APPENDIX P: BASELOAD RETIREMENT STUDY

CONTENTS

Introduction to Baseload Retirement Study

Minnesota Power (or the "Company") submits this Baseload Retirement Study to the Minnesota Public Utilities Commission ("Commission") as part of its Integrated Resource Plan ("IRP"), in compliance with Order Point 6.a. of its January 24, 2019 Order Approving Affiliated Interest Agreements with Conditions, in Docket No. E-015/AI-17-568 ("January 2019 Order"). In that Order, the Commission required Minnesota Power, in its next IRP filing, to include the following information:

> A baseload retirement analysis that thoroughly evaluates and includes a plan for the early retirement of Boswell 3 and 4, individually and in combination . . . .[1]

This Baseload Retirement Study (or "Study") complies with this Order point by evaluating the considerations and stating a plan for early retirement of Boswell Energy Center Units 3 ("BEC3") and 4 ("BEC4") prior to the end of their potential useful lives. This Study is also part of the Company's 2021 IRP, which provides in-depth evaluation of multiple resource futures that include both reference case and early retirement scenarios for BEC3 and BEC4. The Study itself discusses the factors relevant to BEC early retirement considerations and brings together additional data and analyses in the broader IRP that is pertinent to planning for early retirement of the BEC facility. As described later in this Study, the Company's preferred plan in the IRP – its "2021 Plan" – ultimately supports retirement of BEC3 as of December 31, 2029 and retirement of BEC4 no earlier than December 31, 2035 (after the conclusion of the IRP planning period).

In developing a plan for the early retirement of BEC3 and BEC4, the Company evaluated the following scenarios:

1. 2021 Plan: BEC3 retires in 2029 and BEC4 retires no earlier than 2035;[2]
2. "Expedited" Retirement of BEC3 and BEC4: BEC3 retires in 2025 and BEC4 retires in 2030;
3. Retire BEC3 as Early as Feasible: BEC3 retires in 2025; and
4. Retire BEC4 as Early as Feasible: BEC4 retires in 2030.

These four scenarios were chosen for further evaluation in the IRP because they reflect the earliest feasible retirement dates for these units. This feasibility baseline is premised on an aggressive implementation schedule for improvements to the transmission system necessary to ensure continued safe and reliable service for customers that meets all applicable federal and state standards, factoring in advancements in carbon free technology, and considering the significant host community impacts. In general, these scenarios reflect that retiring BEC3 earlier than BEC4 is feasible based upon (i) the relative transmission infrastructure improvements (based on potential impacts) that would be required to ensure continued system reliability in the absence of each Unit; (ii) the larger role that BEC4 plays in the Company's system as its largest baseload generator; and (iii) the need to ensure regional reliability as a generation asset. A primary takeaway from this Baseload Retirement Study is that a thoughtful transition plan will be crucial to ensuring safe and reliable operations for the region, particularly from transmission and reliant community perspectives.

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[1] *In re Minnesota Power's Petition for Approval of the Energy**Forward** Res. Package*, Docket No. E-015/AI-17-568, Order Approving Affiliated Interest Agreements with Conditions at 29 (Jan. 24, 2019) [hereinafter January 24 Order].
[2] The retirement occurs at the end of the year. For example, for the remainder of the document a 2025 retirement refers to the unit being retired on December 31, 2029.

Boswell Energy Center Introduction

The Boswell Energy Center, located in Cohasset, Minnesota, consists of Minnesota Power's last remaining coal plant units and only source of baseload power. Overall, BEC3 and BEC4 currently generate a combined 823 MW.[3] In 2018, property taxes from BEC accounted for nearly 70 percent of Cohasset's tax base, nearly 20 percent of the Grand Rapids School District tax base, and 13 percent of Itasca County's tax base. Further, BEC currently provides direct, full-time, highly-skilled jobs to approximately 170 Minnesotans, as discussed in more detail in the study, *Minnesota's Power Plant Communities: An Uncertain Future* at 19, included at Appendix M.

While there is presently no formal retirement date set for either unit, BEC3 and BEC4, as well as BEC common facilities, will be fully depreciated by the end of 2035. Meanwhile, the remaining balance on these units presently totals approximately $725 million, excluding decommissioning costs, due in significant part to major environmental retrofits that occurred in 2009 for BEC3 and 2015 for BEC4. At this time, and barring unforeseen circumstances, the Company does not anticipate major additional investments in the form of further environmental retrofits for either Unit through 2035.

Study Objectives and Scope

The objective of this Baseload Retirement Study is to evaluate scenarios for the orderly and cost-effective retirement of Minnesota Power's remaining coal units, BEC3 and BEC4, in compliance with the Commission's January 2019 Order. The scope of this evaluation consists not only of resource plan scenario creation and other important considerations, but also regional transmission planning in coordination with the Midcontinent Independent System Operator ("MISO"). This Baseload Retirement Study will also support the inputs for the resource plan evaluation and decisions presented in the overall IRP.

General Approach

The general analytical approach to evaluating potential scenarios for the early retirement of BEC3 and BEC4 is through the use of EnCompass modeling as part of the IRP, in addition to evaluating other significant considerations, such as ensuring local and regional transmission system reliability, incorporating input from stakeholders, customer impacts and considering socioeconomic impacts of the retirement of baseload generation. This overall evaluation in the IRP and Baseload Retirement Study also enables consideration of a variety of nuanced cost factors, including (as discussed in more detail in Appendix J to the IRP): 1) the remaining value of the asset being retired; 2) the cost of physical decommissioning and restoration of the site; 3) the replacement cost of additional generating supply; 4) the cost of transmission upgrades required to maintain reliability; and 5) the avoided environmental costs or carbon regulation and environmental externality costs. Likewise, it is important to assess the effect of these factors on customer power supply costs, as well as the time it will take to build replacement generation and/or new transmission to maintain customer reliability.

This is the first time that Minnesota Power is utilizing EnCompass to model retirement scenarios for the retirement of a baseload generation resource in its IRP. It is likewise the first time any Minnesota utility is initiating a baseload retirement study and IRP using EnCompass from the outset. However, EnCompass is merely the modeling tool utilized to assess various

[3] BEC4, totaling 585 MW, is co-owned by Minnesota Power and WPPI Energy. Minnesota Power owns 80 percent of BEC4 at 468 MW, and WPPI owns 20 percent at 117 MW.

scenarios. As noted above, other factors, not all of which are quantifiable in firm costs or specific to BEC3 and BEC4, must also be considered in creating the retirement scenarios.

The Commission's January 24, 2019 Order included the following additional discussion regarding Minnesota Power's carbon emission goals:

> Minnesota's Next Generation Energy Act establishes goals for reducing statewide greenhouse gas emissions to a level at least 15% below 2005 levels by 2015, at least 30% below 2005 levels by 2025, and at least 80% below 2005 levels by 2050.
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> ***
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> While the EnergyForward package is a step in the right direction, it does not address the biggest obstacle to Minnesota Power achieving state emission-reduction goals in the long term: the Company's continued reliance on the two coal-fired generators at its Boswell Energy Center. These two generators (Unit 3 and Unit 4) have a combined capacity of more than 800 MW, and though the units are scheduled to be fully depreciated in 2034–2035, the Company has not committed to any plan for their retirement.[4]

Thus while this Baseload Retirement Study addresses BEC3 and BEC4 and the IRP addresses these goals from a broader fleet and resource planning perspective, it is important to underscore Minnesota Power's other significant contributions to reducing greenhouse gas emissions in the state. Consistent with Minnesota Power's *Energy**Forward*** strategy, the Company's renewable transformation has been underway for a number of years, and the Company reached its key milestone of 50 percent renewable energy for its customers in December of 2020. This level of reduction makes Minnesota Power a leader among the utilities in its region. The Company also has the highest portion of renewable energy on its system, as a percentage of total system generation, of any Minnesota utility. Minnesota Power in January of 2021 announced its long term vision to reach a carbon-free power supply by 2050, this vision sets the course for continuing to exceed the current state statute goals and sets ambitious targets for the future. This background underscores Minnesota Power's overall renewable transformation goals and achievements, of which the BEC (including the past retirement of BEC1&2) is a part.

As part of its overall evaluation, the Company also engaged with MISO regarding potential retirement of BEC3 and BEC4 as allowed under the MISO tariff, and as discussed in detail in Appendix F, Part 7, and referenced below. Because Minnesota Power is a member of MISO, any generating unit closure on the Minnesota Power system will be required to utilize the MISO Attachment Y (unit closure) process to enable retirement from the bulk electric grid, which is therefore a vital consideration in the Company's approach to retirement.

Finally, Minnesota Power engaged in a first-of-its-kind stakeholder process, where the Company was able to learn priorities and considerations from a diverse group of stakeholders, which informed the overall IRP and this Baseload Retirement Study. The stakeholder meetings took place over the course of about a year and a half, formed the framework for evaluation of BEC3 and BEC4 retirement, and allowed participants the opportunity to contribute their insights regarding Minnesota Power's future energy mix and the impacts of transitioning the current power system under the *Energy**Forward*** strategy. This process and insights is described in more detail later in this Study and in the IRP at Appendix R.

[4] January 2019 Order at 24 (citations omitted).

Evaluation Framework

As noted above, identifying the appropriate timing for any future retirement of a coal-fired, baseload asset is a complex evaluation that includes consideration of the utility's current and future power supply needs, impacts to the reliability of the transmission system, and the time it will take to implement transmission system reliability and replacement energy solutions for the retired units. Once a decision is made and it becomes necessary to move forward with mitigating solutions, subsequent large transmission project and/or large resource addition implementation timelines may take 10 years or more depending on the scope and scale of the solutions. And because BEC3 and BEC4 are the only remaining baseload generators in Minnesota Power's system, the only generation of this size and operations in all of northern Minnesota, and provide jobs and support to the local communities, early retirement presents a particularly wide variety of customer, community, and local and regional transmission factors must be considered.

Due to the significance of the potential impacts to Minnesota Power's system, the regional grid, and the community, Minnesota Power combined its traditional resource planning methods with detailed evaluation of potential important impacts of early retirement of BEC3 and BEC4. In evaluating plans for early retirement, and based on the feedback gathered during its Stakeholder Process, Minnesota Power considered the impacts of four, significant perspectives:

1. Minnesota Power's system and to the region.
2. Impacts to host community.
3. Impacts to Minnesota Power's customers.
4. Impacts to the environment.

Each of these perspectives forms a section of this Study, discussed in more detail below. Each also plays a role in the feasibility of various BEC3 and BEC4 early retirement timeframes, resulting in the identification of the specific early retirement scenarios outlined at the beginning of this study.

Remainder of Study

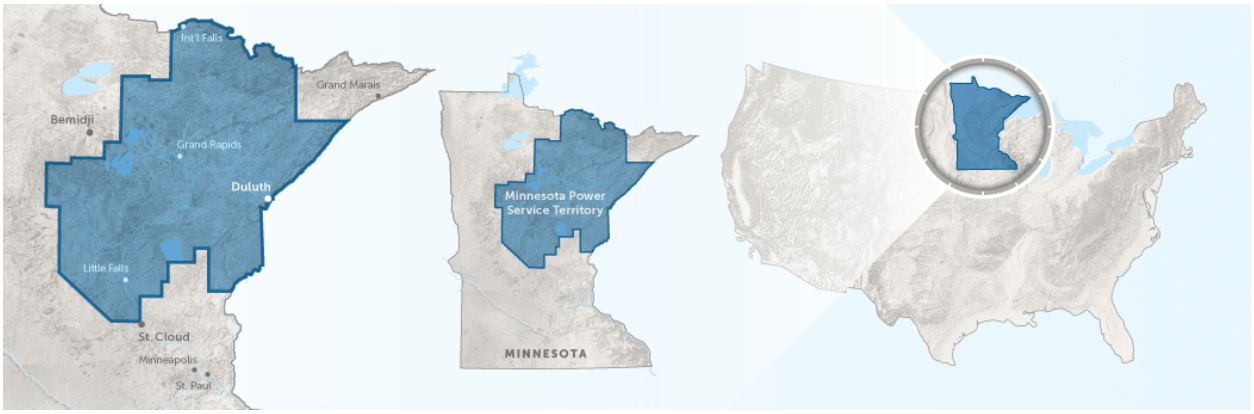
The Company's Baseload Retirement Study begins by providing additional background on ALLETE, Inc., Minnesota Power's generation portfolio, the Company's *Energy**Forward*** strategy, and the BEC. It continues by addressing the stakeholder process by which the Company structured its approach to BEC3 and BEC4 retirement considerations. The Study then turns to an in-depth evaluation of each of the four primary perspectives on early retirement noted above, referring to additional data in other parts of the IRP as appropriate and to avoid redundancy. Next, the Study turns to the feasibility of the identified early retirement scenarios (2021 Plan, Expedited retirement of both units, Early retirement of BEC3, and Early retirement of BEC4). Ultimately, the economic modeling through EnCompass and the presentation of the Company's 2021 Plan is detailed in the main body of the Company's IRP and its associated appendices. Lastly, the Company summarizes the insights derived from this study, and next steps associated with BEC retirement decision-making processes. In this Study and the IRP, the Company recommends, based on a wide variety of considerations, that BEC3 be moved to economic dispatch in 2021 and retired at the end of 2029, that BEC4 be retired no earlier than 2035, and that the Company continue to investigate economic operations of BEC4 in the near term, all without change to the current depreciation schedule for either Unit at this time.

