2026 Integrated Resource Plan

LANSING BWL

Hometown People. Hometown Power.

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Term Table

Acronym	Definition
ARS	Automated Resource Selection
BWL	Lansing Board of Water & Light
CCS	Carbon Capture & Sequestration
DLOL	Direct Loss of Load
DR	Demand Response
ELCC	Effective Load Carrying Capability
EO	Energy Optimization
EV	Electric Vehicle
EPRI	Electric Power Research Institute
FERC	Federal Energy Regulatory Commission
GDP	Gross Domestic Product
HVAC	Heating, Ventilation & Air Conditioning
IOU	Investor-Owned Utility
IRP	Integrated Resource Plan
LSE	Load Serving Entity
LOLE	Loss of Load Expectation
MCEV	Midsize Commercial EV Charging Rate Class
MIP	Mixed Integer Programming
MISO	Midcontinent Independent System Operator
MMBtu	Million British Thermal Units
MPPA	Michigan Public Power Agency
MPSC	Michigan Public Service Commission
MW	Megawatt
MWh	Megawatt-hour
NERC	North American Electric Reliability Corporation
NEVI	National Electric Vehicle Infrastructure
NITS	Network Integrated Transmission Service
NLR	National Lab of the Rockies
NOAA	National Oceanic and Atmospheric Administration
OBBBA	One Big Beautiful Bill Act of 2025
PA	Public Act
PPA(s)	Power Purchase Agreement(s)
PRMR	Planning Reserve Margin Requirement
RES22	Residential EV Charging Rate
RESTOU	Residential Time of Use Rate
RPS	Renewable Portfolio Standard
SMR	Small Modular Reactor
TO	Transmission Owner
TRM	Technical Resource Manual
UCAP	Unforced Capacity

1 Executive Summary

1.1 Introduction

The Lansing Board of Water & Light (BWL) is a municipally owned utility that serves approximately 100,000 customers in the greater Lansing area. BWL's electric utility operates, procures, and manages a diverse portfolio of generation and demand side resources to meet customer needs while complying with state and federal regulations. This 2026 Integrated Resource Plan (IRP) evaluates long-term resource strategies by analyzing future electric load growth, system reliability, generation resource options and costs, and public policy to align with BWL's mission and Strategic Plan. The IRP and Strategic Plan reflect BWL's commitment to providing safe, reliable, and affordable utility service through public ownership, climate consciousness, and innovative strategies.

1.2 Objectives

The objective of this IRP is to identify and evaluate resource strategies, provide a roadmap for BWL to comply with Michigan Public Act 235 (PA 235) of 2023, and assess the financial impacts of the legislation on the utility and its customers. This IRP is not a day-to-day operational plan. Rather, it is a guide to resource investment over the next 5–10 years, informed by an evaluation of scenarios over a 20-year planning horizon. External factors, including technological advancements, resource availability, and state and federal energy policy, require adjustments to resource investment strategies.

1.3 Energy Policy Considerations

Michigan Public Act 295 (PA 295), the Clean, Renewable Energy, and Efficient Energy Act, was enacted in 2008. The legislation required electric service providers to establish renewable energy portfolios and energy optimization programs. It aimed to modernize electric generation and reduce reliance on non-renewable energy by increasing the use of renewable energy sources such as wind and solar. PA 295 was a landmark piece of Michigan energy legislation that served as the basis for future amendments in 2016 and 2023. Most importantly for the purposes of this IRP, PA 295 was amended in 2023 by PA 235, which extended and expanded the state's renewable energy portfolio standard to 50% of retail sales, effective in 2030, and established a clean energy standard of 80% that will take effect in 2035. The renewable energy portfolio standard increases to 60% in 2035, while the clean energy standard increases to 100% in 2040. Additionally, Public Act 229 (PA 229) of 2023 raised energy optimization and efficient electrification mandates to 1.5% of retail sales annually. Together, PA 235 and PA 229 will affect how BWL serves its customers in the future and the plan for resource procurement over the next 20 years. While the 2020 IRP anticipated policy changes and included a goal of carbon neutrality by 2040, PA 235 now establishes a binding requirement for 100% clean energy by 2040. Achieving these regulatory targets is a simultaneous goal of BWL's 2026 Strategic Plan and is thus the focus of this IRP.

As state requirements for renewable and clean energy are increasing, federal policy has shifted in the opposite direction, with reduced support for such energy sources under the One Big Beautiful Bill Act of 2025 (OBBBA). In the summer of 2025, Congress officially ended federal tax credits and incentives for renewable energy projects, such as wind farms and solar arrays, as well as for energy optimization measures, which are the primary technological options available to BWL to meet the renewable portfolio standard set in PA 235. Congress' elimination of the Inflation Reduction Act (IRA) tax credits and incentives for renewable energy resources increases the costs of projects needed to comply with PA 235. Tax credits were retained for small modular nuclear reactors (SMRs) and carbon capture with sequestration (CCS), which are technologies evaluated in this IRP.

1.4 Methodology

Beginning in the summer of 2025, BWL conducted an online survey and held several public open houses and stakeholder meetings to identify the goals of customers and stakeholders for the electric utility's future. BWL then gathered current market data and held discussions with forecasters, engineers, and utility operators to develop the basic cost assumptions, scenarios, and sensitivities for the IRP.

A general overview of the IRP load forecasting methodology is listed below (**Figure 1**):

1. BWL collects and analyzes aggregated historical customer energy usage and demand data.
2. Population and economic growth projections are incorporated.
3. Historical weather data is collected, climatic assumptions are applied, and weather is projected through the end of the study period.
4. Electrification adoption trends are evaluated.
5. Historical and future impacts of energy optimization programs are considered.
6. Customer adoption rates for distributed energy resources are incorporated.
7. Data is combined, and a regression is performed to develop a 20-year forecast of electrical usage and demand.

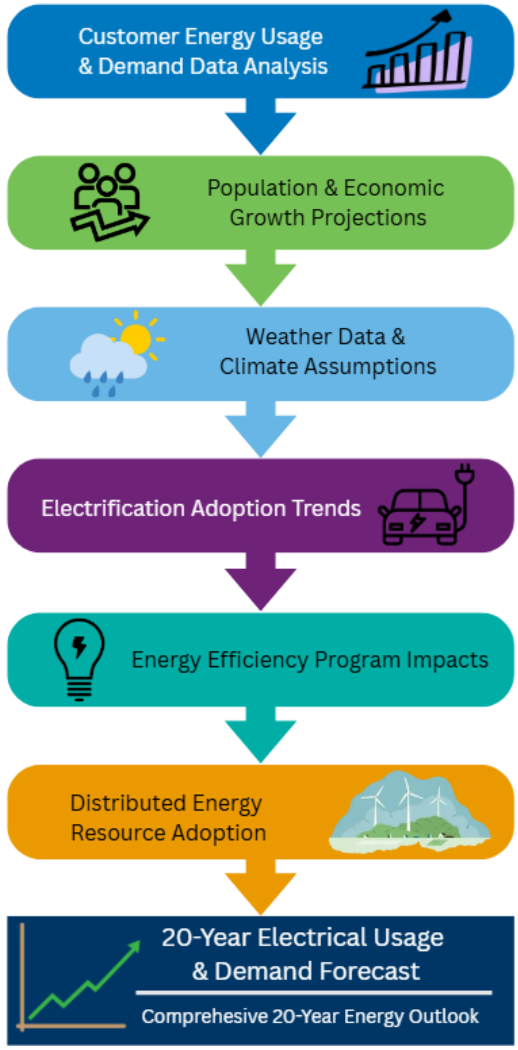


Figure 1. Characteristics of BWL's 20-Year Load Forecast

Load growth from new large industrial electric loads, including data centers, and from building and vehicle electrification is a challenge that electric utilities across the country face. This IRP uses a baseline load forecast with no additional large load growth, along with three growth sensitivities, to demonstrate how different levels of load growth, driven by large loads and electrification, affect BWL's generation portfolio.

A comparison of BWL's forecasted energy and capacity needs with its currently available generating assets, both owned and contracted, indicates that, starting in 2027, BWL could meet existing customers' electricity requirements and Midwest Independent System Operator (MISO) planning reserve margin requirements (PRMR) for capacity through 2040. BWL assesses the cost of complying with PA 235 by comparing revenue requirements across scenarios with and without clean energy and renewable mandates.

1.5 Modeling for the Future

Based on customer feedback, this IRP includes five resource scenarios and four load sensitivities. Each scenario represents a different package of technologies or a different approach to serving customers. Capacity expansion modeling then determines the least cost way to achieve that goal for each sensitivity.

The scenarios are:

1. Reference Case. PA 235 compliance using currently viable renewable energy and energy storage technologies.
2. PA 235 compliance with the possible addition of a small modular nuclear reactor (SMR) and carbon capture and sequestration (CCS) at current estimated costs.
3. PA 235 compliance with all compliant technologies and carbon neutrality through the early retirement of the REO Cogeneration Facility in 2040 and the purchase of carbon credits.
4. PA 235 compliance with all compliant technologies and removal of the Moltke Wind project as an available resource starting in 2027.
5. Operate BWL's existing baseload generating resources with added storage to meet capacity requirements.

Each of the five scenarios includes four load sensitivities, which are:

1. Base load growth
2. Base load plus the addition of a 45 MW large load
3. Base load plus the addition of a 500 MW large load
4. Base load accounting for high electrification adoption rate.

Each combination of scenario and sensitivity yields 20 distinct strategies evaluated in this IRP. **Figure 2** identifies and explains the scenarios and resource sensitivities modeled in this IRP.

SCENARIOS		SENSITIVITIES	
1	**Reference Case; PA 235 Requirement** Clean and Renewable Energy Requirement Renewable Energy: 15% now, 50% by 2030, 60% by 2035 Clean Energy: 80% by 2035, 100% by 2040	1	**Baseline Utility Forecast** Represents the BWL's least cost portfolio option based on its 20-year load forecast alone. This sensitivity targets all scenarios.
2	**PA 235 Requirement with Additional Technology Options** Same requirements as Scenario 2; Carbon Capture & Sequestration and Small Modular Reactors are added options	2	**Large Load Addition: 45 MW** Considers the addition of a 45 MW large load into BWL's service territory and is incorporated into the BWL's 20-year load forecast. Large loads could include data centers, industrial sites, etc.
3	**Carbon Neutral Scenario** Early Retirement of REO Co-generation Plant in 2040; Carbon Credit Purchases to offset remaining CO_2 emissions; Contains Michigan's PA 235 Requirement	3	**Large Load Addition: 500 MW** Considers the addition of a 500 MW large load into BWL's service territory and is incorporated into the BWL's 20-year load forecast. Large loads could include data centers, industrial sites, etc.
4	**No Moltke Ridge Wind Resource** Removal of Moltke-Ridge Wind Project from BWL's current resource portfolio; contains Michigan's PA 235 Requirement	4	**Electrification Load Addition** Introduces an Electrification trend in BWL's current 20-year load forecast to account for things like EV Usage, electric space heating and cooling, and other equipment electrification
5	**Baseline Generation & Capacity Needs** Represents BWL's current generation portfolio with the exploration of storage as a viable technology to meet capacity requirements		

Figure 2. IRP Scenario and Resource Sensitivities

This allows the modeling program to select from a variety of resource options and increments to meet the IRP objectives. These options include natural gas, solar, wind, energy storage, CCS, and SMR.

1.6 Recommendations

Scenario 1, as described above, is the recommended course of action among the five scenarios because it achieves BWL's compliance goals with viable technologies. This scenario adds almost 1,400 MW of renewable energy capacity over the study period to achieve the 100% clean energy goal starting in 2040 and to replace existing power purchase agreements (PPAs) that will expire between 2035 and 2046. Given the divergent federal and state policies and current federal attitudes toward renewable energy, BWL must be flexible in its timeline for procuring new generation resources.

1.6.1 Short-Term Plan

The model recommended that the near-term action plan (next five years) prioritize adding approximately 280 Megawatts (MW) of new wind generation through PPAs. Wind energy is a mature, cost-effective renewable energy technology currently available to support compliance with PA 235 and help diversify BWL's resource portfolio. Procuring capacity in the near-term allows BWL to secure resources before regional supply conditions tighten and competition for qualifying renewable projects increases. The projected buildout enables BWL to achieve affordability objectives in the Strategic Plan while pursuing regulatory requirements, even if interconnection or permitting delays push the wind facility's energization beyond the short-term planning horizon.

In addition to larger regional renewable procurement efforts, BWL will continue pursuing small, local utility owned solar projects on an ongoing basis throughout the planning horizon. These projects provide incremental renewable energy additions that can be deployed flexibly while making productive use of available local sites and existing utility infrastructure. Local solar investments also enhance community visibility of BWL's clean energy projects, support grid resilience and diversify BWL's generation portfolio alongside larger wind resources. BWL will also continue to promote customer owned, renewable, distributed generation by offering a rebate for customers who install solar and crediting customers who return energy to BWL's distribution system.

1.6.2 Future Analysis – Carbon Capture & Sequestration (CCS) and Nuclear

Both small modular reactors (SMRs) and CCS were considered in this IRP because they are approved technologies for meeting the clean energy targets set by the State in PA 235. In all applicable scenarios (2, 3, and 4), the model selected CCS to meet those targets as the least cost option, and allow BWL to claim clean energy credit, even though there are no operational CO_2 pipelines to transport captured carbon near Lansing, and no active utility-scale storage facilities in the United States. This means that despite the model's selection as the least cost option, it is impossible to accurately account for the true costs of CCS. Similarly, although many nuclear developments are underway in the United States, the capital costs, specialized fuel supply chains, and permitting uncertainties for SMRs make SMRs and CCS currently unviable.

While BWL does not consider either technology viable over the next 5 years, Federal incentives and tax credits remain available for carbon capture and sequestration and for nuclear technologies, with active pilot projects underway and construction beginning across the country. Because SMR and CCS projects offer a pathway to compliance with PA 235, and because technology companies and other utilities are entering into contracts to develop SMR and CCS, the technologies must be further evaluated, specifically for a CCS retrofit of BWL's existing natural gas facilities.

Additionally, fuel cells and other cell technologies were not considered in this IRP because they have not reached utility-scale market maturity.

Over the next 5 years, the costs, permitting concerns, and deployment timelines for new technologies such as CCS or SMRs may become more reliable and accurate. BWL will continue to monitor the economics of these clean options and to discuss potential partnerships with other utilities, the Michigan Public Power Agency (MPPA), and other third parties.

2 Integrated Resource Plan (IRP)

2.1 About the Lansing Board of Water & Light

The Lansing Board of Water & Light (BWL) is a not-for-profit utility owned by the City of Lansing. BWL is governed by eight board members appointed by the mayor and approved by the Lansing City Council. As of 2025, BWL serves approximately 100,000 electric customers across Lansing, East Lansing, Delta Township, Lansing Township, and surrounding areas. BWL's peak load as of June 2025 was 476 MW, and its total generation nameplate capacity is 735.2 MW. While BWL is not regulated by the Michigan Public Service Commission (MPSC), its Board has adopted a policy (Policy A1-09) requiring the development of Integrated Resource Plans to align long-term planning with industry best practices.

2.2 About the IRP

BWL's 2026 IRP is a 20-year plan that demonstrates best practices for meeting its customers' future energy needs while maintaining its commitment to its mission, vision, and values laid out in its Strategic Plan and mission statement to provide safe, reliable, and affordable utility services through public ownership, climate consciousness, and innovative strategies.

A primary objective of this IRP is to identify feasible, cost-effective pathways to comply with PA 235, legislation enacted by Michigan in 2023. Each scenario is evaluated using four 20-year energy and peak demand forecasts to determine which resource portfolios yield the lowest cost outcomes while managing uncertainty and aligning financial, operational, and environmental objectives. BWL actively sought participation from a diverse group of customers and stakeholders, which informed the development of the plan's scope and evaluation metrics. The IRP is an important component of BWL's energy strategy and builds on the 2023 all-source request for proposals (RFP) and subsequent resource procurement efforts.

2.3 Recent Resource Procurement Efforts

In 2023, BWL issued an all-source request for proposals (RFP) to procure new energy resources to address capacity gaps identified in its 2020 IRP, to provide capacity for a new LG battery manufacturing facility, and to support the planned retirement of the Erickson coal plant. The all-source RFP included new generation to meet electricity demand and demand response programs to conserve energy and reduce waste. Rather than releasing individual RFPs for specific technology types, the all-source RFP allowed BWL to collect, analyze, and compare technologies across a wide spectrum. The RFP initially received 96 bids representing approximately 8.3 GW of proposed capacity. Bids were narrowed based on cost effectiveness, risk, and alignment with BWL's clean energy goals. Ascend Analytics served as an independent evaluator, scoring bids and providing quantitative economic analyses and qualitative risk assessments. BWL departments then conducted additional risk and strategic alignment assessments for each proposal. The RFP was successful, resulting in BWL's Peak Power Partners demand response pilot program, a new RICE plant, local solar arrays, and additional wind and solar PPAs. BWL sees value in conducting future all-source RFPs to inform energy planning by providing market based pricing signals and evaluating the viability of emerging energy technologies.

2.4 Recent Strategic Plan

Following the resource procurement efforts in 2022-23, BWL released its FY 2026-2030 Strategic Plan, which outlines five priorities for the utility: customer & community; workforce development & diversity; climate & environment; operational resiliency & continuous improvement; and financial stability. Each priority includes specific progress measures and initiatives that BWL uses to track progress toward that priority. Most relevant to this IRP is the climate & environment priority, the progress measures for which are shown below.

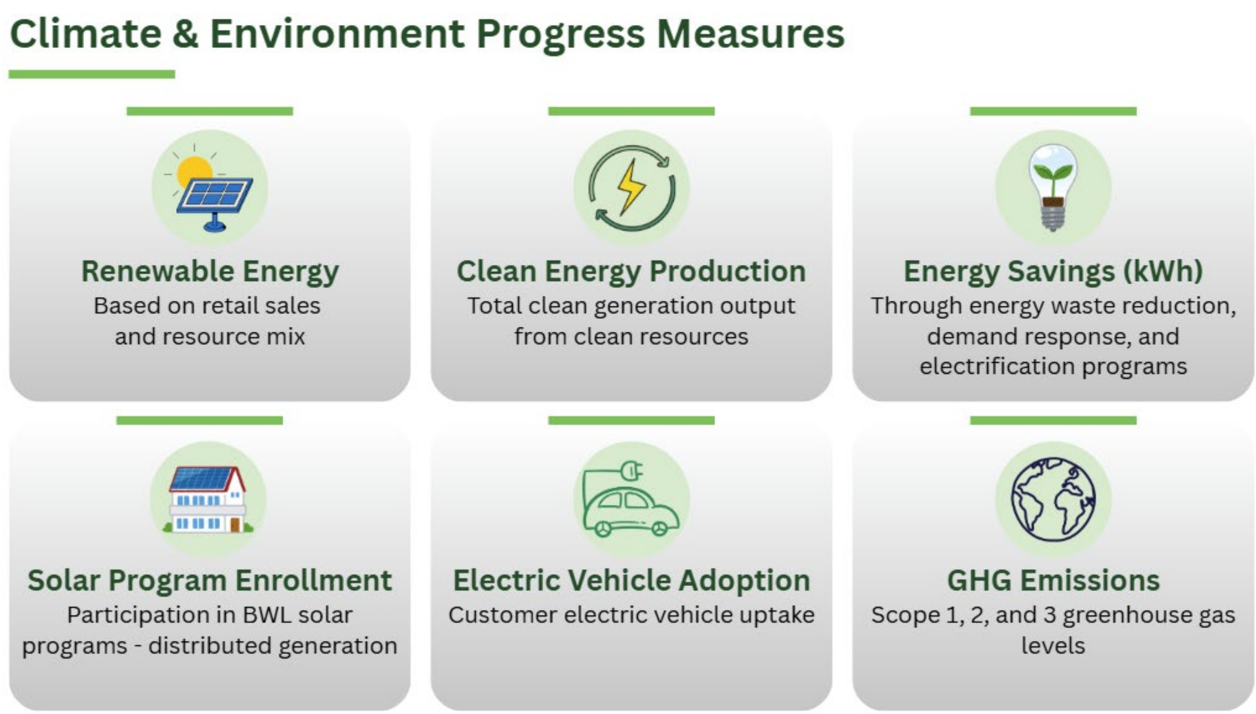


Figure 3. FY26-30 Strategic Plan Climate & Environment Progress Measures

These measures closely align with the requirements of Michigan's Public Acts 229 and 235.

2.5 Michigan's Public Act (PA) 235 of 2023

Signed into law in November 2023, PA 235 establishes clean and renewable energy standards for electric providers in the state. The standards define certain generating resources as clean or renewable and set updated targets that are used by electric providers. The standards are expressed as the percentage of megawatt-hours (MWh) generated by renewable or clean facilities owned or purchased by the electric provider, compared to its annual retail sales, subtracting outflows from customer-owned distributed generation and voluntary green pricing programs (BWL's Greenwise Program) from the utility's annual retail sales.

$$\begin{matrix} Percent \\ Renewable \end{matrix} = \frac{MWhs\ from\ clean\ or\ renewable\ sources}{\left(\begin{pmatrix} Total \\ Retail\ Sales \end{pmatrix} - \begin{pmatrix} Outflow\ MWhs\ from \\ dsitributed\ generation \end{pmatrix} - \begin{pmatrix} Greenwise \\ purchases \end{pmatrix} \right)}$$

Figure 4. Renewable Energy Calculation

Clean energy sources include nuclear and natural gas with carbon capture, and renewable energy sources, including solar, wind, geothermal, biomass (with sustainability requirements), hydropower, methane digesters, and landfill gas. (**Table 1**). The clean energy standard requires electric providers to reach 80% clean energy by 2035 and 100% by 2040. The renewable energy standard is 15% through 2029, 50% from 2030 through 2034, and 60% in 2035 and beyond. Both standards must be met to comply with the legislation. This also means that utilities must have at least 60% of their retail sales served by renewable energy resources.

Table 1. PA 235 Generation Resource Type Eligibility

Resource Type	Renewable Energy Mandate Eligible	Clean Energy Mandate Eligible	REC Calculation
Wind	Yes	Yes	1 REC for each MWh generated
Solar	Yes	Yes	1 RECs for each MWh generated
Natural Gas with Carbon Capture & Sequestration	No	Yes	1 REC for each MWh generated
Nuclear	No	Yes	1 REC for each MWh generated

Compliance with the renewable requirement in PA 235 is tracked through renewable energy credits (RECs). Each REC is equivalent to one MWh of renewable generation and only those resources that are considered renewable (wind and solar) or clean (Natural Gas with CCS and Nuclear) qualify for producing the base 1 REC per 1 whole MWh generated. Some resource types can generate more than the base 1 REC per MWh and these additional RECs are called Incentive Renewable Energy Credits (IRECs), which are interchangeable with RECs for compliance purposes.

Solar and storage resources have the potential to generate IRECs. IRECs are bonus RECs received for various technologies and adhere to specific dates and times. Stipulations for IRECs from resources include:

- Solar power sites approved in a renewable energy plan before April 20, 2017, receive 2 IRECs for every 1 MWh generated
- Solar power sites receive 1/5 of an IREC for every MWh of electricity generated during MISO on-peak hours, which occur between 6 am and 10 pm on weekdays
- All renewable energy resources receive 1/10 of an IREC for every MWh of electricity generated if the resource was constructed using equipment manufactured in Michigan.
- All renewable energy resources receive 1/5 of an IREC for each MWh of renewable generation that is generated during off-peak hours, stored utilizing an energy storage facility, and discharged during on-peak hours.

Electric providers must retire RECs each year to comply with PA 235. RECs can also be bought and sold, though purchased RECs can be used only for compliance purposes until 2035 for municipal utilities. RECs may also be saved for 5 years to meet future compliance needs. Electric providers must file plans with the Michigan Public Service Commission showing future clean and renewable generation against forecasted load.

The table below shows the current BWL generating sources in each portfolio, along with the estimated annual generation and RECs for each resource.

Table 2. RECs Associated with Each Renewable Portfolio Resource

Group	*Resource Name*	Average Annual Clean MWh	Average Annual RECs
Commercially Operating	Beebe Wind 1b	54,110	54,110
	Calhoun Solar Energy Park	18,540	20,394
	Delta Solar 1	13,033	40,792
	Delta Solar 2	25,075	78,484
	Pegasus Wind	204,574	204,574
	Ranger Assembly Solar 1	19,777	21,754
	Ranger Assembly Solar 2	122,864	135,150
In Development	Comfort Street Solar	6,381	7,019
	Delta Energy Park Solar	18,137	19,951
	Lake Lansing Solar	9,580	10,538
	Moltke Ridge Wind	414,660	414,660
	Watertown Solar 1	14,534	15,987
	Watertown Solar 2	10,048	11,053
	White Tail Solar	238,286	N/A until 2035
	Total	**1,169,599**	**1,034,466**

The expected REC net balance from BWL's 2025 renewable energy plan, completed to meet PA 235 requirements, is shown in **Figure 5** below.

