NORTHWESTERN ENERGY'S

SOUTH DAKOTA INTEGRATED RESOURCE PLAN 2022

NorthWestern Energy
Delivering a Bright Future

Table of Contents

1. Executive Summary

1.1. Overview of the NorthWestern Energy 2022 South Dakota IRP

NorthWestern Energy's (NorthWestern or NWE) 2022 South Dakota Integrated Resource Plan (IRP or Plan) provides a roadmap to inform the development of an adequate energy supply to meet customer load for the coming years. The Plan presents an evaluation of different potential generation resource portfolios that could meet the needs of our South Dakota electric customers reliably, safely, and affordably over a twenty-year time horizon. This process involves the assembly and analysis of a wide range of data on loads, prices, and resource performance, along with technical information on resource costs and capabilities.

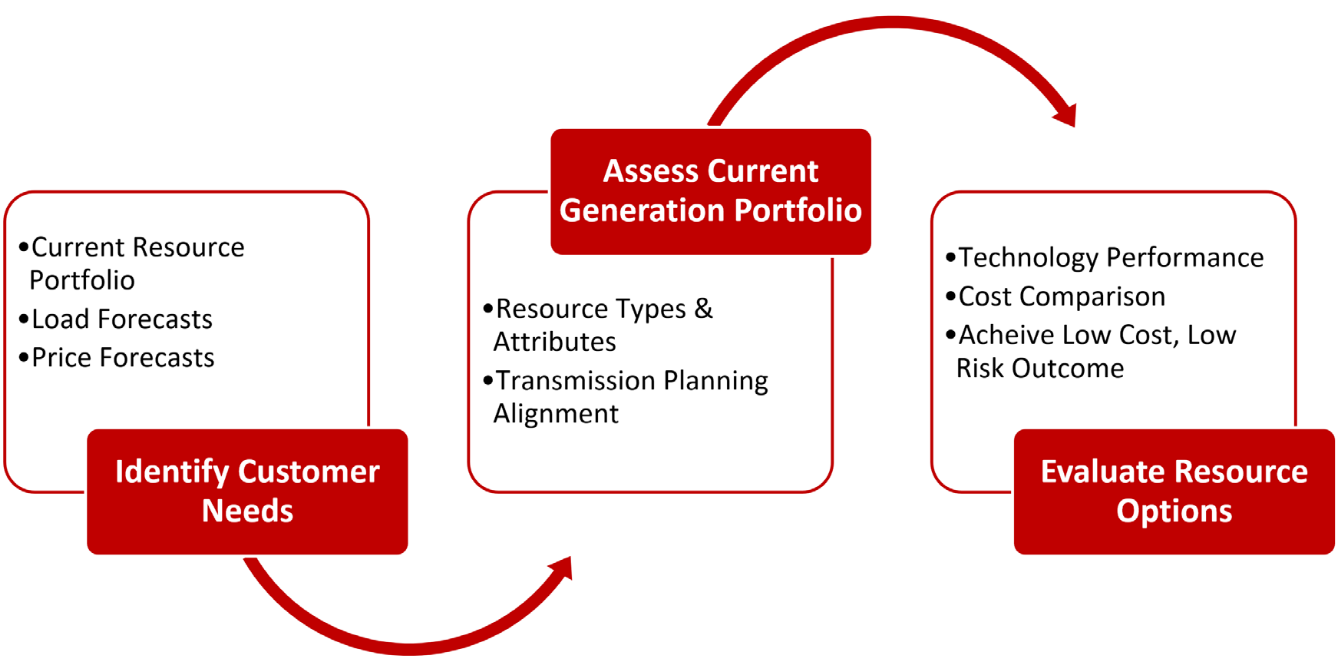
NorthWestern is a member of the Southwest Power Pool (SPP), which creates benefits for NorthWestern's customers but also entails certain responsibilities and requirements for NorthWestern as a member of the broader community of market participants. These benefits and requirements are incorporated throughout NorthWestern's analysis and discussed where relevant throughout the IRP.

This Plan analyzes how a variety of generation resource portfolios might perform across a range of future conditions. Planning requires the consideration of information about the future, meaning it must consider information that is not known with certainty — including forecasts of prices and electric loads — and incorporate assumptions about the costs and characteristics of different factors, such as generating technologies (among other things).

Accordingly, the Plan does not result in specific decisions about new resources for addition to NorthWestern's generation portfolio.[1] Instead, the Plan provides information about the system's likely future needs under different conditions and evaluates various resource types based on their generic costs and characteristics. The Plan thus serves as a useful foundation to guide future resource determinations, which necessarily take into account more specific information. NorthWestern remains flexible and responsive as the future unfolds and will reassess options along the way when pursuing actions identified in this Plan that are likely to meet our customers' needs reliably, affordably, and safely.

The analysis presented in this Plan is based on historical data, forecasts of energy needs (both at peak demand times and over sustained periods), and estimates of a wide range of other relevant factors. The following graphic depicts the major categories of information used and the ways this information is processed and evaluated.

Figure 1: Major Planning Categories



[1] Such decisions about specific resource selections would only result following the analysis of detailed and specific information of the candidate resources. (These are typically received in response to a formal Request for Proposal (RFP) but may also arise through unforeseen opportunities or offers.).

1.2. The Planning Landscape

NWE's planning landscape has changed since the publication of our 2020 IRP. NorthWestern completed construction of the 58 MW Bob Glanzer Station and is currently evaluating resources for potential retirement. Additionally, the company made a net-zero commitment and is awaiting SPP regulation changes due to Storm Uri.

1.2.1. Retirements and Replacements

NorthWestern has a mature portfolio serving our South Dakota service territory. Many of the resources in our portfolio are eligible for retirement and replacement evaluations. Aberdeen 1, Yankton, Clark, and Faulkton will be the next set of resources to undergo this evaluation.

1.2.1.1. The Supply Chain

COVID-19 and the war in Ukraine have had lasting impacts on the supply chain. From massive shortages, to unprecedented material and labor cost increases, nearly every industry has been touched. Results of the 2019 RFP suggested multiple resources may be advantageous for addition to NorthWestern's portfolio; however, when competitive bids were revisited, we discovered that proposed costs no longer reflected what these projects would cost to build. NorthWestern may issue another RFP to better understand what types of resources may provide a good financial and operational fit to replace some of our aging generation units.

1.2.2. Coal Fleet Evaluations

NorthWestern and the co-owners of the coal facilities in NorthWestern's fleet continue to discuss the future of the plants. Industry wide, the push toward carbon neutrality is accelerating the pace of coal retirements; however, this swift transition has raised concerns about reliability and resource adequacy. NorthWestern still finds coal to be a valuable resource in its portfolio due to its high level of reliability.

1.2.2.1. NorthWestern's Coal Fleet

NorthWestern has three jointly-owned coal facilities that generate power to meet customer load: Big Stone, located in Grant County, South Dakota; George Neal Unit 4, located in Woodbury County, Iowa; and Coyote Station, located in Mercy County, North Dakota. NorthWestern is a minority owner of each plant. As a minority owner, NorthWestern has input into the future of each of these resources, but owners with larger ownership interests may desire early plant closures.

While coal is a valuable resource, ongoing operations result in many challenges. The Coyote Station may need environmental upgrades to comply with federal regulations. George Neal 4 has been challenging from a dispatch perspective. The plant operator and the majority of the owners conduct business in the MISO market, but NorthWestern is in the Southwest Power Pool (SPP). Neal is generally dispatched to MISO price signals, which do not always correspond with SPP needs.

1.2.3. Net-Zero Announcement

Over the past 100 years, NorthWestern Energy has maintained our commitment to provide customers with reliable and affordable electric and natural gas service while also being good stewards of the environment. We have responded to climate change, its implications and risks, by increasing our environmental sustainability efforts and our access to clean energy resources.

NorthWestern also committed to achieving net-zero by 2050 for scope 1 and 2 emissions. You can find additional information on our net-zero plan on NorthWestern's website.[2]

1.2.4. Winter 2021 Storm Uri

Storm Uri was an unprecedented weather and operational event that hit Texas in 2021 that significantly impacted both SPP and ERCOT markets. In response to these events, SPP appropriately declared its highest level of emergency conditions to maintain grid stability. Following Storm Uri, SPP initiated an analysis of fuel supply, stakeholder communications, and resource adequacy that resulted in the delivery of recommended changes to structure and operational requirements to avoid this type of emergency in the future.

1.3. Summary of the 2022 IRP

NWE's 2022 IRP covers the constantly evolving planning landscape. It dives into changes we expect to see near-term, how said changes impact the planning horizon, customer needs and growth, and least cost potential portfolios. Additionally, it covers different retirement scenarios, potential pricing structures, and plans to accommodate various changes should they arise in the future.

1.3.1. Our Customers' Future Needs

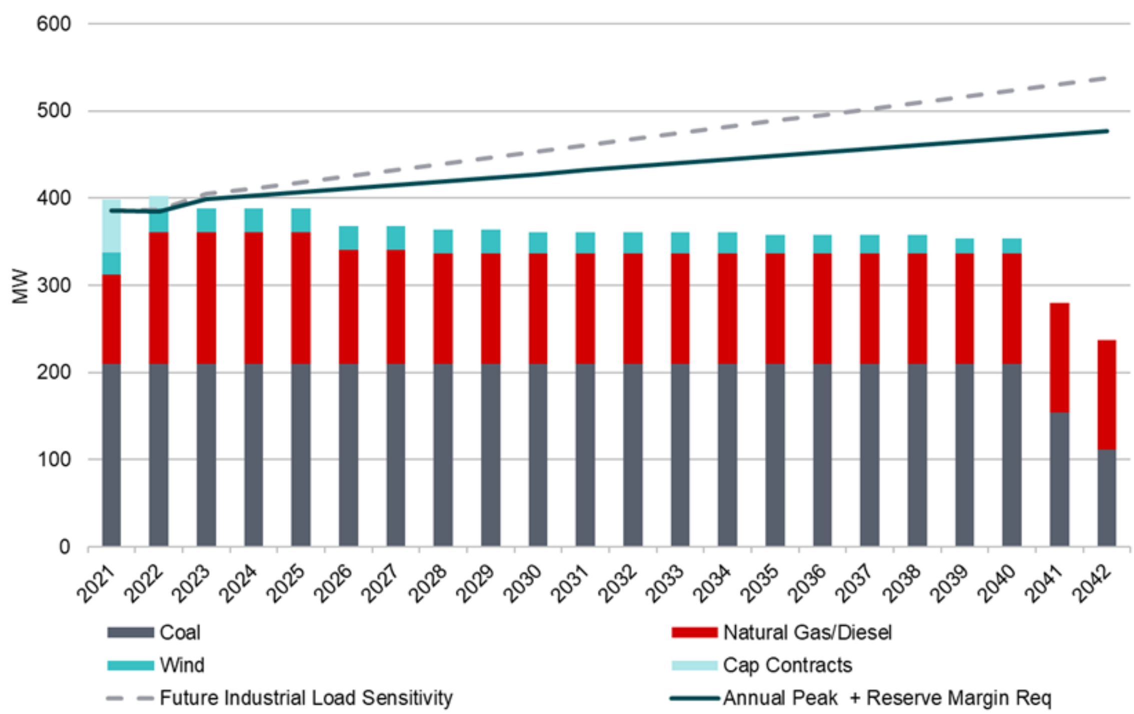
Our customers' needs are expected to increase over the planning horizon. While our current portfolio meets these needs, NorthWestern will need to plan appropriate resource replacements and additions to maintain resource adequacy and cost effective service. As mentioned in recent remarks made on the Bob Glanzer Generating Station, this is crucial for NorthWestern to maintain system reliability.

[2] See NorthWestern's Net-Zero Vision at https://www.northwesternenergy.com/clean-energy/net-zero-by-2050.

1.3.1.1. Capacity Needs and Expected Growth[3]

Peak load is expected to grow at a moderate rate of approximately 1% per year over the planning horizon. As shown in the figure below, numerous retirements will cause our current portfolio to be short in meeting these needs. However, NorthWestern plans to fill any gaps with new resources and/or short term market contracts to bridge the gap between current and future needs and make resource additions where necessary. This strategy will allow the company to meet customers' needs while focusing on least cost, most reliable replacement options.

Figure 2: Capacity Need



1.3.1.2. Energy Needs and Expected Growth[3]

NorthWestern also expects to see a modest 1% growth in energy needs. Future capacity resources should, in many cases, allow NorthWestern to meet these increased total energy needs. However, it is important to note that unexpected increases or decreases in industry activity or energy conservation within NorthWestern's territory could significantly affect future energy requirements. NorthWestern will continue to monitor industry activity and plan accordingly.

1.3.2. Portfolio Modeling

NorthWestern uses production cost modeling to provide information on how the resource portfolio would respond under different conditions and regulations. There have been a number of changes made to the modeling process and assumptions in this Plan. One of the most significant changes is the use of a twenty year planning horizon as opposed to the ten year horizon historically used. The Plan now includes multiple modeling sensitivities and scenarios that include different pricing assumptions, various coal plant retirement dates, and different resource additions.

[3] Please note, electric vehicle load is not included in the current load forecast. NorthWestern will continue to monitor this additional load potential and consider its inclusion in the future

1.3.3. Action Plan

NorthWestern identified a number of action items in this IRP. These include the replacement of Yankton and Aberdeen 1 generation units as well as creating a request for proposal for additional capacity if necessary.

1.3.3.1. Transmission Projects

There are a number of significant transmission projects that are in early planning stages. These include the Chamberlin Switchyard Project, Big Stone to Blair line upgrades, and Huron to Highmore line improvements. Each project is classified as a high priority for the transmission planning group and have expected completion dates in 2023 and 2025. Please note, project plans and dates are subject to change since these projects are still in early planning stages.

1.3.3.2. Yankton and Aberdeen Replacement

As mentioned above, Aberdeen 1 and Yankton are candidates for retirement and replacement evaluations. These two facilities account for approximately 43 MW in our current portfolio and were chosen for replacement in the last IRP. Between a fire at Huron, COVID-19, and other unforeseen events, NorthWestern decided to strategically postpone the retirement of these facilities to allow the market and supply chain to return to equilibrium.

1.3.3.3. Request for Proposals (RFP)

To accommodate upcoming retirements and customer load growth, NorthWestern may need to issue an RFP. This IRP outlines what that process may look like should the company decide to pursue new resources in this manner between 2023 and 2024.

2. SPP and NorthWestern's Service Territory

NorthWestern provides power to 756,600 customers across Montana, South Dakota, and Nebraska. In South Dakota, customers' needs and Southwest Power Pool (SPP) requirements are filled with a variety of generation assets powered by different fuel types. These generators are located both within South Dakota and outside the state as shown in the figure below.

Figure 3: NorthWestern Energy Service Territory

2.1. Southwest Power Pool – Structure and Requirements

NorthWestern is a member of the Southwest Power Pool (SPP). SPP members, like NorthWestern, commit their transmission and generation assets into SPP and then buy and sell wholesale energy and reserves on a day-ahead and real-time basis to meet their loads. SPP coordinates these wholesale power and transmission activities. NorthWestern currently has a number of transmission lines controlled by the SPP Tariff. See Section 2.1.2 for detailed transmission information.

SPP requires utilities to meet an annual resource adequacy requirement to ensure the entire system has an adequate supply of energy to meet the peak needs of all member companies. SPP requires its member companies that are Load Responsible Entities (LRE) to maintain at least a 12% Planning Reserve Margin (PRM). Please note, the PRM minimum requirement will increase to 15% in 2023.

Each LRE's PRM is calculated based on the tested operational capacity of the generation assets included in its portfolio. SPP's entire Balancing Area (BA) Planning Reserve Margin is 23.2% for the 2022 Summer Season and decreases to 12.7% by planning year 2026. PRM's for each LRE within SPP range from 12.28% to 32.63%, but the actual total BA PRM is forecasted to decline until it reaches 12.5% in 2025. For the 2021 Resource Adequacy (RA) requirement, NorthWestern carried 19.72% that was in excess of the minimum PRM of 12%; however, the majority of SPP LREs carry a PRM greater than 20%.[4]

NorthWestern currently holds one of the lowest PRM's among its investor owned utility peers in SPP. This can, and likely will, change as thermal units are retired and their capacity is replaced with other resources such as Variable Energy Resources better known as VER's. The following table offers a comparison of our 2022 Resource Adequacy position relative to our peers.

---

[4] See the 2021 SPP June Resource Adequacy Report https://spp.org/documents/64801/2021%20spp%20june%20resource%20adequacy%20report.pdf.

Figure 4: **2022 Peer RA Position**

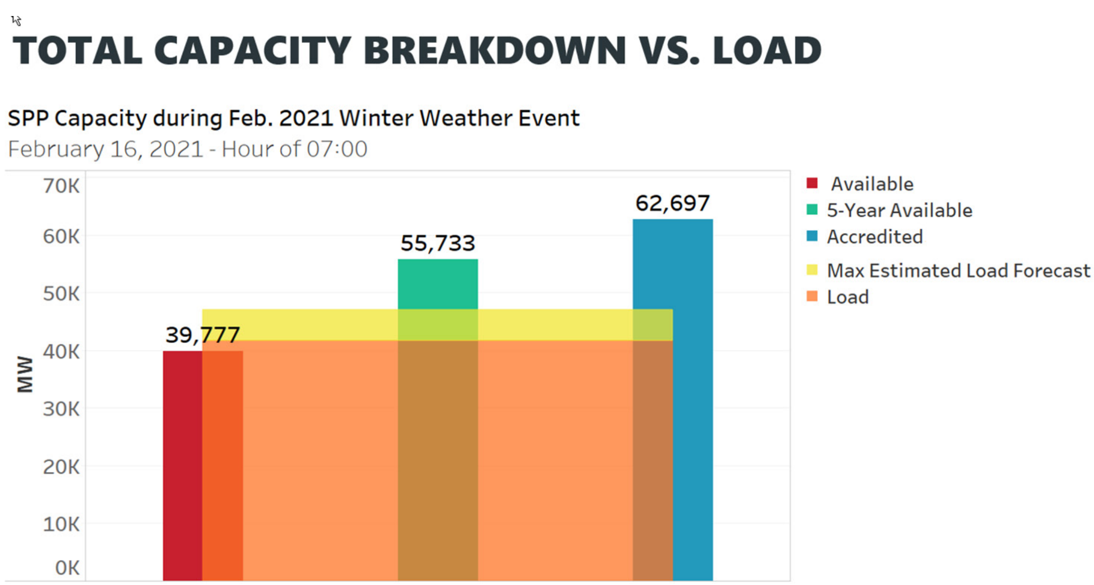
Investor-Owned Utility	2022 Resource Adequacy %
Liberty Utilities (fka Empire District)	17.76%
SouthWest Public Service (subsidiary of Xcel Energy)	30.89%
MidAmerican Energy (subsidiary of Berkshire Hathaway)	22.18%
American Electric Power	17.14%
Westar (Subsidiary of Evergy)	24.21%
NorthWestern Energy SD	21.66%
OK Gas and Electric	12.11%

2.1.1. Winter Storm Uri

Winter Storm Uri hit Texas and the Midcontinent during President's Day weekend 2021. The impact on organized markets in SPP and ERCOT was significant. SPP experienced a conflux of unprecedented weather events and fuel supply disruptions that prompted it to declare its highest level of emergency conditions, and to shed load in two events, for 50 minutes on Feb 15th and roughly three hours on February 16th. A significant portion of the natural gas supply that fuels power plants in the midcontinent is extracted from the Permian basin, located in TX, which experienced production freeze offs at the wellhead, as well as processing plant operational disruptions. Supply disruptions caused a run in commodity pricing, resulting in Locational Market Prices (LMPs) in excess of $1,000/mWh (violating SPP's market offer cap authorized by FERC) for extended durations, which in turn created very high credit exposure for many market participants.

Historically, SPP has never needed to resort to load shedding for grid stability, and it took appropriate serious action following these events. Following an analysis of fuel supply, stakeholder communications, and resource adequacy requirements, SPP delivered a set of recommendations tiered to indicate level of importance. SPP is currently working on the most urgent of these tiered recommendations, those that address the root cause, through its stakeholder process. Changes resulting from this stakeholder process are likely to impact resource adequacy program requirements, increase coordination between gas and electric industry actors, and increase fuel supply firmness.

Figure 5: **SPP Capacity, Available vs. Accredited Capacity Breakdown v. Load**[5]



[5] July 27 2021 SPP Board of Directors meeting, from presentation titled "Comprehensive Review Steering Committee Update."

The most pressing SPP action items stemming from Storm Uri relate to resource adequacy and capacity accreditation – both of which are clearly critical priorities given the delta between accredited and available capacity during the Storm Uri load shed event, as depicted above.

SPP is proposing multiple new requirements to support these action items through its Stakeholder Groups. These include:

- Increased PRM requirements for the upcoming RA seasons, a minimum of 15% has been approved.
- Seasonal Capacity showings (Summer and Winter)
- Performance-based accreditation (ELCC for VERs and storage; for thermal resources, moving from an installed capacity accreditation (ICAP) to an unforced capacity methodology (UCAP) that will incorporate a generators' forced outage rate). This will in turn decrease the PRM, and increase the data reporting requirements for Market Participants (MPs).
- Increased data reporting requirements for small and behind the meter generators, to ensure that performance characteristics are tracked.
- Development of increased performance incentives and service offerings that reward unit availability, such as the uncertainty reserve product, to help bridge forecast and dispatch errors.

The requirements and implementation timelines of these initiatives will continue to work through the stakeholder process. While NorthWestern generally supports a move to performance-based accreditation, we recognize that much of our fleet consists of older units with somewhat low capacity factors, so we will continue to monitor these proposals and their impacts to the assets we use to serve customer load.

2.1.2. Transmission Requirements

In addition to maintaining resource adequacy, NorthWestern is required to follow SPP transmission guidelines. SPP's definition of transmission facilities can be found under Attachment AI of the SPP tariff. While Attachment AI has six criteria for inclusion of transmission facilities, all of NorthWestern's qualifying transmission facilities fall under one or both of the two criteria listed below:

- Criteria #1: "All existing non-radial power lines, substation, and associated facilities, operated at 60 kV or above, plus all radial lines and associated facilities operated at or above 60 kV that serve two or more Eligible Customers not Affiliates of each other……"
- Criteria #3: "Control equipment and facilities necessary to control and protect a facility qualifying as a Transmission Facility."

Through the application of these criteria, NorthWestern has approximately 303 miles of 115 kV line and 158 miles of 69 kV line under the SPP tariff. With less than 500 total line miles meeting the criteria for this designation, NorthWestern is considered a Transmission Using Member (TU) in the Regional Transmission Organization (RTO). Members with over 500 miles of transmission in SPP are considered Transmission Owning Member (TO) and are offered different voting privileges under the tariff.

All of NorthWestern's transmission facilities reside in SPP zone 19, which is also referred to as the Upper Missouri Zone (UMZ). The UMZ is a multi-owner zone consisting of 20 different TO or TU members with interconnected facilities located across six states. As part of an effort to establish consistency in construction, operations and SPP tariff interpretation, the UMZ Coordination Group created a formal charter, developed zonal planning criteria, and approved a zonal voting process. These efforts have led to fair treatment of all zonal members while also outlining processes to move needed projects forward.

Figure 6: Map of UMZ

NorthWestern updates its list of qualifying facilities on April 1 each year. The annual update process includes an annual meeting where significant changes are highlighted, and an outline of deadlines for parties to submit data requests and informal or formal challenges. For the 2022 rate year, NorthWestern's Annual Transmission Revenue Requirement is $5,869,954.

2.2. A Changing Resource Mix

The generation mix within SPP is changing as coal facilities are retired and more natural gas and renewable resources are brought online. It is worth noting that there has been a large increase in the amount of wind energy located within SPP's footprint, and that SPP integrates more wind into its system than any other organized market. As of January 27, 2022, SPP had a generating capacity of 105,464 MW. A total of 29.6% of the generating capacity, or 31,217 MW, comes from wind resources.[6] This increase is expected to continue as wind capacity additions are outpacing thermal retirements. Solar capacity is starting to trend the same direction.

The substantial increase in VER's causes variability in generation and presents additional complexity in resource forecasting. This shift has affected prices and caused operational challenges. For instance, ancillary services are required to balance the production rate variability of power generation, a need that can often be greater for weather-fueled resources. The increase in VERs, plus the need to keep the power grid operating stably at 60hz incentivizes generation that can be dispatched quickly. It is important to note that a 1 MW increase in nameplate VER generation capacity is not equivalent to a 1 MW increase in accredited capacity. This means that only a fraction of the renewable energy added to the system can be counted on to serve a peak load.

Most of the projects in the SPP interconnection queue are VER resources due to comparatively lower and declining capital and O&M costs, public desire for renewable energy, and policy preferences that favor renewable generation. Policy preferences exist at the local, state, and federal levels. Some investor owned utilities have defined carbon free and emissions goals that favor renewable generation. Not all projects in the interconnection queue will become operational. However, even with a subset of these projects reaching commercial operation, the stability and coordination requirements of SPP will continue to be essential.

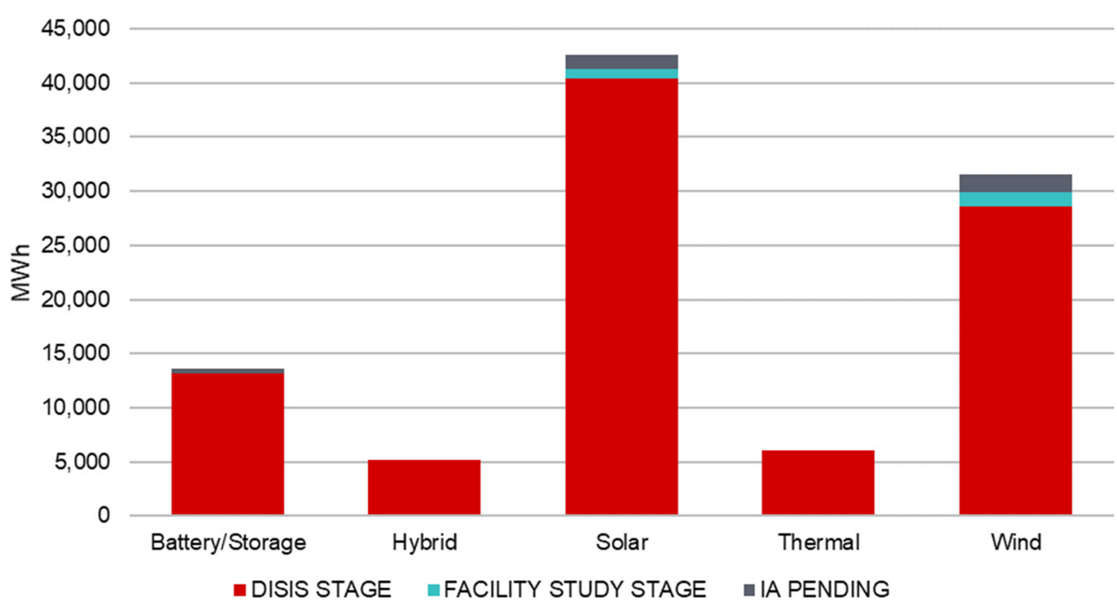
SPP has been working to simplify and streamline its interconnection process to accommodate the volume of requests it receives. In SPP's April 27, 2022 update on mitigating its generator interconnection backlog, it estimates that the queue will be clear in 2024, absent any intervention.[7] Starting in 2019, SPP proposed a three-step DISIS study process, which clustered interconnection studies and laid out a clear timeline for completion.