Background

Minnesota Power

At the risk of repeating other portions of the Company's 2021 IRP, it is worth providing some Company background that is relevant and specific to the Baseload Retirement Study. Minnesota Power is a public utility operating division of ALLETE, Inc. First incorporated in 1906, Minnesota Power serves electricity to more than 145,000 residential and commercial customers, 15 municipal systems, and some of the nation's largest industrial customers across a 26,000 square mile service area in central and northern Minnesota. Figure 1, below, shows the general area of Minnesota where Minnesota Power serves customers.

Figure 1: Minnesota Power Service Area

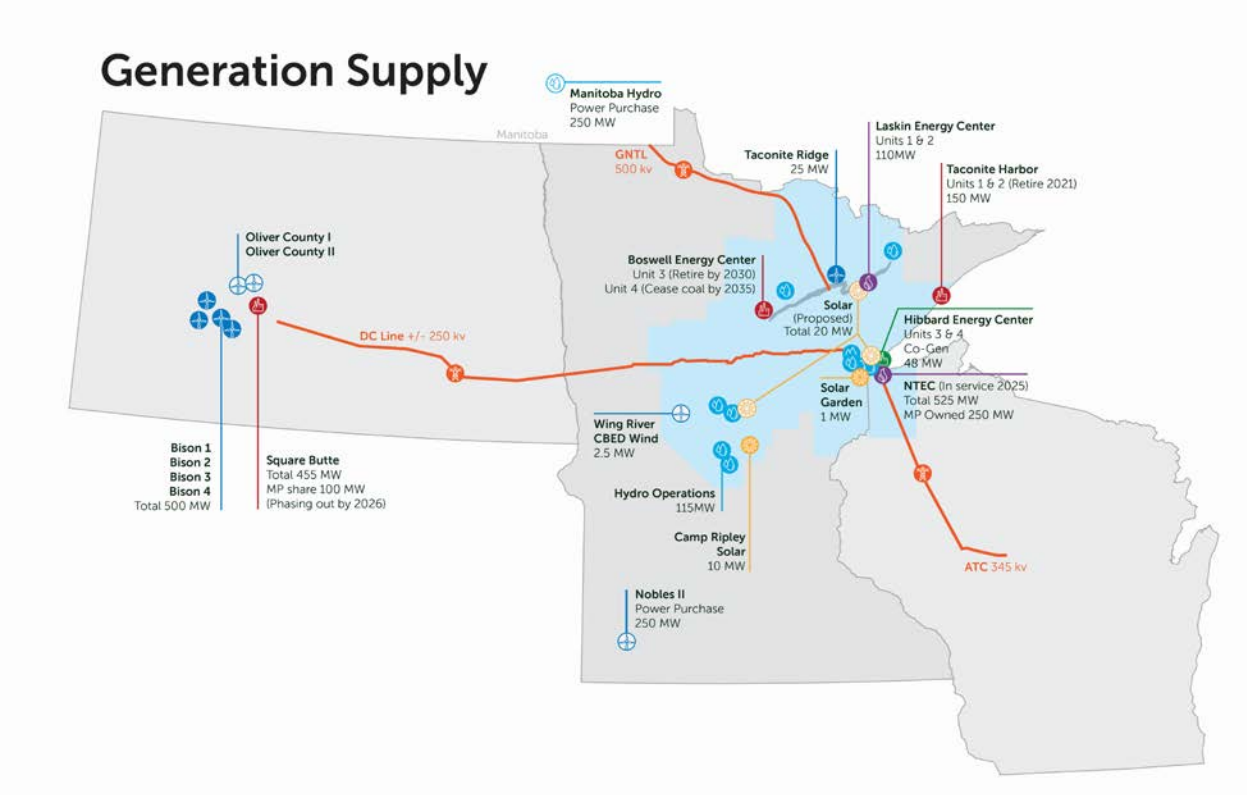


As explained further in Section I of the IRP, Minnesota Power has one of the most unique load profiles in the region and country, with one of the highest industrial customer concentrations. According to the Energy Information Administration ("EIA"), Minnesota Power had the ninth highest industrial customer concentration out of 179 investor owned utilities, including related subsidiaries, with industrial customers currently representing approximately 74 percent of retail kWh energy sales as of 2019. This industrial concentration is much different than other utilities in the state and most of the nation.

Minnesota Power's Current Generation Portfolio

Minnesota Power currently owns a combination of wind, hydro, solar, coal, biomass, and small amounts of natural gas generation to serve its customers, with a net maximum capability of nearly 1,650 MW. The Company's system is changing significantly. In addition to significant coal retirements (nearly 700 MW by 2021) and the increased reliance on renewable resources, Nemadji Trail Energy Center ("NTEC"), which is scheduled to begin operation in 2025, will add renewable-enabling natural gas generation to Minnesota Power's system. Minnesota Power also maintains power purchase agreements ("PPAs") with Manitoba Hydro, NextEra Energy Resources, and Tenaska, as well as sale agreements with neighboring utilities, and further explained in Appendix C, Part 2. Below, Figure 2 provides a graphical representation of Minnesota Power's generating portfolio.

Figure 2: Minnesota Power Generating Supply



On the distribution and transmission front, Minnesota Power maintains more than 9,000 miles of electric transmission and distribution lines with over 150 Federal Energy Regulatory Commission ("FERC") reportable substations. This total includes mileage for the Great Northern Transmission Line ("GNTL"), which went into service in 2020, and facilitates delivery of additional carbon-free hydroelectric energy. In addition, Minnesota Power has a stake in CapX2020 transmission lines. The Company continues to make additional transformational investments in substation and transmission infrastructure to modernize its aging infrastructure and maintain local and regional reliability through the transition of idling, re-missioning, or retiring the region's coal fired baseload generation facilities.

*Energy**Forward** Strategy*

For more than a decade, Minnesota Power has been advancing a transformation of its power supply to a cleaner energy future through its *Energy**Forward*** strategy. Through successful implementation of its vision, the Company is exceeding state greenhouse gas ("GHG") emissions goals. Specifically, as part of this transition Minnesota Power has either retired or refueled seven of its nine coal-fired generating units, including BEC1&2. Minnesota Power continues its *Energy**Forward*** strategy with approved resource additions, which have so far created a power supply that is providing customers with 50 percent renewable energy, a significant milestone the Company achieved in December 2020. The Company has also reduced carbon emissions by 50 percent, compared to 2005 levels.

Overall, Minnesota Power is exceeding its goals for carbon reduction and is assisting the state in its mission to have a lower carbon-intensive future by doing more than is required. All told, Minnesota Power's thermal generation has been decreasing since 2013 due to baseload generation facility retirements, while the Company has been adding predominantly renewables

to augment the power supply. Minnesota Power has also more than doubled its renewable energy since 2014, particularly with the 2020 additions of Manitoba Hydro and the Nobles 2 wind farm. This transformation has made Minnesota Power a state and regional leader in clean energy, while at the same time providing affordable and reliable electric service for customers.

While these changes have greatly reduced Minnesota Power's carbon emissions, the addition of renewable generation has created a new profile for Minnesota Power's supply portfolio that is less dispatchable and more intermittent in nature as compared to the Company's previous baseload operations. This is because the new renewable generation that has been added does not provide energy 7 days a week, 24 hours a day on command like the dispatchable thermal generation Minnesota Power previously held, and like BEC3 and BEC4 currently provide. The result is a generation output profile that is much more variable than in the past. As generation availability changes due to power supply transition, and more intermittent generation is added, additional factors like wind availability increase the uncertainty of the total generation energy production available hourly, daily, or annually. The Company's hourly surplus/deficit can currently vary significantly during high-wind and low-wind conditions each day, just due to the Minnesota and North Dakota wind in the portfolio.

Looking forward to 2021 and beyond, the Company continues to implement its *Energy**Forward*** strategy as reflected in its 2021 IRP. In this Baseload Retirement Study, the Company provides potential impacts to its overall power supply portfolio as a result of the early retirement of BEC3 and BEC4, against the backdrop of the *Energy**Forward*** transformation.

Boswell Energy Center

Overview

BEC3 and BEC4 are currently the backbone of Minnesota Power's dispatchable power supply, which serves customers' energy needs and provides essential reliability services to the region. The BEC, located in Cohasset, Minnesota and depicted below in Figure 3, is Minnesota Power's largest thermal facility and only remaining source of coal-fired generation.

Figure 3: Boswell Energy Center, Cohasset, Minnesota

At its peak, Boswell generated coal-fired power from four operating units, which were constructed over a period from 1958 to 1980. In 2016, the facility had an overall net generation capability of 1,065 MW. BEC1&2, however, were retired from operation in 2018. The two

remaining operating units, BEC3 and BEC4, have a combined capability of approximately 935 MW. These two units have historically provided approximately half the energy needs of Minnesota Power's customers.

More specifically, BEC3 was commissioned in 1973, followed by BEC4 in 1980, to serve the region's growing natural resource industrial electric loads. The net generating capability of BEC3 is 350 MW, after turbine efficiencies were made to this asset in 2009. BEC4 is Minnesota Power's largest baseload generator. Subsequent turbine efficiency investments in BEC4 during 2010 expanded the net generating capability of this unit to 585 MW. WPPI Energy (formerly Wisconsin Public Power, Inc.) has a 20 percent (117 MW) ownership interest in BEC4, which makes available to Minnesota Power 818 MW of combined capacity. WPPI coordinates with Minnesota Power on facility management. Both BEC3 and BEC4 have undergone major environmental control system retrofits, completed in 2009 and 2015, respectively, as discussed in more detail below.

With the BEC1&2 retirements in late 2018, in addition to other fleet changes that have occurred with the ***Energy*Forward*** strategy, the BEC staff completed a workforce planning exercise to align and optimize the staffing resources needed to operate the facility and support the remaining fleet after retirement of BEC1&2. This workforce planning exercise resulted in the elimination of 57 positions and a new operations and maintenance structure at BEC. This exercise also resulted in a rescaled support services group of technical and professional staff called "Generation Operations" at Minnesota Power's central support services group. This new BEC organizational structure is comprised of approximately 170 people at BEC3 and BEC4, and Fuel Handling.

The BEC1&2 assets remain in place, disconnected from the utility system, and have been retired in a way so as to not pose a safety or environmental risk to the BEC staff and site. Because BEC1&2 were the first units to be constructed and placed in service at Boswell, certain total-facility infrastructure was integrated into the BEC1&2 assets. Portions of BEC1&2 infrastructure are needed to support BEC3 and BEC4 through retirement, including the intake structure, service water pumps, electrical infrastructure, and condensate make-up water systems. Prior to retirement, BEC1&2 also provided the steam heating needs of the entire BEC. With the retirement of BEC1&2 in 2018, a new auxiliary steam system had to be engineered and installed. This new auxiliary steam system now provides BEC heating needs from either BEC3 or BEC4 operating during the winter months.

Major Environmental Retrofits

BEC3 and BEC4 are well-run generation units that reliably, safely, and economically meet customer needs and applicable environmental requirements. As of 2009 and 2015, respectively, BEC3 and BEC4 largely completed major multi-emission retrofit work that was approved by the Commission in Docket Nos. E-015/M-06-1501 and E-015/M-12-920.

Specifically, in 2009 Minnesota Power replaced BEC3's original turbine with a more efficient design that is able to operate at 389 MW gross capability and 350 MW net output without increasing the steam flow or consuming additional fuel. In combination with this upgrade, a major environmental upgrade was completed at BEC3 to meet state and federal environmental requirements. Following the retrofit, the facility now employs low NO_x burner, over-fire air, and a selective catalytic reduction system for NO_x control, a spray tower absorber which is also commonly referred to as wet flue gas desulfurization for SO_2 control, and an activated carbon injection system and fabric filter for mercury and PM control. BEC3 operates at a high load factor, providing base load energy in the Minnesota Power system.

In 2010, Minnesota Power replaced Boswell 4's original turbine with a more efficient design that is able to operate at over 635 MW gross capability and 585 MW net capability, without increasing the steam flow or consuming additional fuel. In essence, the Company added 50 MW of zero-emission, dispatchable, capacity and energy as a result of this efficiency improvement project. BEC4, like BEC3, also operates at a high load factor. BEC4 operates with NO_x emission reduction control systems including low NO_x burners and selective non-catalytic reduction, along with a high efficiency turbine rotor.

