The scope of this study is to determine the transmission facilities needed to deliver at least 1,996 MW of new generation at the Sherco Substation POI.

The primary assumptions underlying this analysis are summarized in the subsections that follow. Detailed modeling assumptions are described in Appendix G. Appendix G also describes the technical analyses Xcel Energy performed on the ten transmission options.

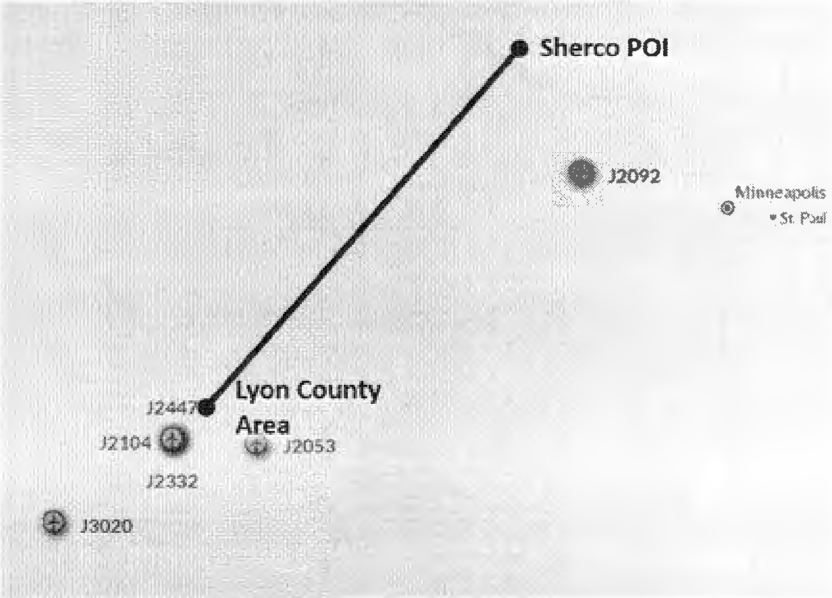
1. Generation Type

Wind generation was assumed to be Type 3 wind turbine models. Type 3 wind turbine models are doubly fed induction generators with the active control by a power converter connected to the rotor terminals. As a result, the amount of energy that could be transmitted by the Project would not differ based on the type of resource, *i.e.* wind or solar, because wind and solar facilities are both inverter-based. However, if the generation differed from Type 3 wind turbine models, additional equipment installations at the substations may be required. Regardless of generation type, any interconnections would require further analysis to determine any necessary substation equipment based on size, type, and location of installed generation.

2. Location

In the IRP, Xcel Energy proposed Lyon County as the location for the Project's endpoint. This location is proposed based on the quality of the wind resource in Southwestern Minnesota. The Lyon County west-end termination is also supported by the MISO generation interconnection queue. Image 5.1 shows the location of approximately 1,300 MW of wind generation in the MISO Queue seeking interconnection to the transmission system as of October 2022.

Image 5.1: MISO Interconnection Requests



Further support for the endpoint derives from the RFI Xcel Energy conducted in June 2022 regarding wind and solar generation within and near Lyon County. The responses to the RFI confirmed the significant interest in renewable development and appropriateness of a Lyon County endpoint -- more than 5,000 MW of potential capacity was identified in the area. A Request for Proposal process will be used to further identify and procure more specific energy resources.

3. MISO Replacement Generation Process Requirements

The MISO Business Practice Manual (BPM) establishes requirements for interconnecting replacement generation through the MISO Generation Queue. All transmission and generation connections must comply with BPM-015. Within MISO BPM-015, replacement generation is covered under Section 6.7.2, Generating Facility Replacement Process. The key requirements are:

- The reliability of the transmission system with the replacement generation must be comparable with the reliability of the transmission system with existing generation. This is analyzed through a Replacement Impact Study and is completed by MISO.

- The transmission system must be reliable during the time between the date that the existing generation facility ceases commercial operations and the commercial operation date of the replacement generation facility. This is analyzed through a Reliability Assessment Study and is completed by MISO.

- Steady-state performance (voltage and thermal) must be comparable to the existing system.

