2023 INTEGRATED RESOURCE PLAN

Published July 2023

Manitoba Hydro
energy for life

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LAND ACKNOWLEDGEMENT

Manitoba Hydro has a presence right across Manitoba – on Treaty 1, Treaty 2, Treaty 3, Treaty 4 and Treaty 5 lands – the original territories of the Anishinaabe, Cree, Anishininew, Dakota, and Dene peoples and the homeland of the Red River Métis.

We acknowledge these lands and pay our respects to the ancestors of these territories. The legacy of the past remains a strong influence on Manitoba Hydro's relationships with Indigenous communities today, and we remain committed to establishing and maintaining strong, mutually beneficial relationships with Indigenous communities.

MESSAGE FROM PRESIDENT & CEO

Whether it's heat for your homes, light for your spaces, or power for your factory floors, you trust Manitoba Hydro to deliver the safe, reliable energy you need. It's our mandate and one we've proudly fulfilled for over 60 years.

Now, as Canada looks to a cleaner energy future, the landscape is shifting. Your needs and expectations are also changing. We are committed to continuing to serve you and to preparing now to be ready for whatever these changes may bring.

We started this work by developing our long-term strategy, Strategy 2040. It sets a path to prepare for the future and continue building on our legacy of providing clean, renewable hydropower and reliable natural gas service to Manitobans at the lowest possible cost. This Integrated Resource Plan (IRP), our first, is an initiative of Strategy 2040 and an important part of how we are working to understand and prepare for the future.

The 2023 IRP is a product of a two-year process to understand the key factors driving change in the Manitoba energy landscape and what that means for the supply and delivery of electricity and natural gas. We conducted multiple rounds of engagement with you to build an understanding of your plans and perspectives and inform the IRP with a Manitoba context. We completed extensive modelling and analysis on a range of potential future scenarios and sensitivities that incorporated your feedback. We also considered how existing and potential government actions at all levels are impacting the energy landscape, including the Province of Manitoba's recently released Manitoba Energy Roadmap.

Through this process, we've learned that the energy transition is already underway in Manitoba. More of you are considering the purchase of electric vehicles. Some businesses are taking steps to decarbonize their operations. And governments – at the federal, provincial, and municipal levels – are taking or contemplating actions that will further drive this transition. We also learned that there is a lot of uncertainty in the pace of change and managing this uncertainty through careful consideration of future decisions will be critical to continuing to efficiently and economically serve you with reliable energy.

The challenge of preparing for this change is not unique to Manitoba Hydro; it's something that energy utilities around the world are facing. We do, however, have some advantages that can help us navigate that change. Manitoba is well-positioned because of your past investments in developing the clean, renewable hydroelectric system that delivers nearly all the electricity we produce at costs among the lowest in North America and because of your investments in transmission interconnections to neighbouring energy markets. As a vertically-integrated utility that supplies and delivers both electricity and natural gas, we are also well positioned to leverage these two energy sources in identifying solutions that benefit all Manitobans.

That said, successfully navigating the energy transition and ensuring the continued supply of reliable energy at the lowest possible cost – while balancing the need to maintain Manitoba Hydro's financial resources to address risks such as severe drought – will not be easy.

The modelling and analysis completed for this IRP confirmed Canada's move towards net-zero goals and the transition to low or no-carbon energy will accelerate the need for clean, reliable electricity. However, Manitoba Hydro's energy and capacity resources are limited. We already anticipate not renewing some of our current contracts for exports of electricity as that surplus energy will be increasingly required to meet your needs here in Manitoba. And, while there is some uncertainty in the timing of Manitoba's need for new energy resources, it could be within the next 10 years.

In short, the IRP makes it clear that considerable investments will be required to meet additional electricity needs and the pace of those investments will put upward pressure on rates. The IRP results also show the shorter the timeline for achieving net-zero goals, the greater the scale of these investments and the likelihood developing, unproven technologies will be required. Similarly, if government actions lead our customers to move away from using natural gas or increase restrictions on the strategic use of natural gas generation to meet the additional electricity demand created by decarbonization of other sectors, such as transportation, the scale of these investments grows significantly.

These and other learnings helped to build the road map at the heart of the 2023 IRP. This road map is not a development plan. It's a planning tool that describes how Manitoba Hydro will monitor, prepare for, and respond to changes in the energy landscape, and outlines the near-term actions we need to take to best prepare to meet your future energy needs.

These steps are not steps we can take alone. The process of developing this IRP and the conversations we've had throughout confirmed the importance of working together with the broader energy planning community – including governments, regulators, Efficiency Manitoba, Indigenous communities, other interested parties and most importantly you, our customers – to understand and chart a path forward.

We support Manitoba's Energy Roadmap including the recommendation for coordinated governance between Manitoba, Manitoba Hydro and Efficiency Manitoba with the Public Utilities Board to provide policy advice to government. Specifically, there is an opportunity to establish the clearer roles, authorities and energy-related expertise that will allow us to effectively navigate a more complex energy future.

The 2023 IRP and Manitoba's Energy Roadmap are also aligned on:

- leveraging our province's clean energy advantage by expanding the role of efficiency measures to make the most of the energy we already have and smooth the transition to a low-carbon future;
- growing our energy supply by creating opportunities for independent power producers, including Indigenous communities, to develop new sources of supply such as wind farms; and
- recognizing future decisions about energy will be complex and will need to consider factors beyond reliability and cost, including climate goals, economic opportunities and affordability.

I want to take this opportunity to thank all those who participated in the development of the 2023 IRP. The value of your contribution to this plan and our collective efforts to prepare for the future cannot be overstated. I look forward to continued conversations and further collaboration as we work to implement the road map, evolve our integrated resource planning process, and ensure a continuance of the reliable and low-cost energy you count on.

Jay Grewal, President & CEO
Manitoba Hydro

EXECUTIVE SUMMARY

INTRODUCTION

PURPOSE OF THE 2023 INTEGRATED RESOURCE PLAN

The energy transition is underway in Manitoba. How energy is produced, delivered and consumed is changing. Preparing for this change is a challenge utilities around the world are facing. As we move towards a cleaner energy future, technology, customer decisions and government actions are driving the pace of this change and impacting how Manitoba Hydro supplies and delivers electricity and natural gas.

Investments over the past 100 years to build out Manitoba's generation, transmission, and distribution system have resulted in a reliable, low-cost electricity supply. The rates Manitobans pay for electricity today are among the lowest in North America. However, Manitoba Hydro's energy and capacity resources are limited. The energy transition will increase demand for capacity in the electricity system, consuming the current surplus and driving the need for investments in new resources that will put upward pressure on costs. The pace of the transition will determine how quickly this happens, but new resources could be needed in the next 10 years.

Manitoba Hydro's 2023 Integrated Resource Plan (IRP) serves as a foundation for understanding the impacts of the energy transition and identifies actions needed to prepare for that change to ensure we continue to meet our customers' needs for reliable, low-cost energy and fulfill our legislated mandate. That mandate is: "…to provide for the continuance of a supply of power adequate for the needs of the province, and to engage in and to promote economy and efficiency in the development, generation, transmission, distribution and end-use of power."

MANITOBA HYDRO'S ELECTRICITY AND NATURAL GAS SYSTEMS

On average, over 97 percent of the electricity Manitoba Hydro supplies our customers is clean and non-emitting. Any surplus electricity not needed in Manitoba is sold on the export market, helping neighbouring jurisdictions reduce their carbon emissions. We also supply customers in southern Manitoba with reliable natural gas that not only helps heat their homes in the winter but also is an input to many industrial processes. As a vertically integrated utility that supplies and delivers these two energy sources, we are well positioned to study how shifts in energy use will impact these systems and identify solutions that will keep energy rates as low as possible

MANITOBA HYDRO'S FIRST IRP

While there is a long history of energy planning at Manitoba Hydro, this was Manitoba Hydro's first IRP. The 2023 IRP advanced our planning process significantly. It considered electric generation, transmission, and distribution as well as natural gas as an integrated system. It also established a process that is structured and repeatable. Our focus was to understand the energy transition, including the changing needs of our customers, and identify the first steps needed to prepare for future decisions that will impact energy supply and delivery in Manitoba.

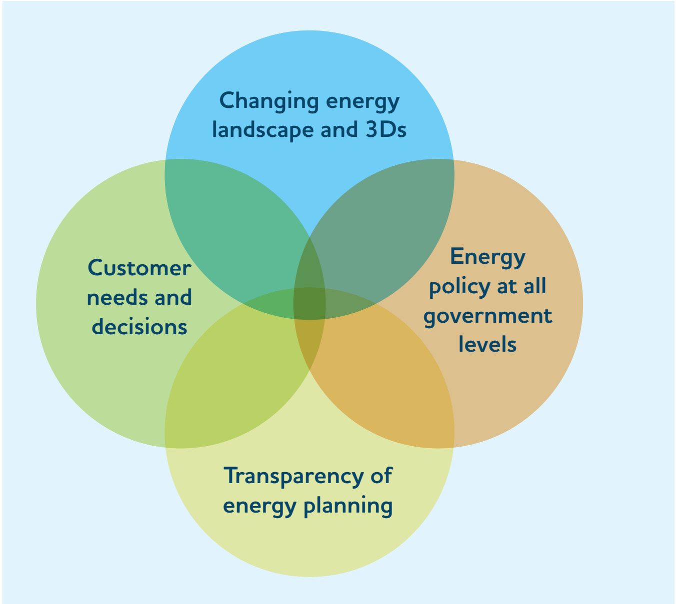


Figure ES-1 – Considerations for the 2023 IRP

With the 2023 IRP, we evolved our energy planning to include engagement with customers and interested parties to provide transparency in energy planning and develop a clearer understanding of our customers' needs and decisions. Throughout the process, engagement was aligned to key IRP milestones to ensure continuous and ongoing feedback. We also considered how existing and potential government policies at all levels are impacting the energy transition. Our goal was to be technology-neutral, so the 2023 IRP studied a variety of utility scale resources, non-Manitoba Hydro owned assets, behind-the-meter options, as well as Efficiency Manitoba programming.

IRP DEVELOPMENT & ENGAGEMENT PROCESS

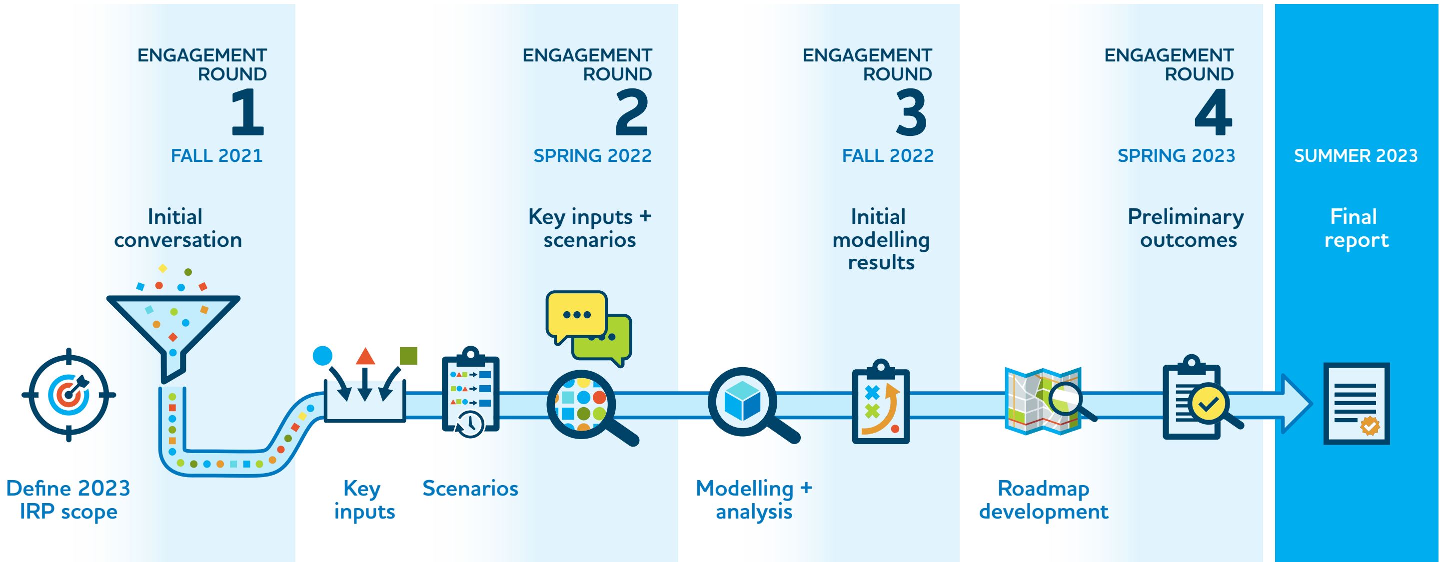
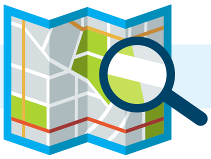


Figure ES-2 – 2023 IRP development and engagement processes

Since there are several ways the future may unfold, the outcomes of the 2023 IRP process allow for multiple approaches to respond to a broad range of futures. Rather than a specific development plan, the result is a road map that outlines steps to be taken now to help prepare to meet our customers' energy needs for the next 20 years and beyond.



2023 IRP ROAD MAP

The 2023 IRP road map is a representation of outcomes from more than two years of work. It is a planning tool to help us successfully navigate the energy transition.

LEARNINGS:
Knowledge gained from the process.

NEAR-TERM ACTIONS:
Actions over the next five years.

SIGNPOSTS:
Policy, market, technology, and customer trends and events.

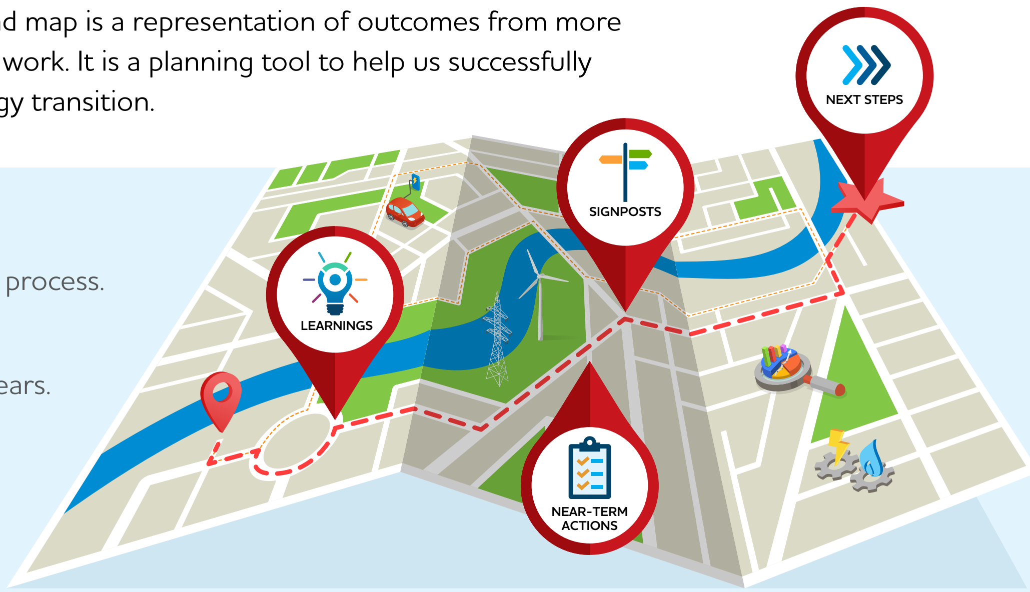


Figure ES-3 – 2023 IRP road map

The road map consists of six learnings, which are rooted in the results of the IRP work. They summarize key insights gained throughout the process from customer input and feedback, engagement, modelling and analysis, and understanding government policy. The learnings form the basis for five near-term actions, each with multiple sub-actions that identify the potential steps over the next five years to prepare for the energy transition. Four signposts are also identified for monitoring how the energy landscape is actually changing so we can understand if we need to adjust any near-term actions as we move forward.

2023 IRP LEARNINGS

The six 2023 IRP learnings are specific to this IRP and are likely to evolve with future IRPs.

We learned through this IRP that the energy transition is underway in Manitoba. Some customers are already making decisions to switch their current energy sources. The pace of change for this transition is uncertain. Managing the energy transition will be critical to ensuring Manitoba Hydro can continue to provide safe, reliable, and low-cost energy. The analysis of a broad range of future scenarios helped with understanding the potentially wide range of energy supply and delivery costs, greenhouse gas (GHG) emissions, resource mixes, and dates when new resources will be needed. Energy planning must continue to monitor and evaluate a broad range of scenarios, including pathways to net-zero GHG emissions. Energy policy will be a major influence on the pace of decarbonization and is an important tool to manage the energy transition. There is an opportunity to manage this transition to the benefit of all Manitobans and governments, Crown corporations, regulators, interested parties, and customers all have an important role to play.

LEARNINGS

1. The energy transition is underway in Manitoba.
2. Managing the energy transition will be critical to continue safe, reliable, and low-cost energy.
3. Investment is required in all scenarios.
4. Strategic use of natural gas assets and gaseous fuels are an integral part of the energy transition in Manitoba.
5. Analysis findings common to all scenarios can inform responses to an accelerated energy transition.
6. Future energy-related decisions will require complex considerations.

Figure ES-4 – 2023 IRP learnings

We learned that significant investment will be needed to support the energy transition, particularly as demand increases due to space heating and transportation electrification, and new resources could be needed within the next 10 years. While existing electricity surplus is currently sold in the export market, the 2023 IRP assumes firm export contracts expiring during the study period are not renewed and this electricity is redirected to meet Manitoba's needs. Increasing winter peak demand in all future IRP scenarios – up to two and a half times current demand – signals the need for new generation resources and the associated transmission and distribution infrastructure to deliver electricity to where it is needed. These investments will increase costs. The choices made on the technology and strategies to serve and shape this demand will have significant impact on the cost and when new resources are needed. These decisions also become more complex as the energy transition occurs.

Firm export contracts are electricity sales that Manitoba Hydro is committed to fulfil at all times, similar to domestic needs. **Short-term opportunity sales**, based on water conditions and demand in the province, are expected to continue.

We also learned that some of the need for new investments could be mitigated through the strategic use of natural gas assets and fuels, while still enabling overall reductions in Manitoba's GHG emissions. For example, strategies such as using dispatchable thermal generation fueled by natural gas to support variable resources like wind, can be a low-cost way to support the electrification of transportation, resulting in a net decrease in overall emissions. In comparison, a future with more stringent restrictions on emissions from electricity generation, has a significant increase in costs and only marginal further reduction in overall emissions.

Modelling and analysis results demonstrate that as decarbonization efforts accelerate, so does the need to invest. Net present values over 20 years for the scenario and sensitivity results range from approximately $12 billion to nearly $27 billion, which is in addition to investments needed to maintain existing infrastructure. The impact to our customers' total energy costs from all sources, such as electricity, natural gas, and refined petroleum products requires further analysis.

The electrification of space heating would have a significant impact on winter peak demand, so strategies such as using dual fuel space heating systems could be a cost-effective way to meet peak demand by avoiding and potentially delaying some of the investment in new electricity resources.

There are also common observations across a range of modelling results that point to where some of the near-term future decisions can be made, particularly for an accelerated energy transition. In 20 years, most of our energy will still come from the electricity and natural gas assets that are in service today, so we must continue to invest in improving and maintaining them. Expanded or additional energy efficiency measures will also play a role in managing energy needs, with our modelling and analysis indicating that actions reducing electrical peak demand are most valuable. New resources will be required, with the IRP results indicating that wind is a cost-effective source for electricity, so long as there are also dispatchable capacity resources to complement its variability. Other resources, such as solar, were noticeably not selected in the analysis, while new hydropower was only selected in sensitivity analysis with significant load growth and significant restrictions on natural gas use.

The final learning is that future decisions around energy resources are complex and will involve factors beyond the reliability and low-cost objectives considered in this IRP. Further work is required to understand how to balance these additional factors – such as environment, climate, economic, and social considerations – when making energy resource decisions to best meet the needs of all Manitobans.

2023 IRP NEAR-TERM ACTIONS

To prepare for the future, the IRP identified five near-term actions. These actions are comprehensive and encompass the ongoing energy planning to prepare for a range of potential futures. Each action identifies multiple sub-actions with specific work to be completed over the next five years. Further work to detail the specific scope of each sub-action and prioritization of the sub-actions will be required as part of implementing the 2023 IRP road map. Knowing that new resources and significant new investment may be needed in the next 10 years, there is an urgency associated with some of the sub-actions in order to prepare for and manage the energy transition.

NEAR-TERM ACTIONS

1. Actively manage increasing winter peak load.
2. Pursue near-term options to be ready for potential rapid demand growth.
3. Develop options to reduce carbon content in natural gas.
4. Enhance integrated resource planning to address evolving needs.
5. Continue planning to meet the challenges of deep decarbonization.

Figure ES-5 – 2023 IRP near-term actions

The first near-term action addresses the potential challenges of increased winter peak load and emphasizes the importance of proactive management of peak electrical demand to ensure the continued provision of reliable and low-cost energy to our customers. Further exploration of the potential of dual fuel systems for space heating, particularly the feasibility of this technology in Manitoba, is a key focus. Another focus is collaboration with Efficiency Manitoba to pursue high value energy efficiency measures that maximize energy savings during peak demand times. We also want to better understand the value of demand response programs and potential rate design options that could reduce peak demand

The second near-term action positions Manitoba to be ready for rapid growth in electricity demand. This includes pursuing cost-effective opportunities to enhance supply from our existing hydropower stations and taking steps to reduce lead times for new resources. Work will begin to identify a range of resource development plans to meet customers' future needs, and more detailed analysis will be done for high potential resources identified in this IRP, like wind and dispatchable capacity resources. Strategies will be developed to modernize and expand the grid to enhance current operations and support future customer peak demand growth.

The third action is to develop options to leverage existing natural gas assets by using low carbon alternative fuels such as renewable natural gas (RNG) and hydrogen. Learning about blending these gases into the existing natural gas system is part of this action.

The fourth action to enhance our integrated resource planning acknowledges the uncertainty in the pace and direction of change and the value of ongoing conversations to prepare for a more complex energy future. Conversations will continue with the energy planning community to further develop and integrate engagement into the IRP process. There is also an opportunity for Manitoba, Manitoba Hydro, Efficiency Manitoba, and the Public Utilities Board, to align and work together in the best interests of Manitobans. We will also enhance our planning by developing a framework to evaluate total energy-related costs, studying the evolving role of energy markets and interconnections, and advancing detailed planning to reflect regional variations across Manitoba.

The fifth near-term action focuses on the work Manitoba Hydro needs to do now to address the challenges of deep decarbonization and be ready for significant changes in electricity and natural gas use. This includes understanding the impacts of integrating large amounts of variable renewable resources like wind into the electricity system, assessing potential hydrogen supply and direct-use, and continuing our investigation of longer-term energy storage. It also calls for further work to understand the role of technologies in earlier stages of development, such as carbon capture and storage and small modular reactors, and their potential feasibility in Manitoba.

As the energy landscape continues to change, our energy planning will adapt, and these actions will be prioritized accordingly.

2023 IRP SIGNPOSTS

The 2023 IRP road map includes four signposts serving as indicators of changes in the energy landscape in Manitoba. The four signposts are government actions, customer decisions, zero emission vehicles (ZEVs), and technologies and markets. Monitoring these signposts will inform decision-making and allow for timely adjustments to the road map. It will enable Manitoba Hydro to navigate the evolving energy landscape, prioritize actions, and help ensure we can continue to supply the electricity and natural gas customers need well into the future. These signposts will be further developed as the road map is implemented.

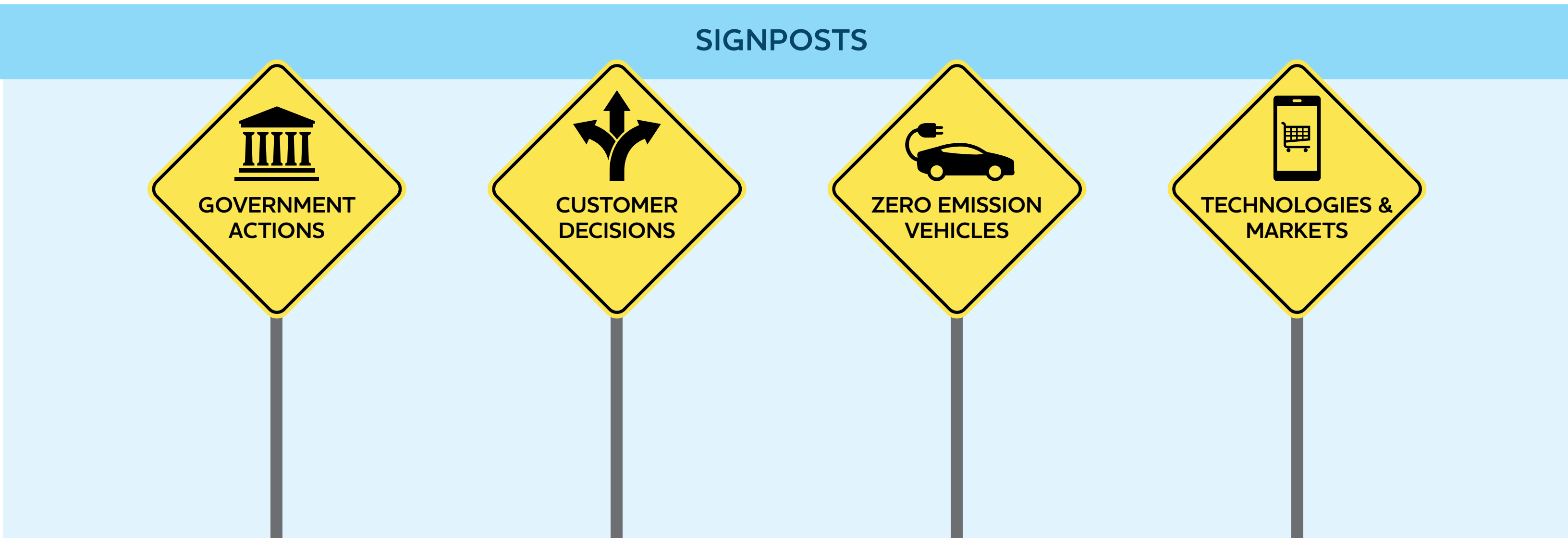


Figure ES-6 – 2023 IRP signposts

The government actions signpost encompasses actions taken – such as providing incentives or establishing regulations – by federal, provincial, and municipal governments, as well as regulators and international bodies. These actions can influence the supply, demand, or price of energy, including the pace and scale of decarbonization and customers' energy-related decisions.