Figure 7: DISIS Stages

DISIS 1	DISIS 2	DISIS 3	negotiate / finalize GIA
90 calendar days from close of study window	125 calendar days from DISIS 1 decision	135 calendar days from DISIS 2 decision	60 days from final decision to proceed

SPP recently obtained approval from FERC to implement some additional queue streamlining processes, including increased financial commitments from potential developers, and increased penalties for late stage project withdraw, which can prompt massive restudy efforts for projects located lower in the queue. While SPP's backlog remains, as evidenced by the number of MW in the DISIS stage, the process as a whole is improving.

Figure 8: Expected Resources



[6] See the SPP Fast Facts webpage Fast Facts - Southwest Power Pool (spp.org)

[7] Submission of Tariff Revisions to Modify the Generator Interconnection Procedures to Mitigate Generator Interconnection Backlog, ER-22-253. Pg. 27 (2019). (Testimony of David Kelley).

3. Current and Future Position – Capacity and Energy

NorthWestern's customers continue to have steady but modest growth in their peak needs and total energy consumed each year. The analysis throughout this plan, as is typical in resource planning, considers energy and capacity needs separately.

Capacity and energy are the key drivers of energy supply planning because a utility, like NorthWestern, must plan to have sufficient capacity to meet the highest momentary energy demand over the course of the year. It must also have adequate energy to meet customers' needs over a prolonged period. It is important to remember that NorthWestern's total system load is relatively small and the addition of a new large customer could cause a meaningful increase in energy and capacity needs.

As mentioned in Chapter 2, SPP requires that NorthWestern maintain adequate capacity levels to meet expected peak load conditions, but does not have a specific annual energy production requirement for participants. NorthWestern plans to meet the market-defined capacity requirement and seeks to ensure we have enough energy during peak events while also taking advantage of peak pricing in the market.

3.1. Capacity Needs

Capacity is the maximum amount of energy that a generator or portfolio of generation can provide over a period of time, whether at a single moment or sustained for a longer period. It represents the capability of the system to meet the needs of the system's customers when their needs peak, which is often during extreme weather. Capacity is measured in megawatts (MW).

During the summer season, SPP requires NorthWestern to maintain adequate generation capacity to meet our forecast peak loads plus a planning reserve margin (PRM) of 12%, or 15% starting in 2023, above the forecast peak. As discussed in Chapter 2, there is a strong likelihood that SPP will also institute a capacity requirement for the winter season. In South Dakota, NorthWestern's peak needs are lower in the winter than in the summer season. With the addition of Glanzer to our portfolio, we expect to have sufficient capacity to meet SPPs' summer reserve requirements and any winter reserve requirements should they be defined. However, as noted earlier, we will need to replace several of our existing generation resources that are near the end of their useful lives and becoming more costly to maintain. Chapter 7 evaluates scenarios for replacing NorthWestern's aging generation. The 2022 Plan and the analysis described here build on the detailed engineering assessment of NorthWestern's resource fleet that was presented in the 2020 IRP.

Figure 9 shows NorthWestern's projected capacity position over the next 20 years. You notice that there are a number of retirements, shown in Figure 10, that occur toward the end of 2025 and 2040 that cause the portfolio to fall short of the required generation and PRM. These deficits will be filled with either new opportunity resources or new resources that are contracted or acquired through an RFP (see Chapter 8 for additional discussion).

Figure 9: Projected Capacity Position

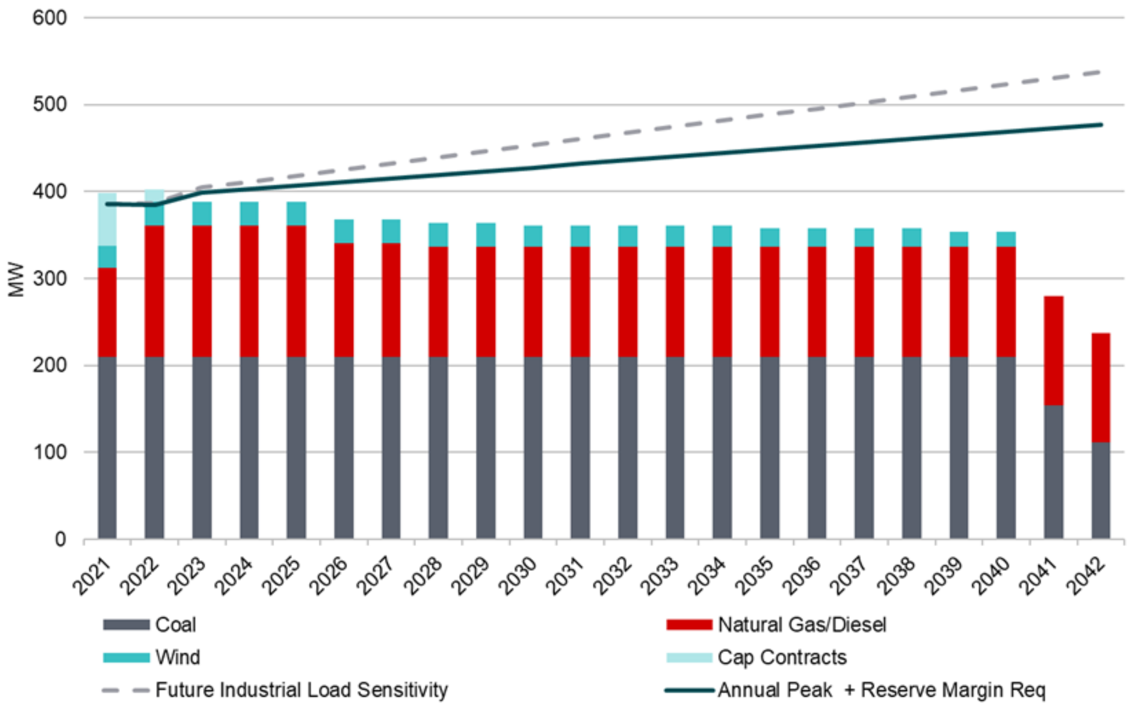


Figure 10: Projected Retirements (Subject to Change)

Retirement Year (Subject to Change)	Total Capacity Contribution (MW)
2022	15
2025	20
2027	4
2029	3
2034	2
2038	4
2040	74
2041	42

3.1.1. Total Capacity Provided by Our Generation Resources

As mentioned in the previous section, NorthWestern currently meets capacity requirements with the resources in its portfolio. However, the portfolio includes several aging units that are in need of replacement (see Chapter 4 for further discussion). The table below shows Northwestern's current portfolio and its attributes. Capacity values in this table represent the portfolio's current capacity showing. As discussed in Chapter 2 and Chapter 3 Section 3.1.1.1, SPP is implementing changes to how accredited capacity is determined, which will impact NorthWestern's capacity showing in future planning years.

Figure 11: NorthWestern's Generation Resource Portfolio

Generation Unit	Type	Fuel Type	Owned/Contracted Nameplate Capacity (MW)	Accredited Capacity (MW)*	Accredited Capacity (% of Nameplate Capacity)	COD	Contract Term
Big Stone (JOU, 474 MW Total)	Steam	Coal	111	111	100%	1975	23.4% Owner
Neal 4 (JOU, 644 MW Total)	Steam	Coal	56	56	100%	1979	8.7% Owner
Coyote (JOU, 427 MW Total)	Steam	Coal	42.7	42.5	100%	1981	10% Owner
Total Coal			**210**	**210**			
Aberdeen 2 (AGS2)	CT	NG / Diesel	82.2	59.3	72%	2013	Owned
Bob Glanzer Generating Station	RICE	NG	58	55.7	96%	2022	Owned
Yankton Generating Station (YGS)**	RICE	NG / Diesel	13.6	0	0%	1974	Owned
Total Natural Gas			**154**	**115**			
Aberdeen 1 (AGS)	CT	Diesel	28.8	20.1	70%	1978	Owned
Clark	RICE	Diesel	2.8	2.1	75%	1970	Owned
Faulkton	RICE	Diesel	2.8	2	71%	1969	Owned
Mobile C	RICE	Diesel	2	1.8	90%	2009	Owned
Mobile B	RICE	Diesel	1.8	1.6	89%	1991	Owned
New Mobiles - Unit 1	RICE	Diesel	1	1	100%	2019	Owned
New Mobiles - Unit 2	RICE	Diesel	1	0.9	90%	2019	Owned
New Mobiles - Unit 3	RICE	Diesel	1	1	100%	2019	Owned
New Mobiles - Unit 4	RICE	Diesel	1	1	100%	2019	Owned
New Mobiles - Unit 5	RICE	Diesel	1	1	100%	2019	Owned
New Mobiles - Unit 6	RICE	Diesel	1	1	100%	2019	Owned
New Mobiles - Unit 7	RICE	Diesel	1	0.9	90%	2019	Owned
New Mobiles - Unit 8	RICE	Diesel	1	1	100%	2019	Owned
Big Stone	RICE	Diesel	0.3	0	0%	1975	23.4% Owner
Total Diesel			**47**	**35**			
Beethoven Wind	VER	Wind	80	17.7	22%	2015	Owned
Titan I Wind (Rolling Thunder I Power Partners, LLC)	VER	Wind	25	3	12%	1/1/2010	20 years
Aurora County Wind CED LLC	VER	Wind	20	2.3	11%	10/1/2018	20 years
Brule County Wind CED LLC	VER	Wind	20	1.8	9%	10/1/2018	20 years
Oak Tree (Oak Tree Energy, LLC)	VER	Wind	19.5	2.5	13%	1/1/2015	20 years
Total Wind			**165**	**27**			
Total Portfolio			**575**	**387**			

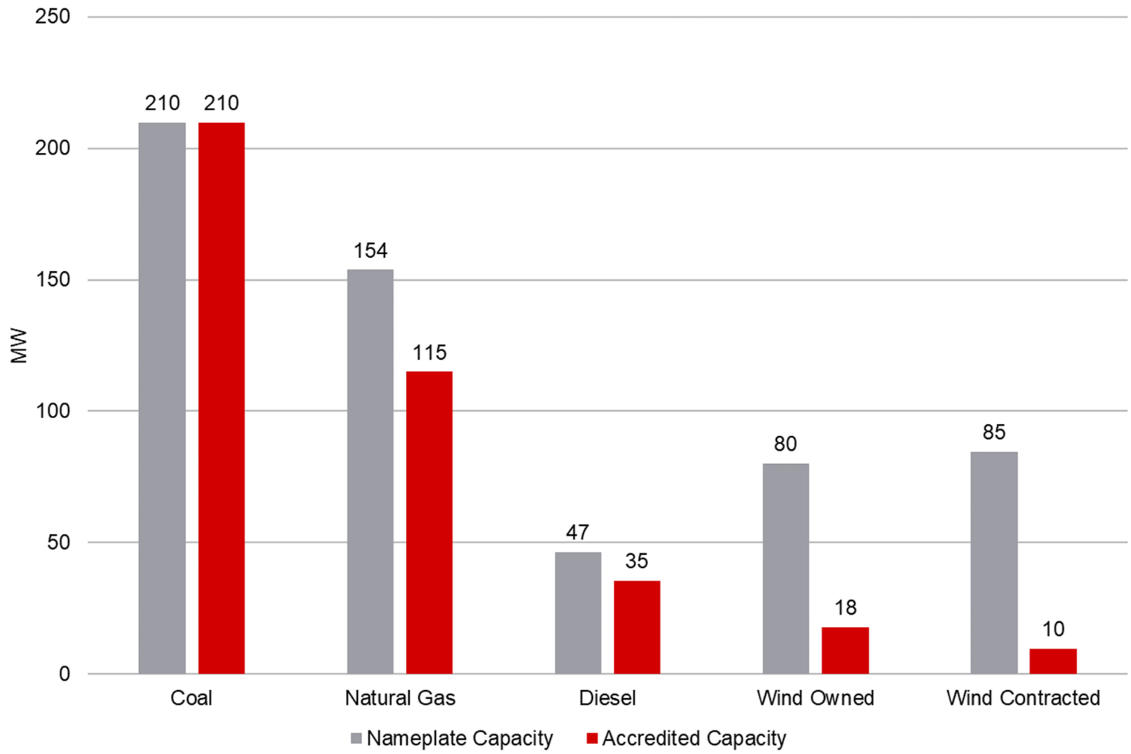
* Accredited capacity values reflect the 2022 RAW filing.

** YGS is not currently operational. The facility would require extensive upgrades to safely and reliably bring back online.

As shown in the table above, the capability of a resource to provide generation when loads peak is not necessarily equal to its maximum technical capacity, or nameplate capacity. Unforeseen outages might limit a dispatchable resource's availability, and the absence of wind or sun could limit the generation from weather driven resources. Nonetheless, to ensure a reliable system, NorthWestern must identify the amount of generation capacity a resource is likely to provide during peak load conditions.

In accordance with current capacity accreditation methods, SPP evaluates the capacity of thermal or dispatchable resources using the results of operational testing conducted by the LRE. Tests are conducted for a minimum of 1 hour during peak load conditions. The facility must also meet 90% of its previous testing value. It is a requirement of SPP that each market participant test their thermal generation one time per year during the summer. Please note, SPP recently voted to move to a new method of accreditation for dispatchable resources. NorthWestern will monitor and follow these changes as they are defined by SPP. Currently, weather-driven resources' dependable capacity is calculated using a function of the correlation between the wind or solar resource and load conditions. Measuring this for planning purposes requires a more complex assessment method to understand how much NorthWestern and SPP can rely upon that resource to meet peak capacity needs. Overall, thermal resources provide approximately 92% of the dependable capacity for NorthWestern's customers. The other 8% is provided by on-system wind. It is important to note that of the total 165 MW of wind online, only 27 MW can be counted on during peak times. A discussion of upcoming capacity accreditation calculations can be found in the next section.

Figure 12: Existing and Accredited Capacity by Fuel Type



3.1.1.1. Capacity Contributions: VER Calculations and Anticipated Changes

NorthWestern currently follows SPP's methods for determining the capacity contributed by variable energy resources (VERs). Under SPP's current Planning Criteria, the contribution of a VER towards a utility's capacity requirement is determined by a Net Planning Capability (NPC) calculation. This calculation is based on the hourly generation from the actual operation of a generation facility during the previous 3-10 years. The accredited capacity of the VER is measured as the generation that the facility provided in at least 60 percent of the peak load hours (i.e., the 60th percentile of generation). Peak load hours are defined as those containing the top 3 percent of loads during the peak load month of each year.

In FERC Docket ER-22-379, SPP proposes to transition to using the Effective Load Carrying Capability (ELCC) metric to assess capacity contributed by VER and energy-limited (storage) resources in the SPP footprint. ELCC is an industry-supported method of calculating the likely capacity contribution of a resource using a probabilistic analysis, to determine the likelihood of a 1 in 10 system load loss likelihood, or a Loss of Load Expectation (LOLE).

The ELCC method importantly reflects the impacts of increased penetration of a resource type, and how that increase in resource penetration promotes a decrease in the ELCC of later-added resources. SPP requires that Market Participants organize their VER resources into tiers, with the highest tier available for Designated Resources the MP uses to serve its load. Effectively, this allows a MP to select a resource to receive a higher ELCC relative to its other portfolio resources of the same fuel type.

The figure below shows estimated ELCC values for the wind resources in NorthWestern's fleet. It is expected that these numbers may change when SPP completes their final ELCC studies. We expect to transition to ELCC metrics in 2023, or as soon as FERC approves SPP's proposal.

Figure 13: Draft Wind ELCC Values

Plant Name	Summer Tier Value (MW)	Summer ELCC (MW)	Summer ELCC (%)	Winter Tier Value (MW)	Winter ELCC (MW)	Winter ELCC (%)
Aurora Wind Project	20	3.24	16%	20	3.01	15%
Beethoven Wind	80	15.37	19%	80	20.57	26%
Brule Wind Project	20	3.79	19%	20	4.59	23%
Oak Tree Wind Farm	20	3.70	19%	20	5.42	27%
Rolling Thunder Wind Farm	17	2.99	18%	8	2.08	26%
Rolling Thunder Wind Farm	8	1.19	15%	17	2.76	16%
Total	**165**	**30.28**		**165**	**38.43**	

* This table represents the preliminary values calculated using the new ELCC methodology. These results slow a slight increase in portfolio wind accredited capacity.

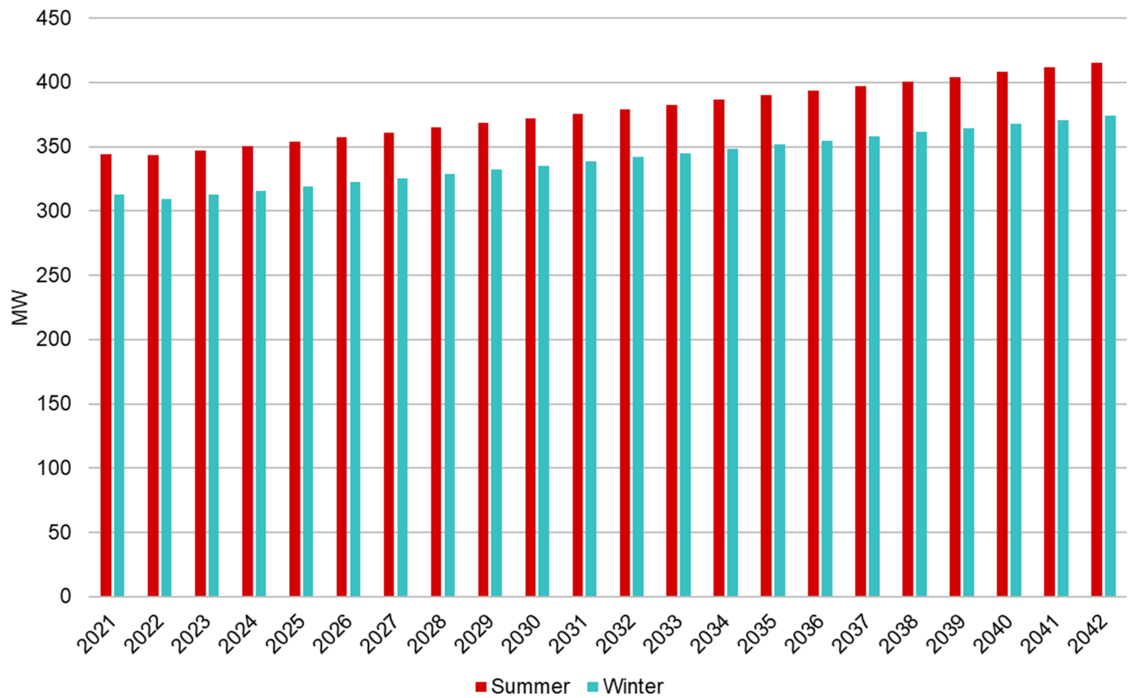
SPP is currently considering which reliability metrics should be used in planning activities (i.e., LOLE, EUE, etc.). Further evaluations are needed to determine which metrics adequately address outage events and the changing energy landscape. Changes to reliability metrics will likely impact PRM requirements and the ELCC values of resources.

Thermal accreditation calculations are also anticipated to change to use UCAP instead of ICAP (see Chapter 2 for more detail).

3.1.2. Capacity Forecast

Most of NorthWestern's load and its need for capacity is created by residential and small commercial customers. Thus, due to the high demand of electricity for purposes of space heating and cooling, the system load shape varies seasonally. This also causes NorthWestern's system to be called upon to meet maximum demands during summer and winter extreme temperature events. Figure 14 shows NorthWestern's projected peak loads. In all years, the annual peak occurs in the summer. In addition, the same figure displays the 2021 peak of 334 MW, the slight decrease expected in the 2022 peaks, and the expected, consistent increase of all future peaks in both the summer and winter months. As mentioned in the prior chapter, NorthWestern has been historically required to maintain a 12% PRM and will be expected to maintain a 15% PRM starting in 2023 in the SPP.

Figure 14: Projected Peaks



In general, NorthWestern's peaks follow the trends listed below:

- Summer peaks generally occur in the evening (hours 15-18) while winter peaks are usually in the morning (hours 8-9)
- Summer peaks correspond with maximum daily temperatures at or above 91 °F and winter peaks with minimum daily temperatures at or below -7 °F
- 70% of summer peaks occurred in July and 60% of winter peaks occurred in January

Future capacity accreditations for wind and solar resources have been proposed by SPP. They are presented in the figures below. To find the capacity contribution of a new resource, the total portfolio nameplate of that resource type is determined. The total nameplate is then used to determine what tier the new resource would fall under. That tier is used to assign an ELCC value in relation to a point on the ELCC curve. The more of one resource in a portfolio, the lower the ELCC value.

Figure 15: Preliminary Wind ELCC Values[8]

ELCC Category	Installed Capacity Nameplate	Installed Capacity Nameplate	Installed Capacity Nameplate	Installed Capacity Nameplate
SPP Installed Wind (MW)	12,634	15,141	26,885	40,000
NWE Installed Wind (MW)	100	119	212	316
Wind ELCC	**22%**	**21%**	**17%**	**14%**

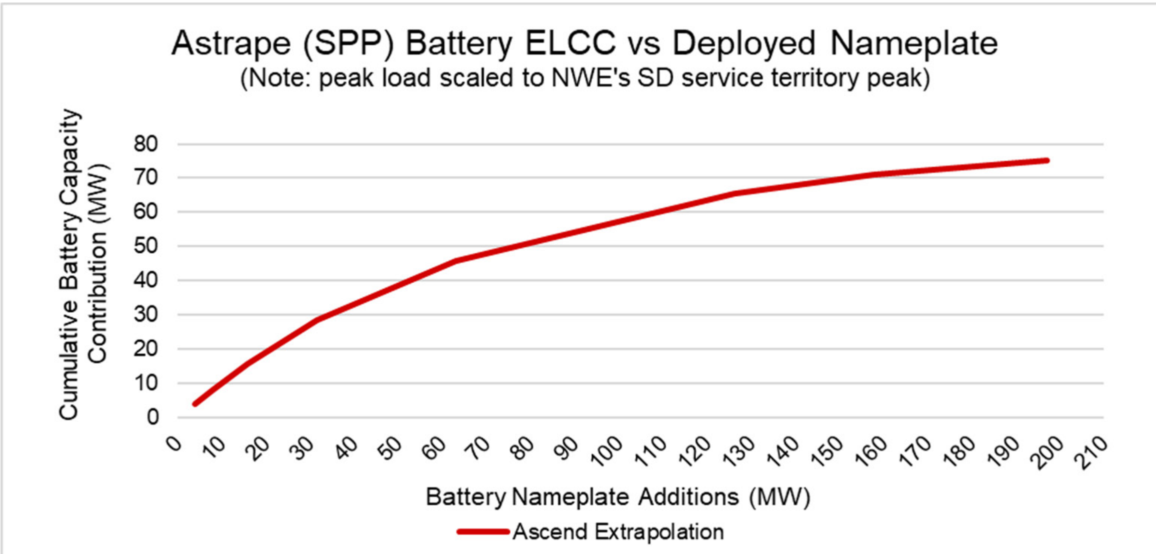
Figure 16: Preliminary Solar ELCC Values6

ELCC Category	Installed Capacity Nameplate	Installed Capacity Nameplate	Installed Capacity Nameplate	Installed Capacity Nameplate	Installed Capacity Nameplate	Installed Capacity Nameplate
SPP Installed Solar (MW)	275	1,000	3,000	5,000	10,000	20,000
NWE Installed Solar (MW)	2	8	24	39	79	158
Solar ELCC	**85%**	**72%**	**71%**	**68%**	**61%**	**40%**

[8] See the 2020 ELCC Wind and Solar Study Report 2020 elcc wind and solar study report.pdf (spp.org).

Preliminary storage ELCC values have yet to be announced, but are expected in the near future. Please refer to SPP's webpage for future updates on program changes. The battery ELCC curve that NorthWestern assumes for this plan is shown in Figure 17 below. This curve uses results from Astrape's SPP Energy Storage Study which were scaled down based on NorthWestern's customer load and extrapolated by Ascend Analytics.[9]

Figure 17: Battery ELCC with Deployment



For battery storage, this curve suggests that, as more nameplate capacity is added to the system, the capacity contribution of the cumulative storage does not increase linearly but approaches a maximum value. In terms of NorthWestern's resource adequacy, this suggests that batteries have a diminishing value as more are added, and it is not clear if they have any incremental value beyond 200 MW nameplate capacity.

3.1.3. Deficit Events

As mentioned in Chapter 2, SPP requires utilities to maintain an annual resource adequacy requirement to ensure the entire system has an adequate supply of energy to meet member companies' peak needs. SPP requires member companies that are LRE's to hold at least a 15% PRM beginning in 2023. This, in general, provides NorthWestern's customers protection under peak conditions. That said, it is still important for NorthWestern to understand its own potential to experience deficits and ability to respond to protect customers in extreme events where we may not be able to rely on other SPP members and the market.

NorthWestern's South Dakota service territory can experience severe winter weather that causes transmission outages. During these outages, it can be impossible to import power from generating resources outside of NorthWestern's system. To assess the amount of generation capacity that may be needed to serve load in the event of a transmission outage during an extreme weather event, NorthWestern analyzed winter loads in three load center locations that may be suitable for adding new generation. To determine how much load each location likely needs at any given point, NorthWestern calculated the distribution of historical loads after removing large customer load. The results provide a basis for considering the amount of capacity that would be required locally to ride through a temporary transmission outage.