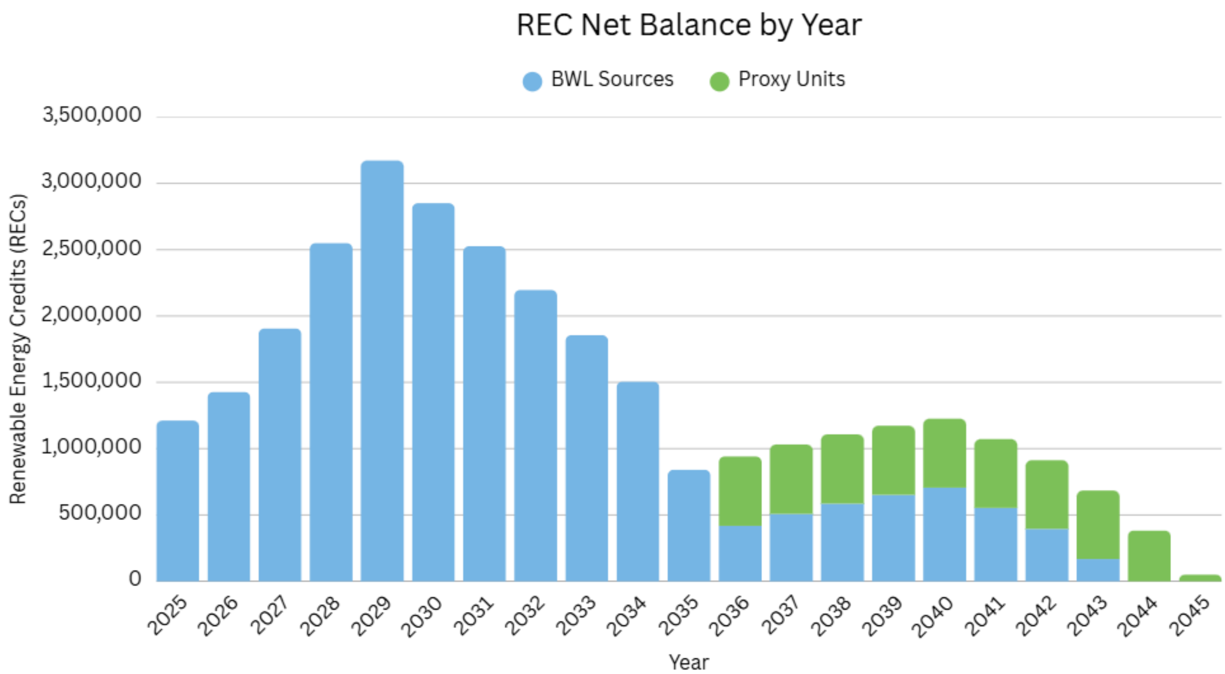


Figure 5. REC Net Balance per Year.

Note: Proxy units were included to account for resources needed but not yet built.

2.6 Michigan's Public Act (PA) 229 of 2023

Another important piece of legislation was signed into law in 2023. PA 229 requires Michigan utilities to file Energy Optimization plans with the state. These plans include measures to reduce energy waste and improve the efficiency of electrification. In total, these measures must achieve 1.5% savings, measured as a percentage of total retail sales. BWL has finalized and submitted its Energy Optimization plan for 2026–2029.

As required by PA 229, these savings targets must be included in a utility's IRP. Energy optimization targets are also incorporated into all long-term load forecasts. These targets are assumed to remain at 1.5% per year over the entire IRP timeframe, and BWL expects to achieve the required savings. BWL has offered energy optimization programs since 2009 and has achieved the targets year over year to present.

2.7 Explanation of Scenarios and Sensitivities

To account for uncertainty in future capacity needs, resource availability, and market prices, BWL's modeling process uses multiple load sensitivities and resource scenarios. Together, these capture meaningful uncertainty across a range of potential futures. A matrix of scenarios and sensitivities is presented in **Table 3**.

Table 3. Matrix of Scenarios and Sensitivities used in this IRP

Sensitivities	***Scenario 1*** *Reference Case: PA 235*	***Scenario 2*** *PA 235, CCS + SMR*	***Scenario 3*** *PA 235, Net Zero*	***Scenario 4*** *PA 235, No Moltke Ridge*	***Scenario 5*** *Baseline Generation & Capacity Needs*
Base Load	1.1	2.1	3.1	4.1	5.1
45 MW Load	1.2	2.2	3.2	4.2	5.2
500 MW Load	1.3	2.3	3.3	4.3	5.3
High Electrification	1.4	2.4	3.4	4.4	5.4

Each of the five scenarios represents a different approach to meeting future customer electric needs, industry conditions, and legislative requirements. An explanation of each scenario is provided in

Figure 6 below.

Scenario 1: Reference Case - PA 235 Requirement

- Michigan PA 235 Compliance:
  - 50% renewable by 2030; 60% renewable by 2035
  - 80% clean energy by 2035; 100% clean energy by 2040
- Existing resources are kept for reliability, building only renewables to achieve renewable and clean energy goals

Scenario 2: PA 235 with Carbon Capture and Nuclear Availability

- Michigan PA 235 Compliance
- Assumes keeping existing resources, and includes other resource options such as small modular nuclear (SMR) and carbon cature of gas-fired generation

Scenario 3: Net Zero

- BWL's Carbon Neutrality Goal pre-PA 235
- Includes purchase of carbon credits to offset current emissions from BWL-owned generation resources
- Includes early retirement of REO geneartion plant in 2040

Scenario 4: No Moltke Ridge Wind Resource

- Michigan PA 235 Compliance
- Existing resources are kept for reliability, building only renewable to achieve renewable and clean energy goals
- Removes proposed Moltke Ridge Wind project, a 149 MW wind farm located in northern Michigan

Scenario 5: Baseline Generation & Capacity Needs

- Operate existing fleet of BWL generation resources
- Storage explored to meet capacity requirements

Figure 6. IRP Scenario Descriptions

For each sensitivity, BWL's load forecast is adjusted to reflect the impact of new technologies and developments, including potential large load additions and the widespread adoption of electric vehicles and electric heating (**Figure 7**). For each sensitivity, the capacity expansion model is paired with a resource scenario that provides a different generation mix to meet the given load sensitivity. These resource scenarios include BWL's existing generation assets, a fully renewable buildout, carbon capture and sequestration, and nuclear. Different load forecasts influence which resources are selected to produce the lowest cost portfolio.

Figure 7. IRP Sensitivity Descriptions

3 IRP Process

The IRP process began by defining the study's scope and establishing the strategies to be evaluated, including planning objectives, regulatory requirements, and input assumptions that guide the analysis. Public participation was integral to the process, providing stakeholders with opportunities to offer input, raise concerns, and help shape priorities.

A comprehensive data collection effort followed, incorporating input from third party sources, consultants, and BWL internal teams to support credible modeling. Data on usage, EV forecasts, weather, GDP, and population were used to develop a 20-year load forecast, which serves as the foundation for the strategy modeling later in the process.

Using that forecast, the strategies defined earlier in the process are modeled. First, a capacity expansion model is run to identify which resources to add to BWL's current generation portfolio to meet the specific criteria for each strategy. This is followed by a production cost model to assess performance, costs, reliability, risk, and environmental impact. The results are reviewed and refined, and the resulting portfolios are presented as potential future pathways.

The sections below provide additional detail on the steps involved in this IRP.

3.1 Public Participation

Throughout the summer of 2025, BWL hosted five open house events to invite the public to learn about the IRP process and share feedback. Events were held at community centers, libraries, and the BWL REO Depot at various times throughout the day to maximize accessibility. For those unable to attend in person, the same survey conducted at these events was also available online. In total, 79 responses were received.

At each open house, residents were guided through stations focused on specific aspects of the IRP process and BWL's customer programs, with a BWL representative at each station to answer questions. Topics included PA 235, capacity expansion modeling, home electrification and efficiency rebates, and BWL's new energy projects. At the end of the stations, attendees could record their feedback. Survey questions asked residents to rank utility priorities, indicate plans (if any) to purchase electric vehicles, heat pumps, and solar panels, and provide input on the development of renewable power sources.

Based on 79 responses to the IRP survey, customers ranked utility priorities as follows:

1. Affordability
2. Reliability
3. Clean Energy
4. Diverse Energy Options
5. Economic Development and Growth

When asked about plans to adopt new technologies over the next 5–10 years, 49% of respondents said they plan to purchase an electric vehicle, 34% are considering a home solar system, 26% are considering a heat pump system, and 24% are considering a battery energy storage system.

Some comments from the online and in-person survey:

> "While I don't plan to buy another EV in the next few years, I do own one now and it's amazing. I don't have the data to decide whether BWL should go nuclear, but I think if the demand can be met with solar, there are many opportunities for the expansion of that technology. Look at what MSU has done with the solar panels in their parking lots."

> "I support SMRs if they prove technically and financially practical. Are data centers a concern within the BWL service area? If so, can we ensure the developers for the site/the data center companies commit to building renewable energy for their entire load?"

> "Only use marginal lands for solar and wind, etc., such as but not limited to landfills and contaminated sites. No farmland or arable land!!!"

Full survey results can be found in *Appendix A: IRP Survey Responses*.

3.2 Load Forecasting

Utilities continuously experience fluctuating customer electricity demand. Thus, utilities must be flexible and adjust generation up or down in real time as needed. If a utility cannot do this easily, the grid can become unstable, causing considerable damage. **Figure 8** shows the daily load profile for an average summer day for BWL's entire system.

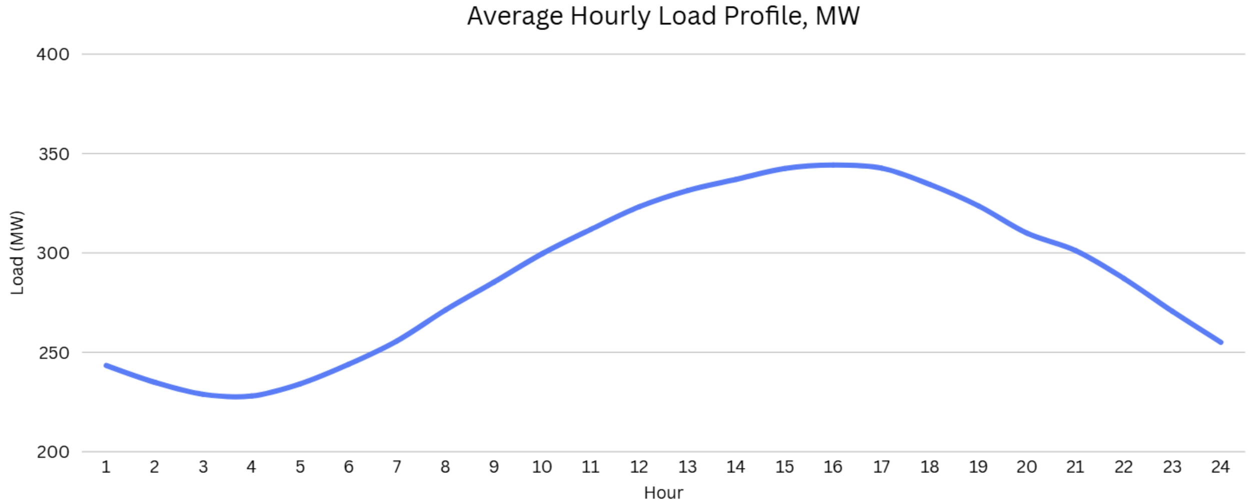


Figure 8. Average Summer Daily Load Profile

Demand varies throughout the year, with peak demand for an electric utility typically occurring in the summer months. Secondary peaks occur in the winter. Spring and fall are referred to as "shoulder" months, when demand is generally lower than in summer and winter. **Figure 9** illustrates seasonal variation in daily minimum and maximum demand over the course of a year.

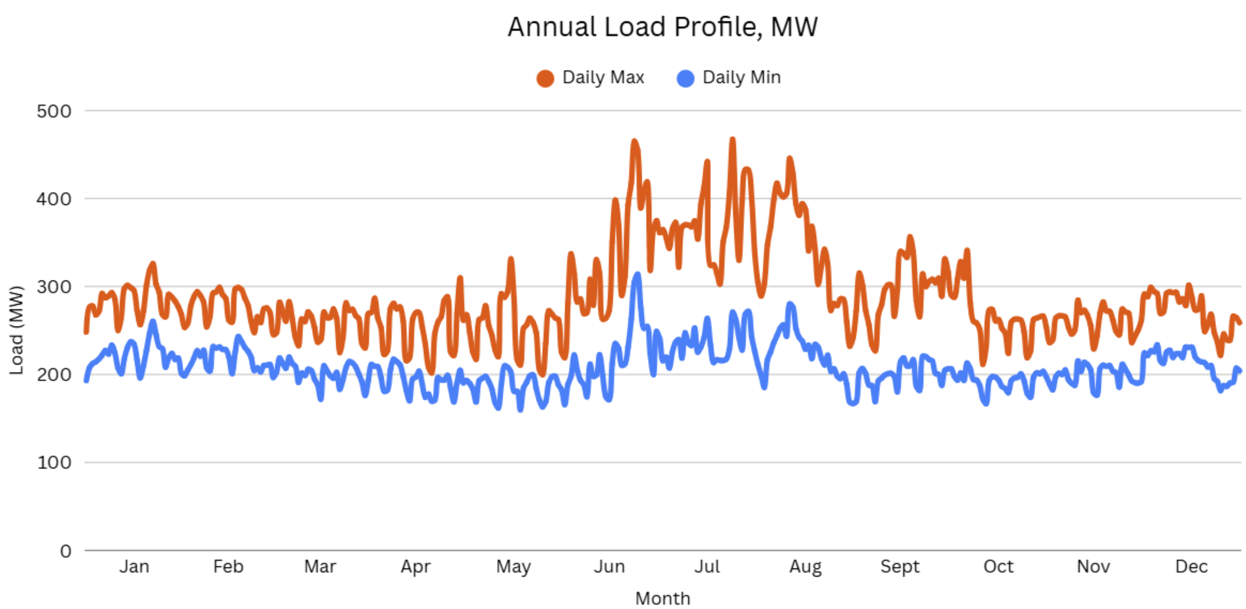


Figure 9. BWL's Annual Load Profile, MW

One important part of the IRP is to ensure BWL maintains the appropriate portfolio of generating resources to always meet demand. BWL expects load to increase year over year throughout the first half of the IRP timeframe, with growth slowing thereafter. **Figure 10** presents the base load forecast used in the initial load sensitivity analysis across all resource scenarios.

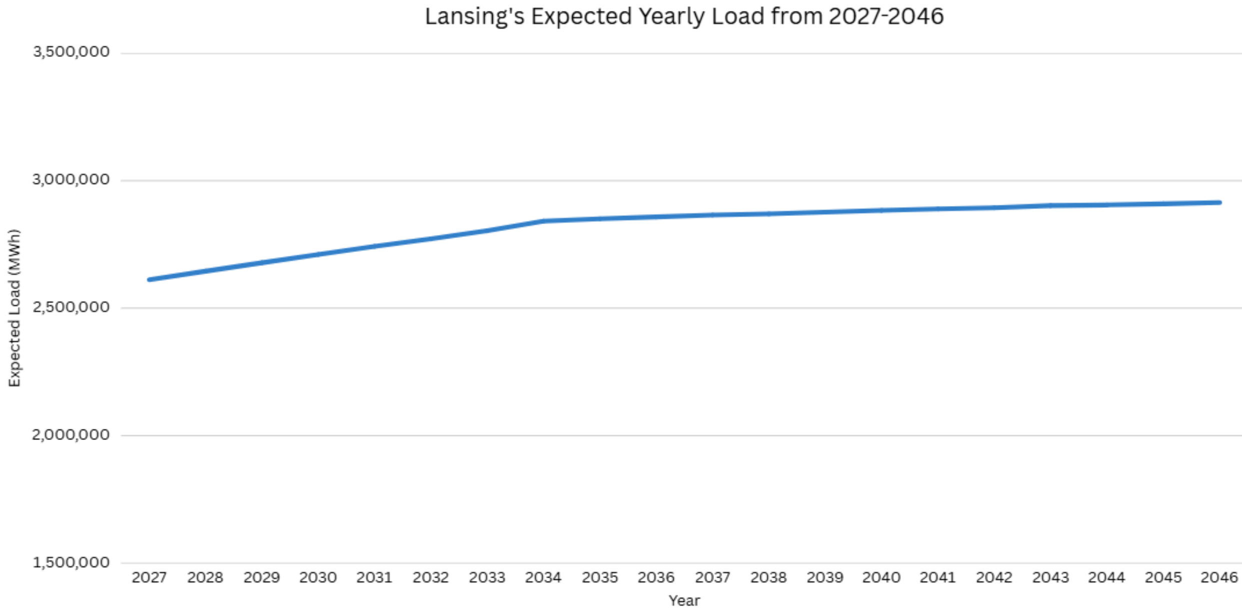


Figure 10. BWL's Annual Load Profile, MWh

Customer demand is forecast for each of BWL's rate classes: residential, small commercial, medium commercial, and large industrial. Each rate class is further broken down by monthly consumption in kilowatt-hours (kWh) and peak loads in kilowatts (kW). The load forecast uses historical data to project demand for each year of the study period. A multiple regression model relates historical load data to economic and weather predictor variables. These econometric models are the industry standard for load forecasting and are among the methods accepted by MISO. BWL uses economic forecast data from Woods & Poole. Weather predictor variables are derived from NOAA historical weather data with trends developed by Great Lakes Integrated Sciences and Assessments (GLISA).[1] The model is updated multiple times per year with new load data to capture changes in consumption.

GLISA is a research collaboration between the University of Michigan, Michigan State University, and the University of Wisconsin, funded by NOAA's Climate Adaption Partnerships. These researchers develop global climate models that project future seasonal average temperatures. BWL uses a multi-model average specific to the Great Lakes region. For BWL's purposes, average seasonal temperatures are converted into heating and cooling degree days (**Figure 11**). These metrics compare a given day's average temperature to a base temperature of 65°F.

[1] GLISA | A NOAA CAP Team

Cooling Degree Days (CDD) Calculation Example

Temperature: Daily high of 90°F and daily low of 66°F

Temperature Mean: (90°F + 66°F) / 2 = 78°F

Since the result is larger than 65°F:

CDD: 78°F - 65°F = 13

Heating Degree Days (HDD) Calculation Example

Temperature: Daily high of 33°F and daily low of 25°F

Temperature Mean: (33°F + 25°F) / 2 = 29°F

Since the result is smaller than 65°F:

HDD: 65°F - 29°F = 36

Figure 11. Guide to Calculating Cooling and Heating Degree Days

BWL then uses a monthly average of these days, forecasted through 2046. The first ten years of this forecast are graphed below (**Figure 12**).

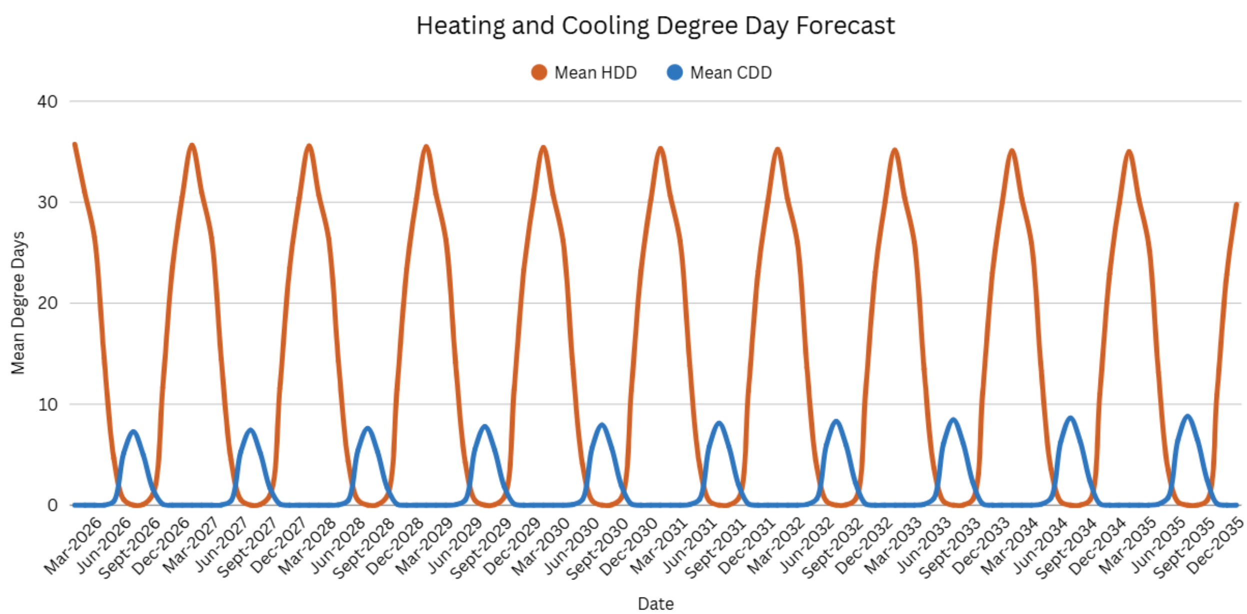


Figure 12. Heating and Cooling Degree 10-Year Forecast

Michigan averages more heating degree days than cooling degree days annually. Over 95% of BWL customers currently rely on gas furnaces for heating, although the IRP models a scenario in which residents adopt electric heating at a rate higher than BWL currently projects. In other scenarios, hot summer days drive peak demand.

Other variables used in the load forecast include socioeconomic factors such as GDP per capita and population growth. These variables are more relevant for forecasting long-term trends over many years, whereas weather variables are useful for annual seasonal trends.

Different variables may also be used for different rate classes. For example, GDP per capita is more relevant for predicting long-term growth in BWL's commercial electric rate classes than for predicting residential consumption. Another example is electric vehicle adoption, which is used as a predictor variable in BWL's rate classes designated for EV charging, but not in any other rate class.

3.2.1 Large Loads

While the methodology described above has proven effective in forecasting most customer classes, large industrial customers are modeled individually because they have a significant impact on overall electricity demand. BWL uses the same regression model applied to other rate classes to estimate how a facility's consumption varies seasonally but relies on direct communication with large load customers to determine specific power needs and ramp schedules.

3.2.2 Energy Optimization (EO) & Efficient Electrification

One of the ways that BWL attempts to control long-term load growth and the addition of large load customers is through energy optimization programs, known as Hometown Energy Savers. In November 2025, BWL formalized its Energy Optimization (EO) Plan for 2026 through 2029, which took effect in January 2026. This plan includes measures to reduce energy waste and promote efficient electrification for residential and commercial customers. In each year of the plan, the minimum energy conservation savings goal is set at 1.5% of total annual sales, in compliance with Michigan Public Act 229 (PA 229). The following three sections are drawn from the Energy Optimization Plan.

3.2.2.1 Residential EO Programs

The residential sector includes the following seven EO programs, with two new offerings: New Construction and, in response to PA 229 and MPSC Order U-21567, Income Eligible Health and Safety. The EO 2026-2029 Plan addresses the absence of a large savings reservoir in residential lighting, which used to provide more than half of residential sector savings, by pivoting to measures that deliver long lived savings, albeit at a higher cost per savings, notably weatherization measures such as insulation.

BWL's 2026-2029 residential programs include:

- Income Eligible Services
- Income Eligible Health and Safety
- High Efficiency Appliances
- High Efficiency Heating, Ventilation & Air Conditioning (HVAC)
- Appliance Recycling
- Multifamily

- New Construction

3.2.2.2 Commercial & Industrial EO Programs

The commercial and industrial sectors include three programs to achieve electric energy savings from new and existing customers. The EO 2026-2029 Plan continues the current strategy of offering financial incentives for a broad range of electric efficiency technologies including lighting, HVAC, refrigeration, compressed air, processes, and controls. Incentive offers are supported by engagement of market providers and advisory services offered on behalf of BWL. Electric savings from the commercial and industrial sector are highly cost-effective, and include the following programs:

- Prescriptive Lighting & Non-Lighting Measures with deemed savings
- Custom Measures or Processes based on calculated savings
- Small Business offers higher incentives

3.2.2.3 Efficient Electrification (EFEL)

BWL's Efficient Electrification (EFEL) program will help customers transition from natural gas systems to efficient electric alternatives. These programs are designed to promote the adoption of technologies such as air source heat pumps, heat pump water heaters, electric lawn equipment, electric forklifts, and electric bicycles. By supporting electrification alongside conventional energy efficiency measures, BWL aims to reduce greenhouse gas emissions, improve indoor and outdoor air quality, and ensure alignment with its carbon neutrality goals and PA 229 requirements. The EFEL program includes offerings to support both residential and commercial customers. The IRP modeling includes a sensitivity in which BWL sees a high rate of electrification among all customers. The program is designed to ensure non-participant electric rates do not increase, as calculated by assessing impacts using a custom Electric Rate Impact Measure (E-RIM) benefit-cost test. Most electrification measure characterizations are sourced from the Vermont 2023 Tier III Technical Resource Manual (TRM).

For this IRP, BWL extends the Energy Optimization Plan across the study timeframe. As retail sales grow, the energy savings requirement, defined as a percentage of total sales, will increase proportionally. BWL will update the plan over time to incorporate new energy optimization and efficiency measures as consumption trends change and technology advances. The target savings percentage of 1.5% of retail sales remains in effect throughout the planning period.

3.2.3 Residential Building Electrification

As previously noted, BWL's capacity needs are driven by peak electricity demand, which currently occurs during the hottest days of the year as customers cool their homes and businesses. In the residential sector, heating and cooling are the primary energy uses, with most households in BWL's service territory and across the region relying on natural gas for winter heating and electricity for summer cooling. As a result, BWL currently experiences peak electricity demand in the summer months, with peak load directly correlated with extreme summer temperatures. Large-scale adoption of electric heating in the residential sector could transform BWL from a summer peaking to a winter peaking utility, such that electric heating could align the winter and summer peaks.