Monitoring and anticipating customer decisions is vital to planning for the supply and delivery of electricity and natural gas to meet customers' needs. Different types of customers will consider and weigh factors like upfront capital and operating costs, climate change mitigation and adaptation, resiliency, and other factors differently in their energy-related decisions. Monitoring and understanding the factors behind those decisions can help Manitoba Hydro prepare to continue meeting our customers' changing needs.

The ZEVs signpost focuses on the factors influencing the adoption of ZEVs like charging or fueling availability, driving range, upfront costs, total cost of ownership, and availability of vehicles. Monitoring these factors provides insights into the related changes in energy use, including changes in the type of energy used, the pace of the change, and when and where the change is occurring.

The technologies and markets signpost includes: the technologies used to produce, deliver, or store energy; the production and supply of renewable fuels; and, changes in wholesale markets and energy price forecasts. This signpost will ensure that energy planning reflects current information on emerging technologies and market dynamics.

CONCLUSION

The 2023 IRP road map outlines the first steps that we need to take to prepare for the energy transition. Implementing the road map will start immediately, first by developing specific plans and schedules for the near-term actions and monitoring the signposts. We are committed to transparency in this process and will communicate the progress of near-term actions, monitoring of signposts, and outcomes from any new analysis required when material changes occur in the energy landscape. The exact timing of these communications will be determined with consideration to the pace of change.

While there is still much uncertainty in what the future will be, or how fast change will happen, the work done through this first IRP has established a foundation, a repeatable process, Manitoba Hydro can use to plan for that change. We will continue to evolve our IRP development process to ensure it is aligned with the changing energy landscape. And, we will continue to further develop our engagement and build the energy planning community so we can work together to manage the energy transition for the benefit of all Manitobans.

1

INTRODUCTION

Energy use around the world is changing. It's visible in the choices consumers are making, in the innovative use of technology to supply and deliver energy and in the actions governments are taking or contemplating. Manitoba Hydro's Integrated Resource Plan (IRP) is a process for studying these changes and what they mean for the supply and delivery of electricity and natural gas in Manitoba. The goal of this process is to enhance our understanding of how the future may unfold and identify the steps we need to take to continue meeting our customers' needs for the next 20 years and beyond.

The 2023 IRP is not a specific development plan. Rather, it is a road map that will help us to successfully navigate the changing energy landscape.

This road map includes three main components:

- **Learnings** – the knowledge we've gained from the IRP process;
- **Near-term actions** – the actions to be taken over the next five years;
- **Signposts** – the changes in the energy landscape we will continue to monitor moving forward, including policy, market, technology, and customer trends, so we can adapt the plan if needed.

Collectively, the road map will guide how Manitoba Hydro monitors, prepares for and responds to the changing energy landscape.

LEARNINGS:
Knowledge gained from the process.

NEAR-TERM ACTIONS:
Actions over the next five years.

SIGNPOSTS:
Policy, market, technology, and customer trends and events

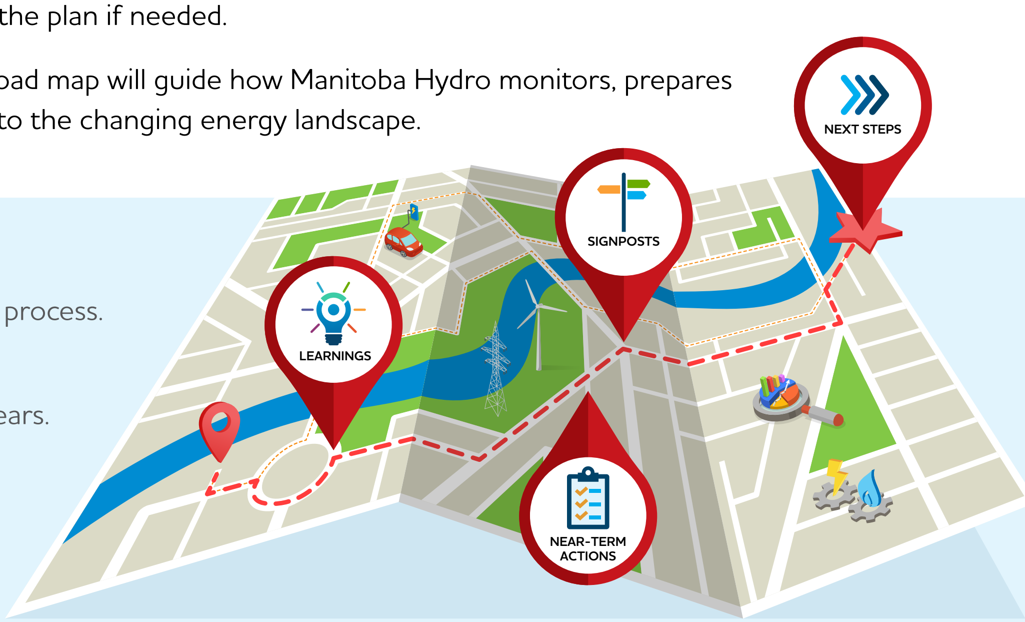


Figure 1.1 – 2023 IRP road map components

Manitoba Hydro's mandate to provide safe, reliable energy services at a fair price was fundamental to the technical analysis that informed development of this road map. The technical analysis solved for lowest cost options to meet potential future needs, assuming current levels of safety and reliability would not change. The results presented in this report are directional in nature and not structured to support specific resource investment decisions. As the need for potential future resources becomes more clear, future analysis will inform any specific resource decisions.

This 2023 IRP report summarizes work completed over more than 24 months, from the initial stages of planning what to study, through to outlining the path forward. Engagement with customers and interested parties was an important part of this work. The report walks through the IRP development process and notes where engagement feedback was used. It is intended as a high-level summary of the work, with only data and discussion most relevant to supporting the details of the 2023 IRP road map included.

Full technical details are included in the appendices, including a summary of the IRP engagement. A standalone engagement report will be published in Fall 2023 with full details of our engagement activities and feedback shared with Manitoba Hydro, and it will further describe how that feedback was incorporated into the 2023 IRP.

2

MANITOBA HYDRO OVERVIEW

Manitoba Hydro is a provincial Crown corporation providing reliable electricity and natural gas – energy that powers our province and supports economic growth. As outlined in the *Manitoba Hydro Act*, Manitoba Hydro is governed through the Manitoba Hydro-Electric Board, whose members are appointed by the Government of Manitoba.

Our mission is to help all Manitobans efficiently navigate the evolving energy landscape, leveraging their clean energy advantage, while ensuring safe, clean, reliable energy at the lowest possible cost. As one of the largest integrated electricity and natural gas utilities in Canada, we are uniquely positioned for the combined study of natural gas and electricity solutions to prepare for the energy transition and help build a better future for all Manitobans. While other jurisdictions may be planning for decarbonization of existing electric assets, our past investments in clean, renewable electricity, interconnections to other energy markets, and natural gas distribution create a solid foundation from which to start.

2.1. WHO WE SERVE

Manitoba Hydro serves over 608,000 customers across the province with electricity and over 293,000 customers in southern Manitoba with natural gas. We also trade electricity within wholesale markets in the Midwestern United States and Canada. Exports of electricity provide revenue that keeps rates in Manitoba lower than they would be otherwise while also displacing greenhouse gas (GHG) emissions in jurisdictions where fossil fuels are a primary source for generation.

2.2. OUR COMMITMENT TO INDIGENOUS RELATIONS

As a predominantly hydroelectric utility, our past and our future are inextricably intertwined with Indigenous communities who have a strong connection to the waters and the lands that support our existing operations. Our relationships with Indigenous communities will continue to be of great importance no matter how Manitoba's energy future unfolds.

We acknowledge the impacts of our existing projects and operations and are committed to working collaboratively to strengthen and improve our relationships with Indigenous communities. We support the advancement of reconciliation in Manitoba, and we will work to contribute to reconciliation efforts in our interactions with Indigenous peoples and communities.

3

WHY DO AN IRP?

Worldwide the energy sector is experiencing unprecedented change driven by forces including decarbonization, digitalization, and decentralization. These forces are reshaping the energy landscape from how energy is produced and delivered to how energy is used. We see this change in Manitoba as more people choose to drive electric vehicles, and some businesses choose to decarbonize the energy they use to meet environmental, social, and governance goals. What is uncertain is the timing, pace, and scale of these changes, in particular with the less apparent changes due to decentralization and digitalization. Strategy 2040 is Manitoba Hydro's strategic direction to respond to this changing energy landscape and the uncertainty it brings. As an initiative to better understand the changing energy landscape and the steps we may need to take to continue to meet the energy needs of our customers in the future, development of an IRP is directly tied to Strategy 2040.

DECARBONIZATION is the act of moving away from energy that produces carbon dioxide and other greenhouse gases. The pace of decarbonization is accelerating worldwide to address the impacts of climate change.

DIGITALIZATION is advancement in technology that is changing customer preferences and expectations of how they interact with their energy provider. New technologies offer creative solutions to delay the need to build new infrastructure.

DECENTRALIZATION is the increase of options for energy beyond those offered by utilities, many of which still rely on the power grid to allow two-way flow of electricity. Shifting to two-way flow of energy means utilities need to reconsider how costs are fairly recovered from customers.

3.1. GOVERNMENTS ARE CHANGING THEIR POLICIES AROUND ENERGY

Actions by governments at all levels – federal, provincial, and municipal – are already shaping the changing energy landscape. In Canada, the federal government is working on strategies to address climate change and transition to a cleaner economy. Actions taken include tabling plans to meet legislated greenhouse (GHG) emission targets, pricing GHG emissions, and regulating emission reductions from liquid fossil fuels. The federal government is also providing funding for energy efficiency retrofits, industrial fuel switching, clean fuel production, and clean technologies like zero emission vehicles (ZEVs) and charging and fueling stations. This growth in funding has been and is expected to continue influencing customer energy choices and may impact the cost of various supply and delivery options.

Zero emission vehicles (ZEVs) include battery electric, plug-in hybrid electric, and hydrogen fuel cell vehicles. The 2023 IRP analysis focuses on the impact of electric vehicles.

More actions are expected including:

- regulating lower emissions from electricity generation;
- requiring the sale of more ZEVs;
- introducing a Green Buildings Strategy to reduce emissions from buildings; and,
- reducing methane emissions from the oil and gas sector.

Recently, a Canada Electricity Advisory Council was appointed to advise on actions needed in the electricity sector to support the government's net-zero goals. These current and planned actions will impact the supply and demand for electricity and natural gas.

Provincial and local governments are also changing the energy landscape through their actions, including introducing measures to attract economic development. The Manitoba Government is moving forward with several initiatives, such as the Efficient Trucking Program, updating building codes, and providing financial support for projects that address climate change. Some communities are also moving to address climate change, planning actions to support switching to electricity for heating in buildings and for transportation, and considering if natural gas should be a future option in new buildings. In contrast, other municipalities are seeking expansion of the natural gas system to their communities to attract economic development and to displace the use of other, more expensive fossil fuels such as propane.

Governments around the world are also making decisions that change the energy landscape. In the United States (U.S.), significant federal funding is expected to bolster a switch to electric air-source heat pumps for heating, the adoption of electric vehicles and availability of charging. This funding will also support the buildout of non-emitting electricity resources and the transmission infrastructure needed to connect them to the grid. States like Minnesota are also taking actions to reduce emissions from electricity and other sectors to achieve their net-zero targets.

Net-Zero means emitting no greenhouse gas emissions or offsetting emissions through actions such as tree planting or using technologies that can capture and store carbon, so it is not released into the air.

All of these government actions, shaping how energy will be supplied and used in the future, are expected to change the electricity generation mix within the midwestern U.S. and Canada and how the customers of other utilities use electricity. A transition to more electric heating, for example, may mean some utilities in the Midcontinent Independent System Operator (MISO) market, where Manitoba Hydro buys and sells electricity, will see their greatest need for electricity shift to the winter season. Subsidies encouraging more solar and wind generation in the U.S. may create surpluses in energy and lower the average market prices for electricity. These kinds of changes in the market would impact Manitoba Hydro, affecting the price we receive for exported electricity or pay for imported electricity.

Manitoba Hydro buys and sells electricity in the MISO market through contracts with other utilities and through short-term sales.

See the "**Existing role of interconnections and energy markets"** section of this report for more details of how Manitoba Hydro interacts in the MISO market.

Government actions related to the supply and use of natural gas are also expected to have a significant impact on Manitoba Hydro's systems, particularly if they drive electrification of space heating and industrial processes.

For further information on specific government actions, including policies and funding, and discussion of how they are shaping the evolving energy landscape, please read **Appendix 6: Policy landscape**.

4

THE IRP DEVELOPMENT PROCESS

Developing an IRP is a common practice for utilities across North America and each utility's approach reflects a unique combination of customer needs, service territory, the energy products offered to customers, existing assets and policy drivers. The process for developing Manitoba Hydro's 2023 IRP included an assessment of the changing energy landscape in this province, with insights gained through engagement with customers and interested parties, and sought to identify the first steps needed to prepare for future decisions that will impact energy supply and delivery in Manitoba.

Interested parties are any individual or group with a demonstrated interest in participating in the development of the 2023 IRP. This can include customers, advocacy groups, governments at all levels, business associations, Indigenous peoples and communities, and others.

Further details on engagement are included throughout this document, as well as in **Appendix 7: Summary of engagement process.**

As there are several ways the future may unfold, the outcomes of our IRP process allow for multiple approaches to respond to a broad range of futures. This process considered all energy supply and grid delivery infrastructure, including natural gas and electricity generation, transmission, and distribution in addition to, non-Manitoba Hydro owned assets or any investment that can defer construction or upgrades on the system – so-called non-wires solutions, such as Efficiency Manitoba programming. Other factors like government policy, standards, and mandates that may affect energy and other policies on climate, energy, economic development, and environment were also considered.

Non-wires solutions, also known as non-wires alternatives, are investments or solutions that can eliminate or defer a need to construct new components of generation, transmission, or distribution systems. Examples can include efficiency measures, demand response, and rate design.

The 2023 IRP is Manitoba Hydro's first and it won't be the last. Developing an IRP is not a one-time event and many utilities publish new or updated plans on a recurring basis. The time between published IRPs is different for each utility, based on its unique needs. While we have not yet determined the frequency of future plans, they will build on the foundation established by the 2023 IRP, evolving the development process, including how engagement informs the plan, with each iteration.

4.1. OBJECTIVES, SCOPE, AND DELIVERABLES

The primary objective of the 2023 IRP is to plan for safe, reliable energy that meets the evolving needs of Manitobans at the lowest cost possible, per our mandate as defined in the *Manitoba Hydro Act*. We sought to understand the impacts of the changing energy landscape in Manitoba and identify a way forward to prepare for the future. Providing transparency of the energy planning process and including customer and interested parties' feedback was key to achieving this objective.

Also important was completion of the broad analysis needed to understand potential futures and how they may impact electricity and natural gas supply and delivery across the province. This broad analysis did not seek the details needed to support a recommended development or construction plan. Rather, this IRP aimed to understand the energy landscape, the potential future, and the numerous options that may be available to meet future needs. Analysis was used to understand the relative differences between various futures or strategies and develop a directional road map for navigating the energy transition. Given the road map is forward looking, the 2023 IRP does not include analysis of current or past operations, projects, practices, and decisions.

Similarly, the 2023 IRP does not include specific community or regional needs and solutions, but rather takes the approach of identifying a broad range of options, some of which may be of particular interest to a region. In the future, IRP analysis may consider regional specific solutions, through more specialized, focused planning in order to understand specific energy needs and circumstances in support of regionally specific solutions.

The 2023 IRP took a pragmatic approach to considering potential solutions, recognizing the established benefits of conventional resource technologies, for example, while also considering the potential of evolving and new resource options. Building new interconnections with other power systems as resource options for importing electricity in place of building other generating resources to meet demand was not part of this IRP's scope. The 2023 IRP assumes that all existing import and export contracts are not renewed once they expire; however, future opportunities to export and import using existing interconnections are considered.

A study period of 20 years was set for the 2023 IRP, starting in 2022 and ending in 2042. With uncertainty in the energy landscape increasing as one looks further into the future, a 20 year analysis was chosen to provide sufficient long-term direction, while maintaining focus on a time period with a greater level of certainty than that beyond 20 years. The 2023 IRP scope did not include solving for net-zero GHG emissions; however, significant analysis regarding the emissions impact of different futures and strategies was incorporated.

4.2. A STRUCTURED, REPEATABLE PROCESS

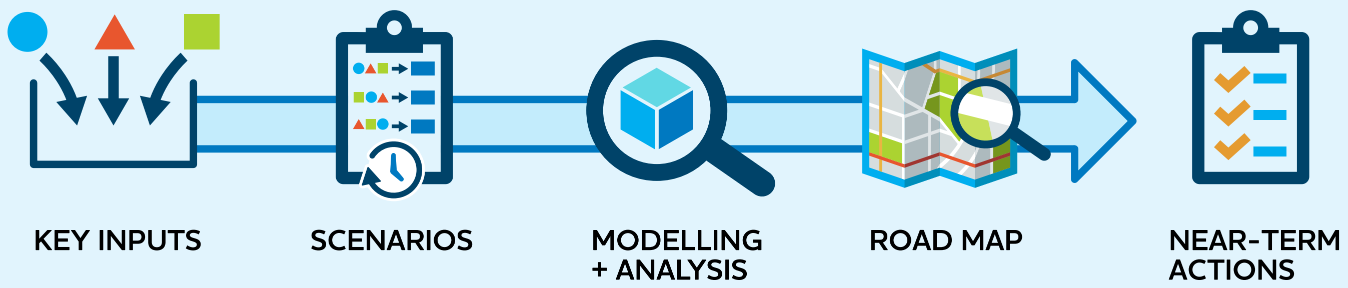


Figure 4.1 – IRP development process

The IRP development process was structured and designed to be repeatable. It began with defining the key inputs for the analysis. This context helped frame the development of scenarios. The scenarios formed the basis for modelling and analysis of the electric and natural gas energy demand over time and potential supply alternatives and infrastructure impacts.

Using outcomes from the modelling and analysis, a road map for a number of potential futures was developed, which identifies near-term actions required to assess options in more detail and the additional studies needed to support potential future decisions.

Key inputs are those inputs to the analysis with the most uncertainty and potential to significantly impact future energy needs in Manitoba. Key inputs help frame the future energy landscape and the development of scenarios. They are not an exhaustive list of all inputs and assumptions used in the modelling and analysis.

A **scenario** represents a specific energy future using a combination of key inputs. The range of scenarios in the 2023 IRP reflects a reasonable range of the potential energy futures considered.

A **road map** helps define where we may need to go, describes a number of ways we could get there and identifies signposts which may indicate a need to change direction as the future unfolds. It prepares us to respond to what may happen in the next 20 years and identifies near-term actions.

Near-term actions identify the immediate next steps required in the next five years to help interpret results, develop a more detailed understanding of potential strategies, define the steps for informing potential major infrastructure investment decisions, and prepare for the next IRP. These are the actions needed now to prepare for the longer-term future.

4.3. INFORMED BY ENGAGEMENT

Engagement was foundational to the development of the 2023 IRP. To ensure continuous and ongoing engagement during the IRP Development Process, each round of engagement was aligned to key IRP milestones as shown in Figure 4.1 above. The diverse perspectives provided by participants in the engagement helped us better understand the Manitoba context and helped inform the plan. Appendix 7 includes a summary of the engagement process for the 2023 IRP. The results of the process and how they informed this IRP are described in this document. A separate, comprehensive report on engagement for the 2023 IRP will be published providing further details on the engagement objectives, process, and outcomes.

4.3.1. ENGAGEMENT OBJECTIVES FOR THE 2023 IRP

- Inform the 2023 IRP with the needs and perspectives of Manitoba customers and interested parties.
- Initiate a dialogue with these groups on the evolving energy landscape and drivers relevant to Manitoba and Manitoba Hydro and foster a shared understanding of diverse perspectives related to energy planning in Manitoba.
- Add openness and transparency to the energy planning process.
- Ensure the engagement process is meaningful and accessible.

More detailed information on participants can be found in
Appendix 7: Summary of engagement process.

4.3.2. ROUNDS OF ENGAGEMENT

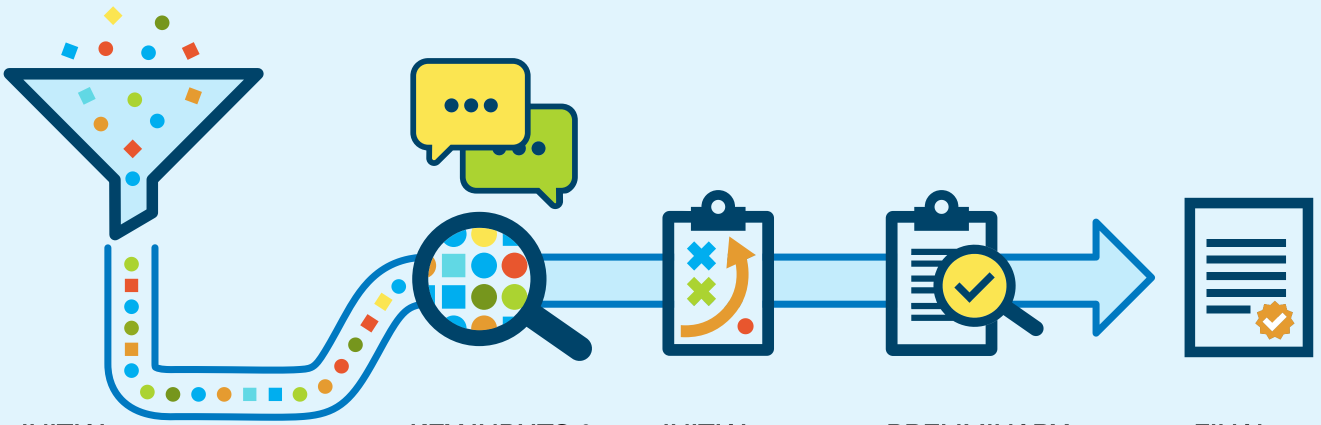


Figure 4.2 – IRP rounds of engagement

ROUND 1
Initial conversation

Sought to start the conversation and understand what customers value and any future energy decisions they may be contemplating.

ROUND 2
Key inputs & scenarios

Provided information on the IRP development process and asked for feedback on the key inputs and scenarios. Invited large customers to share perspectives and insights on future planning and decision making that should be considered in the 2023 IRP.

ROUND 3
Initial modelling results

Described the modelling process and presented initial modelling results. Asked for feedback on additional modelling and analysis that should be considered within the 2023 IRP.

ROUND 4
Preliminary outcomes

Shared completed modelling and analysis results and identified how additional analysis informed the IRP road map. Presented the draft road map including learnings, near-term actions, and signposts. Sought feedback on what near-term actions were most important and what signposts would have most influence.

What feedback was shared and how was it used to inform the 2023 IRP?

Look for this icon throughout the 2023 IRP report to see how engagement feedback informed each step of the development process. For more details see the full **2023 IRP Engagement Report**.

4.3.3. ENGAGEMENT OPPORTUNITIES

Dedicated project website

27,616
visits

All publicly available information shared during each round of engagement was hosted on Manitoba Hydro's website at (www.hydro.mb.ca/corporate/planning). This included: recorded video presentations; documents summarizing key information; and, "What We Heard" documents summarizing engagement feedback and how it was incorporated into the 2023 IRP. The web content also invited people to subscribe to our IRP mailing list. Between November 2021 and May 2023 the IRP webpages received nearly 28,000 unique visitors.

Subscriber mailing list

4,927
subscribers

Starting with the first round survey and throughout the IRP development process, customers and interested parties were invited to sign up to receive email IRP updates. In all, nearly 5,000 people subscribed and received the same information shared in interested parties workshops, and they could provide feedback through surveys or by directly submitting feedback through a dedicated IRP email address.

Customer survey

14,973
responses

As part of the initial conversation on the 2023 IRP, an online customer survey was widely promoted across Manitoba through bill inserts, direct email invitations, digital, radio, and newspaper advertising, and social media. Available in both French and English, the survey was also provided in paper form on request. Nearly 15,000 Manitobans completed the survey sharing important information about their values, motivations, and plans related to current and future energy use.

Focus groups

21
participants

Focus groups were held with typically underrepresented population segments to gain insights on their plans for energy use and to enhance the diversity of perspectives represented in the 2023 IRP. Round two engagement included three focus groups: two with Manitobans aged 18–25 and one with women ages 26 and up. Each group included three participants that self-identify as Indigenous, as well as three considered low income (less than $75,000 combined household income). In total, 21 people participated in the focus groups.

Interested parties workshops

14
workshops

Engagement in rounds two, three, and four included workshop sessions with select interested parties. These sessions had multiple objectives, including: to share updates on findings from the 2023 IRP development process; to create opportunities for participants to share and learn from each others perspective; to provide information on key components of the development process; and, to seek specific feedback to inform development of the 2023 IRP. Over 120 groups were invited to participate, including non-governmental organizations (NGOs), associations, academia, Indigenous organizations, economic development organizations, public sector institutions, and Efficiency Manitoba. Interested parties invited to participate in these workshops met several criteria, including bringing representative or collective perspectives to the discussion. In total, 14 workshop sessions were conducted constituting approximately 40 hours of engagement.

Customer conversations and targeted surveys

20
participants

Individual conversations and targeted surveys were used to understand the perspectives of individual customers identified to have the greatest potential impact to Manitoba Hydro systems. Twenty large customers were asked for feedback, including large industrial and public sector customers with significant natural gas use, as well as large transportation users and those with fleets that may become large energy users in future. Understanding the major drivers for these customers' specific future energy related decisions not only helps us understand how their decisions may impact the evolving energy landscape, but also helps identify potential impacts to Manitoba Hydro's energy supply and delivery systems.