On November 5, 2013, in Docket No. E-015/M-12-920, Minnesota Power received Commission approval for its BEC4 mercury emission reduction plan.[5] In 2015, Minnesota Power largely completed the environmental retrofit project on BEC4 as a multi-pollutant solution for reducing mercury, PM, SO_2, and other hazardous air pollutants being addressed by the Environmental Protection Agency ("EPA") regulations, while also reducing plant wastewater contemplated for regulation under EPA's Effluent Limit Guidelines. Minnesota Power installed a semi-dry flue gas desulfurization system, fabric filter, and powder activated carbon injection system to comply with MERA, the EPA Mercury and Air Toxics Rule, and other enacted or pending federal and state environmental rulemakings regulating air and water emissions and solid byproducts from coal-fired power plants. Through multi-pollutant control technology, Minnesota Power cost-effectively achieves the mercury emission reduction required by MERA while positioning the facility for compliance with other regulatory programs over the long term. Current operation and maintenance practices continue with performance of routine maintenance inspections and actions implemented as needed.

As discussed later in this Study, these retrofits allowed BEC3 and BEC4 to continue supporting Minnesota Power customers on a sustainable basis, in compliance with existing environmental regulations, such that additional major retrofits are not currently anticipated. At the same time, a significant amount of the approximately $725 million of remaining balances on Boswell are associated with these investments.

The Company provides this background to illustrate Company's commitment to the *Energy**Forward*** strategy and State of Minnesota policy goals, and the relevant history of the Boswell Energy Center. The Company conducted its early retirement planning with this information as its backdrop.

[5] The Commission's decision was affirmed on appeal in an unpublished Minnesota Court of Appeals' decision. See *In re Minnesota Power's Petitions for Approval of its Boswell Energy Ctr. Unit 4 Envtl. Retrofit Project, Boswell 4 Envtl. Improvement Rider*, No. A14-0253, 2014 WL 5507039 (Minn. Ct. App. Nov. 3, 2014).

Stakeholder Process

In compliance with Commission direction and to engage stakeholders on evaluation of the future of this important generating asset, Minnesota Power engaged in a first-of-its-kind stakeholder process for the IRP and Baseload Retirement Study. The now over year-long process brought together a diverse group that included customers, regional, and statewide stakeholders. Stakeholder meetings allowed participants the opportunity to contribute their insights regarding Minnesota Power's future energy mix and the impacts of transitioning the current power system under the *Energy**Forward*** strategy. As applicable to the Baseload Retirement Study, the Company encouraged the participation of host community members to share their perspectives of BEC3 and BEC4 retirements, and obtained input that guided the Company's evaluation of the four retirement scenarios. Center for Energy and Environment ("CEE"), the Great Plains Institute ("GPI"), and Lasky Consulting (together "Facilitators") were utilized to independently facilitate the stakeholder process. The final Stakeholder Report is located at Appendix R.

Broad Stakeholder Proceedings

First, the Company engaged stakeholders for education and outreach meetings in order to provide a shared base of knowledge about the IRP, the Baseload Retirement Study, and securitization. By way of summary, stakeholders expressed concerns or issues of interest from certain perspectives – Customer, Host Community, and Environment (a fourth Utility (system) perspective was also considered), resulting in a number of individual issues described later in this Study in connection with host community perspectives on baseload retirement. The Company then held joint meetings with stakeholders to further evaluate potential impacts, and better understand "best case" and "worst case" situations in each of these areas. An issue map was developed to reflect these stakeholder perspectives, and is presented in the final Stakeholder Report at Appendix R.

Recognizing that not all customers have the time or expertise to participate in a formal stakeholder process, particularly during a global pandemic, Minnesota Power also engaged all of its customers directly through a survey to better understand customers' opinions and preferences related to their future energy supply. The Company engaged customers directly through bill messages, social media, and the Minnesota Power website. The survey included questions regarding system reliability, affordability, carbon free renewable goals, and local economic impacts. These results are provided at Appendix R.

Effect on Boswell Retirement Planning

Minnesota Power factored these stakeholder perspectives into its assessment of potential BEC3 and 4 retirement scenarios. Specifically, the feasibility of retirement scenarios from a system management perspective presents parameters around the earliest possible dates. Likewise, Minnesota Power understands the environmentally-focused goal of removing coal-fired generation from the Company's system as soon as possible. In contrast, host communities seek a sufficient runway toward retirement, specifically for BEC4, to enable planning and measures to attempt to mitigate the effect of plant retirement on the community. Cost is also of concern to all customers, and the Encompass modeling efforts evaluated the least cost plan for customers that is feasible and factors in both rate and societal impacts of each path. Ultimately, Minnesota Power examined each of these areas in more detail in this Study and in the IRP, as discussed below.

The Four Perspectives on Boswell Energy Center Retirement

In the following sections of this Study, the Company explains its approach to creating the four retirement scenarios for the BEC and evaluating each perspective described above: (1) System and regional reliability considerations for retirement of significant baseload generation at BEC3 and BEC4; (2) Host community, employee, and socioeconomic impacts of BEC retirements; (3) Customer impacts of retirement approaches; and (4) Environmental considerations and impacts.

1. Minnesota Power System and Regional Reliability Perspectives

Minnesota Power has the obligation to ensure adequate resources to safely and reliably serve its customers – utilizing the MISO market appropriately. This requires assessment of the Company's broader load-serving needs and available resources, which is undertaken in the IRP of which this Baseload Retirement Study is a part. With respect to generation retirements, it is necessary to determine the effect of losing more than 800 MW of baseload generation capacity on the Company's ability to serve its customers and its load. This includes consideration of not only the Company's generation capabilities, but also the needs of the local and regional transmission system.

Electric utilities in Minnesota serve retail service areas that are spread throughout the state, and a utility's service area is sometimes non-contiguous. Electric utilities in Minnesota and the upper Midwest (investor owned, cooperatives, and municipal utilities) have worked together for many years to develop a transmission network that will serve our respective native load customers. As a result, electric utilities in Minnesota and the region have highly interconnected transmission facilities that do not necessarily follow the patchwork of retail service area boundaries. This cooperation benefits customers by providing the transmission infrastructure needed to serve our loads at a lower cost than if the Company and neighboring utilities each independently constructed facilities to reach their respective service area loads.

In the IRP, the Company also evaluated the potential impact of a BEC unit's or units' shutdown on the transmission system to identify the potential for significant reliability concerns. Minnesota Power has identified in its transmission evaluation six "pillars" that are key to understanding the significance of BEC to the region and the transmission system impacts from changing operations at BEC, as described in more detail further below in the section on Transmission Planning Activities and in IRP Appendix F, Part 7 (three of the pillars can be better understood as subsets of pillar two). While this initial evaluation is valuable, the ultimate impact of a unit shutdown on the transmission system will be determined through extensive engineering coordination with MISO and other regional counterparties in the event of any formal shutdown decision.

This is a particularly challenging situation for the territory Minnesota Power serves and the surrounding region. If the entire BEC facility were to shut down or transition to economic operation, the entire northern half of Minnesota and a large part of eastern North Dakota could be left with no operating baseload generators. Operating in this manner permanently or for extended periods of time would be a major change for the local area and the region and would result in both local and regional reliability concerns that would need to be addressed. BEC presently provides essential reliability services – electrical support needed to ensure continuous reliable operation of the power system – and energy supply to this unique geographic area. The energy and reliability needs of both demanding large industrial loads and sprawling rural areas must be served while also balancing regional power transfer needs, particularly as regional renewable energy production varies on a minute-by-minute basis.

It is also important to consider that Minnesota Power is also a member of MISO, which operates the combined transmission system of transmission owners in its footprint, including Minnesota Power, and also manages the dispatch of Minnesota Power's generation fleet. Because Minnesota Power operates under the MISO tariff, certain activity, such as the proposed shutdown of baseload generation, is governed by provisions of the MISO tariff, as discussed in more detail below and in Appendix F, Part 7, to the IRP.

An additional question pertaining to the future impacts of BEC3 and/or 4 on Minnesota Power's and the regional system pertains to potential replacement generation. In the IRP, the cost of replacing the capacity and energy lost due to a retirement was included in the customer cost impact through the selection of the least cost alternatives available for each retirement scenario. Alternative technologies included conservation (demand side management), natural gas, wind, solar, energy storage, biomass, and clean coal. More details are provided in Appendix D and Appendix J to the IRP on the type of generation resources and demand side resources included as replacement alternatives, which in turn factored into the Company's selection of the 2021 Plan as identified in the IRP.

Finally, it is also important to consider the potential benefits of site re-use. If BEC3 or 4 or both are shut down and repurposed, use of the existing infrastructure should be thoroughly evaluated and utilized, if possible, in order to ensure efficient and cost-effective use of the system. Notably, the current infrastructure holds significant value for replacement generation as an existing interconnection with the transmission system. Replacement generation at the BEC site that is dispatchable for long periods of time, such as new natural gas generation, also holds significant potential value for alleviating some of the transmission system reliability concerns associated with unit retirements. Finally, reinvestment in communities that have hosted utility generation for decades to help facilitate a just transition was a key insight gained through the formal stakeholder process.

Ultimately, in the event of BEC3 and 4 retirements, the evaluations indicate significant transmission investment and/or in-place dispatchable generation will be needed to serve regional reliability needs, and these solutions will likely require ten years or more to implement from the time a retirement decision is made.

Generation Access

The MISO Market

Minnesota Power's generation is dispatched according to MISO market price signals, which has allowed the Company to optimize the value of its various generation resources. While the Company retains primary responsibility to serve its customers, and in fact each utility must do so for the MISO marketplace to function properly, the MISO market, including the Day-Ahead, Real-Time, and Ancillary Services, has allowed Minnesota Power to make economic use of the wholesale power market. Additional benefits include increased purchase and sale opportunities, more transparent pricing, a reserve sharing pool, and the ability to purchase the energy needed based on customer demand. As Minnesota Power evaluates potential impacts due to the early retirement of significant baseload generation at Boswell, Minnesota Power has identified resource adequacy construct changes as one of two areas of uncertainty that must be considered as part of the resource planning process (transmission reliability concerns, the other area, is discussed below). These concerns are presented in greater detail in Section V of the IRP.

Briefly, however, and pertinent to this Study, prior to organized markets, the utilities traditionally generated most of the electricity needed to serve their customers, and bought or sold any deficit or surplus from or to neighboring utilities. In contrast, under MISO's tariff, utilities

sell all power from their electric generation and other resources into the wholesale market, and purchase power back from the market to provide electric service for their ratepayers. Thus, the MISO market depends on participating members like Minnesota Power to have and install sufficient generation capacity for the market to function, which Minnesota Power considers as part of its resource planning process as resources like BEC3 and BEC4 are evaluated for retirement.

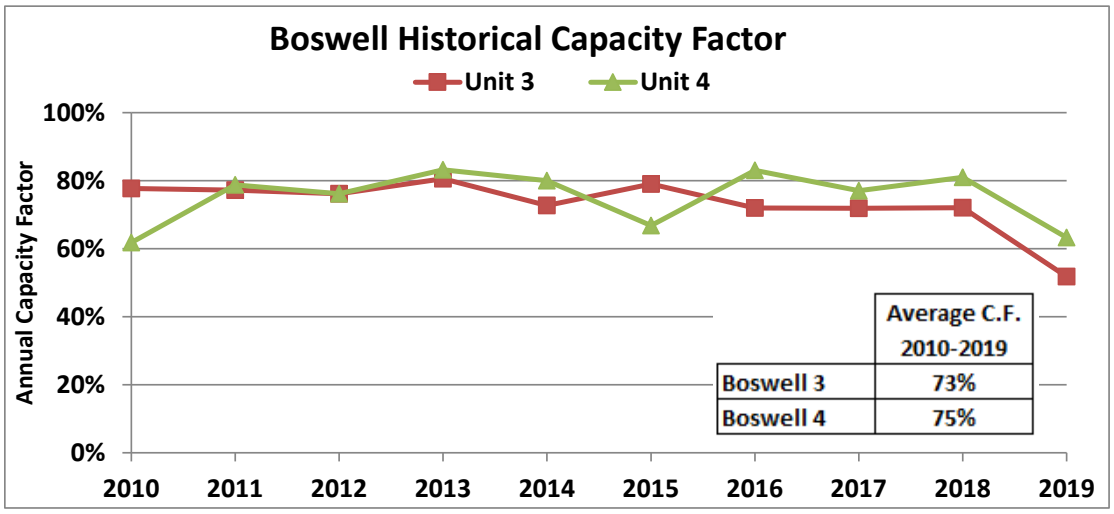
Cost is also a key consideration. The prices at which a utility can expect to sell and purchase energy in the MISO market depend heavily on whether the sale or purchase is during on- or off-peak periods, and the price differential between the on-peak and off-peak time periods from 2015 to 2020 has been approximately 40 percent. Thus, if Minnesota Power needs additional power or has surplus to sell with the MISO market, the price can vary significantly depending on when the energy is needed or available.