Under extreme weather or transmission outage conditions, NorthWestern must carry enough capacity to supply customers with electricity. These events have the potential to isolate our customers from other suppliers within SPP. Deficit event analysis utilizes our historic load to better understand how our portfolio would perform in these conditions. This analysis of our system helps ensure NorthWestern has an appropriate mix of resources that when combined can meet the industry LOLE 1 in 10 standard for reliability: 1 outage day every 10 years.

[9] See Astrape's study results https://www.astrape.com/spp-energy-storage-study/

The areas within our service territory most susceptible to the impacts of a bad storm or lengthy outages are Huron, Aberdeen, and Yankton. Yankton, in particular, has a higher risk of isolation from the market due to its location and transmission constraints. Mitchell, while still considered to be somewhat at risk, has the advantage of blended transmission. This means Mitchell could receive transmission support from Aberdeen should an outage occur. These two towns demonstrate the importance of generation location. In order to ride through a transmission outage, isolated towns need to have enough generation within their immediate network to meet peak loads.

The table below sets a minimum requirement surrounding localized load. This requirement is then used when reviewing new, potential resource characteristics. Resources that meet the minimum requirement would be beneficial to the system as they would be able to serve a community in an outage scenario.

Figure 18: Deficit Durations

South Dakota Deficit Durations (Oct 2015 - June 2021)						
Capacity	Total Deficit Events	Annual Deficit Events	Duration Percentile (hr)	Max Duration (hr)	Average Duration (hr)	Portfolio Capacity (MW)
			99.97th*			
340	0	0.0	0.0	0.0	0.0	379
320	12	1.1	4.0	5.0	3.1	379
300	71	6.6	8.8	14.0	4.1	328
280	225	20.9	16.8	18.0	4.9	328
260	491	45.7	39.8	45.0	6.7	328
240	846	78.7	68.8	154.0	8.6	328
220	1,214	112.9	226.1	355.0	11.1	328
200	1,467	136.5	399.8	425.0	14.8	328

*99.97th percentile is the standard of 1 day in 10 years which is the recommendation to maintain reliable service

Some of NorthWestern's resources rely on natural gas to operate, including the new Bob Glanzer Generating Station. The company currently has some excess transportation capacity on Northern Natural Gas (NNG) that is released to transportation customers. After the capacity releases expire in November 2023, NorthWestern will utilize the NNG capacity to ensure that BGGS can operate on a firm basis. NorthWestern is also evaluating the feasibility of building an LNG facility for future load growth and to provide continued transportation capacity solutions to some of our transportation customers that have used NorthWestern's NNG released capacity for their operations. Additional analysis is underway and a decision is expected sometime this year.

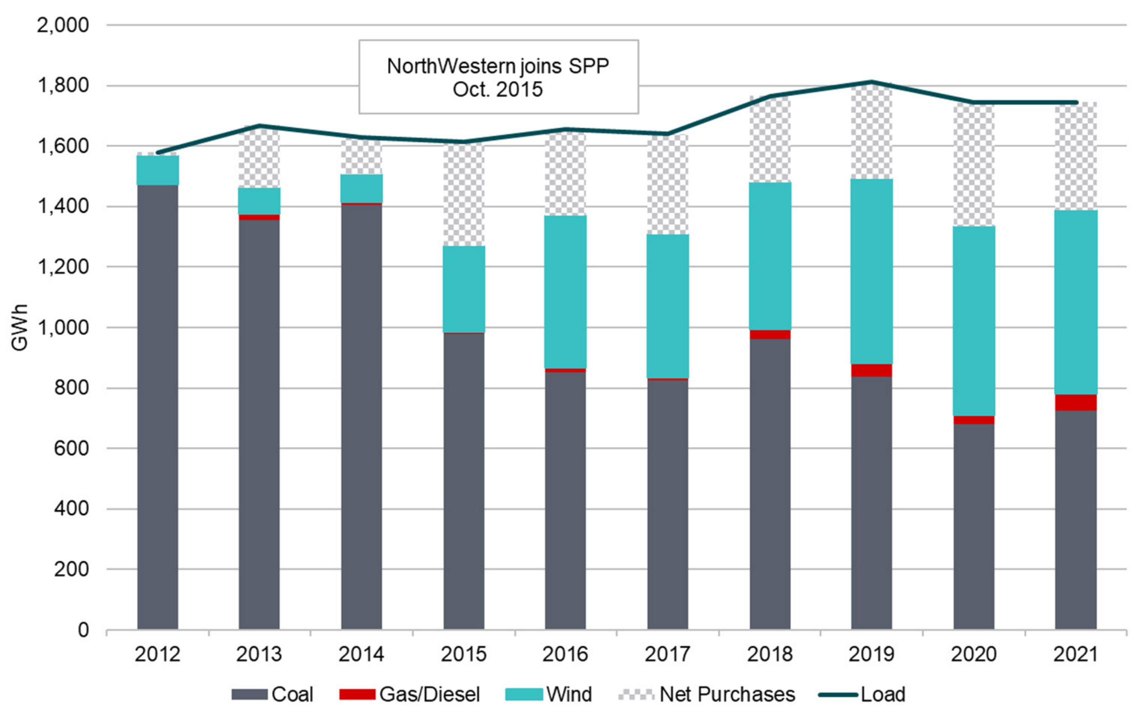
3.2. Energy Needs

Energy is the total amount of electricity that customers use in a given time period and is commonly measured hourly, monthly, daily, or annually. It is typically measured in megawatt-hours (MWh) or gigawatt hours (GWh). In 2021, total energy delivered to NorthWestern's customers was approximately 1,745 GWh, which is 5.2% more than 5 years before.

The figure below shows historic energy production in South Dakota from 2012 – 2021. Approximately 44% of NWE's 2021 energy in South Dakota was produced by a carbon free generation source. While coal still provided over 50% of energy for NorthWestern Energy's South Dakota system, it is a significant decrease from 2018 where it provided over 60%.

While the figure shows the annual production of each resource and a "Net Purchases" piece of each bar, it is important to note that NorthWestern simultaneously sells all MW produced by its generation to the market, and purchases what is required to fulfill load requirements. This allows NorthWestern to purchase the lowest-cost power to serve its load, and to operate its generation fleet only when production costs are in the money, increasing the net benefit of its market participation. All participants in the SPP operate in a similar manner. This structure is beneficial as it allows utilities to more easily sell excess energy and to purchase energy to fill an hour where they may have a need.

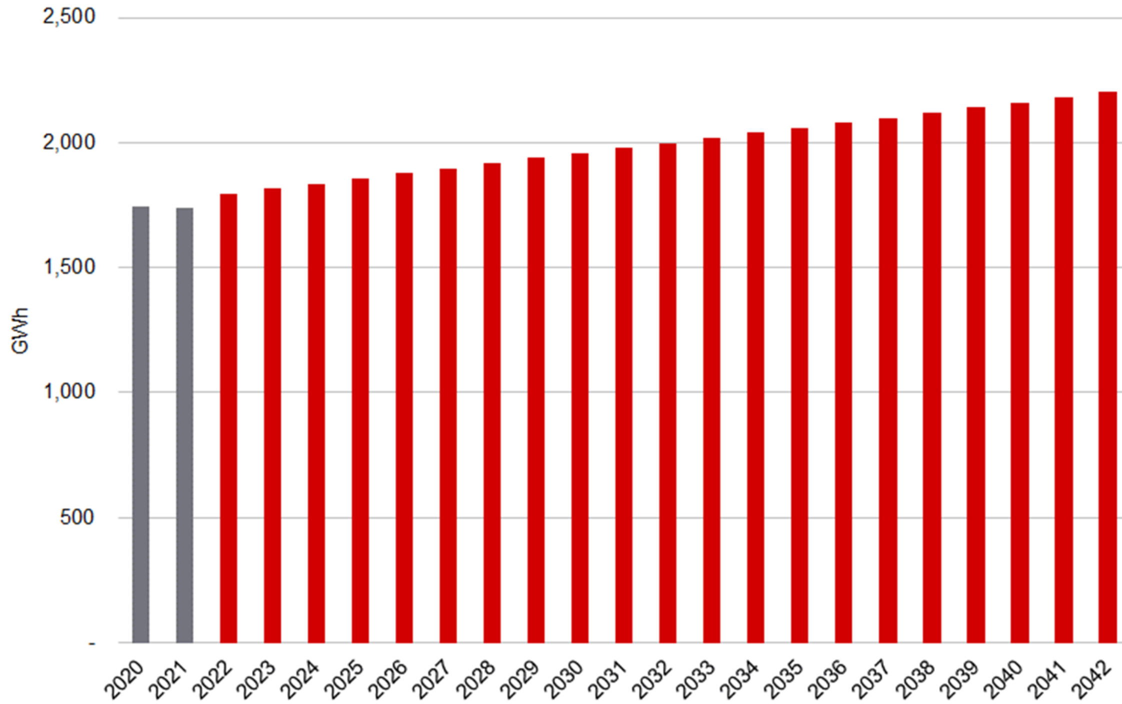
Figure 19: Historic Energy Production



3.2.1. Energy Forecast

The total annual energy used by NorthWestern's customers has grown steadily over the last twenty years, increasing from approximately 1,745 GWh in 2020 to 1,746 GWh in 2021. Starting with 2022, energy usage is forecasted to increase at an average rate of 1% for the next twenty years. Figure 20 below reflects this anticipated continued growth in residential consumption and the commercial sector. The bars represent the forecast used in our portfolio modeling (see Chapter 7) that includes all historical load plus known, new industrial customer loads. Energy requirements for 2042 are expected to exceed 2,200 GWh. Unexpected increases or decreases in industry activity or energy conservation within NorthWestern's territory could significantly affect future energy requirements.

Figure 20: **Forecast Total Annual Energy**



3.3. Advanced Metering Infrastructure (AMI)

Since the publication of the 2020 IRP, AMI meters have been deployed for all NorthWestern customers in South Dakota and Nebraska. Along with prior improvements to communications networks and data management, these meters allow NorthWestern to provide improved reliability, power quality, and customer response. AMI implementation is expected to reduce metering related net expenses providing additional value to customers by allowing us to deploy important resources elsewhere in the system. From a load forecasting perspective, AMI has the potential to allow us to better understand customer load at a more granular level and to be able to separate electric usage by customer classes. NorthWestern is currently in the data collection process, but plans to begin analyzing the data as soon as the company has access to an adequate amount of historic data.

4. NorthWestern's Generation Resource Portfolio

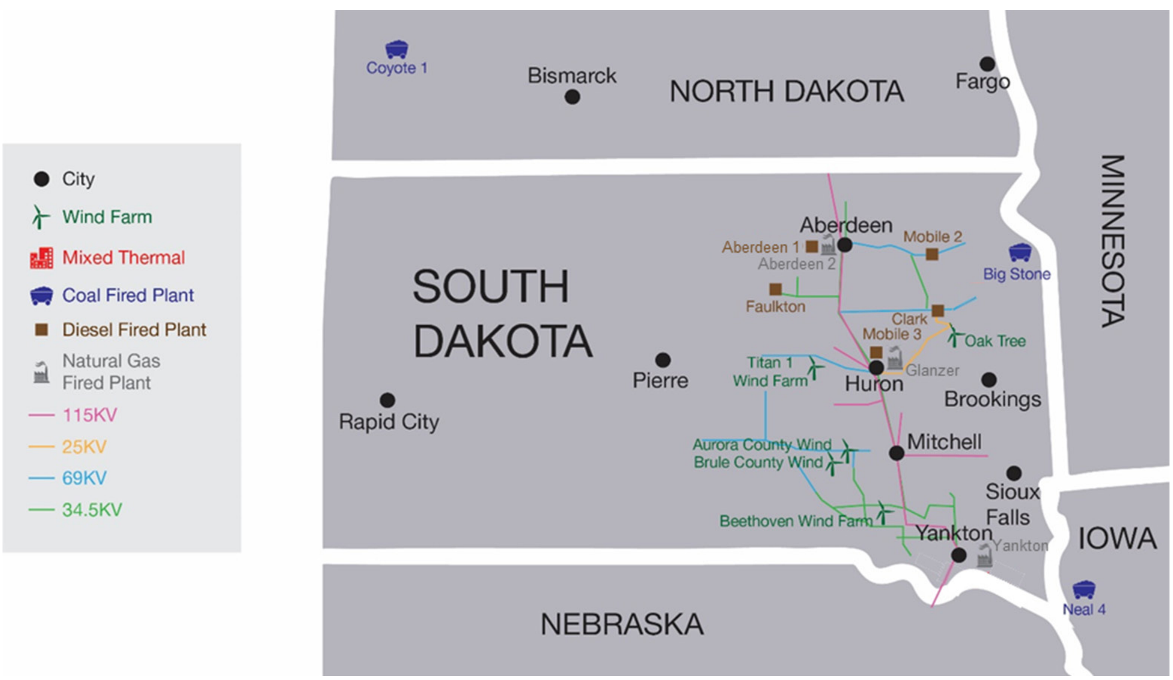
At a conceptual level, all South Dakota generation is sold into the SPP Market, and NorthWestern "buys" all energy to meet its daily load. The net of these two activities is charged (or credited) to NorthWestern. From a physical perspective, the generators used to serve load in South Dakota are bid into the SPP day-ahead market. SPP selects and dispatches units to meet forecast load based on their cost to operate, as defined and reported by generator owners. SPP will continue to dispatch the least expensive unit to meet load, followed by the next least expensive unit, and so on. This generally tends to mean that units with the lowest operational costs, like VERs, will be dispatched first. However, it is important to note that VER generation expectations are based off forecasted values which are merely predictions. For NWE, the next units to dispatch are the lower cost baseload coal Joint Owned Units (JOUS; save for Neal 4, discussed further in Section 4.1). On a real time basis, any deviation between load and committed or forecast generation is either filled by physically dispatching a unit that can ramp to meet the difference, or by making market purchases. Again, the market selects the lowest cost available resource to meet load.

4.1. Current Generation Portfolio and Fuel Mix

NorthWestern's current resource portfolio includes coal, natural gas, wind, power purchase agreements (PPA's) with qualifying facilities (QF's), and other capacity contracts. Taken altogether, the nameplate capacity of our portfolio is 591 MW, and the peaking capacity is 408 MW. In 2021, wind energy was used to serve 34.8% of total customer load requirements.

The figure below shows a map of the current resources in NorthWestern's portfolio that serve South Dakota customers. Resource specific information can be found in later sections of this chapter.

Figure 21: Map of Generating Units



4.1.1. Dispatchable Generation

NorthWestern's portfolio consists of a number of peaking units made up of reciprocating internal combustion engine (RICE) and simple cycle combustion turbine (CT) units. They have a combined summer peaking capacity of 92.4 MW. These units range in age from 2 to 52 years with many over 40 years old. NorthWestern recently placed the Bob Glanzer station, a RICE peaking plant, into service; it is expected to supply an additional 55.7 MW of summer peaking capacity. The smaller RICE peaking units (Clark, Faulkton, Yankton, Mobile B, and Mobile C) either rely on natural gas and diesel fuel or diesel fuel alone.

Capital and O&M costs for large resources currently found on NorthWestern's system are shown below. No capital costs are expected at the new Glanzer Generating Station over the next few years.

Figure 22: O&M Costs

O&M ($1,000)	2020	2021	2022	2023	2024	2027
BGGS	$ 1,480	$ 2,000	$ 2,040	$ 2,081	$ 2,122	$ 2,165
Aberdeen 1	$ 101	$ 103	$ 105	$ 107	$ 109	$ 111
Aberdeen 2	$ 1,432	$ 1,461	$ 1,490	$ 1,520	$ 1,550	$ 1,581

Figure 23: Capital Costs

Capital ($1,000)	2022	2023	2024	2025	2026	2027
Aberdeen 2	$ 50	$ 3,000	$ 1,200	$ -	$ -	$ -

NorthWestern shares ownership of three jointly owned coal fired units (JOUs): Big Stone Unit 1, Coyote Station Unit 1, and George Neal Generating Station Unit 4. Participation in JOUs requires that all parties coordinate decisions about the plant's operation and maintenance on an ongoing basis. This coordination can be challenging as each party has different business objectives and planning constraints that they advocate. The figure below shows the ownership of each JOU.

Figure 24: Ownership of JOU's

Joint-Owned Units		Big Stone	Coyote	Neal 4
Type	-	Cyclone	Cyclone	Pulverized
COD	Year	1975	1981	1979
Fuel	-	Coal	Coal	Coal
Capacity (Nameplate)	MW	474.0	427.0	644.0
Heat Rate	Btu/kWh - HHV	10,739	11,077	9,949
NorthWestern Ownership (SPP)	MW	111.0	42.7	56.0
	%	23.4%	10.00%	8.70%
Other Party Ownership (Organized Market)	%	Otter Tail Power 53.9% (MISO)	Otter Tail Power 35% (MISO)	MidAmerican Energy 36.6% (MISO)
	%	Montana-Dakota Utilities Co 22.7% (MISO)	Northern Municipal Power Agency 30% (MISO)	Interstate Power and Light 25.7% (MISO)
	%		Montana-Dakota Utilities Co 25% (MISO)	Corn Belt Power Co-op 8.7% (MISO)
	%			Other Fractional Owners (12), < 5 %

A major point of discussion at present is the early retirement of coal facilities. While NorthWestern supports the goal of a cleaner energy future, the present landscape is not conducive to early coal retirements. These facilities are particularly important to help NorthWestern get through severe weather events and times when other generating resources are not in operation.

4.1.2. Weather-driven Generation

NorthWestern owns the 80 MW Beethoven wind farm and also receives wind energy through four power purchase agreements (PPAs) in South Dakota. NorthWestern's 80 MW Beethoven wind farm generates an average of 301 GWh annually and contributes 17.72 MW of planning capacity. Beethoven consists of 43, 1.8 MW GE turbines that are maintained under a full service agreement with General Electric.

4.2. Future Resource Outlook

NorthWestern's portfolio consists of aging generation units that are facing imminent retirements. As mentioned throughout this plan, these resources are critical to maintaining capacity requirements as determined by SPP and will require replacements. This section discusses operational characteristics, but additional information regarding environmental impacts and State Implementation Plan (SIP) / Federal Implementation Plan (FIP) status can be found in Chapter 5.

4.2.1. Big Stone

Northwestern owns 23.4% of the Big Stone Plant (Big Stone), which is a 475 MW JOU operated by Otter Tail Power Company. NorthWestern is the only owner who is a SPP participant (the others operate in Midcontinent Independent System Operator (MISO)). Big Stone is a coal fired, cyclone burner, non scrubbed base load plant that was placed in service in 1975. The fuel source is Powder River Basin sub bituminous coal delivered by Burlington Northern Santa Fe Railway Company.

NorthWestern's current contractual commitment for the Big Stone facility requires a 5 year notice prior to termination. In addition to the partial ownership of Unit 1, NorthWestern owns approximately 300 kW of diesel RICE capacity from the station.

4.2.2. Coyote Station (Coyote)

The Coyote Station began commercial operations in 1981. NorthWestern is one of four joint owners of the plant and the only owner in SPP. (The remaining owners operate in MISO.) Coyote is a coal-fired, cyclone-burner, dry-scrubbed baseload plant with a total plant rating of 427 MW. NorthWestern's ownership share is 10% or 42.7 MW. The plant is fueled by North Dakota lignite, which is obtained from an adjacent coal mine owned by a subsidiary of the North American Coal Company. NorthWestern is party to a long-term coal supply contract for the Coyote Station that carries significant penalties for early termination.

Coyote Station's operations and future plans are currently under review. Otter Tail Power Company's Application for Resource Plan Approval 2022–2036[10] discusses its desire to withdraw from its ownership interest in Coyote Station by 2028. Facility owners are reviewing options and will analyze scenarios after those options are defined. Additional information may be provided as it becomes available.

4.2.3. George Neal Unit 4 (Neal 4)

George Neal 4 is a 646-MW pulverized sub-bituminous coal, non-scrubbed baseload plant and was placed into service in 1979. It is jointly owned by 14 entities, with NorthWestern owning an 8.7% interest. NorthWestern is the only owner of a significant plant share who is in SPP. (All other major owners operate in MISO.) MidAmerican Energy Company is the principal owner and operating agent for the plant. The fuel source for George Neal 4 is Powder River Basin sub-bituminous coal delivered by the Union Pacific Railroad.

The operating agreement for George Neal 4 is effective through 2014 "or so long after as Unit 4 shall be used or useful for the generation of electric power." NorthWestern has concerns with MidAmerican's operating decisions. Given that the major owners are in MISO, MidAmerican dispatches the plant based on the MISO market rather than allowing NorthWestern the right to call upon generation up to its ownership share. NorthWestern has attempted to resolve this issue through discussions with MidAmerican. NorthWestern will continue to pursue resolution.

---

[10] See Otter Tail's Application for Resource Plan Approval 2022-2036 https://www.otpco.com/media/3646/irp_application-for-resource-plan-approval.pdf

4.2.4. Glanzer Station Update

As described in the 2020 IRP, there was a fire at Huron in January 2019 that resulted in a total loss of the 43 MW Huron 2 Generating Station. Building the replacement for Huron 2 began in 2020 and was completed this year. The facility is now online and operational. Huron 1 was due for replacement as it is the oldest unit in the portfolio. It has been retired since Glanzer became operational. At the time of this Plan, Glanzer is an energy-only dispatch unit. However, by the end of 2022, Glanzer will be configured to offer all applicable ancillary services, including contingency reserves, regulation and Fast Start. It is anticipated to be selected by the market frequently, due to its quick start capability and flexibility.

4.2.5. Aberdeen 1

AGS1 is a 28.8 MW diesel oil fueled CT that is restricted in its capabilities because of its age. It has a low historical availability and has one of the highest heat rates. Because of the age of the machine and limited support from the original equipment manufacturer (OEM), replacement parts are often reverse engineered and custom manufactured. NorthWestern is concerned about growing challenges with obtaining replacement parts. While AGS1 is bid into the SPP market, it is rarely called on for economic dispatch. AGS1 is typically only operated for testing or in emergencies and has further reduced operation since AGS2 came online in 2013. NorthWestern may consider AGS1 as a candidate in future retirement and replacement evaluations. If AGS1 is retired, replacement capacity would likely be required on a MW for MW basis to support voltage regulation in the immediate vicinity.

Figure 25: Aberdeen 1 Characteristics

Aberdeen Generating Station		AGS1
Type	-	CTG
Make	-	GE
Model	-	MW5001
COD	Year	1978
Fuel	-	Fuel Oil
Capacity (Nameplate)	MW	28.8
Heat Rate	BTU/kWh - HHV	13,500

NorthWestern planned to replace AGS1 with one of the resources that bid into the 2019 RFP. However, we have seen an extreme increase in material and labor costs as well as a severe supply chain shortage over the past year, making any of these projects unfeasible at this time. The choice to forego the replacement of AGS1 with a resource submitted in the 2019 IRP was made to help protect customers from incurring uncharacteristically high costs to procure a new resource. NorthWestern believes that market activity will settle, supply chain issues will resolve, and prices will normalize allowing an RFP to be released in the near term. AGS1 will be heavily considered, along with Yankton, as a candidate for replacement. One scenario for review by NorthWestern is the replacement of AGS1 and Yankton concurrently as it may be more economical to replace the facilities together. See Chapter 8 for additional information on the next potential RFP.

4.2.6. Aberdeen 2

Since AGS2 was placed into service, most of the operating hours for the dual fuel unit have been on natural gas. AGS2 is a relatively new 82.2 MW combustion turbine. However, emissions permits for the Aberdeen location are based on both units. Therefore, AGS2 faces constraints as a result of AGS1.

Figure 26: Aberdeen 2 Characteristics

Aberdeen Generating Station		AGS2
Type	-	CTG
Make	-	Pratt & Whitney
Model	-	FT8-3
COD	Year	2013
Fuel	-	Dual Fuel
Capacity (Nameplate)	MW	82.2
Heat Rate	BTU/kWh - HHV	9,420

Based on the vintage of the unit, historical reliability, and relatively low cost to generate power, AGS2 would not be suitable for retirement at this time. However, there are opportunities to optimize operating capability and cost-effectiveness going forward (i.e., addition of an on-site water treatment facility, removal of air operating permit dispatch limitations, etc.) that could increase its economic dispatch in both the energy and ancillary services markets.

AGS2 has an annual dispatch limitation given that all assets on the site are covered under the same air permit. The air permit for AGS2 is based on the unit heat input and a rolling number of unit starts and stops for each 12-month period. Ideally, NorthWestern would not have any dispatch limitations on AGS2 given that it is currently the most cost-effective thermal unit in the South Dakota fleet. NorthWestern filed to extend its permit on AGS1 as a part of normal operations and has recently filed for increased dispatch of AGS2. Increased starts will better allow NorthWestern to optimize its operations at Aberdeen.

4.2.7. Mobile Units

NorthWestern has a number of diesel fired mobile reciprocating engine (RICE) units in its portfolio. These mobile units provide system redundancy during transmission outages or system maintenance. In addition to supporting system reliability events, capacity from the mobile generators is used to meet the 12% PRM requirement in SPP. If there is a reliability event in the area over the summer season (June 1st through September 30th), these generators can be and are commonly called by SPP for load support. As part of the PRM requirement, NorthWestern needs to have these generators connected at a point of interconnection (POI), and ready to support any directive from SPP from June 1st through September 30th. The Aberdeen Siebrecht Substation and the Yankton Northwest Substation have been designated as the two locations to store and interconnect these units starting June 1st. Per the SPP Business Practices, NorthWestern has a 5 MW injection threshold at a POI that, when met, triggers an SPP Generation Interconnection Study. NorthWestern only interconnects four generators at each of these two substations to stay below the 5 MW threshold.

NorthWestern plans to continue evaluation and development of fixed pads around its system. Fixed pads are not required to deploy a mobile unit, but do make it easier to connect. This ease of connection would allow NorthWestern to respond more quickly in an outage scenario.

4.2.8. Clark and Faulkton

The Clark and Faulkton units are small 2.8 MW Fairbanks Morse RICE units installed in 1970 and 1969, respectively. Initially, NorthWestern planned to retire these facilities when the mobile units were placed in service. However, due to the fire at Huron and Yankton's continued outage state (which is expected to continue in the foreseeable future), Clark and Faulkton are still maintained in the portfolio.

The units are fueled by diesel and used strictly for back up service during transmission outages. Due to the age of the Clark and Faulkton engines, maintenance is becoming more difficult and costly. Replacement parts are not available and must be fabricated, and there are only a few people available with the technical/mechanical knowledge to work on the engines and associated equipment.