Importantly, the high electrification load sensitivity assumes a high level of residential electrification. With rooftop solar installations reducing the summer peak, the winter peak becomes relatively larger. This has implications for BWL's generation portfolio and its relationship with the grid operator, MISO, as its generation resources are accredited seasonally by MISO. While BWL's current investments in new solar arrays match its current summer peak, MISO currently offers a 50% summer accreditation and a 5% winter accreditation for solar power. As BWL's accredited capacity must cover its peak load plus a reserve margin, other resources become more favorable under a high electrification scenario.

To define market adoption of residential electrification in a high electrification scenario, NLR's Electricity Futures Study is used. NLR's study explored how the emergence of various technologies would affect the industry, including residential heating and appliances. Their modeling was split into reference, medium, and high scenarios that represented varying levels of electrification across different regions of the United States. In the high scenario, BWL's load sensitivity projections show residential electrification reaching 80% of homes by 2050. This scenario represents a drastic increase in electrification beyond BWL's current experience and is used to model a situation in which electrification affects BWL's resource adequacy needs.

3.2.4 Electric Vehicles

In addition to buildings, many customers have already adopted or plan to adopt electric vehicles. According to vehicle registration data from the Michigan Secretary of State, there are 2,906 fully electric and 1,081 plug-in hybrid electric vehicles registered in BWL's service territory as of the summer of 2025. This represents about 2.5% of the 158,597 total active passenger vehicle registrations in the service territory. While the electric vehicle market has experienced fluctuations in growth, BWL has seen a steady increase in both the number of EVs registered in its service territory and the kWh consumption associated with charging.

Rate 22, the rate which BWL assigns to all residential EV charging equipment that is separately metered from the home, has grown year over year, as shown in **Figure 13** below.

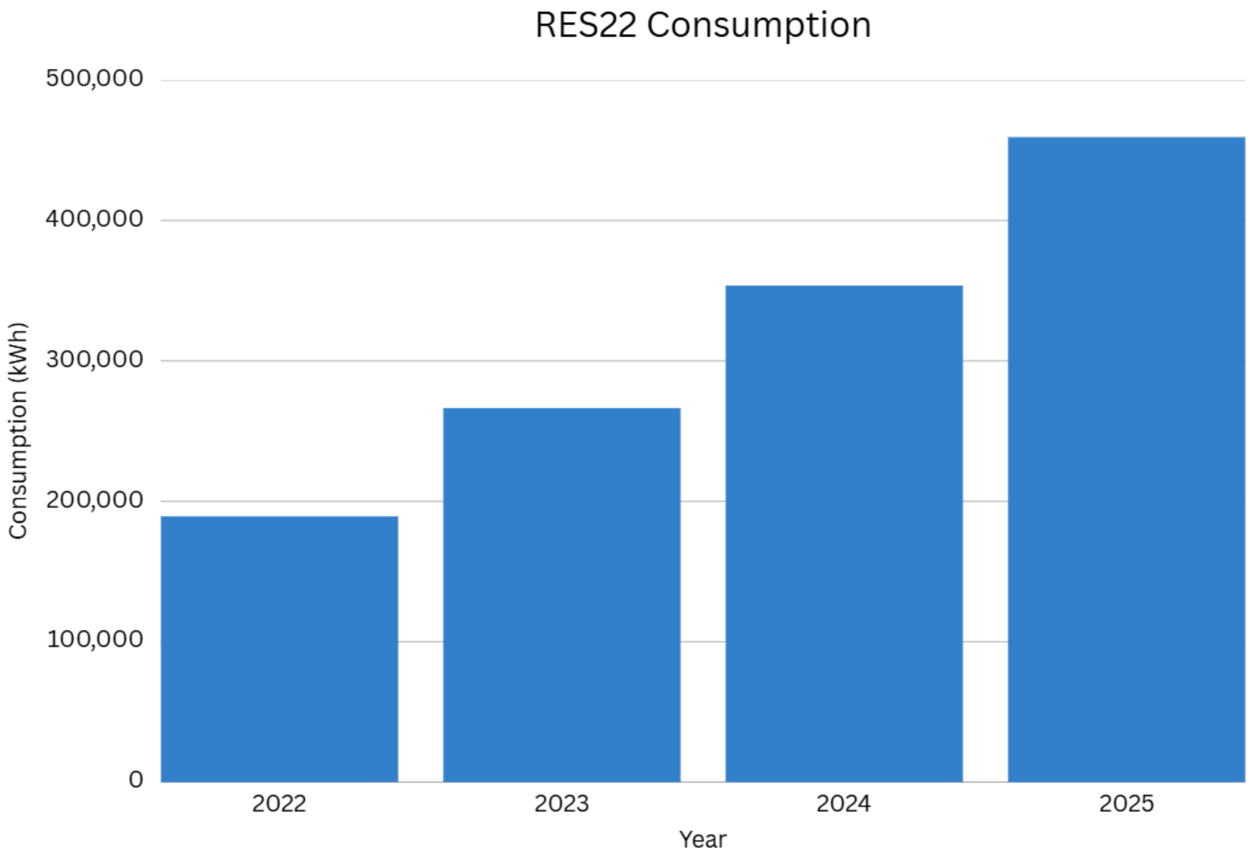


Figure 13. Consumption for BWL's Rate RES22

3.2.4.1 Residential vs. Commercial Charging

In addition to EV charging at homes in BWL's service territory, there are various locations offering public charging throughout the territory (**Figure 14**). Some of these are dedicated EV charging stations, while others are at businesses and other public venues that offer charging in their parking lots. The bulk of these chargers are Level 2, or AC chargers, with power up to 19.2kW. These are more affordable and easier for businesses to install using existing service infrastructure than their counterpart DC Fast chargers, which deliver more than 50kW. Because DC Fast chargers can charge a vehicle four times faster than a Level 2 charger, the Michigan Department of Transportation has invested federal funds in building a network of them to support greater EV adoption. This National Electric Vehicle Infrastructure (NEVI) program has so far built one of these stations in BWL service territory, with three more anticipated.

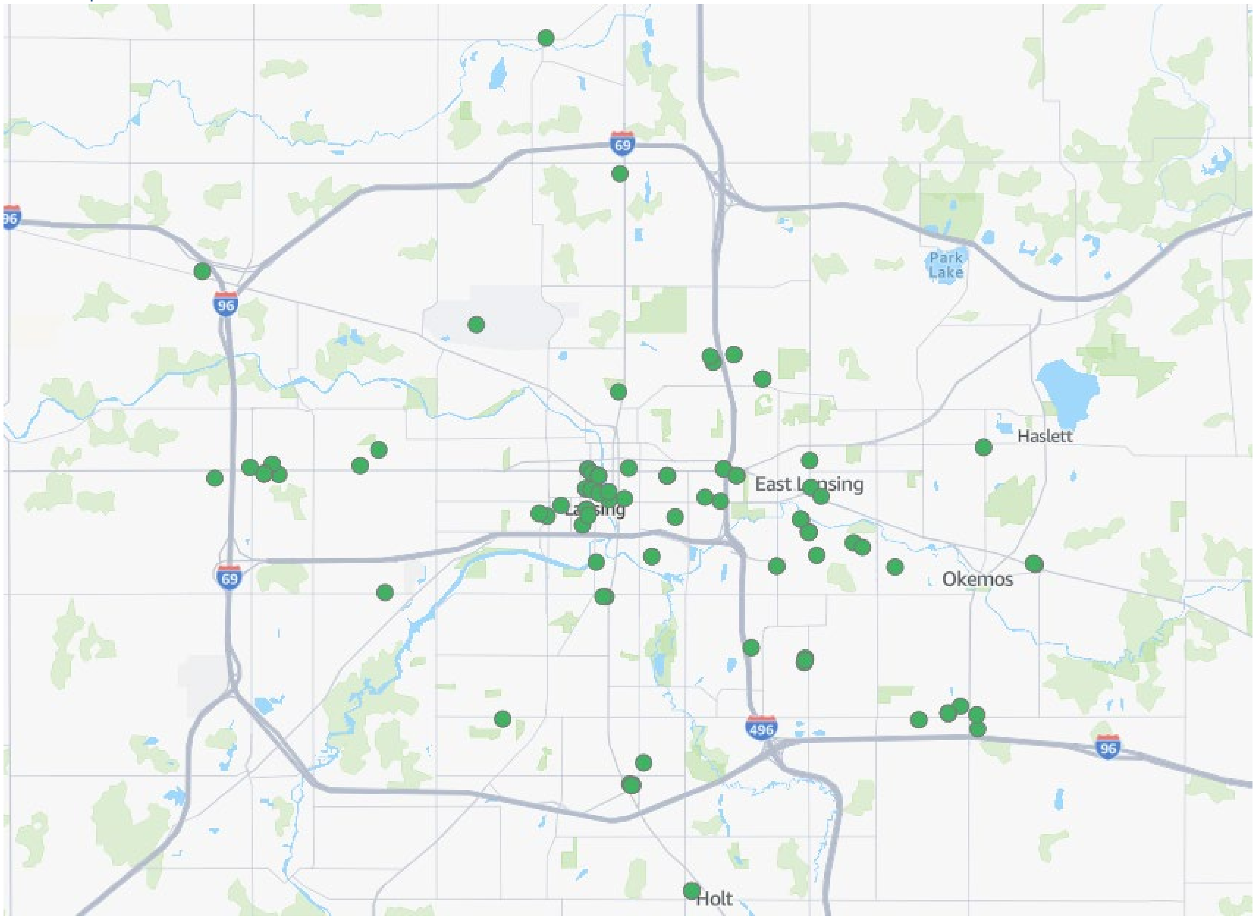


Figure 14. Public Locations of EV Charging Stations[2]

3.2.4.2 Load Impacts of Electric Vehicles

All BWL customers who install a separate, dedicated meter for electric vehicle charging and accept BWL's rebate for doing so are metered at the RES22 rate. While not all EV drivers choose to do so, the RES22 rate class provides a representative sample of the charging behavior of EV drivers who own charging equipment.

As EV charging on this rate increases year over year, the load shape remains unchanged. BWL's customers charge their vehicles at home, preferring to do so at night, with the bulk of power demanded between 8:00 pm and 4:00 am. BWL currently incentivizes this consumption pattern through its RES22 and RESTOU rates, which charge higher prices per kWh between 1:00 p.m. and 8:00 p.m. as evidenced by the load shape below (**Figure 15**). This incentive has proven effective in shifting load away from peak hours.

[2] Alternative Fuels Data Center, February 2026.

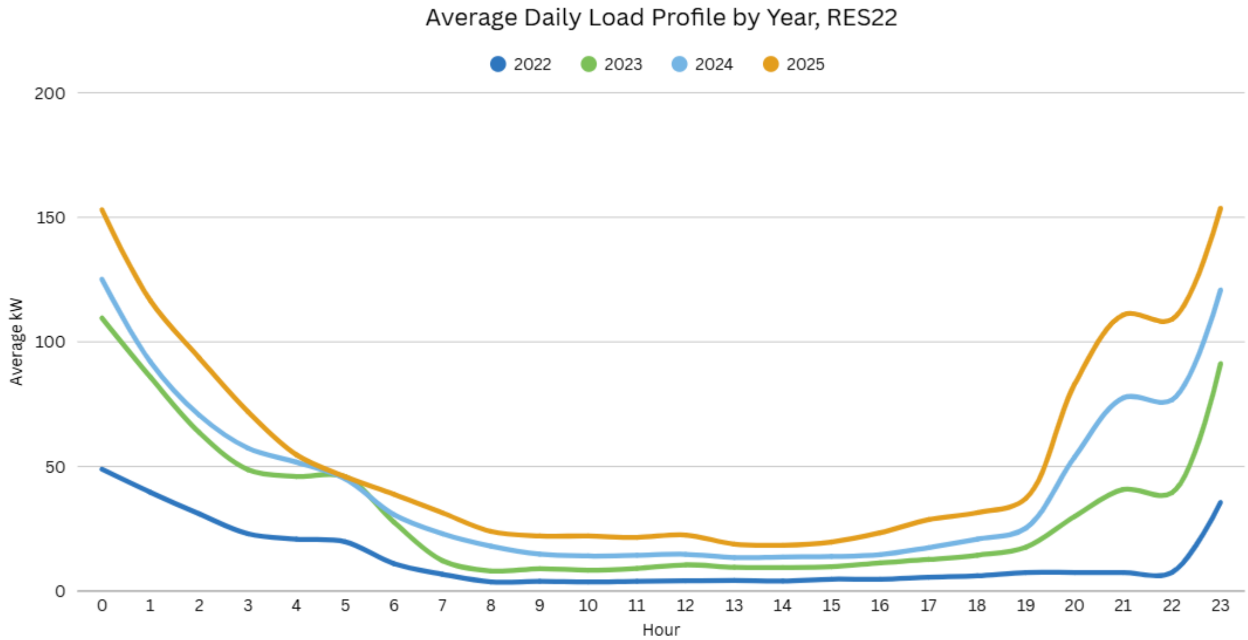


Figure 15. Average Daily Load Profile in Years 2022-2025 under BWL's RES22 Rate

BWL's MCEV rate is designed for dedicated public EV chargers, including the single built NEVI-compliant charger. This rate does not include every publicly available charger in the service territory, as some businesses install chargers without a separately dedicated meter. However, meters on MCEV show that these chargers have different usage patterns from their residential counterparts, drawing more energy during peak afternoon hours rather than overnight. (**Figure 16** below). As EV adoption in the service territory grows, the balance between public and private charging will determine the impacts of EV use on BWL's system.

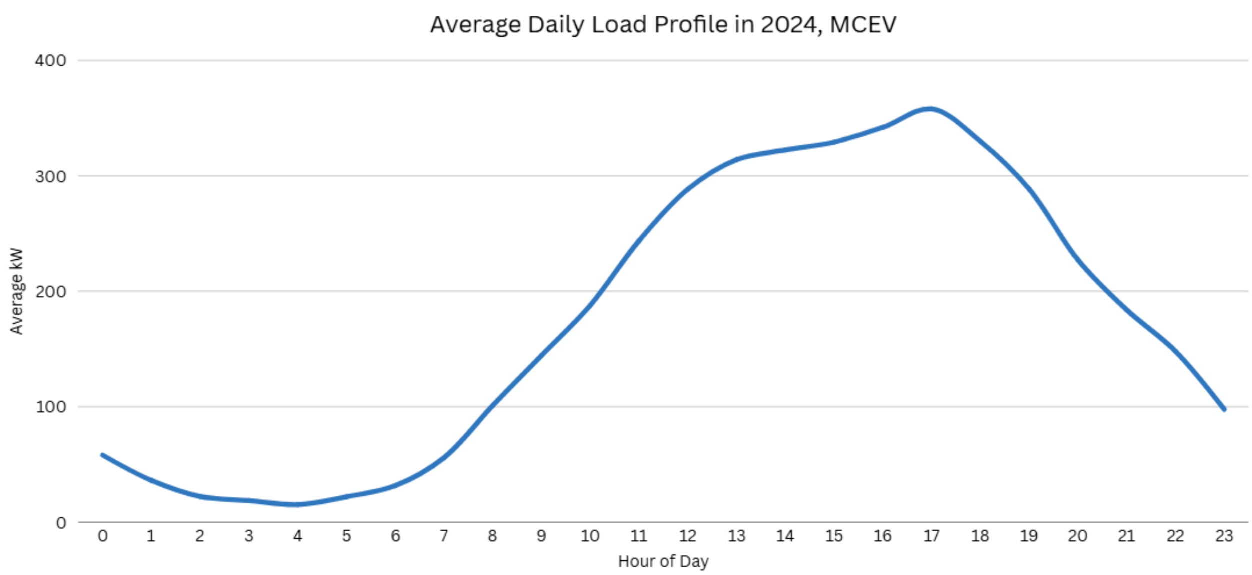


Figure 16. Average Daily Load Profile of BWL's Rate Class MCEV in 2024

The economic data used for BWL's load forecast includes EV adoption as a data point, alongside GDP and population growth. To forecast load growth associated with EV charging, the model combines this data with data from Argonne National Laboratory's Assessment of Plug-in Light Duty Electric Vehicles in the United States, 2010-2019. This report finds that the average passenger EV consumes 3,770 kWh per year. To fit this into seasonal and hourly profiles, BWL's historical consumption patterns described above are used to allocate yearly kWh consumption across each month and to forecast peak load impacts from EV charging.

3.2.5 Adjusted Demand Forecasts - Sensitivities

Load forecast adjustments for large industrial and data center loads use existing customer data to estimate load patterns for new developments. Existing data centers in BWL's service territory operate at high load factors and exhibit less demand variability than other customers. The load profiles of these facilities are then scaled to simulate the electric demand of larger data centers. Although these facilities use similar technology, the load profile of a large data center may differ from those already in the system. To balance the generation needed to support these sites, some operators are exploring load flexibility to reduce overall capacity requirements. In any case, supporting a customer of this scale would be addressed on a case-by-case basis, with demand and capacity requirements defined contractually.

Electric demand (or load) forecasts are adjusted based on the model's various sensitivities. The load forecasting methodology uses long-term weather, demographic, and economic projections to predict demand, and historical data are used to define relationships between these variables and load. Adjustments rely on these same relationships and incorporate changes in consumption driven by new and expanding end uses of electricity. These sensitivities include high growth in residential electrification and large industrial and data center development in the region.

3.3 Determination of Generating Capacity Needs

Once trends in customer electric demand and usage are incorporated into a load forecast, the forecast is used to determine capacity needs by applying MISO's planning reserve margin requirement (PRMR). The PRMR is the primary requirement for BWL's capacity needs each season. MISO's PRMR represents the reserve margin required above expected demand in each season to ensure reliability under unexpected conditions. MISO calculates seasonal PRMR values using its peak forecast and loss of load expectation study. BWL uses the load forecast to predict its peak electric demand for each season and applies MISO's PRMR to that peak. The seasonal reserve margins for MISO Planning Year 2026–2027 are compared to those for 2025–2026 in **Figure 17** below.[3]

[3] Planning Year 2026-2027 Loss of Load Expectation Study Initial Report - MISO

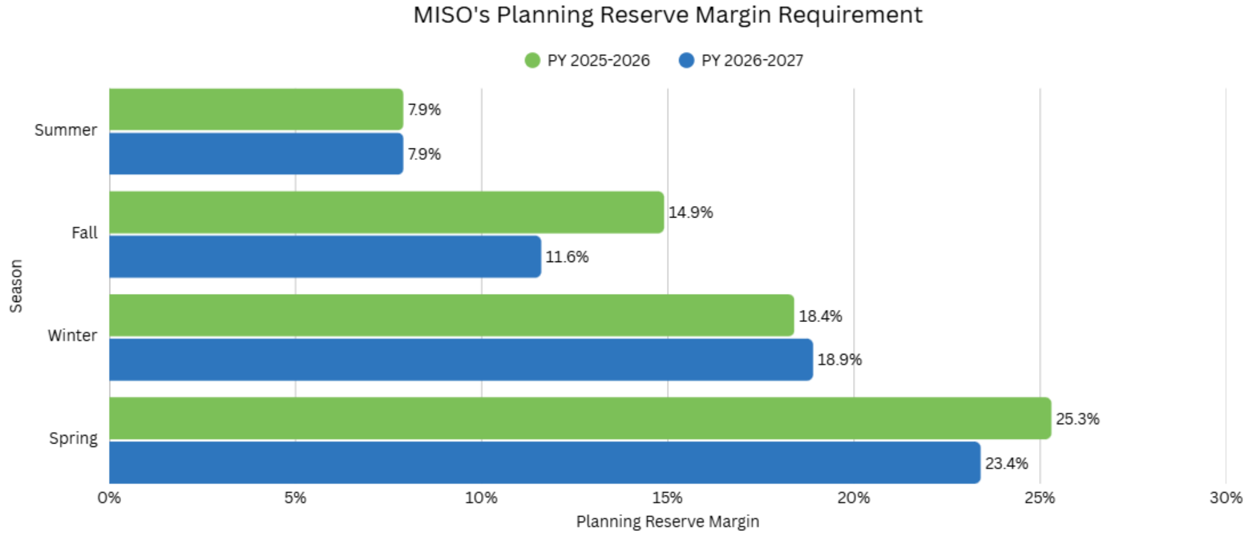


Figure 17. Planning Reserve Margin Requirement set by MISO

For BWL, this means that in each season, generation capacity must exceed forecasted peak load.

3.3.1 Accredited Capacity

Meeting PRMR with sufficient capacity is not as simple as matching projected peak load with equal nameplate generation capacity. MISO accredits different generation types at different capacity values, and dispatchable resources, such as natural gas generators, typically receive higher accredited capacity than non-dispatchable resources, such as wind and solar. BWL must comply with regulations established by the North American Electric Reliability Corporation (NERC) and enforced by the Federal Energy Regulatory Commission (FERC). These regulations require BWL to demonstrate, through annual testing, that it owns or contracts for sufficient generating resources to meet historical and projected peak demand, including a safety margin, using accredited capacity. If these requirements are not met, BWL must procure capacity from a third party. This requirement is known as the Planning Reserve Margin Requirement (PRMR).

MISO requires that utilities acquire enough Zonal Resource Credits to meet their PRMR. These credits can come from a Load Serving Entity's (LSE) own generation from purchases at auction from other generation owners. In the 2020 BWL IRP, this PRMR was set by MISO to a single value for the entire planning year. The current method of meeting PRMR varies seasonally, with a different PRMR each season of the planning year.

Changing capacity accreditation methodologies complicates resource planning. Because generating resources perform differently based on fuel type and dispatchability, MISO accredits resource types differently across seasons. For dispatchable generation, nameplate capacity is reduced by a factor that accounts for the unit's historical forced outage rate, which is the frequency of unscheduled outages resulting in unforced capacity

(UCAP). This value can vary seasonally to account for changes in thermal generation performance and scheduled maintenance.

Intermittent, non-dispatchable resources such as wind and solar are accredited based on their ability to contribute to system load. In recent planning years, MISO has calculated this using a renewable resource's effective load carrying capacity (ELCC). To determine ELCC, MISO simulates system conditions with and without the resource, under a fixed reliability standard of a 1-in-10-year loss of load expectation (0.1 day/year LOLE). The incremental load that a resource can serve while maintaining this standard is divided by its registered maximum output and expressed as a percentage. These ELCC values inform MISO's seasonal accredited capacity for wind and solar resources. **Figure 14** shows MISO's ELCC values.[4]

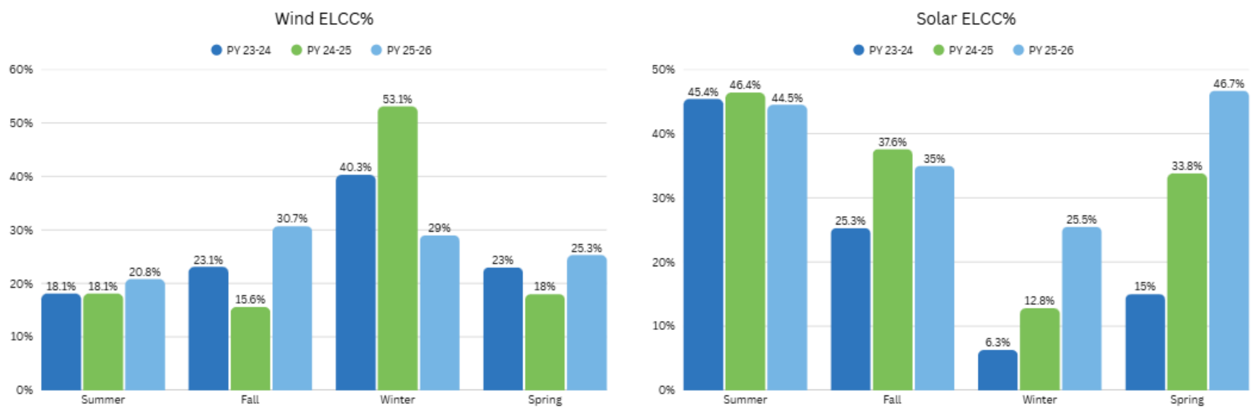


Figure 18. MISO Effective Load Carrying Capacity Values

MISO has indicated it will transition to Direct Loss of Load (DLOL) for capacity accreditation in the coming years. Beginning in Planning Year 2028–2029, MISO will use DLOL to assign capacity values to each resource class. Previously, ELCC was used to evaluate a resource type's contribution to serving load during peak demand hours, with each resource accredited based on its average capacity value during those hours. DLOL instead accredits resources based on marginal ELCC, or their incremental contribution to system reliability. This methodology assumes that higher renewable penetration will shift the hours with the greatest load loss risk. As more intermittent resources enter the generation mix, periods of highest reliability risk are not always aligned with peak demand but can also occur during periods of reduced supply. This change will likely reduce accredited capacity values for renewable resources. **Figure 15** illustrates this difference.[5]

[4] Planning Year 2024-2025 Wind and Solar Capacity Credit Report
[5] Zachary Ming, Prepared Direct Testimony on behalf of the Midcontinent Independent System Operator, Inc., Docket No. ER24-1638-000 (Mar. 26, 2024).