Minnesota Power's surplus and deficit profile for MISO purchases and sales has been changing, and with the addition of wind generation, now follows the variable wind generation patterns. When the wind energy availability is higher, Minnesota Power typically has a surplus. When the wind energy availability is lower, however, there is typically a deficit and Minnesota Power purchases energy.

These patterns are relevant to consider in the analysis of potential retirement of BEC3 and BEC4, in multiple respects. As Minnesota Power moves further toward renewable resources with higher quantities of variable wind and solar generation patterns and absent of baseload generation, the Company is more likely to be a buyer than a seller in the MISO market. This can be beneficial when prices are low, but it puts the Company more at the mercy of market variability and pricing it cannot control. And if the Company is typically in need of energy to purchase when wind energy availability is lower, the Company may be purchasing energy when prices are less favorable. Finally, the MISO market can only function properly when each participating utility prepares for sufficient capacity and energy to serve its customers under most circumstances. Over-reliance on MISO would not only create greater pricing risk for customers, it can also put the Company (and other utilities) at risk of insufficient access to capacity and energy necessary to provide reliable electric service.

Current market outlooks show that operation of BEC3 and BEC4 are economical during both on-peak and off-peak hours for the remaining 10 years of depreciable operation (2025-2035), especially for on-peak hours. This is because energy costs for BEC3 and BEC4 are projected to be more level, or have a lower rate of increase, than the wholesale energy market overall. This allows BEC3 and BEC4 to operate as protection against increasing market costs in the plant's lifetime. Historically, market prices have also supported operating BEC3 and BEC4 as baseload generation, which over the period 2010-2019 have had an average capacity factor of 73 and 75 percent, respectively, as shown in the Figure 4 below:

Figure 4: Boswell Energy Center Historical Capacity Factor



This means that BEC3 and BEC4 have typically been online to provide energy cost savings for customers compared to the market. In addition, looking forward, there could be further energy cost volatility in the wholesale market due to the increased retirement of coal units aggregately on the system and due to the addition of renewable generation resources.

In the near term, however, prior to any early retirement, either BEC3 or 4 could be considered for economic dispatch.

Economic Dispatch

Minnesota Power optimizes its resource portfolio within the MISO market to ensure efficient utilization of its generation assets to serve customer energy needs reliably and at least cost. As part of this optimization, it is important to note that BEC was designed and continues to operate as a baseload resource that takes about 12 hours to start up from a cold status and needs extended operational time to manage and normalize emissions in order to meet its environmental permit requirements. However, Minnesota Power recognizes that market conditions are changing and has evaluated what steps are needed for BEC operations to adapt to conditions in the MISO market, including the option to utilize economic dispatch rather than current “must run” operations. With this information, decisions can be made about how a baseload resource should run while in service in addition to deciding how long generation assets like BEC3 and BEC4 should be in service.

In a March 2, 2020 filing in Docket No. E999/CI-19-704, the Commission’s investigation into self-commitment and self-scheduling of large baseload generation facilities, Minnesota Power stated that it was investigating how feasible it would be for BEC3 and BEC4 to move to economic dispatch. Simultaneous with this IRP filing, Minnesota Power is submitting a compliance filing in that docket, in which it summarizes the Company’s evaluation of the feasibility of moving BEC3 and BEC4 to economic dispatch. The Company’s economic dispatch submission also discusses its announcement that it anticipates transitioning BEC3 to economic dispatch in July 2021. This strategy would offer flexibility, and ensure that BEC3 would be available during peak periods, during periods of low renewable production, or to ensure system reliability. Moving BEC3 to economic dispatch will also ensure that lower-cost energy is

available to be dispatched as appropriate, and is part of Minnesota Power's leadership and commitment to transforming its coal generation fleet and committing to being coal-free by 2035.

As further discussed in our filing in Docket No. E999/CI-19-704, the Company will also continue to work with MISO and investigate moving BEC4 to economic dispatch, and will gain significant experience and knowledge from first transitioning BEC3 to economic dispatch. Moving BEC4 to economic dispatch, however, is more complex. As discussed in more detail in the compliance filing, Minnesota Power will work with WPPI, the co-owner of BEC4, on the transition and has identified milestones in the areas of: 1) market readiness; 2) joint ownership; 3) transmission reliability; 4) environmental emission compliance; 5) generating facility impacts; and 6) fuel procurement and fuel operations. These considerations, that Minnesota Power will undertake with WPPI, will be critical to identifying a transition plan that will be acceptable for each BEC4 owner.

Minnesota Power will continue to coordinate with WPPI on a transition plan for BEC4 leading up to retirement, and will provide updates to the Commission in the annual self-commitment and self-scheduling compliance filing.

Local and Regional Transmission Reliability

Transmission Access

As a transmission-owning member of MISO, while Minnesota Power owns and maintains transmission assets, MISO operates the combined system, including Minnesota Power's assets, in conjunction with the transmission systems of more than 50 transmission owners. Furthermore, MISO establishes: (1) the process and rules for wholesale customers to access the transmission system on a non-discriminatory basis; (2) the annual transmission planning process for reviewing, expanding and upgrading the regional transmission system (i.e., MISO Transmission Expansion Planning ("MTEP")); and (3) the policies and procedures that provide for the allocation of costs incurred to construct certain transmission upgrades and the distribution of revenues associated with those costs. Access to the jointly-developed, multi-owned transmission grid is available under the MISO tariff, which dictates how revenues and expenses must be accounted for within the transmission system. However, each utility must also play its part in overall local and regional transmission planning.

MISO Region Reliability Imperative

In December 2020, MISO published the first draft of what it refers to as a "living document" called *MISO's Response to the Reliability Imperative*, which will be updated as MISO's work continues.[6] MISO refers to the "Reliability Imperative" as the shared responsibility it has with states in its region and with utilities to ensure the reliability of the transmission system. MISO states that work conducted under the Reliability Imperative is not optional and cannot be delayed due to long planning horizons for infrastructure.[7] Moreover, MISO states that "[a]s the region's resource mix changes, we must understand what capabilities are needed to maintain reliability and ensure that sufficient amounts of those resource capabilities are available when needed."[8] MISO has organized its work in four areas, including: 1) market redefinition; 2) Long Range Transmission Planning; 3) Operations of the Future; and 4) Market System Enhancements.

[6] This MISO report is available at: https://www.misoenergy.org/about/miso-strategy-and-value-proposition/miso-reliability-imperative/.
[7] MISO Region Reliability Imperative at 1.
[8] *Id.* at 2.

The MISO Region Reliability Imperative has been informed by other MISO initiatives and describes how they are interconnected.[9] For instance, the MISO Region Reliability Imperative notes that "MISO's Renewable Integration Impact Assessment ["RIIA"] concludes that the complexity of planning and operating the grid increases exponentially beyond 30 percent of the load being served by wind and solar, requiring more coordination and advanced action to maintain grid stability at higher renewable penetration levels."[10] While the RIIA addresses transmission system challenges due to retiring baseload generation and replacing with increasing amounts of renewable generation, the MISO Region Reliability Imperative addresses potential easing of these challenges through Long Range Transmission Planning ("LRTP") and additional transmission enhancements.[11] MISO will coordinate LRTP with other transmission-planning programs, such as the MTEP.[12]

Minnesota Power shares the responsibility of ensuring a reliable transmission system for its customers and the region, and in the following section discusses transmission planning activities that would ensure a reliable system for its customers. As the generation mix has changed under the *Energy**Forward*** strategy, and continues to change through the addition of more renewable energy and the potential retirement of traditional baseload generation like BEC3 and BEC4 – as well as across the MISO footprint – the transition must be thoughtful in order to ensure that the transmission system continues to be reliable and safe for customers, while at the same time allowing for flexibility in order to leverage existing infrastructure as much as possible. This is a primary conclusion of this Baseload Retirement Study.

Minnesota Power Transmission Planning Activities

When considering retirement of its remaining baseload generation, Minnesota Power must factor in any potentially resulting reliability concerns regarding operation of the transmission system. That is, if retirement of BEC3 and BEC4 would cause concerns with the reliable operation of the transmission system, those considerations must be recognized and addressed, including allowing for the length of time anticipated to place needed improvements in service prior to retiring the units. If BEC3 and BEC4 were to shut down, the entire half of northern Minnesota and a large part of eastern North Dakota would be left with no operating baseload generators. With little support from the remaining smaller dispatchable generators, the majority of energy requirements and essential reliability services required to serve this area would need to be provided from remote resources.

Shutting down or changing the operational profile of BEC3 and BEC4 would be a major change for the area and, based on recent experience and transmission system analysis discussed in Parts 6 and 7 of Appendix F, would result in local and regional reliability concerns. For example, conversion of Laskin Energy Center to peaking natural gas operations and the closure of Taconite Harbor Energy Center has required investment in multiple local transmission projects over a period of more than 5 years in order to provide the reliability to the system that these coal units once provided, as discussed in more detail in Appendix F, Part 6.

Without having the necessary transmission solutions in place to maintain reliability of the system after unit retirements, there will be reliability risks and uncertainties that are unacceptable under transmission planning and operating regulatory standards and customer expectations. This was demonstrated after the retirement of BEC1&2, when a necessary transmission upgrade, the Boswell Transformer Project, was delayed and subsequent cold

[9] *Id.* at 6.
[10] *Id.* at 3, 6.
[11] *Id.* at 13.
[12] *Id.*

temperatures during the 2019 polar vortex caused a lock out on a transmission circuit breaker, bringing the local transmission system very near to a critical lack of redundancy and voltage support. In that case, service interruptions were fortunately avoided, but the experience reinforces the need to ensure timely implementation of reliability solutions in coordination with unit retirements to avoid impacting the reliable operation of the transmission system.

Therefore, a thoughtful transition plan is crucial to ensure continued safe and reliable operations in this region and must include the development of new operational tools and criteria, coordination with MISO and other affected entities, and preparation of the transmission system to ensure both regional and local reliability is not compromised by changing operations at BEC3 and BEC4. To that end, Minnesota Power conducted a transmission system analysis of BEC3 and BEC4 early retirements, which is located at Appendix F, Part 7 to the IRP, as part of its overall transmission planning activities discussed at length in Appendix F. The Company identified the following "pillars" that are key to understanding the significance of BEC3 and BEC4 to the region, as well as the transmission system impacts from changing operations, including early retirement, and which are discussed in more detail in Appendix F, Part 7:

1. If BEC3 and BEC4 are shut down or transition to non-baseload operation, alternative solutions must be identified that can simultaneously meet the needs and expectations of large industrial sites, serve rural demand, and respond to significant variations in regional transfers across a large geographic footprint.
2. If BEC3 and BEC4 are shut down or transition to non-baseload operation, solutions must be identified that can replace the essential reliability services formerly provided by the local baseload generators on a continuous basis. Based on the Company's assessments, the focus of the discussion of impacts from shutting down BEC3 and BEC4 is on three main aspects of essential reliability services provided by these units: a) Voltage Support and System Strength, b) Local Power Delivery, and c) Regional Power Delivery.
    a. Voltage Support and System Strength: Solutions must be identified that effectively and locally replace the voltage regulation, dynamic voltage support, and short circuit capability formerly provided by the local baseload generators on a continuous basis because these services can't be imported from remote sources.
    b. Local Power Delivery: Solutions must be identified that strengthen delivery paths for energy from remote sources to be delivered to the local transmission system and/or maintain a presence of local dispatchable generation to be delivered to energy consumers in northern Minnesota.
    c. Regional Power Delivery: Solutions must be identified that strengthen the regional transmission network to ensure continued stable and reliable operation in light of new and increased use and/or maintain a presence of local dispatchable generation in northern Minnesota.
3. Subsequent transmission project implementation timelines and/or large resource additions may take ten years or more depending on the scope and scale of the solutions. If BEC3 and BEC4 are shut down or transition to non-baseload operation, solutions must be thoroughly vetted and coordinated with other affected entities through a multi-year process of detailed analysis and project development, including applicable routing, permitting and regulatory review timelines for large transmission projects. Baseload retirement study decisions about resource actions should recognize and allow for a sufficient amount of time for the real-world implementation of these solutions.

Retirement decisions surrounding BEC3 and BEC4, respectively, would likely differ in timing and would require unique planning, which are reflected in the timeline for each of the four early retirement scenarios. Based on the analysis discussed in Appendix F, Part 7, the likely cost, complexity, and magnitude of transmission upgrades to accommodate an early retirement of BEC3 is expected to be less than what is necessary to accommodate an early retirement of BEC4. Critically, the timing of the BEC4 retirement decision must take into account the need for larger and more complex transmission upgrades to address broader and more regional transmission system impacts from retirement of BEC4. Note that locating replacement generation at the BEC site will avoid the more complex transmission upgrades for BEC 4 retirement, but similar to the transmission needs the timing must account for planning and construction. The reliability concerns that must be addressed as a result of generation baseload shutdown, such as ensuring voltage stability, are discussed at length in Appendix F to the IRP.