4.4. ACTIONS TO ENSURE QUALITY

There is extensive expertise in energy planning within Manitoba Hydro accumulated over decades of planning for supply and delivery of electricity and natural gas. Development of the 2023 IRP included considerable collaboration and coordination across Manitoba Hydro to draw on and build upon these existing planning processes and expertise. To ensure quality in the development of the 2023 IRP and alignment with industry best practices, Manitoba Hydro engaged two consultants to provide technical expertise and independent perspectives.

Energy & Environmental Economics (E3) is a consulting firm based in the United States with experience in reviewing and developing IRPs for both electric and natural gas utilities in the U.S. and Canada. E3 was hired by Manitoba Hydro in May 2022 to review the IRP development process, the results of the modelling and evaluation, and to advise on the development of the road map.

Manitoba Hydro also engaged Prairie Research Associates (PRA Inc.) to support the engagement process. PRA is a research firm based in Winnipeg and Ottawa providing client focused research services, including program evaluation. While Manitoba Hydro has internal expertise in public engagement, those resources were required to support other ongoing enterprise initiatives. Having an external party to support engagement with customers, interested parties, and Indigenous groups also provided a neutral intermediary to communicate between parties as needed.

5

WHAT IS OUR CURRENT STATE?

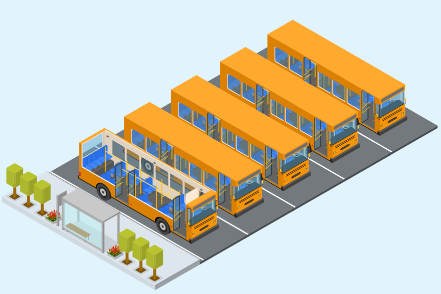
To better understand the steps needed to prepare for the changing energy landscape, we first wanted to establish the current Manitoba context. Existing energy assets and systems, for example, are likely to influence potential options and strategies for the future. Along with the existing energy usage, we examined customer expectations related to energy choices; GHG emissions in Manitoba, particularly those influenced by energy use; and, the influence of current policy. What follows is a description of Manitoba's current energy landscape along with descriptions of the roles of regulators, rates, and energy efficiency.

Before describing the current state, however, it is important to establish that Manitoba Hydro's electricity generation system provides both energy and capacity. Capacity is the maximum amount of electricity that can be made by generators at any particular time, typically measured in megawatts (MW). Energy is the amount of electricity made and used over a period of time, usually measured in megawatt-hours (MWh). Peak demand occurs at the point in time when our customers' requirement for energy is the highest. In Manitoba, this happens in the winter when our customers are heating with electricity.

Manitoba Hydro must consider all three of these things – capacity, energy and peak demand – when planning the electrical system. The system must have capacity to meet peak demand that customers place on it and be able to provide the energy required throughout the day. When peak demand is greater than the system capacity, or energy supply over time is short, we either need to add more generation capacity to the system or reduce demand.

CAPACITY
Maximum generator output (MW)

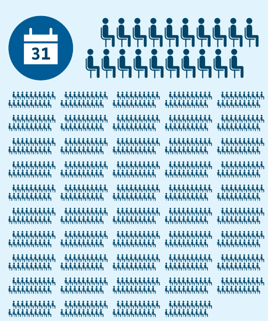
Maximum number of people that can get on the bus at any one time



5 buses with 20 seats = 100 riders

ENERGY
Electricity produced in time period (MWh)

How many people are transported in a day



Riders per day: 1,000 riders

PEAK DEMAND
Greatest hourly electricity use (MW)

The highest number of passengers at a given point in the day

Peak ridership: 75 in morning rush hour

5.1. HOW ENERGY IS CURRENTLY USED

There are many different sources and uses of energy in Manitoba. Manitoba Hydro supplies both electricity and natural gas. Additional energy sources are supplied by other providers through refined petroleum products, like gasoline or diesel. Energy use is typically split into segments based on what it is used for, like residential applications, industrial, commercial uses, and transportation.

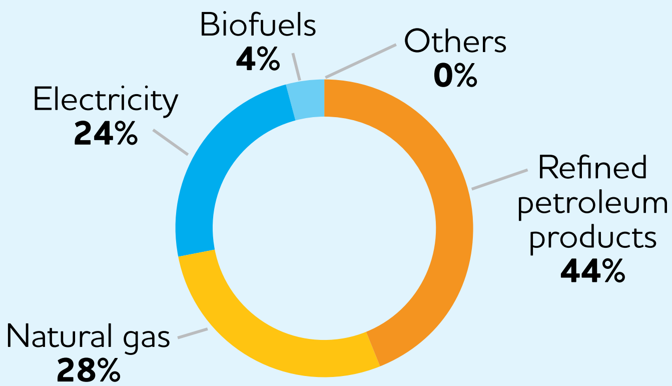


Figure 5.1 – Manitoba end-use energy by source (2019)

Source: Canada Energy Regulator. Canada's Energy Future Data Appendices. https://apps.rec-cer.gc.ca/ftrppndc/dflt.aspx

Manitoba has a significant clean electricity advantage, given 97 percent of electricity supplied in an average year is non-emitting, but electricity only makes up 24 percent of all energy used in the province. The majority of the rest of the energy used in Manitoba is carbon-based – in the form of natural gas and refined petroleum products. A significant amount of energy in the form of natural gas is used to heat buildings because of Manitoba's cold climate in addition to industrial and other purposes. Refined petroleum products are mainly used for transportation.

Decarbonization will influence changes in the end use of these energy sources, including using electricity to replace fossil fuel sources. The changing energy landscape is already driving a transition from gasoline and diesel powered vehicles to ZEVs. Customers already have options to heat their homes with electricity instead of natural gas. Other approaches to decarbonization need to be explored further to understand how they may apply in Manitoba – in particular, how new technologies work in Manitoba's specific climate and their cost.

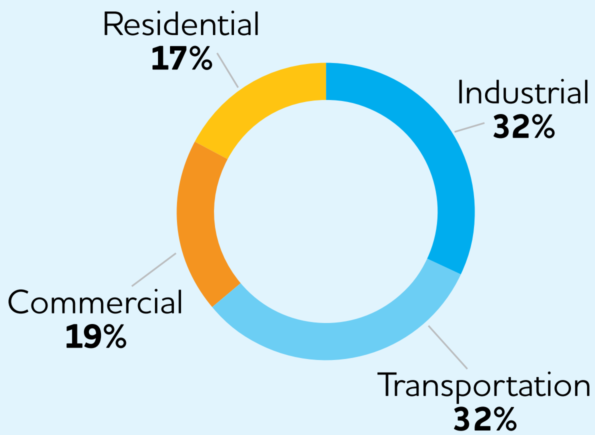
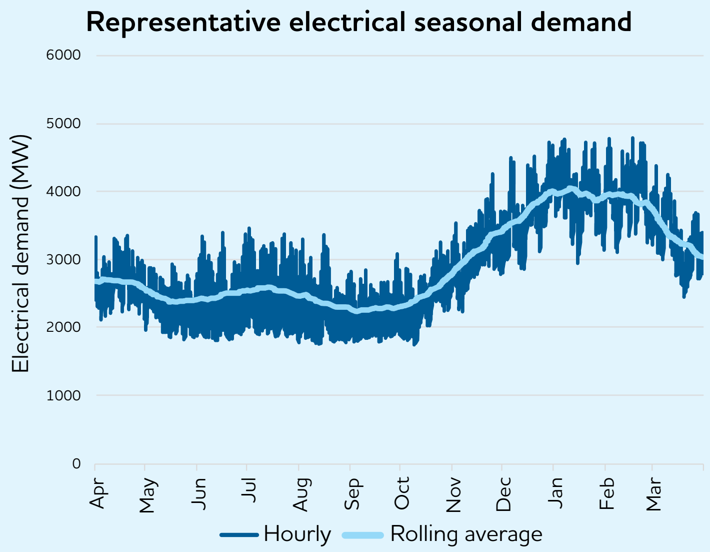


Figure 5.2 – Manitoba energy use by sector (2019)

Source: Canada Energy Regulator. Canada's Energy Future Data Appendices. https://apps.rec-cer.gc.ca/ftrppndc/dflt.aspx

5.2. ELECTRICITY AND NATURAL GAS DEMAND

Demand for electricity and natural gas in Manitoba varies year to year. There are also seasonal demand variations throughout the year, variation between the days of the week, and variation between the hours of the day. Generally, seasonal variation is consistent in Manitoba, with electrical and natural gas peak demand occurring in winter when both energy sources are used to heat homes and businesses. This variation for electricity and natural gas is represented in Figure 5.3.



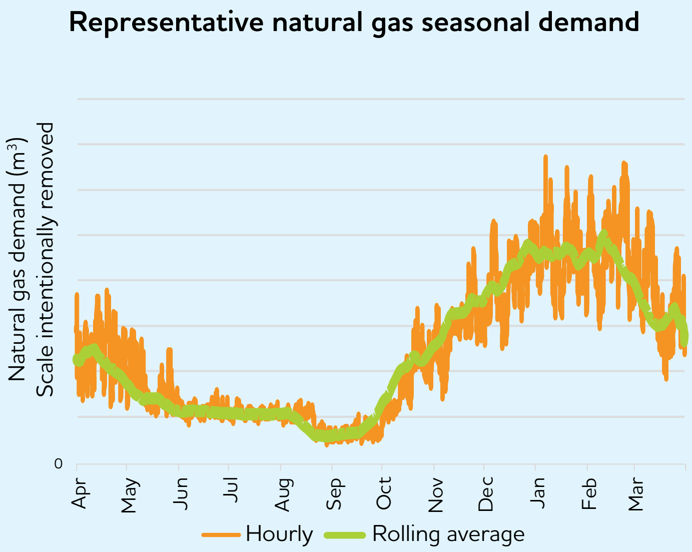


Figure 5.3 – Representative seasonal demand charts for electricity and natural gas

Demand is how much electricity or natural gas is needed at any one point in time.

Peak demand is the highest demand at a single point in time within a certain period, like a season or a year.

5.3. SUPPLY AND DELIVERY SYSTEMS FOR ELECTRICITY AND NATURAL GAS

5.3.1. ELECTRICITY AND NATURAL GAS SUPPLY SYSTEMS

Figure 5.4 – Manitoba Hydro electricity and natural gas supply and distribution schematic

Almost all electricity in Manitoba currently comes from hydropower, with wind generation, imports, thermal generation, and solar generation contributing the rest.

Sixteen hydropower stations across Manitoba with a capacity of 5,768 MW generate approximately 97 percent of our electricity in an average year, with significant capacity installed on the Nelson River located in northern Manitoba.

Another important source of energy and capacity for Manitoba Hydro is imported electricity from other neighbouring jurisdictions. Electricity is also purchased from independent wind and solar producers in Manitoba, as well as excess energy from residential solar installations. Four off-grid communities are served by diesel generators.

Manitoba Hydro also owns and operates one natural gas fueled thermal generating station in Brandon, Manitoba. While it is run infrequently, this is an important resource for the electrical system. The station provides support during times of peak winter demand, outages, and during droughts.

The recently completed Keeyask generating station, a collaborative effort between Manitoba Hydro and four Manitoba First Nations – Tataskweyak Cree Nation and War Lake First Nation (acting as the Cree Nation Partners), York Factory First Nation, and Fox Lake Cree Nation – added an additional 695 MW of capacity to the province's electricity system. This followed the completion of the Wuskwatim generating station a decade earlier. Built in partnership with the Nisichawayasihk Cree Nation, Wuskwatim added 200 MW to the system. A new 500 kilovolt (kV) transmission line interconnection to Minnesota was also recently completed, which added additional import and export capabilities to the electric delivery system.

The current surplus capacity in the electrical system is limited and is only expected to meet Manitoba's future needs until the early 2030s assuming current energy trends and population growth remains the same. With high electric load growth, surplus capacity would be further constrained and new capacity resources may be needed sooner. High electric load growth could result from any number of factors, including rapid economic development or electrification of the economy. Current electricity exports supported by Keeyask end during this timeframe; the 2023 IRP assumes these contracts are not renewed. Any surplus capacity and energy will be required for Manitoba load during this timeframe..

Natural gas supply

Most of the natural gas used in Manitoba comes from Western Canada by a large capacity natural gas pipeline system owned and operated by TransCanada PipeLines Limited (TCPL). The TCPL system is also interconnected with and provides access to the U.S. natural gas market. The variability in Manitoba customer natural gas demand is met through reliable and flexible supply arrangements in the integrated North American gas market. These arrangements include pipeline transportation as well as the use of natural gas storage.

5.3.2. DELIVERY SYSTEMS

Electrical system

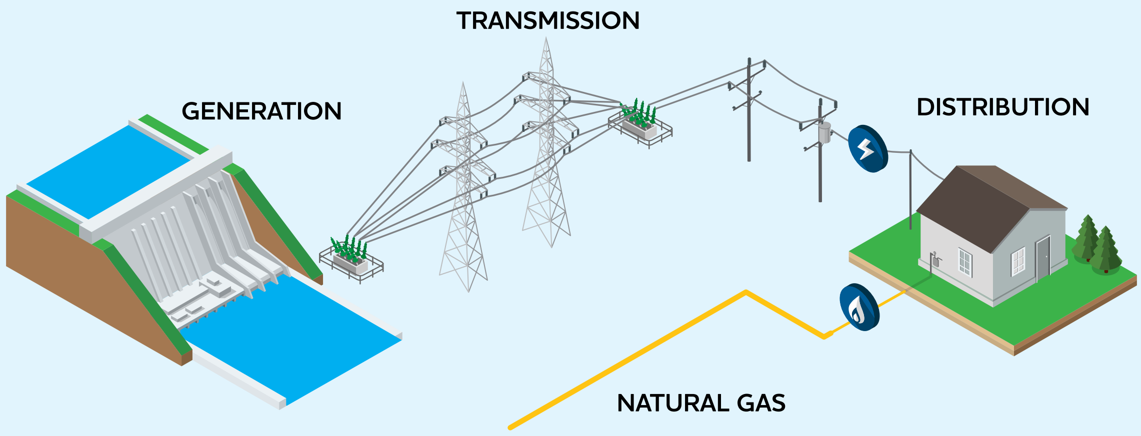
Electricity is delivered throughout the province by both transmission and distribution systems. There are more than 11,000 kilometres (km) of transmission lines in Manitoba and over 75,000 km of distribution lines using over 1.1 million wood poles.

The transmission system is a high voltage network used to deliver electricity long distances, generally from the electrical generators to stations near population centres. Electricity is then reduced in voltage using transformers in the stations and delivered to customers through the distribution system. Some customers using significant amounts of electricity are supplied directly off the transmission system. The transmission system also allows for the exchange of electricity with neighbouring utilities and markets.

Much of Manitoba's electrical distribution system was built during urban and rural electrical expansion that occurred between 1945 to 1960. In many older areas, the system operates at a much lower voltage than more modern systems, and is at or beyond capacity with limited ability to serve significant increases in electric demand. Additionally, most of the current distribution system is not designed for the two-way flow of electricity that might be desired by customers investing in self-generation and would need more sophisticated protection and control upgrades.

Natural gas system

Natural gas in Manitoba is distributed through a system owned by Manitoba Hydro. This system is interconnected with the TCPL pipeline system and consists of over 10,800 km of main pipeline and 7,500 km of service pipeline located across southern Manitoba.



5.3.3. ROLE OF INTERCONNECTIONS AND ENERGY MARKETS

Most of the electricity generated by Manitoba Hydro is hydropower and this supply can be impacted by changes and variation in water conditions. Transmission interconnections with neighbouring markets helps us maintain a dependable energy supply at the lowest cost possible by enabling imports and exports of electricity. During low water years or drought, importing energy ensures reliability of the system. During high water years, there is significant opportunity to increase revenue by exporting surplus energy. Exporting energy helps keep rates low for Manitobans, as it provides an opportunity to earn revenue on surplus water that would otherwise not be used.

Imports and exports also provide an opportunity to enter into seasonal diversity exchanges with neighbouring markets. Seasonal diversity exchanges allow utilities whose peak loads occur in different seasons of the year to share surplus generating capacity during off peak seasons. Both utilities avoid building generating facilities that are only required at peak times, saving money for their customers.

Interconnections to neighbouring markets have also helped other jurisdictions switch to cleaner energy. Both Saskatchewan and U.S. utilities have purchased electricity from Manitoba Hydro enabling a reduction in their use of fossil fuels to generate electricity. Over the past ten years, Manitoba Hydro has exported approximately 30 percent of all electricity generated to markets outside Manitoba.

Note: The 2023 IRP assumes all import and export contracts that expire during the timeframe of the analysis are not renewed so that the associated energy and capacity is available to meet Manitoba demand. Opportunity exports will continue when surplus electricity is available and these are included in the IRP analysis. Future potential imports are considered as a resource in the IRP analysis.

- **Imports** are the purchase of electricity from outside of Manitoba.
- **Exports** are sales of electricity beyond Manitoba's borders. Manitoba Hydro only exports energy that is not required to meet Manitoba demand.
- **Firm exports** are contracts established for a guaranteed amount of energy from Manitoba Hydro, available even under the lowest historic water conditions.
- **Opportunity exports** are shorter duration sales of surplus energy, based on immediate or near-term demand.

5.3.4. ENERGY EFFICIENCY PROGRAMMING

Efficiency Manitoba promotes adoption of a variety of different energy efficiency measures to residential, income-based, Indigenous, commercial, agricultural, and industrial customer segments through over forty different programs and offers. They also support the advancement of codes and standards that require higher levels of energy efficiency. These actions are outlined in Efficiency Manitoba's 2020–23 Efficiency Plan that was reviewed by the Public Utilities Board of Manitoba (PUB) and approved by the Manitoba Government. Based on this plan, Efficiency Manitoba provides Manitoba Hydro with a projection of electric and natural gas savings it expects to achieve that Manitoba Hydro includes within energy planning.

5.3.5. RATES AND RATE DESIGN

Manitoba Hydro's electric and natural gas rates, as approved by the PUB, are based on the cost of providing service to customers and other considerations as set out in legislation. Manitoba Hydro's existing rate structures are relatively simple, using flat energy rates and demand charges that reflect the average cost to serve. Current rate structures do not incorporate any seasonal or time-varying differences in cost or value. Some utilities have more complex rate structures in place, which allow the utility to provide more dynamic pricing with the goal of shifting energy use to lower demand times in the day. Price signals allow the customer to take advantage of lower cost periods, which enables the utility to improve the overall effectiveness of managing the grid.

Electricity rates

Residential and small commercial rate structures are a combination of a fixed basic monthly charge and a charge based on energy used. Rate structures for large commercial and industrial customers also include a monthly demand charge.

Natural gas rates

Rates for natural gas are largely set to recover the costs to buy and deliver natural gas to customers. Residential and small commercial rate structures are a combination of a fixed basic monthly charge and a charge based on natural gas consumption. Rate structures for large commercial and industrial customers also include a monthly demand charge based on highest daily natural gas consumption.

5.4. GREENHOUSE GAS EMISSIONS

Greenhouse gas (GHG) emissions in Manitoba come from a number of sources. Generally, there are few emissions from electricity generation because almost all of Manitoba's electricity comes from hydropower and Manitoba Hydro's natural gas fueled generators are very rarely operated. Stationary combustion GHG emissions are mainly from burning fossil fuels for space heating in addition to industrial and other uses. Transportation based GHG emissions are from vehicles using fossil fuels. Both stationary combustion and transportation emissions can be impacted by customer choices. The remaining emissions in Manitoba, representing a significant source at 41 percent, are generally from agriculture and waste and not associated with energy use. These emissions for Manitoba are shown in Table 5.1.

Table 5.1 – GHG emissions by source in Manitoba (2019)

Sector	2019 Manitoba GHG emissions [tonnes, millions], (% of Total)
Stationary combustion	4.29 (19.2%)
Transportation	8.84 (39.6%)
Electricity generation	0.03 (0.1%)
Other	9.14 (41.0%)
Total	22.3 (100.0%)

Source: National Inventory Report 1990–2020. Totals exclude all GHGs from the Land-Use, Land-Use Change and Forestry Sector

5.5. ENERGY PLANNING IN MANITOBA

In addition to the Government of Manitoba, three organizations with a defined leadership role in energy planning in our province are: Manitoba Hydro, Efficiency Manitoba, and the PUB.

Manitoba Hydro is a provincial Crown corporation with a mandate to create value for Manitobans by meeting customers' expectations for the delivery of safe, reliable energy services at a fair price. Several acts, regulations, and directives guide this mandate and our planning and operations. Under the current legal framework, Manitoba Hydro has a duty to supply power to all customers ready, willing, and able to meet the requirements of receiving service without undue discrimination as to price or terms of service. Updated provincial policy can help manage the pace of electric load growth and support Manitoba Hydro's continued ability to provide safe, reliable, low-cost energy to meet the changing needs of its customers well into the future. For example, in the fall of 2022 the Government of Manitoba introduced a moratorium on connecting new cryptocurrency operations to allow time to assess the impact of the industry on our system.

Efficiency Manitoba is also a provincial Crown corporation with a mandate to cost-effectively develop and support energy efficiency initiatives to reduce provincial consumption of electricity and natural gas, with the intent of helping to keep energy rates low. Efficiency Manitoba's current legislated targets are to reduce consumption of electricity by 1.5 percent and natural gas by 0.75 percent annually, compared to what would have occurred in the absence of its programming. Manitoba Hydro funds Efficiency Manitoba and its programming. Efficiency Manitoba collaborated with Manitoba Hydro throughout the development of the 2023 IRP to incorporate its efficiency plan and consider energy efficiency measures within the broad set of resource options to meet future customer needs. This unique approach to analysis provided insights that may be used to inform future efficiency plans and programs, or related government policy.

The PUB is an independent provincial regulatory body that considers both the impact to customers, as well as the financial requirements of Manitoba Hydro in approving just and reasonable electricity and natural gas rates in Manitoba. The PUB also reviews Efficiency Manitoba's three year efficiency plans and makes recommendations to the Minister of Environment and Climate if it should be approved or rejected.

The Government of Manitoba is responsible for establishing the mandates of Manitoba Hydro, Efficiency Manitoba, and the PUB. It is also responsible for establishing policies like energy policy. Over the course of developing the 2023 IRP, there has been increasing interest from businesses wanting to expand their existing electricity service, and from new businesses and industry wanting to locate in Manitoba. At the time of writing this report, the Manitoba Government is working on a new Manitoba Energy Roadmap with a focus on economic development, recognizing that the energy landscape has changed substantially since the last energy strategy was published in 2012. Manitoba Hydro is supporting the Manitoba Government as they develop the new strategy, sharing what we've learned throughout development of the 2023 IRP.

5.6. CHANGING CUSTOMER NEEDS AND EXPECTATIONS

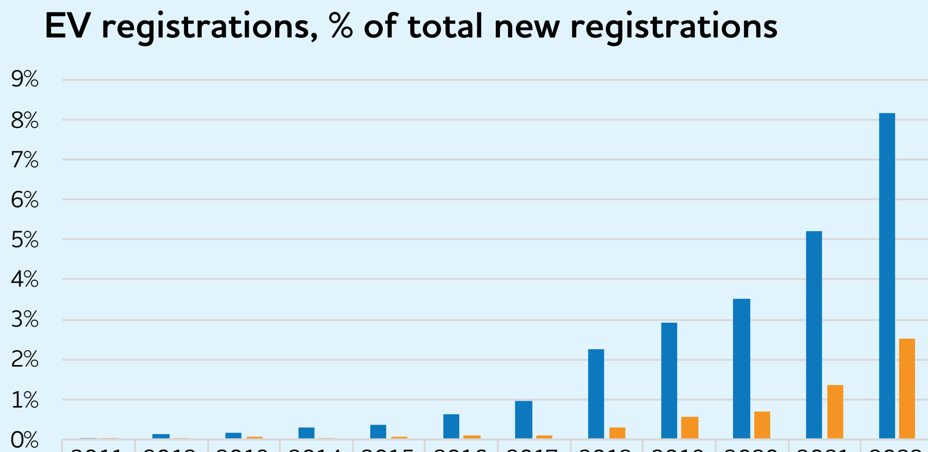
Our first step in the development of the 2023 IRP was seeking to better understand customers' perspectives and trends related to their current and future energy use. Conversations were also had with larger existing customers, as their energy choices could have significant impacts on Manitoba Hydro's energy systems. Some businesses we spoke with said they were taking steps to decarbonize their operations to support environmental, social and governance goals, while others did not anticipate significant changes to their energy needs and were more focused on energy costs. Current and anticipated government actions like increasing carbon pricing and financial incentives and tax credits are also influencing their energy-related decisions. Of the businesses we spoke with who were taking steps to decarbonize, many were thinking about electrifying operations. Some expressed interest in learning more about renewable natural gas for example, asking if it would be available from Manitoba Hydro in the future.

Most residential customers said they are not actively looking to switch from using natural gas to electricity in their homes. Only 11 percent of residential natural gas customers in the round one customer survey indicated that they intended to change some of their appliances to electric supply. Energy costs and affordability are important considerations for our customers, and right now it costs less to heat a home with a natural gas furnace than an electric furnace. Manitoba Hydro also heard from customers, including some rural municipalities, who would like natural gas service extended or expanded to support efforts to attract economic development opportunities, meet the needs of a growing community, or to reduce reliance on other more expensive fossil fuels such as propane.

In addition to cost, reliability of energy service and environmental concerns were also identified as important considerations by those who responded to our round one customer survey. Reliable service is a fundamental part of Manitoba Hydro's mandate and core to its planning and analysis. As customers rely increasingly on electricity to meet their future energy needs, ensuring reliable service will become even more important.

Customers also told us electric vehicles are increasingly in their near-term plans, both for personal use and for fleet. The number of electric vehicle models is expanding, driving range is improving, and many electric vehicle models are eligible for federal government purchase or tax incentives. Federal government funding is also supporting a build out of charging stations across Canada, and studies have shown that better access to charging can increase adoption of electric vehicles. Together, technology development and government actions are influencing greater customer interest in electric vehicle adoption.

The round one customer survey found that 60 percent of respondents were thinking of buying or leasing an electric vehicle, with the majority of those intending to do so within the next five years. This increasing interest in electric vehicles can be seen in new vehicle registrations in Canada and in Manitoba, as shown in Figure 5.5.