While Clark has been generally reliable, the building housing the engine is in poor condition. If the Clark plant were to remain in service on a long term basis, additional capital would be required for upgrades and repairs.

Clark and Faulkton may be evaluated for retirement at some point over the next few years. Once retired, some of NorthWestern's mobile units can be moved to fill in the generation need. There are direct connections that the mobiles can use to establish a connection with the transmission system. This means, there will be minimal time between removing Clark and Faulkton from service and getting replacement mobiles in place.

4.2.9. Yankton

The Yankton Generating Station (YGS) has four reciprocating internal combustion engine (RICE) units totaling 13.6 MW. None of the four units are currently operational and each is in an outage state. This facility may not come back online prior to retirement as it would require a substantial amount of time and money to ensure it is a safe, operable resource.

When operational, YGS receives natural gas from a radial tap off of the Northern Natural Gas (NNG) system. The Yankton area has limited access to natural gas supply due to pipeline infrastructure constraints on the Northern Natural Gas (NNG) system. Considering these constraints, the age of the units, the cost to bring YGS back into reliable operation and to maintain/operate the units relative to the amount of generation they provide, NorthWestern has made the decision to not complete repairs. If necessary, NorthWestern will rely on delivered capacity under its short term market contract to mitigate any capacity shortfall. Further planning in 2022 will determine the final retirement date for the facility.

4.3. New Resource Options

The 2022 plan considers different combinations of thermal, storage, nuclear, wind, and solar resources as potential additions to the portfolio. These resources were analyzed using portfolios of interest defined by NorthWestern (see discussion in Chapter 7).

4.3.1. Thermal Resource Options

SC Aero CT

Two simple cycle aeroderivative combustion turbine (Aero CT) technology sizes, nominally 30 MW and 53 MW, were considered as potential resource options in this IRP. When directly compared with industrial frame CTs, Aero CTs are lighter weight, have a smaller size footprint, and are made of more advanced, lightweight materials, because the design is adopted from aerospace designs for use in power applications. Due to this, Aero CTs can handle a greater number of starts and stops during their lifecycle.

Aero CTs require a higher gas pressure to operate making it difficult or costly to site. The effective heat rate of CT units increases significantly as the unit is dispatched at lower output levels below maximum capability and may not be able to run effectively below 50% capacity.

SC Reciprocating Internal Combustion Engine (RICE)

A simple cycle RICE facility is evaluated as a potential future resource in this IRP. RICE units are internal combustion engines, and are a larger version of an automobile engine. Similar to simple cycle CT plants, simple cycle RICE installations are used to supply peaking power and to operate in load following scenarios. RICE technology is favorable for peaking applications due to its wide range of operability and rapid response capability. Generally, in utility power generation applications, RICE technology is smaller in scale and has better efficiency as compared to simple cycle CT technology.

4.3.2. Storage Resource Options

NorthWestern considers a Battery Energy Storage System (BESS) as a potential future storage resource in this IRP. Utility-scale energy storage systems deployment is poised to continue to grow in the US.[11] BESS technology is useful in the following applications:

- meet normal demand
- help minimize peak demand
- smooth load variations due to renewables integration
- improve local grid resilience and availability
- provide ancillary services.

BESS can be comprised of many technologies, but this plan models the most common, which is a 4-hour lithium-ion (Li-ion) battery. Li-ion batteries provide a high energy storage density that has resulted in adoption across the transportation, technology and power generation markets Due to its characteristics, Li-ion technology is well suited for fast-response applications like frequency regulation, frequency response, and short-term spinning reserve.

An important consideration of BESS is round trip energy efficiency, which is the amount of AC energy the system can deliver relative to the amount of AC energy used by the system during the preceding charge. Losses experienced in the charge/discharge cycle include those from the PCS (inverters), heating and ventilation, control system, and auxiliary systems. Li-ion technology experiences degradation both in terms of capacity and round-trip efficiency with time due to a variety of factors including number of full charge/discharge cycles and environmental exposure.

[11] See EIA's Today in Energy https://www.eia.gov/todayinenergy/detail.php?id=49236#:~:text=U.S.%20large%2Dscale%20battery%20storage,rapid%20growth%20set%20to%20continue.

Batteries are housed within shipping containers for protection against the elements. The containers house battery racks that hold individual battery cells. This allows for the replacement of individual components.

In addition to stand alone storage options, batteries can also be paired with a wind or solar resources to create a hybrid project. It is beneficial to pair these technologies together because it allows for the shift in energy from lower need hours to peak load hours. In general, the battery is connected to the VER resource that is used to charge the battery. The battery is then dispatched to market and load signals. Some configurations allow for the battery to be charged from both a VER and the grid while others only allow charging from the VER.

The configuration and sizing of hybrids varies vastly making it difficult to model a representative hybrid resource. In addition, evaluating these as stand-alone resources allows for more flexibility in the battery's dispatch under SPP price signals, and potentially more value to NorthWestern from an energy arbitrage perspective, than being constrained to charging from a VER. In this IRP, NorthWestern chose to model a number of portfolios that include both stand-alone battery and stand-alone VER resources. The intent is to demonstrate how these resources would provide value from an energy supply perspective.

Utility scale battery disposal is an ongoing question that is still being explored at the time of this IRP's publication. According to the "National Blueprint for Lithium Batteries", major goals include the development of a recycling program. The document states that near-term objectives, with a target implementation date of 2025, include developing sorting and processing methodologies, creating technologies that allow for the re-introduction of materials to the supply chain, and implementing federal incentives to promote battery recycling.[12] NorthWestern will continue to monitor the development of battery disposal techniques.

4.3.3. Nuclear Resource Options

Small Modular Reactors (SMRs) are becoming a realistic energy producing technology capable of providing reliable, safe, and carbon-free power. There are numerous SMR designs utilizing different technologies, with the most advanced and safest being those that fall under Generation III and IV designs. Since the publication of the 2020 IRP, the development of Generation III and IV SMRs has advanced quickly, with numerous countries deploying their own designs. In the U.S. designs including X-Energy, TerraPower, and NuScale have been leading the way for SMR development.

As an example, NuScale has successfully created partnerships with many different entities including the Department of Energy. These partnerships have led to participation in Utah Associated Municipal Power Systems' (UAMPS) Carbon Free Power Project (CFPP). Part of this project will include siting a NuScale 12-module reference plant in Idaho. This plant is expected to reach COD in 2027.[13]

X-Energy is working to deploy its first reactor through the Department of Energy's Advanced Reactor Demonstration Program in 2027. As part of this process, X-Energy and other participants must secure Nuclear Regulatory Commission (NRC) licensing approval for their designs.

Many Generation III and Generation IV reactors do not require safety level electrical power, active systems, or operator action to keep the public safe. The NRC provides additional information on many topics, including safety of these reactors.[14] There are a number of sources The SMR modeled in this plan is 1 reactor facility that can ramp up or down between 40 and 100 percent power in increments of 5 percent per minute. This resource can be easily scaled to a 320 MW (4 reactor) plant depending on system needs.[15]

---

[12] See the National Blueprint for Lithium Batteries 2021–2030 https://www.energy.gov/sites/default/files/2021-06/FCAB%20National%20Blueprint%20Lithium%20Batteries%200621_0.pdf

[13] See NuScale's DOE Partnership https://www.nuscalepower.com/about-us/doe-partnership.

[14] See the U.S. NRC website Advanced Reactors (non-LWR Designs) | NRC.gov

[15] See the Advanced Nuclear Power Reactors page https://world-nuclear.org/information-library/nuclear-fuel-cycle/nuclear-power-reactors/advanced-nuclear-power-reactors.aspx.

Small SMR's, like the Xe-100, significantly minimize environmental impact. The Xe-100 Standard Plant 4-reactor modules operate on a site footprint of only 27 acres, reducing its land-use impact compared to other energy sources. All spent fuel will be stored on-site in air-cooled dry storage casks in a below-ground storage vault. This disposal method is extremely safe in the interim until long-term storage is developed by the federal government. Permanent storage options will be made final as part of the NRC decommissioning plan. Once the plant reaches its end of life, the detailed decommissioning plan will be implemented. The site will be dismantled and restored to "greenfield" status in accordance with the most current regulations, codes and standards.

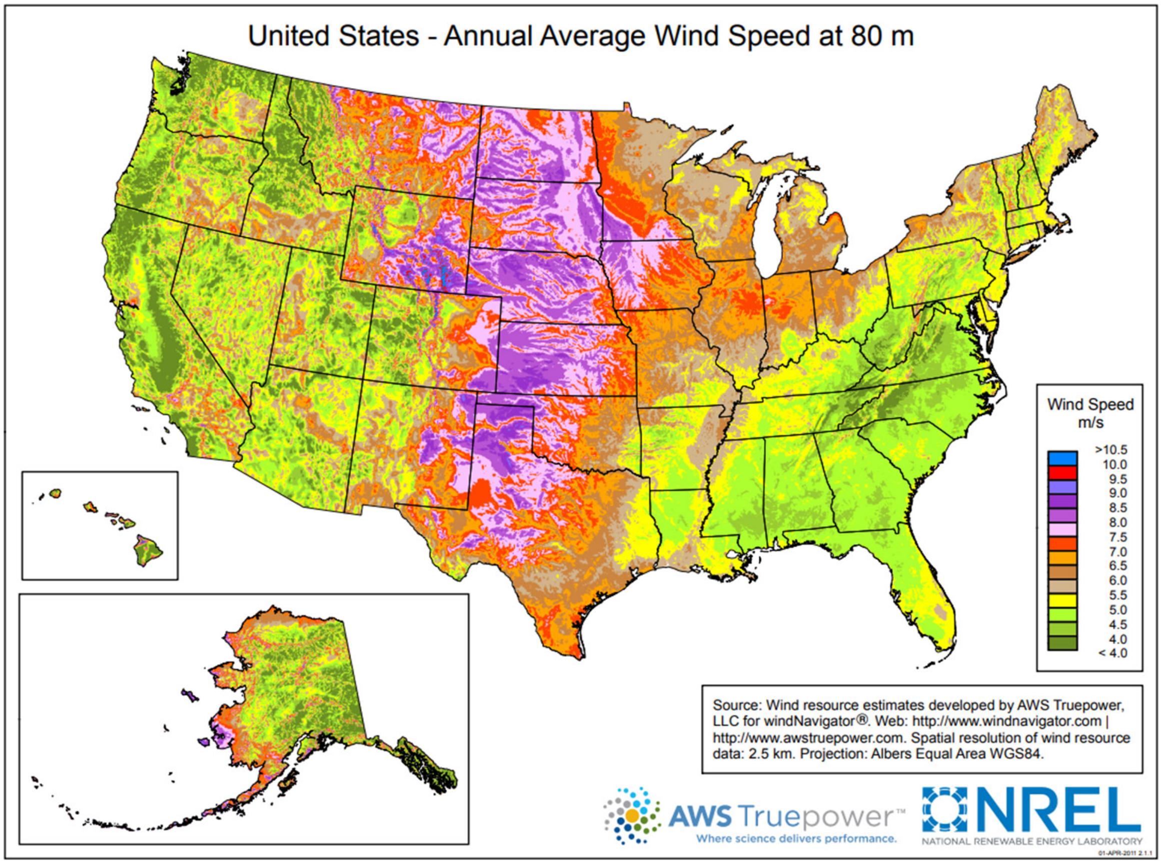
Figure 27: X-Energy Site Overview (4-Pack, 320 MWe)

4.3.4. Wind Resource Options

As discussed in the chapter on SPP, installation of wind generation in the US has grown considerably in recent years and is expected to continue; therefore, wind is included as a potential resource in this IRP. Generally, the costs of building new wind resources are decreasing and the size of wind farms is increasing, even though production tax credits (PTCs) are expiring. The PTC period began for projects installed in 2016, and the benefit has reduced over time. The last effective year was extended from 2020 to 2021. Wind project construction must have commenced by December 31, 2021 to receive PTCs. The PTC rates for 2021 and 2022 are 2.5 cents per kilowatt hour and 2.6 cents per kilowatt hour, respectively.

Wind turbines can be designed for sizes between1.5 – 5 MWs. Capacity is based on blade length. Longer blades require a taller turbine installation. Wind availability in much of South Dakota is favorable. The figure below shows wind speeds across the United States.

Figure 28: United States Average Wind Speeds[16]



While wind farm growth is expected to continue into the future, it is important to acknowledge that wind turbine blades cannot be recycled. Blades are large, durable pieces of fiberglass that are challenging to cut, bend, or otherwise repurpose. According to an article published by Bloomberg, many spent blades are currently being disposed of in landfills. That said, the article mentions that a start-up company, Global Fiberglass Solutions, has created a method to repurpose the fiberglass turbines. While this is a step in the right direction, until the business is able to substantially scale up operations, or others are able to adopt their methods, recycling will not be readily available for spent blades.[17]

4.3.5. Solar Resource Options

NorthWestern evaluates a solar facility as a potential resource in this IRP. Solar PV technology uses photovoltaic cell (PV) arrays to convert light from the sun directly into electricity. PV cells are made of different semiconductor materials and come in many sizes, shapes, and ratings. Solar cells produce direct current (DC) electricity and require a DC to alternating current (AC) converter to allow for grid connected installations. Solar PV arrays are mounted on structures that can either tilt the PV array at a fixed angle or incorporate tracking mechanisms that automatically move the panels to follow the sun across the sky. The fixed angle is determined by local latitude, orientation of the structure, and electrical load requirements. Tracking systems provide more energy production. Single-axis trackers are designed to track the sun from east to west and dual axis trackers allow for modules to remain pointed directly at the sun throughout the day.

[16] See U.S. Average Annual Wind Speed at 80 Meters https://windexchange.energy.gov/maps-data/319.

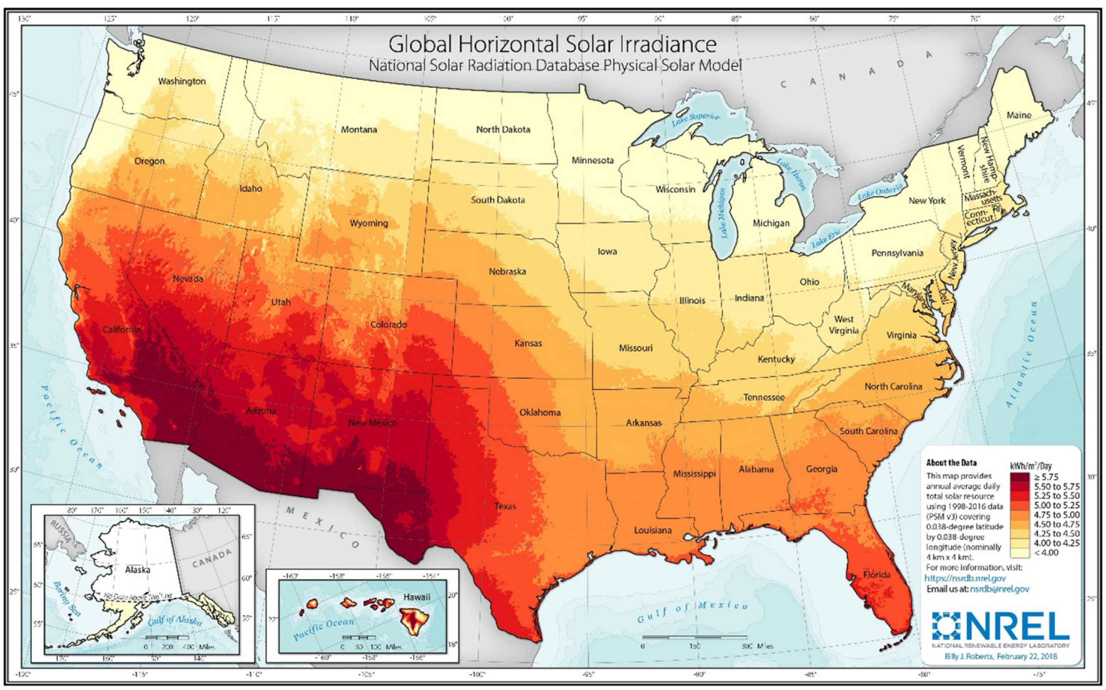
[17] See Bloomberg's Gr Wind Turbine Blades Can't Be Recycled, So They're Piling Up in Landfills article https://www.bloomberg.com/news/features/2020-02-05/wind-turbine-blades-can-t-be-recycled-so-they-re-piling-up-in-landfills.

The Federal Investment Tax Credit (ITC) provides a tax credit for the investment cost of solar systems and has been instrumental in supporting the growth of solar energy in the US. The eligible ITC percentage scales down over time as follows:

- 30% tax credit for projects commencing construction between January 1, 2006, and December 31, 2019, but placed in service before 2026.
- 26% tax credit for projects commencing construction between January 1, 2020, and December 31, 2022, but placed in service before 2026.
- 22% tax credit for projects commencing construction between January 1, 2023, and December 31, 2023, but placed in service before 2026.
- 10% tax credit for projects commencing construction after December 31, 2023, or placed in service after December 31, 2025.

The major components of a PV system include the PV modules/arrays, DC to AC converters/inverters, and mounting structures. An average capacity factor range for a solar power facility is typically in the range of 10 to 30 percent, with annual averages around 25 percent depending upon solar resources within the region. The estimated average annual capacity factor for the South Dakota site was estimated using NREL's PVSyst program, and determined to be approximately 24%. The figure below shows the solar irradiance across the United States.

Figure 29: Solar Irradiance across the United States[18]



While solar projects are on the rise, some may face disruptions due to the Department of Commerce's (DOC) investigation into tariff evasion.[19] NorthWestern will continue to monitor the investigation and its impact on potential future projects.

Similar to battery storage, nuclear, and wind facilities, there are questions surrounding the disposal methods for solar projects once they reach end of life. Many materials in a solar panel can be recycled, but panels also contain components such as valuable or toxic metals and critical materials that are not recyclable. The EPA notes that while recycling practices are currently being developed, none are available on a large scale.[20]

---

[18] See NREL's Solar Resource Maps and Data https://www.nrel.gov/gis/solar-resource-maps.html.

[19] See McGuireWoods U.S. Department of Commerce Investigation of Solar Panel Imports Puts Solar Projects at Risk article https://www.mcguirewoods.com/client-resources/Alerts/2022/4/us-department-commerce-investigation-solar-panel-imports-puts-solar-projects-risk.

[20] See the EPA's Solar Panel Recycling page https://www.epa.gov/hw/solar-panel-recycling#How%20Solar%20Panels%20are%20Recycled.

4.3.6. Hydrogen

Hydrogen resources are not modeled in this IRP; however, as an emerging technology, it is important to mention its future potential. Clean hydrogen is expected to have a greater contribution in meeting the total energy demand by 2050. There are a number of different types of hydrogen presented in the figure below.[21]

Figure 30: Types of Hydrogen[22]

Hydrogen Colors	Production Process
Green Hydrogen	Electrolysis of water using clean electricity from renewable energy sources.
Blue Hydrogen	Steam reforming of natural gas using CSS technology
Grey Hydrogen	Steam reforming of natural gas without CSS technology
Black and Brown Hydrogen	Steam reforming of black or brown coals
Pink Hydrogen	Water electrolysis using nuclear energy
Turquoise Hydrogen	Methane pyrolysis
Yellow Hydrogen	Electrolysis using solar power
Red Hydrogen	High-temperature catalytic process using nuclear power
White Hydrogen	Naturally occurring Hydrogen

One potential use of hydrogen is to blend concentrated hydrogen with natural gas. Blending the two essentially dilutes the methane content of the natural gas leading to fewer carbon emissions.[23] While this blending technique is still in its infancy, NorthWestern plans to continue to monitor its development and potential use in future applications.

There are also a number of hydrogen projects across North America that are under construction and are expected to come online in the near future. Many of these projects utilize polymer electrolyte membrane (PEM) electrolysis to create energy.[24] Essentially, these projects use water, a positively charged electrode, and a negatively charged electrode to create a reaction that produces hydrogen gas, oxygen, heat, and (most importantly) electricity.[25]

According to the Office of Energy Efficiency and Renewable Energy, while this technology will likely have a place in energy production in the future, it is important to be mindful that this type of resource requires a large amount of energy to operate. It is expected that hydrogen facilities may play a role in shifting energy produced by intermittent resources, like wind farms.[26] NorthWestern will continue to monitor hydrogen's development and feasibility as a future resource.

[21] See Morgan Stanley's Could Green Hydrogen Fuel a Reduced Carbon World? Article https://www.morganstanley.com/ideas/green-hydrogen-economy.

[22] See the Color of Hydrogen article https://whatispiping.com/colors-of-hydrogen/.

[23] See the FCHEA's Hydrogen Blending page https://www.fchea.org/transitions/2021/3/8/hydrogen-blending.

[24] See the Clean Energy Group's Hydrogen Projects in the US page https://www.cleanegroup.org/ceg-projects/hydrogen/projects-in-the-us/.

[25] See The Office of Energy Efficiency & Renewable Energy's Fuel Cell Basics https://www.energy.gov/eere/fuelcells/fuel-cell-basics.

[26] See The Office of Energy Efficiency & Renewable Energy's Hydrogen Production: Electrolysis https://www.energy.gov/eere/fuelcells/hydrogen-production-electrolysis.

4.4. Location Reliability

In general, NorthWestern's customer needs are met by SPP's coordination of regional generation assets and dispatch of said assets to economically serve load. However, disruptions can occur from equipment outages, which are often caused by harsh weather conditions such as ice storms or tornadoes. It is critically important that NorthWestern avoid service disruptions. To combat potential outage scenarios, NorthWestern manages reliability at the local distribution system level. The use of mobile generation units is critical to meet this distribution level need.

5. Environmental Responsibilities

NorthWestern Energy provides affordable, reliable and safe energy services while responsibly managing the natural resources under our stewardship. We support using renewable resources that are consistent with meeting the needs of our portfolio and our commitment to ensure our customers always get the energy they need in all weather conditions. Our commitment to environmental stewardship and compliance affects all facets of our business, including our resource procurement planning. We prepare an annual publication called "Environmental Stewardship: Our Commitment in Action" which is available on our website.[27] We encourage those interested to review this publication.

5.1. Environmental Trends that Influence the 2022 Plan

5.1.1. NorthWestern's Statement of Environmental Policy

NorthWestern Energy's policy is to provide cost-effective, reliable and stably-priced energy while being good stewards of natural resources, complying with all applicable regulations and demonstrating environmental leadership. We apply the following environmental principles in our day-to-day business:

1. Our business practices reflect a respect for, and a commitment to, sustainability and the long term quality of the environment.
2. One of our priorities is being good stewards of natural and cultural resources at our hydroelectric projects.
3. We comply with the spirit as well as the letter of environmental laws and regulations.
4. Environmental issues and impacts are an integral part of our planning, operating and maintenance decisions.
5. We promote our customers' efforts to conserve energy, subject to regulatory approval.
6. We support providing energy through non-carbon emitting and renewable resources when consistent with our statutory requirement to provide cost effective energy.
7. We strive to minimize the generation of wastes and promote the reuse and/or recycling of materials.
8. We seek to continuously improve our environmental compliance and stewardship.
9. We embrace a team culture where positive environmental stewardship and compliance are encouraged.
10. Our contractors and consultants must comply with this policy when working for or representing NorthWestern Energy.

5.2. Regulation of Greenhouse Gas (GHG) Emissions

Regulations covering GHG emissions from new and existing electric generating units demonstrate the impact the Clean Air Act can have on the planning process. Coal-fired generation plants are under particular scrutiny due to their level of GHG emissions.

5.2.1. New Source Performance Standards (NSPS)

Under Section 111(b) of the Clean Air Act, EPA sets New Source Performance Standards for greenhouse gas (GHG) emissions from new, modified, and reconstructed fossil fuel-fired power plants.

In 2015, EPA issued final regulations to limit GHG emissions from new fossil fuel-fired utility boilers and from natural gas-fired stationary combustion turbines.

In 2018, EPA proposed to amend the limits for newly constructed coal-fired units. EPA did not propose to amend the standards of performance for newly constructed or reconstructed stationary combustion turbines. In January 2021, EPA issued a final rule for determining when standards are appropriate for GHG emissions from stationary source categories under Clean Air Act (CAA) section 111(b)(1)(A). EPA did not take final action to revise the 2015 final rule.

---

[27] See NorthWestern's Environmental Stewardship Report http://www.northwesternenergy.com/environment/our-environment.

On March 17, 2021, EPA asked the D.C. Circuit to vacate and remand the "significant contribution" final rule. The rule was promulgated without public notice or opportunity to comment. On April 5, 2021, the D.C. Circuit vacated and remanded the January 2021 final rule therefore the emissions limits in the 2015 rule remain in place today.

EPA's carbon dioxide emissions limit for fossil fuel-fired electric utility steam generating units precludes the construction of any new base load coal-fired plants because the BSER includes carbon capture and storage systems which are not yet ready for commercial use. New base load natural gas combined cycle and simple cycle combustion turbines are also required to meet a CO2 emissions standard. NorthWestern's analyses in this plan factored in consideration of the NSPS for combustion turbines.

5.2.2. Existing Source Performance Standards

Currently, the United States Supreme Court is considering whether or not Section 111(d) of the Clean Air Act limits the BSER to only those measures that can be applied at, and to, an individual source as opposed to shifting generation to other sources with lower greenhouse gas emissions. At the time of writing this Plan, the Court has not yet made a decision in this case. As such, NorthWestern cannot predict the Court's decision or the impacts of the decision on the jointly owned coal plants used to serve our South Dakota customers. No additional costs were modeled in this Plan for potential scenarios associated with the Court's decision. We will continue monitoring the status of the existing source performance standards relating to emissions of greenhouse gases and update our assessment if there are any final decisions prior to preparation of our next SD Plan.

5.2.3. Carbon Costs

Estimated potential future costs associated with the regulation of CO2 emissions from thermal power plants represent one of the risks that NorthWestern considered in its modeling analysis. In the 2014 Plan, NorthWestern accounted for the potential costs resulting from CO2 reduction regulation by including a cost for carbon. The 2016, 2018, and 2020 Plans did not assign a cost to carbon emissions, but noted that carbon is included in the market prices produced by the EIA in its Annual Energy Outlook for the SPP North Reference case. The 2022 Plan treats carbon costs in the same manner as the 2020 Plan.