- Reactive power performance at POI must be comparable to the existing system.

- System stability (stability analysis) must be comparable to the existing system.

Based on the requirements laid out in MISO BPM-015, system stability is a critical factor to maintain when replacing a firm dispatchable resource like coal-powered generation with an intermittent, non-dispatchable generation resource such as wind and solar. This stability assessment studied the power system's ability to experience a fault or sudden change in the system without prolonged loss of synchronism.

4. Sherco Retirement, Unit 1 and Unit 2 and Conversion to Synchronous Condensers

Sherco Unit 1 and Unit 2 are expected to be converted to synchronous condensers when retired. Previous steady state studies have shown the need for 300 megavolt ampere reactive power (MVAR) in the Sherco area to maintain steady state voltages at Monticello Nuclear Power Plant within permissible voltage requirements. Synchronous condensers at Sherco fulfill the steady state voltage needs in the area and provide robust system stability in a critical area of the transmission system. The transmission system has been built around having robust system stability support at Sherco and converting the existing units will help ensure compliance with the requirements laid out above in MISO BPM-015, will provide similar required reactive performance to the existing generation units, and are important to system stability.

Conversions of Sherco Unit 1 and Unit 2 to synchronous condensers are included in every evaluated option. If Sherco Unit 3 were also converted to a synchronous condenser, it would strengthen the system stability further and provide redundancy to the results in this study for loss of one Sherco synchronous condenser for maintenance or outage.

Table 6.2: Magnetic Field Calculation Summary

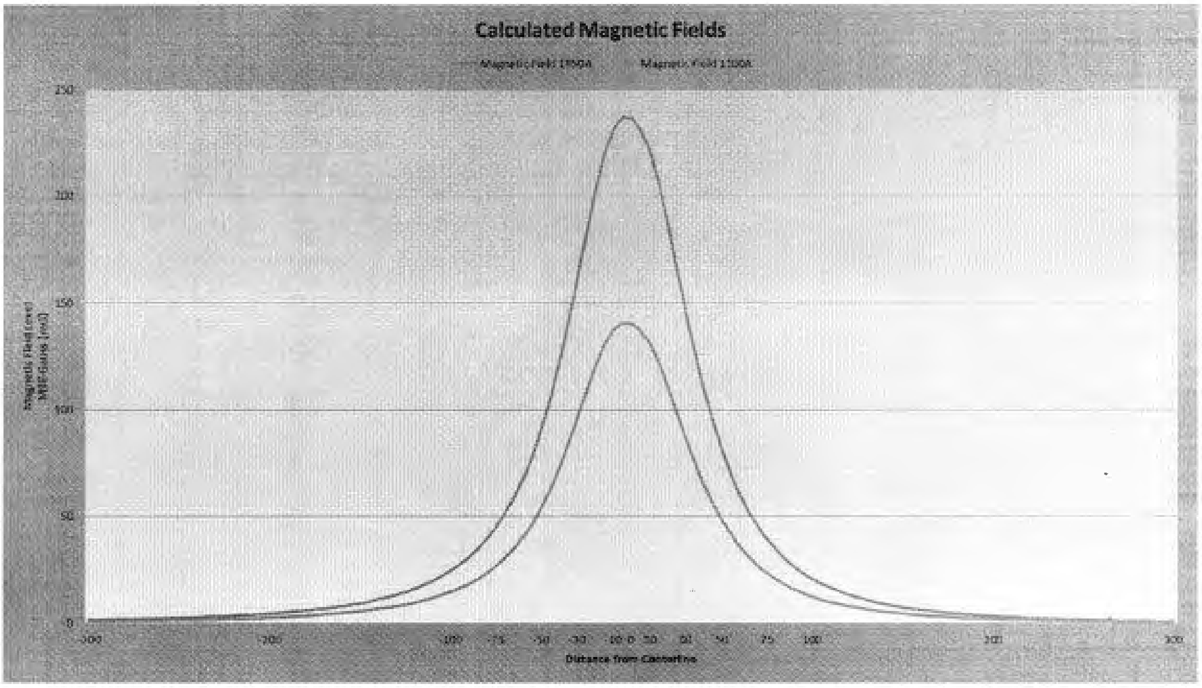
Structure Type	System Condition	Current (Amps)	Distance to Proposed Centerline (feet)												
			-300	-200	-100	-75	-50	-25	0	25	50	75	100	200	300
345 kV/345 kV Double-Circuit Monopole	Peak System Energy Demand (1100MVA/1100MVA)	1850/1850	1.5	4.5	25	45	90	161	237	167	95	45	24	3.5	1
	Average System Energy Demand (660 MVA/660 MVA)	1100/1100	1	2.6	15	27	54	96	141	99	56	27	14	2	0.6