	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Canada	0.03%	0.12%	0.18%	0.29%	0.37%	0.63%	0.97%	2.24%	2.91%	3.52%	5.22%	8.17%
Manitoba	0.01%	0.05%	0.05%	0.03%	0.06%	0.11%	0.09%	0.29%	0.56%	0.70%	1.36%	2.54%

Source: Statistics Canada. Table 20-10-0024-01 New motor vehicle registrations, quarterly
https://www150.statcan.gc.ca/t1/tbl1/en/tv.action?pid=2010002401

Figure 5.5 – Historical new EV registrations in Manitoba and Canada

Many customers also expressed interest in reducing their overall energy use by adopting energy efficiency measures, or shifting when they use energy through demand response programs. While customers are interested in learning how they could generate their own electricity, they did not expect to adopt self-generation options, such as solar, quickly on a large scale.

How and when customers' needs may change depends on a variety of factors, including costs, technology development and availability, government policies and funding, and other influences. While the pace of change is uncertain, there is certainty that more electricity will be needed in the future than is needed today. There is also certainty that continued conversations with customers can help Manitoba Hydro plan to meet their changing needs.

6

UNDERSTANDING OUR FUTURE ENERGY NEEDS

Along with considering the current energy landscape, the IRP process studies potential future states and analyzes options to meet future energy needs. Specifically, the 2023 IRP analyzed options within the electrical and natural gas supply and delivery systems, behind-the-meter customer-based decisions, and non-wires solutions. By identifying where there is the most uncertainty in the changing energy landscape, the analysis was structured to consider a reasonable range of potential futures. The result was a better understanding of potential options, as well as the differences between options, that will inform decisions on how to best prepare for the future.

6.1. KEY INPUTS

Key inputs are those inputs to the analysis with significant uncertainty and the potential to significantly impact future energy needs. They do not represent all inputs and assumptions used in the 2023 IRP.

6.1.1. HOW KEY INPUTS WERE DEVELOPED

The conversation to inform the development of the key inputs started with the nearly 15,000 responses to the round one engagement customer survey. This initial customer survey was used to better understand values and future energy decisions of customers. Several key findings from the customer survey responses influenced the initial development steps in the 2023 IRP. The survey results found that customers are:

- Strongly motivated by cost and affordability
- Focused on the importance of reliability and environmental impacts
- Interested and engaged in how rates are structured
- Increasingly considering electric vehicles in their near-term plans
- Not looking to electrify their natural gas uses
- Not expected to quickly adopt self-generation technologies (e.g., solar panels)

This feedback informed the development of the key inputs, as well as helped to ensure the key inputs reflected the Manitoba context. With further research and analysis the proposed list of key inputs was developed.

This proposed list was then confirmed through additional conversations with customers and interested parties in the round two engagement, before establishing specific estimates and values for each key input. Feedback was sought to ensure the proposed key inputs and their driving factors reflected the greatest uncertainty and potential for impact in the changing energy landscape. The engagement confirmed that the correct key inputs were considered, though clarifications were needed to some of the factors creating the most uncertainty. One such clarification was to refine the uptake of various electric vehicle classes assumed in each scenario.

6.1.2. WHAT EACH KEY INPUT REPRESENTS

The five key inputs selected based on analysis and survey results are: economic growth, decarbonization policy, electric vehicles, natural gas changes and customer self-generation.

These key inputs all have potential to cause significant changes to future energy needs. Economic growth includes assumptions on population growth and gross domestic product (GDP) growth, both of which could lead to new housing development and new and expanded businesses. Decarbonization policy reflects the significant impact government policy may have on future energy needs, particularly if policy limits the use of carbon-based energy sources, either through incentives or mandates. Decarbonization is also closely related to the key inputs for electric vehicle and natural gas changes. Electric vehicles would shift the energy source powering transportation from petroleum products to electricity and greatly impact future energy needs (transportation currently uses about 32 percent of energy in Manitoba). Natural gas changes include the role of natural gas and related infrastructure. These changes may be driven by policy changes or environmental and sustainability goals and could involve transitioning from natural gas to renewable forms of energy (natural gas currently represents about 28 percent of all energy used in Manitoba). Customer self-generation may reduce the amount of energy customers require from the utility in the future and even provide excess energy that could be used to serve other customers.

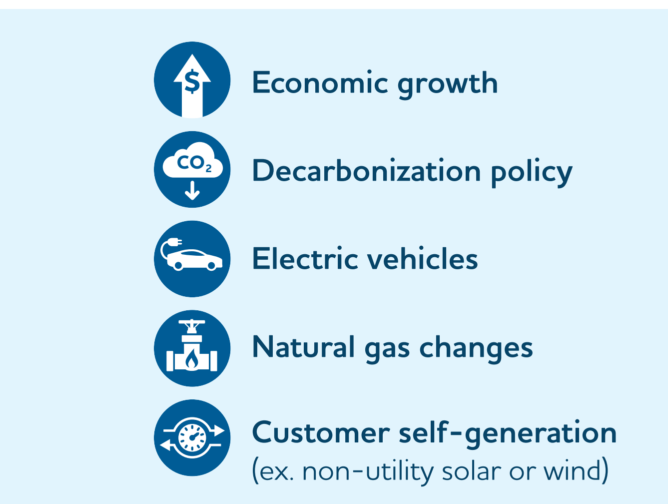


Figure 6.1 – 2023 IRP key inputs

Factors contributing to the most uncertainty were also identified for each key input.

Economic growth	Decarbonization policy	Electric vehicles	Natural gas changes	Customer self-generation
• Global economic environment • Population growth/ immigration • Business development (including community and First Nations investment)	• International climate change commitments • Government policy, mandates and regulations • Codes & standards • Viability and availability of new technologies • Available incentives	• Total cost of EV ownership • Availability of charging infrastructure • Technology capability • Supply availability • Policy/mandates/ standards/ regulations • Available incentives	• Building energy and space heating changes (includes geothermal) • Cost of natural gas vs. electricity • Availability & cost of alternative fuels (ex: hydrogen, renewable natural gas) • Cost of alternative natural gas infrastructure • Dual fuel programs • Viability of industrial process energy alternatives • Technology availability • Codes & standards • Available incentives	• Cost of behind the meter resources • Cost of electricity • Purchase price of excess electricity • Electric rate structure • Building energy use • Technology availability • Policy/mandates/ standards • Available incentives

Figure 6.2 – Factors of the 2023 IRP creating the most uncertainty

6.2. SCENARIOS

A scenario represents a specific energy future and builds on a combination of key inputs to describe that future. Scenarios are not a forecast or prediction of which future is likely to occur. Each scenario is intended to represent a possible future and multiple scenarios taken together represent a reasonable range of possible futures.

6.2.1. WHY A SCENARIO-BASED APPROACH WAS USED

Developing scenarios is a helpful way to describe the future and to think about the range of possibilities. They provide a logical and consistent way of grouping specific inputs to describe a potential future. Using a range of scenarios also provides the ability to assess and compare customer needs and infrastructure requirements in futures that unfold differently. They also helped to structure the analysis, enabling incremental comparisons between scenarios, while also providing appropriate bounds, or "book-ends".

6.2.2. HOW SCENARIOS WERE DEVELOPED

The first objective of developing the 2023 IRP scenarios was to identify a reasonable range of futures for Manitoba. The aim was not to identify and analyze every possible future. Given that inputs can have multiple possibilities, we looked at multiple scenarios. Decarbonization was viewed as the primary force driving change in the energy landscape and as having the most impact on the future. Decentralization was also identified as an important force driving change. Digitalization was viewed as supporting the implementation of potential resources. Therefore, decarbonization and decentralization were used as a foundation for developing the scenarios.

As mentioned previously, a key unknown in the future is the pace of change. Four paces of change, relative to one another, were developed: slow, modest, steady, and accelerated. The scenarios were developed based on a pace of change in decarbonization and decentralization. Specific assumptions were made for the amount of change for each key input to align with the scenario.

6.2.3. WHAT EACH SCENARIO REPRESENTS

The circles in each field in Figure 6.3 represent relative amount of change over the 2023 IRP study period for each key input within each scenario. A single circle representing the least amount of change, and four circles representing the most. These different rates of change are translated into different assumptions, so that each scenario results in different future energy needs.

	1 SCENARIO 1: Slow decarbonization & slow decentralization	2 SCENARIO 2: Modest decarbonization & modest decentralization	3 SCENARIO 3: Steady decarbonization & modest decentralization	4 SCENARIO 4: Accelerated decarbonization & steady decentralization
Economic growth	●	●●	●●	●●●
Decarbonization policy	●	●●	●●●	●●●●
Electric vehicles	●	●●	●●●	●●●●
Natural gas changes	●	●●	●●●	●●●●
Customer self-generation	●	●●	●●	●●●

● represents amount of change

Figure 6.3 – 2023 IRP scenarios and key input pace of change

The following narratives for each scenario describe a future consistent with each set of key inputs.

1 **SCENARIO ONE:** slow decarbonization and slow decentralization

In this scenario, economic growth is slower. The implementation of decarbonization policy could be slower for various reasons; sometimes targets and policies can have unforeseen implementation challenges. There would be continued adoption of electric vehicles, but the rate of adoption is not as fast as in other scenarios. Potential causes of a slower rate of adoption could be lack of incentives or availability of electric vehicles and the necessary infrastructure. Natural gas would continue to be used, with limited customers choosing to switch from natural gas to electricity. Similarly, there would be limited uptake of customer self-generation, possibly due to limited availability of technology or high cost.

2 **SCENARIO TWO:** modest decarbonization and modest decentralization

An increase in the amount of change from scenario one could be realized through economic growth, and an increased prioritization on climate policy; however, climate policy is one of several policy priorities in this scenario. Customers are starting to switch to electric vehicles in greater numbers, especially for light-duty or the passenger vehicles. There would be a slight increase in consumption of natural gas, due to population growth. Customer self-generation is still seen as having some challenges for large uptake, likely due to economics.

3 **SCENARIO THREE:** steady decarbonization and modest decentralization

Economic growth and self-generation are comparable to scenario two. The amount of change for decarbonization policy, electric vehicles and natural gas increases relative to scenario two. Decarbonization policy is a greater priority, which could influence the uptake in electric vehicles. In this scenario, uptake in medium-duty vehicles increases, in addition to light-duty vehicles. A reduction in natural gas as an end use fuel is seen, and alternatives such as renewable natural gas and hydrogen may start to play a role.

4 **SCENARIO FOUR:** accelerated decarbonization and steady decentralization

Scenario four describes a future for Manitoba with a significant amount of change in the energy landscape. All inputs have an increase in the amount of change relative to scenario three. In this scenario, a higher rate of economic growth is assumed. Decarbonization policy is a key focus and priority, which would result in stringent targets for GHG reductions. This scenario would see the highest proportion of switching to electric vehicles for all vehicle types. The role of natural gas and its infrastructure changes significantly. Given the significant move towards decarbonization, there is increased use of renewable natural gas and hydrogen, specifically for some sectors, which may be more difficult to decarbonize. Building space heating is assumed to move away from natural gas to electric space heating and geothermal. Customer self-generation becomes cost effective and is likely present in forms such as solar. Scenario four reflects a pathway towards net-zero

Engagement in round two focused on ensuring the scenarios reflected a reasonable range of potential energy futures in Manitoba. Feedback overall was that the scenarios adequately captured Manitoba's changing energy landscape, so long as the scenarios allowed for a pathway towards net-zero. This feedback was used to ensure that scenario four did in fact represent a pathway towards net-zero. This scenario has the most aggressive pace of adoption (relative to the other scenarios) of electric vehicles and decarbonization of space heating through electrification. While this scenario does not solve for net-zero by a specific year, its aggressive pace of change provides insight into the potential impacts of rapid decarbonization.

Specific values for each key input, for each scenario are available in **Appendix 3: Scenario specific inputs**.

6.2.4. HOW SENSITIVITIES IMPACT SCENARIOS

Sensitivities are variations on scenarios, where one or two inputs or assumptions are changed to understand what, if any impact, it may have on the results. Simply put, sensitivities ask: what if this were to happen? Sensitivities may be used to introduce specific constraints into a scenario, like the potential for new government decarbonization policy to restrict certain resource types, or to consider the impact of some technological development becoming less expensive in the future.

6.3. MODELLING AND ANALYSIS

The modelling and analysis for the 2023 IRP aimed to integrate electric and natural gas supply and delivery planning functions. Manitoba Hydro is unique compared to most utilities – it is a vertically integrated utility, serving customers with electricity, from generation through to transmission and distribution, and with the supply and delivery of natural gas. Providing both natural gas and electric services creates an opportunity to optimize decisions to minimize cost while maximizing value across both energy systems. Manitoba Hydro has significant interaction with external markets and these interactions are also an important part of the optimization process.

6.3.1. HOW THE MODELLING AND ANALYSIS PROCESS WORKS

The Figure 6.4 shows the major inputs and outputs of the modelling and analysis process which uses sophisticated software specifically designed and used to model hydropower systems.

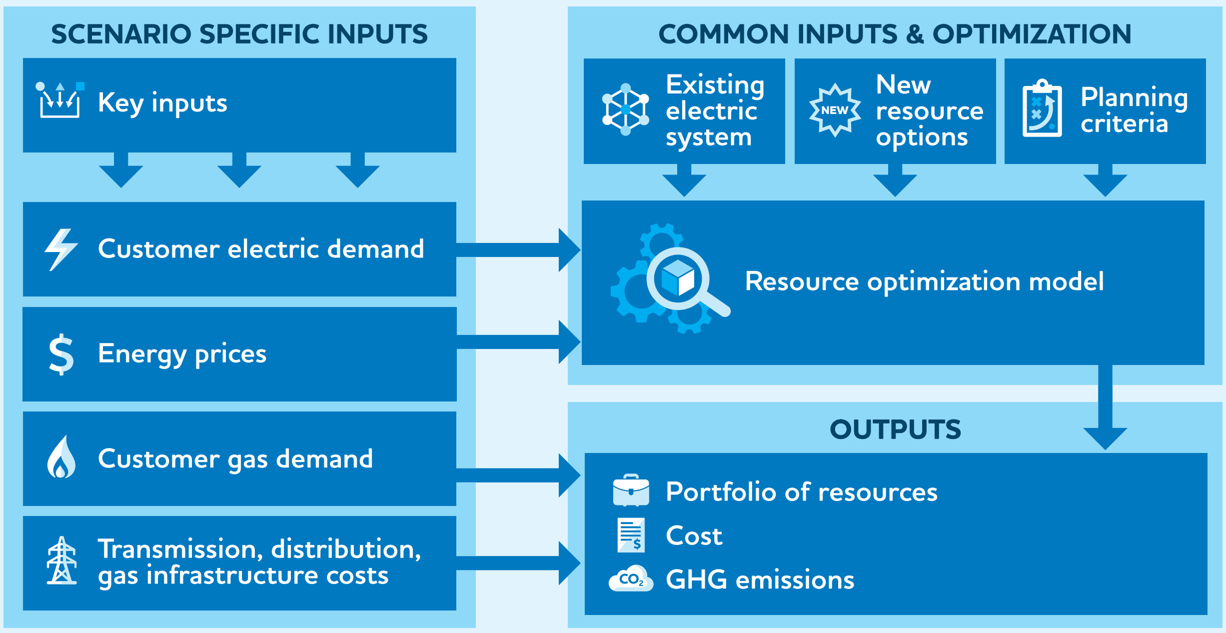
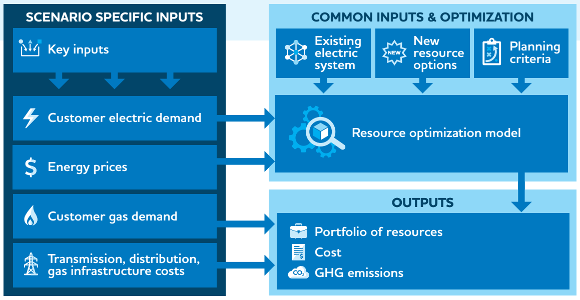


Figure 6.4 – 2023 IRP modelling process

The process can be divided into three parts,

- scenario specific inputs,
- common inputs & optimization, and
- outputs.

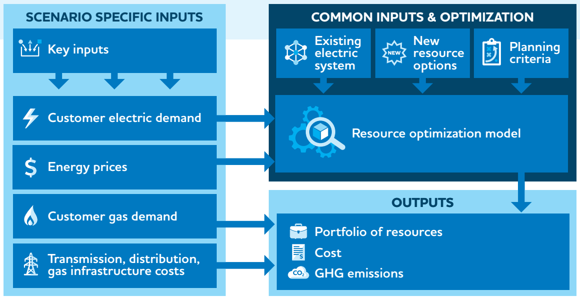
SCENARIO SPECIFIC INPUTS are:



- **Key inputs** and other inputs used to project **Customer electric demand** and **Customer gas demand** for each scenario or sensitivity.
- **Energy prices** in the resource optimization model are specific to each scenario or sensitivity, and impact exported electricity revenue, imported electricity costs, and fuel costs for natural gas-fueled generation.
- **Transmission, distribution, gas infrastructure costs** specific to each scenario or sensitivity, reflecting an estimate for the cost to serve electric and natural gas demand.

Further details on the Scenario Specific Inputs can be found in **Appendix 3: Scenario specific inputs**.

COMMON INPUTS & OPTIMIZATION include:



- **Existing electric system** is a representation of the system and the characteristics of the system components (e.g. generation capacity, generation energy, cost), including export and import capabilities.
- **New resource options** are the potential new electricity supply options available to meet customer energy needs like wind, solar generation, nuclear, or hydropower, and includes options like energy efficiency savings and demand response.
- **Planning criteria** are the generation planning criteria that ensure adequate energy and capacity to meet Manitoba load and long-term export contracts.
- **Resource optimization model** is a suite of third party software for modelling hydropower based systems and identifies the lowest cost portfolio of electric resources that meet planning criteria.

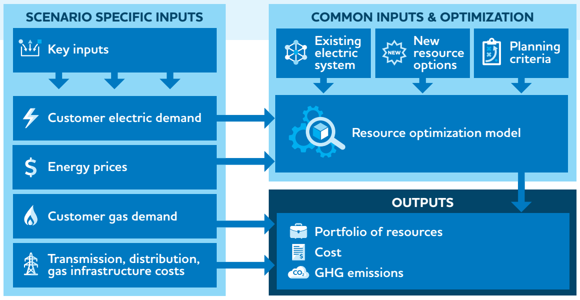
The existing electrical system is further described in **Appendix 1: Existing system & load**.

New resource options are further described in **Appendix 2: New resource options**.

Planning criteria and the resource optimization model are further described in **Appendix 4: Analysis approach**.

OUTPUTS are:

- **Portfolio of resources** is the set of lowest cost resources to meet generation planning criteria.
- **Cost** is an estimate of the costs for the selected portfolio and include associated electric and natural gas supply and delivery costs.
- **GHG emissions** is an estimate of the carbon dioxide equivalent (CO_2e) emissions associated with a given scenario or sensitivity.



GHG emissions are further described in **Appendix 4: Analysis approach**.

As shown in the process diagram, **Customer gas demand** and **Transmission, distribution, gas infrastructure costs** are not inputs to the **Resource optimization model**. Instead, these scenario specific inputs are added directly to the outputs of the resource optimization model.

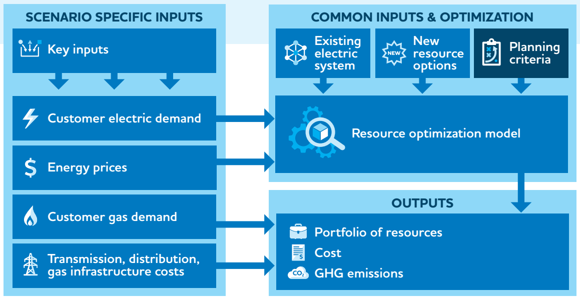
This analysis approach does not optimize electricity and natural gas systems together in the resource optimization model. Instead, the interaction between electricity and natural gas usage is explored by comparing scenarios and sensitivities. Given the broad analysis of the 2023 IRP and the fact this is the first time Manitoba Hydro has integrated planning electricity and natural gas, this approach was determined to be the most feasible to implement. The resource optimization model results ensure customer electric demand for each scenario can be met, while satisfying the planning criteria. Because the context and assumptions of the key inputs for the 2023 IRP scenarios do not result in significant increase in customer natural gas demand, a basic assumption in the modelling is that our customers' natural gas demand can be met by the existing natural gas distribution system.

Portfolios of new resources are optimized according to a lowest cost objective that meets both the firm capacity and dependable energy needs, per the planning criteria. These costs reflect net system costs, which include: capital and operating costs for new and existing resources; generation, transmission, and distribution infrastructure; generation fuel costs; water rentals; import costs; export revenues; natural gas distribution costs; and, customer natural gas costs. The net system cost excludes financing costs for new capital spending. The type, quantity, and timing of resources added in each scenario are based on their cost and characteristics relative to the other available resources. Modelling and analysis results must be interpreted by reviewing all results, balancing individual scenario and sensitivity insights with those that are repeated across multiple results.

Further analysis can also be done on the outputs. Some of this analysis is complex to conduct and was not done for the 2023 IRP because it did not align with the scope. Such examples are determining environmental and social impacts. Social impacts resulting from future decisions could include local economic impacts, Indigenous reconciliation, and other impacts. For any future major projects, an environmental impact assessment will be undertaken and incorporated into the analysis as required for regulatory approval.

Quantitative risk analysis is another example of further analysis not considered in the 2023 IRP because the broad high level scope of the plan did not support it. Some examples of quantitative risk analysis are cost estimate uncertainties associated with specific resource technologies, longer than anticipated lead times for resource technologies, longer than expected construction timelines, and policy that limits resource options.

6.3.2. PLANNING CRITERIA



Manitoba Hydro must reliably supply energy to its customers. Planning criteria, as one of the common inputs to the modelling process, set the requirements for planning a reliable supply and delivery of electricity and natural gas.

Electric supply criteria

To ensure electrical energy is available when Manitobans need it, Manitoba Hydro must meet two principal planning criteria:

- **Dependable energy**: enough electrical energy must be available to meet or exceed Manitoba demand plus firm export contracts during water flows at the level of the worst drought on record (1940/41).
- **Capacity**: enough firm electrical capacity must be available to meet or exceed Manitoba peak demand, plus a planning reserve margin, plus firm export contracts.

The **planning reserve margin** is an additional amount of capacity that must be available to account for the risk of equipment outages due to breakdowns and extreme weather events.

The criteria for dependable energy is consistent with other predominantly hydropower utilities, which are uniquely exposed to risks of drought. The criteria for capacity is consistent with utilities across North America. These criteria are constraints in the IRP modelling process and all results generated through the analysis meet both criteria.

Electric delivery criteria

Delivery of electricity is through transmission and distribution systems, which have their own set of planning criteria. The transmission system is connected to the rest of the North American electrical grid and is required to conform to standards set by the North American Electric Reliability Corporation (NERC), as adopted by the Province of Manitoba. The distribution system is also subject to planning criteria, which is consistent with the electric utility industry. In general, these systems are planned to meet peak demand needs without violating any established planning criteria.

Natural gas supply criteria

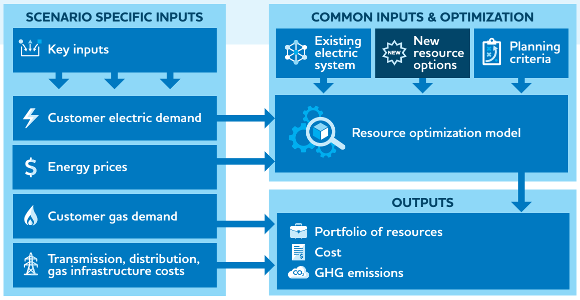
The North American natural gas market is highly integrated, combining robust production, long-duration storage, and interconnected large-capacity pipelines. Natural gas utilities plan supply to meet firm customer demand on a designated day, or the coldest day within the utility's planning criteria. Supply is also planned seasonally to ensure firm demand can be met for the duration of a coldest winter scenario.

Natural gas delivery criteria

Natural gas distribution systems also have planning criteria. In general, these systems are planned to provide minimum pressures to meet rated connected load. The 2023 IRP analysis made certain assumptions for future use of natural gas, which resulted in a proxy for natural gas distribution planning criteria.

Further details on natural gas supply and delivery assumptions are provided in **Appendix 4: Analysis approach**.

6.3.3. RESOURCE OPTIONS



Resource options added in the modelling and analysis as a common input include utility scale generation, energy efficiency and demand response, and customer self-generation.

Utility scale generation

Utility scale generation options encompass a variety of technologies, including: new hydropower plants and refurbishment of existing hydropower units; commercially available mature technologies like wind, solar, and natural gas combustion turbines; imports; and, less mature technologies like battery storage, biomass, small modular reactors, natural gas combustion turbines with carbon capture and storage, and hydrogen fueled combustion turbines. These resources can have significantly different attributes with some being dispatchable, such as hydropower and combustion turbines, and others representing variable renewable resources, such as wind and solar.

Variable renewable resources can only produce energy when the right conditions exist, such as the sun is shining. Variable renewable resources are good for energy needs but cannot always be counted on for capacity because they cannot be relied upon to produce energy during peak demand.

Dispatchable resources are those that can be turned on and off as needed to produce energy. Not only do dispatchable resources provide both energy and capacity, they also are usually very good options to provide capacity to support variable renewable resources.

Thermal generators are evaluated as resource options with a variety of fueling options like natural gas, natural gas with carbon capture, or green hydrogen. Green hydrogen consumed by thermal generation is assumed to be produced with surplus electricity in Manitoba during seasons with low energy use and stored in large geological formations until it is needed to meet peak winter demand.

Existing wind power purchase agreements are assumed to expire at the end of their term. New wind farms or wind farm contracts are considered to be future resource options. Energy imports are modelled based upon existing transmission capabilities, while capacity imports are modelled at a low amount with specific market opportunities continuing to be evaluated.

Appendix 2: New resource options describes the characteristics of resources considered in the 2023 IRP including cost, ability to reliably meet peak winter demand, time to build, economic lifetime, and maturity of technology.

Energy efficiency

Using energy more efficiently is another resource option. Energy efficiency looks to reduce electricity and natural gas use, instead of building new electrical or natural gas resources to meet increasing demand. Efficiency Manitoba and Manitoba Hydro worked collaboratively to include a range of customer measures that can reduce overall energy usage within the 2023 IRP.