5.3. Regional Haze

The Regional Haze Rule addresses visibility impairment in Class I areas. Class I areas include national parks and wilderness areas. Facilities built between 1962 and 1977, with emissions in specified quantities that contribute to visibility impairment in Class I areas, are required to install best available retrofit technology (BART) to control emissions.

5.3.1. Big Stone Plant (Big Stone)

Big Stone has been online since 1975 and was BART-eligible. Air dispersion modeling for Big Stone indicated the plant contributed to visibility impairment at Class 1 areas in South Dakota, North Dakota, Michigan and Minnesota. Therefore, Big Stone was required to install and operate BART that was determined by the South Dakota Department of Agriculture and Natural Resources (DANR) to be selective catalytic reduction in conjunction with separated over-fire air for control of nitrogen oxides (NOX), a scrubber for reducing sulfur dioxide (SO2), and a bag-house to control particulate matter. The air quality control system comprised of this equipment was commissioned on December 29, 2015 and is fully operational.

SD DANR's second round Regional Haze State Implementation Plan (SIP) was submitted to EPA in May of 2022. The SD SIP did not include any additional requirements for the Big Stone Plant. Since Big Stone Plant was required to install and operate BART, it is not anticipated that further requirements relative to Regional Haze compliance will be required in the future.

5.3.2. Coyote Station

The Coyote Station has been online since 1981 and was not eligible for Best Available Retrofit Technology (BART) determination. Although the unit was not BART-eligible, the North Dakota Regional Haze State Implementation Plan (SIP) required Coyote to reduce nitrogen oxide (NOX) emissions by July 2018. To satisfy the SIP, separated over-fire air equipment was installed during a spring 2016 planned maintenance outage.

The public comment period on the North Dakota Department of Environmental Quality's (DEQ) draft second-round Regional Haze SIP ended on June 1, 2022. The draft SIP did not include any additional controls for Coyote. The North Dakota DEQ plans to submit a final SIP to the Environmental Protection Agency (EPA) by August 15, 2022. The EPA may take up to 18 months to provide a response to the DEQ's second-round SIP and may not agree with the DEQ's analysis. NorthWestern will continue to monitor the North Dakota DEQ SIP and EPA's approval process and will consider the impacts of the EPA's final decision on our South Dakota IRP. NorthWestern acknowledges that any changes related to the EPA's final decision will trigger additional evaluations.

5.3.3. Neal Unit 4

The Iowa Department of Natural Resources (IDNR) is working on a draft second-round Regional Haze SIP. George Neal 4 was not selected for a four-factor analysis, and impacts to the plant resulting from the Regional Haze Rule are not anticipated at this time.

5.4. Mercury and Air Toxics Rule (MATS)

All of the jointly owned coal-fired power plants in our portfolio –Big Stone, Coyote, and Neal 4 – are currently in compliance with the MATS rule. Therefore, we assume subsequent SIPs will contain no additional requirements for material upgrades to any of the plants.

5.5. Coal Combustion Residuals (CCR)

"The Disposal of Coal Combustion Residuals from Electric Generating Utilities" was published in the FR on April 17, 2015. These regulations set forth requirements for the disposal of CCR as non-hazardous waste under the solid waste provisions in subtitle D of the Resource Conservation and Recovery Act. The rule establishes requirements for new and existing CCR landfills and surface impoundments. The requirements also cover groundwater protection, operating criteria, record keeping and notification, and public information posting.

All of the jointly owned coal-fired power plants in our portfolio –Big Stone, Coyote, and Neal 4 – are currently in compliance with the CCR rule.

5.6. Other Environmental Considerations

5.6.1. Renewable Energy Certificates (RECS)

RECs are created for each MWh of energy produced by certain registered generators. RECs are used for compliance with state Renewable Portfolio Standard (RPS) requirements. They are also purchased by corporate parties that are seeking to meet corporate and social environmental goals using certified renewable energy. The REC-eligible facilities in SD are Rolling Thunder and Beethoven. Because RECs are used to meet various statutory and environmental compliance goals, it is necessary to use a third party to validate production data. The South Dakota RECS are registered in the MidWest Renewable Energy Tracking System (MRETS) system for tracking and validation purposes.[28] South Dakota does not have a Renewable Portfolio Standard, although it did have a Renewable Energy Objective (REO) set at 10% by 2015. While this REO requirement is no longer in place, NorthWestern provides updates on our generation mix as requested by the SD PUC.

5.6.2. Wind Generation

In siting the 80 MW Beethoven Wind Farm, the developer and now NorthWestern as the owner/operator, followed the U.S. Fish and Wildlife Service's (USFWS) Land-Based Wind Energy Guidelines, which are voluntary guidelines for addressing wildlife conservation concerns. The Bird and Bat Conservation Strategy for the project is being implemented. Post-construction monitoring to determine impacts of operations on birds and bats has been completed. Results of the monitoring indicate that additional material mitigation at our wholly owned wind facility is not needed.

The USFWS has regulatory authority to administer the following regulations that could affect siting or operating a wind farm in South Dakota: the Migratory Bird Treaty Act, the Bald and Golden Eagle Protection Act, the Endangered Species Act as amended, the National Wildlife Refuge System Improvement Act of 1997, and the National Environmental Policy Act. New wind generation in South Dakota will be subject to the aforementioned regulations.

5.7. Summary

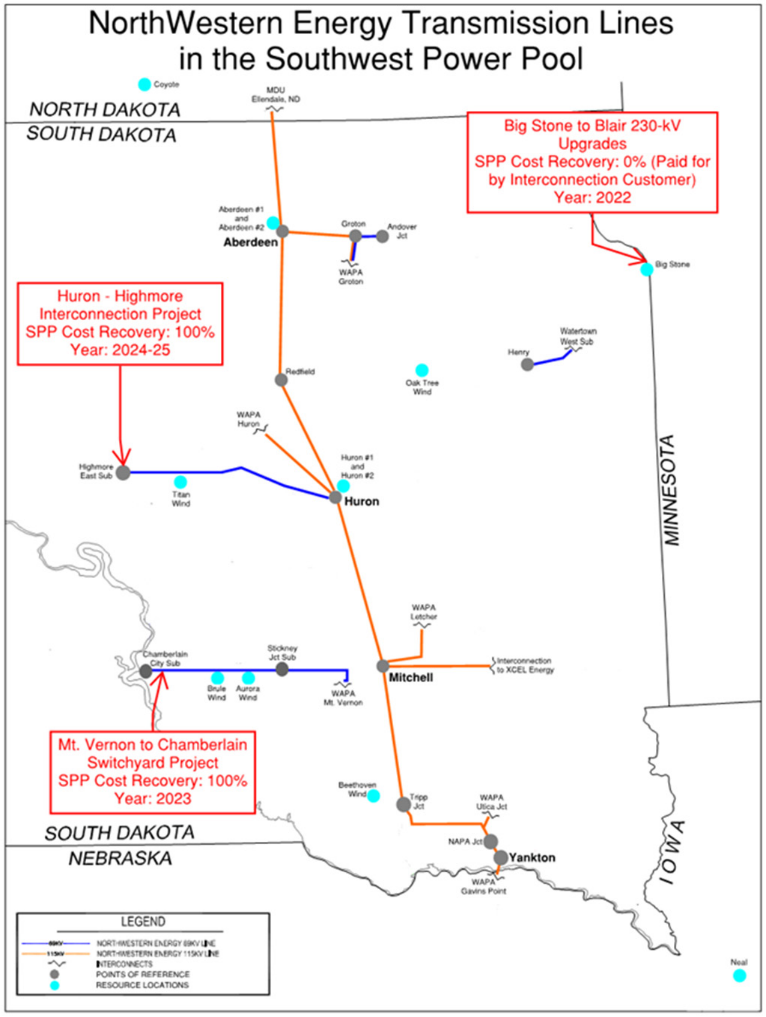
NorthWestern's planning process will continue to be impacted by environmental and wildlife regulations, as well as legislation that will affect current and future thermal and renewable generation resources. Providing reliable, cost-effective energy in an environmentally safe manner remains one of NorthWestern's commitments. We will continue to comply with environmental statutes and guidelines while fulfilling our responsibility to our customers.

[28] See the MRETS webpage https://www.mrets.org/.

6. NorthWestern's Transmission System

NorthWestern's has a 115-kV backbone transmission system that starts at Ellendale, ND and ends at Yankton, SD. The system has a number of interconnections with Western Area Power Administration (WAPA) and a 115-kV interconnection with Xcel Energy east of Mitchell, SD. The 69-kV and 34.5-kV facilities that source our distribution substations tap off of the 115-kV backbone system to move the energy to NorthWestern customers in over 110 communities.

Figure 31: NorthWestern's Transmission Lines in SPP



Outside of the South Dakota service territory, NorthWestern also owns sections of generator lead lines that move energy generated from our coal plants to our transmission system. These facilities include 18.2 miles of 230-kV out of Big Stone, 23.1 miles of 345-kV out of Coyote and 2 miles of 345-kV out of Neal 4.

The increase of renewable resources in the upper Midwest has led to two separate upgrades to our Big Stone 230-kV line in recent years. As new wind farms interconnect in the area, this facility has been flagged as an affected system in study process, and capacity upgrades have been necessary to accommodate the new generation. As renewable resources continue growing their footprint in the grid's overall resource mix, it's reasonable to expect to see more upgrades on these lines in the years ahead.

6.1. High Priority Transmission Projects

There are a number of significant transmission projects that have been completed or are currently in early planning stages. Project updates and plans are outlined below. Please note that planned projects are not yet finalized and are subject to change between now and the time of final approval.

6.1.1. Aberdeen

The completion of the 115-kV loop through Aberdeen along with the Aberdeen A-Tap Switchyard have resolved the transmission local reliability concerns in the area.

Figure 32: **Aberdeen A-Tap Switchyard**

6.1.2. Chamberlain Switchyard Project

Reliability improvements to the radial 69-kV system from WAPA Mt. Vernon to Chamberlain is a high priority for transmission planning in 2022. Design and engineering on a project is ongoing with a goal for construction in 2023. The project being designed is a new 4-terminal, 69-kV switchyard, to be located a couple miles east of Chamberlain. The switchyard would interconnect the radial East River and NorthWestern 69-kV systems, creating a looped system and bringing multiple sources into the area. The proposed $4 million project has successfully gone through three separate studies, been endorsed by SPP's Transmission Working Group, and been approved for cost recovery by the UMZ Coordination Group.

6.1.3. Big Stone to Blair 230-kV Upgrades

NorthWestern and Otter Tail Power Company have identified upgrades needed on the Big Stone–Blair 230-kV line to accommodate a 200-MW wind generation interconnection request in MISO. The line needs to meet a higher capacity rating to accommodate the generation interconnection request. NorthWestern and Otter Tail each own portions of this particular line. The cost of the upgrades, estimated at $1,300,000, will be paid for by the interconnection customer. NorthWestern intends to enter into an agreement with Otter Tail to construct the upgrades. This work would likely start in 2022 and be completed in 2023 if the interconnection customer moves forward with the project.

6.1.4. Highmore Interconnection Project

Similar to Chamberlain, the radial 69-kV system from Huron to Highmore also ranks highly for near-term transmission reliability improvements. While discussion and design are not as far along as the Chamberlain project, it is expected that connectivity with East River at Highmore will be closed, and a looped system will be created. Future studies will determine the upgrades necessary to enhance our normal-open emergency tie with East River at Highmore to accommodate a closed loop. This project is scheduled for 2024 – 2025.

6.2. Long Term Transmission Plan

Joining SPP has shifted the way NorthWestern and our transmission-owning neighbors approach planning. There was a time where participants only considered their owned facilities and needs; however, now any entity within the SPP must have an understanding of all SPP tariff facilities and consider how resources can be used in combination to solve a need. NorthWestern and East River, in particular, have a history of supporting each other through a handful of normal-open emergency interconnections between our two systems. We plan to take that a step further and pursue the reliability enhancement opportunities of closing those ties and creating a loop between our systems. These interconnects have demonstrated fantastic cost-benefit ratios, and we expect this recent trend to continue in the years ahead.

6.2.1. SPP Integrated Transmission Planning (ITP) Process

SPP's Integrated Transmission Planning (ITP) process is a single annual study that combines near-term, 10-year and NERC planning assessments. Each year, NorthWestern and the rest of the TOs submit dozens of different modeling scenarios as part of the process to identify any needs on our system. Once modeling is complete, different seasonal and operational scenarios are analyzed by SPP to identify system violations. Violations are typically posted in the fall, absent any study delays. Since joining SPP in October 2015, SPP has not identified any needs on the NorthWestern system that have resulted in the construction of new facilities.

6.2.2. Zonal Planning Criteria (ZPC)

Over the past few years, the UMZ has spent countless hours developing the Zonal Planning Criteria (ZPC). This criteria is critical in helping to ensure fair treatment of necessary transmission upgrades within each zone. Ahead of SPP's annual April 1 ZPC deadline, the UMZ submitted a revised ZPC for the 2022 – 2023 planning session with a few modifications from the prior year. The most significant change was the creation and inclusion of combined MW-mile criteria that allows separate TOs within the zone to interconnect radial transmission facilities and create a single looped facility. Each of the TOs radial facilities need to meet certain load-at-risk criteria to qualify for a combined MW-mile project. Once qualified, the TOs are allowed to work out a cost recoverable solution to improve the reliability in these areas. The NorthWestern system has two areas that meet the specified criteria, Mt. Vernon to Chamberlain and Huron to Highmore. Both locations will likely see NorthWestern and East River enhance current connectivity and create normally closed loops from the two radial systems.

7. Portfolio Modeling and Analysis

Modeling provides insight into NorthWestern Energy's portfolio behavior under various market constraints, alternative resource additions, and early retirement scenarios. In the past, we have used a 10 year planning horizon; however, this IRP presents a 20 year planning horizon.

7.1. Modeling Inputs

The simulation of the future market and load conditions that determine the dispatch of resources in the model are defined by historical data for weather, customer loads, electricity and gas prices, and renewable generation. In addition to historical data, the model utilizes forecasts of power prices, natural gas prices, and loads. Customer load does not influence the dispatch of NorthWestern's resources in SD because they are economically dispatched based on price alone. However, load influences the portfolio NPV by determining how much power must be purchased from the market. Inputs into the model include:

- VER historic, hourly generation data
- VER forecast, monthly and peak generation
- VER PPA costs
- Thermal resource/generation characteristics including heat rates, start-up costs, operational constraints, fuel switching information, capacity, outages, and ancillary contributions
- Price forecasts
- Generating resource portfolio that includes all resources currently online, expected to join, and those evaluated for illustrative purposes only

Each input plays an important role in defining current and expected resource characteristics, costs, and the future planning landscape. Input time step levels range from hourly to annual values.

7.1.1. Resource Costs

Capital costs and operations and maintenance (O&M) metrics for potential new resources were estimated by Aion Energy LLC (Aion) based on updating the metrics utilized in previous NorthWestern plans. These resource cost estimates are intended to represent a reasonable indication of current and near-term forecasted resource cost trends. The capital and O&M cost metrics were developed consistently, regardless of technology, representing a consistent basis for modeling and planning purposes.

The capital and O&M cost estimates appear to trend consistently with observed industry trends as well as previous NorthWestern planning data when considering the disruption observed in 2021 and in 2022 to date. The estimated new resource costs are also generally consistent with the cost metrics included in the National Renewable Laboratory's Annual Technology Baseline (NREL ATB).[29]

Figure 33: Estimated Resource Costs in 2022 Dollars[30]

	Generation		Storage			2022$							
South Dakota	Scale (MW_{ac})	Heat Rate (Btu/kWh-HHV)	Scale (MW_{ac})	Duration (hours)	Capability (MWh)	EPC Overnight ($/kW)	Installed Overnight[1,2] ($/kW)	Installed Overnight[1] ($/kWh)	Fixed O&M[2] ($/kW-yr)	Fixed Hourly Fee ($/hour)	Start Fee ($/start)	Variable O&M ($/MWh)	Total Non-Fuel Variable Costs ($/MWh)
Wind	50	-	-	-	-	$ 1,578	$ 1,736	n/a	$ 44.30	$ -	$ -	$ -	$ -
Solar PV - SAT	20	-	-	-	-	$ 1,409	$ 1,550	n/a	$ 25.32	$ -	$ -	$ -	$ -
BESS - Li-Ion[3]	-	-	20	4	80	$ 1,546	$ 1,623	$ 406	$ 28.01	$ -	$ -	$ -	$ -
SC CT - Aero[5]	33	9,600	-	-	-	$ 1,465	$ 1,641	n/a	$ 23.90	$ 100	$ -	$ 0.53	$ 3.56
SC CT - Aero[5]	55	9,260	-	-	-	$ 1,322	$ 1,481	n/a	$ 17.98	$ 250	$ -	$ 0.45	$ 5.00
SC RICE[5]	28	8,750	-	-	-	$ 1,699	$ 1,954	n/a	$ 33.10	$ 225	$ -	$ 2.15	$ 10.07
SMR	80	n/a	-	-	-	-	$ 3,738	n/a	$ 75.53	$ -	$ 54,122	$ 13.01	n/a

Notes

1. Overnight installed costs include direct and indirect EPC project costs and owner's cost but exclude AFUDC, electric transmission network upgrades, and bulk gas system upgrades, as applicable.
2. Overnight installed ($/kW) and fixed O&M ($/kW-yr) costs expressed based on dividing total costs by the renewable component output.
3. BESS resources based on lithium ion technology, 365 equivalent cycles per year, and capacity augmentation throughout the study period.
4. Solar + BESS hybrid resources based on dc-connected, SAT solar PV.
5. O&M costs for simple cycle configurations assume a dispatch profile of 150 starts per year and 1,000 hours of operation per year.
6. O&M costs for combined cycle configurations assume a dispatch profile of 150 starts per year and 4,000 hours of operation per year.
7. SMR resource costs represent an 80 MW ownership share (1 independently operated unit) within a 320 MW (4 unit) SMR plant .

---

29 See NREL's 2021 ATB https://data.openei.org/files/4129/2021-ATB-Data_Master_new.xlsm.

30 Values are calculated and provided by Aion Energy LLC and X-Energy

7.1.2. Capacity Accreditation

As mentioned previously, this IRP utilizes a summer peak and summer capacity accreditation for planning purposes. Please reference Chapter 3 for further discussion on expected SPP changes to planning criteria beginning next year.

Capacity accreditation associated with intermittent resources were assigned based on initial estimates provided by SPP. SPP is planning to implement a tiered capacity accreditation structure. The total nameplate of each resource associated with our portfolio would be used to determine which tier capacity accreditation would apply to all resources of that type on our system.

Currently, SPP requires participants to plan to a summer peak. As mentioned in Chapter 2, the recent winter storm has sparked debate on if participants should not only plan to summer peaking conditions, but also winter peaking conditions. Since this change in planning structure has not yet been made, NorthWestern is still utilizing summer peaking modeling assumptions in this IRP. That said, NorthWestern will include winter planning criteria in the model should it be required by SPP.

7.1.3. Price Forecasting[31]

Price forecasts for power and natural gas are created by Ascend Analytics and used to define the expected (average) value of power and fuel prices over an extended time period. NorthWestern evaluates potential resource additions or retirements by simulating a range of values around these averages to reflect the inherent uncertainty in future conditions. NorthWestern uses the PowerSimm™ modeling software to conduct these simulations.

Ascend forecasts begin with market forward prices for fuel and power prices over the duration for which they are liquid, ensuring that Ascend's models are calibrated to observed market conditions. Ascend then blends the end of the liquidity period with a long-run forecasting approach that explicitly accounts for the new market dynamics that are caused by increasing deployment of storage and intermittent (non-dispatchable) renewable resources with zero/near-zero marginal costs.

7.1.3.1. Electricity Price Forecast

Ascend's approach for long-run forecasting monthly on/off-peak forwards accounts for two mechanisms of price depression due to increased renewables: shifting of the supply stack and negative price formation during surplus renewable generation. Ascend's fundamental modeling accounts for changes to the marginal generation unit as the renewable penetration rises. Chapter 3 discusses historical price trends as related to renewable penetration.

As renewable penetrations rise, the up/down movement in prices becomes important to forecast alongside the monthly averages. Ascend forecasts day-ahead price volatilities at the monthly level, with volatility defined as standard deviation in price residual from the average shape divided by the mean price. Price shapes are also forecasted at the monthly level, providing 24-hour price shapes. Ascend's price shape forecast uses fundamental modeling that incorporates evolution in load shape (due to forecasted electric vehicle adoption, building electrification, energy efficiency, and behind-the-meter solar and storage deployment), as well as changes to renewable generation deployment to evolve price shapes into the future. This price shape model also accounts for the impact of structural changes in the net load shape (such as the net load ramp rate) that also affect price shapes.

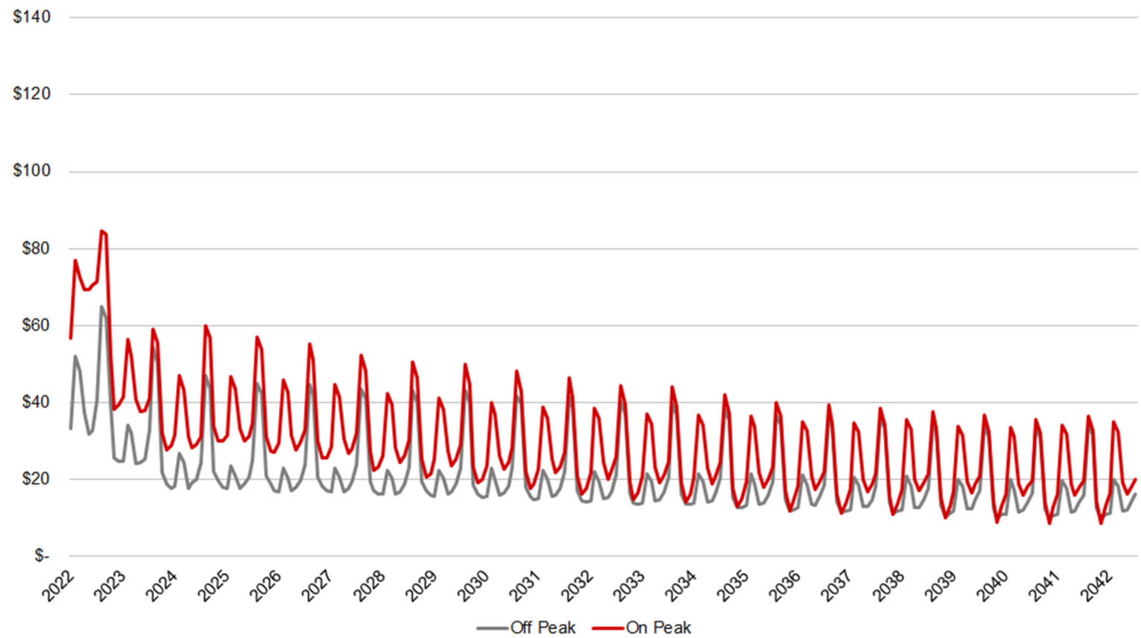
Ascend similarly uses modeled relationships between day-ahead price volatility and renewable penetration to forecast long-run volatility in the day-ahead market, with the volatility evolving in accordance with forecasted changes in renewable penetration and battery deployment.

Ascend uses relationships derived from market fundamental modeling for price depression mechanisms to evolve the modeled implied heat rates, which allows separating the power price impacts of renewable penetration from the impacts of fuel prices. The modeling incorporates the impact of storage by calculating an adjusted renewable penetration that accounts for the ability of storage to absorb surplus renewable generation. Hourly, monthly, and seasonal variation in renewable generation and load shapes provide a more granular basis for forecasting the renewable curtailment by peak period, month, and year.

[31] Ascend Analytics provided electric and gas forecasts for each scenario and related descriptions

The forecasted implied heat rates are then multiplied by the natural gas price forecast to generate an initial power forecast. The figure below shows the base case power price forecast.

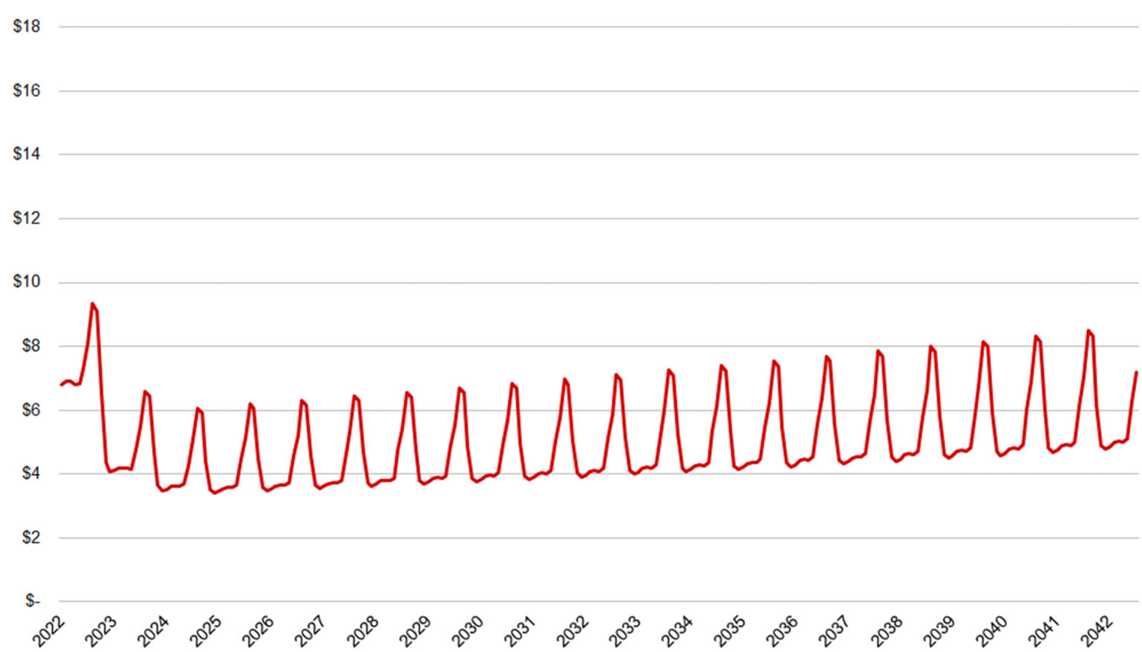
Figure 34: Base Case Power Price Forecast



7.1.3.2. Natural Gas Price Forecast

Natural gas price forecasts rely on the Pindyck approach, which takes market forward data and then indexes by inflation after the liquidity period. Pindyck's analysis showed that using this method for natural gas forecasting is more reliable than a fundamentals-based approach, as price changes can drive a variety of unforeseen developments, including efficiency gains, alternative sources, and fuel switching. The figure below shows the base case gas price forecast.