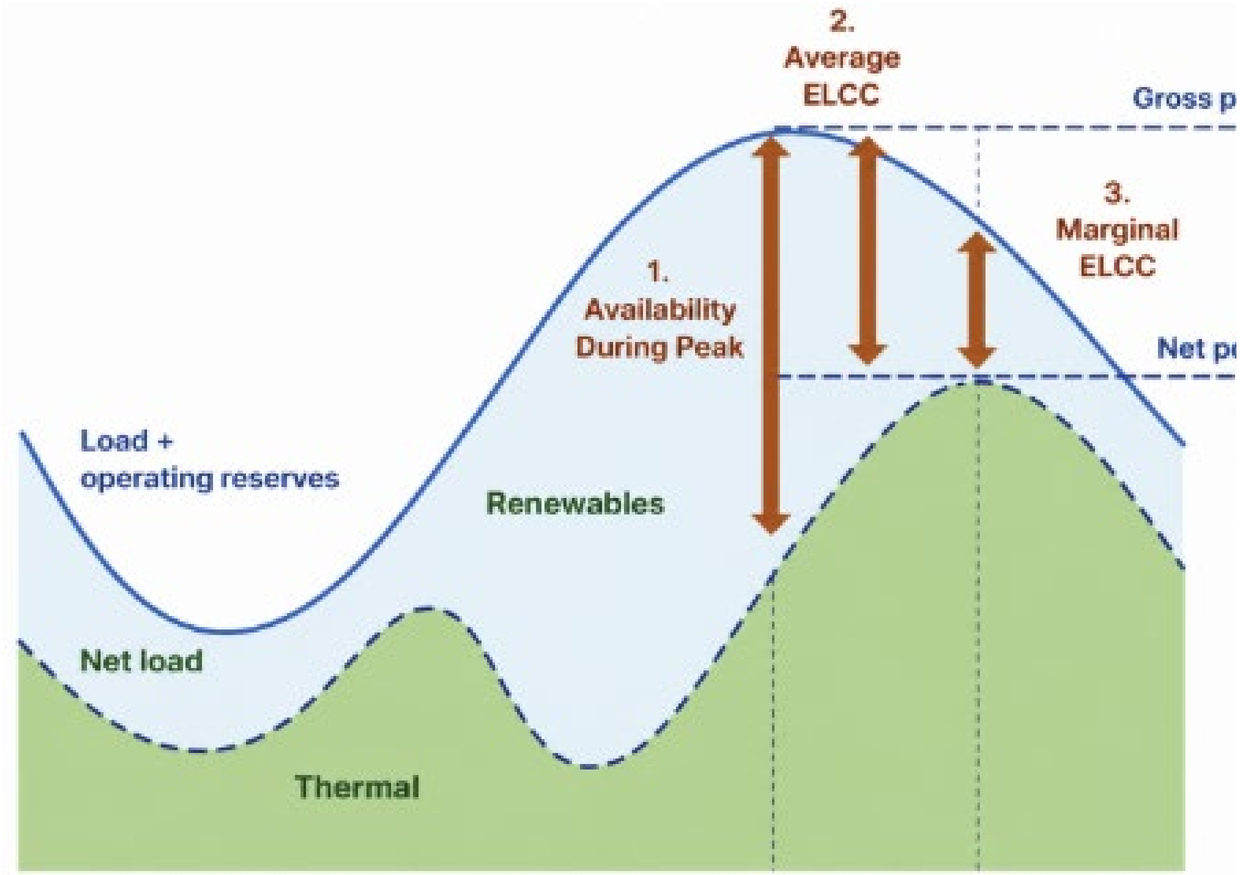


Figure 19. The Evolution of Different Resource Accreditation Methodologies Over One Day

MISO will not be the first ISO to transition to marginal ELCC for capacity accreditation. PJM, the ISO covering much of the Mid-Atlantic region and Chicago, adopted a similar methodology in 2024. [6] In the subsequent capacity auction for planning year 2025-2026, prices settled 262% higher than in the prior year. While growing demand explains part of this increase, the marginal ELCC framework reduced the accredited capacity of existing renewable resources in PJM, decreasing overall capacity supply. This also incentivized older dispatchable thermal generation to remain online rather than retire. Although MISO does not have the same concentration of data centers as PJM, its capacity prices are also expected to increase.

While this accreditation methodology will likely continue to reduce the accredited capacity of renewable resources, it is consistent with the declining ELCC values already reflected in BWL's forecast. This shift reduces BWL's total capacity credits from existing wind and solar assets and from future renewable additions. In the context of the IRP, this affects the total amount of resources required to meet BWL's capacity needs. As the accredited capacity of solar and wind decreases, the cost of procuring capacity increases. At the same time, as renewable energy requirements under PA 235 increase, BWL's portfolio must include more

[6] FERC Order, PJM Interconnection, L.L.C., Docket No. ER24-99-000 (Jan. 30, 2024).

renewable resources that contribute to energy requirements but provide limited capacity value.

3.4 Resource Options, Evaluation & Cost Assumptions

In this IRP, BWL evaluated both non-renewable and renewable resources, as well as other clean energy technologies. For non-renewable sources, BWL considered natural gas units, including reciprocating internal combustion engines (RICE), combined cycle (CC), and combustion turbine (CT) units. Wind and solar resources were also evaluated. Additional technologies considered in this IRP include carbon capture and sequestration (CCS), small modular reactor (SMR) nuclear, and battery storage (4-hour and 8-hour durations). **Table 4** provides additional detail on the resources available for selection in this IRP.

Table 4. Resource Options Available for Each IRP Scenario/Sensitivity

Resource Type	Key Assumptions
Gas	• CC natural gas technology is available starting in 2031, sized at 193 MW per facility. Projects available over time frame: 4 • CT natural gas technology is available starting in 2028, sized at 57 MW per facility. Projects available over time frame: 18 • RICE natural gas technology is available starting in 2028, sized at 112 MW per facility. Projects available over time frame: 9 • A CCS retrofit of the BWL's Delta Energy Park natural gas plant available start in 2035, sized at 170 MW
Nuclear	• One 77 MW SMR facility is available starting in 2030

Solar	• Local Solar: sized at 3 MW per site
	  ○ Base and High Electrification Sensitivities: 20 sites available over the entire time frame
	  ○ 45 MW and 500 MW Large Load Sensitivities: 40 sites available over the entire time frame
	• Non-Local Solar: sized at 10 MW per site
	  ○ Base and High Electrification Sensitivities: 140 sites available over the entire time frame
	  ○ 45 MW Large Load Sensitivity: 224 sites available over the entire time frame
	  ○ 500 MW Large Load Sensitivity: 300 sites available over the entire time frame

Storage	• Local 4-hr Battery: sized at 2 MW per site. Projects available over time frame: 200
	• Non-Local 4-hr Battery: sized at 25 MW per site
	  ○ Base and High Electrification Sensitivities: 16 sites available over the entire time frame
	  ○ 45 MW and 500 MW Large Load Sensitivities: 26 sites available over the entire time frame
	• Local 8-hr Battery: sized at 2 MW per site. Projects available over time frame: 25
	• Non-Local 8-hr Battery: sized at 25 MW per site
	  ○ Base and High Electrification Sensitivities: 2 sites available over the entire time frame
	  ○ 45 MW Large Load Sensitivity: 3 sites available over the entire time frame
	  ○ 500 MW Large Load Sensitivity: 4 sites available over the entire time frame

Wind	• Wind projects are sized at 35 MW per site
	  ○ Base and High Electrification Sensitivities: 8 sites available over the entire time frame
	  ○ 45 MW Large Load Sensitivity: 11 sites are available over the entire time frame
	  ○ 500 MW Large Load Sensitivity: 86 sites are available over the entire time frame

In addition to the prospective resource options described above, BWL operates existing generation resources. **Table 5** shows the capacity and average generation of BWL's natural gas facilities, while **Table 6** presents the same information for renewable facilities. Belle River 2 is expected to complete its transition from coal to natural gas by the end of 2026. As the study period begins in January 2027, Belle River is modeled as a gas peaking unit based on DTE's projections.

Table 5. BWL's Current Thermal Generation Resources

Generation Facility	Capacity (MW)	Average Generation (MWh)
Belle River 1	73	77,443
Belle River 2	73	74,691
Delta Energy Park CC	203.25	1,352,882
Delta Energy Park CTG1	57	61,944
Project Dynamic RICE	111.8	254,877
REO Cogeneration Plant	119.7	509,042
Total	***637.75***	***2,330,879***

Table 6. BWL's Current Renewable Resources

Generation Option	Capacity (MWac)	Average Generation (MWh)	Technology
Beebe 1b	19.2	48,566	Wind
Calhoun Solar Energy Park	10	18,543	Solar
Comfort Street Solar	4	6,708	Solar
Delta Solar 1	8.1	13,390	Solar
Delta Solar 2	15.9	25,743	Solar
Lake Lansing Solar	6.19	9,713	Solar
Watertown Solar 1	8	14,670	Solar
Watertown Solar 2	6	10,549	Solar
Pegasus Wind	68	204,574	Wind
DEP Solar	10	18,987	Solar
Ranger Solar Assembly 1	10	19,777	Solar
Ranger Solar Assembly 2	70	122,946	Solar
White Tail Solar	115	238,286	Solar
Total	***350.39***	***752,452***	

3.5 Capacity expansion modeling

Capacity expansion modeling evaluates the ability of future resources to reliably and cost-effectively serve BWL's projected load. To address potential load growth scenarios, BWL uses four load sensitivities that reflect varying levels of industrial load growth and the electrification of other end uses. On the supply side, BWL defines the resource options available to the capacity expansion model. For each resource type, the model receives inputs such as capital cost estimates, contributions to accredited capacity, contributions to compliance with PA 235, and limits on the amount of capacity that can be built. The model then selects the resource combination that most cost-effectively serves the load.

Resource types available to the model are defined within each scenario. BWL uses five scenarios in the capacity expansion modeling process. In each scenario, a different mix of resources is available to serve each load sensitivity. Additional details on the capacity expansion modeling approach are provided in *Appendix B: Ascend Analytics*.

3.5.1 Candidate Resources

Table 7. Candidate Resource Costs and Ownership Options

Resource	Capital Cost $/kW	PPA, $/MWh or $/kW-mo	PA 235 Clean Energy?	PA 235 Renewable Energy?
Gas - Combined Cycle	$3,210 - $3,513	N/A	No	No
Gas - Combustion Turbine	$1,624 - $2,002	N/A	No	No
Gas - RICE	$1,597 - $1,969	N/A	No	No
Carbon Capture Retrofit	$1414/-kW	N/A	Yes	No
Nuclear (SMR)	$12,369	N/A	Yes	No
Solar - Local	N/A	$76.84 - $97.67	Yes	Yes
Solar - Non-Local	N/A	$77.84 - $98.67	Yes	Yes
Wind	NA	$58.21 - $87.46	Yes	Yes
4-hr Storage - Local	$1,236 - $1,292	$13.49 - $19.25	No*	No*
4-hr Storage - Non-Local	$1,236 - $1,292	$14.49 - $20.25	No*	No*
8-hr Storage - Local	$2,113 - $2,210	$22.73 - $31.44	No*	No*
8-hr Storage - Non-Local	$2,113 - $2,210	$23.73 - $32.44	No*	No*

*If storage is collocated with renewable energy, then it is an eligible resource for meeting the PA 235 clean and renewable energy requirements

3.5.1.1 Natural Gas Combined Cycle (CC)

Cost estimates for CC plants are derived from multiple sources, including discussions with vendors, manufacturers, and engineering, procurement, and construction firms. The model includes four plants with a total nameplate capacity of 193 MW over the IRP timeframe. Construction timelines for new CC plants are based on current market conditions. Generation characteristics for the candidate CC plant are based on operational data from Delta Energy Park.

3.5.1.2 Natural Gas Combustion Turbine (CT)

CT cost estimates are derived from Ascend Analytics' Market Intelligence platform, while operational assumptions are based on BWL's existing assets. The model includes 18 turbines, totaling 1,026 MW of nameplate capacity over the IRP timeframe. Construction timelines for new CT plants are based on current market conditions. The candidate CT's generation characteristics are based on operational data from the CT at Delta Energy Park.

3.5.1.3 Natural Gas Reciprocating Internal Combustion Engine (RICE)

RICE plants use natural gas to generate electricity, achieving better heat rates and greater dispatchability than combustion turbines. These plants typically comprise multiple engines, with BWL's current project consisting of six units. Each unit can operate independently and start up faster than turbines, allowing the plant to operate at various output levels and dispatch with greater flexibility than traditional thermal units.

Operational cost and sizing assumptions for the RICE resources available in the model are based on BWL's current RICE project. Capital cost estimates for future construction are derived from Ascend Analytics' Market Intelligence platform. The model includes nine units, totaling 1,008 MW of nameplate capacity.

3.5.1.4 Natural Gas Combined Cycle with Carbon Capture & Sequestration (CCS)

CCS is a process by which carbon emitted from the combustion of natural gas is captured and stored underground rather than released into the atmosphere. The carbon capture system removes carbon dioxide from exhaust gas and compresses it for transport to a sequestration site. This process could reduce carbon dioxide emissions from power plants by up to 95%. However, CCS is an emerging technology, and its costs and performance remain uncertain. Because Michigan Public Act 235 (PA 235) qualifies CCS as a clean energy resource, alongside wind, solar, and nuclear generation, it is none the less included in this IRP. In addition, the $85/ton 45Q tax credit is currently available for qualifying projects.

To estimate the cost and performance of both new combined cycle construction and retrofits of existing generation, BWL referenced data from Ascend Analytics and discussions with other utilities that have evaluated CCS retrofits. These discussions included results from studies assessing the feasibility of retrofitting combined cycle plants for CCS. These findings informed estimates of capital and incremental maintenance costs, as well as impacts on plant heat rates. The results were then scaled to evaluate the impact of a CCS retrofit on BWL's Delta Energy Park facility. Retrofitting an existing plant with carbon capture reduces its net generating capacity and increases its heat rate, meaning it consumes more fuel to produce electricity. These changes in capacity and operating costs affect the resource's performance in capacity expansion modeling.

Another uncertainty for CCS is the availability of carbon sequestration. There are currently no active sequestration sites in Michigan, although data from the U.S. Geological Survey indicates potential for developing underground carbon storage in the state. Cost estimates associated with carbon sequestration were not included in this modeling. Site selection, permitting, and long-term maintenance are also outside the scope of this analysis. If pursued, a CCS project would likely represent a first of its kind development in this region.

3.5.1.5 Heat Rates for Natural Gas Combined Cycle with Carbon Capture & Sequestration

A power plant's thermal efficiency is measured by its heat rate, expressed in million British thermal units (MMBtu) per megawatt-hour (MWh). This value varies by plant, season, and output level. To remain competitive, power plants must maintain lower heat rates (i.e., higher thermal efficiency) than prevailing market heat rates. BWL's Delta Energy Park typically operates at a heat rate of 7,000-8,000 MMBtu/MWh.

Retrofitting the plant with a carbon capture system would increase its heat rate. The engineering study modeling a potential CCS retrofit estimated heat rates of 8,400 to 8,500 MMBtu/MWh. This indicates that, if BWL were to retrofit Delta Energy Park with a carbon capture system, the facility would emit less but require more fuel to generate the same amount of electricity. In the MISO wholesale market, this would reduce its competitiveness relative to other generators.

3.5.1.6 Nuclear

Small modular nuclear reactors (SMRs) are also included as a resource type in the model. These SMRs differ from conventional nuclear reactors in size and construction. While traditional nuclear plants are unique, site-specific projects, modular reactors are intended to be standardized and deployable across multiple locations, similar to combustion turbine technology. Some SMR designs use advanced reactor technologies, such as sodium or molten salt cooling. None of these designs have yet reached commercial operation, although several development agreements have been announced among utilities, data center developers, and SMR vendors. The 45U nuclear production tax credit remains available to qualifying projects.

BWL has not previously constructed or invested in nuclear generation, and historically, customers have opposed BWL's participation in nuclear facilities. As with CCS, the costs associated with sitting, permitting, and long-term waste management are not included in this analysis. Although nuclear is considered clean generation under Michigan Public Act 235 (PA 235), stakeholder feedback raised concerns about its use, including a preference that any such facilities be located outside the Lansing area. The absence of operating SMRs with publicly available cost and performance data introduces uncertainty in cost projections. For modeling purposes, BWL assumes a 77 MW SMR, with cost estimates based on the National Laboratory of the Rockies (NLR) Annual Technology Baseline and data from the Electric Power Research Institute (EPRI).

3.5.1.7 Local Solar

The model includes both local and non-local solar resources. Local arrays are those connected to BWL's transmission and distribution system. At the local level, the model includes solar resources available for development in 3 MW increments. The size and cost of these arrays are based on BWL's current projects at Comfort Street, Lake Lansing, and Delta Energy Park.

3.5.1.8 Non-Local Solar

Non-local solar arrays have greater capacity than local arrays because utility scale solar projects require large, open tracts of land. As a result, they are typically developed in remote, rural areas outside BWL's service territory. BWL does not own solar assets of this scale; instead, it enters into power purchase agreements (PPAs) as an off taker with project developers. In the model, non-local solar is represented as an expandable resource option, with costs based on the net present value of associated PPA payments over the study period. Non-local solar resources are modeled in 10 MW increments to accommodate a range of sizing options.

3.5.1.9 Wind

Wind is modeled exclusively as a non-local resource, and only onshore wind is considered in this IRP. While utilities in other regions of the country are exploring offshore wind development, no offshore wind projects in the Great Lakes have reached commercial operation. Costs are modeled using the same net present value approach used for non-local solar resources. Wind resources are modeled in 35 MW increments to reflect BWL's option to serve as the sole off taker of a project or to purchase a share of a larger facility.

3.5.1.10 Local 4-hr and 8-hr Battery Storage

Local battery storage is modeled in 2 MW increments to reflect the modular nature of battery storage systems. Smaller increments allow the capacity expansion model to add storage more precisely to meet BWL's needs. These increments represent distributed battery installations across the service territory, providing accredited capacity and resiliency for local distribution circuits.

3.5.1.11 Non-Local 4-hr Battery Storage

Non-local battery storage is modeled in 25 MW increments. These facilities would likely be developed by independent developers and structured through tolling agreements with BWL, rather than as utility-owned local assets. These facilities may be deployed as standalone systems or collocated with existing BWL renewable PPAs to improve project economics.

3.5.1.12 Non-Local 8-hr Battery Storage

A limited number of non-local 8-hour storage facilities are available to the model. These systems are modeled as paired 4-hour storage units to provide longer duration capability. Longer duration storage options remain in the early stages of market adoption, though BWL will continue to monitor their development. These resources are modeled using the same incremental approach as 4-hour storage.

3.5.2 State and Federal Policy Impact on Renewable PPA and Equipment Prices

One input to the capacity expansion model is a price forecast for new generation resources. BWL uses multiple sources to estimate the costs of owning or investing in different resources, including Ascend Analytics' Market Intelligence platform, the NLR Annual Technology Baseline, and data from BWL's existing and planned assets. Each of these sources incorporates tax credits for renewable generation affected by the OBBBA, creating uncertainty about future renewable power purchase prices and the cost of new generation. Following the enactment of this legislation, BWL updated its modeling assumptions to reflect revised generation cost estimates.

In general, BWL expects the OBBBA to increase prices for renewable generation (Table 8). BWL's currently ongoing solar projects will not be affected because they achieved construction milestones before the OBBBA's enactment, preserving eligibility for previously available tax credits. Once these grandfathered projects are completed, the cost of developing new solar projects without these credits is expected to increase.

Table 8. OBBBA Cost Impacts on Renewable Technology. Source: Ascend Analytics

Resource	Pre-OBBB	Post-OBBB
Solar	$63-72 / MWh	$76-97 / MWh
Wind	$56-61 / MWh	$57-86 / MWh

Michigan Public Act 235 (PA 235) also affects price forecasts for renewable resources in the state. Beginning in 2035, renewable generation used to comply with PA 235 must be located in MISO Zone 7 (the Lower Peninsula). Renewable energy projects already face challenges with interconnection costs, siting, and permitting, and BWL expects increased competition among utilities and developers in Michigan for a limited supply of viable wind and solar sites, which will further increase costs.

3.5.3 Energy Optimization

BWL's Energy Optimization Plan includes a 1.5% annual target for waste reduction. These savings enter BWL's model not on the generation resource side but as a reduction in load.

3.5.4 Distributed Generation

Generation sources located behind BWL customer meters have grown steadily since the 2020 IRP, primarily through rooftop solar installations. By number of installations, distributed generation in BWL's service territory is led by small rooftop installations, typically under 7 kW. In terms of total capacity, these smaller installations are collectively comparable to a larger commercial solar array. In either case, BWL has recorded average solar installation costs reported by customers, and solar costs have steadily declined alongside an increase in total installed solar capacity. As of June 2025, BWL had 453 customers on distributed generation electric rates. Their combined installed solar capacity totals 4.7 MW, up from about 800 kW in 2020. These installations vary in size, ranging from residential rooftops to commercial installations exceeding 500 kW.

3.5.5 Technical Potential for Distributed Rooftop Solar

BWL's 2020 IRP included a forecast of distributed generation adoption based on the National Renewable Energy Laboratory's SolarDS model. This model accounts for retail electric rates and installation costs to estimate the rate at which customers invest in distributed generation options. The results from the model are shown in **Table 9** below.

Table 9. Forecast Distributed Generation Adoption

	Commercial				Residential			
	Program	Low	Ref.	High	Program	Low	Ref.	High
2010	0	0	0	0	2	0	0	0
2011	0	0	0	0	2	0	0	0
2012	0	0	0	0	3	0	0	0
2013	0	0	0	0	4	0	0	0
2014	0	0	0	0	5	0	0	0
2015	1	1	2	2	7	0	0	0
2016	2	1	2	2	11	0	0	0
2017	2	2	3	3	14	0	0	0
2018	0	2	3	3	23	0	0	0
2019	4	2	4	4	44	0	0	0
2020	-	2	5	7	-	0	1	3
2021	-	3	5	9	-	0	1	3
2022	-	3	6	15	-	0	2	13
2023	-	4	8	19	-	0	3	16
2024	-	5	9	23	-	0	3	20
2025	-	6	12	28	-	0	4	25
2026	-	8	14	35	-	0	5	30
2027	-	10	17	43	-	0	6	37
2028	-	12	21	52	-	0	7	45
2029	-	14	26	64	-	0	9	55
2030	-	18	32	79	-	0	11	67
2031	-	53	53	129	-	149	149	669
2032	-	64	64	158	-	182	182	814
2033	-	78	78	192	-	220	220	988
2034	-	95	95	233	-	267	267	1198
2035	-	115	115	283	-	323	323	1449
2036	-	139	139	342	-	390	390	1749
2037	-	168	168	413	-	470	470	2106
2038	-	202	202	497	-	564	564	2528
2039	-	242	242	595	-	675	675	3024
2040	-	288	288	709	-	804	804	3603

The number of current solar installations in BWL's service territory is roughly equal to the 2035 reference case in the 2020 IRP and to the 2030–2031 high case. While current trends do not suggest that BWL customers will follow the aggressive growth in the high case scenario over the next 15 years, this previous projection illustrates the rapid acceleration of distributed solar growth over the past 5 years.

3.5.6 Distributed Solar Forecast

Distributed solar is included as an item in each portfolio under each scenario/sensitivity and the forecast comes from a multiple regression model like the one used in the load forecast. Using population, GDP, and the average dollar per kW cost of installing rooftop solar as predictive variables, the model fits the installation of distributed solar that BWL has seen over the past ten years and provides a forecast over the time frame covered by the IRP.

A key uncertainty in the data is the future cost of installing solar panels. While BWL customers have reported steadily decreasing costs for purchasing and installing solar panels, predicting future costs remains difficult. The model relies on the NLR Annual Technology Baseline for price forecasts. However, recent, sudden changes to federal and state incentives for solar panels will negatively impact adoption rates. Given the current uncertainty about the future of these tax credits, the model likely overestimates rooftop solar adoption after the OBBBA.

Commercial sized arrays will also have a significant impact on distributed solar in the near-term. Many of the solar installations in BWL's service territory are under 10 kW and are sited on residential homes. Currently, the Lansing School District is developing 3.5 MW of solar arrays, which will nearly double the total installed distributed solar capacity in the BWL service territory. For this forecast, all other installations are used to model the relationship between installed solar capacity and the dollar-per-watt cost, and the Lansing School District installations are added on top of this to avoid skewing the data.

3.5.7 Demand Response – Peak Power Partners

Demand response programs are designed to reduce load during peak hours. These programs can take various forms, with differing levels of utility involvement and control. For example, time of use rates that disincentivize consumption during peak hours are sometimes considered demand response programs, even though the utility has no direct control over demand reduction. BWL first adopted time of use rates in 2023, reflecting the fact that electricity during peak hours, from 1:00 pm to 8:00 pm, is more expensive than at other times. Other programs typically include utility access to customer load, such as the smart thermostat program that BWL is currently piloting.

Launched in April 2024, BWL's Peak Power Partner program is a 3-year demand response pilot. Under the program, enrolled BWL customers with smart thermostats in their homes receive a notification at least 24 hours in advance of an expected peak day during the summer season, between June and September. If the customer doesn't opt out of the demand response event after receiving this notification, BWL increases the temperature setting on their smart thermostat by up to four degrees for the duration of the event. Events last up to four hours and typically occur between 1:00 and 4:00 pm.

The goal of the pilot program is to enroll 1,300 participants and reduce 1 MW of peak demand during the summer of 2026. At the end of the second year of the program, 585 customers are enrolled. The full 2025 system impacts are shown below in **Figure 20**, showing the kW of demand reduced across each of the sixteen demand response events. events.