In Manitoba, Efficiency Manitoba plans and manages energy efficiency programming as a dedicated Crown corporation with a mandate to reduce electricity and natural gas consumption. Current energy efficiency opportunities include but are not limited to: home and building envelope improvements; high-efficiency lighting and controls; high-efficiency commercial and industrial equipment and/or systems; and, heat pump technologies. Efficiency Manitoba provides incentives and supporting strategies to encourage and enable Manitobans and Manitoba businesses and communities to access energy savings upgrades and opportunities.

Total resource cost refers to the cost of implementing energy efficiency measures through Efficiency Manitoba programming. It includes program administration costs, incremental product costs (to purchase energy efficient products instead of standard products, including incentives) and other avoided costs.

The 2023 IRP demand projections are reduced to reflect Efficiency Manitoba's planned programs. The IRP modelling process also considers the potential of energy efficiency measures above Efficiency Manitoba's planned programs as resource choices. Efficiency Manitoba and Manitoba Hydro worked together to sort the large number of efficiency measures into groups, based on similar load shapes and cost. Examples of groupings include residential heating, commercial cooling, and commercial lighting. The resource cost modelled for each energy efficiency grouping represents the total resource cost of the programs (including incremental customer costs to buy, install, operate, and maintain the energy saving technology) so that the resource selection considers a broader community perspective to energy efficiency programs.

Customer self-generation

Customer self-generation can also contribute energy towards meeting Manitoba Hydro's overall customer demand. For most residential and commercial customers, the only practical self-generation option is the installation of solar panels. As Efficiency Manitoba plans and manages a solar self-generation program, this resource was included in the 2023 IRP analysis in the same way as other energy efficiency programs.

Demand response

Demand response involves using programs or technologies which cause a shift in the use of energy from a time of high demand to a time of lower demand. Demand response was modelled through a sensitivity, rather than as a resource option that could be selected within the resource optimization model. This approach was taken due to complexities associated with incorporating a variable demand while also optimizing around all other resource options. Further information on demand response can be found in the **Modelling and Analysis – Outputs** section on sensitivity results.

Resource costs

There is significant variation and range in the cost of various resources. This variation can be seen between different resources, but also in the costs for one individual resource. Understanding these relationships helps to identify where resources are more cost effective at supplying energy versus meeting capacity needs. A simplified way is to examine the cost of different resources for providing energy (the levelized cost of energy, which is on the left of Figure 6.5) and the cost of that same resource for providing capacity (the levelized cost of capacity, which is on the right of Figure 6.5). For example, Figure 6.5 identifies a wide range of cost for air-source heat pumps because of the differences and advancement of the different air-source heat pump technologies. However, because air-source heat pumps cannot provide winter firm capacity (as they lose their efficiency at cold temperatures and act like electrical resistance heating), they do not appear on the winter capacity chart.

Note: For Figure 6.5, solar and air-source heat pumps are not included in the capacity chart because they do not provide winter firm capacity. Wind appears in the energy chart, but not in the capacity chart because as a capacity resource, its costs would be very high relative to the other resource options.

The cost of resources for providing energy and capacity are included in the analysis to determine the lowest cost resources to meet generation planning criteria. Only through this analysis can the value of the contribution of a resource in various scenarios be determined.

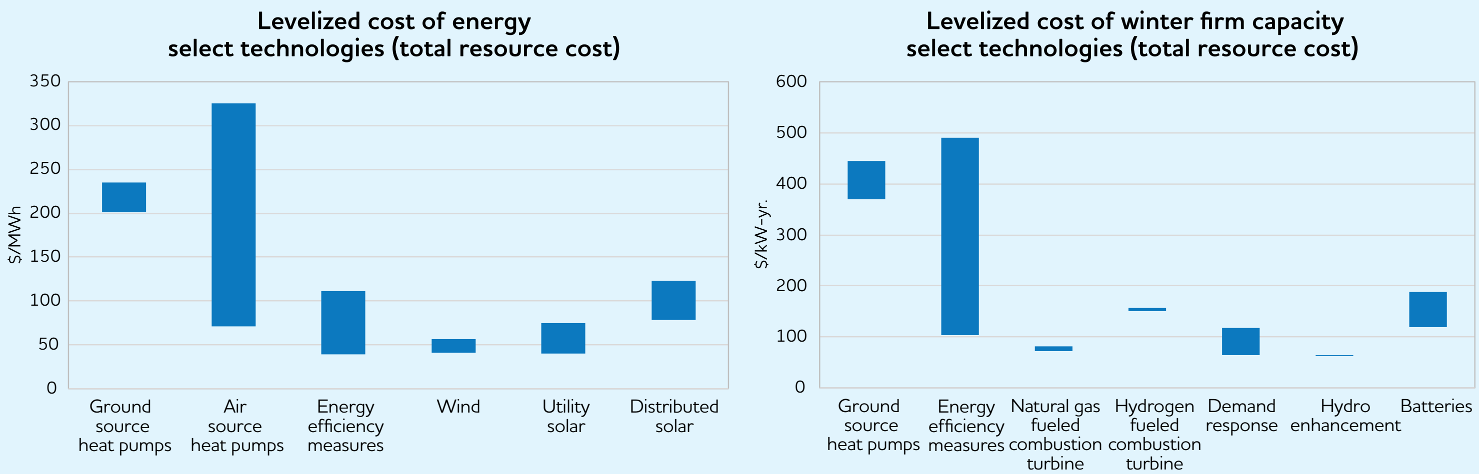
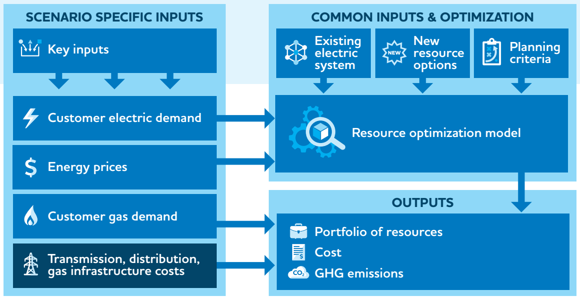


Figure 6.5 – Cost of select energy and capacity resources

See **Appendix 2: New resource options** for additional discussion about resources and their attributes in the 2023 IRP.

6.3.4. TRANSMISSION, DISTRIBUTION AND GAS INFRASTRUCTURE COSTS

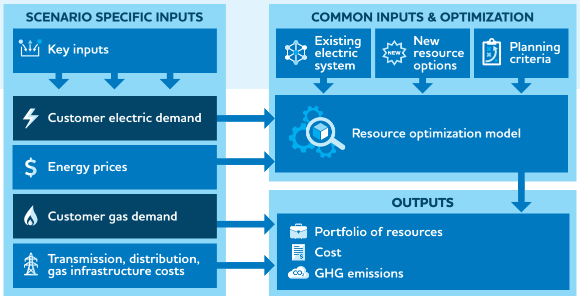


Transmission, distribution, and gas infrastructure costs are also considered in the modelling process. Transmission costs were considered from two perspectives: the cost to interconnect new generation and the cost to serve peak demand. Distribution costs were considered from the perspective of the cost to serve peak demand.

To estimate both the cost to interconnect new generation and the cost to serve peak demand, a simplified method was used. A unit value was calculated based on the average cost to serve incremental peak demand (in this case, dollar per incremental MW). This unit value is also used to subtract the avoided costs of any energy efficiency resources that are part of the scenario or sensitivity portfolio of resources. All cost estimates are high level and indicative, based on broad assumptions. In reality, the costs to serve peak demand will vary significantly based on localized concentrations of load growth and specific locations of new generation.

No new costs were assumed for natural gas infrastructure as it was assumed the existing infrastructure would be sufficient throughout the IRP study period.

6.3.5. CUSTOMER ELECTRIC AND NATURAL GAS DEMAND



Key input assumptions on economic growth, electric vehicle adoption, natural gas changes and customer self-generation that are specific to each scenario determined projections for future customer electric and natural gas demand. Electric projections and natural gas projections are interrelated with assumptions of increasing decarbonization from scenario one to scenario four resulting in an increasing demand for electric energy and a decreasing demand for natural gas energy consumption.

Key input assumptions

Economic growth

Economic growth is captured through economic indicators (including GDP growth, population growth, real disposable income) in Manitoba, all of which impact changes to energy usage throughout the economy. Broad economic development initiatives were not considered, though input gathered through individual customer conversations and targeted surveys, were considered. The population growth in each scenario is shown in Figure 6.6.

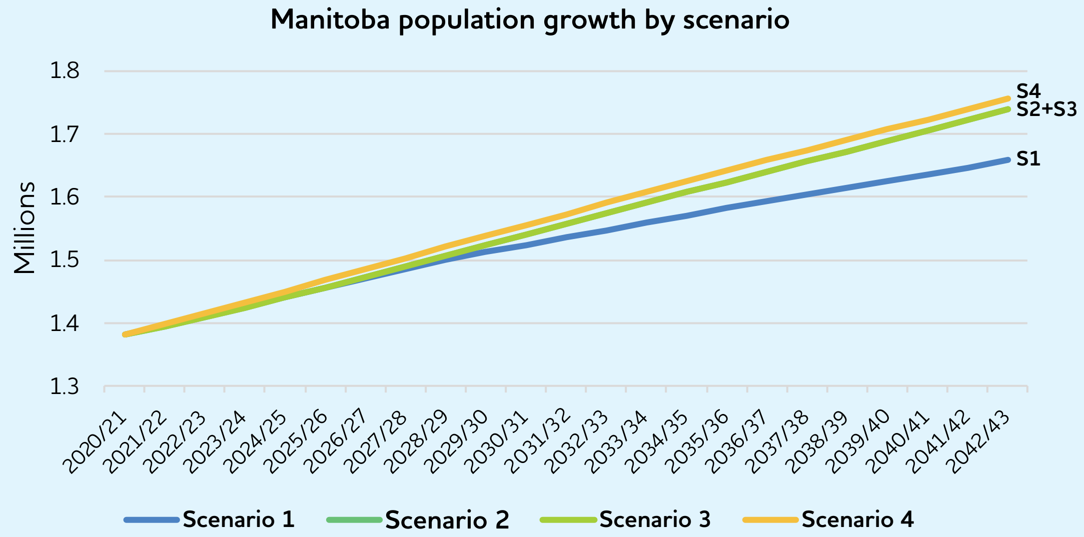


Figure 6.6 – IRP scenario assumptions over study period for Manitoba population growth

Decarbonization policy

Decarbonization policy is a very broad topic with wide ranging impacts and was most directly reflected within the electric vehicle and natural gas changes key input assumptions.

Electric vehicles

Electric Vehicle (EV) sales as a percentage of total vehicle sales projections correspond to the pace of decarbonization represented in each scenario. Figure 6.7 details these assumptions for each vehicle class, for each scenario.

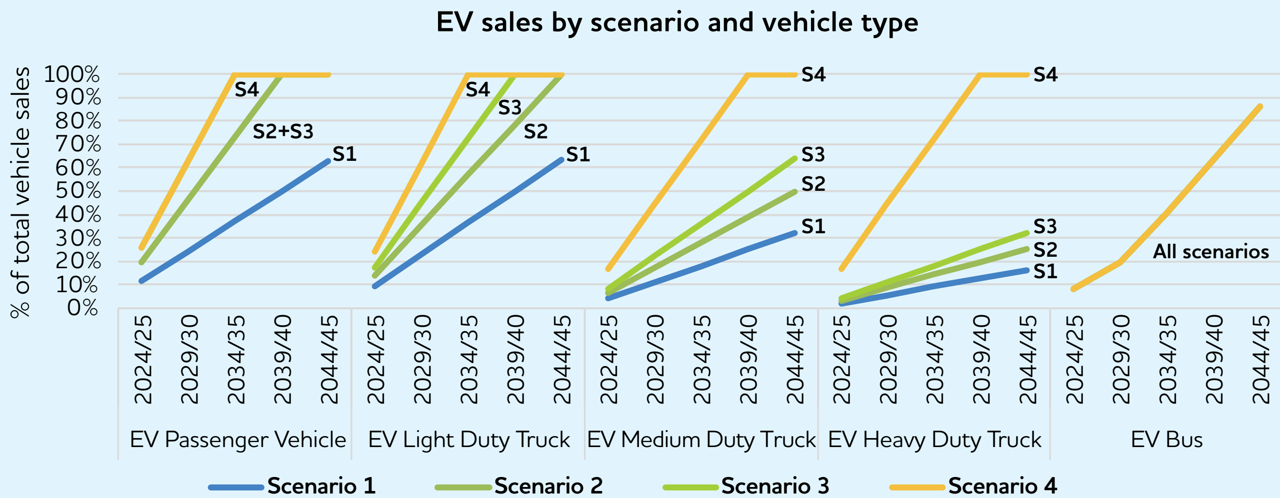
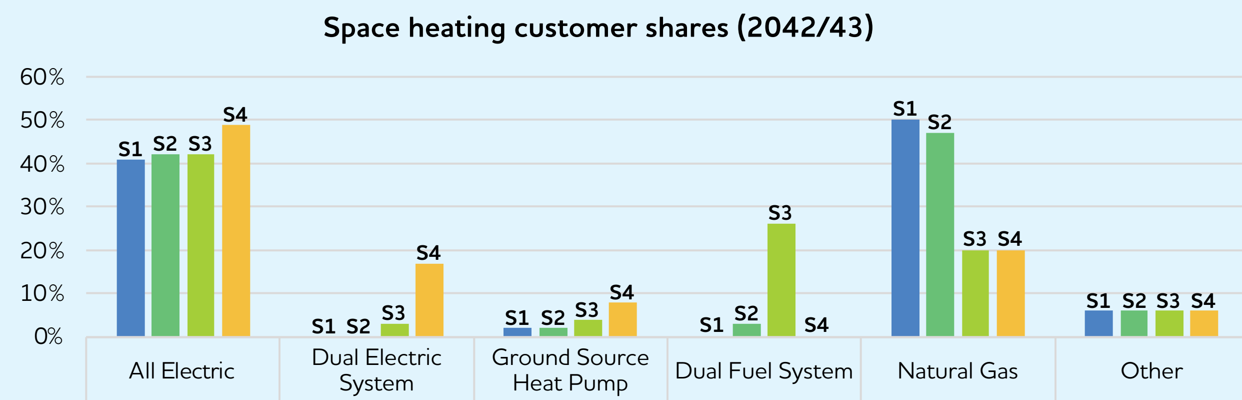


Figure 6.7 – IRP scenario assumptions in select year of study period for EV sales by vehicle type

Natural gas changes

Space heating fuel choices assumed for each scenario corresponds to the pace of decarbonization and lead to different levels of electric and natural gas consumption. Figure 6.8 reflects the percentage of customers by space heating system type for each scenario at the end of the study period.



	All Electric	Dual Electric System	Ground Source Heat Pump	Dual Fuel System	Natural Gas	Other
Scenario 1	41%	0%	2%	0%	50%	6%
Scenario 2	42%	0%	2%	3%	47%	6%
Scenario 3	42%	3%	4%	26%	20%	6%
Scenario 4	49%	17%	8%	0%	20%	6%

Figure 6.8 – IRP scenario assumptions in 2042/43 for space heating

Customer self-generation

While customer self-generation can include multiple types of electrical energy systems, the 2023 IRP assumes all customer self-generation is through solar generation. Varying rates of solar generation were assumed for each scenario, consistent with the pace of decentralization and informed by the results of the round one customer survey. Table 6.1 provides the total number of solar installations and generation at the end of the study period.

Table 6.1 – IRP scenario assumptions in 2042/43 for customer self-generation

Value at end of study period	Scenario 1	Scenario 2	Scenario 3	Scenario 4
Number of installations	15,345	29,857	58,441	116,529
Total installed capacity (MW)	142	288	573	1,154
Annual electrical energy (GWh)	166	336	670	1,348
Total consumed by customer (GWh)	125	252	502	1,011
Total sold back to grid (GWh)	42	84	167	337

Additional information on assumptions underpinning electric and natural gas demand projections can be found in **Appendix 3: Scenario specific inputs**.

Electric and natural gas demand projections

Based on the assumptions for key inputs and other model inputs, the scenarios result in a wide range of energy needs into the future, with the largest change being seen in scenario four. Scenario four results indicate natural gas usage would drop by nearly half, electric energy needs would double, and peak electric demand would increase to 2.5 times what it is today, as shown in Figure 6.9 and Figure 6.10. The assumption in scenario four, that all existing natural gas space heating is converted to all electric resistance heating, drives the growth in peak demand relative to other scenarios. This growth can also be seen in the monthly peak electrical demand for 2042 in Figure 6.11 where winter demand in scenario four rises much more than in the other scenarios.

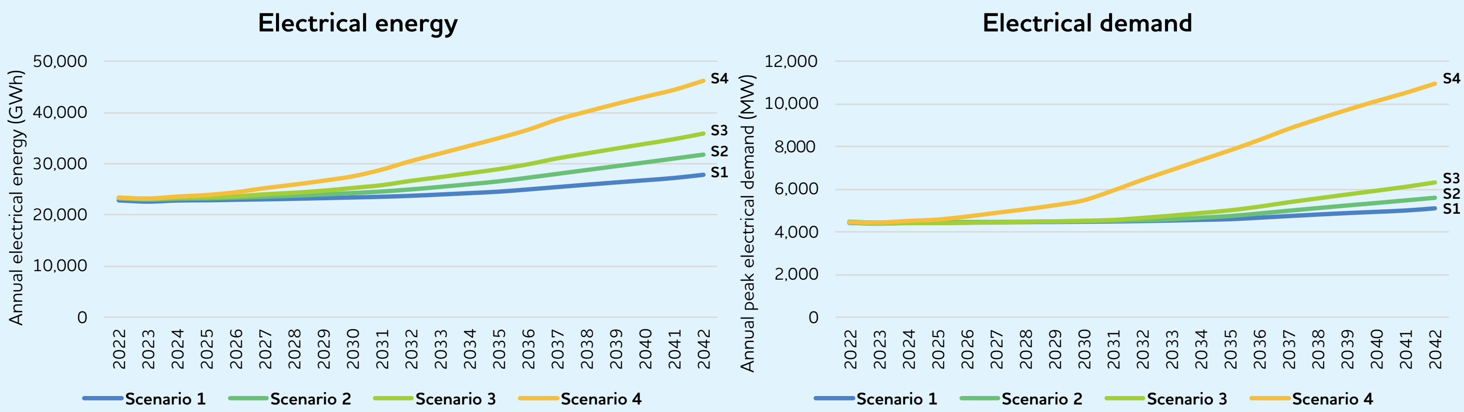


Figure 6.9 – IRP scenario demand projections over the study period for electrical energy and demand

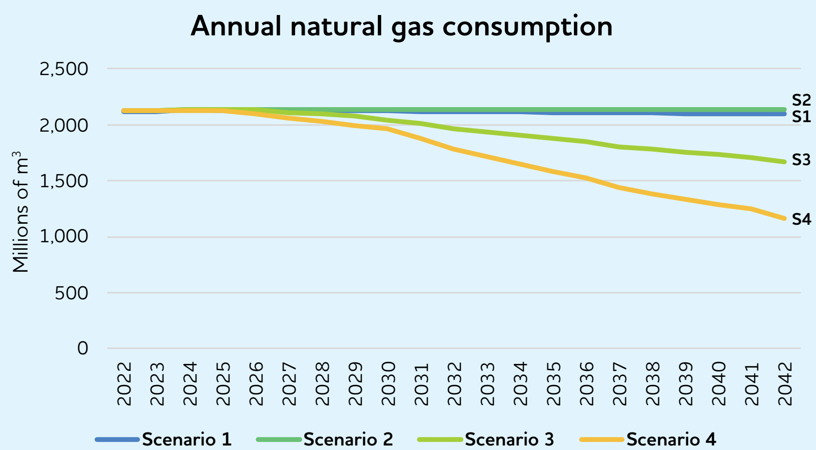


Figure 6.10 – IRP scenario demand projections over the study period for natural gas consumption

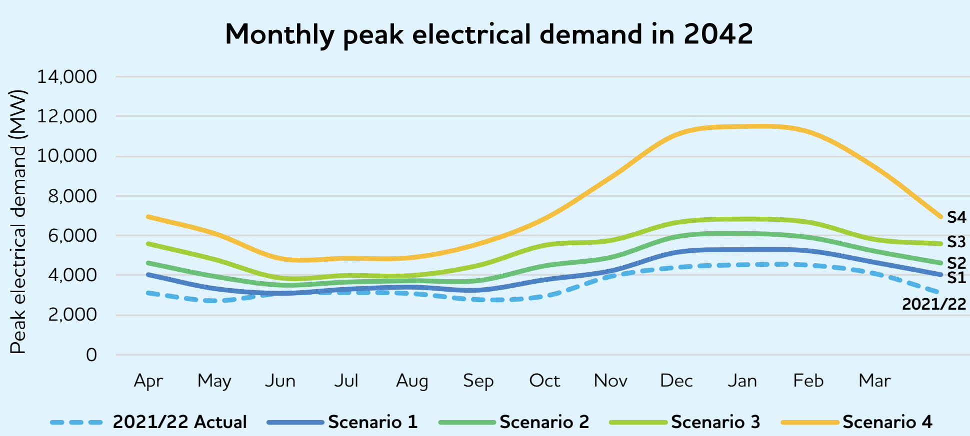
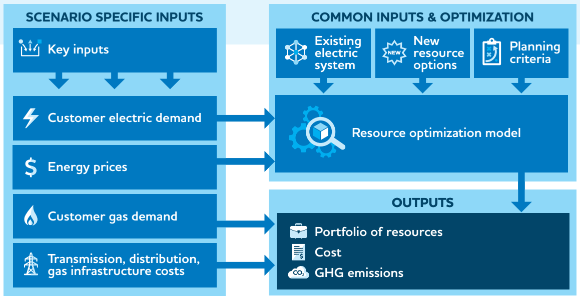


Figure 6.11 – IRP scenario demand projections for monthly peak electrical demand in 2042

6.3.6. OUTPUTS

Our modelling and analysis process resulted in three primary outputs: portfolio of resources, cost, and GHG emissions. Additional key information can be drawn from these primary outputs, in particular, understanding the pace of change of the results can be an indication of when resources may be needed.



Again, the portfolio of resources shown in the 2023 IRP are based on the modelling and analysis objectives of minimizing net system costs. Additional evaluation criteria will be considered when completing future analysis to support a specific resource decision.

Additional detail on all information presented within this section can be found within **Appendix 5: Analysis results**.

Scenarios

The following results, observations, and discussion examine the portfolio of resources, cost, GHG emissions and the pace of change outputs for the four 2023 IRP scenarios. A summary of notable observations is also provided.

Portfolio of Resources

Figure 6.12 provides the average annual energy and the firm winter capacity supplied by each type of resource in 2022 and compares it to the resource optimization model results in 2042 for each scenario.

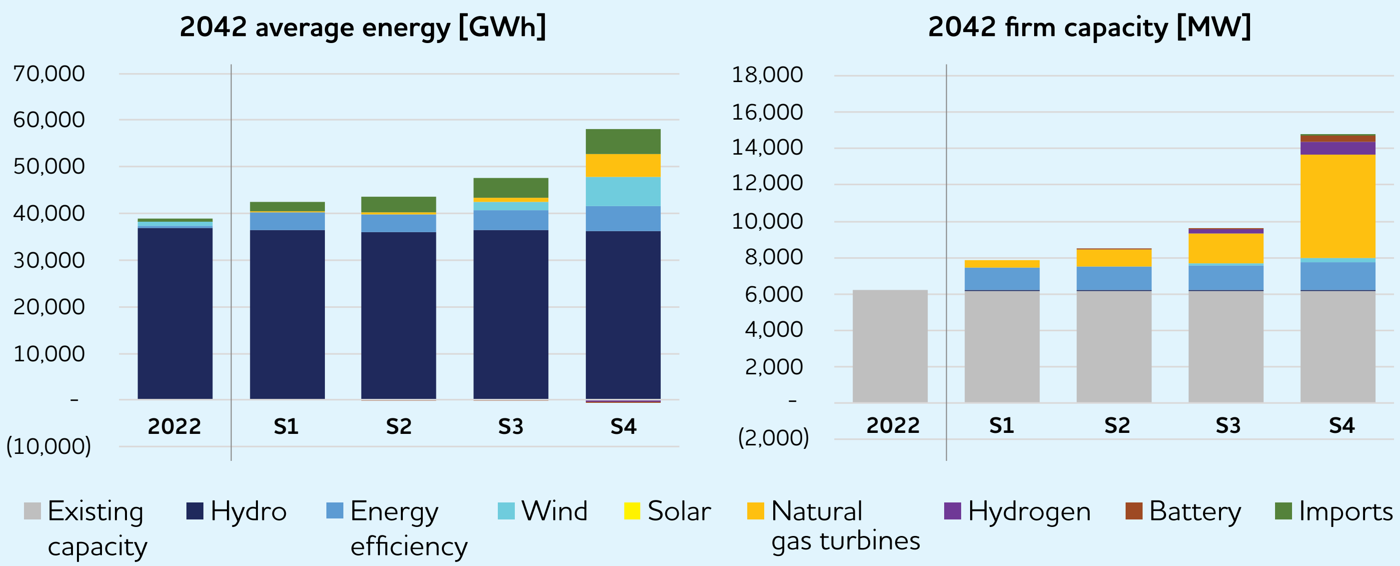


Figure 6.12 – Portfolio of resources in 2042 for each IRP scenario

Note: The quantities in Figure 6.12 are different than those shown in Figure 6.9 and Figure 6.11.

The left side of Figure 6.12 shows average energy from different generation resources in 2042; given the variability in what can be generated from a predominantly hydroelectric system, this is useful to understand how each resource contributes to meeting energy needs based on observed historical water variability. Figure 6.9 represents total energy usage in Manitoba throughout a year for each IRP scenario, reduced to reflect Efficiency Manitoba's planned programs.

The firm capacity shown at the right in Figure 6.12 is greater than what is shown in Figure 6.9 and Figure 6.11. The amount in Figure 6.12 shows the total amount of capacity required to satisfy planning criteria in 2042, including firm export contracts, losses associated with transmission and distribution systems and planning reserve margin.