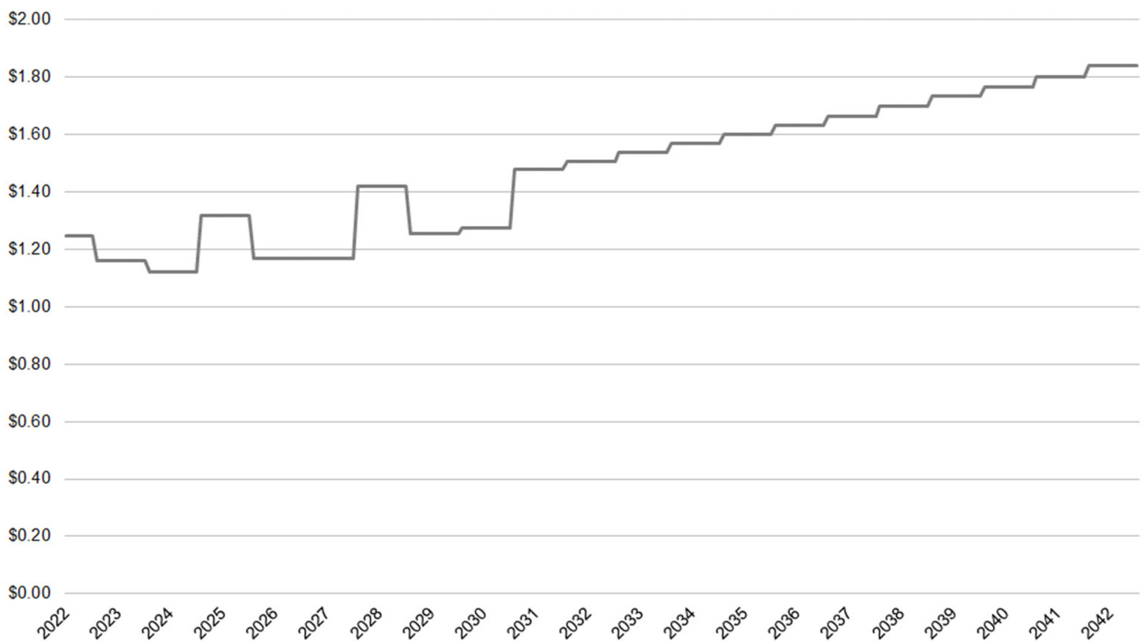
Figure 35: Base Case Gas Price Forecast



7.1.3.3. Coal Price Forecast

NorthWestern created the coal price forecast used in this IRP. Coal price forecasts are derived from existing supply contracts for Big Stone through 2027, Coyote through 2031 and Neal through 2031 as a starting point for projections. An annual escalation rate of 2.0% is applied to extend the forecast for the remainder of the planning period. The escalation rate is calculated using a 20 year average of historical annual escalation rates for Implicit Price Deflators for Gross Domestic Product (GDP) published by the U.S. Bureau of Economic Analysis.

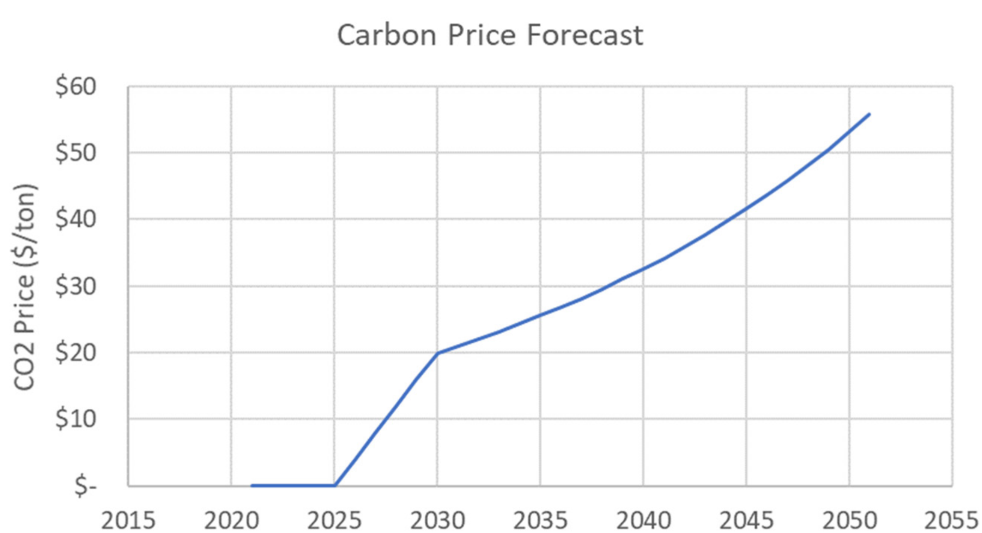
Figure 36: Base Case Coal Price Forecast



7.1.3.4. Carbon Scenario Price Forecast

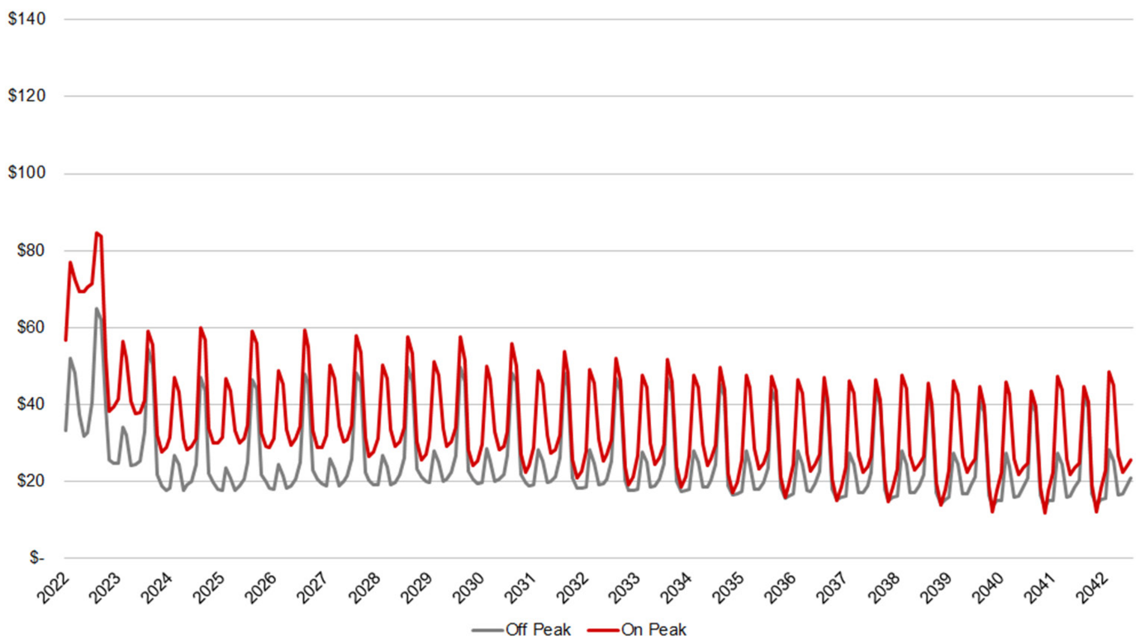
The base price forecast in this resource plan assumes no carbon costs will be imposed on fossil fuel resources. For the carbon pricing scenario, Ascend assumed the carbon prices shown in Figure 37.

Figure 37: Carbon Prices used in the Carbon Cost Scenario



Ascend's power price forecast for the carbon cost scenario calculates power prices based on the forecasted carbon price and the monthly carbon intensity forecast. Carbon costs affect power prices when the marginal resource is either natural gas or coal. Ascend's model adds carbon costs to the supply stack and recalculates costs based on the amount of time fossil fuel plants are on the margin and the carbon intensity of the marginal plants. The figure below show the forecast power prices for this scenario. The forecast gas prices are the same as those used in the base case and can be found in Figure 35.

Figure 38: Carbon Pricing Scenario Power Price Forecast



7.1.3.5. High Gas Price Forecast

In addition to the carbon price scenario, Ascend calculated power prices that would result from a doubling of the natural gas prices. The resulting power price increases were more pronounced in the early years when natural gas is expected to be on the margin more often. As renewables grow in the model, the effect of the doubling in natural gas prices is diminished. The figures below show the forecast power and gas prices for this scenario.

Figure 39: High Gas Scenario Power Price Forecast

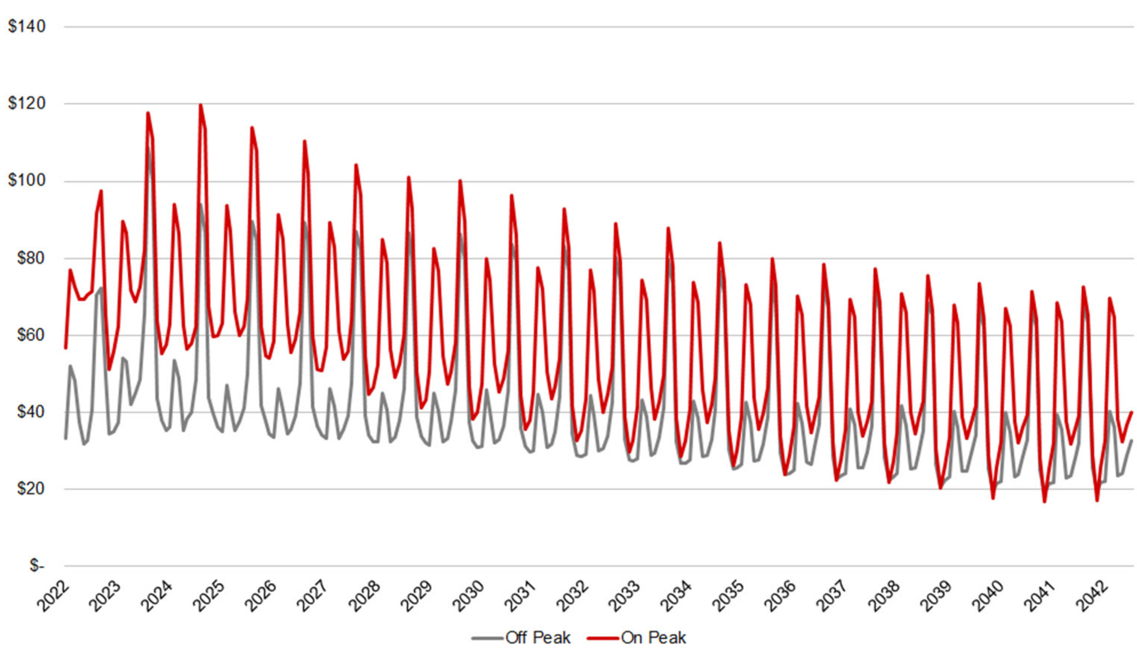
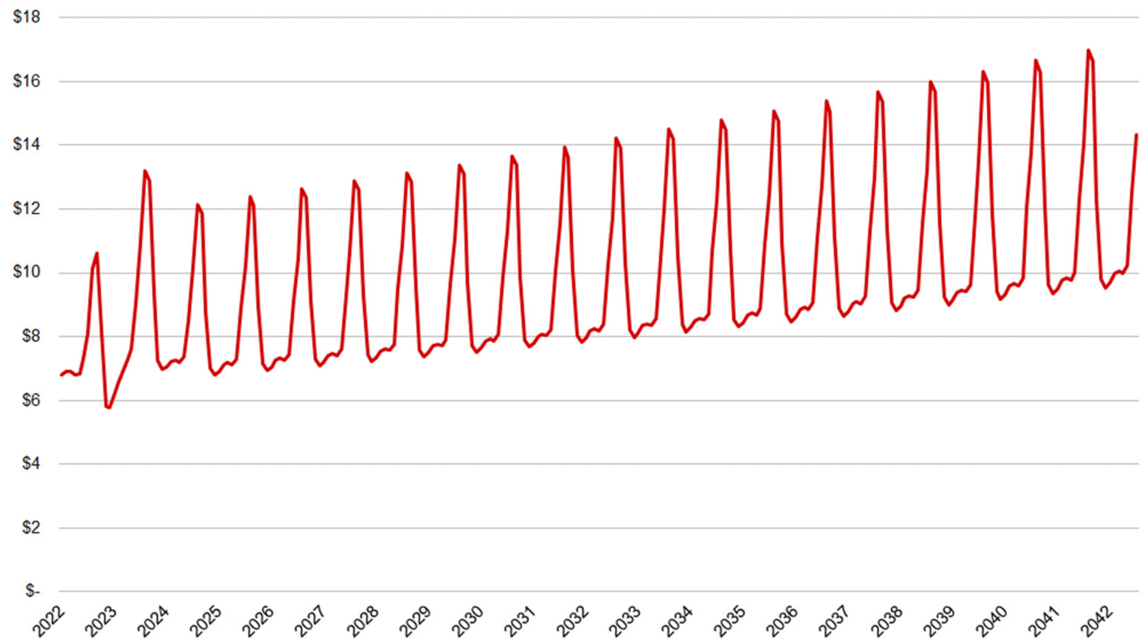


Figure 40: High Gas Scenario Gas Price Forecast



7.1.4. Modeling Scenarios

This IRP utilizes multiple scenarios to evaluate potential, future resource types under different conditions. Since we cannot predict exactly what will happen with respect to power and gas prices, coal retirements, and carbon adders, NorthWestern has defined a number of modeling scenarios that represent a wide range of what the future energy landscape may look like.

7.1.4.1. Modeling Scenarios and Sensitivities

NorthWestern reviewed a few different modeling scenarios and sensitivities:

- Base power and base gas prices (base case)
- Allow carbon emitting resource additions after 2035
- Base power and high gas prices
- High power and high gas prices
- Carbon-adder power and base gas prices
- Early coal retirements

7.1.4.2. Base Case Power and Gas Prices

The base case is the starting point for all modeling activities presented in this IRP. Each portfolio presented in section 7.2 is evaluated under base case assumptions. This case is used to find the top performing portfolios for further evaluation under other sensitivities discussed above. Base case assumptions are as follows:

- Power and gas prices are forecast based on what we know now and would expect going forward based on the current planning landscape
- We do not assume any changes from the status quo
- No additional carbon emitting resources are added to the system after 2035
- Yankton is not included in the portfolio
- Current resource retirement dates are assumed (note, assumptions made for modeling purposes only and are subject to change)

Figure 41: Assumed Retirement Dates

Facility	Base Retirement Date	Early Retirement Date
Aberdeen	12/31/2025	n/a
Clark	12/31/2027	n/a
Faulkton	12/31/2027	n/a
Beethoven	8/31/2040	n/a
Neal	12/31/2040	12/31/2028
Coyote	12/31/2041	12/31/2028
Big Stone	12/31/2046	n/a

7.1.4.3. Carbon Emitting Resource Additions after 2035

This sensitivity utilizes all base case assumptions; however, NorthWestern assumes that carbon emitting resources can be added to the portfolio through the entire 20 year study period. Even though NorthWestern has pledged to not acquire additional carbon emitting generation after 2035, it is important to study and understand the cost difference between this scenario and others that have been identified.

7.1.4.4. Base Power and High Gas Prices

NorthWestern also wants to understand the impact high gas prices would have on top performing base case portfolios. Because forecast base case prices are not guaranteed, it is critical for NorthWestern to perform exploratory analyses to ensure customers have the best valued and most reliable energy under any price structure that may arise.

7.1.4.5. High Power and High Gas Prices

High gas prices can cause an increase in power prices. Because of this, it is also important for NorthWestern to evaluate top performing portfolios under the assumption of high power and high gas prices.

7.1.4.6. Carbon Scenario

NorthWestern chose to evaluate a carbon pricing sensitivity. This sensitivity acts as a proxy to represent a theoretical carbon adder included in power pricing in the future. Generating resources that produce carbon are penalized in the form of increased costs. Again, top performing base case portfolios were evaluated under the carbon pricing assumption.

7.1.4.7. Early Coal Retirement Scenario

The early coal retirement scenario evaluates the early retirement of both Coyote and Neal. As discussed in Chapter 4, both of these facilities have run into a number of challenges that make it within reason to evaluate their early retirement. It is important to reiterate that NorthWestern Energy sees value in both these resources and supports their continued operation into the future. However, it is important for the company to understand what portfolio operations and potential future resource types would look like if these resources were retired early. In this scenario, both Coyote and Neal are assumed to retire in 2028.

7.2. Portfolios

Portfolios of resources are defined by NorthWestern to evaluate under each different scenario. A base portfolio that includes only current resources is defined as a baseline for the study period. Additionally, multiple portfolios with different resource additions are considered in this Plan to determine how different resource types may respond with our system.

7.2.1. Current Portfolio

NorthWestern's current portfolio contains coal, natural gas, wind, and market contracts. The table in Chapter 3 details these resources. For 2023, NorthWestern's current portfolio is adequate to meet the summer need set forth by SPP, and is also believed to be adequate to meet the winter need (should a winter planning criteria be set forth in the future). However, in future years this portfolio does not meet resource adequacy requirements as load continues to grow steadily and some resources are retired.

As mentioned above, early retirement of coal plants are evaluated in this IRP. In the event one or more coal plants are retired early, NorthWestern will need to add a new capacity resource to our portfolio to meet customer need and SPP requirements. Natural gas, storage, nuclear, wind, and solar resources, as well as combinations of some of these resources, were evaluated in this IRP. Results can be found in Section 7.3.

7.2.2. Capacity Additions

This IRP studies resources that are feasible to add to the system over the planning period, likely to be bid into an RFP, and have well defined characteristics and costs. See Chapter 4 for a discussion on potential, future resources and their modeling feasibility.

NorthWestern extended and updated its capacity need forecast from the 2022 SPP Resource Adequacy Workbook filing and hand selected resources to fill any capacity deficit the portfolio experienced. Modeling activities begin by running the current portfolio with no additions as a baseline for comparison. Next, models were created to fill any current portfolio capacity deficits with either RICE, Aero CT, nuclear, battery, solar, or wind. After we identify the relative value of singular type additions to our portfolio, we look at combinations of resources to define mixed resource portfolios.

In total, NorthWestern evaluated six individual resource portfolios and three mixed resource portfolios under base case assumptions. An additional set of these three mixed portfolios were created under the early coal retirement scenario where the same resource types were used with adjustments to schedule and quantity. When building these 12 portfolios, a number of assumptions were made:

- Resource additions are not generally overbuilt in this plan. This means, a resource is only added to the portfolio when the capacity deficit is nearly equal to the capacity contribution of a potential resource/combination of potential resources.
- In years when the capacity deficit is too small to add a resource, the deficit is assumed to be covered via a capacity contract for that amount.
- Initial models do not put an upper limit on the quantity of any specific resource type and additional units are added as necessary to meet this resource adequacy strategy.

7.3. Portfolio Results

Portfolios are compared on the basis of net present value of total net portfolio costs including existing resources and new resource additions. This includes revenue requirements from capital expenditures, initial commissioning costs (nuclear), variable and fixed operating and maintenance costs, fuel related costs, startup costs, costs of market purchases from SPP to serve NorthWestern load and charge batteries, and revenue from market sales of all generation to SPP for serving load and providing ancillary services. Sales revenues include a credit assigned to each flexible, fast-ramping, dispatchable resource that has the ability to respond to 5 minute market signals and provide additional revenue.

In addition to net portfolio costs, there is a risk component inherent in any portfolio or resource selection. Through stochastic modeling, NorthWestern has included some measure of risk analysis that accounts for variations in weather forecasts which drive load shapes, renewable generation patterns, and in turn, price shapes. Through price scenario modeling, long-term increases to fuel and power prices are simulated to better understand the risk associated with these conditions for different portfolios. Furthermore, the possible early retirement of coal plants due to policy or regulation change is considered as a sensitivity to further assess how the more favorable portfolios would perform under these conditions.

Another risk that is acknowledged but not accounted for in the modeling is the risk of market exposure of portfolios having extremely long energy positions. For example, a portfolio with a large amount of wind generation will likely have excess energy at times and can create transmission congestion problems. A result can be that this energy has to be sold into the market under associated negative LMP prices. Since joining SPP in 2015, LMP differentials to SPP North hub Day-Ahead prices are modeled as static average values through time based on historical data and do not account for time-varying effects of local generation on prices. As more historical data is collected on how NorthWestern's LMPs change with local generation, there is potential for modeling LMPs more dynamically and accurately to account for these effects.

The portfolios modeled in this plan are numbered 1-12 with a brief description of the new resource additions considered, shown in Figures 42 and 43 below.

7.3.1. Phase I

The first phase of modeling compares Portfolios 1-6 with single resource type additions including thermal, VER, and batteries. The initial focus of these comparisons is on the period 2023-2035 and uses all resource types deemed to be available throughout this period, which excluded nuclear SMR. The results of these studies indicate that the current portfolio with the addition of a large aero CT in 2030 is the least cost portfolio for this period (Portfolio 2).

Figure 42: Portfolios for Modeling Phase I

Portfolios - New Capacity (MW)										
Portfolio	Composition	NPVRR (Billions)	Rank	Capacity Measure	Natural Gas	Battery Storage	Nuclear	Wind	Solar	Total
Phase I: Individual Resources (2023 - 2035)										
1	RICE	$ 0.77	2	Accred. Cap:	54	0	0	0	0	54
				Nameplate:	56	0	0	0	0	56
2	Large CT	$ 0.75	1	Accred. Cap:	51	0	0	0	0	51
				Nameplate:	53	0	0	0	0	53
3	Small CT	$ 0.77	3	Accred. Cap:	58	0	0	0	0	58
				Nameplate:	60	0	0	0	0	60
4	Wind	$ 1.02	6	Accred. Cap:	0	0	0	70	0	70
				Nameplate:	0	0	0	500	0	500
5	Solar	$ 0.82	5	Accred. Cap:	0	0	0	0	72	72
				Nameplate:	0	0	0	0	180	180
6	Battery	$ 0.79	4	Accred. Cap:	0	76	0	0	0	76
				Nameplate:	0	200	0	0	0	200

7.3.2. Phase II

As a sensitivity in Phase II, these same individual resource portfolios are extended through the planning horizon (2023-2042), except for Portfolio 6 (Battery). Batteries are not evaluated through the end of the period due to their declining ELCC value with increased deployment. After 200 MW of battery nameplate capacity are added to the portfolio, the reduced ELCC values indicate that more additions are not effective at meeting resource adequacy.[32] Portfolios 1, 2, and 3, which add carbon-emitting resources after 2035, are considered for cost comparison purposes, but do not meet NorthWestern's carbon goals. Results indicate that Portfolio 2 would still bet the least cost portfolio.

In addition, Phase II considers mixed additions to the current portfolio to cover the planning horizon. These additions include a large aero CT in the near term followed by non-carbon-emitting resources in the later portion of the planning horizon, 2036-2042. Nuclear SMR resources are not selected first because of their larger size relative to the capacity need. Based on their initial ELCC values, batteries are selected until the point mentioned above where their resource adequacy value becomes unclear. At that point, either solar, wind, or nuclear SMR resources are added, referred to as Portfolio 7, 8, and 9, respectively. The results of this phase indicate that Portfolio 7 and 9 are close with 7 being the least costly, and both compared favorably to Portfolio 8.

[32] See Chapter 3 Section 3.1.2

Portfolio 7, with the additions of a large aero CT, battery storage, and solar generation, represents the least cost portfolio that meets NorthWestern's resource adequacy strategy and carbon goals. Therefore, Portfolio 7 is considered the base portfolio for modeling sensitivities. For comparison purposes, other Phase II portfolios are included in subsequent analysis and are shown in these figures. Figure 43 shows the results and a brief description of addition types and amounts for Phase II and III.

7.3.3. Phase III

Phase III considers the impact of early coal retirements utilizing adjusted schedules and quantities of resources from Phase II mixed addition portfolios. In this scenario, Neal 4 and Coyote are assumed to retire at the end of 2028. Portfolio 10 is the least cost portfolio under this scenario.

Figure 43: Portfolios for Modeling Phase II and III

Portfolios - New Capacity (MW)										
Portfolio	Composition	NPVRR (Billions)	Rank	Capacity Measure	Natural Gas	Battery Storage	Nuclear	Wind	Solar	Total
Phase I: Individual Resources (2023 - 2035)										
1	RICE	$ 0.77	2	Accred. Cap:	54	0	0	0	0	54
				Nameplate:	56	0	0	0	0	56
2	Large CT	$ 0.75	1	Accred. Cap:	51	0	0	0	0	51
				Nameplate:	53	0	0	0	0	53
3	Small CT	$ 0.77	3	Accred. Cap:	58	0	0	0	0	58
				Nameplate:	60	0	0	0	0	60
4	Wind	$ 1.02	6	Accred. Cap:	0	0	0	70	0	70
				Nameplate:	0	0	0	500	0	500
5	Solar	$ 0.82	5	Accred. Cap:	0	0	0	0	72	72
				Nameplate:	0	0	0	0	180	180
6	Battery	$ 0.79	4	Accred. Cap:	0	76	0	0	0	76
				Nameplate:	0	200	0	0	0	200

7.3.4. Phase IV

Phase IV focuses on the effects of alternative pricing scenarios on the base portfolio (7) selected from Phase II. Portfolio 9 is included for comparison in Figure 44 below. Price scenarios include:

- High Gas and High Power,
- High Gas and Base Power, and
- Base Gas and Carbon Power.

In all of these scenarios, Portfolio 7 is the least costly option.

Figure 44: Pricing Scenario Results

Portfolio	Phase IV: Base Portfolio Pricing Scenarios (2023 - 2042)							
	Base Scenario		Carbon Price		High Gas and High Power Prices		High Gas Price, Base Power Price	
	NPVRR (Billion)	Rank	NPVRR (Billion)	Rank	NPVRR (Billion)	Rank	NPVRR (Billion)	Rank
7	$ 1.04	1	$ 1.08	1	$ 1.01	1	$ 1.04	1
9	$ 1.05	2	$ 1.08	2	$ 1.06	2	$ 1.10	2

Comparing across Phase II and III results, modeling results indicate that portfolios where Neal and Coyote are retired early are more expensive than similar portfolios where these coal plants do not retire early. This is consistent with NorthWestern's position that these coal plants continue to add value for our customers through this planning horizon. Additionally, results indicate that Portfolio 7 under High Gas and High Power and High Gas and Base Power price scenarios is even more cost-effective relative to Portfolio 9 than it is under Base Gas and Base Power prices.