In addition, the Company discusses several studies assessing the impacts of BEC unit retirements in Appendix F, Part 7. The discussion of these studies begins with regional impacts evaluated through the MISO Generator Retirement Study process (i.e. Attachment Y-2 Study). This MISO study concluded that robust mitigating solutions would likely need to be built before MISO would allow the retirement of BEC units. This discussion then transitions to Minnesota Power's complementary assessments of the regional and local impacts from BEC retirement scenarios to further assess the transmission impacts identified by MISO and identify other, more local transmission system impacts.

Overall, studies discussed in Appendix F, Part 7, include the Northern Minnesota Voltage Stability Study, Beyond Boswell Study, Short Circuit Study, and the Synchronous Motor Starting Analysis. A short synopsis of each study is provided below. Importantly, these studies helped inform the transmission network upgrade cost assumptions used for purposes of modeling different BEC operating scenarios in the IRP, discussed in Appendix F, Part 8, and support the Company's conclusion that a thoughtful approach to baseload retirement is needed in order to implement identified solutions given the long planning horizon to implement such solutions:

- **MISO Generator Retirement (Attachment Y-2) Study:** In August 2018, Minnesota Power submitted an Attachment Y-2 Study request to MISO for a transmission system reliability assessment of various BEC retirement combinations. Mirroring the standard MISO generator retirement study (Attachment Y) process, the Attachment Y-2 Study was an information-only study of various scenarios to identify reliability issues due to the potential retirement of the BEC units. Based on the results of the Attachment Y-2 Study, MISO concluded that robust mitigating solutions would likely need to be built before the retirement of the BEC3 and BEC4 could be allowed.
- **Northern Minnesota Voltage Stability Study:** Minnesota Power conducted the Northern Minnesota Voltage Stability Study in order to build on and further understand the results from the MISO Attachment Y-2 Study and previous Minnesota Power studies. The results from this study helped to clarify the nature, primary drivers, and magnitude of the underlying voltage stability issue from the Attachment Y-2 study, as well as providing insight into how to define, monitor and manage the Northern Minnesota (NOMN) voltage stability interface.
- **Beyond Boswell Study:** The Beyond Boswell Study was performed by Siemens PTI and Minnesota Power in 2016-17, as an early attempt to understand the technical transmission issues surrounding the possible retirement of BEC3 and BEC4. The study included steady state analysis, voltage stability analysis, and transient stability analysis performed on a range of historically challenging peak and off-peak system conditions. In

addition to laying the groundwork for understanding issues later found and analyzed in the Attachment Y-2 and Northern Minnesota Voltage Stability Studies, the Beyond Boswell Study provides insight into other related local transmission reliability impacts associated with following BEC unit retirements.

- **Short Circuit Study:** Minnesota Power's real-world experiences demonstrate the importance of voltage support and system strength that baseload generators provide to the local transmission system. After completing preliminary screening of short circuit levels with and without BEC3 and BEC4 online, Minnesota Power is gathering information and working with MISO to determine the best way to establish and maintain a minimum system strength requirement for the Minnesota Power system to ensure adequate support is provided to the transmission system at all times. As of the writing of this section, the studies and coordination discussions around minimum system strength requirements were still in development.
- **Synchronous Motor Starting Analysis:** Minnesota Power has a number of large industrial customers whose processes place uniquely demanding requirements on the transmission system, including the starting of large electric motors. Based on previous experiences evaluating synchronous motor starting following fleet transition in the North Shore Loop, Minnesota Power commissioned Siemens PTI to study potential impacts on motor starting capability for large power customers on the Iron Range if BEC3 and BEC4 were to be retired. The motor starting study results and the previous generator retirement experiences both indicate that the most effective leading indicator of whether or not large industrial customer motor starting and other processes will be negatively impacted by BEC unit retirements is Minnesota Power's ability to provide a healthy, predictable transmission system voltage similar to what is presently available with the BEC units online.

Value of the Existing Boswell Energy Center Site Infrastructure

BEC3 and BEC4, as they currently operate, provide significant value as baseload generation resources and to maintaining reliability of the transmission system. Above, the Company discusses potential transmission reliability concerns if either units are shutdown or transitioned to new operations for the long term, such as economic dispatch, as presented in more detail in Appendix F.

Nevertheless, if either unit is shut down and repurposed, use of the existing infrastructure should be thoroughly evaluated for further usage to ensure efficient use of the system. Notably, the current infrastructure holds significant value for replacement generation as an existing interconnection with the transmission system. As an example of repurposing existing infrastructure, the Company was able to realize significant cost efficiencies at the LEC by repurposing the existing boilers for peaking natural gas by inserting natural gas burners, and achieved cost savings for customers by repurposing LEC infrastructure for peaking natural gas generation rather than building an entirely new natural gas plant. Historically, at BEC, all four units (before BEC1&2 were retired) shared common infrastructure, such as crucial electrical, water and heating infrastructure, ancillary services and fuel handling, and which today serves BEC3 and BEC4. BEC is also served by a natural gas pipeline that would facilitate conversion of a unit boiler to natural gas. Moreover, use of existing BEC infrastructure would represent continued investment in the Cohasset community and would have important socioeconomic impacts. Replacement generation at the BEC site that is dispatchable, such as new natural gas generation, also holds significant potential value for alleviating some of the transmission system reliability concerns associated with unit retirements.

As technology progresses and new resource carbon free options become cost-effective and available beyond natural gas, the existing infrastructure at BEC could facilitate introduction of these developed technologies as replacement resources for BEC. Planning for a thoughtful, orderly retirement of BEC3 and BEC4 not only permits adequate time to implement transmission improvements needed to continue to provide reliable service to customers, but would also provide time for the development of new and emerging technologies as well as value for facilitating implementation of new replacement resources. For a more detailed discussion of potential future resource options, see Appendix D of the IRP.

In sum, regional reliability requirements present key considerations and fundamental requirements for any early retirement plan for BEC3 and BEC4. MISO market factors, including the ongoing move to renewable, intermittent generation, also each provide both opportunities and challenges for the early retirement of dispatchable resources. While consideration of appropriate replacement resources, including the potential use of BEC's existing infrastructure, may help mitigate these issues, they play an important role in the overall evaluation of feasible and cost-effective scenarios for BEC's future.

2. Community and Socioeconomic Perspectives

Resource planning decisions can have real-life socioeconomic impacts on communities that "host" generation plants, which should also be considered in deciding whether to retire a large generation resource. As part of planning for its IRP, including this Baseload Retirement Study and securitization plan, Minnesota Power worked with the Facilitators of the stakeholder process to conduct an extensive stakeholder process that elicited input on key impacts of resource planning on communities, among other impacts. This process is described above, and in more detail in Appendix R of the IRP. In addition, the Company utilizes three reports evaluating the economic and social impacts of retirement of baseload generation plants on the communities, surrounding areas, and the state, which are provided in whole at Appendix M to the IRP.

Regional Impact Studies

- The first study, entitled "*Minnesota's Power Plant Communities: An Uncertain Future*" and prepared in February 2020 by CEE ("CEE Study"), took a qualitative approach in its evaluation of the social and economic impacts that the retirement of baseload generation plants have on their "host" communities in Minnesota, including BEC for Cohasset. Overall, this study finds that generation plants are important to their host communities and that retirements will be economically impactful, communities must have ample time horizons to plan and prepare for such transformations, and that transition plans should be clear to all involved, including stakeholders like labor unions that have members at plants.

  As it did with other large baseload generation in Minnesota,[13] the study provided findings and survey results from interviews with local officials, community leaders, and residents about the potential impacts that BEC retirement would have on the Cohasset community.[14] The study noted that BEC employs about 170 workers, who live in and around Cohasset and largely in Itasca County, and that property taxes for BEC make up about 70 percent of Cohasset's annual tax base, about 13 percent of Itasca County's tax

[13] The study also considered impacts to host communities for the Sherburne County Generating Station (Becker, MN), the Monticello Nuclear Generating Station (Monticello, MN), the Allen S. King Plant (Oak Park Heights, MN), and the Prairie Island Generating Station (Red Wing, MN and the Prairie Island Indian Community).
[14] CEE Study at 18-26.

base, and about 19 percent of the Grand Rapids School District tax base.[15] According to the study, the Cohasset community is significantly concerned about a potential BEC retirement in how it could negatively impact local taxes and employment.[16] The City Director of Operations and Finance Manager noted that BEC has allowed the city to keep tax rates lower than surrounding communities, such as Grand Rapids, due to tax revenue received from BEC.[17] As for employment implications, there are significant reported concerns over lack of employment alternatives for BEC employees should it retire.[18] One person noted concerns with employment opportunities in general, citing a recent closure of a paper mill.[19] Cohasset officials are also concerned that economic development activities, such as development of a new industrial park, will be insufficient to completely replace the loss of economic activity due to a BEC retirement.[20] In that vein, officials noted that a moved up timeline for retirement would strain long-term economic development efforts.[21] It is the city's hope that if there were an early retirement of BEC, that there will be a replacement on the site, such as a natural gas plant or other generation.[22]

The study also evaluated concerns reported by labor unions, the International Brotherhood of Electrical Workers ("IBEW"), the Laborers' International Union of North America ("LIUNA"), and Boilermakers Local #647.[23] The study noted that a majority of Minnesota Power full-time plant workers are members of IBEW.[24] IBEW's top concern is the loss of jobs for its members.[25] The study noted that IBEW members would likely need employment support as baseload generation plants retire.[26] LIUNA noted that its members are the first workers on a power plant site and are also the last workers on the site.[27] The study reported that a primary concern of LIUNA is that a retired power plant is idled and not deconstructed. LIUNA wants stakeholders in Minnesota to ensure that projects employ local workers.[28] Finally, the study noted that Boilermakers' members have a highly-specialized skillset.[29] The study reported that a primary concern for Boilermakers is that its industry is transitioning away to employment that requires different skills.[30]

- The Minnesota Power Economic Impact Study, prepared in March 2020 by the Business Research Division, Leeds School of Business at the University of Colorado ("Economic Impact Study") in connection with the CEE Study, examined the economic impact to Itasca County and Minnesota of the retirement of BEC3 and BEC4 under two scenarios: 1) retirement of BEC3 in 2030 and BEC4 in 2036 (staggered); and 2) retirement of BEC3

[15] *Id.* at 19.
[16] *Id.* at 20-24.
[17] *Id.* at 21.
[18] *Id.*
[19] *Id.*
[20] CEE Study at 22-23, 25.
[21] *Id.* at 25.
[22] *Id.* at 26.
[23] *Id.* at 62-72.
[24] *Id.* at 63.
[25] *Id.*
[26] CEE Study at 66.
[27] *Id.* at 67.
[28] *Id.* at 69.
[29] *Id.*
[30] *Id.* at 70.

in 2035 and BEC4 in 2036[31] (less staggered), compared to a baseline scenario of operation of BEC3 and BEC4 until at least 2050. Overall, the study indicates that the economic impact to Itasca County would be more significant than statewide, and any economic impact would be lower under the delayed retirement that affords more time for the community to prepare for retirement.

- The Socioeconomic Impacts of Minnesota Power's 2021 Plan, conducted solely by Minnesota Power, includes an examination of the 2021 Plan's macroeconomic and demographic impacts on the Northeastern Minnesota region using the Regional Economic Model Inc. ("REMI") software.. The Company identified the net/total impact of four resource actions on northeastern Minnesota's regional economy, as well as the distinct impacts of each resource action. These actions are:
    1. Construction of three solar projects totaling 20 MW of local scale solar in 2021;
    2. Construction of 200 MW of utility scale solar at the BEC site or another Minnesota Power facility by 2030;
    3. Retirement of BEC3 by December 31, 2029; and
    4. Construction of transmission solutions to address reliability issues related to the early retirement of BEC3.

  The Company expects the economic impacts of its Plan will be felt most acutely in the BEC3 host communities of Cohasset, Grand Rapids, and Deer River. Overall, the Company observed that construction of solar generation and new transmission to both have immediate, positive impacts. Their economic benefits are a noteworthy buffer, but they do not entirely offset the strong and, lasting negative effects of a BEC3 retirement to the region.

Community Stakeholder Input

During the stakeholder process for the IRP, participants also expressed significant concern for potential socioeconomic impacts of shutting down BEC3 and BEC4. Stakeholders recognized the impacts of the BEC to the host community, Cohasset, and were concerned about job and tax base risks. Stakeholders also expressed concerns that included how the site would be used if BEC units were retired early, cascading impacts across the uniquely interrelated industries in northern Minnesota, how Minnesota Power could invest in job development, and that an early retirement plan for BEC3 and BEC4 is necessary to plan for infrastructure and workforce changes.