Several common themes emerge when examining Figure 6.12. In 2042, the existing system continues to meet a majority of total electrical energy needs in all scenarios, primarily with hydropower. Energy efficiency measures, wind, natural gas thermal generation, and imported energy are common sources of new electrical energy. The existing system also continues to meet a significant portion of capacity needs. New resources include energy efficiency measures, wind, thermal, hydrogen, and in some cases, battery storage. Small quantities of new hydropower representing upgrades to existing facilities are present in the resource mix in every scenario. Solar, new hydropower facilities, small modular reactors (SMRs), and biomass are not selected as new resource options.

A significant insight from the portfolio of resources output is how the characteristics and attributes of the different selected resources contribute to the energy and capacity mix. When reviewing the scenario four results there is significant new natural gas thermal generation needed to support capacity needs (the gold segment that is about 40 percent of all capacity resource outputs), but the same thermal generation contributes only about an average of 10 percent of the energy throughout the year (the gold segment on the left-hand energy graph). By comparison, the wind results for scenario four provide significantly more energy than capacity (blue segments). This means that for most of the year, energy is supplied through clean electricity, such as hydropower and variable renewable resources like wind. However, as these resources cannot always be counted on when we have significant winter peak capacity needs, we need to pair these variable renewable resources with a dispatchable resource. Our results favour thermal generation, fueled by natural gas, for this role because it is one of the lowest cost resources for providing capacity.

Cost

All cost outputs from the 2023 IRP modelling process are net system costs. These net system costs are calculated on an annual basis and shown as a cumulative present value basis over the 20 year study period. In other words, these costs give a sense of the investment needed to get to 2042 for each scenario. Figure 6.13 demonstrates that results for scenarios one, two, and three are similar, but significantly more investment is needed for scenario four.

Remember! Net system costs include: capital and operating costs for new and existing resources; generation, transmission, and distribution infrastructure; generation fuel costs; water rentals; import costs; export revenues; natural gas distribution costs; and, customer natural gas costs.

The net system cost excludes financing costs for new capital spending.

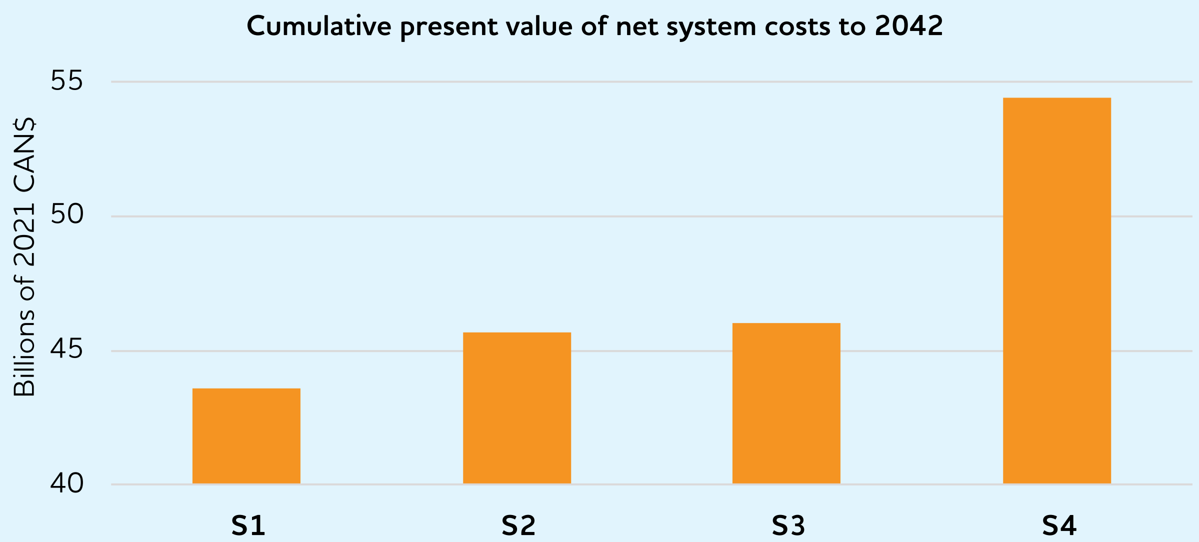


Figure 6.13 – Present value of net system costs to 2042 for each IRP scenario

Figure 6.14 compares different outputs and calculations. Understanding how these interact helped to inform the 2023 IRP road map and near-term actions. The firm electric capacity (blue column), electric and natural gas energy supplied (light green column), and net system costs (orange column) are shown as percentages relative to 2022. The results show that all scenarios require some level of investment. The results also show that firm electric capacity needs rather than energy needs are largely driving required investment.

The fourth calculation on Figure 6.14 is for the unit cost of energy (dark teal column), where the net system costs are divided by the energy supplied in each scenario for both electricity and natural gas. This calculation provides directional indication on the cost per unit of energy in the scenarios to serve that energy. The cost per unit of energy only accounts for changes in use of electricity and natural gas in the scenarios; it does not factor in customers' potential reduced use and spending on refined petroleum products because of the scenario assumptions of increased electric vehicles uptake. For scenario four, even though more electricity will be supplied, the unit cost result shows that the cost per unit of energy to meet demand is higher than in the other scenarios. The impact to customers' total energy costs from all sources, such as electricity, natural gas, and refined petroleum products requires further analysis.

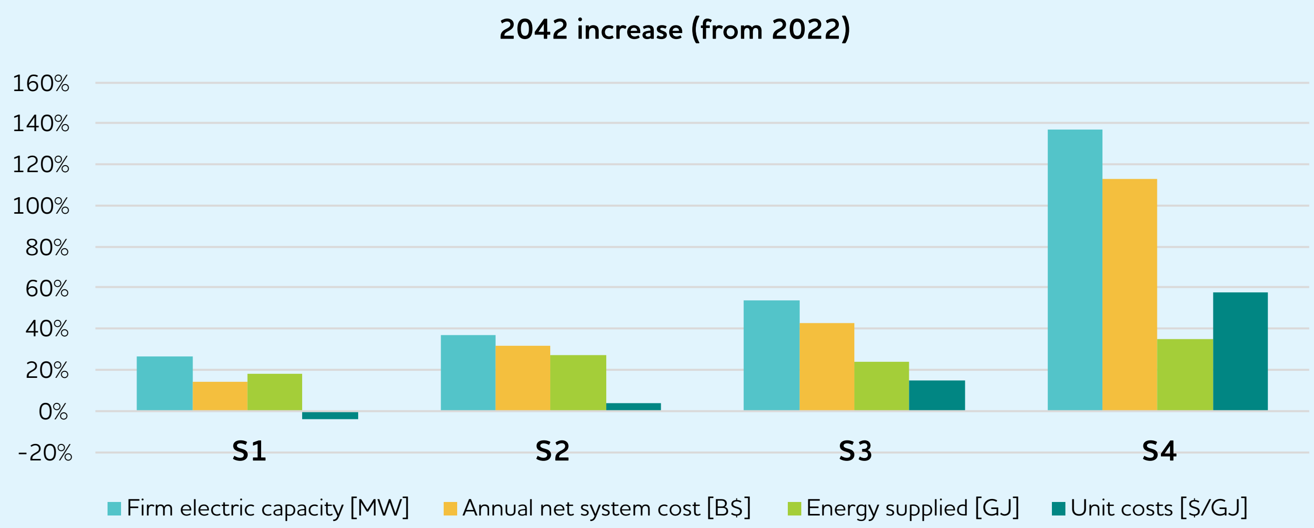


Figure 6.14 – Comparison of different modelling and analysis outputs for each IRP scenario

GHG Emissions

GHG emissions for each scenario can be calculated based on the modelling and analysis outputs. Figure 6.15 shows that energy related GHG emissions decline over the study period in every scenario. Figure 6.16 shows that at the end of the study period, the proportion of the sources of GHG emissions will change from 2022 values. For all scenarios, the portfolio of resources has some level of natural gas fueled thermal generation, which increase GHG emissions from generation sources. However, this increase supports a greater reduction of GHG emissions from other sources, as compared to 2022 emissions.

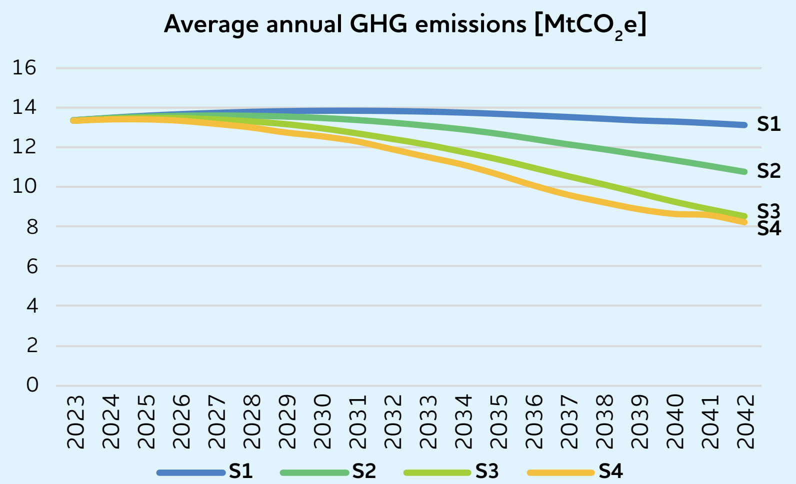


Figure 6.15 – GHG emissions over the study period for each IRP scenario

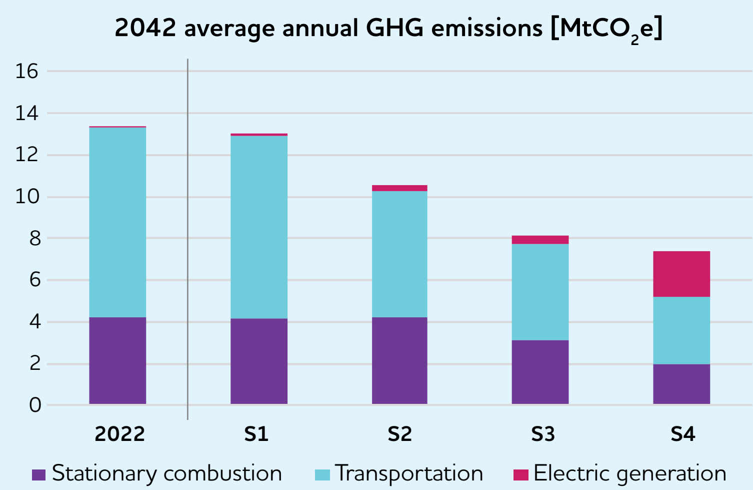


Figure 6.16 – GHG emissions by emission source in 2042 for each IRP scenario as compared to 2022 actuals

Figure 6.17 shows that declining GHG emissions are associated with increasing net system costs. GHG emissions for each scenario in 2042 are compared to the net system cost, this time shown as an annual value, to understand how different customer energy choices in each scenario can impact results. The same data for 2022 is also shown for comparison.

The scenario results represent the lowest cost option for meeting the scenario loads. Other options were explored in the sensitivity analysis, such as non-generation resources and restrictions on generation emissions that result in different GHG emissions. Additionally, the availability of renewable fuels in the future may provide even more options and support the evolving role for the existing natural gas system. This could avoid costs associated with the need to build new electric capacity resources.

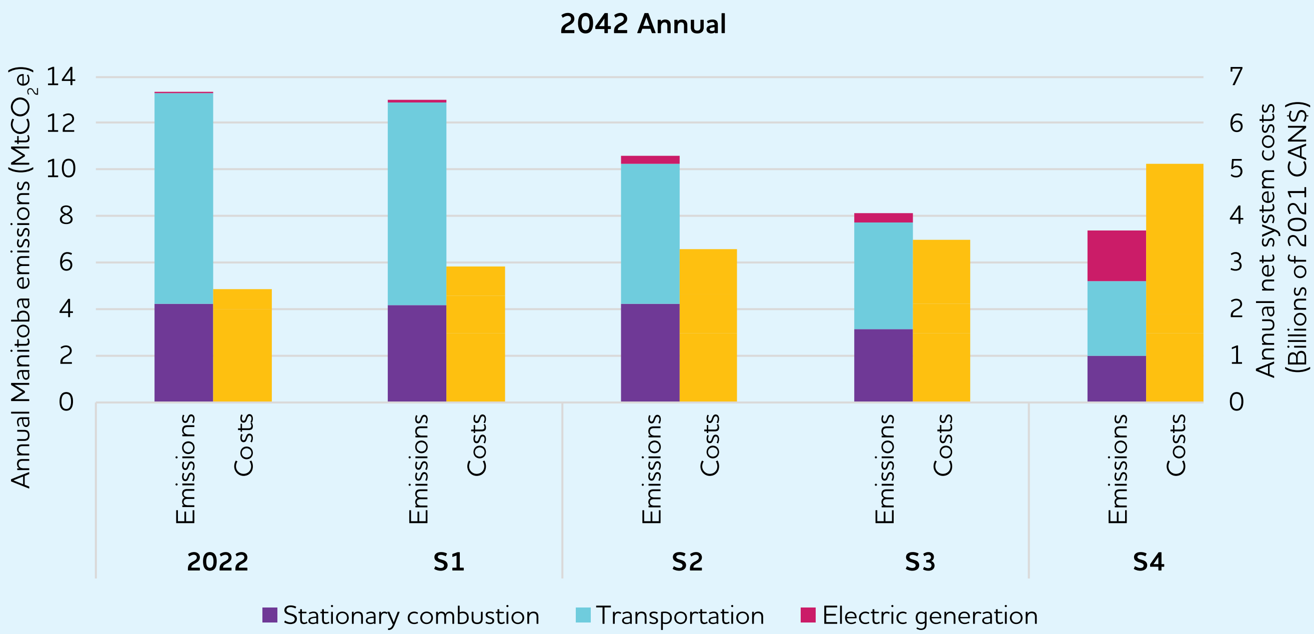


Figure 6.17 – GHG emissions and annual net system costs for each IRP scenario as compared to 2022 actuals

Pace of change and need dates for new resources

So far, we've shown results for 2042, the end of the 20 year study period. However, observations related to the pace of change over the study period can also help understand results. Figure 6.18 illustrates the pace of change in each scenario for the dependable energy in the left-hand chart and winter capacity in the right-hand chart. The red lines in each chart represent the dependable energy and capacity the current system can supply. When a scenario's need crosses the red line, new resources will be needed – this is the need date for new resources. Ultimately, how the future unfolds and the actual need dates will depend upon a combination of factors that can be different than the scenario assumptions.

The existing system continues to meet most of the energy and capacity needs for scenarios one, two and three, though new resources would start to be required in the early 2030s. Though the modelling assumed that existing export contracts will not be renewed, the results indicate that using this previously exported electricity in Manitoba will only meet demand for a short period of time and new resources will still be needed. Scenario four presents a particular challenge, as new resources may be needed as early as 2025. Many of the new resources studied through the 2023 IRP require a longer time to plan, construct and put into service.

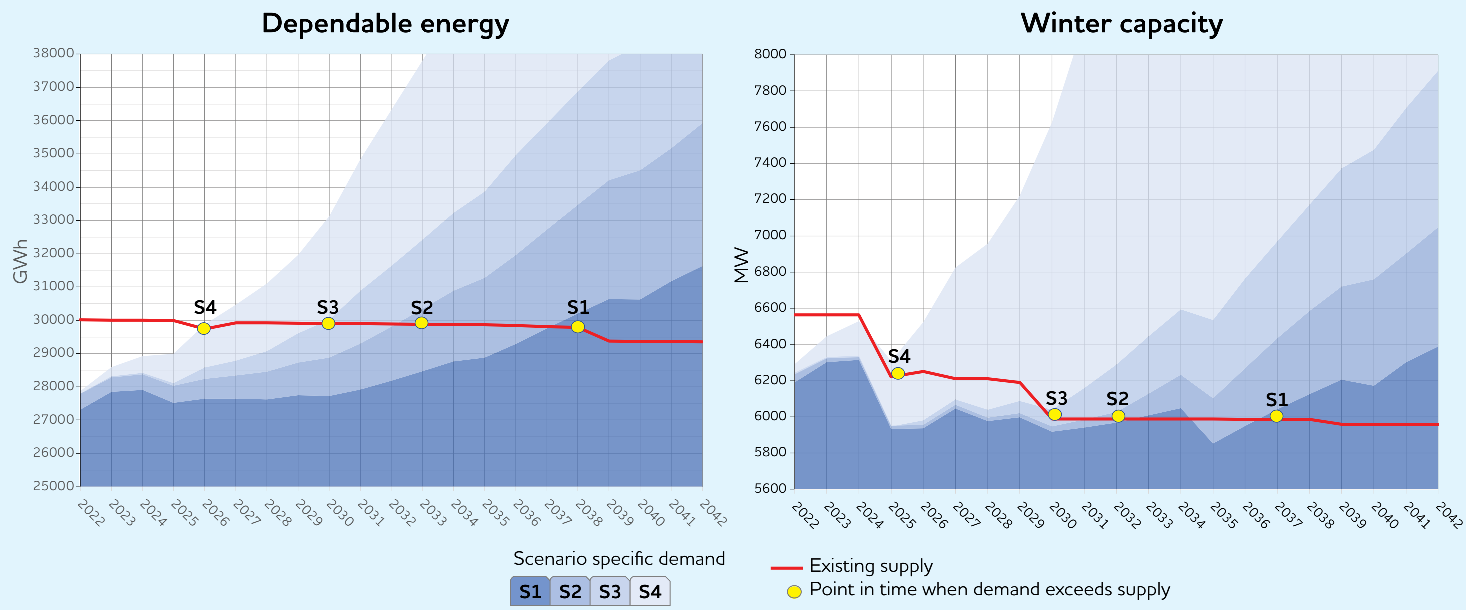


Figure 6.18 – Pace of change over the study period for dependable energy and winter capacity for each IRP scenario

Note: The red line representing the winter capacity of the current system is shown reducing over time to reflect when existing capacity import agreements expire. The 2023 IRP assumes that these capacity agreements are not renewed when they expire. The 2023 IRP also assumes existing agreements to export winter capacity are not renewed as they expire, which reduces the scenario specific demand as shown in blue.

Summary of key observations from scenario results

The modelling and analysis results for the four scenarios provided key observations that helped inform development of the 2023 IRP road map. These include:

- Investment is needed in all scenarios to support growth and to maintain and modernize existing assets;
- Energy related emissions drop in all scenarios;
- Different levels of electrification result in different net system costs;
- Increases in emissions from electric generation enable overall emission decreases;
- Need for capacity resources are driving costs;
- Use of renewable fuels to decarbonize by leveraging existing gas infrastructure needs further investigation;
- Existing system meets early demand in scenarios one, two and three; and,
- Meeting early demand in scenario four will be challenging.

Figure 6.19 – Summary of observations from scenario results

Sensitivities

Sensitivities explore the impact of a change to a scenario assumption or input to understand how it might affect the model's outputs or results. Sensitivity analysis, or what if analysis, helps to understand how individual inputs or constraints are driving outputs of the model.

In round three engagement feedback was sought on what additional analysis or sensitivities should be considered in the 2023 IRP. That feedback resulted in additional analysis considerations for customer solar generation, ground source heat pumps, demand response, as well as several suggestions that will be considered for future planning and analysis.

Given the considerable investment required for all scenarios, many of the sensitivities in the 2023 IRP explored if there were other potential ways to serve customer demand and understand if they lowered costs. Of particular focus were sensitivities with the potential to reduce peak demand given the observed connection between increasing peak demand requirements and increasing cost. Other sensitivities looked to understand the impacts of potential new government policies on restricting certain resources.

All sensitivities analyzed are listed below, followed by the select results presented in this document. Detailed results for all sensitivities are provided in **Appendix 5: Analysis results**.

All sensitivities:

- Natural gas generation grouping
  - Restricted use of natural gas generation
  - Carbon capture and storage required for all new natural gas generation
  - No new natural gas generation
  - High GHG emissions cost
  - GHG emissions budget
- Energy price and market interactions
  - Reduced imports
  - Low export and import market price
- Demand side grouping
  - Demand response
  - Dual fuel for heating
  - Optimization of energy efficiency
  - Ground source heat pumps and air source heat pumps
  - Distributed solar
  - Lower customer incentive level for energy efficiency
- Other sensitivities
  - Climate change
  - New hydropower
  - Wind
  - Solar (utility scale)
  - Electric vehicles
  - Provincial fees

Select natural gas generation and dual fuel results:

- Restricted use of natural gas generation
- Carbon capture and storage required for all new natural gas generation
- No new natural gas generation
- Dual fuel for heating

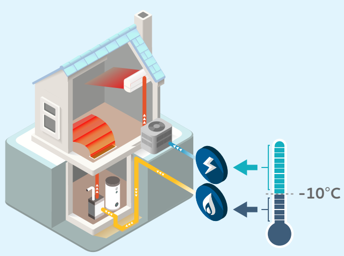
Select customer grouping results:

- Demand response
- Ground source heat pump
- Distributed solar
- Optimization of energy efficiency

Select natural gas generation and dual fuel results

Results for the dual fuel for heating, restricted natural gas generation usage, carbon capture required for natural gas generation and no new natural gas generation sensitivities provided the most observations informing the 2023 IRP road map. Those sensitivities are presented in this report as changes related to scenario four since it represents the greatest degree of change and provides the greatest opportunity to explore impacts to results. In scenario four, the need for capacity resources is driving costs and much of the winter peak demand is due to assumptions about electric resistance space heating requirements. The select sensitivity for dual fuel showed how changes in assumptions to space heating requirements can impact the scenario four results. The select sensitivities for restricted natural gas generation, carbon capture and no new natural gas generation show how differing assumptions on the uncertainty of energy policy can impact the scenario four results, particularly for Manitoba Hydro's integrated electricity and natural gas systems.

The following describes the four sensitivities in more detail:



Dual fuel sensitivities adjusted the assumption in the scenarios that space heating is electrified. Instead, a dual fuel system is used, where an air-source heat pump is combined with a natural gas furnace to heat and cool a building. Two sensitivities were analyzed, one where space heating switches from the air-source heat pump to the natural gas furnace at -10C, and the other where the switch over temperature is reduced to -20C.

Restricted natural gas generation usage assumed natural gas generation is not included as a resource to satisfy dependable energy planning criteria, rather it can only be used to satisfy capacity planning criteria. In practice, this should mean natural gas generation is run less often than in scenario four.

Carbon capture required for natural gas generation explored a potential future requirement to capture and store carbon emissions from natural gas thermal generation.

No new natural gas generation explored the impact of only non-emitting electricity being used, by removing the option of using any new natural gas generation. When paired with the assumptions in scenario four that space heating transitions to being electrified, this sensitivity has the most aggressive restrictions on the use of natural gas.

The dual fuel sensitivity results, as illustrated in Figure 6.20, show use of this technology can reduce the peak demand as compared to that of scenario four. Figure 6.22 also shows that this technology can mitigate the cost associated with assumptions of full electrification of space heating, while achieving significant GHG emission reduction.

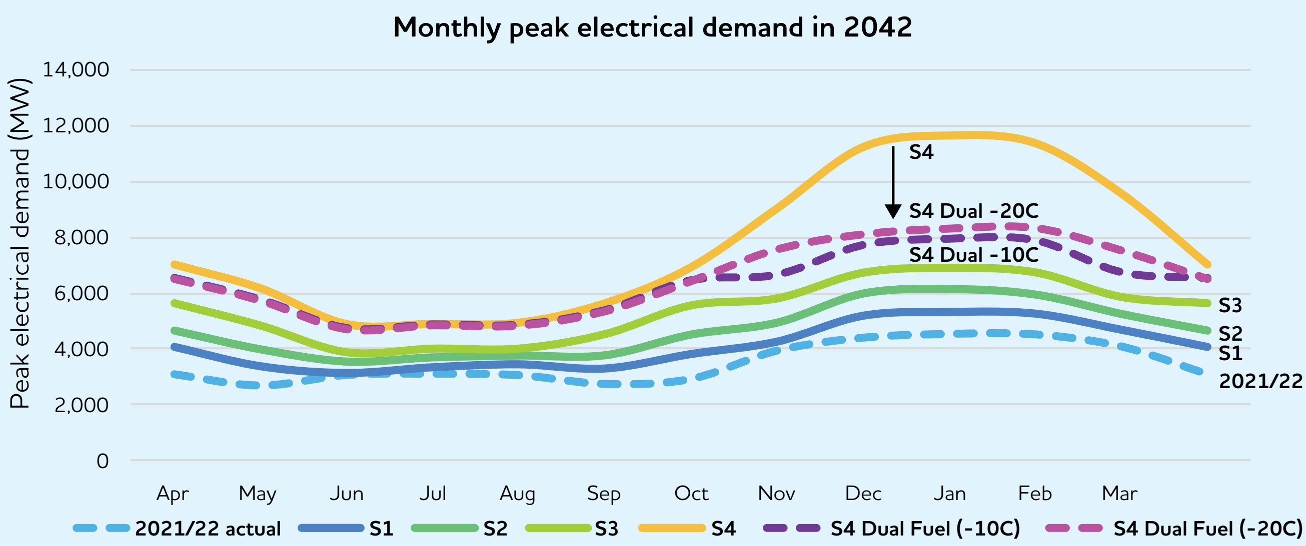


Figure 6.20 – IRP scenario demand projections for monthly peak electrical demand in 2042, including dual fuel sensitivities

The restricted natural gas generation usage and the carbon capture required for natural gas generation sensitivities reduced the electric generation GHG emissions as compared to scenario four results. However, as shown in Figure 6.22, in both cases it results in higher costs to achieve these greater GHG reductions.

The no new natural gas generation sensitivity further reduced electric generation GHG emissions – to near zero – but the cost is significantly greater than scenario four with a relatively small impact on total GHG emissions. The cost increase is a result of a requirement for more expensive resources, including hydrogen fueled combustion turbines, biomass, small modular reactors, and new hydropower development.

Resource additions, cost, and emissions information for the natural gas generation and dual fuel sensitivities can be seen in Figure 6.21, Figure 6.22 and Figure 6.23.