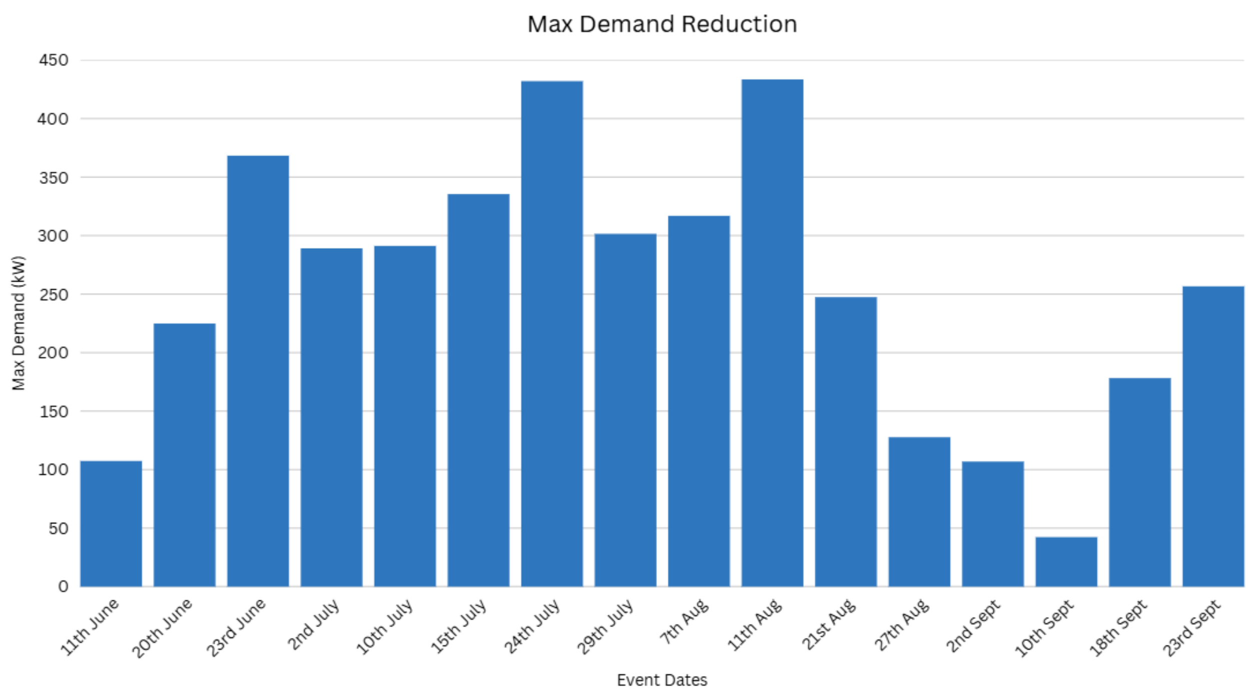


Figure 20. Max Demand Reduction Achieved through BWL's Demand Response Pilot Program

During the second year of demand response events, residents saved over 10,000kWh across 16 separate events. The highest demand reduction occurred on August 11th, with 404 participants combining to reduce demand by 433kW.

Based on the current goal of 1300 participants, and the observed opt-in rates and kW/kWh reductions over the past two summers, the demand response program is expected to reduce BWL's summer peak by nearly 1MW in the coming years. This goal is forecast for future years in the current load sensitivity scenario. While BWL's Peak Power Partner program has seen year over year growth in its pilot phase, there will be natural limits to the program. Virtual demand response programs such as this one require customers to have smart thermostats, which are gaining in popularity but are not in every household. Additionally, in the high electrification scenario in which demand response is modeled, BWL's peak shifts away from summer. BWL customer response to peak shaving of winter heating rather than summer cooling is currently unknown.

3.5.8 Transmission

While BWL owns and operates its own transmission system, it transacts with the interstate electric grid through the Midcontinent Independent System Operator (MISO) wholesale market. This allows BWL to sell excess power into the market and to purchase power during periods of internal generation shortfall. Participation in the MISO market requires utilities to take transmission service, which is generally divided into network and point-to-point services.

Network service allows a utility to move power from any source to any sink within the transmission system, but it also exposes the utility to the socialized costs of new transmission upgrades. BWL instead uses point-to-point service, which requires the utility to identify the specific resource from which it purchases power. This structure gives BWL operational flexibility to dispatch generation in response to customer load and to participate in the wholesale market. While point-to-point service is not the specific MISO service that governs BWL's dispatch rights, it is part of BWL's current relationship with MISO. Any future changes to this relationship would require evaluating both point-to-point service arrangements and the treatment of BWL's behind the meter, local generation.

BWL's transmission entitlements under the Belle River power purchase agreement provide grandfathered access to firm point-to-point service at favorable rates. These agreements divide BWL's transmission capacity into three components. The first is 150 MW associated with the Belle River PPA; the second provides an additional 12 MW through participation in MPPA; and the third covers transmission capacity from 162 MW to 400 MW. This final segment is the most expensive and defines the maximum transmission constraint used in BWL's modeling.

3.5.8.1 Market Prices and BWL's MISO Status

BWL has recently evaluated the value of its transmission entitlements and the impact on its owned generation if it were to change its MISO status. Currently, BWL operates independently, meeting its load with behind the meter generation and transacting in the wholesale market primarily to sell excess power or purchase energy during outages. If BWL were to change its status within MISO, it could become a MISO Transmission Owner (TO) and take Network Integrated Transmission Service (NITS) in place of its current point-to-point service. Under this structure, BWL's load and generation would be functionally separated: all generation would be bid into the MISO market, and all loads would be served through market purchases. This would affect both BWL's cost to serve load and the dispatch of its generation.

On the generation side, BWL's fleet would be dispatched differently if it responded to MISO market prices rather than to BWL's system peaks. Because BWL owns generation in excess of its load, it currently maintains a positive net energy position. Operators dispatch units to meet local load and sell excess generation into the MISO market. Under a market based dispatch approach, units would be dispatched more frequently because they are generally competitive in the wholesale market. This relationship is evaluated using the market heat rate, calculated as the ratio of the MISO energy price ($/MWh) to the natural gas price ($/MMBtu). This metric assumes that the marginal unit setting the market price is a natural gas fired generator. BWL's units typically operate at lower heat rates than the implied market heat rate, indicating they are cost competitive. When a unit's dispatch cost is below the market price, the difference is realized as revenue.

Under this structure, BWL's load would be fully served through market purchases. BWL would pay MISO market prices for the energy needed to serve its load. Because BWL currently generates more energy than it consumes, and would likely generate even more under this structure, it would maintain a positive net energy position, purchasing less energy than it sells. In sensitivity cases with large load additions, the relationship reverses, and BWL buys more energy than it sells. **Figure 21** illustrates this transaction.

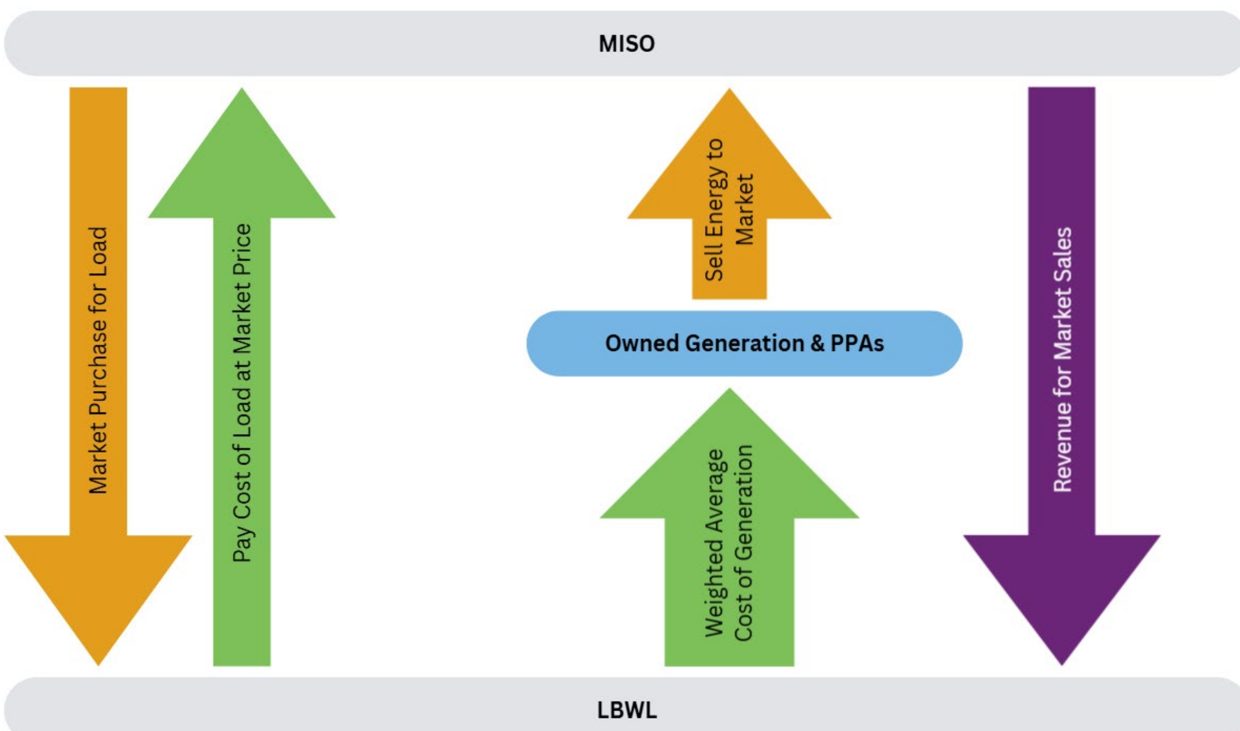


Figure 21. Hypothetical Market Interaction between BWL and MISO

3.5.9 Renewable Energy Credit (REC) Purchases

BWL's compliance with Michigan Public Act 235 (PA 235) is tracked through the Michigan Renewable Energy Certification System (MIRECS), where BWL retires renewable energy credits (RECs). Each REC represents the generation of one megawatt-hour (MWh) of electricity from a qualifying renewable source, including solar, wind, hydropower, biomass, methane digestion, and landfill gas. BWL obtains RECs from owned generation or purchased power and can sell them to other entities or retire them to meet PA 235 compliance requirements. In years when BWL generates or purchases more renewable energy than required, it may bank RECs for up to five years or sell them in the market. In years when BWL does not generate or purchase sufficient renewable energy to meet compliance targets, it may purchase RECs to satisfy those requirements.

Based on a forecast of REC market prices, the IRP model includes RECs as a resource option alongside other generation resources. Because REC purchases do not serve load in the same way as new generation, they are modeled as an option for PA 235 compliance, but do not provide capacity value. Under PA 235, REC purchases may be used to meet compliance targets only through 2035. Accordingly, the option to purchase RECs is removed from the model after 2035.

3.5.10 Carbon Credits

BWL does not currently purchase carbon credits to offset any of its emissions. However, similar to the REC pricing forecast, BWL can monitor the carbon credit market to potentially offset its CO2 emissions and achieve net zero status. This is modeled as an option post-2040, with carbon credit purchases assigned to each ton of CO2 emitted from BWL's generation.

Whereas RECs are legally defined by the state of Michigan and tracked and verified through the MIRECs system, carbon credits lack a similar legal definition or verification system. Without a single standard carbon credit product to evaluate, projecting market costs and credit availability is difficult. The Michigan Department of Natural Resources (DNR) has designated conservation projects on its forest lands for carbon offsets. Anew Climate is a partner on this project, managing the sales and verification of carbon credits. Of the DNR's four designated forest areas in the state, only one project is currently fully subscribed, with the first 10 years of credits owned by DTE Energy. Using publicly available details from that project, BWL has estimated a per credit carbon price of $10.15 per ton. Each credit represents one ton of CO2 emissions. While liquidity in the carbon credit market may pose a risk in 2040, the Michigan DNR currently has carbon credit products representing just 220,000 acres of the 4.6 million it owns.

4 IRP Modeling

The IRP modeling process comprises several steps that produce the results presented later in this report. First, BWL establishes assumptions for the 20-year study period, including inputs for candidate resources available over that timeframe. Using software developed by Ascend Analytics, an automated resource selection (ARS) model is then run to identify the least cost portfolio of candidate resources, in addition to BWL's existing generation, that meets capacity requirements and PA 235 compliance targets across Scenarios 1–5. The selected candidate resources are then defined as portfolio specific assets for each strategy and used as inputs to the Production Cost Model (PCM), which evaluates performance and financial outcomes for each portfolio. Additional details on Ascend Analytics' modeling tools are provided in *Appendix B: Ascend Analytics*. The following sections describe each step in the modeling process.

4.1 Assumptions

Table 10. IRP Modeling Assumptions

Assumption	Value	Source
Modeling Software	ARS/PowerSimm	Ascend Analytics
Study Period	2027–2046	BWL
Model Region	Lansing, MI	BWL
Weighted Cost of Capital	5.00%	BWL
Retail Sales Growth	Varies by Sensitivity	BWL
Energy Optimization	1.50%	BWL
Natural Gas Cost - 2035	\$3.50 - \$4.25/MMBTU	Ascend Analytics
Renewable Energy Capacity Credit – 2035 (Yearly Average)	Solar - 34%, Wind - 16%	Ascend Analytics, MISO
Market Energy Price Forecast Lansing Node – 2035	\$30-\$60/MWh on/off peak	Ascend Analytics
Capacity Credit Price Michigan – 2035	\$31.08/MW	Ascend Analytics

4.1.1 Financial

BWL uses a 5% discount rate for the value of future generation investments.

4.1.2 Fuel Prices

Having retired its last coal fired generation in 2022, BWL's only fuel price affecting its cost of generation is natural gas. The IRP model forecasts natural gas prices at Consumers Energy's Citygate price node, using Henry Hub pricing as the reference. The price forecast is presented visually in **Figure 22** below.

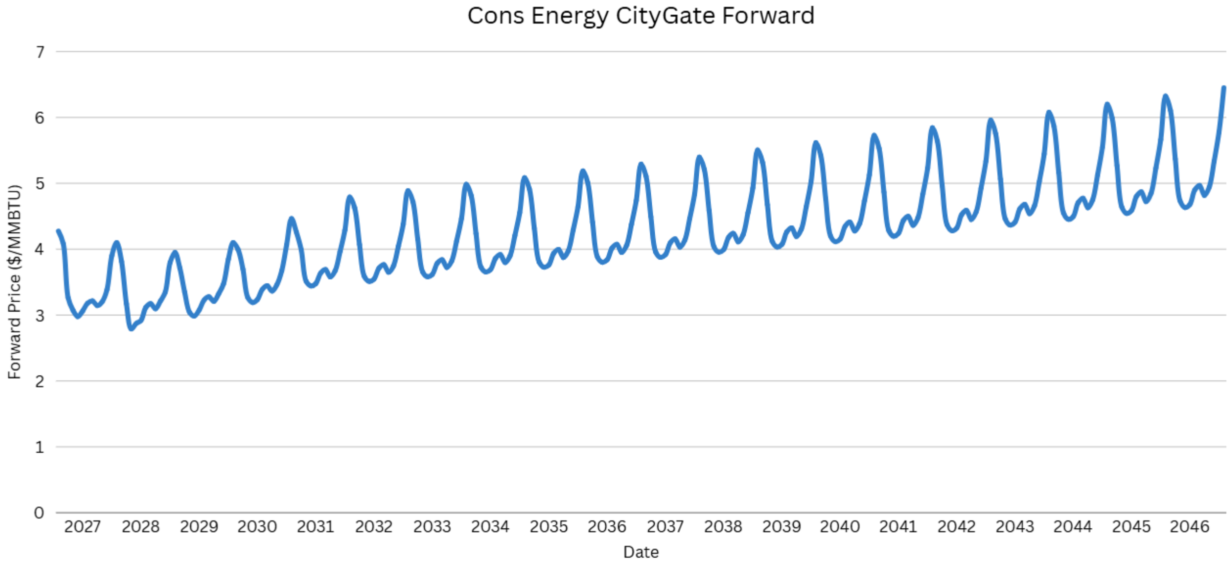


Figure 22. Cons Energy Citygate Forward Prices provided by Ascend Analytics

The natural gas forward reflects a steady price increase that aligns with historical averages. The forecast is entered into BWL's production cost model, which evaluates the cost of serving BWL's load with a given generation portfolio. For each unique portfolio selected across the resource scenarios and load sensitivities, BWL uses the production cost model to assess the present value and budgetary needs of maintaining the selected portfolio.

4.1.3 Power Prices

The power price forecast used for modeling is based on MISO's Michigan hub prices. BWL transacts most of its power at MISO's CONS.LANS node, which is derived from the Michigan hub and trades at a similar price. Other nodes where BWL transacts power are near its renewable resources outside the Lansing area and trade at prices similar to the Michigan hub and CONS.LANS. As BWL is a net exporter of electricity, this forecast is generally used to estimate the price BWL would receive for selling its excess energy. illustrates the Michigan Hub's on-peak, off-peak, and mean Day Ahead (DA) pricing forecast.

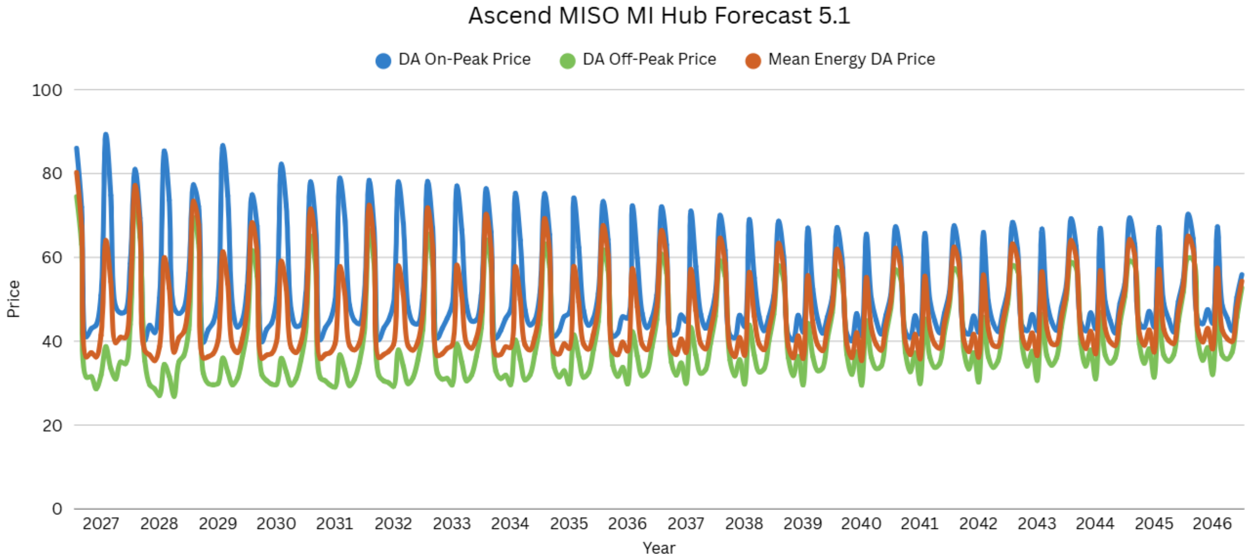


Figure 23. Ascend Analytics MISO MI Hub Forecast 5.1 from January 2025 to December 2050

Over the next ten years, the forecast predicts a widening spread between on-peak and off-peak prices in Michigan. The forecast assumes that the goals of PA 235 are largely met and that the grid becomes dominated by non-dispatchable resources. Intuitively, this future is possible with a large amount of solar added to the system, while peak demand remains concentrated on the hottest hours of the summer, when solar arrays are at peak production and depress market prices. It is assumed that wind generation in the state is much more difficult to site and build. With changing federal policies, local land-use policy, tax credits, tariffs, and resource availability in the state, there is some uncertainty associated with this forecast.

4.2 Strategies for meeting future energy requirements

4.2.1 Capacity requirements for sensitivities

Each load sensitivity represents a distinct forecast of demand and, as a result, has unique capacity requirements. (**Table 11**). Given the same set of candidate resources, the model may select different portfolios of generation assets across sensitivities, reflecting differences in both total load and load profile. Annual capacity requirements for each load sensitivity are shown below.

Table 11. Largest Reserve Margin Capacity Needed (in MW) for Each of the Sensitivities Explored in this IRP. *All values are dated July 2046.*

Load Sensitivity	Reserve Margin Capacity Needed
Base Load	669.66 MW
45 MW Large Load	752.79 MW
500 MW Large Load	1,593.24 MW
High Electrification	903.5 MW

These values represent the annual peak reserve capacity requirements. Peak capacity is derived from the load forecast, with MISO's PRMR applied for each relevant season. In sensitivities that include 45 MW and 500 MW of additional industrial load, annual load profiles remain similar in shape to the base case because these loads are modeled as relatively constant throughout the year. The high electrification sensitivity, which includes the adoption of electric vehicles and electric heating, results in a more pronounced shift in the annual load profile. Under this sensitivity, BWL remains a summer peaking utility. Future IRPs will incorporate updated electrification assumptions based on increased adoption of these technologies in the Lansing area.

4.3 Modeling Results

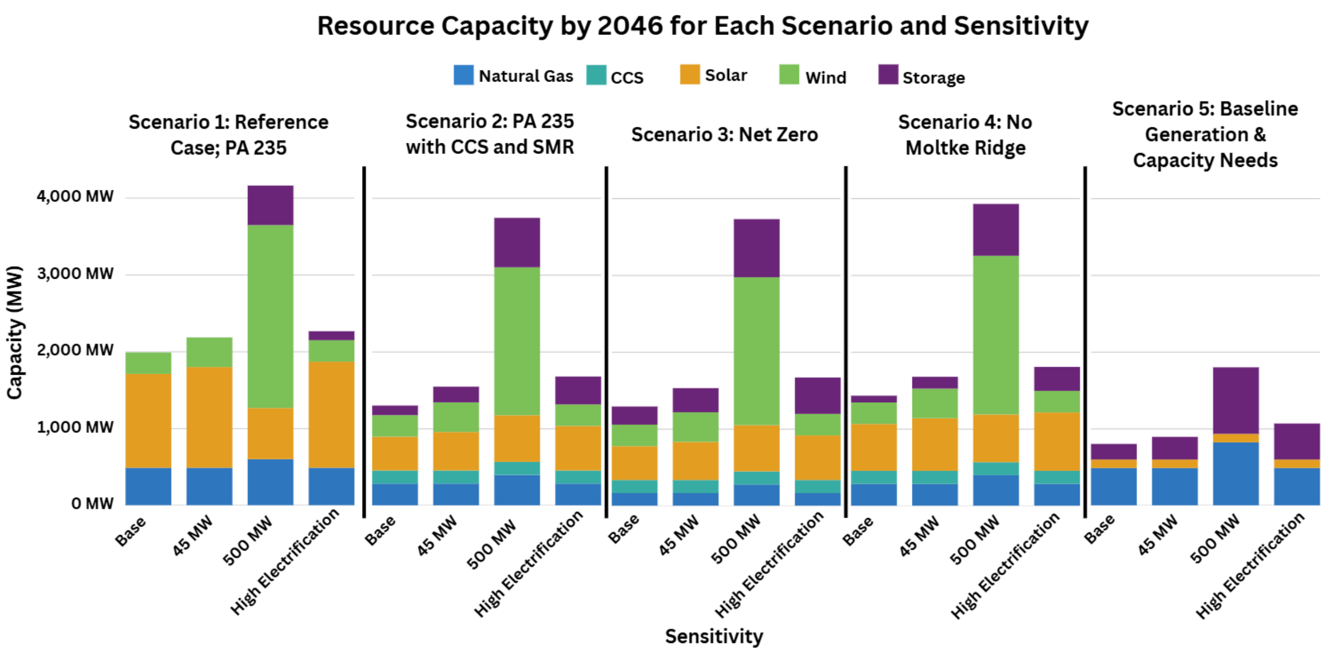


Figure 24. Resource Capacity for Each Scenario by the End of the IRP Time Frame

4.3.1 Scenario Analysis

Each resource scenario provides the model with a different set of available generation assets. From these options, the model selects the lowest cost portfolio to meet each load sensitivity's needs, subject to applicable constraints, including capacity and greenhouse gas emissions.

4.3.2 Scenario 1 – Reference Case

Using cost inputs from BWL's existing wind and solar contracts and Ascend Analytics' market price forecasts, this resource scenario meets BWL's PA 235 compliance goals through new wind, solar, and battery energy storage resources. A challenge under this scenario, particularly in sensitivities with large load growth, is the projected decline in accredited capacity for these resources. As MISO continues to refine its capacity accreditation methodology, wind and solar PPAs are expected to contribute less to BWL's accredited capacity requirements.

4.3.3 Scenario 2 - PA 235 Compliance (CCS/SMR)

This scenario expands on Scenario 1 by adding carbon capture and sequestration (CCS) and small modular nuclear reactors (SMRs) to the set of available resources. Near-term cost estimates for these technologies are based on publicly available market data, while long-term projections rely on the NLR Annual Technology Baseline. BWL continues to monitor developments in these technologies as new information becomes available.

There are significant challenges associated with developing CCS and SMR projects that are not fully captured in the model. These include political, siting, and engineering considerations, which are partially reflected in higher capital cost assumptions but not explicitly modeled. While the model allows BWL staff to limit the number of these resources selected within a given portfolio, real-world deployment will be necessary to fully understand the risks and complexities associated with their development.

4.3.4 Scenario 3 - Net Zero and REO Early Retirement

BWL's REO Town cogeneration plant supports both the electric and steam utilities. As BWL transitions away from its steam system in favor of hot water service for customers on the loop, alternative approaches to providing this service will be evaluated. Because REO primarily supports the steam system, it is expected to be less competitive in the MISO market as a standalone electric generation asset. To reflect this and align with PA 235 compliance requirements, this scenario assumes the REO Town plant will retire in 2040, coinciding with the planned transition of the steam system. This scenario also includes CCS and SMR among the candidate resources.