Takeaways regarding host community and regional impacts resulting from the reports and stakeholder input can be summarized as follows:

- Typically, large baseload generation units are the economic engines for their host communities, are among the largest employers, and are often the largest single source of tax revenues for their host communities.
- Retiring large baseload generation plant units like BEC3 and BEC4 could have significant, real-life impacts to a host community and the surrounding area. For instance, there could be direct economic impacts to the community due to a plant retirement, like job loss, reduced income for a facility's suppliers and service providers, and loss of tax

[31] As indicated above, these are the current accounting lives for the two units, respectively, by which the units will be fully depreciated.

revenues for the community, as well as secondary economic impacts like reduced economic activity in retail and associated tax revenues.

- Minnesota's host communities need time to plan and prepare for power plant closures and the economic transition that they will require. While strategies to address the economic impact of baseload generation retirement are not expected to fully offset the economic impact of a plant closure, identifying strategies and solutions for projects to replace lost revenue may help mitigate negative community impacts due to plant retirements.

Additional detail is discussed in Appendix M to the IRP.

In light of these issues, limiting socioeconomic impacts is an important overall consideration in evaluating the retirement scenarios in this Baseload Retirement Study, as it is for the IRP overall. For instance, choosing the earliest possible retirement dates for both BEC3 and BEC4 could present significant concerns for the host community and could present higher economic impacts, due to affording insufficient time to adequately mitigate impacts, such as job loss and tax revenue. On the other hand, the studies show that taking a more delayed, staggered approach to retirement of BEC3 and BEC4 could continue to provide economic benefit, or mitigate impacts, to the host community, while affording time to plan and prepare for closure. Planning could include taking certain actions to mitigate impacts, like building new energy infrastructure. Moreover, a thoughtful approach to continued operation, in lieu of earliest retirement, such as moving to economic dispatch, can provide continued benefits by reducing emissions and retaining low-cost energy on the system for customers, while keeping many full-time, highly experienced positions in place for longer.

3. Customer Cost Considerations

The estimation of customer impacts is a further, integral part of the planning process. In addition to the non-cost factors discussed throughout the IRP and this Baseload Retirement Study, Minnesota Power continues to identify and implement prudent power supply projects through its resource planning process, by comparing power supply alternatives to identify the most reasonable cost solution to meet customer load requirements. Responsible planning in turn leads to reasonably-priced and reliable electric service. Power supply cost trends are tracked and analyzed through the planning process to give insight into the range of customer impacts that can be expected under the scenarios evaluated. This evaluation of unit retirement also considers the remaining asset value and any decommissioning costs associated with the facility, which need to be factored into a holistic analysis of early retirement and available alternatives.

During the stakeholder process, participants likewise expressed a significant interest in the competitiveness of rates for all customers, particularly Minnesota Power's large industrial customers. In addition, stakeholders expressed significant concern for the reliability of power for customers, including any need to curtail industrial customers. Stakeholders also expressed concerns with the affordability of customer rates due to increased use of renewable energy.

Ultimately, the costs of retiring BEC3 and BEC4 – and at what time – are the subject of the broader IRP analysis contained in the main body of the IRP and its analyses. The EnCompass modeling evaluates these costs and compares them to alternatives, as described later in this Study with respect to retirement of the remaining BEC facilities and in the IRP with respect to the overall least cost approaches to system planning. However, this Study provides an overview of remaining costs of BEC3 and BEC4, and cost factors in the IRP analysis.

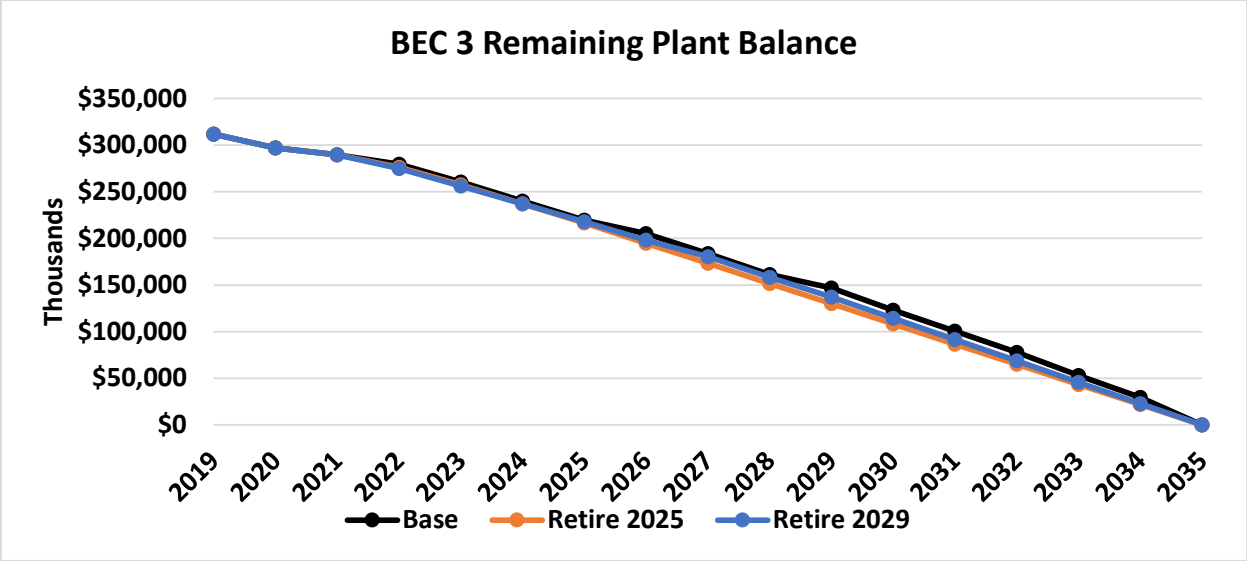
BEC3 and BEC4 Depreciation Schedule

BEC3 and BEC4 (and common facilities) are currently scheduled to be fully depreciated by 2035 and the Company does not propose to change this timeframe. [32] At this time, the remaining balance on these units totals approximately $725 million (excluding decommissioning costs), with a significant part resulting from Minnesota Power's past, Commission-approved investments to install a variety of emission control equipment on the units. (Minnesota Power completed these major environmental control system retrofits for BEC3 and BEC4 in 2009 and 2015 respectively, as previously discussed.) The ongoing operation and maintenance strategy for BEC3 and BEC4 is aligned with reliability, to ensure the units serve Minnesota Power's customers and maintain safety and environmental compliance.

If either or both of BEC3 and BEC4 are retired early, the remaining undepreciated amounts for the units will still need to be recovered. Under Minnesota law, "[i]f the commission orders a generating facility to terminate its operations before the end of the facility's physical life in order to comply with a specific state or federal energy statute or policy, the commission may allow the public utility to recover any positive net book value of the facility as determined by the commission." Minn. Stat. § 216B.16, subd. 6. One of the ways that undepreciated balances for BEC3 and BEC4 could be recovered from customers is through a securitization plan, as the Commission required Minnesota Power to propose in Order point 6.b. in its January 24 Order: "Minnesota Power shall include the following in its next resource plan . . . [a] securitization plan that could be used to mitigate potential ratepayer impacts associated with any early retirement of one of both of BEC3 and BEC4 facilities. . . ." The securitization plan is included in Appendix Q to the IRP.

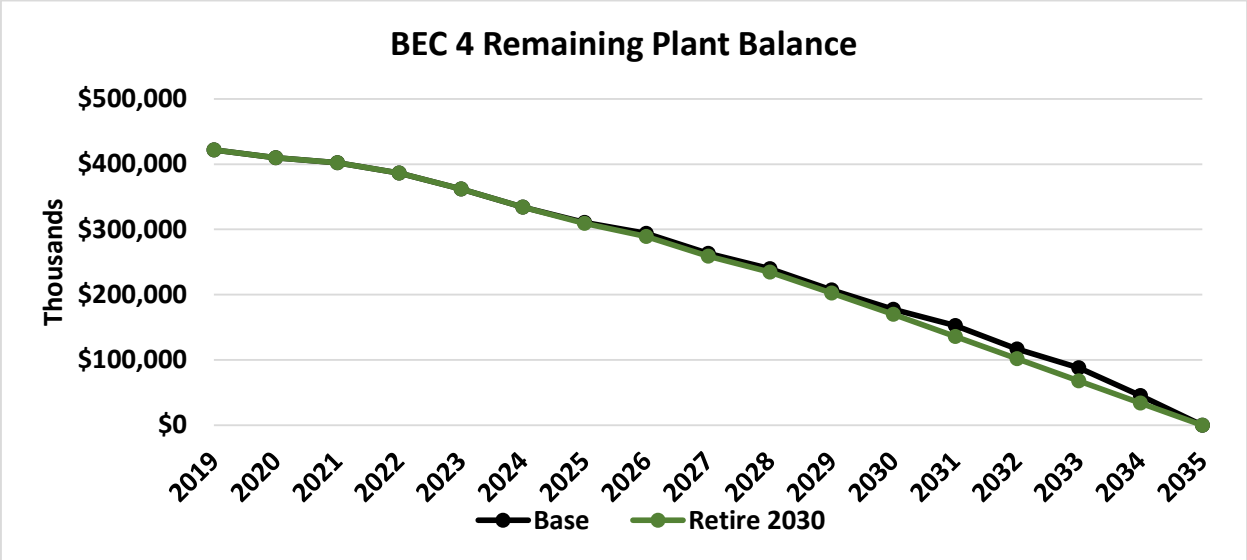
Depending on the actual retirement date, undepreciated capital amounts could still remain for these units, as indicated in Figures 5 and 6 below.

Figure 5: Boswell Energy Center Unit 3 Remaining Plant Balance



[32] The Company is not proposing changes to the depreciation rates for BEC3 and BEC4 in this proceeding, although changes to the economic end of life of either unit may ultimately affect customer rates. The Company is utilizing its most current decommissioning study data and approved economic lives from the Company's latest depreciation study for purposes of this IRP.

Figure 6: Boswell Energy Center Unit 4 Remaining Plant Balance

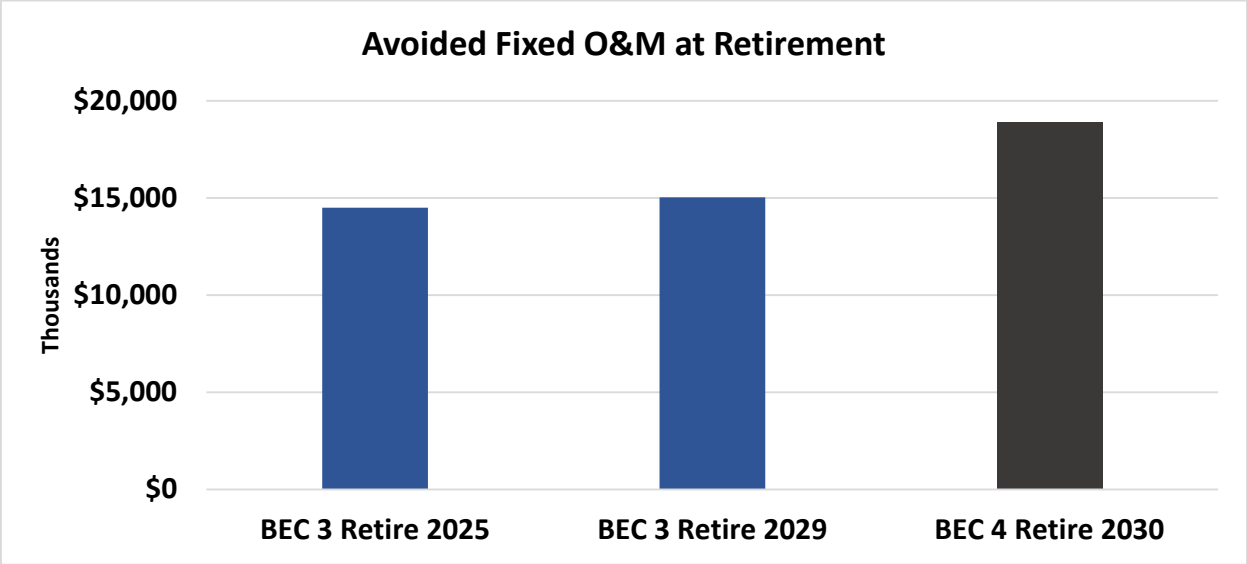


These figures demonstrate the approximately $725 million plant balance for both BEC3 and BEC4 together (as of the end of 2019), including a certain percentage of common facilities plant. These figures also demonstrate modest cost savings that may be available once retirement occurs and certain anticipated capital work is no longer needed. For BEC3, early retirement somewhat reduces plant post retirement by about $7 million, due to canceling projects that would no longer be needed (compared to not retiring prior to 2035). For BEC4, early retirement reduces remaining plant by about $12 million, due to canceling projects that would no longer be needed.