Figure 45 gives a breakdown of the basic cost components as well as the total NPV of portfolio costs (in $B, 2023 dollars). These include:

- Existing Resource Fixed Costs,
- New Resource Fixed Costs,
- Net Market Costs, and
- Variable Costs.

Figure 45: Portfolio Cost Components

In Figure 45, Net Market subtotals (gray) are shown as negative cost values, representing positive revenue values, and appear to the left of $0.0B on the bottom axis. The two most significant components in comparing these portfolios are the New Resource Fixed Costs (purple) to the corresponding Net Market Costs (gray). For example, Portfolio 4, which has substantial wind additions, generates more net market revenue (larger gray bar) but also incurs more fixed costs (larger purple bar) than other portfolios require to maintain resource adequacy.

For this plan, NorthWestern models the current portfolio under base case assumptions regarding existing resources and their retirement schedules, load growth, fuel and power price forecasts, historical weather, and SPP market operations and planning requirements. To evaluate potential portfolios, candidate resources are added to the current portfolio to meet the resource adequacy strategy and carbon goals, and these portfolios are then modeled through the planning horizon. The resulting net portfolio costs are compared and the least cost portfolio is selected as a base case for further analysis under different scenario assumptions. Results indicate that adding the combination of a large aero CT, battery storage, and solar generation (Portfolio 7) is the most cost effective option under all the scenarios considered.

8. Action Items

Following the development of this Plan, and consistent with the major findings of NorthWestern's previous resource plan, the key near-term actions for NorthWestern include:

8.1. Transmission Projects

There are a number of significant transmission projects that are in early planning stages. These include the Chamberlin Switchyard Project, Big Stone to Blair line upgrades, and Huron to Highmore line improvements. Each project is classified as a high priority for the transmission planning group and have expected completion dates in 2023 and 2025. Please note, project plans and dates are subject to change since these projects are still in early planning stages.

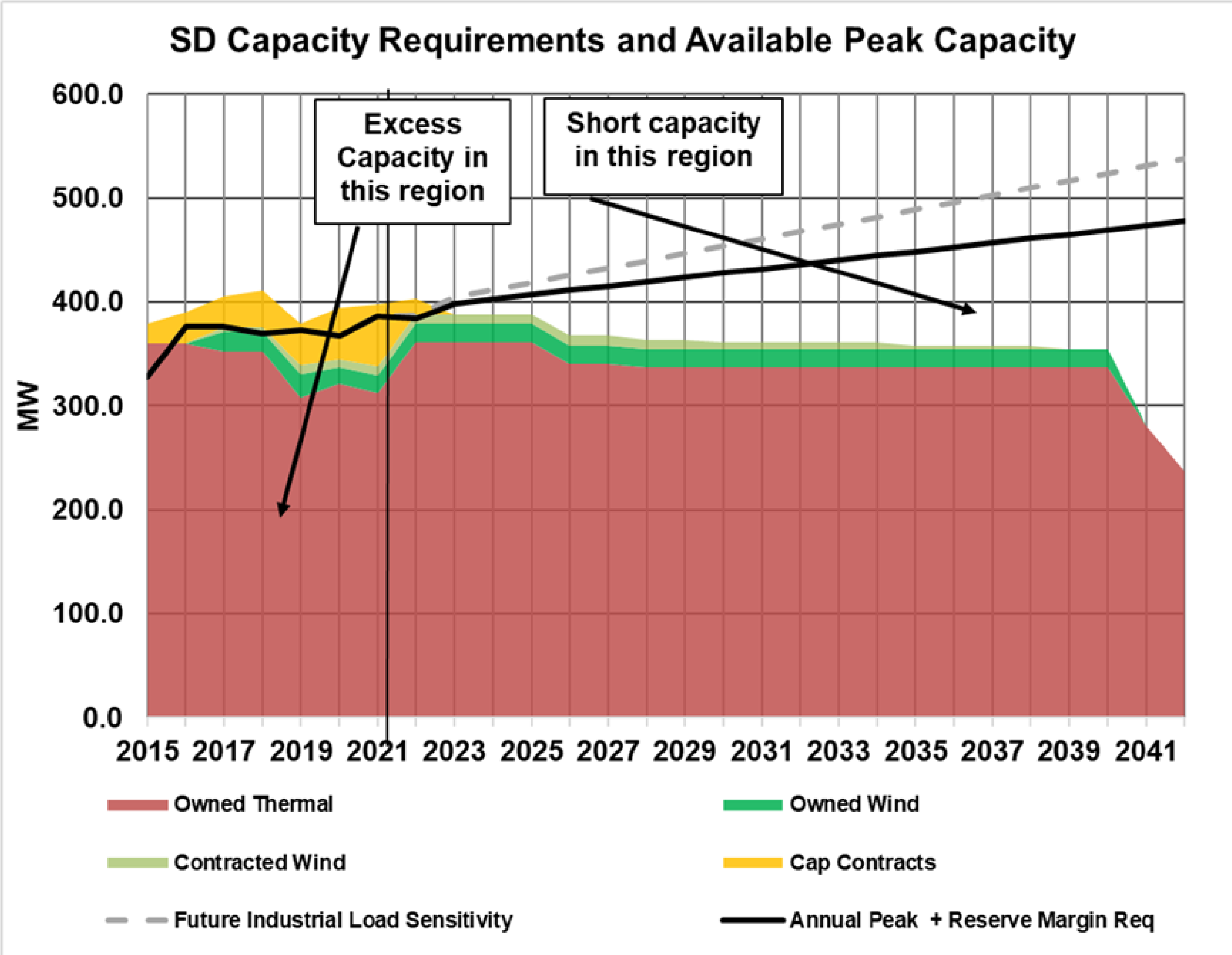
8.2. Aberdeen and Yankton Replacement

As noted throughout this document, Aberdeen 1 and Yankton are strong contenders for retirement and replacement. Both resources were slated for retirement and replacement after the 2019 RFP was conducted. The fire at Huron and the COVID-19 pandemic caused NorthWestern to make the strategic decision to keep the resources online for a few more years. At the time of publication, NorthWestern was reviewing replacement options for each of these facilities. Further planning through 2022 will be needed to identify a replacement strategy.

8.3. Request for Proposal (RFP)

This section describes the strategy and action plan NorthWestern will use when considering additions to our supply portfolio. Figure 46 below illustrates the peak load forecasts, the capacity contributions of existing resources, and the additional capacity contributions needed to meet our planning reserve margin.

Figure 46: Additional Need for Peaking Capacity



NorthWestern Energy's current resources provide about 386 MW of peaking capacity, which is the energy available during periods of our customers' highest demand. With the potential retirement of Aberdeen 1 and Yankton 1-4 we will need an additional 40 MW of peaking capacity to meet our needs.

The figure illustrates the need for NorthWestern to begin arranging for peaking capacity resources. Resource additions are shown to begin in 2024 because that is the earliest timeframe in which NorthWestern could file the 2022 Plan, solicit proposals using a competitive RFP process, and allow for construction of new-build resources (should those resources win the solicitation). NorthWestern's strategy includes the following steps.

1. Seek short term capacity to help bridge the gap until long term capacity can be added to the portfolio as needed.
2. Conduct an initial competitive solicitation RFP process should one be required.
3. Solicit additional competitive proposals with the goal of maintaining or modestly exceeding adequacy plus a planning reserve margin as necessary.

NorthWestern may solicit competitive proposals to evaluate all cost-effective resources including power purchase agreements and owned energy resources comprised of different structures, terms, and technologies with the long term objective of a clean, stable, and reliable energy portfolio. Individual proposals, and combinations of proposals if appropriate, will be evaluated for their ability to meet our customers' needs and for their ability to add value to our resource portfolio at lowest long-term total cost.

8.3.1. Resource Acquisitions Strategy

8.3.1.1. Competitive Solicitations of Proposals for Resource Acquisitions

NorthWestern Energy may use competitive solicitations and opportunity resources.

The competitive solicitation process may result in the acquisition of resources identified in the modeling conducted for this plan. However, it is possible that resources that were not identified or modeled, or could not be identified during the planning process, may be acquired.

8.3.1.2. Request for Proposal (RFP) Process

Any future RFP will focus on the most reliable, lowest long-term cost bids that meet NorthWestern's identified resource needs. It may include, but is not limited to, the following types of resources.

- Sale of all or part of existing resources.
- New generation resources including:
  - ↳ Solar generation combined with storage.
  - ↳ Wind generation combined with storage.
  - ↳ Natural Gas-fired generation.
  - ↳ Other generation technologies, including hydro and nuclear.
- Energy storage technologies including:
  - ↳ Pumped hydro energy storage.
  - ↳ Battery storage technologies.
  - ↳ Compressed air energy storage.
- Demand response resources under automated control.

For future RFP's, Northwestern may use an independent, third–party administrator (RFP Administrator) to conduct any future RFP process. To ensure equitable treatment of each proposal, the RFP Administrator may be instructed to not identify any bidders by name until the resources have been selected for final negotiations. The RFP will be publicly noticed and sent to any party expressing a desire to receive one, and to developers that NorthWestern is aware of from prior solicitations. The RFP may request, at a minimum, the following information.

- Developers must demonstrate a proven safety record.
- Developers must demonstrate their proposed project can be completed on the timeline included in the proposal.
- Developers will be required to provide references to similar projects, or at a minimum, demonstrate that capital markets support the proposed project.
- Developers will be required to demonstrate their financial worthiness to perform.

NorthWestern Energy will evaluate the winning proposals for their ability to meet a rigorous set of criteria which include, but not limited to:

- Scale of the project to meet our needs
- Resource capacity accreditation
- Location and site control
- Operational flexibility
- Fuel, charging, and permit requirements
- Electrical interconnection feasibility
- Development progress
- Commercial operation date
- Suitability for inclusion in the SPP

8.3.1.3. Opportunity Resources

Opportunity resources are those resources that NorthWestern cannot foresee or model in a resource planning process. Typically, opportunity resources are existing assets that become available for acquisition on short notice and with a short time-frame for transaction completion. Usually the owner (or owners) of opportunity resources control the process, usually their own RFP process, and NorthWestern has no control over that process. NorthWestern evaluates opportunity resources in a manner consistent with the methodologies contained in the most current Plan to determine if the opportunity resource could fill a portfolio need in an economical manner.

9. Appendix

9.1. Potential Resource Costs[33]

The resource costs noted herein are based on estimated 2022 costs with an earliest notice-to-proceed (NTP) in 2023. As such, new resource capital and O&M costs are presented in 2022 dollars. Estimated capital costs are presented as overnight, installed costs based on an engineer, procure, construct (EPC) project execution and are inclusive of owner's costs but exclusive of an allowance for funds used during construction (AFUDC)/construction financing costs. Owner's costs are assumed and presented as a percentage of total EPC project costs and are based on previous NorthWestern planning and RFP activities. The estimated capital costs are also exclusive of "outside-the-fence" electrical and/or natural gas infrastructure and are generally based on scope within the project boundary/fence line (to the high-side of the generator step-up transformer, on-site gas-yard, etc.). These outside-the-fence costs are excluded from the planning evaluation given that they are heavily dependent on development and project-specific attributes as compared to the generic resources contemplated herein. General assumptions considered in the evaluation are summarized below.

Figure 47: General Estimating Assumptions.

Resource Type	Cost Estimate (Year)	Earliest NTP (Year)	Earliest In-Service (Year)	Implementation Schedule (Months)	Owner's Costs (%)
Wind	2022	2023	2024	24	10%
Solar PV	2022	2023	2024	18	10%
BESS	2022	2023	2024	14	5%
Wind + BESS	2022	2023	2024	24	10%
Solar + BESS	2022	2023	2024	18	10%
PHES	2022	2023	2030	60	14%
Geothermal	2022	2023	2026	36	14%
SC CT - Aero	2022	2023	2024	22	12%
SC RICE	2022	2023	2024	22	15%
CCCT	2022	2023	2025	36	14%

As a basis of adjusting previous NorthWestern Plan inputs as well as observed costs from other data sources, the following levels of inflation were considered. The assumed 2021 inflation rate is based on published Consumer Price Index (CPI) data. The same rate of inflation for 2021 was assumed for 2022 based on the continued inflationary environment observed since the beginning of 2022 and at the time of estimate development. The inflation rates assumed for 2023 and later are consistent with those assumed in the National Renewable Energy Laboratory (NREL) 2021 Annual Technology Baseline (ATB). The assumed 2021 and 2022 inflation rates are higher than those observed in other recent industry IRPs/publications but commensurate with as-received bid data/actual project developments.

Figure 48: Inflation Assumptions.

Inflation	2021	2022	2023	2024
Assumed Inflation (%)	4.70%	4.70%	2.50%	2.50%

Additionally, IRPs as well as industry publications account for technology-specific cost increases or declines for future planning purposes as a function of industry, material supply and manufacturing influences. The table below summarizes the annual cost adjustment factors utilized to develop the new resource cost metrics for each resource type considered. Like the inflation rate assumptions discussed previously, the 2021 and 2022 rates are based on observed market trends/bid data. Cost adjustment factors for 2023 and 2024 are assumed at levels resulting in resource costs that do not change year-over-year when considering inflation rates for the same years, representing a continued inflationary environment and continued supply chain disruptions. The rates for 2025 and on are based on NREL 2021 ATB data. As with the inflation rates, published IRP data and industry publications generally showed expectations of cost declines in 2021 and 2022 as compared to the increases actually experienced and observed from bid data received and project developments pursued in 2021 and 2022.

[33] Contributed by Aion Energy LLC

Figure 49: **Technological Specific Cost Increase/Decrease (%)**

Resource	2021	2022	2023	2024
Wind	5.00%	10.00%	-2.44%	-2.44%
Solar PV	5.00%	10.00%	-2.44%	-2.44%
BESS	5.00%	10.00%	-2.44%	-2.44%
Wind + BESS	5.00%	10.00%	-2.44%	-2.44%
Solar + BESS	5.00%	10.00%	-2.44%	-2.44%
PHES	5.00%	10.00%	-2.44%	-2.44%
SC CT - Aero	0.00%	10.00%	-2.44%	-2.44%
SC RICE	5.00%	10.00%	-2.44%	-2.44%
CCCT	0.00%	10.00%	-2.44%	-2.44%

9.2. Forward Curves[34]

Rapid deployment of renewables has caused significant changes to SPP market price dynamics. Continued disruption of physical processes and market economics is expected as renewables reach 60% of system energy over the next decade. As renewable penetration rises, the shifting of the supply stack drives general price depression, in line with the slope shown in Figure 50 and Figure 51, while reflecting steeper supply stack slopes at periods of high demand than at periods of low demand.

Figure 50: **Price Depression in the DA**

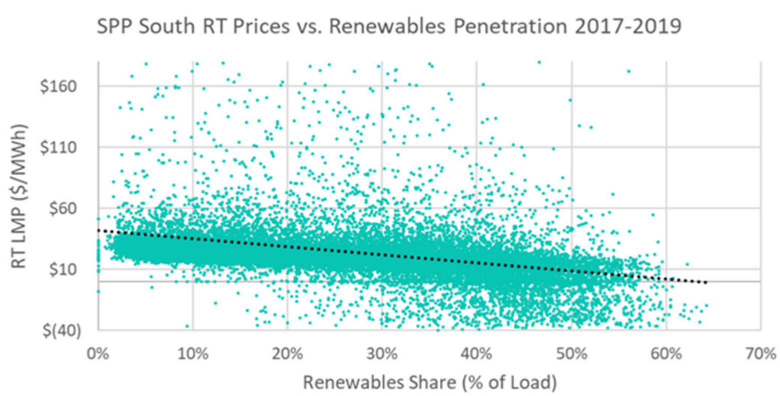


Figure 51: **RT Markets as a Function of Renewable Penetration**

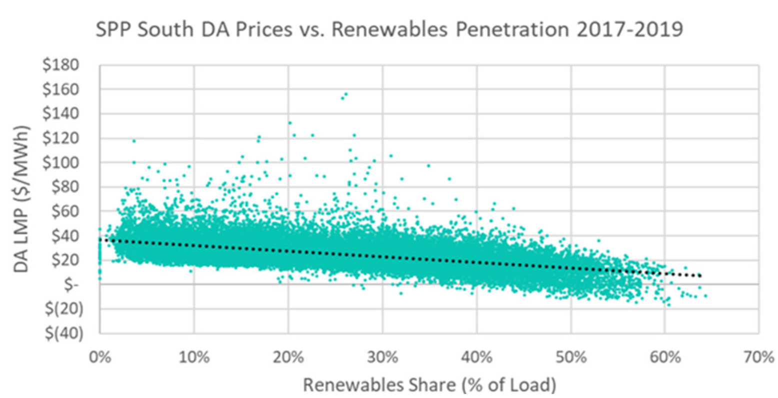


Figure 52 shows the acceleration of price depression and negative price formation at high renewable penetrations in SPP, while Figure 53 demonstrates accelerating growth in curtailment in SPP in recent years. High solar penetrations already cause regular negative price formation during afternoons in CAISO, and these dynamics will emerge with forecasted solar growth in SPP as well. Recent load depression of commercial sector electricity demand from COVID-19 amplifies this phenomenon. See Chapter 7 for additional discussion on forecasted prices used in each modeling scenario.

[34] Contributed by Ascend Analytics

Figure 52: Negative Price Formation as a Function of Renewable Penetration

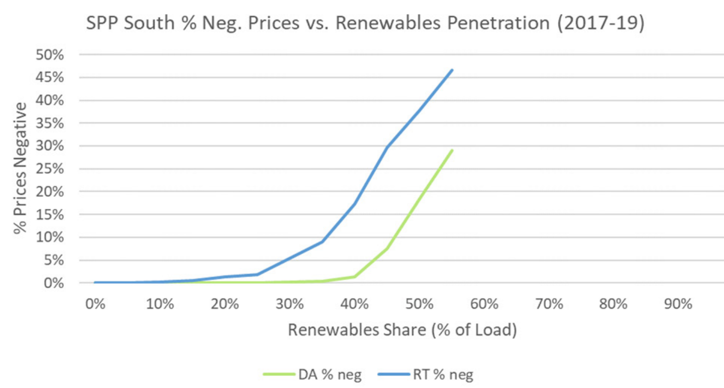
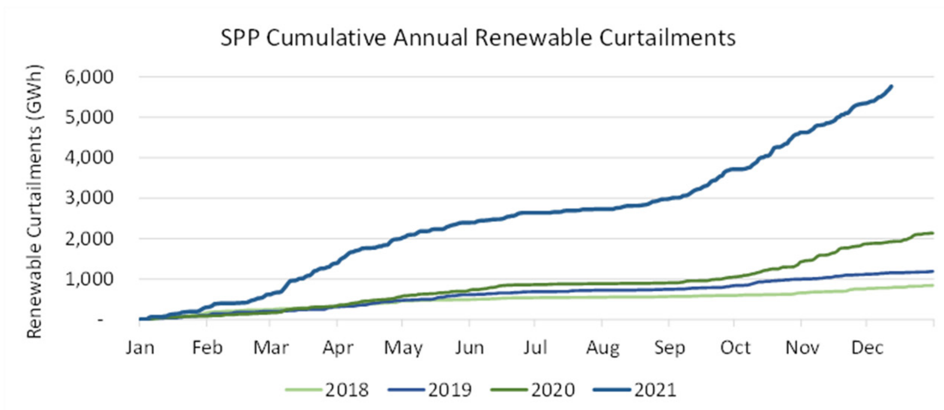
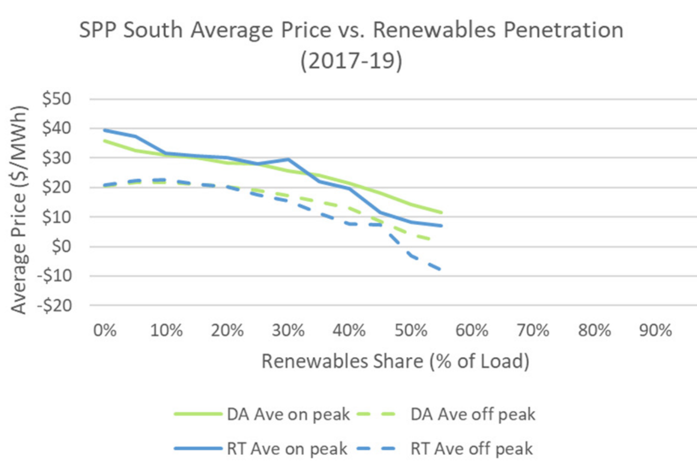


Figure 53: Annual Growth in Renewable Curtailment in SPP



In addition to Ascend's fundamental modeling, Figure 54 indicates minimal to no curtailment at renewable penetrations below 10-20%, slowly rising curtailment and frequency of negative prices as renewable penetrations rise to 40%, followed by a rapid increase in curtailment and negative prices at renewable penetrations above 40%. As renewable curtailment becomes increasingly common at high renewable penetrations, zero/negative prices will accordingly weight the average prices.

Figure 54: Average DA On- and Off-Peak Prices



9.3. Data Tables

The tables below contain the underlying data associated with graphics presented in the 2022 IRP.

Figure 55: Capacity Need Data (corresponds with Figure 2 and Figure 9)

Year	Coal	Natural Gas/Diesel	Wind	Cap Contracts	Future Industrial Load Sensitivity	Annual Peak + Reserve Margin Req
2021	210	102	26	60	386	386
2022	210	150	27	15	387	384
2023	210	150	27	0	405	399
2024	210	150	27	0	412	403
2025	210	150	27	0	419	407
2026	210	130	27	0	426	411
2027	210	130	27	0	433	415
2028	210	126	27	0	440	419
2029	210	126	27	0	447	424
2030	210	126	24	0	454	428
2031	210	126	24	0	461	432
2032	210	126	24	0	468	436
2033	210	126	24	0	475	440
2034	210	126	24	0	482	444
2035	210	126	22	0	489	448
2036	210	126	22	0	496	453
2037	210	126	22	0	503	457
2038	210	126	22	0	510	461
2039	210	126	18	0	517	465
2040	210	126	18	0	524	469
2041	154	126	0	0	531	473
2042	111	126	0	0	538	477

Figure 56: Expected Resources Data (Corresponds to Figure 8)

Stage	Battery/Storage (MWh)	Hybrid (MWh)	Solar (MWh)	Thermal (MWh)	Wind (MWh)
DISIS Stage	13,215	5,163	40,394	6,035	28,615
Facility Study Stage	-	-	896	-	1,303
IA Pending	340	-	1,328	-	1,644

Figure 57: Existing and Accredited Capacity by Fuel Type (Corresponds to Figure 12)

Type	Coal	Natural Gas	Diesel	Wind Owned	Wind Contracted
Nameplate Capacity (MW)	210	154	47	80	85
Accredited Capacity (MW)	210	115	35	18	10

Figure 58: Projected Peaks Data (Corresponds to Figure 14)

Year	Forecast Winter Peak (MW)	Forecast Summer Peak (MW)
2021	313	344
2022	309	343
2023	313	347
2024	316	350
2025	319	354
2026	322	358
2027	326	361
2028	329	365
2029	332	368
2030	335	372
2031	339	376
2032	342	379
2033	345	383
2034	348	386
2035	351	390
2036	355	394
2037	358	397
2038	361	401
2039	364	404
2040	368	408
2041	371	412
2042	374	415

Figure 59: Historic Energy Production Data (Corresponds to Figure 19)

Year	Coal	Gas/Diesel	Wind	Net Purchases	Load
2012	1,469	5	95	10	1,579
2013	1,356	20	85	206	1,668
2014	1,404	10	93	123	1,630
2015	979	5	284	346	1,615
2016	853	15	501	286	1,655
2017	825	9	476	331	1,640
2018	961	33	487	285	1,765
2019	837	45	609	320	1,811
2020	682	28	623	411	1,744
2021	725	55	608	357	1,745

Figure 60: Forecast Total Energy Data (Corresponds to Figure 20)

Year	Forecast Energy (GWh)
2020	1,745
2021	1,741
2022	1,796
2023	1,817
2024	1,837
2025	1,857
2026	1,877
2027	1,898
2028	1,918
2029	1,938
2030	1,958
2031	1,979
2032	1,999
2033	2,019
2034	2,039
2035	2,059
2036	2,080
2037	2,100
2038	2,120
2039	2,140
2040	2,161
2041	2,181
2042	2,201

Figure 61: Average Annual Forecast Power Prices (Corresponds to Figure 34, Figure 38, and Figure 39)

Year	High Gas		Base Case		Carbon	
	Off Peak	On Peak	Off Peak	On Peak	Off Peak	On Peak
	(Nominal $)					
2022	$39.31	$69.52	$39.31	$69.52	$39.31	$69.52
2023	$50.58	$74.58	$34.53	$50.46	$34.53	$50.46
2024	$52.17	$74.01	$26.08	$37.00	$26.08	$37.00
2025	$48.97	$76.86	$24.49	$38.43	$24.49	$38.43
2026	$47.06	$72.58	$23.53	$36.29	$24.78	$38.28
2027	$46.82	$69.86	$23.41	$34.93	$25.84	$38.68
2028	$45.20	$65.03	$22.60	$32.51	$26.05	$37.64
2029	$44.74	$62.40	$22.37	$31.20	$26.84	$37.62
2030	$44.24	$59.89	$22.12	$29.94	$26.72	$36.35
2031	$43.04	$57.48	$21.52	$28.74	$26.18	$35.14
2032	$41.73	$55.15	$20.87	$27.57	$25.55	$33.96
2033	$40.37	$52.53	$20.19	$26.27	$24.90	$32.59
2034	$39.95	$51.86	$19.97	$25.93	$24.82	$32.41
2035	$38.36	$49.56	$19.18	$24.78	$24.02	$31.22
2036	$37.09	$47.53	$18.55	$23.76	$23.40	$30.17
2037	$36.16	$46.12	$18.08	$23.06	$22.98	$29.51
2038	$35.81	$46.12	$17.91	$23.06	$22.95	$29.76
2039	$34.65	$44.50	$17.32	$22.25	$22.38	$28.94
2040	$33.42	$43.07	$16.71	$21.53	$21.76	$28.25
2041	$33.16	$42.83	$16.58	$21.41	$21.77	$28.34
2042	$33.82	$43.68	$16.91	$21.84	$22.40	$29.16

Figure 62: Average Annual Forecast Gas Prices (Corresponds to Figure 35 and Figure 40)