In addition to retiring the REO plant, this scenario includes carbon credit purchases beginning in 2040 to offset each ton of carbon dioxide emitted from BWL's generation. While Michigan Public Act 235 (PA 235) requires utilities to achieve 60% renewable energy by 2035 and 100% clean energy by 2040, some residual emissions from natural gas fired generation may remain.

4.3.5 Scenario 4 - No Moltke Ridge

Scenario 4 evaluates a future in which the Moltke Ridge wind project, for which BWL has a signed PPA, does not come into service due to interconnection costs, siting delays, or changes in federal policy related to wind energy. This outcome would make compliance with PA 235 more challenging in the near-term and would likely require BWL to purchase renewable energy credits or enter into alternative PPAs at potentially higher prices. This scenario reflects the uncertainty associated with renewable generation development and interconnection in the current policy environment.

4.3.6 Scenario 5 – Baseline Generation & Capacity Needs

In this scenario, each load sensitivity is met through BWL's existing generation portfolio, market purchases, and investments in new storage resources. This scenario serves as a baseline for comparison with other scenarios, enabling BWL to estimate the incremental costs of complying with PA 235 across different load sensitivities.

4.4 Net Present Value Revenue Requirement

Metric	Description	Formula
Net Present Value Revenue Requirements	Portfolio's present value revenue requirements 2027 – 2036 or 2046	$\frac{\sum Revenue\ Requirements}{(1+k)^\wedge n}$

BWL uses net present value as the primary metric to evaluate the costs of generation portfolios under each modeling configuration. Revenue requirements for each portfolio include the estimated total costs and revenues for each generation asset, including capital expenditures, operating expenses, purchased power costs, wholesale revenues, and capacity revenues.

4.5 Definition of Reliability Metrics

Metric	Description	Formula
Resource Diversity	Evaluates how many different resource types are contributing to total capacity by their combined MW of capacity.	$\frac{\sum n(n-1)}{N(N-1)}$
Dispatchable Generation Percent of Peak Demand	Compares nameplate capacity of dispatchable generation sources (natural gas, battery storage) to peak demand in a given period	$\frac{\sum Capacity\ Dispatchable\ Generation\ MW}{Forecast\ Peak\ Demand\ MW}$

4.6 Results

Table 12. 10- and 20-Year Financial Metrics for Each Scenario/Sensitivity Combination

Scenario - Sensitivity	NPV Revenue Requirements - 10 year	NPV Revenue Requirements - 20 year
Reference Case - 1.1	$1,263,000,000.00	$2,624,000,000.00
Reference Case - 1.2	$1,423,000,000.00	$2,981,000,000.00
Reference Case - 1.3	$3,391,000,000.00	$7,404,000,000.00
Reference Case - 1.4	$1,310,000,000.00	$2,796,000,000.00
Incremental Portfolio Costs		
SMR + CCS - 2.1	-$1,000,000.00	-$160,000,000.00
SMR + CCS - 2.2	$2,000,000.00	-$142,000,000.00
SMR + CCS - 2.3	-$92,000,000.00	-$241,000,000.00
SMR + CCS - 2.4	$13,000,000.00	-$78,000,000.00
Net-Zero, REO Retirement - 3.1	-$4,000,000.00	-$36,000,000.00
Net-Zero, REO Retirement - 3.2	-$2,000,000.00	-$11,000,000.00
Net-Zero, REO Retirement - 3.3	-$93,000,000.00	-$129,000,000.00
Net-Zero, REO Retirement - 3.4	$9,000,000.00	$64,000,000.00
No Moltke Ridge - 4.1	-$20,000,000.00	-$134,000,000.00
No Moltke Ridge - 4.2	-$22,000,000.00	-$120,000,000.00
No Moltke Ridge - 4.3	-$81,000,000.00	-$207,000,000.00
No Moltke Ridge - 4.4	-$13,000,000.00	-$70,000,000.00
BWL Baseline Generation & Capacity Needs - Sensitivity 1	-$88,000,000.00	-$284,000,000.00
BWL Baseline Generation & Capacity Needs - Sensitivity 2	-$101,000,000.00	-$285,000,000.00
BWL Baseline Generation & Capacity Needs - Sensitivity 3	-$626,000,000.00	-$1,763,000,000.00
BWL Baseline Generation & Capacity Needs - Sensitivity 4	-$59,000,000.00	-$116,000,000.00

Key takeaways from the scenario and sensitivity portfolio metrics indicate that higher load sensitivities increase portfolio revenue requirements. BWL should continue to follow best practices to ensure that costs associated with new load growth are appropriately allocated to the customers driving that growth. Compliance with PA 235 is generally less expensive under lower load growth scenarios. However, when large new loads are added, the associated resource costs can be directly attributed to those customers, helping limit impacts on existing customers.

4.6.1 Estimating Costs of Compliance with Michigan's PA 235

Using the base load sensitivity to compare Scenario 5 and Scenario 1, the estimated cost of compliance with Michigan Public Act 235 (PA 235) is $284,366,912, measured as the change in the net present value of revenue requirements between the two portfolios. Notably, this difference is driven primarily by cost divergence in the latter half of the IRP timeframe. As the analysis approaches 2035 and 2040, the clean and renewable energy requirements under PA 235 become more stringent.

Market forecasts used in this analysis indicate that renewable power purchase agreements (PPAs) are expected to become more expensive in these later years while providing less accredited capacity. As a result, a greater share of compliance costs is concentrated toward the end of the study period, introducing additional uncertainty into long-term cost projections.

4.6.2 Scenario 1 - Reference Case, PA235

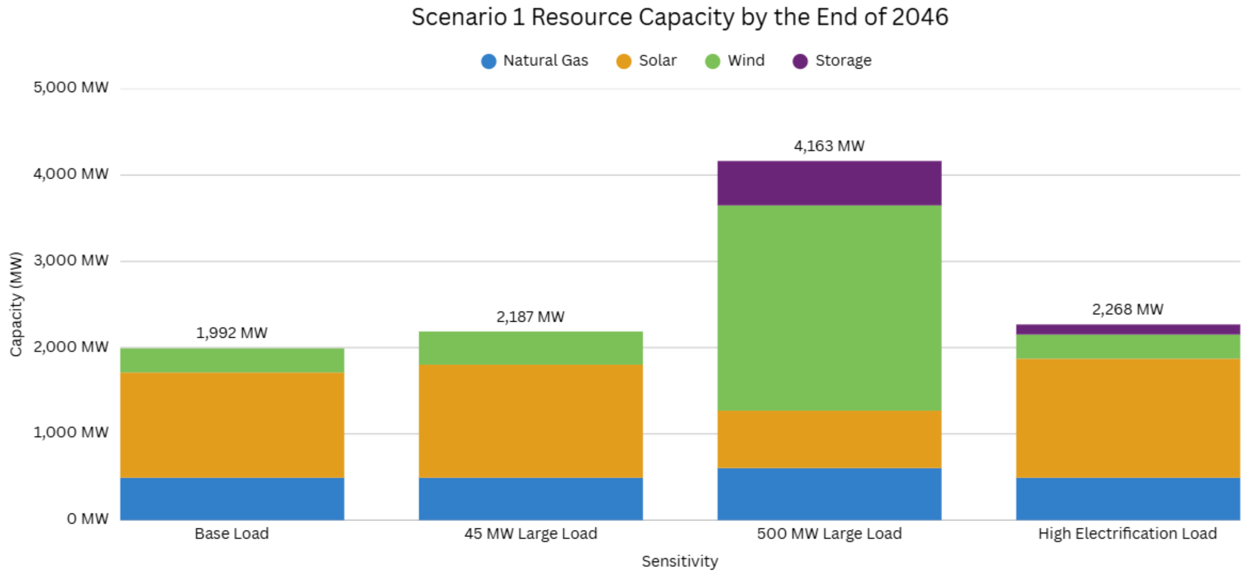


Figure 25. Scenario 1 Portfolio Resource Make-Up for Each Sensitivity at the End of 2046

The base load and 45 MW large load sensitivities yield similar resource buildouts. In both cases, local solar and wind are developed to their maximum capacity, with non-local solar filling the remaining energy requirements. Under the base sensitivity, the model selects 60 MW of local solar, 1,050 MW of non-local solar, and 280 MW of wind by the end of the study period, representing an additional 1,390 MW of capacity added to BWL's existing portfolio.

Under the 45 MW large load sensitivity, the model selects 120 MW of local solar, 1,080 MW of non-local solar, and 385 MW of wind, resulting in a total addition of 1,585 MW by the end of the study period.

Under the 500 MW large load sensitivity, wind is the primary resource selected to meet BWL's capacity requirements, with 2,380 MW of wind capacity added by the end of the study period. In addition, the model selects 105 MW of local solar, 450 MW of non-local solar, a 112 MW RICE facility, and 514 MW of 4-hour battery storage. These additions total 3,561 MW of new capacity. Despite this buildout, a portion of PA 235 compliance is met through REC purchases between 2030 and 2034.

The high electrification sensitivity results in a resource mix broadly similar to the base load sensitivity. Additions include 60 MW of local solar, 1,210 MW of non-local solar, 280 MW of wind, and 116 MW of 4-hour battery storage, for a total of 1,666 MW of new capacity by the end of the study period.

Table 13. Reliability and Financial Metrics for Scenario 1 Base Load Sensitivity

IRP Metrics	10-Year	20-Year
NPV Revenue Requirements	$1,262,501,396	$2,623,904,812
Dispatchable Generation % of Peak	126%	88%
Resource Diversity	72%	58%
Emissions Reduction from 2005 - CO_2	-84%	-84%
Emissions Reduction from 2005 - NO_x	-95%	-96%
Emissions Reduction from 2005 - SO_2	-100%	-100%

Table 14. Reliability and Financial Metrics for Scenario 1 45 MW Large Load Sensitivity

IRP Metrics	10-Year	20-Year
NPV Revenue Requirements	$1,423,069,399	$2,981,039,412
Dispatchable Generation % of Peak	126%	88%
Resource Diversity	87%	95%
Emissions Reduction from 2005 - CO_2	-85%	-85%
Emissions Reduction from 2005 - NO_x	-95%	-96%
Emissions Reduction from 2005 - SO_2	-100%	-100%

Table 15. Reliability and Financial Metrics for Scenario 1 500 MW Large Load Sensitivity

IRP Metrics	10-Year	20-Year
NPV Revenue Requirements	$3,390,907,512	$7,403,980,825
Dispatchable Generation % of Peak	229%	199%
Resource Diversity	70%	60%
Emissions Reduction from 2005 - CO_2	-86%	-89%
Emissions Reduction from 2005 - NO_x	-94%	-96%
Emissions Reduction from 2005 - SO_2	-100%	-100%

Table 16. Reliability and Financial Metrics for Scenario 1 High Electrification Load Sensitivity

IRP Metrics	10-Year	20-Year
NPV Revenue Requirements	$1,310,416,606	$2,795,512,919
Dispatchable Generation % of Peak	126%	108%
Resource Diversity	72%	60%
Emissions Reduction from 2005 - CO_2	-84%	-84%
Emissions Reduction from 2005 - NO_x	-95%	-96%
Emissions Reduction from 2005 - SO_2	-100%	-100%

4.6.3 Scenario 2: Small Modular Nuclear and Carbon Capture and Sequestration

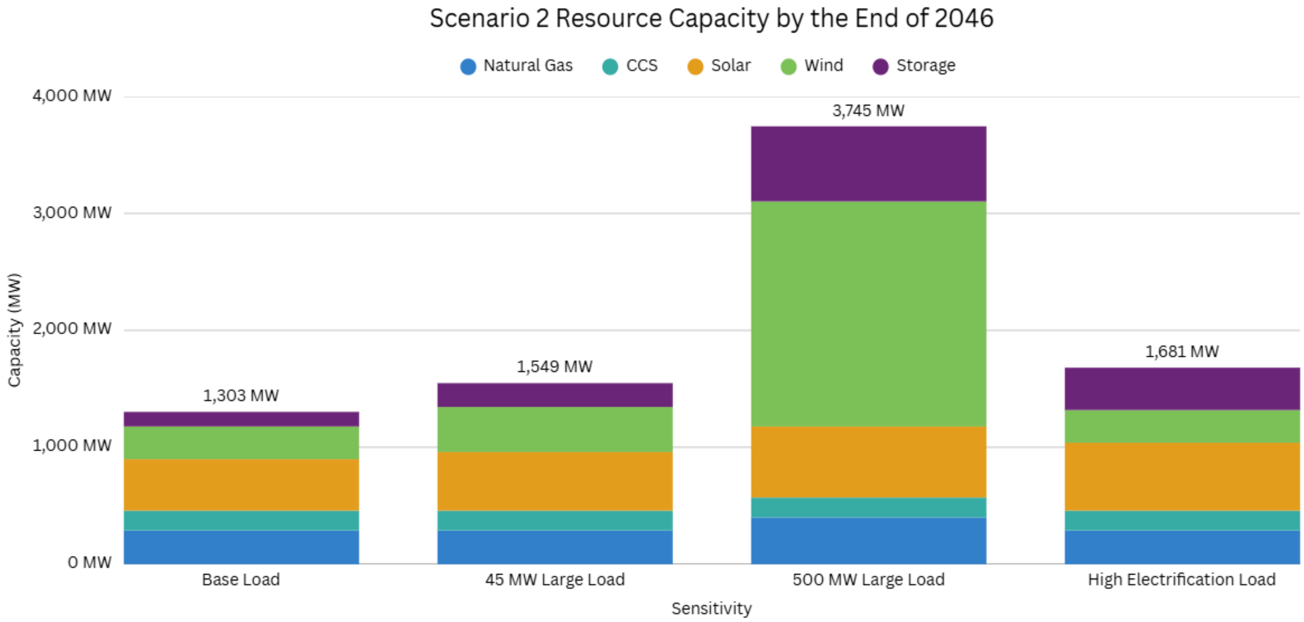


Figure 26. Scenario 2 Portfolio Resource Make-Up for Each Sensitivity at the End of 2046

Scenario 2 introduces two additional technologies to the resource mix: carbon capture and sequestration (CCS) and small modular reactors (SMRs). SMRs are not selected under any sensitivity due to their high estimated capital and operating costs. In contrast, all sensitivities include converting BWL's Delta Energy Park to incorporate CCS. Because CCS qualifies toward compliance with PA 235, it displaces a portion of renewable PPAs selected under other scenarios.

The base load, 45 MW large load, and high electrification sensitivities produce similar resource buildouts. The base load and high electrification sensitivities follow trends similar to Scenario 1, fully developing available local solar and wind resources, while the 45 MW large load sensitivity does not fully utilize available local solar capacity. All three sensitivities also include local 4-hour battery storage.

Under the base load sensitivity, the model selects 60 MW of local solar, 270 MW of non-local solar, 280 MW of wind, and 124 MW of local 4-hour battery storage, for a total addition of 734 MW by the end of the study period. The 45 MW large load sensitivity results in a total addition of 980 MW, including 81 MW of local solar, 310 MW of non-local solar, 385 MW of wind, and 204 MW of local 4-hour storage. Under the high electrification sensitivity, the model selects 60 MW of local solar, 410 MW of non-local solar, 280 MW of wind, and 362 MW of local 4-hour battery storage, for a total addition of 1,112 MW.

As in Scenario 1, the 500 MW large load sensitivity favors wind to meet capacity requirements, with 1,925 MW of wind capacity added by the end of the study period. Additional resources include 57 MW of local solar, 440 MW of non-local solar, an 112 MW RICE facility, and 642 MW of 4-hour battery storage, resulting in a total capacity addition of 3,176 MW. Despite this buildout, PA 235 compliance is partially achieved through REC purchases between 2030 and 2034.

Table 17. Reliability and Financial Metrics for Scenario 2 Base Load Sensitivity

IRP Metrics	10-Year	20-Year
NPV Revenue Requirements	$1,261,748,946	$2,464,126,953
Dispatchable Generation % of Peak	119%	104%
Resource Diversity	71%	71%
Emissions Reduction from 2005 - CO_2	-88%	-86%
Emissions Reduction from 2005 - NO_x	-93%	-94%
Emissions Reduction from 2005 - SO_2	-100%	-100%

Table 18. Reliability and Financial Metrics for Scenario 2 45 MW Large Load Sensitivity

IRP Metrics	10-Year	20-Year
NPV Revenue Requirements	$1,425,248,810	$2,839,101,309
Dispatchable Generation % of Peak	119%	118%
Resource Diversity	70%	73%
Emissions Reduction from 2005 - CO_2	-88%	-87%
Emissions Reduction from 2005 - NO_x	-93%	-94%
Emissions Reduction from 2005 - SO_2	-100%	-100%

Table 19. Reliability and Financial Metrics for Scenario 2 500 MW Large Load Sensitivity

IRP Metrics	10-Year	20-Year
NPV Revenue Requirements	$3,299,135,650	$7,162,863,993
Dispatchable Generation % of Peak	237%	216%
Resource Diversity	73%	65%
Emissions Reduction from 2005 - CO_2	-88%	-90%
Emissions Reduction from 2005 - NO_x	-93%	-95%
Emissions Reduction from 2005 - SO_2	-100%	-100%

Table 20. Reliability and Financial Metrics for Scenario 2 High Electrification Load Sensitivity

IRP Metrics	10-Year	20-Year
NPV Revenue Requirements	$1,323,242,711	$2,717,996,016
Dispatchable Generation % of Peak	140%	146%
Resource Diversity	74%	74%
Emissions Reduction from 2005 - CO_2	-88%	-87%
Emissions Reduction from 2005 - NO_x	-93%	-94%
Emissions Reduction from 2005 - SO_2	-100%	-100%

4.6.4 Scenario 3: Net Zero and REO Retirement

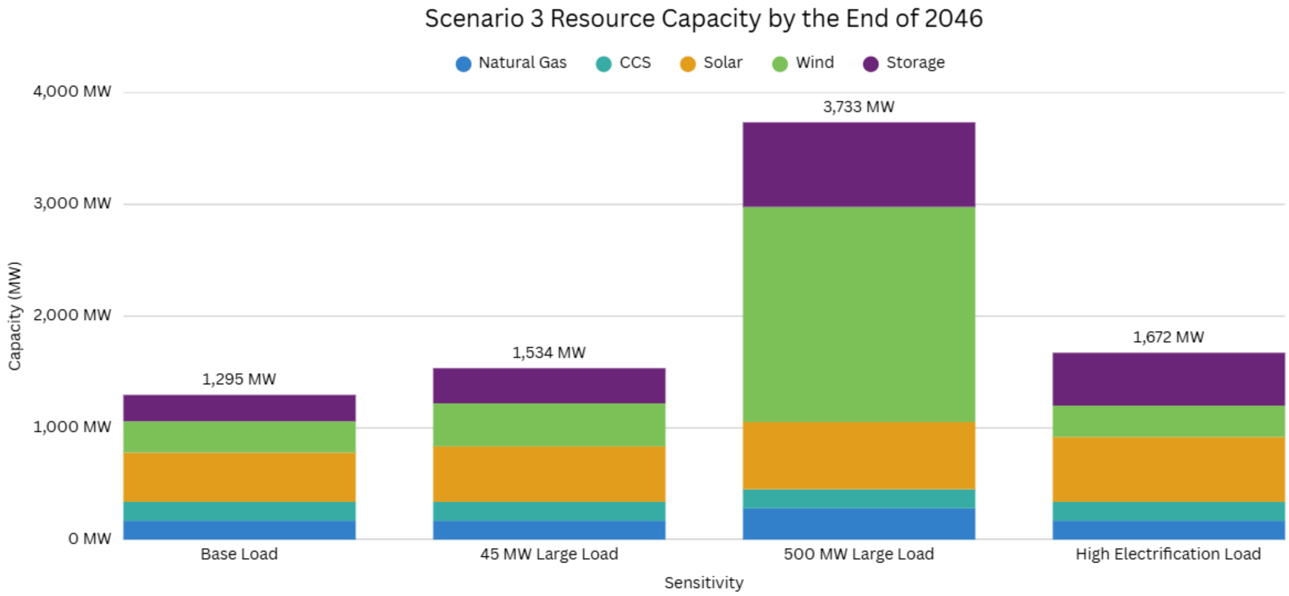


Figure 27. Scenario 3 Portfolio Resource Make-Up for Each Sensitivity at the End of 2046

In this scenario, BWL maintains its previously stated carbon neutrality objective by retiring the REO Town cogeneration plant in 2040. As the steam system transitions to hot water, the plant's primary function of providing steam is no longer required. All portfolios in this scenario include a carbon capture retrofit at Delta Energy Park and achieve the greatest reductions in carbon dioxide emissions across all modeled scenarios.

As in Scenario 1, the base load and 45 MW large load sensitivities yield comparable resource buildouts, including local solar, non-local solar, wind, and local 4-hour battery storage. Under the base load sensitivity, the model selects 60 MW of local solar, 270 MW of non-local solar, 280 MW of wind, and 236 MW of local 4-hour battery storage, for a total addition of 846 MW by the end of the study period. The 45 MW large load sensitivity results in a total addition of 1,085 MW, including 66 MW of local solar, 320 MW of non-local solar, 385 MW of wind, and 314 MW of local 4-hour battery storage.

In addition to these capacity additions, this scenario includes carbon credit purchases beginning in 2040 to offset emissions from remaining generation. Under the base load sensitivity, 2,847,548 carbon credits are required between 2040 and 2046, resulting in a cost of $28,617,857. The 45 MW large load sensitivity requires 2,881,841 credits, at a cost of $28,962,504.

Under the 500 MW large load sensitivity, wind remains the primary resource for meeting capacity needs, with 1,925 MW added by the end of the study period. Additional resources include 51 MW of local solar, 440 MW of non-local solar, a 112 MW RICE facility, and 756 MW of 4-hour battery storage, for a total addition of 3,284 MW. REC purchases are required to meet PA 235 compliance, with 1,947,827 RECs purchased. Due to the addition of new natural gas generation, carbon emissions increase, requiring 6,602,033 carbon credits at an estimated cost of $66,350,434.

The high electrification sensitivity differs from the other sensitivities in this scenario by including both local and non-local 4-hour battery storage. The model selects 398 MW of local battery storage and 75 MW of non-local battery storage, along with 60 MW of local solar, 410 MW of non-local solar, and 280 MW of wind, for a total addition of 1,223 MW. This scenario results in 2,856,440 tons of CO_2 emissions requiring offset, with an associated cost of $28,707,224.

Table 21. Reliability and Financial Metrics for Scenario 3 Base Load Sensitivity

IRP Metrics	10-Year	20-Year
NPV Revenue Requirements	$1,258,663,574	$2,587,407,490
Dispatchable Generation % of Peak	119%	103%
Resource Diversity	71%	74%
Emissions Reduction from 2005 - CO_2	-88%	-90%
Emissions Reduction from 2005 - NO_x	-93%	-96%
Emissions Reduction from 2005 - SO_2	-100%	-100%

Table 22. Reliability and Financial Metrics for Scenario 3 45 MW Large Load Sensitivity

IRP Metrics	10-Year	20-Year
NPV Revenue Requirements	$1,421,479,618	$2,969,890,920
Dispatchable Generation % of Peak	119%	116%
Resource Diversity	70%	74%
Emissions Reduction from 2005 - CO_2	-88%	-91%
Emissions Reduction from 2005 - NO_x	-93%	-96%
Emissions Reduction from 2005 - SO_2	-100%	-100%

Table 23. Reliability and Financial Metrics for Scenario 3 500 MW Large Load Sensitivity

IRP Metrics	10-Year	20-Year
NPV Revenue Requirements	$3,298,385,876	$7,275,379,343
Dispatchable Generation % of Peak	237%	215%
Resource Diversity	73%	64%
Emissions Reduction from 2005 - CO_2	-88%	-92%
Emissions Reduction from 2005 - NO_x	-93%	-96%
Emissions Reduction from 2005 - SO_2	-100%	-100%

Table 24. Reliability and Financial Metrics for Scenario 3 High Electrification Load Sensitivity

IRP Metrics	10-Year	20-Year
NPV Revenue Requirements	$1,319,722,806	$2,859,837,959
Dispatchable Generation % of Peak	140%	145%
Resource Diversity	74%	74%
Emissions Reduction from 2005 - CO_2	-88%	-91%
Emissions Reduction from 2005 - NO_x	-93%	-96%
Emissions Reduction from 2005 - SO_2	-100%	-100%

4.6.5 Scenario 4: No Moltke Ridge

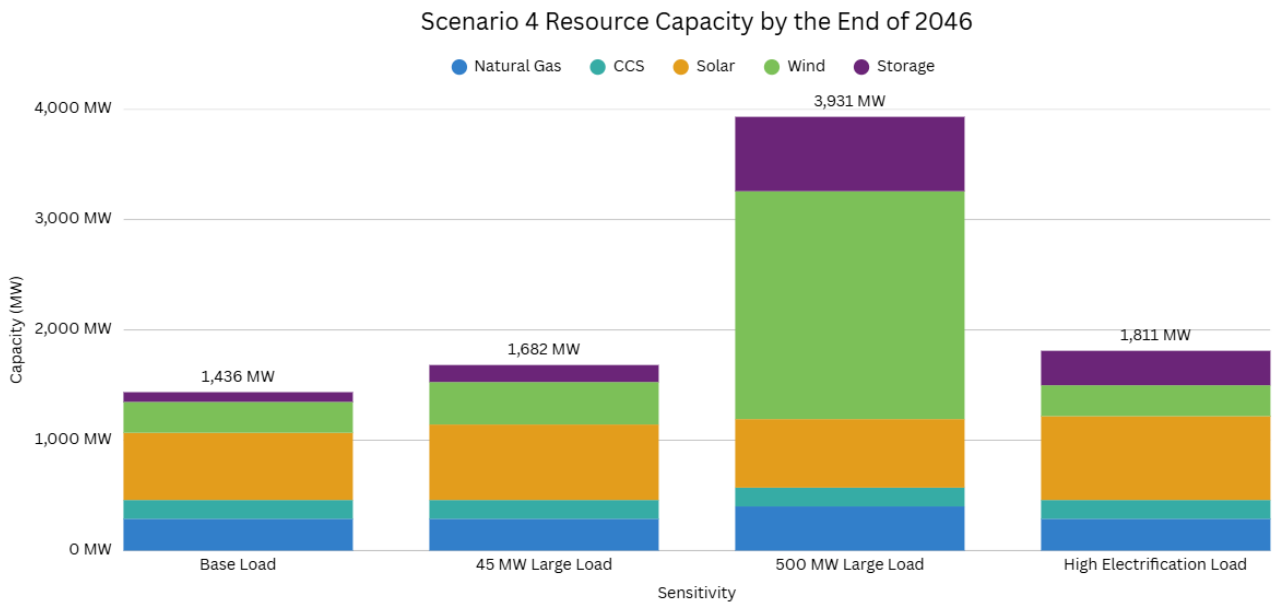


Figure 28. Scenario 4 Portfolio Resource Make-Up for Each Sensitivity at the End of 2046

There is inherent risk in adding new resources to BWL's generation portfolio, particularly for wind projects. Wind developments typically require large land areas and are located far from load centers, introducing challenges related to siting, competition with other projects, and the MISO interconnection process.