Calculate for 3,000 amps App. p. 26 (revised)

edge of ROW 150' wide

- For CapX 2020, Xcel/NSP grossly understated expected magnetic field
- See WHO & NIEHS recommendations of mG - 2-4mG!!
- Off Peak loading is usually heavier - bulk power transfers

Image 6.3: Calculated Magnetic Flux density (mG) for Proposed 345/345 Kilovolt Transmission Line Design (3.28 feet above ground)



There are presently no Minnesota regulations pertaining to magnetic field exposure. Applicant provides information to the public, interested customers, and employees so they can make informed decisions about magnetic fields. Such information includes the availability for measurements to be conducted for customers and employees upon request.

Considerable research has been conducted since the 1970s to determine whether exposure to power-frequency (60 hertz) magnetic fields causes biological responses and health effects. Public health professionals have also investigated the possible impact of exposure to EMF on human health for the past several decades. While the general consensus is that electric fields pose no risk to humans, the question of whether exposure to magnetic fields can cause biological responses or health effects continues to be debated.

Since the 1970s, a large amount of scientific research has been conducted on EMF and health. This large body of research has been reviewed by many leading public health agencies such as the U.S. National Cancer Institute, the U.S. National Institute of Environmental Health Sciences, and the World Health Organization (WHO), among others. These reviews do not show that exposure to electric power EMF causes or contributes to adverse health effects.

compaction In addition, farmers will be compensated for their expense to deep rip compacted areas. If an individual does not have access to deep ripping equipment, the Applicant will provide this service.

Ground-level vegetation disturbed or removed from the right-of-way during construction of the Project will naturally reestablish to pre-construction conditions. Vegetation that is consistent with substation site operation outside the fenced area will be allowed to reestablish naturally at substation sites. Areas where significant soil compaction or other disturbance from construction activities occur will require additional assistance in reestablishing the vegetation stratum and controlling soil erosion. In these areas, the Applicant will use seed that is noxious weed free to reestablish vegetation.

Another aspect of restoration relates to the roads used to access staging areas or construction sites. After construction activities are complete, the Applicant will ensure that township, city, and county roads used for purposes of access during construction will be restored to their prior condition. The Applicant will meet with township road supervisors, city road personnel, or county highway departments to address any issues that arise during construction with roadways to ensure the roads are adequately restored, if necessary, after construction is complete.

E. Maintenance Practices

Transmission lines and substations are designed to operate for decades and require only moderate maintenance, particularly in the first few years of operation. Xcel Energy will be responsible for the operation and maintenance of this Project. Xcel Energy will perform aerial annual inspections of the 345 kV transmission lines and will inspect the lines from the ground every four years. Typically, one to two workers are required to perform aerial inspections and three workers are required to perform the ground inspections. Any defects identified during these inspections will be assessed and corrected. Xcel Energy will also perform necessary vegetation management for the line. Vegetation maintenance generally occurs every four years.

??. Easement language Re: notice, spraying, etc.

The annual inspections are the principal operating and maintenance cost for transmission facilities. The aerial inspections cost approximately $35 to $55 per mile and the ground inspections cost approximately $200 to $400 per mile. Actual line-specific maintenance costs depend on the setting, the amount of vegetation management necessary, storm damage occurrences, structure types, materials used, and the age of the line.