Year	High Gas	Base Case	Carbon
	Ventura	Ventura	Ventura
	(Nominal $)		
2022	$7.08	$7.08	$7.08
2023	$7.93	$5.37	$5.37
2024	$8.70	$4.35	$4.35
2025	$8.45	$4.23	$4.23
2026	$8.62	$4.31	$4.31
2027	$8.80	$4.40	$4.40
2028	$8.97	$4.49	$4.49
2029	$9.15	$4.58	$4.58
2030	$9.33	$4.67	$4.67
2031	$9.52	$4.76	$4.76
2032	$9.71	$4.86	$4.86
2033	$9.91	$4.95	$4.95
2034	$10.10	$5.05	$5.05
2035	$10.31	$5.15	$5.15
2036	$10.51	$5.26	$5.26
2037	$10.72	$5.36	$5.36
2038	$10.94	$5.47	$5.47
2039	$11.16	$5.58	$5.58
2040	$11.38	$5.69	$5.69
2041	$11.61	$5.80	$5.80
2042	$11.84	$5.92	$5.92

Figure 63: **Additional Need for Peaking Capacity Data (Corresponds to Figure 46)**

Year	Owned Thermal	Owned Wind	Contracted Wind	Cap Contracts	Future Industrial Load Sensitivity	Annual Peak + Reserve Margin Req
2015	360	0	0	19	328	328
2016	360	0	0	30	376	376
2017	352	19	5	30	376	376
2018	352	19	5	35	370	370
2019	309	21	9	40	373	373
2020	322	15	8	50	367	367
2021	312	17	9	60	386	386
2022	361	18	10	15	387	384
2023	361	18	10	0	405	399
2024	361	18	10	0	412	403
2025	361	18	10	0	419	407
2026	341	18	10	0	426	411
2027	341	18	10	0	433	415
2028	337	18	10	0	440	419
2029	337	18	10	0	447	424
2030	337	18	7	0	454	428
2031	337	18	7	0	461	432
2032	337	18	7	0	468	436
2033	337	18	7	0	475	440
2034	337	18	7	0	482	444
2035	337	18	4	0	489	448
2036	337	18	4	0	496	453
2037	337	18	4	0	503	457
2038	337	18	4	0	510	461
2039	337	18	0	0	517	465
2040	337	18	0	0	524	469
2041	280	0	0	0	531	473
2042	237	0	0	0	538	477
2043	237	0	0	0	545	482
2044	237	0	0	0	552	486
2045	237	0	0	0	559	490

9.4. Acronyms

A

AC – Alternating Current

AERO – Aero-derivative

AGS1 – Aberdeen Generating Station 1

AGS2 – Aberdeen Generating Station 2

Aion – Aion Energy LLC

AMI – Advanced Metering Infrastructure

Ascend – Ascend Analytics

B

BART – Best Available Retrofit Technology

BESS – Battery Energy Storage System

Big Stone – Big Stone Plant

BSER – Best System of Emission Reduction

C

CAA – Clean Air Act

CASIO – California Independent System Operator

CCR – Coal Combustion Residuals

Coyote – Coyote Station

CT – Combustion Turbine

D

DA – Day Ahead

DANR – Department of Agriculture and Natural Resources

DC – Direct Current

DEQ – Department of Environmental Quality

DOC – Department of Commerce

E

ELCC – Effective Load Carrying Capability

EPA – Environmental Protection Agency

F

FERC – Federal Energy Regulatory Commission

FIP – Federal Implementation Plan

G

GDP – Gross Domestic Product

GHG – Greenhouse Gas

Glanzer – Bob Glanzer Generating Station

GWh – Gigawatt Hours

H

I

ICAP – Installed Capacity Accreditation

IDNR – Iowa Department of Natural Resources

IRP – Integrated Resource Plan

ITC – Investment Tax Credit

ITP – Integrated Transmission Planning

J

K

kV – Kilovolt

L

Li-Ion – Lithium-Ion

LOLE – Loss of Load Expectation

JOU – Joint Owned Unit

LRE – Load Responsible Entities

M

MATS – Mercury and Air Toxics Rule

MISO – Midcontinent Independent System Operator

MP – Market Participant

MWh – Megawatt Hours

N

ND – North Dakota

Neal – Neal Unit 4

NERC – North American Electric Reliability Corporation

NNG – Northern Natural Gas

NorthWestern – NorthWestern Energy

NOX – Nitrogen Oxides

NPC – Net Planning Criteria

NPV – Net Present Value

NRC – Nuclear Regulatory Commission

NREL – National Renewable Energy Laboratory

NSPS – New Source Performance Standards

O

OEM – Original Equipment Manufacturer

O&M – Operation and Maintenance

P

PEM – Polymer Electrolyte Membrane

POI – Point of Interconnection

PPA – Power Purchase Agreements

PRB – Powder River Basin

PRM – Planning Reserve Margin

PTC – Production Tax Credit

PV – Photovoltaic

Q

QF – Qualifying Facility

R

RECS – Renewable Energy Credits

RFP – Request for Proposal

RICE – Reciprocating Internal Combustion Engine

RT – Real Time

RTO – Regional Transmission Organization

S

SC – Simple Cycle

SD – South Dakota

SIP – State Implementation Plan

SMR – Small Modular Reactor

SPP – Southwest Power Pool

T

TU – Transmission Using Member

TO – Transmission Owning Member

U

UCAP – Unforced Capacity Methodology

UMZ – Upper Missouri Zone

USFWS – U.S. Fish and Wildlife Service

V

VER – Variable Energy Resource

W

WAPA – Western Area Power Administration

X

Xe – X-Energy

Y

YGS – Yankton Generating Station

Z

Zone 19 – Upper Missouri Zone

ZPC – Zonal Planning Criteria

#

2022 Plan – 2022 Integrated Resource Plan

9.5. – Glossary

A

Acre-foot – A unit of volume used for reservoirs (1 acre-foot = 43,560 cubic feet).

Ancillary Services – Those services that are necessary to support the transmission of capacity and energy from resources to loads while maintaining reliable operation of the transmission system in accordance with good utility practice. These services include, among others, Regulation and Frequency Response, Reactive Power, Contingency Reserve, incremental and decremental capacity.

Arbitration – A process in which an impartial third party is hired to help multiple parties resolve disputes.

Attainment – National ambient air quality standards (NAAQS) air quality status for an area with concentrations of criteria pollutants that are below levels established by NAAQS.

Available Transmission Capacity – (ATC) Available transmission capacity after considering firm commitments.

Average Annual Energy – The total amount of energy, measured in kWh or MWh, delivered over a period of one year divided by 8,760 hours per year.

Avoided Costs – Incremental cost to an electric utility of electric energy or capacity which, but for the purchase from the Qualifying Facility, such utility would generate itself or purchase from another source.

B

BAL-001-2 – FERC approved NERC standard for Real Power Balancing Control Performance or Reliability Based Control (RBC).

Baseload – The minimum amount of electric power delivered or required over a given period at a constant rate.

C

<u>Capacity</u> – The maximum electric output that a facility can produce under certain conditions.

<u>Capacity Factor</u> – The ratio of actual output to potential output over a period of time. Normally calculated by actual output in MWh divided by the product of nameplate capacity times 8,760 hours.

<u>Contingency Reserves</u> – As defined by NERC Standard BAL-002-WECC-2a, capacity held for deployment in the event of a contingency such as a generator or transmission trip. Contingency Reserve is comprised of Spinning and Non-spinning Reserves.

<u>Cooling Degree Day</u> – (CDD) A measurement used to indicate a building's cooling (air conditioning) energy consumption, defined relative to an outside (base) temperature, below which the building needs no cooling.

<u>Criteria Pollutants</u> – EPA identified pollutants under the 1970 Clean Air Act amendments setting standards for total suspended particulates, sulfur dioxide, nitrogen oxide, ozone, carbon monoxide, and lead.

<u>Customer-generator</u> – A user of a net metering system.

D

<u>DEC</u> – Capacity to decrease generation output on short notice (sub-hourly, typically within the 10 to 15 minute timeframe). Also called decremental capacity.

<u>Demand</u> – The highest rate of electrical use during a period of time.

<u>Demand Response</u> – Programs used by utilities as resource options for balancing supply and demand with methods such as time-based rates, peak pricing rates, and direct load control.

<u>Demand Side Management</u> – The potential for reduction of consumer demand for energy through various methods such as financial incentives and behavioral change.

<u>Deterministic</u> – Process or model in which the output is fully determined by inputs, thus containing no variability or risk.

<u>Dispatchability – </u>The ability of a generating resource to deliver its output on demand.

<u>Distributed Energy Resources</u> – Small generation resources, energy storage, energy efficiency, and demand response resources on the distribution system, substation, or behind a customer meter that store or produce electricity and are not otherwise included in the formal NERC definition of the Bulk Electric System or at levels below 100kV.

E

<u>Economic Derate</u> – A reduction in generation due to availability of cheaper energy.

<u>EIM</u> – Western Energy Imbalance Market is a real-time bulk power trading market system that automatically finds the lowest-cost energy to serve real-time customer demand. The Balancing Areas joining the EIM remain responsible for their reliability standards as well as the requirement to enter with sufficient capacity.

F

<u>Flexible Capacity Resource</u> – A resource that can be dispatched (operated) relatively quickly to provide ancillary services such as regulation, spinning reserve, non-spinning reserve, INC, or DEC. This could include storage and demand response as well as generation.

<u>Fly Ash</u> – Non-combustible residual particles from the combustion process carried by flue gas.

<u>Fundamental Market Relationships</u> – The market price for electricity is governed by supply and demand economics, and is partially dependent on the market price of natural gas, through the spark spread and, more directly, the heat rate of natural gas-fired generation.

G

Geothermal Energy – Heat energy generated and stored in the Earth, which can potentially be converted to create steam to generate electricity.

Gross Domestic Product (GDP) – Measure of all goods and services produced in a country.

H

Heating Degree Day – (HDD) A measurement used to indicate a building's heating energy consumption, defined relative to an outside (base) temperature, above which the building needs no heating.

Heat Rate – The amount of thermal energy (Btus) required by a generating unit to produce 1 kWh of electrical energy, expressed in this Plan as the higher heating value heat rate.

Heavy Load Hours – (On-Peak Hours) The periods of the week designated as traditionally having higher energy use; defined as hour ending 7 through hour ending 22 (inclusive) from Monday – Saturday.

Higher Heating Value – (Heat Rate) A specific measure of the heat of combustion, the total energy released as heat, which is determined by bringing all products of combustion back to pre-combustion temperature and condensing any vapor produced.

I

INC – Capacity to increase generation output on short notice (sub-hourly, typically within the 10 to 15 minute timeframe). Also called incremental capacity.

Independent System Operator – An independent Federally regulated entity established to coordinate regional transmission in a non-discriminatory manner and to ensure the safety and reliability of the electric system. ISOs typically include day-ahead and real-time markets for energy and ancillary services, with some including capacity markets.

Intercontinental Exchange – A trading platform that helps to define markets through an electronic exchange including energy commodities and other products.

Illiquid – (Market) Condition where commodities are not easily sold or exchanged for cash without significant loss in value or due to a lack of buyers and sellers.

Implicit Price Deflator – A metric that measures the changes in the value of goods and services.

Implied (Market) Heat Rate – A calculation of the day-ahead electric price divided by the day-ahead natural gas price. (Note that only a generation source with an operating heat rate efficiency below the calculated value can make money in the market.)

Implied Volatility – A measure of future potential market price moves; high IV indicates large price swings (either positive or negative) while low IV indicates smaller price swings.

Inadvertent Generation – An unintended power exchange that was either not agreed upon or in an amount different from the amount scheduled, and is usually attributed to the variable energy resources.

Integration – (Resource use) The process of adding new generation resources and rebalancing the operations of existing resources in a portfolio to continue to meet load and other balancing authority requirements, including regulation reserves, imbalance service, and scheduling.

Interconnected – (Transmission Grid use) The condition of being electrically connected and in synchronous operation with the electric transmission system operated by a BA.

Intermittent – (Resource use) Not continuously available, random, or varying in output.

Inverter – An electronic device that converts direct current (DC) to alternating current (AC), i.e., solar PV generation to grid-compatible power.

J

Jointly-Owned Coal-Fired Units (JOU) – A coal facility owned by multiple parties. These parties may be in different states and markets.

K

L

Light Induced Degradation – The initial process of declining efficiency in solar PV cells after first exposure to sunlight. It results in a permanent reduction in nameplate capacity.

Light Load Hours – (Off-Peak Hours) The periods of the week designated as traditionally having lower system demand; hours not included in the definition of Heavy Load Hours.

Liquid – (Market) Condition where many buyers and sellers exist and commodities can be easily exchanged for cash without significant loss in value.

Load – The net use of electric power from the transmission and distribution system for customers or devices.

Load Following – The use of on-line generation, storage, or load equipment to track the intra- and inter-hour changes in customer loads, similar to regulation, but over longer periods of time.

Load Responsible Entities (LRE)[35] – A participant in SPP's market that owns load or participates in firm Export Interchange Transactions.

Load Shifting – Moving the time period of a portion of electricity demand from higher demand hours to lower demand hours.

Loss of Load Expectation – (as defined by NERC) The expected number of days per year for which available generating capacity is insufficient to serve the daily peak demand (load). The LOLE is usually measured in days/year or hours/year. The convention is that when given in days/year, it represents a comparison between daily peak values and available generation. When given in hours/year, it represents a comparison of hourly load to available generation. LOLE is sometimes referred to as loss of load probability (LOLP). Also see LOLP.

Loss of Load Probability – (as defined by NERC) The proportion (probability) of days per year, hours per year, or events per season that available generating capacity/energy is insufficient to serve the daily peak or hourly demand. This analysis is generally performed for several years into the future and – the typical standard metric is the loss of load probability of one day in ten years or 0.1 day/year. Also see LOLE.

The NWPCC uses a metric, which establishes a minimum threshold LOLP standard of 5% for the Columbia River Basin (Region).

M

Marginal Unit of Generation – The next higher cost of generating an additional MWh (energy) compared to the current cost of energy supply.

Market Taker – An entity that must accept whatever price the market dictates.

Mass-based – EPA CPP methodology for reducing CO2 emissions by using goals specifying the total weight of CO2 emissions measured in tons of CO2.

Mean – (Statistical) Average or expected value of a set of values.

Meaningful Uncertainty – A stochastic modeling term that recognizes the need to produce plausible ranges of results that inform rather than providing results which effectively have no useful application.

Mean Reversion – The assumption that prices will eventually move towards the average price over time.

---

[35] See Home - Southwest Power Pool (spp.org)

Microgrid – A localized electrical grid or system with at least one distributed energy resource and one demand source which is considered as controllable load from a utility or that can be disconnected from the traditional grid.

Minimum Down Time – (Generator use) A constraint on the least amount of time that a generating unit must be off after shutdown, typically due to necessary maintenance.

Minimum Up Time – (Generator use) A constraint on the least amount of time that a generating unit must be on once it starts, typically to minimize thermal stresses in the equipment.

MISO[36] – (Midcontinent Independent System Operator) is an independent, not-for-profit, member-based organization responsible for operating the power grid across 15 U.S. states and the Canadian province of Manitoba.

Mode – (Statistical) The most often occurring value in a set of values.

Monte Carlo – Modeling method that uses probability distributions for input values that have uncertainty, and produces distributions of possible outcomes.

Mountain Prevailing Time – Time of day based on the Mountain Time Zone and either Standard or Daylight Saving Time, whichever is applicable.

Must-take – (Resource use) A plant that requires, by physical design or contractual agreement, that the owner or purchasing customer accept all power production as it is generated.

N

Nameplate Capacity – The maximum rated generating output of a facility under specific conditions defined by the manufacturer.

NERC – North American Electric Reliability Corporation is a nonprofit corporation formed by the electric utility industry to promote the reliability and adequacy of bulk power transmission in the electric utility systems of North America.

Net Energy Metering – (NEM) Measuring the difference between the electricity distributed to and the electricity generated by a customer-generator that is fed back to the distribution system during the applicable billing period.

Net Present Value – The present value of future cash flows at a determined rate of return, used to discount future values back to today's dollars for a cost comparison of multiple projects, for example, alternative energy supply portfolios.

New Source Review – A CAA permitting program that requires industrial facilities to install modern pollution control equipment when they are built or when making a change that increases emissions significantly (as defined by EPA).

NGX – (TMX Group Limited – NGX) A Canadian natural gas exchange, trading, and clearing market.

Nodal Prices – Prices for a commodity such as electricity and natural gas determined by location or supply (interconnect) points and conditions of supply and demand associated with that location.

Non-attainment – (NAAQS use) Air quality status for an area with concentrations of criteria pollutants that are above levels established by NAAQS.

Non-Spinning Reserves – Also known as "Operating Reserve – Supplemental." Reserves that are not online but are capable of coming online to serve demand within 10 minutes or interruptible loads that can be removed from the system within a similar timeframe.

Northwest Power Pool – A voluntary organization of utilities in the Northwestern U.S., British Columbia, and Alberta Canada focusing on reaching maximum benefits of coordinated operations of its members.

---

[36] See Home (misoenergy.org)

NREL SAM – National Renewable Energy Laboratory's system advisor model for systems-based analysis of solar technology improvement.

NREL Wind Toolkit – A national dataset of meteorlogical conditions and turbine power for over 126,000 sites across the U.S. provided by the National Renewable Energy Laboratory.

O

Off-Peak Hours – Those hours defined by NAESB business practices, contracts, agreements, or guides as periods of lower electric demand and also may be those hours not included in On-Peak Hours.

On-Peak Hours – Those hours defined by NAESB business practices, contracts, agreements, or guides as periods of higher electric demand and also may be the Heavy Load hours for the months of January, February, July, August, and December.

Open Access – Federal Energy Regulatory Commission (FERC) Order 890: provides for non-discriminatory access to jurisdictional transmission systems to all eligible customers. NorthWestern has an Open Access Transmission Tariff.

Opportunity Resource – Those generation resources, either existing or new-build, which remain unknown as to their availability until an opportunity to purchase arises. Opportunity resources cannot be known or modeled in a resource planning process, but will be evaluated in a manner consistent with portfolio evaluation methodology in the 2022 Plan.

Optimization – Process of determining the lowest NPV utilization of resources to reliably meet energy, capacity, and ancillary needs.

P

P5 – The 5th percentile of a sample is the value below which 5% of all values within that sample occur.

P95 – The 95th percentile of a sample is the value below which 95% of all values within that sample occur.

Pacific Prevailing Time – Time based on the Pacific Time Zone and either Standard or Daylight Saving Time, whichever is applicable.

Parasitic Load – The power consumed by a generating device or system for its own operation and/or when not generating, such – as transformer losses in a solar PV system at night.

Particulate Matter – Microscopic solid or liquid particles suspended in the Earth's atmosphere.

Peak Demand – The highest hourly net energy consumption for load.

Peak Shaving – Process of reducing the amount of energy purchased from a utility – company during peak demand hours.

Performance Ratio – (Solar PV system) Ratio between actual annual production of AC energy and the theoretical annual production of energy.

Pet Coke – (Petroleum coke) A solid by-product of oil refineries that can be used as a fuel.

Photovoltaic – An electricity generation system that converts sunlight (photons) into electric current (voltage) within a semiconductor panel.

PM10 – Particulate matter smaller than 10 microns in diameter.

Point of Interconnection (POI) – A location where two or more networks connect with one and other.

Portfolio – A specified mix of actual resources or selection by software, of various combinations of resources used to meet electric load demand.

Powder River Basin (PRB) – A region in the United States where coal is heavily mined.

PPA – (Power Purchase Agreement) is a contract between the utility and generation facility owner that defines the terms of the purchase and sale of energy and/or capacity production.

Prevention of Significant Deterioration – (as defined by EPA) A CAA New Source Review permitting program that applies to new major sources or major modifications at existing sources for pollutants where the area in which the source is located is in attainment or unclassifiable with the NAAQS. It requires the following:

1. installation of the "Best Available Control Technology" (BACT);
2. an air quality analysis;
3. an additional impacts analysis; and
4. public involvement.

Price-Taker – Company or resource that is not significant enough to influence the price of a good or service.

Procurement – The process of acquiring new resources.

Pro Forma – (Accounting use) A statement of a company's financial activities excluding unusual or non-recurring transactions.

Pulverized Sub-Bituminous Coal – Coal in the form of a fine powder that is commonly used to be burned to create steam which then used to power turbines that create electricity.

Pumped Hydro Energy Storage – A type of hydroelectric energy storage used by electric power systems for load balancing. The method stores energy in the form of gravitational potential energy of water, pumped from a lower elevation reservoir to a higher elevation.

PVsyst – Photovoltaic generation modeling software designed by PVsyst SA.

Q

Qualifying Facility – A small power production or cogeneration facility that meets either the renewable fuel or secondary recovery criteria for the generation of electricity and capacity, set forth by PURPA, including all pertinent requirements of Code of Federal Regulations Title 18 Conservation of Power and Water Resources and state law corollaries.

R

Ramp Rate – Speed at which a generator can increase or decrease generation, typically measured in units of MW/minute during the ramp period.

Regional Haze Rule – (CO2 Emissions use) EPA CPP methodology for reducing CO2 emissions that uses goals specifying the ratio of pounds of CO2 emissions to the net energy produced, measured in units of (lbs. CO2/net MWh).

Rate-based – (Resource use) A utility-owned generation resource in which the costs to purchase or build the resource are paid by the utility's customers through billed electric rates.

Rate of Return – The profit on an investment over a period of time, expressed as a proportion of the original investment.

Realtime – The balancing and marketing of electric energy in the present-time as opposed to any future time. Also referred to as 24 hours a day, seven days a week.

Regional Transmission Organization – An independent Federally regulated entity established to coordinate interstate transmission facilities in a non-discriminatory manner and to ensure the safety and reliability of the electric system.

Regression model – A technique to analyze a dependent variable's reaction to changes in other independent (explanatory) variables.

Regulation – An ancillary service consisting of reserves that are responsive to automatic generation control and are sufficient to provide normal regulating margin..

Reliability – Adequacy and security of the transmission system to operate properly under stressed conditions.

Reliability-Based Control – Refers to NERC Standard BAL-001-2, Real Power Balancing Control Performance. Among other things, the Standard requires a Balancing Authority to operate such that its Area Control Error does not exceed defined limits for more than 30 consecutive clock minutes. The Standard becomes effective July 1, 2016.

Renewable – A type of energy, or resource that generates the energy, that is produced from essentially sustainable fuel, such as falling water, wind, geothermal, or solar radiation.

Renewable Energy Credit – One megawatt-hour of renewable energy generation from an eligible renewable resource (defined by § 69-3-2003, MCA).

Reserve margin – Excess generating capacity above expected peak demand normally used in recovering from contingencies (unexpected events) within the BA.

Risk premium – A monetary value associated with the risk of a specific portfolio, defined as the integral of the cost distribution above the mean.

S

Scrubbers – Systems that remove particles or gases from industrial exhaust streams.

Solar PV – (see Photovoltaic) An electricity generating resource that uses sunlight as fuel to create an electric charge in semiconductor panels.

Southwest Power Pool (SPP)[37] – A regional transmission organization (RTO): a nonprofit corporation mandated by the Federal Energy Regulatory Commission (FERC) to ensure reliable supplies of power, adequate transmission infrastructure, and competitive wholesale electricity prices on behalf of its members.

Spark Spread – The gross-generation profit margin earned by buying natural gas and burning it to produce electricity (compared to purchasing electricity from the market), which depends on energy prices and generator efficiency (heat rate), measured in units of ($/MWh).

Spinning Reserves – Also known as “Operating Reserve – Spinning.” Must be online and immediately and automatically responsive to frequency deviations and fully deployable within 10 minutes.

SPP Business Practices[38] – An administrative elaboration and clarification of the OATT for the purpose of administering the OATT. They establish a basis for consistent application of OATT provisions.

Stochastic – A process in which there is inherent randomness; where the same inputs will produce a distribution of outcomes through iterative sampling of variables.

Sub-bituminous – An intermediate coal with properties between lignite and bituminous coal.

T

Time of Use – A variable rate structure that charges customers a rate dependent on the time of day and season the energy is used.

Tolling PPA – A power purchase agreement where the buyer provides fuel as needed to meet the generation which is controlled and purchased by the buyer.

Total Transmission Capacity – Total designed and approved transmission capacity of a transmission path (TTC).

[37] See Home - Southwest Power Pool (spp.org)

[38] See Home - Southwest Power Pool (spp.org)

Transmission Constraint – A condition where the electric transmission system is not able to transmit power to the location of demand, due to congestion at one or more points of the transmission network.

Transmission Owning Member (TO)[39] – An SPP member that has placed more than 500 miles of non-radial facilities operated at or above 60 kV under the independent administration of SPP for the provision of regional transmission service as set forth in the Membership Agreement.

Transmission Using Member (TU) – An SPP member that does not meet the definition of a Transmission Owning Member.

Turbine – A rotary mechanical device that extracts energy from a fluid (i.e. water) or the wind and converts it into work, such as turning a rotor.

U

Upper Missouri Zone (UMZ; Zone 19)[40] – The rate pricing zone initially consisting of the following facilities that meet the requirements of Attachment AI, upon the transfer of those facilities to the functional control of the Transmission Provider: (i) the facilities of Western-UGP within the Eastern and Western Interconnections; (ii) the facilities owned or leased by Basin Electric Power Cooperative or Heartland Consumers Power District within the EasternUtility System – The interconnected grid within the BA area consisting of generation, transmission, and distribution equipment.

U.S. Bureau of Economic Analysis[41] – An independent, principal federal statistical agency that promotes a better understanding of the U.S. economy by providing timely, relevant, and accurate economic accounts data in an objective and cost-effective manner.

V

Variable Energy Resource – A renewable energy source that is non-dispatchable either due to its fluctuating nature or must-take contract requirements.

Volatility – The degree of variation of a market price over a period of time.

W

Waste Coal – A usable material byproduct of a previous coal processing operation.

Waste Coke – (Petroleum coke) A solid by-product of oil refineries that can be used as a fuel.

Weighted Average Cost of Capital – The rate that a company is expected to pay on average to all its security holders to finance assets. It is used to discount all costs back to present value in order to compare portfolio cash flows in the future. At the time of this Plan, NorthWestern used a WACC of 7.24%.

X

Y

Z

Zero discharge – Permit requirement prohibiting waste water discharge from a site.

[39] See Home - Southwest Power Pool (spp.org)

[40] See Home - Southwest Power Pool (spp.org)

[41] See U.S. Bureau of Economic Analysis (BEA)