Moltke Ridge, an estimated 149 MW wind project for which BWL has a signed PPA, is currently facing interconnection and land-use challenges identified at the federal level and should therefore be considered at risk. Given the size of the project, its removal from BWL's portfolio would have significant ramifications for meeting regulatory requirements and serving customer load.

Under the modeled results, the base load and high electrification sensitivities include similar resource mixes, with local and non-local solar, wind, and local 4-hour battery storage, differing in capacity. The base load sensitivity results in additions of 39 MW of local solar, 460 MW of non-local solar, 280 MW of wind, and 88 MW of local 4-hour battery storage, for a total of 867 MW. The high electrification sensitivity results in 1,242 MW of new capacity, including 60 MW of local solar, 590 MW of non-local solar, 280 MW of wind, and 312 MW of local 4-hour battery storage.

Both the 45 MW and 500 MW large load sensitivities require REC purchases to meet PA 235 compliance requirements. Under the 45 MW large load sensitivity, the model selects 1,113 MW of new capacity, including 84 MW of local solar, 490 MW of non-local solar, 385 MW of wind, and 154 MW of local 4-hour battery storage. The 500 MW large load sensitivity results in a larger buildout of 3,362 MW, including an 112 MW RICE facility, 674 MW of local 4-hour battery storage, 111 MW of local solar, 400 MW of non-local solar, and 2,065 MW of wind.

Table 25. Reliability and Financial Metrics for Scenario 4 Base Load Sensitivity

IRP Metrics	10-Year	20-Year
NPV Revenue Requirements	$1,242,221,483	$2,489,916,440
Dispatchable Generation % of Peak	119%	98%
Resource Diversity	72%	69%
Emissions Reduction from 2005 - CO_2	-88%	-86%
Emissions Reduction from 2005 - NO_x	-93%	-94%
Emissions Reduction from 2005 - SO_2	-100%	-100%

Table 26. Reliability and Financial Metrics for Scenario 4 45 MW Large Load Sensitivity

IRP Metrics	10-Year	20-Year
NPV Revenue Requirements	$1,400,744,682	$2,861,100,058
Dispatchable Generation % of Peak	119%	109%
Resource Diversity	72%	70%
Emissions Reduction from 2005 - CO_2	-88%	-87%
Emissions Reduction from 2005 - NO_x	-93%	-94%
Emissions Reduction from 2005 - SO_2	-100%	-100%

Table 27. Reliability and Financial Metrics for Scenario 4 500 MW Large Load Sensitivity

IRP Metrics	10-Year	20-Year
NPV Revenue Requirements	$3,310,233,247	$7,197,305,605
Dispatchable Generation % of Peak	235%	222%
Resource Diversity	73%	65%
Emissions Reduction from 2005 - CO_2	-88%	-90%
Emissions Reduction from 2005 - NO_x	-93%	-95%
Emissions Reduction from 2005 - SO_2	-100%	-100%

Table 28. Reliability and Financial Metrics for Scenario 4 High Electrification Load Sensitivity

IRP Metrics	10-Year	20-Year
NPV Revenue Requirements	$1,297,775,777	$2,725,607,081
Dispatchable Generation % of Peak	128%	137%
Resource Diversity	73%	70%
Emissions Reduction from 2005 - CO_2	-88%	-87%
Emissions Reduction from 2005 - NO_x	-93%	-94%
Emissions Reduction from 2005 - SO_2	-100%	-100%

4.6.6 Scenario 5 – Baseline Generation & Capacity Needs

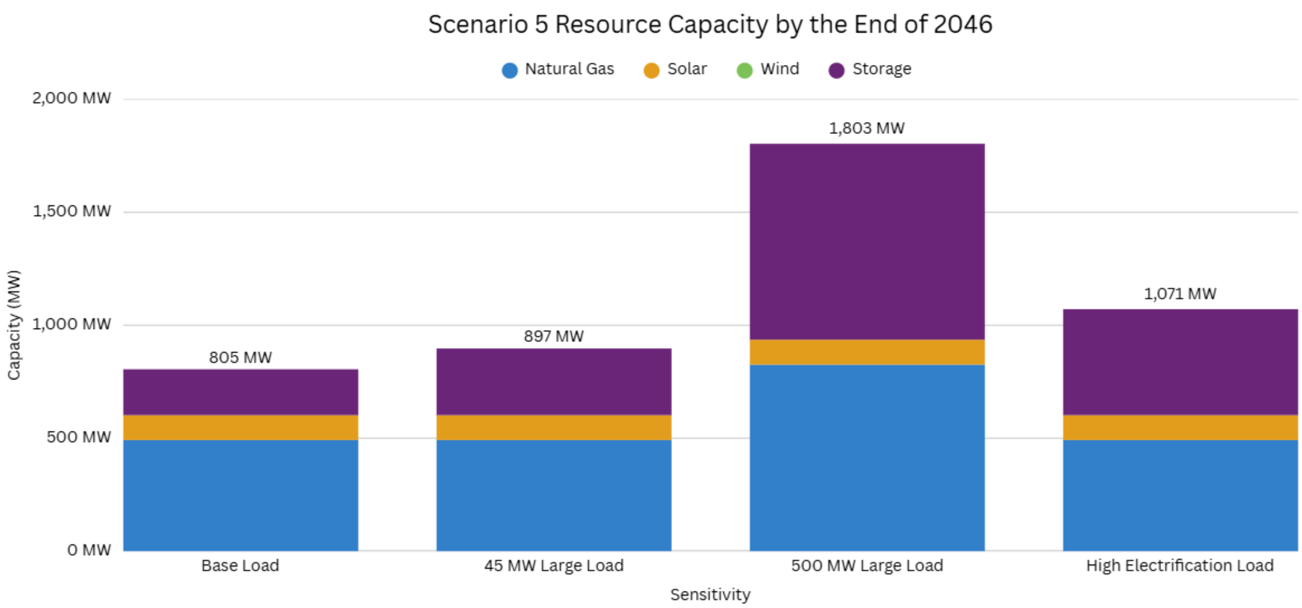


Figure 29. Scenario 5 Portfolio Resource Make-Up for Each Sensitivity at the End of 2046

Scenario 5 models the performance BWL's existing generation fleet. Under Scenario 5, all four load sensitivities rely primarily on battery storage additions to meet capacity needs. The base load, 45 MW large load, and high electrification sensitivities include only local and non-local 4-hour battery storage additions, totaling 203 MW (beginning in 2040), 295 MW (beginning in 2034), and 469 MW (beginning in 2031), respectively. These sensitivities rely on BWL's existing generation portfolio to serve load, using battery storage to meet incremental capacity requirements.

Under the 500 MW large load sensitivity, the model selects a different mix of resources. In addition to 4-hour battery storage, both local and non-local 8-hour battery storage and new RICE units are added. The model selects 800 MW of 4-hour storage and 67 MW of 8-hour storage, for a total of 867 MW of storage capacity. In addition, 336 MW of RICE generation is added, resulting in a combined total of 1,203 MW of new storage and natural gas capacity.

In this sensitivity, 8-hour battery storage is introduced beginning in July 2043. Given the uncertainty surrounding long duration storage technologies, BWL will continue to monitor their development and market adoption over time.

Table 29. Reliability and Financial Metrics for Scenario 5 Base Load Sensitivity

IRP Metrics	10-Year	20-Year
NPV Revenue Requirements	$1,174,707,162	$2,339,537,899
Dispatchable Generation % of Peak	126%	124%
Resource Diversity	70%	66%
Emissions Reduction from 2005 - CO_2	-80%	-72%
Emissions Reduction from 2005 - NO_x	-93%	-93%
Emissions Reduction from 2005 - SO_2	-100%	-100%

Table 30. Reliability and Financial Metrics for Scenario 5 45 MW Large Load Sensitivity

IRP Metrics	10-Year	20-Year
NPV Revenue Requirements	$1,332,092,862	$2,695,825,502
Dispatchable Generation % of Peak	132%	140%
Resource Diversity	72%	68%
Emissions Reduction from 2005 - CO_2	-79%	-74%
Emissions Reduction from 2005 - NO_x	-93%	-93%
Emissions Reduction from 2005 - SO_2	-100%	-100%

Table 31. Reliability and Financial Metrics for Scenario 5 500 MW Large Load Sensitivity

IRP Metrics	10-Year	20-Year
NPV Revenue Requirements	$2,765,158,265	$5,641,460,822
Dispatchable Generation % of Peak	304%	302%
Resource Diversity	72%	62%
Emissions Reduction from 2005 - CO_2	-75%	-75%
Emissions Reduction from 2005 - NO_x	-92%	-93%
Emissions Reduction from 2005 - SO_2	-100%	-100%

Table 32. Reliability and Financial Metrics for Scenario 5 High Electrification Load Sensitivity

IRP Metrics	10-Year	20-Year
NPV Revenue Requirements	$1,251,788,349	$2,679,591,955
Dispatchable Generation % of Peak	151%	171%
Resource Diversity	75%	68%
Emissions Reduction from 2005 - CO_2	-80%	-73%
Emissions Reduction from 2005 - NO_x	-93%	-93%
Emissions Reduction from 2005 - SO_2	-100%	-100%

4.7 Recommendations

This IRP evaluates BWL's long-term energy strategy by assessing projected load growth, resource options, system reliability requirements, and the impacts of recent state and federal energy policies. Through scenario and sensitivity analysis, the IRP identifies resource portfolios that can achieve BWL's strategic goals, including compliance with PA 235, and maintaining system reliability. The results highlight both near-term priorities and longer-term uncertainties, including shifting capacity accreditation methodologies, emerging technologies, and changes in market and policy conditions. Given the pace of change across the electric industry, particularly the areas of electrification, large load development, interconnection timelines, and regulatory requirements, it is essential that BWL revisit and update this analysis on a regular basis. BWL intends to perform this analysis on a 3-year cycle to ensure that planning assumptions, resource strategies, and investment decisions remain aligned with current conditions, strategic goals, and future expectations.

4.7.1 Wind Energy

The model predicts wind generation to play a critical role in achieving compliance with PA 235, particularly as renewable energy standards rise to 50% by 2030 and 60% by 2035, and as the 80% clean energy standard takes effect in 2035. Compared with other renewable technologies, utility scale wind remains competitive due to its production characteristics, the ability to develop projects at scale, and more consistent year-round accredited capacity values. Given the long lead times for project development, transmission interconnection, and contracting, initiating these procurements in the near-term planning horizon is prudent and necessary. As noted previously, the successful siting of wind projects is likely to continue to be an issue.

4.7.2 Local Solar

Local solar was consistently shown by the model to be one of the most cost-effective ways to achieve compliance targets. Every model configuration adds local solar arrays to the portfolio. These arrays were modeled after existing projects and those currently under construction, such as the Comfort Street and Lake Lansing arrays. To the extent that land is available, local solar is a cost-effective resource for meeting BWL's needs. Local solar assets increase community visibility of solar and can be placed on otherwise unused or undesirable parcels of land. Given the time required to secure permitting and procure certain long lead time electrical equipment, BWL will continue to construct solar arrays that feed into locally owned distribution and transmission systems during the short-term planning horizon.

4.7.3 Battery Energy Storage Systems

In all but two modeling configurations, batteries were among the most cost-effective ways to meet capacity requirements. The only scenario in which batteries did not play a role was Scenario 1, the Reference Case, where additions of solar and wind resources ensured BWL could meet its capacity requirements. Given the prevalence of battery energy storage systems in the modeling results, BWL will continue to evaluate opportunities to include these resources in our portfolio, both locally owned and operated and through tolling and power purchase agreements for facilities in the Lower Peninsula. By colocating battery storage systems with other renewable energy sources, BWL will seek to increase energy market revenues while advancing incremental progress toward compliance targets.

4.7.4 Carbon Capture & Sequestration and Nuclear

When available to the model, CCS is part of the lowest cost resource mix across all load sensitivities. Costs for the CCS retrofit were based on available market data and do not reflect the true operational costs of capturing carbon. BWL will monitor the development and commercialization of this technology.

SMRs offer several potential advantages, including the ability to be deployed with large loads, developed at smaller, local sites with limited transmission upgrades, and to provide stable baseload generation that qualifies toward compliance requirements under PA 235. As the technology matures and additional cost and operational data become available, BWL will continue to monitor and evaluate the feasibility of SMRs as a potential future resource option.

4.7.5 REC Purchases

In certain scenarios, particularly under high load growth and in the absence of planned renewable resources such as the Moltke Ridge wind project, the model relies on REC purchases to meet PA 235 requirements through 2034. While RECs provide a near-term compliance pathway, they do not contribute to compliance beyond 2035 and are therefore only a short-term solution. However, Section 29(4) of PA 235 allows municipal utilities with a single customer representing more than 25% of total load to continue using REC purchases beyond 2035. In such cases, REC purchases may remain a cost-effective compliance option, provided associated costs are appropriately allocated.

5 Appendix A: IRP Survey Responses

During the summer of 2025, BWL reached out to the greater Lansing area to discuss the IRP process, gather feedback, and encourage suggestions from a diverse group of stakeholders, including local governments, municipal representatives, neighborhood associations, and industrial and commercial businesses. **Table 33** includes the organizations and stakeholders BWL talked to.

Table 33. Stakeholder Group IRP Meeting List

Category	Participants
Local Governments	Delta Township
	City of Lansing
	Lansing Township
Local Leaders	Chris Harkins
	Semone James
	David Price
	Dale Schrader
	Bob Worthy
	Sandra Zerkle
	Andy Schor
Neighborhood and Other Associations	Lansing City Council
	Lansing Economic Area Partnership
	Lansing Economic Development Corporation
	Lansing Regional Chamber of Commerce
Commercial and Industrial Stakeholders	Auto Owners
	Farm Bureau
	General Motors
	JNL
	Liquid Web
	Sparrow

These stakeholder meetings provided valuable recommendations for modifying and continuing to develop innovative programs that can meet Greater Lansing's needs. Discussion topics included: sustainability and environmental responsibility; familiarity with industry trends; rate flexibility and energy management; economic development and other goals; and a strategic planning discussion on opportunities and feedback. Stakeholders were encouraged to share their thoughts on sustainability goals, onsite renewable development, and joint community projects, and on how BWL can assist in achieving these goals through contracts and rate-based products. Additionally, talking points were provided that included: distributed generation, demand response, electric vehicles, battery storage, energy optimization, renewable energy credits, and more. The specific programs that showed the greatest interest, based on frequency, are listed in Figure 30 below.

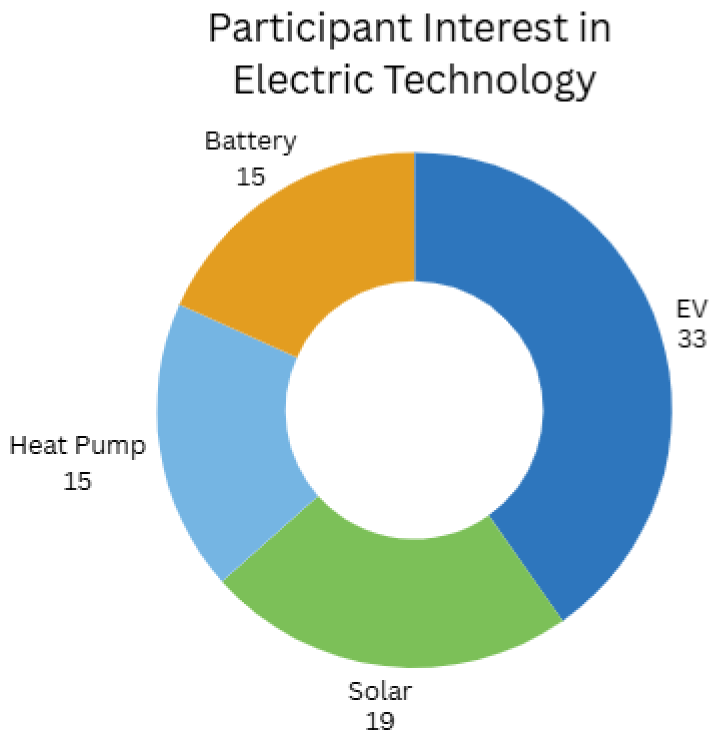


Figure 30. Survey Participant Interests in Different Electric Technologies

In the survey, stakeholders were also asked to rank BWL priorities as the organization plans for the coming decades, aiming to balance reliability, economic, and environmental goals while mitigating risks and meeting regulations. The results of those rankings can be seen in **Figure 31** below.

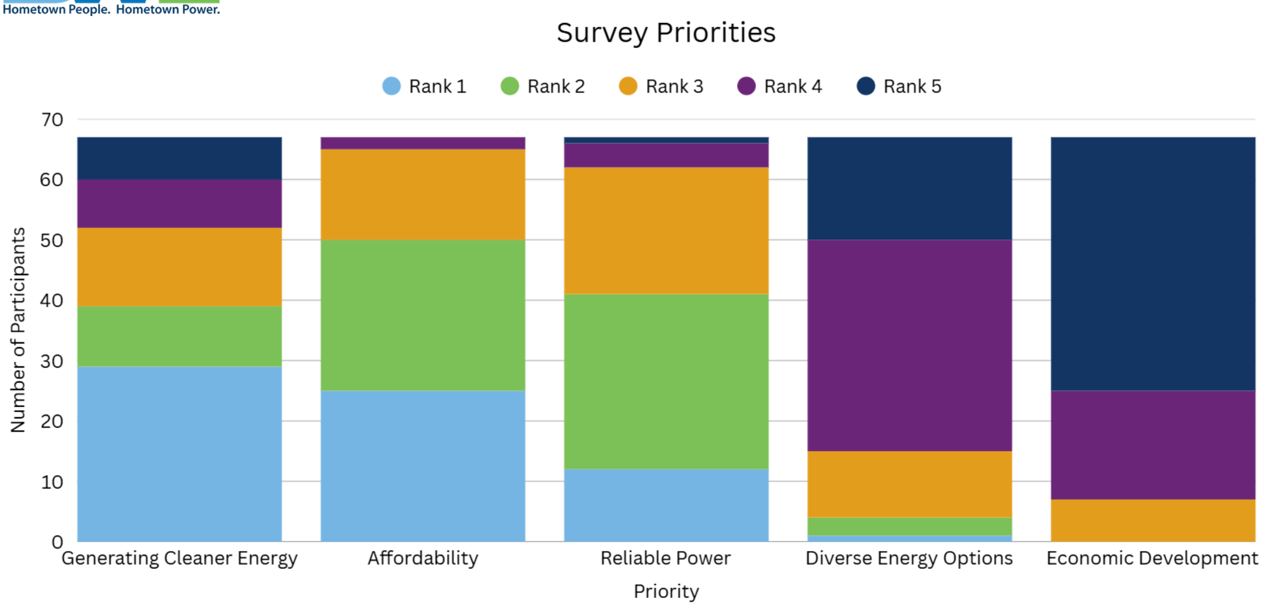


Figure 31. Customer Interests in BWL's 5 Priorities

The normalized average for these results can be seen in **Table 34** below. The lower the average, the higher the priority sits in the ranking. In this case, Affordability ranked number 1, whereas Economic Development ranked last.

Table 34. Weighted Averages of Survey Participants' Ranked Priorities

Priority	Weighted Average
Generating Cleaner Energy	2.31
Affordability	1.91
Reliable Power	2.29
Diverse Energy Options	3.94
Economic Development	4.52

The survey also asked about customers' preferences for the location of renewable generation resources to meet their electric needs. Locations for renewable generation seemed to be almost evenly split between within BWL's service territory, in Michigan, or in the Midwest. These results can be seen in **Figure 32** below.

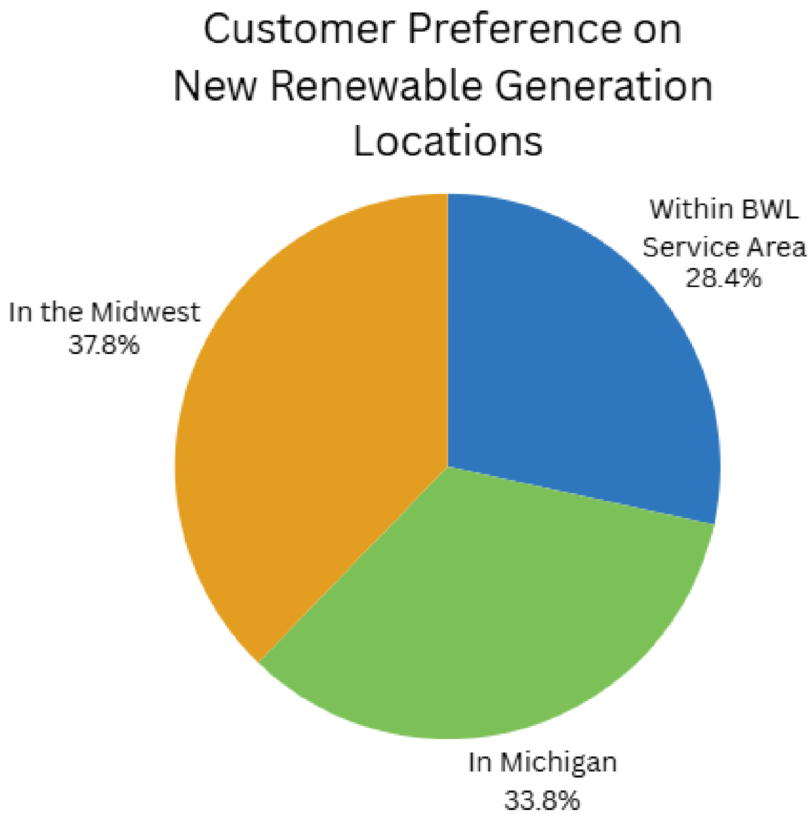


Figure 32. Customer Preference on New Renewable Generation Locations

The question about nuclear power on the survey was slightly more controversial: survey respondents did not support BWL investing in nuclear technology, though almost a third were unsure. See **Figure 33** below for the results of the nuclear preferences.

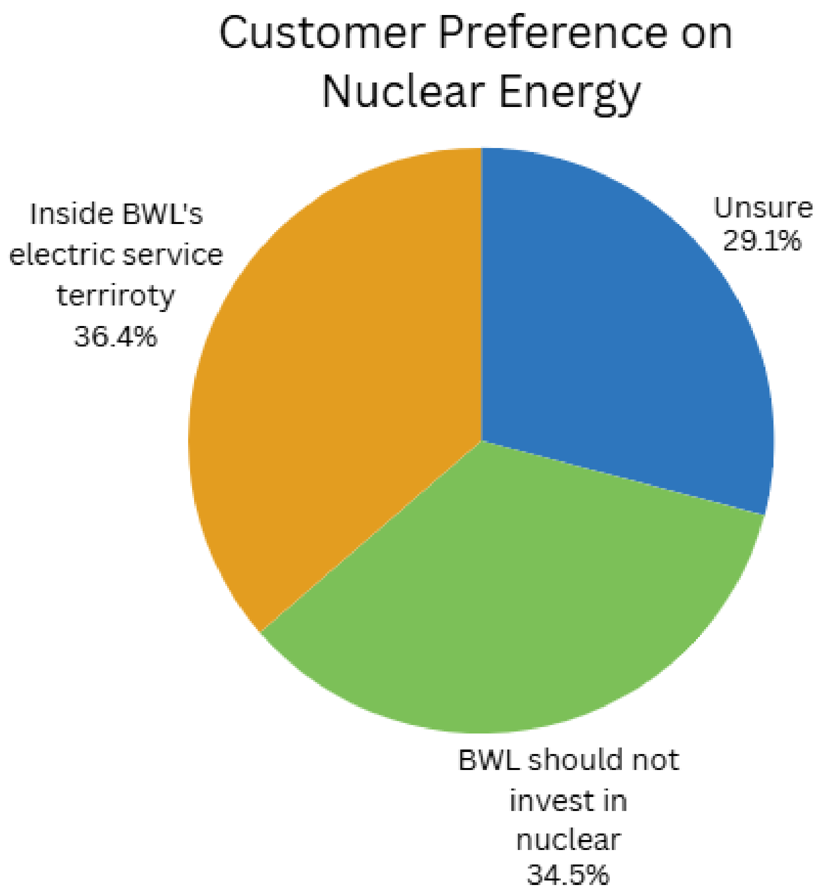


Figure 33. Customer Preference on Nuclear Energy

The information gained through the survey provides a foundation for long-term planning efforts, informs the Commission's decisions, and serves as a tool to determine future electricity needs.