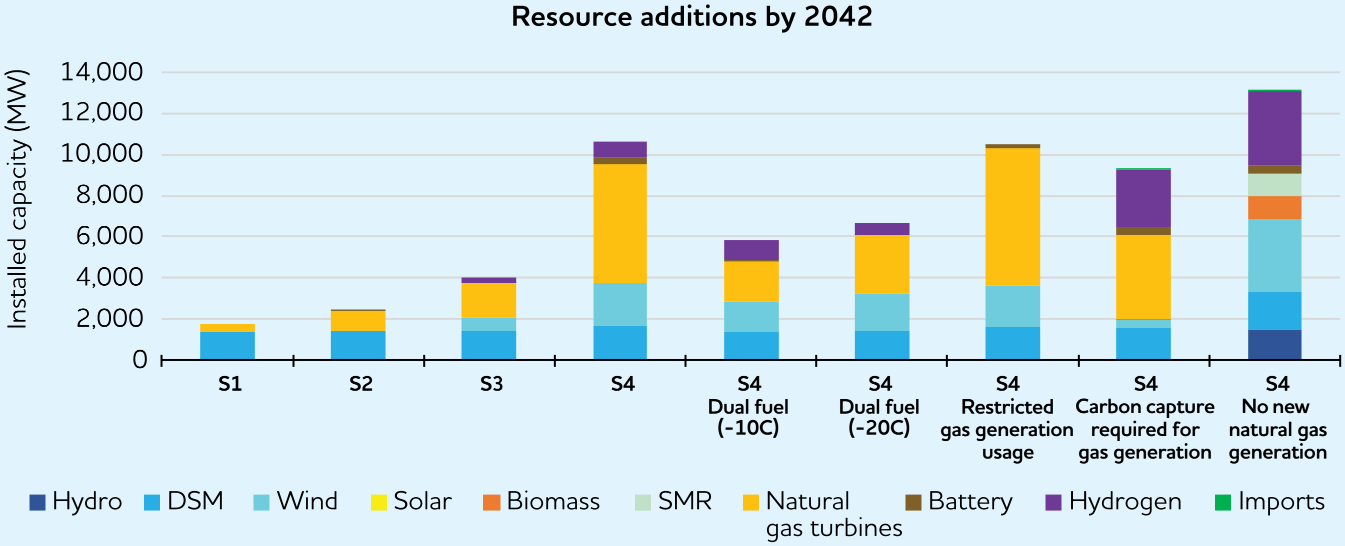


Figure 6.21 – Portfolio of resources for each IRP scenario and select sensitivities in 2042

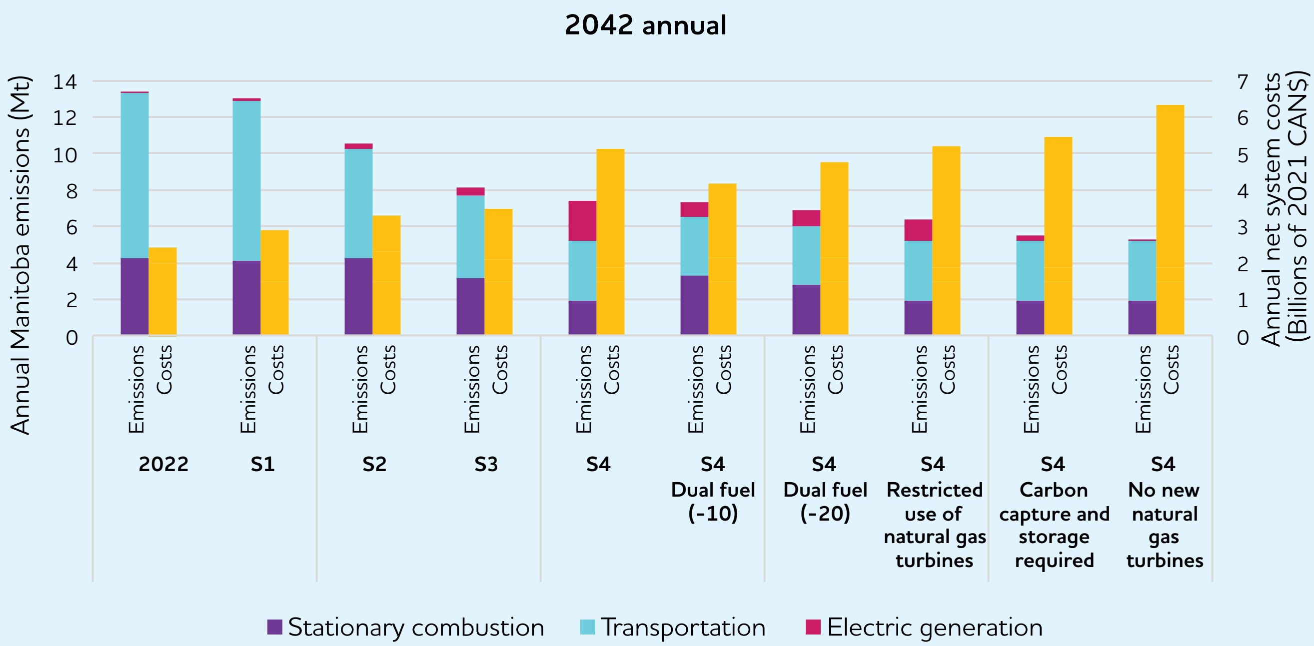


Figure 6.22 – GHG emissions and annual net system costs for each IRP scenario and select sensitivities as compared to 2022 actuals

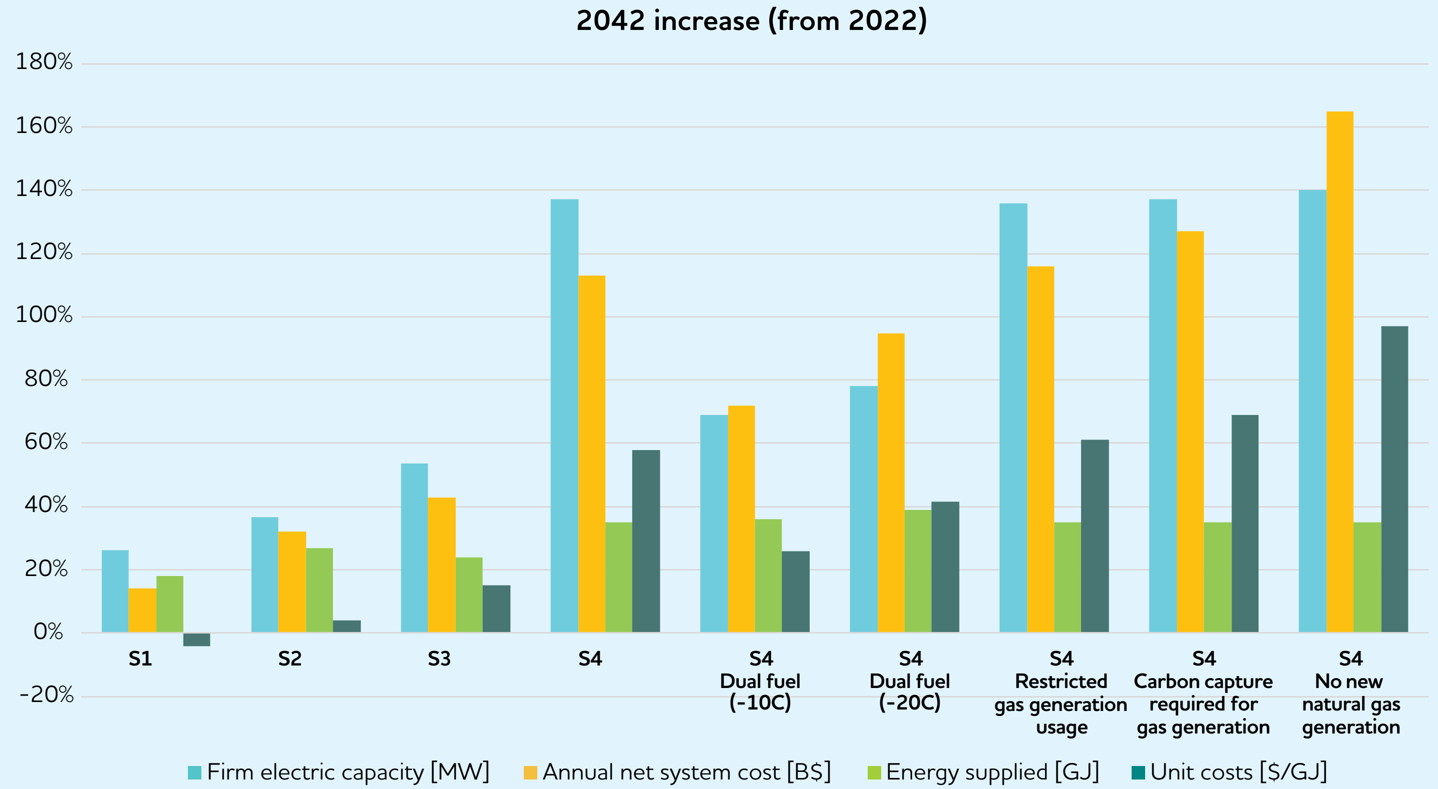


Figure 6.23 – Comparison of different modelling and analysis outputs for each IRP scenario and select sensitivities

Select demand side grouping results

Select sensitivities from the demand side grouping described below also contributed to key modelling and analysis observations. These sensitivities are:

- **Demand response**, non-wires solutions that influence electricity usage so less is used when customer demand is highest, including: different pricing and rate programs; load control, such as with some electric vehicle chargers; programmable thermostats; and, subscribing large industrial customers to reduce energy at times of peak demand.
- **Ground source heat pumps** that use energy from the ground to provide heating and cooling, with potential benefits of reducing GHG emissions without a significant increase in electric demand.
- **Solar** energy can be produced at utility scale, or by individual customers to first meet their own energy needs with the potential to sell excess energy back to Manitoba Hydro.
- **Energy efficiency** measures that reduce total electricity or natural gas use. Potential energy efficiency measures were modelled for the 2023 IRP in collaboration with Efficiency Manitoba and data provided by a consultant with expertise in energy efficiency.

Demand response programs were found to be a cost-effective alternative to building new capacity resources. The programs may also be implemented faster than building certain new resources, representing another potential benefit. However, the potential of demand response is limited – once the demand peaks are reduced to the point that demand is flat throughout the day, additional demand response provides no further value, as illustrated in Figure 6.24. These programs cannot fully meet the growing need for capacity, but they may play an important role because they can be implemented relatively quickly to manage increasing winter peak load. This could delay the need for additional capacity resources, up to four years in scenario two, providing additional lead-time to develop other capacity resources. For residential customers, demand response may be achieved through programs such as EV smart chargers or thermostat control. For commercial or industrial customers, interruptible rates and manual curtailment can contribute to demand response. In addition, time varying rates may be able to provide similar peak reductions as other demand response programs.

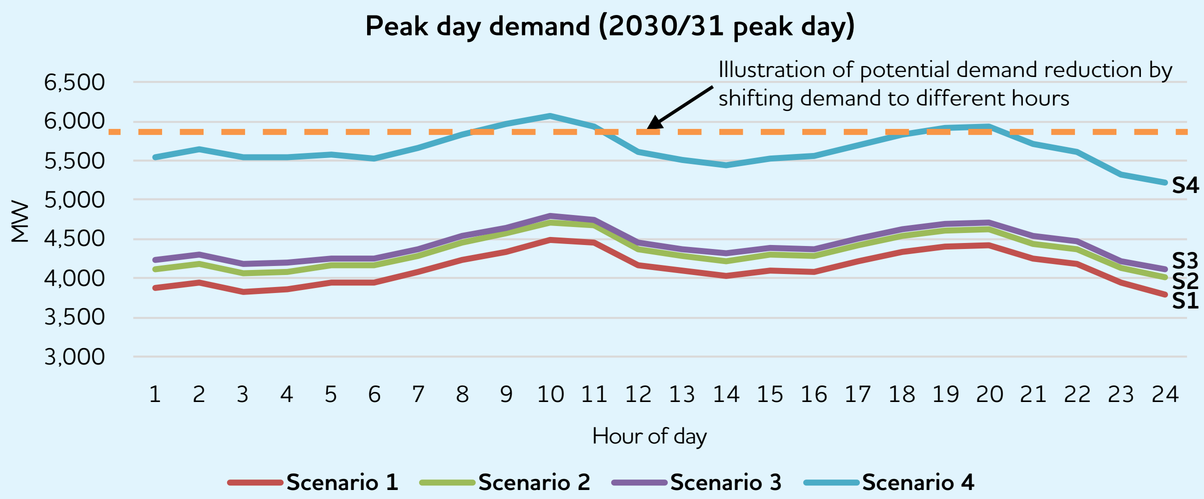


Figure 6.24 – Illustration of potential demand response impact in 2030/31

The ground source heat pump results show typical ground source heat pumps are not cost-effective on average and this can be seen in Figure 6.5 when comparing the levelized cost of energy and levelized cost of winter firm capacity to other resource options. Performance and cost of ground source heat pump systems can vary widely, and further study is required to refine assumptions and investigate specific potential benefits.

Though solar does provide cost-effective energy, it does not provide this energy when it is needed most – during the hours of winter peak load. Winter peak load happens in the early morning and evenings when there is limited to no sunlight available, as shown in Figure 6.25. Other resources would be needed for this time and could also be used to provide energy during other parts of the day. Solar was considered in every scenario and sensitivity but was not selected as a resource option by the model.

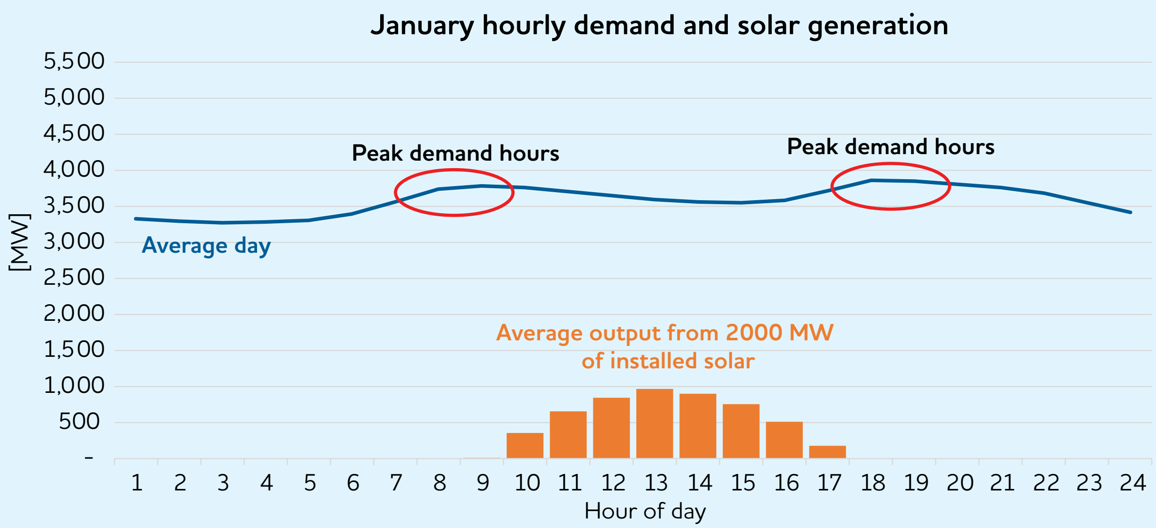


Figure 6.25 – Illustration of winter demand and available solar generation

Utility scale battery storage was included as a resource option within this IRP, with varying amounts included in the portfolio of resources selected for each of the four IRP scenarios. Currently utility scale batteries have relatively short discharge durations (approximately five hours), that do not align well with the needs of Manitoba's electrical system and the requirement to respond to long, multi-day periods of cold temperatures and high winter electricity load, as shown for a period in 2021 in Figure 6.26. Additionally, the cost of firm winter capacity from batteries is not as competitive as other capacity resources (as was shown in Figure 6.5), including natural gas thermal generation, demand response, and enhancements to existing hydropower stations.

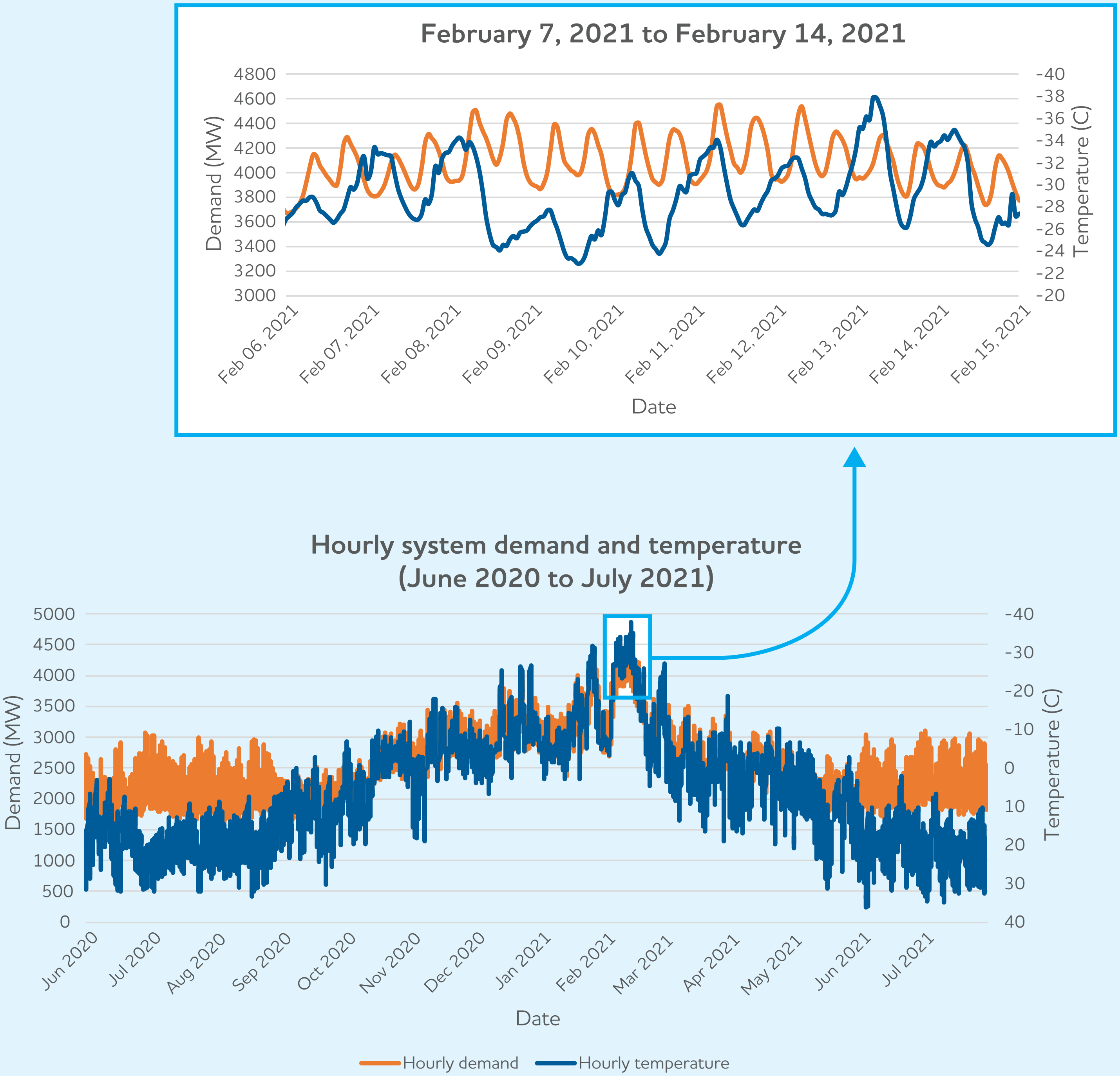


Figure 6.26 – Illustration of demand and temperature, with multi-day cold period in inset

Energy efficiency represents many individual measures with a range of costs and benefits. This range of costs can be seen relative to other resource options in Figure 6.5. Additional work is needed to better understand the role specific measures could play in the future.

Summary of observations from selected sensitivity results

As stated earlier, the select sensitivities highlighted in the preceding pages provided additional observations that contributed to development of the 2023 IRP road map. Those additional observations are:

- No new natural gas generation significantly increases cost and reliance on technologies that are less mature;
- Dual fuel programs have potential to reduce emissions at lower overall cost;
- Limiting thermal generation reduces emissions but increases costs;
- Carbon capture increases use of thermal generation and net system costs;
- Demand response is cost effective for delaying or reducing the need for new capacity resources;
- Ground source heat pumps performance varies widely and was not found to be cost-effective on average;
- Energy efficiency's cost effectiveness is dependent on program and requires closer analysis; and,
- Solar is not as cost-effective as other resources available in Manitoba.

Figure 6.27 – Summary of observations from select sensitivity results

Additional detail on sensitivity results is available in **Appendix 5: Analysis results.**

7

SETTING THE FUTURE DIRECTION

A collection of learnings, signposts and near-term actions that together allow us to navigate the energy transition.

LEARNINGS:
Knowledge gained from the process.

NEAR-TERM ACTIONS:
Actions over the next five years.

SIGNPOSTS:
Policy, market, technology, and customer trends and events

Figure 7.1 – 2023 IRP road map components

7.1. THE 2023 IRP ROAD MAP

The 2023 IRP road map is a product of the outcomes from the planning process. It outlines the steps Manitoba Hydro can take in our journey to the future, recognizing there are a number of directions we could take and that we may have to change direction as the future unfolds. It is a planning tool to help us successfully navigate a transition from today's energy systems to future energy systems, while continuing to serve our customers with safe, reliable energy at the lowest cost possible, even as their needs change.

The IRP road map is not a development plan, it is a collection of learnings, near-term actions, and signposts.

7.1.1. LEARNINGS

IRP learnings are fundamental to the road map and inform the near-term actions and signposts. They are rooted in studied and documented outcomes. They summarize key insights gained through the process of developing the IRP, from engagement and customer input and feedback, modelling and analysis, and studying potential and implemented government policies. Insights may include what the biggest challenges may be moving forward or what challenges need to be addressed in the near-term.

7.1.2. NEAR-TERM ACTIONS

Near-term actions focus on actions intended for the next five years. These actions are the steps we can take now to ensure Manitoba is ready for a range of possible future scenarios. There will be an opportunity for the energy planning community to participate in the planning and execution of near-term actions.

The energy planning community is defined as those who work with and influence energy planning, such as Manitoba Hydro, governments and regulators, Efficiency Manitoba, and interested parties including customers and Indigenous peoples and communities.

7.1.3. SIGNPOSTS

Signposts refer to the policy, market, technology, customer trends and events that will be monitored during implementation of the road map. Monitoring signposts for trends can provide early indication of how the energy landscape is changing. Because these changes can happen quickly, monitoring signposts will help ensure the near-term actions are still the right ones to pursue or if plans need to be advanced, delayed, or modified.

All of these components – learnings, near-term actions and signposts – taken together describe how we will continue monitoring, preparing for, and responding to the changing energy landscape.

7.2. 2023 IRP LEARNINGS

7.2.1. WHAT ARE THE LEARNINGS?

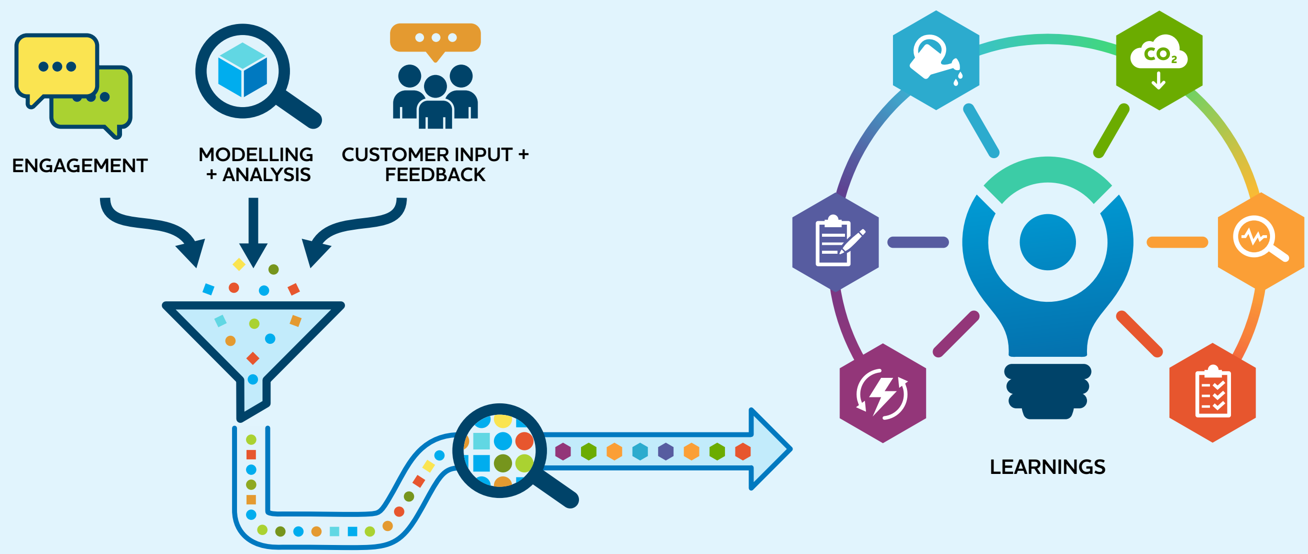


Figure 7.2 – Illustration of learning development

LEARNINGS

1. The energy transition is underway in Manitoba.
2. Managing the energy transition will be critical to continue safe, reliable, and low-cost energy.
3. Investment is required in all scenarios.
4. Strategic use of natural gas assets and gaseous fuels are an integral part of the energy transition in Manitoba.
5. Analysis findings common to all scenarios can inform responses to an accelerated energy transition.
6. Future energy-related decisions will require complex considerations.

Figure 7.3 – 2023 IRP learnings

There are six learnings within the 2023 IRP road map that inform a comprehensive set of near-term actions.

The first learning is that the energy transition is underway in Manitoba, as shown by the data from the last two years of work.

The second learning is how critical managing this energy transition will be to continuing to provide safe, reliable, and low-cost energy to our customers. The uncertainty in the pace and timing of change results in a potentially wide range of related costs, GHG emissions, and resource mixes. Managing this uncertainty, through careful consideration of the timing, type, and execution of future decisions, is critical to ensuring value for all Manitobans.