Early retirement of BEC3 and BEC4 would also result in expense savings for operations and maintenance ("O&M"). When BEC3 and BEC4 are retired early, the O&M expense reduction is expected to approximately be $15 million for BEC3, if retired in 2025 or 2029, and $21 million for BEC4, if retired in 2030, as shown in figure 7.[33]

[33] These O&M reductions assume both units are retired. In scenarios where one unit is retired, the O&M reductions are slightly less than shown in Figure 7 because of common plant (or processes) O&M will remain (i.e. fuel handling).

Figure 7: Avoided Fixed O&M Costs at Boswell Energy Center Plant Retirement



These O&M savings would be realized for BEC3 and BEC4 but would be offset by any future replacement energy costs (i.e. fuel, capital, and O&M) and needed transmission upgrades. This financial analysis is part of the overall IRP assessment and modeling of retirement scenarios and associated costs.

IRP Analysis

The remaining plant balances and fixed O&M data described above is factored into the IRP analysis that informed the 2021 Plan the Company proposes. These data points were included in the revenue requirements used in the EnCompass modeling, along with ongoing capital, fuel, and variable O&M for BEC3 and BEC4. The IRP analysis took into consideration changes in overall revenue requirements under the various retirement scenarios studies, when selecting the least cost plan. The results and insights from this robust analysis are described in Section V and Appendix K of the IRP.

4. Environmental Regulation and Policy

Minnesota Power understands the interest in early retirement of BEC3 and BEC4 to achieve ongoing State policy goals, which are in turn supported by the Company's *Energy**Forward*** strategy and vision identified in January of 2021. Importantly, during the stakeholder process, stakeholders overwhelmingly stated a need to consider the "whole energy picture," or a comprehensive review of energy source options and life cycle impacts, such as a consideration of all materials used in renewable energy production during the life cycle of these assets. Also important to stakeholders were environmental justice concerns. Regarding affordability, stakeholders expressed concern about taconite production and maintaining competitive rates for Minnesota Power's industrial customers. In addition, stakeholders stated that coal plant emissions are cleaner today than they used to be, given investment in pollution reduction. Thus the environmental impacts of early retirement need to be considered from regulatory, policy, and stakeholder interests' perspectives.

Minnesota Power is a Leader in Environmental Stewardship

As summarized elsewhere in this Study, Minnesota Power is a leader in environmental stewardship by planning to exceed its carbon emissions reduction goals that the state has implemented in carrying out its mission to have a lower carbon-intensive future. Through its *Energy**Forward*** strategy, Minnesota Power's commitment to adding carbon-minimizing resources has resulted in the removal of tons of carbon from its generation portfolio. Minnesota Power is proud that its generation portfolio now consists of 50 percent renewable energy. Additionally, Minnesota Power will achieve a 50 percent reduction in CO_2 emissions (from 2005 levels) in 2021 and an 80 percent reduction in CO_2 emissions by 2030 through implementation of its *Energy**Forward*** strategy. As a result, Minnesota Power is meeting and exceeding state policy goals.

Likewise, BEC3 and BEC4 meet or exceed all current environmental standards, as discussed in more detail in Appendix E. This is due in large part to the environmental retrofits described earlier in this Study. Driven by the Minnesota Mercury Emissions Reduction Act and federal environmental regulations, these emissions control projects resulted in significant air and water quality benefits. For example, BEC3 and BEC4 mercury air emissions were reduced by over 90 percent, nitrogen oxides emissions by over 70 percent, and sulfur dioxide emissions by around 80 percent in aggregate. The emission control equipment investments also achieved substantial reductions in air emissions of particulate matter and acid gases, as well as lowering freshwater use and reducing wastewater generation. As such, BEC efforts have contributed to the Company's success in meeting state policy goals.

Environmental Regulation

On a continuing basis, the Company continues to comply with federal and state environmental law applicable to BEC, and to monitor the status of proposed regulations. As such, no additional major capital investments are anticipated in order to keep the BEC in compliance with existing regulations.

That said, and while Minnesota environmental targets are presently well-established, there continues to be uncertainty surrounding EPA regulations covering thermal generation, especially with the transition to a new presidential administration and changes in Congressional leadership. At this time, Minnesota Power cannot make assumptions about what might occur in order to specifically drive decisions around early retirement of BEC3 and BEC4. We recognize that increased stringency of federal regulations and state law ongoing climate policy changes are possible and may further support the early retirement of BEC3 and BEC4. Overall regulations are discussed in Appendix E to the IRP.

Environmental Impacts on Retirement Planning for Boswell Energy Center

Environmental regulations and policy goals factor into all aspects of resource planning, including plans for early retirement of the BEC units. As part of this analysis, it is important consider the following matters.

- At this time, no significant controls or retrofits are anticipated for the BEC, barring new regulations.
- Retiring early BEC3 and BEC4 may nonetheless avoid certain state planning environmental and regulation costs that would otherwise be incurred going forward from the date of retirement.
- The environmental costs of several pollutants and regulation costs are added onto generation included within the power supply that emit these pollutants. These costs are

also removed when generation is retired, but are netted with the costs of emissions from replacement energy, which is called an “Environmental Costs Impact.” Thus, environmental or regulatory costs that are avoided factor into retirement decisions for resources in Minnesota Power’s system.

- However, savings related to avoided environmental effects as a result of early retirement may not result in lower rates for customers. In other words, if the retirement of a generation resource is part of a least-cost resource plan that factors in avoided environmental costs, it may nevertheless result in higher rates for customers.
- Likewise, the nature of replacement resources, and their associated environmental costs (or avoided environmental costs) will further affect customer rates.

Ultimately, the consideration of environmental impacts – from both a societal and revenue requirements perspective – requires a multi-faceted, complex analysis of sometimes competing factors. The factors in this Study pertaining to BEC3 and BEC4 are likewise part of the Company’s broader resource planning analysis in the IRP.

Feasibility of Multiple Early Retirement Scenarios

While each of the perspectives, inputs, and factors described in this Baseload Retirement Study play a role in planning for the future of the BEC, certain factors place specific bounds around what early retirement scenarios are feasible to accomplish. This section discusses the primary drivers of the BEC early retirement scenarios available to the Company and its stakeholders, identifies the potential early retirement scenarios, and identifies the results of the resource plan modeling for the Baseload Retirement Study. The primary modeling of the individual scenarios is undertaken in the IRP itself, with the base case being continued operation of BEC3 and BEC4 subject to economic dispatch implementation as discussed in the IRP 2021 plan. The IRP modeling detail for both the 2021 Plan and the early retirement scenarios discussed here are cross-referenced in this Study, which explains the basis for the alternative scenarios modeled.

Overview of Scenario Selection and Modeling Processes

For the first time, Minnesota Power used the EnCompass model to determine if a shutdown of a generation resource is part of the lowest cost plan. In total, there were four unique plans analyzed in detail with respect to retirement of BEC3 and BEC4. The emerging trends resulting from this analysis are the result of these multiple plans developed with a wide range of assumptions. Ultimately, regional reliability and transmission needs are the largest limiting factors for retirement of BEC3 and BEC4, followed by community impacts and the potential costs of retiring and replacing both sizeable baseload units at the same (or nearly the same) time. At the same time, it is important to be mindful of the additional impacts of all scenarios.

Consistent with these factors, the Company evaluated the scenarios presented below for the early retirement of BEC3 and BEC4 before the end of their depreciable lives – that is, before 2035:

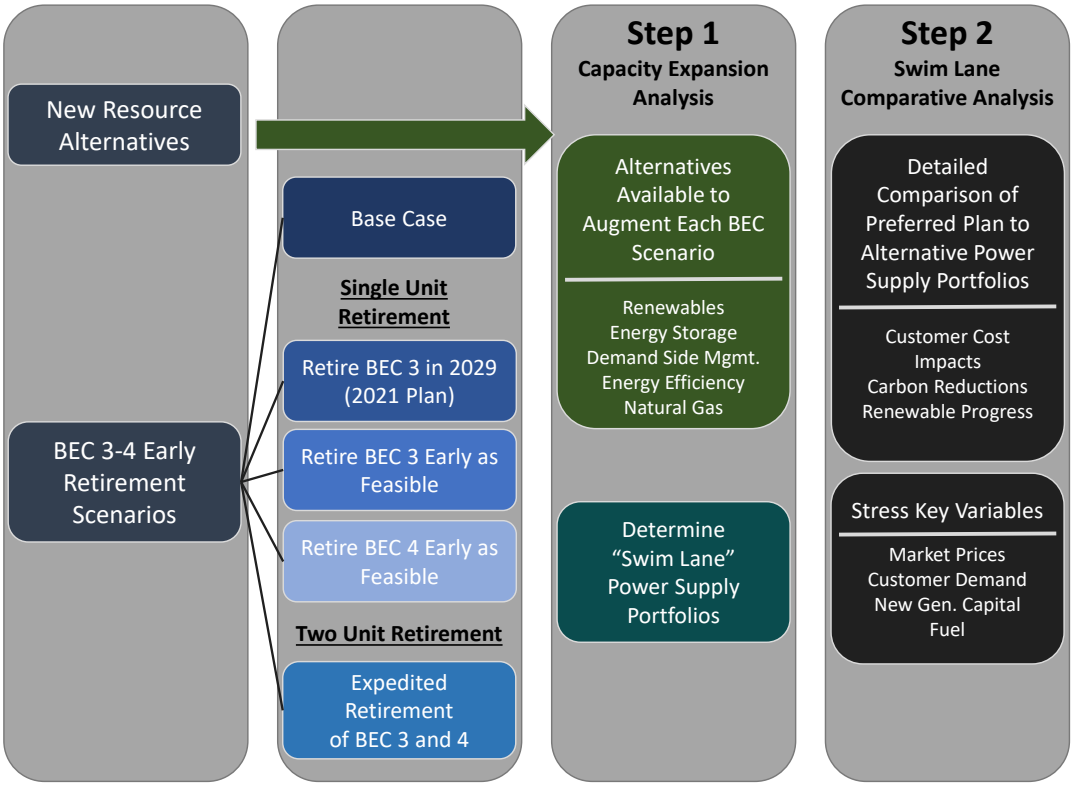
1. 2021 Plan: BEC3 retires in 2029 and BEC4 retires no earlier than 2035;[34]
2. “Expedited” Retirement of BEC3 and BEC4: BEC3 retires in 2025 and BEC4 retires in 2030;
3. Retire BEC3 as Early as Feasible: BEC3 retires in 2025; and
4. Retire BEC4 as Early as Feasible: BEC4 retires in 2030.

These four scenarios were chosen for the EnCompass modeling because they reflect the earliest dates of retirements for these units, respectively, based on the feasibility of implementing necessary improvements to the transmission system to ensure continued safe and reliable service for our customers that meets all applicable federal and state standards. In general, these scenarios reflect that retiring BEC3 earlier than BEC4 would be more feasible based upon (i) the transmission infrastructure improvements (based on potential impacts) that would be required to ensure system reliability in the absence of each Unit; (ii) the larger role that BEC4 plays in the Company’s system as its largest baseload generator; and (iii) the need to ensure continued regional reliability as a generation asset.

As the Company discusses in Section IV of the IRP, the Company then took a two-step modeling approach in order to identify site-specific alternatives for BEC3 and BEC4, as illustrated by the following figure:

[34] The retirement occurs at the end of the year. For example, for the remainder of the document a 2029 retirement refers to the unit being retired on December 31, 2029.