The results shown above were drawn from a survey available to residential and commercial customers on BWL's website and at in-person open houses. Members of the public were invited to attend the open houses to learn about the IRP process, ask questions, and offer suggestions to help shape the IRP. The meeting dates and locations are listed below. below.

Table 35. IRP Open House Meeting Information

Date	Location
07/24/2025	Alfreda Schmidt Center
07/28/2025	Delta Township Public Safety
08/04/2025	REO Depot
08/04/2025	East Lansing Hannah Center
08/05/2025	Allen Neighborhood Center

In addition to the questions above, the survey requested personal information from each participant, including stakeholder area codes and open-ended opinions on any topic. **Figure 34** displays the stakeholder zip code breakdown, and **Table 36** below is the list of feedback from the survey participants.

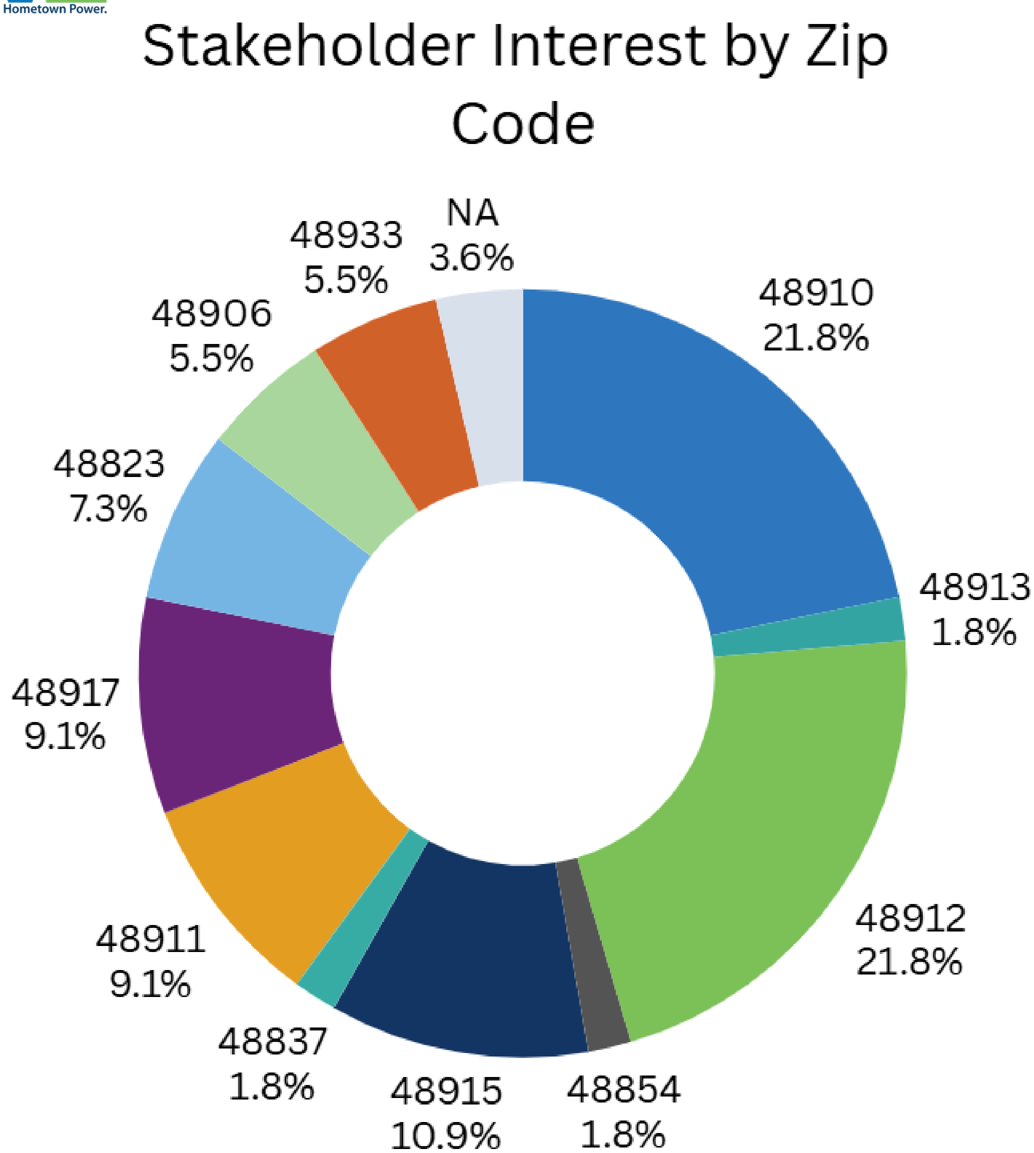


Figure 34. Stakeholder Local Breakdown by Zip Code

Table 36. Open-Ended Responses from Survey Participants

"Not enough information on how the SMRs, like what is done with the waste byproducts? also have you talked about wind power on the smoke stacks downtown Lansing aka (Wink, Blink n Nod). I have given you a conceptual design and there's a prototype in Williamston Michigan that was installed in 2013."
"BWL should plan to move as expeditiously as possible to eliminate all fossil fuel generating capacity. Through a combination of solar+battery, wind, and purchase off the grid when necessary, BWL can meet the electricity needs of the community. BWL should not be investing resources to develop excess capacity in order to sell it outside of its service territory. BWL should be looking to work with community organizations and nonprofits to develop community solar options that would be aimed primarily at low-income residents. An example is the nonprofit that has purchased the former Otto Middle School. They have a plan that BWL should be seriously investigating and investing in. The community solar project that is expected to become available before the end of the year is great. It should be priced affordably, reflecting the fact that solar is the least expensive way to generate electricity, making it available to everyone regardless of household income. Rates for electricity and water have soared the past several

years. Given that solar and wind are the least expensive way to generate electricity, I urge BWL to design their rate plan to reflect that fact.”
“Clean energy is possible and must be the priority over profits.”
“Electricity demand is rising and will rise substantially in the coming decades as the system electrifies. We also have a climate crisis. Luckily, renewable energy paired with batteries is a very reliable and affordable system. Sodium batteries are coming on line, which are less expensive and more stable than lithium batteries (they weigh more, but that matters little for stationary uses). Distributed energy is also a great system to explore, wherein batteries and solar distributed across homes and businesses work with BWL to create a resilient energy system. BWL should be exploring these options as the primary sources for the energy of the future.”
“Please pursue clean and small footprint RE such as Small Modular Nuclear Reactors (SMR). Solar and wind are NOT small footprint, and are destroying our rural farm way of life. Yes. Leaseholder benefits. But that money Leaves the community and all the farming related business are devastated when land goes out of production. BWL can be a Leader in SMR technologies. Also we already have Solar panels and Geothermal on our residence. We are doing our part. We Do Not want Any More Solar and Wind or Battery Storage in our Rural Counties surrounding Lansing.”
“Stop windmill and solar panel farms scam. Use natural gas, coal, and nuclear to generate electricity.”
“Do not put solar on Farmland. Remediate industrial sites for solar”
“greener is better”
“No solar or wind farms on farmland. Nuclear is the future.”
“Grid integrated battery energy storage (BES) systems will be critically important. Managing intermittency will be essential as distributed renewable energy makes up a greater proportion of generating capacity. There is also a strong economic argument since kWh can be purchased from the grid when they are at a low price and then distributed when demand for electricity is high.”
“Full speed ahead”
“High capacity salt batteries; Safe clean and hold heat a long time”
“I am concerned about SMR and would need a lot more information to support this type of development. I also don’t know how BWL’s investment to serve beyond it’s current territory would impact me financially, yes though I would support more renewable energy availability everywhere. I would be also interested in buying internet access from BWL as a utility.”
“Thanx for thinking of us.”
“I believe that the solar panels should be on top of parking garages, buildings and warehouses only!NOT on farmland!”
“I strongly oppose nuclear energy and heavily support solar, wind, bio, and other eco friendly sources of energy. Nuclear is NOT eco friendly, as evidenced by the mining of uranium and the ‘storage’ of the waste. Also, petroleum-based fuels need to be phased out - climate change is real.”
“I support SMRs IF they prove technically and financially practical. Are data centers a concern within the BWL service area? If so, can we ensure the developers for the site/the data center companies commit to building renewable energy for their entire load?”
“I want clean energy but it has to be affordable. Rates jump often. We already don’t get a living wage.”
“I would like to know how much financially this is going to impact the taxpayers in consumers of water and light and will like to know what are all options bwl is currently considering or planning to help make this affordable to taxpayers in consumers this would include salary raises and union contract negotiations.”
“Don’t be strong-armed by climate alarmist. Create reliable, affordable energy for your customers.”
“I’d love to see BWL move away from natural gas and focus on fully cleaner renewables. IE. Nuclear, Solar, Wind, Geothermal.”
“Increasing energy efficiency of buildings should be a high priority, incentivized through rebates and low interest loads.”
“Invest in distribution - as EV charging grows the distribution grid will need improvement.”
“Keep it up for renewable energy”
“Keep moving forward with all energy options.”

“Keep up the good work”
“No”
“no coal and no nuclear”
“Only use marginal lands for solar and wind, etc. such as but not limited to landfills and contaminated sites. No farmland or arable land!!!”
“Our area is already behind in the need to dramatically reduce the production of HAPS for the sake of the community residents’ health and to prevent catastrophic climate change results. On behalf of Delta Township and residents living within 3 miles of the new RICE engines, many of whom are living in poverty and show up on the old EPA environmental justice map as directly in the path of BWL emissions, it is imperative that these engines be phased out more quickly. Working at Head Start, a huge percentage of the preschool kids living along that path already were assessed with asthma by 3 years old.”
“please consider land use implications as you develop cleaner energy. Solar is land extensive and is now the leading cause of deforestation in Michigan. Thanks for building solar on your own coal ash brownfield to clean up your prior mess. Please work with the State to put solar on 24 acres of parking lots west of the Capital.”
“Please don’t greenwash fossil fuels, but work with Delta WWTP and other flare sources to install biofueled microturbines.”
“No more solar or wind towers stealing farm land or within one mile of any home”
“Reliable service to Groesbeck area, especially during weather events”
“I am excited that BWL is considering a variety of options with regard to nuclear energy!”
“I would like to have the option to have a lower monthly base fee in exchange for a higher per unit cost in order to have greater control of my overall monthly cost when reducing energy usage.”
“SHOULD INCLUDE EXPANDED AIR MONITORING SYSTEM WITH EASY PUBLIC ACCESS TO HAPS”
“Solar and wind energy is overpriced and inefficient. Do not even consider placing either outside the BWL service area. The questions are clearly leaning toward the word ‘near’. That is unacceptable. Anything regarding generating power for BWL should be within the service area.”
“Stop wind and solar. Natural Gas has better return on investment. Wing and Solar is most wasteful of natural resources.”
“Thank you for investing in renewable energy options. They help preserve our health and safety, as well as decrease our dependence on polluting fossil fuels. Once the infrastructure is in place, renewable energy sources (such as wind, solar, and hydro) will also allow us to rely less on foreign suppliers for our fuel needs.”
“thank you for this!”
“There is nothing ‘clean’ about nuclear.”
“We need more community solar arrays built up 20 feet in the air, particularly on empty state parking lots, empty GM lots, other large parking lots, possibly along highway egress. Often done with win win lease agreements.”
“We need more solar- and wind-generated electricity. If new power plants are going to be built to attract business and economic growth (such as the auto industry), then those businesses should pay for the facilities.”
“We need to decarbonize in order to avoid the worst effects of climate change. Any plan for BWL’s future must include a plan to retire ALL coal and natural gas power generation and replace it with solar, wind, and nuclear. I came to tonight’s program with the intention of stressing this point, and I’ve done so again and again. While I know that energy storage technologies are still developing, this should not be an excuse for continuing to rely on fossil fuels in the era of climate change. BWL should invest in batteries and pumped or compressed energy storage in order to support retiring the fossil-fired plants. Tonight’s thorough presentation has also made it clear that, while BWL is working to expand its renewable energy projects, these require substantial investment of land, money, and time. I worry that these up-front costs might sap BWL’s resolve to expand renewable energy resources. They may also cause some communities to balk at renewable energy development. I think we as a community need to recognize solar arrays, batteries, and wind farms as the cost of having energy while avoiding climate catastrophe. Please don’t let Michigan use

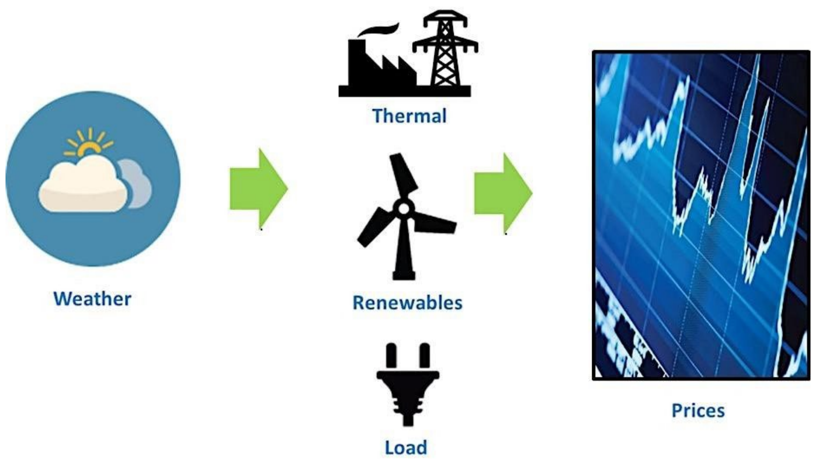
NIMBYism as an excuse to avoid making these necessary transitions. I think with thoughtful and sustained public education and marketing, much of this community hesitancy can be overcome”
“We want renewable energy!”
“While I don’t plan to buy another EV in the next few years, I do own one now and it’s amazing. I don’t have the data to decide whether BWL should go nuclear, but I think if the demand can be met with solar, there are many opportunities for expansion of that technology. Look at what MSU has done with the solar panels in their parking lots.”
“Yes, fire up our coal plant and utilize clean coal”
“Keep pushing renewables despite the blowback from Washington.”
“Yes, please stop investing in natural gas. It is not clean energy, clean energy is semantics. There is natural energy like solar, wind, and water. Synthetic energy comes from fossil fuels like natural gas, coal, and other man made products.”
“Your peak rates are some of the worst on the country”

6 Appendix B: Ascend Analytics -Ascend documentation

PowerSimm Model description

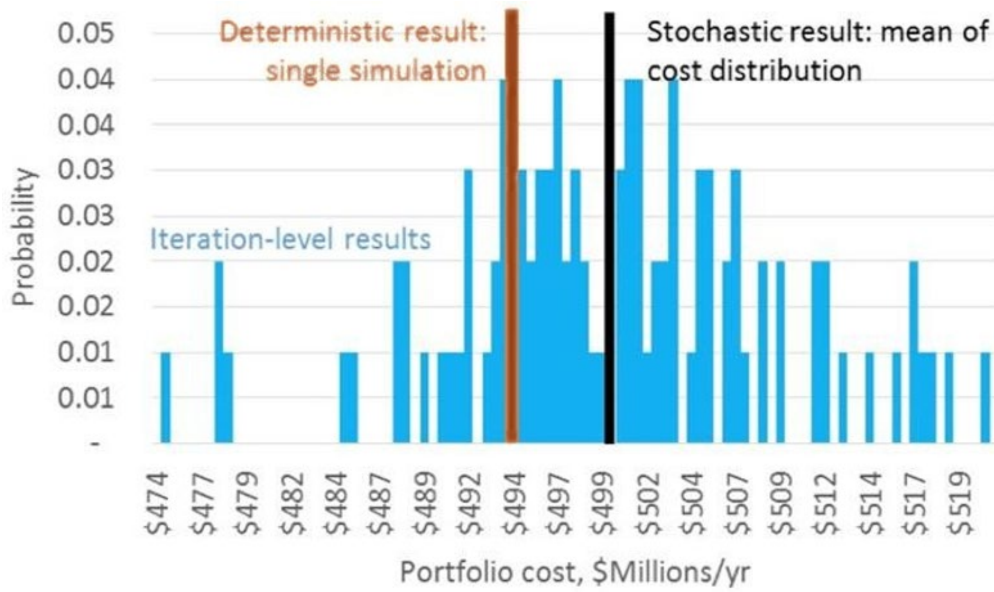
PowerSimm is a dispatch optimization and production cost tool. The tool is comprised of two major elements, the Sim Engine and Dispatch Optimization, that work together to systematically bridge the physical and financial dimensions of electricity provision. PowerSimm uses a simulation-based approach born of the best-in-class techniques to perform decision analysis for portfolio risk management. In that world, managing risk requires characterization of the volatility in fuel price, power price, renewable generation, and outages. PowerSimm adopts this paradigm into the resource planning context.

PowerSimm's Sim Engine Captures Meaningful Uncertainty in weather, load, renewables, and prices



The simulation of uncertainty with respect to weather is becoming ever more critical because "weather is the new fuel" in the emerging high-renewables system. To capture the changing market dynamics with renewables, PowerSimm simulates weather to capture its effect on renewable output and its effect on energy price formation. We call this "characterizing meaningful uncertainty." It is not simply noise around an arbitrary base scenario, but realistic paths of weather driving renewables, loads, and prices. That means PowerSimm is performing dispatch against system conditions as they really exist, not the idealized system modeled by traditional production cost models. PowerSimm is a stochastic construct and through 100 or more simulations, or "sim-reps," we probabilistically envelop all possible future states through a coherent and appropriately correlated set of data inputs and forecasts. Figure C-1 demonstrates the value of PowerSimm's stochastic approach. The orange line represents the result of a single deterministic run, which would have been calculated based on smooth average profiles. PowerSimm generates the blue Sim Reps stochastically, characterizing a full distribution of possible outcomes of portfolio cost. With PowerSimm, resource decision making is supported not only with the mean of the distribution, but also by risk considerations informed by the 5th and 95th percentiles. Therefore, we can solve for the optimal resource portfolio that strikes the best balance between cost and risk.

Figure C-1: The value of stochastic analysis in resource planning

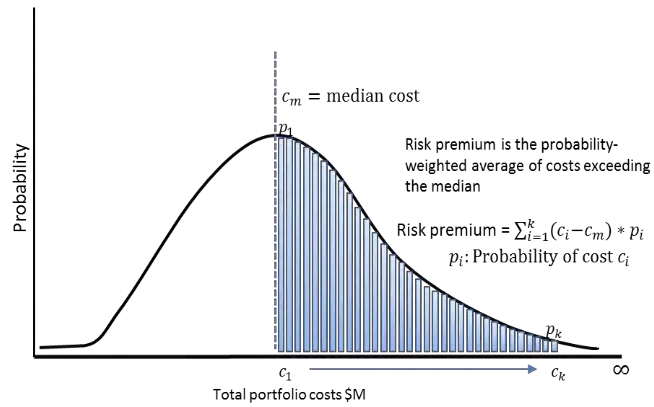


Using Risk Premium for Resource Decision Making

PowerSimm also identifies the risk associated with each energy portfolio option, quantifying this as the "risk premium." Since different energy portfolios have different simulated cost distributions, the risk premium will be larger for wider cost distributions, or riskier portfolios, and smaller for narrower cost distributions, or less risky portfolios. Ascend then adds the risk premium variable to the expected value to put all energy portfolio options on the same playing field. The factors that drive risk in total portfolio cost include fuel price risk, carbon price risk, and market risk.

The risk premium is defined as the probability-weighted average of costs above the median, and this concept is illustrated below in Figure C-2.

Figure C-2: Risk premium is an economic concept measuring how prone a portfolio is to higher than expected costs



PowerSimm planner monetizes risk through applying an actuarial option approach where the value of risk (the risk premium) is calculated as the integral of the cost distribution from the mean to the upper tail of costs, reflecting the downside risk to ratepayers. The underlying distribution of costs follows from production cost modeling with input simulations of market prices and correlated simulations of weather driving both simulated load and renewables. These underlying simulations are developed to satisfy a long set of validation criteria to ensure "meaningful" uncertainty is reflected in the final distribution of costs.

Automated Resource Selection and Capacity Expansion

Introduction and Overview of Automatic Resource Selection Model and Capabilities

Key Take-Aways

- PowerSimm Planner is a sub-package of PowerSimm developed and supported by Ascend Analytics (Ascend) of Boulder, Colorado.
- A trademark feature of PowerSimm Planner is Automatic Resource Selection (ARS) and Capacity Expansion. ARS allows utilities to make long-term resource planning decisions based on least-cost and lowest-risk.
- ARS in PowerSimm uses a stochastic simulation, which allows for the utility to make decisions over hundreds of future scenarios, rather than restricting the decision to a single simulated outcome. This distribution of scenarios provides an understanding of the risk associated with planning decisions.
- ARS optimizes decisions on new generation, repowering, and retirement based on capital and fixed/variable O&M costs to reduce Portfolio Net Present Value. Decisions can be constrained based on a variety of variables, including Renewable

Portfolio Standards, market sales/purchases constraints, and Reserve Margin requirements.

Introduction

Automated Resource Selection (ARS) is an advanced capability of PowerSimm Planner that uses detailed dispatch modeling to make optimal resource planning decisions by determining the least-cost least risk resource options to meet future load and renewable portfolio standard (RPS) requirements. ARS uses mixed nteger programming (MIP) techniques to optimize resource selection decisions, with the objective of minimizing the net present value of capital expenditures and production costs, subject to both physical and financial constraints. While other models have similar algorithms for resource selection, PowerSimm is the only model that solves for the optimal portfolio over hundreds of simulated future states, providing a resource plan that will be practical and cost-effective under the widest variety of possible futures.

Advantages of Stochastics-based Resource Selection

While deterministic models run under various sensitivities may provide insight into resource planning decisions, the limited set of information provided by this method will bias the study results. By contrast, stochastic simulation, in which a wide variety of studies are performed using distributions of underlying parameters, removes this bias. Figure C-2, reproduced below, illustrates this effect by showing how the results of a single deterministic study (shown in orange) may differ substantially from the expected value across many stochastic simulations of future conditions (shown by the solid black line). Furthermore, stochastic simulation provides information on the “meaningful uncertainty” of the results, enabling accurate articulation of risk for each of the proposed portfolios.

The use of stochastic simulations can be combined with the Automated Resource Selection module of PowerSimm Planner to systematize the resource selection process. The methodology provides the best supply portfolio overall based on all simulated future conditions. Given a distribution of possible dispatch scenarios based on hundreds of simulations of weather, load, prices, and renewable generation, each planning scenario can be accurately judged on their associated risk as well as cost. A deterministic model may select the lowest average expected cost, but this may be the most volatile portfolio which introduces risk that the utility cannot take on. The ability to select the optimal portfolio over a broad spectrum of future conditions without loss of generation modeling details provides substantial advantages over picking the best portfolio from a single deterministic run.

Capabilities of Automated Resource Selection

Automated Resource Selection can optimize resource decisions in three primary categories:

- New Generation
- Retirement
- Repowering

Each candidate resource, whether new or existing, is input in full technical detail into PowerSimm to generate accurate simulations of its dispatch and market interactions across all future scenarios. Data from these simulations enables calculation of both the expected revenue generated by this resource as well as the expected marginal costs of operation over the course of its lifetime.

Because resource planning involves a trade-off between long-term capital investment decisions and variable operating costs, the optimal expansion plan seeks to minimize the net present value (NPV) of future capital expenditures and future fixed and variable costs. ARS uses the overnight capital costs and fixed/variable O&M costs to calculate a levelized annual revenue requirement for each candidate resource, thus accounting for any capital investment decisions not fully amortized over the simulated planning horizon.

These calculations are fine-tuned by inputting general economic assumptions such as WACC, inflation, relevant tax rates, and depreciation life of the resource, allowing for accurate discounting of future expenditures and proper depreciation of assets. Please refer to the appendix for a breakdown of the inputs to fixed and variable O&M costs. The projects with maximal value (annualized revenue less annualized cost) are selected for implementation, subject to any imposed system constraints.

One of the key features of ARS is the ability to impose system constraints on the selection of candidate resources into an optimized generation portfolio. Typically, these constraints may include:

- Renewable Portfolio Standards (RPS)
- Market Sales/Purchase Limits (Energy and Capacity)
- Reserve Margin Requirements.

This feature allows the user to input all the available candidate resources and let ARS add, retire, or repower the resources that will most efficiently meet these constraints and minimize capital requirements of the portfolio.

Once the optimal resource portfolio is established, ARS can also determine an optimized build schedule for all candidate resources. If a candidate project has a pre-determined implementation date, ARS can easily make the decision of whether that project is economically viable if it comes online at that time. However, if the plans are more flexible and a resource may come online in a range of time, ARS can calculate when in that time range is optimal for serving both load and economic value and automatically select an optimized start date.