Substations require a certain amount of maintenance to keep them functioning in accordance with accepted operating parameters and the NESC requirements. Transformers, circuit breakers, batteries, protective relays, and other equipment need to be serviced periodically in accordance with the manufacturer's recommendations. The substation site must be kept free of vegetation and adequate drainage must be maintained.

The estimated service life of the proposed transmission lines for accounting purposes varies among utilities. Xcel Energy uses an approximately 60-year service life for its transmission assets. However, practically speaking, high voltage transmission lines are seldom completely retired.

F. Storm and Emergency Response and Restoration

Transmission infrastructure has very few mechanical elements and is built to withstand weather extremes that are normally encountered. With the exception of outages due to severe weather such as tornadoes and heavy ice storms, transmission lines rarely fail. Transmission lines are automatically taken out of service by the operation of protective relaying equipment when a fault is sensed on the system. Such interruptions are usually only momentary. Scheduled maintenance outages are also infrequent. As a result, the average annual availability of transmission infrastructure is very high, in excess of 99%.

However, unplanned outages of transmission facilities can happen for a variety of reasons. Unplanned outages can occur due to mechanical failures or severe weather like heavy ice, wind, and lightning. In the event an unplanned outage of the proposed Project occurs, Xcel Energy has the necessary infrastructure and crews in place in central and southern Minnesota to respond quickly and safely to return this line to service.

If there is a storm or emergency outage on the lines, Xcel Energy has distribution service centers in the region that will initiate a tactical response by deploying one of its 24-hour on-call first responders or "trouble man" to the lines as quickly as possible to patrol the line and immediately assess the damage. Once the damage has been assessed the first responder will immediately relay the following information back to the service center:

- Magnitude of damage;
- Isolation requirements for switching;
- Material required for restoration;
- Number of line crew needed; and
- Equipment needed.

Based on the assessment of the first responder, Xcel Energy will develop a plan to restore the damaged facilities. The goal of the repair is to place the transmission system back into service as quickly as possible to minimize the impact to the transmission system. Xcel

Table 8-12 Agricultural Statistics for the Project Study Area

Murray	395,079 (88% of county)	Corn, soybeans, forage	Cattle, hogs and pigs, sheep and lambs
Cottonwood	370,389 (90% of county)	Corn, soybeans, forage	Cattle, hogs and pigs, poultry
Source: USDA, 2017			

Designated "prime farmland" exists throughout the Project Study Area. In particular, prime farmland is abundant in the Minnesota River Prairie and Couteau Moraines ECSs. Federal regulations define prime farmland as "'land that has the best combination of physical and chemical characteristics for producing food, feed, forage, fiber and oilseed crops and is available for these uses." 7 CFR, 657.5 (a) (1).

Buy the farm MN St § 216E.12 Subd. 4

Impacts on agricultural fields and production can be minimized through avoidance and routing transmission lines along field edges and other existing linear infrastructure (e.g., roads, transmission lines). The Applicant will maintain landowner access to agricultural fields, storage areas, structures, and other agricultural facilities during construction to the extent practicable. If irrigation systems or drain tile are present, the Applicant will work with landowners to avoid these systems. Crop production on some portion of agricultural lands may be temporarily interrupted for one growing season while transmission line facilities are constructed. In cultivated cropland areas, the Applicant will attempt to conduct construction before crops are planted or following harvest, if possible. The Applicant will compensate landowners for impacts on crops resulting from the construction, operation, and maintenance of the Project including compaction that might result from these activities.

6. Forestry Production

Commercial forestry operations are not common in the Project Study Area. Forested areas in the Project Study Area typically consist of narrow swaths of trees along the margins of waterbodies and shelterbelts surrounding farmsteads, along the boundaries of agricultural fields, or in state parks or forest and other federal, state, or locally designated and managed lands (see Figure 7). No commercial forestry operations have been identified within the Project Study Area and the Project is not expected to impact forestry production.

7. Mineral Extraction

The Applicant reviewed publicly available information from the Minnesota Department of Transportation (MnDOT) Aggregate Source Information System and the USGS Mineral Resources Data System to identify mineral mining operations in the Project Study Area (MnDOT, 2022; USGS, n.d.). There are various active and inactive sand, gravel, and stone