Figure 8: IRP Development Process



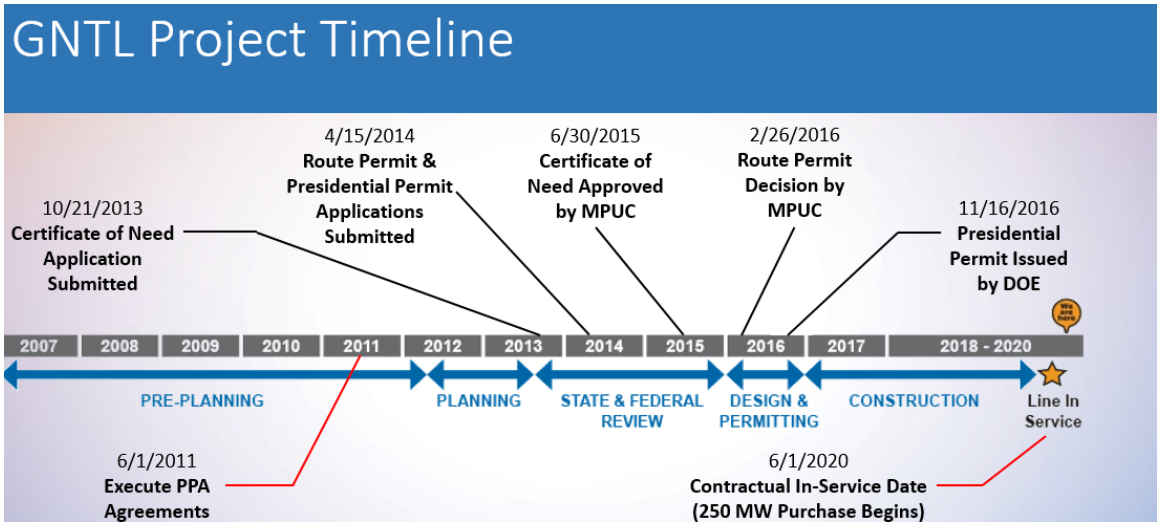
Selection of Scenarios

As stated above, a primary takeaway from this Baseload Retirement Study is that a thoughtful transition plan will be crucial to ensuring safe and reliable operations for the region, particularly from a transmission perspective. As Minnesota Power has retired smaller baseload generators, it has gained significant real-world experience which, coupled with many years of analysis on those baseload generator retirements and BEC3 and 4 retirement scenarios, has aided in the identification of the "pillars" that are key to understanding the significance of BEC3 and BEC4 to serving the region and transmission system. As noted in the "Minnesota Power Transmission Planning Activities" section of this Study, these pillars address the unique area of the electric grid served by BEC3 and BEC4, the importance of taking a holistic view of generator retirements including the replacement of the essential reliability services they provide, key essential reliability services provided by BEC3 and BEC4 like voltage support and system strength, and the necessity of ensuring adequate lead-time for the multi-year solution development, coordination, and implementation process to take place prior to generator retirements to ensure continued safe and reliable operations of the power system.

Based on these pillars and the underlying analysis, at this point in time, the Company anticipates that it would take approximately 10 years to implement improvements to the transmission system to accommodate a BEC4 retirement, while BEC3 would be able to be retired earlier with BEC4 still in service. The primary difference between the two scenarios is that the BEC4 retirement requires a large regional transmission project to be implemented to ensure reliable operations for Minnesota Power and all of northern Minnesota. As shown in

Figure 9 below, the last transmission project of this magnitude undertaken by Minnesota Power, the Great Northern Transmission Line ("GNTL"), took over nine years to implement – on a very aggressive schedule – from the time signed Power Purchase Agreements initiated project development in earnest in 2011 to the time the project was placed in service in 2020.

Figure 9: Large-Scale Transmission Project Implementation Timeline



The following Figure 10 also provides an illustrative depiction of the estimated time needed to implement improvements to the transmission system or replace with new gas resources to accommodate early retirement of BEC3 and BEC4.

Figure 10: Approximate Timeline for Construction of Replacement Transmission or Gas Resources to Accommodate Early Retirement of BEC3 and BEC4

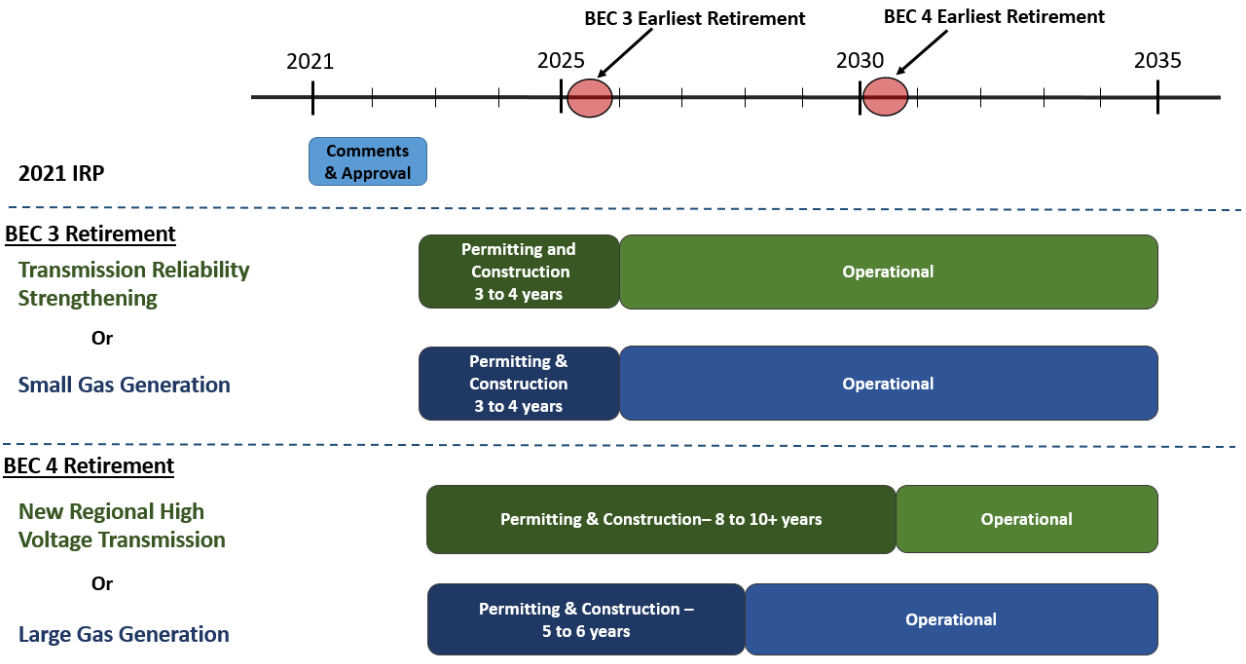


Figure 10 shows that implementation of larger, regional transmission upgrades to accommodate a BEC4 retirement would require a longer time horizon, which is supported by the Company's experience constructing the GNTL.

Given the reality of regional transmission project development timelines, the earliest possible retirement date for BEC4 is 2030, as reflected in the alternative "Earliest" BEC4 retirement scenario noted above. Due to its somewhat more limited and locally-focused transmission needs, the "Earliest" possible BEC3 retirement date is 2025, and also studied was a later retirement date of 2029. The later retirement date of 2029 allows for additional time for the host community, Cohasset and Itasca County, to plan for the impacts a BEC3 retirement will have (including job loss and loss of tax base), and for the state, Minnesota Power, and various stakeholders to work with the community to identify, develop, and implements projects to minimize impacts consistent with findings in the CEE Study. Delaying retirement dates for baseload units would limit societal impacts to a certain extent.

Further, in Appendix F, Part 8, the Company discusses generator retirement network upgrade assumptions that provide potential transmission upgrade costs for a variety of operation scenarios for BEC3 and BEC4. These operating scenarios are not resource decisions or based on a particular retirement year (costs are escalated to any chosen retirement year), but discuss estimated upgrade costs as a result of operational changes, including shutdown of one or both units, for the following impact categories: voltage support and system strength, local power delivery, and regional power delivery. The estimated costs for addressing these impacts are reflected in the EnCompass modeling for the early retirement scenarios.

In addition to the transmission and system reliability impacts of early retirement scenarios for BEC3 and BEC4, other factors also require thoughtful analysis. Specifically, removing either BEC3 or BEC4 – let alone both – from the system will require not only significant transmission upgrades, but also replacement capacity and energy. The specific extent of transmission and/or generation requirements will depend not only on when the units are retired, but how they are replaced. For example, replacing BEC4 with intermittent renewable generation that is not on-site in Cohasset requires a different set of transmission solutions than replace with new natural gas or other on-site dispatchable generation solutions that might be available in the future. Furthermore, since there is a continuous, long-term, and in many cases round-the-clock need for essential reliability services to support the transmission system, storage and intermittent generation resources are at best only partial solutions and in many cases impractical for achieving holistic replacement of essential reliability services provided by the BEC units. But under any scenario, the Company considered the potential need to mitigate the rate impacts that could transpire if both new transmission and new generation are implemented at the same time. Spacing the retirement of BEC3 and BEC4 would somewhat spread out the investments (and therefore the costs to customers) in supporting transmission and replacement resources for each unit. At the same time, such spacing allows more time for the remaining plant balances to decline, thereby also appropriately managing customer costs from multiple perspectives.

Similarly, the impact to the city of Cohasset, its surrounding area, and entire region of Minnesota will be multiplied and magnified if BEC3 and BEC4 are retired in close proximity to each other – particularly if their replacement does not take the form of infrastructure at the BEC site or in the same communities. Consequently, separating the retirement of BEC3 and BEC4 by a reasonable period of time may offer a greater opportunity to likewise mitigate community impacts and smooth the transition process.

It is also necessary to consider the sometimes competing balance between the relatively long lead times necessary to plan, seek regulatory approval, design, and construct transmission and/or generation solutions, and the fact that technology is changing rapidly. Complex resource solutions may require many years of planning and construction before they can be operational. At the same time, technology around evolving solutions such as battery storage, hydrogen alternatives, carbon sequestration, and the like is emerging over time. The potential cost of solutions that remain nascent or not fully developed may be prohibitive at this time, but become more feasible in the near or longer-term. Technology can also be an accelerator, offering solutions that do not exist today.

Likewise, the reliable, 24/7, cost-effective dispatchable energy BEC4 is providing supports the implementation of renewable generation already added to Minnesota Power's system; its replacement of all other coal generation in the region; its ongoing compliance with environmental regulation; its relatively recent retrofits that obviate the need for more substantial capital investments in the next decade; and its early achievement of 50 percent renewable generation, all speak to the value BEC4 may continue to provide during the IRP planning horizon. Maintaining flexibility around one or both BEC units may aid the Company and its stakeholders in planning for and choosing solutions that balance planning horizons with the desire to capture the benefits – and, eventually, reasonable pricing – of alternative solutions.

In light of these considerations, the Company considered numerous aspects of retirement in order to evaluate if, how, and when generation retirement would be economically plausible and showed a benefit to customers. Of significance were an evaluation of transmission system impacts, as discussed above, and what infrastructure would be required to ensure continued reliability of the transmission system under the various shutdown scenarios. The alternative early retirement scenarios that the Company ultimately evaluated therefore contemplated retirement of BEC3 as of December 31, 2025 or December 31, 2029; retirement of BEC4 as of December 31, 2030; and expedited retirement of BEC3 as of December 31, 2025 along with retirement of BEC4 at December 31, 2030.[35]

Minnesota Power compared these scenarios to our reference case, which assumes maintaining the status quo – ongoing operation of BEC3 and BEC4 through 2035, consistent with their current economic (depreciable) lives. This comparison is set forth in Figure 11 below:

Figure 11: Comparison of Early Retirement Scenarios to Reference Case[36]

		Single Unit Retirement			Two Unit Retirement
	Base Case ("Do Nothing"	**2021 Plan**	**Retire BEC3 Early as Feasible**	**Retire BEC4 Early as Feasible**	**Expedited Retirement**
BEC3	No earlier than 2035	2029	2025	No earlier than 2035	2025
BEC4	No earlier than 2035	No earlier than 2035	No earlier than 2035	2030	2030

[35] Note that because this is a Baseload Retirement Study, it does not address non-retirement scenarios such as refueling options for either or both Boswell Units. However, these scenarios are discussed in Section V of the IRP.
[36] Retirement happens at December 31 of referenced year.

As indicated in Appendix J to the IRP and discussed further in this Study, the Company then considered the costs of these scenarios from the perspective of 1) the remaining value of the asset being retired and the cost of physical decommissioning and restoration of the site; 2) the replacement cost of additional generating supply; 3) the cost of transmission upgrades requirements to maintain reliability; 4) the retired asset revenue requirement savings (if any); and 5) the avoided environmental costs or carbon regulation costs. This analysis is conducted in the IRP itself.

Insights and Next Steps

Minnesota Power conducted this Baseload Retirement Study as directed by the Commission in the January 24, 2019 Order Approving Affiliated Interest Agreements with Conditions, in Docket No. E-015/AI-17-568. From this Study, Minnesota Power developed insights into potential resource planning decisions for BEC3 and BEC4. The results of this Baseload Study informed the 2021 Plan Minnesota Power proposes in its 2021 IRP, which includes the retirement of BEC3 by year end 2029 (after moving to economic dispatch in 2021) and the commitment to cease coal operations at BEC4 in 2035. This 2021 Plan accounts for the Company's high load factor customer mix; the State's environmental policy goals; emerging and advancing technologies; the needs of both the system and region, communities, customers, and environment; transmission limitations that would currently exist in the absence of BEC; and the ability of Minnesota Power's system to continue to support the integration of intermittent renewable resources. Significant new transmission will be required to support the retirement of BEC4, in addition to any replacement generation resources, and the impacts of retiring either or both units on Minnesota Power's customers and communities need not only be considered, but also managed for effective implementation, mitigation of negative outcomes, and the successful future of the region Minnesota Power serves.