Learning three is that even with this uncertainty, significant investment is needed in every scenario due to the evolving energy landscape.

Learning four is that some of the investment needs can be mitigated through the strategic use of natural gas assets and fuels, while still enabling overall reductions in Manitoba's GHG emissions.

Learning five is the recognition that some findings from the modelling and analysis were consistent across scenarios and sensitivities and unlikely to change. Therefore, these findings are valuable indicators of where some of the near-term future decisions can be made, particularly for an accelerated energy transition.

Learning six is that future decisions will require supplementary considerations, in addition to the reliability and low-cost objectives in the modelling and analysis. Some considerations may need to be made outside of the existing modelling and analysis approach. This will make future decisions more complex.

7.2.2. DETAILS OF THE 2023 IRP LEARNINGS

LEARNING ONE: The energy transition is underway in Manitoba.

a. Some large energy users are beginning to transition to achieve environmental, social and governance goals.

b. Changes are expected in how energy is produced, delivered and used. The pace of change is uncertain.

c. Meeting the pace of accelerated decarbonization would be a challenge in early years.

The 2023 IRP identified that some large business customers are taking steps to decarbonize their current energy sources, not necessarily because they are mandated to do so, but because their business decisions are supported by other drivers, such as shareholder expectations and consumer preferences. This includes customers already in Manitoba and potential customers who have expressed an interest in moving their business to Manitoba because of our clean electricity advantage.

While there is certainty that the energy transition is happening, we also learned there is still much uncertainty in the energy transition including the pace of change.

The reduction of GHG emissions through decarbonization is not limited to just the electricity sector. It is much broader and includes other sources, such as space heating and transportation. We learned that, should decarbonization of all sectors be pursued through electrification and at an accelerated pace, bringing new resources into service in time to meet the higher demand for electricity will be challenging in the early years of the study period.

LEARNING TWO: Managing the energy transition will be critical to continue safe, reliable, and low-cost energy.

a. Energy policy will be a major influence on the pace of decarbonization and is an important tool to manage the energy transition.

b. Energy planning needs to consider a broad range of scenarios, including pathways towards net-zero GHG emissions.

c. There's an opportunity for the energy planning community (including Manitoba Hydro, governments, regulators and interested parties such as customers and Indigenous peoples and communities) to work together in the best interests of Manitobans.

The second learning is based on the need to manage the energy transition through careful consideration of future decisions. The 2023 IRP looked at a range of possible futures given the uncertainty in the changing energy landscape and found that there are many different ways to address the energy transition.

The 2023 IRP considers existing and potential policy for all levels of government including federal, provincial and municipal. We learned that energy policy will be one of the greatest influences on the pace of change, particularly for decarbonization. Consequently, energy policy can be used to manage the pace and impact of change.

We also learned that, given the uncertainty, energy planning will need to continue to consider broad ranges of scenarios, including pathways towards net-zero. We will need to be agile in managing the energy transition.

Engagement was key to the success in developing the 2023 IRP. The feedback and input heard helped inform the 2023 IRP outcomes with an understanding of the Manitoba context. We learned that continued conversations are needed. As we move forward, there is an important role to play for the broader energy planning community within this energy transition.

The energy planning community is defined as those who work with and influence energy planning, such as Manitoba Hydro, governments and regulators, Efficiency Manitoba, and interested parties including customers and Indigenous peoples and communities. There is an opportunity to work collaboratively with all parties in the best interests of Manitobans.

LEARNING THREE: Investment is required in all scenarios.

a. All scenarios result in increased winter peak demand (up to 2.5 times current demand) requiring new generation, transmission and distribution infrastructure.

b. There are many potential ways to reliably meet long term needs. Some ways are better understood than others and are at different stages of maturity.

A key learning from the 2023 IRP modelling and analysis is that significant investment to support future energy needs is required for all scenarios and sensitivities. This investment is needed by both Manitoba Hydro and customers and is in addition to the investment needed to maintain existing infrastructure.

All scenarios resulted in increased winter peak demand (of up to 2.5 times current demand), indicating a need for new electricity generation, transmission, and distribution infrastructure. The modelling and analysis demonstrated that increasing levels of decarbonization results in increased costs, but there is not a corresponding reduction in provincial GHG emissions. How decarbonization is achieved also impacts costs. The net present value of future net system costs for the scenarios and sensitivities over the study period range from approximately $12 billion to nearly $27 billion, which is in addition to investments needed to maintain existing infrastructure.

We also learned that meeting this increased demand can be achieved in many ways. Many technologies or strategies can be used; it is not necessary to pick just one or two, several together can support future energy needs. That said, some of these options are proven, while others are at less mature stages of development, and may not be tested in the Manitoba context.

LEARNING FOUR: Strategic use of natural gas assets and gaseous fuels are an integral part of the energy transition in Manitoba.

a. Electrification of energy as a means of decarbonization results in our customers needing significantly more electricity.

b. Integrated use of electricity and natural gas systems enables strategies that can reduce Manitoba's GHG emissions while mitigating cost impacts.

c. Leveraging existing natural gas assets can be a cost-effective way of decarbonizing space heating and enables the potential future use of renewable fuels.

As one of the main drivers of the changing energy landscape, decarbonization is not just limited to space heating. Other areas, such as transportation, are also moving to decarbonize their energy sources and electrification of these energy sources increases the need for electricity. The 2023 IRP modelling and analysis showed that using a dispatchable capacity resource, such as thermal generation fueled by natural gas, is a low-cost way to manage the impacts of this increased need for electricity to ensure reliability. A dispatchable resource can be run infrequently to support peak demand, while complementing the intermittent availability of variable renewable energy resources like wind. While generation emissions do increase using natural gas thermal generation, this approach still supports significant reductions in overall GHG emissions in the province.

Similarly for space heating, the modelling and analysis results show that assumptions about decarbonization of space heating through electrification have a significant impact on winter peak demand. In an aggressive decarbonization scenario, the dual fuel sensitivity results showed use of air-source heat pumps combined with natural gas furnaces may be a cost-effective means of supporting overall reductions in Manitoba's emissions because it can avoid some of the costs associated with new electricity resources.

Continuing use of the natural gas system also leverages the past investments in this infrastructure and allows an opportunity for renewable gaseous fuels to be used in the system.

LEARNING FIVE: Analysis findings common to all scenarios can inform responses to an accelerated energy transition.

a. Most energy comes from existing electricity and natural gas assets in the foreseeable future, making continued investment in these assets necessary.

b. Wind generation is a cost-effective future choice for energy.

c. Dispatchable capacity resources are needed to complement future variable renewable energy resources like wind.

d. Energy efficiency measures that reduce peak electricity demand are most valuable to the electricity system.

e. Enhancements to existing hydropower assets are cost-effective, but not major new hydropower.

f. Solar resources are not identified as cost-effective options in the analysis.

There are consistent observations across scenarios that also remained consistent with changes in assumptions and inputs for different sensitivities.

The first such observation is while investment is required to meet the evolving energy landscape, most energy will still come from existing electricity and natural gas assets. As described in learning four, there is value in leveraging the existing natural gas assets, not only for continued space heating requirements, but also for new electricity generation. As such, continued investment in the electrical and natural gas assets, including generation, transmission and distribution is required.

Another observation is wind generation is a cost-effective future choice for energy. Wind was a common resource present in the scenario and sensitivity resource mix results. However, wind and other variable renewable energy resources, must be paired with a dispatchable capacity resource to reliably meet the increasing electricity needs of customers.

Expanded or additional energy efficiency measures will also play a role in managing future energy needs. Modelling and analysis demonstrated that those energy efficiency measures that reduce peak electrical demand provide the most value. This is because these measures reduce electrical system costs more than those measures that reduce energy with little effect on peak demand.

Consistent with the observation that continued investment is needed to support existing infrastructure, another learning is that enhancements to existing hydropower assets are cost-effective as compared to other resources. Existing hydropower enhancements are part of the resource mix in each of the scenario and sensitivity results and are selected before other resources. These enhancements include upgrades of existing generating units to increase their capacity.

There are also common findings for resources that were not selected. New hydropower generation is only cost-effective in extreme sensitivity conditions. Solar resources cannot reliably meet Manitoba's winter peak demand. Other resources that can meet winter peak demand are needed instead. Future planning will continue to study opportunities for these technologies.

LEARNING SIX: Future energy-related decisions will require complex considerations.

a. Future decisions should continue to consider (but not be limited to) cost, reliability, environmental, climate, economic, and social considerations.

b. Further work to understand potential trade-offs beyond Manitoba Hydro's current electricity and natural gas mandates is required.

Because of Manitoba Hydro's mandate, the 2023 IRP analysis focused on identifying utility-based least cost resource options to meet the changing energy landscape. Going forward, it will be necessary to continue considering cost, emission impacts, and reliability, but also other potential factors such as environmental, climate, economic development, and social impacts. Consideration of these factors, and the trade-offs between them, beyond utility-based costs may be necessary to best meet the needs of Manitobans.

7.3. 2023 IRP NEAR-TERM ACTIONS

7.3.1. WHAT ARE THE NEAR-TERM ACTIONS?

There are five near-term actions in the 2023 IRP road map, each developed with consideration for how energy changes in sectors other than the electricity sector in Manitoba could impact the demand for electricity and natural gas. These actions are to be taken over the next five years. Given this broad scope and the uncertainty in the energy landscape, these near-term actions are intended to cover the full range of possible actions to prepare for a changing energy future.

It is important to note that implementation of the near-term actions requires more detailed planning to confirm if individually, they are feasible to complete in the next five years. Each action will need to be planned with a full definition of their individual scope of work and schedule and prioritized.

NEAR-TERM ACTIONS

1. Actively manage increasing winter peak load.
2. Pursue near-term options to be ready for potential rapid demand growth.
3. Develop options to reduce carbon content in natural gas.
4. Enhance integrated resource planning to address evolving needs.
5. Continue planning to meet the challenges of deep decarbonization.

Figure 7.4 – 2023 IRP near-term actions

Where a near-term action is driven from learnings or where there is less certainty and understanding, the actions focus on more **study and research**.

Where there is more certainty and understanding, but less certainty about feasibility in Manitoba, actions focus on **trials and demonstrations**.

Where there is confidence in the need for a program or initiative, actions take steps towards **implementation**.

Actions one and two address the immediate challenges of managing peak demand and readying for potential rapid growth. Actions three and five reflect the learning that strategic use of natural gas can play a role in the energy transition. Action four includes evolving our engagement conversations as well as preparing for a more complex energy future.

Each near-term action provides a contribution towards making sure our electricity and natural gas supply and delivery systems meet the needs of customers for the next 20 years and beyond. The actions complement each other and help prepare for a broad range of potential futures.

7.3.2. DETAILS OF THE 2023 IRP NEAR-TERM ACTIONS

NEAR-TERM ACTION ONE: Actively manage increasing winter peak load.

1.1 Explore the potential for dual fuel space heating, including development of a pilot project.

1.2 Pursue high-value energy efficiency measures in collaboration with Efficiency Manitoba.

1.3 Develop demand response product options.

1.4 Develop rate design options.

The first near-term action, to actively manage increasing winter peak load, comes from our learning that all scenarios resulted in increased winter peak demand. Addressing the potential challenge of peak demand can be accomplished through sub-actions that help address the need for capacity without adding new resources.

The first of these sub-actions is to further explore the potential for dual-fuel space heating in Manitoba. The possible value of a dual-fuel program was demonstrated through sensitivity analysis which showed an overall reduction in Manitoba's GHG emissions with less overall cost. While additional data and understanding of the potential role of air-source heat pumps continues to become available, we are recommending a pilot project to acquire data and assess its specific feasibility and implications in Manitoba.

The next sub-action is to pursue high value energy efficiency measures in collaboration with Efficiency Manitoba. In this IRP, energy efficiency was shown to have most value during peak demand but can also bring value to Manitoba by reducing overall energy consumption.

By shifting load, demand response was shown by our modelling and analysis to delay requirements for new capacity resources. As a result, we've included a sub-action to explore what demand response programs could look like in Manitoba. The scope of this action could include residential or commercial or industrial customers.

Lastly, rates were identified as a topic of high interest in round one engagement – the customer survey – and therefore the role of rates in actively managing winter peak load should be explored by developing rate design options for further consideration.

NEAR-TERM ACTION TWO: Pursue near-term options to be ready for potential rapid demand growth.

2.1 Pursue cost-effective enhancements to existing hydropower plants.

2.2 Increase readiness for new resources including minimizing lead times to initiate, plan and construct.

2.3 Prepare detailed plans for high potential near-term new resources, such as wind and dispatchable capacity.

2.4 Establish a range of potential resource development plans that meet Manitoba's future capacity and energy needs.

2.5 Develop grid modernization and expansion strategies to enable future peak demand growth and enhance operations.

The accelerated decarbonization and steady decentralization future described in scenario four had the highest electricity demand in this IRP. Through the process of developing the plan we also confirmed that the energy transition is happening, that the pace of change is uncertain, and that it could be accelerated by policy. This learning further demonstrates that demand for electricity could be significant and it could be required quickly in the future. Near-term action two positions Manitoba to be ready for rapid growth in electricity demand.

Sub-action 2.1 seeks to pursue cost-effective options to enhance existing hydropower plants. Sub-action 2.2 specifically prepares for an accelerated pace of change by increasing readiness for new resources, including minimizing lead times. Sub-action 2.3 reflects that modelling and analysis results consistently showed wind as an economic energy resource, and that complementary sources of dependable capacity needs to be further investigated.

Sub-action 2.4 is a next step to making a resource decision. A resource development plan outlines a sequence of potential resources to provide energy and capacity with consideration for in-service time and need dates. The 2023 IRP analysis showed that potential supply mixes and solutions may change with adjustments to the forecasts and assumptions in the model. By preparing a range of development plans we can explore the tipping point between alternative resource choices.

Sub-action 2.5 is quite broad and relates to the future of the distribution and transmission systems. It recognizes the need for modernization and expansion to address peak demand and to meet the operational needs of customers in the long-term. The scope of this sub-action will need to be determined and could include a role for technologies that enable advanced metering or demand response. Grid investment requirements could vary by geographic areas in Manitoba with consideration for reliability, efficiency, and cost-effectiveness.

NEAR-TERM ACTION THREE: **Develop options to reduce carbon content in natural gas.**

3.1 Develop renewable natural gas market participation structure.

3.2 Continue investigation of renewable natural gas market and supply potential.

3.3 Investigate hydrogen blending feasibility and market potential.

Another learning from the 2023 IRP was the need to plan towards net-zero GHG emissions, including consideration of the carbon content in natural gas. The sub-actions under the third near-term action – develop actions to reduce carbon content in natural gas – explore the opportunity to leverage existing natural gas assets by using low carbon alternative fuels.

Sub-actions 3.1 and 3.2 explore renewable natural gas (RNG). There are a variety of roles that Manitoba Hydro could potentially play with respect to RNG, from being only a distributor to being a purchaser and seller. The roles, along with the supply, demand, and cost of RNG should be investigated further.

Adding hydrogen to the natural gas system is another potential decarbonization option. Sub-action 3.3 is a first step to investigate the feasibility of this option for Manitoba.

NEAR-TERM ACTION FOUR: **Enhance integrated resource planning to address evolving needs**

4.1 Continue building the energy planning community and evolve engagement with interested parties, including Indigenous and community leadership, as well as representation from a variety of customer segments.

4.2 Develop a framework to evaluate total energy-related costs to help Manitobans understand the implications of future energy choices.

4.3 Study the evolving role of energy markets and interconnections.

4.4 Advance detailed planning to reflect regional variations across Manitoba.

Enhancing integrated resource planning is another of the next steps to prepare for a more complex energy future.

Sub-action 4.1 comes directly from our learning that there is an opportunity for the energy planning community to work together. A foundation was established during this IRP, but there is a need to further develop and integrate engagement into the IRP. There is also an opportunity for the Government of Manitoba, Manitoba Hydro, Efficiency Manitoba, and the PUB to align and work together in the best interests of Manitobans.

Sub-action 4.2 reflects our learning that future decisions will be complex. Evaluation criteria based on total energy-related costs rather than solely on utility-based costs will better inform those decisions. These total-energy related costs will include costs customers may incur directly due to the energy transition. A broader perspective of the cost of the energy transition will help evaluate potential trade-offs between solutions. This sub-action is also intended to identify the additional considerations (i.e. in addition to cost) to factor into future energy-related decisions. Broadening this analysis may also help identify where incentives or financial support could be necessary to help manage the energy transition.

Another of our learnings was that there are many ways to reliably meet long term needs, including energy markets and interconnections. Sub-action 4.3 is to investigate the opportunity to build upon existing interconnections and look for opportunities as energy markets evolve.

Sub-action 4.4 is to advance energy planning in an integrated manner to better reflect regional variations across Manitoba. Manitoba is a vast province with unique needs for different geographic areas. Providing this detailed planning is one way to better manage the energy transition.

NEAR-TERM ACTION FIVE: Continue planning to meet the challenges of deep decarbonization.

5.1 Determine impacts of integrating variable renewable resources like wind, including transmission requirements.

5.2 Identify and assess the potential of hydrogen supply, direct-use, storage and other infrastructure.

5.3 Explore the potential long-term role for technologies such as energy storage, carbon capture and storage, hydrogen fueled combustion turbines, biomass, and small modular reactors.

The fifth near-term action focuses on work needed now to ensure Manitoba is ready for a future with deep decarbonization. Modelling and analysis results indicated that as the energy transition moves further towards deep decarbonization, there may be a greater reliance on less mature or developing technology resources to meet customer demand.

Given the consistent presence of wind in the 2023 IRP results and the near-term action to plan for wind, sub-action 5.1 addresses the complementary need to examine how to optimally integrate variable renewable resources into the electric system. This sub-action is important because there is a limit to the amount of variable renewable resources that can be added to the system before more complex technical issues must be considered, which may impact existing generation and transmission systems and result in increased costs.

Sub-action 5.2 recognizes the potential of hydrogen to support future decarbonization efforts. It can be blended with natural gas to minimize its carbon intensity, used directly to decarbonize energy use that is hard to electrify, or used like a battery for electricity generation. This sub-action is also intended to obtain a better understanding of the potential for short and long-term storage of hydrogen.

Sub-action 5.3 addresses technologies that are generally in their earlier stages of technical development such as energy storage and carbon capture. These resource options appeared in the analysis results, when decarbonization was accelerated and emission reduction regulations were more aggressive. Further work is needed to refine the assumptions and estimates for these options and to better understand the potential feasibility within the Manitoba context.

Manage winter peak	Prepare for rapid demand growth	Develop options to reduce carbon in gas	Enhance planning	Prepare for deep decarbonization
1.1 Explore the potential for dual fuel space heating, including development of a pilot project. **1.2** Pursue high-value energy efficiency measures in collaboration with Efficiency Manitoba. **1.3** Develop demand response product options. **1.4** Develop rate design options.	**2.1** Pursue cost-effective enhancements to existing hydropower plants. **2.2** Increase readiness for new resources including minimizing lead times to initiate, plan and construct. **2.3** Prepare detailed plans for high potential near-term new resources, such as wind and dispatchable capacity. **2.4** Establish a range of potential resource development plans that meet Manitoba's future capacity and energy needs. **2.5** Develop grid modernization and expansion strategies to enable future peak demand growth and enhance operations.	**3.1** Develop renewable natural gas market participation structure. **3.2** Continue investigation of renewable natural gas market and supply potential. **3.3** Investigate hydrogen blending feasibility and market potential.	**4.1** Continue building the energy planning community and evolve engagement with interested parties, including Indigenous and community leadership, as well as representation from a variety of customer segments. **4.2** Develop a framework to evaluate total energy-related costs to help Manitobans understand the implications of future energy choices. **4.3** Study the evolving role of energy markets and interconnections. **4.4** Advance detailed planning to reflect regional variations across Manitoba.	**5.1** Determine impacts of integrating variable renewable resources like wind, including transmission requirements. **5.2** Identify and assess the potential of hydrogen supply, direct-use, storage and other infrastructure. **5.3** Explore the potential long-term role for technologies such as energy storage, carbon capture and storage, hydrogen fueled combustion turbines, biomass, and small modular reactors.

Figure 7.5 – Summary of 2023 IRP near-term actions and sub-actions

7.4. 2023 IRP SIGNPOSTS

7.4.1. WHAT ARE THE SIGNPOSTS?

Signposts are indicators that inform on the timing, pace, magnitude, or type of changes happening in the changing energy landscape.

By actively monitoring signposts, trends can be identified to anticipate and understand when and how changes are occurring. Such insights may cause a change in the road map, including prioritizing, expediting or delaying, modifying, adding or removing near-term actions.

There are four signposts included as part of the 2023 IRP road map. These signposts were proposed because they reflect areas with the most uncertainty and potential to impact the changing energy landscape in Manitoba. They will be further developed and refined as we implement the road map. The four proposed signposts are:

- government actions;
- customer decisions;
- zero emission vehicles (ZEVs); and,
- technologies and markets.

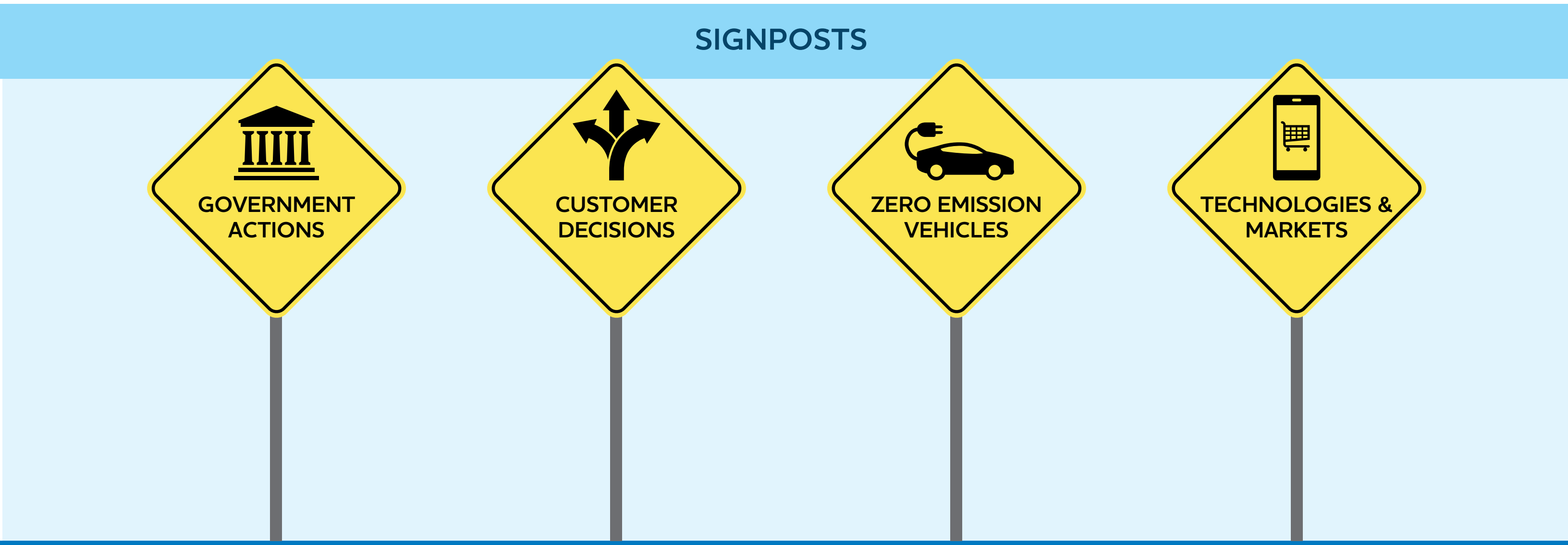


Figure 7.6 – 2023 IRP signposts

7.4.2. DETAILS OF THE 2023 IRP SIGNPOSTS

Government actions

INCLUDES:

- federal, provincial and municipal;
- regulators; and,
- Canada, U.S. and internationally.

POTENTIAL GOVERNMENT PRIORITIES:

- climate;
- environment;
- reconciliation;
- economic development; and,
- energy efficiency.

TYPES OF ACTIONS TO MONITOR:

- Incentives, programs, funding; and,
- Legislation, policy, regulations, codes, standards, and mandates.

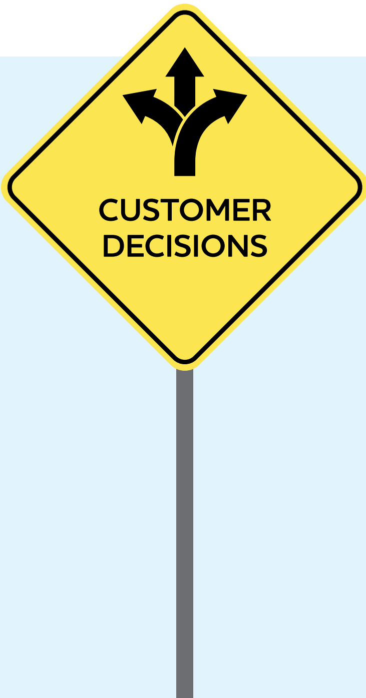
Figure 7.7 – 2023 IRP government actions signpost details

As mentioned previously, a key learning of the 2023 IRP is energy policy will be a major influence on the pace and scale of decarbonization, with potential to influence customers' decisions related to energy and Manitoba Hydro's supply options. The term energy policy includes both the rules – legislation, regulations, codes, and standards – and the financial supports that governments provide through incentives, programs, and funding.

While climate change has been a focus of governments, energy policy can also be used to advance other priorities like economic development.

In addition to monitoring government actions in Canada, the actions of U.S. governments and international bodies will also be monitored because of their potential to impact Manitoba Hydro and its customers or provide insights into the direction of potential future policy.

Customer decisions



INCLUDES:

- residential, commercial, industrial, institutional;
- current and potential new customers; and,
- pace, profile and location of load changes and growth.

PREFERENCES AND ATTITUDES:

- increasing focus on reaching net-zero;
- environmental, social, governance (ESG) targets;
- energy sources;
- increasing focus on enhancing resilience; and,
- energy affordability.

TYPES OF CUSTOMER DECISIONS TO MONITOR:

- fuel switching choices (e.g. heating, industrial);
- changing energy usage (e.g. more transit);
- self-generation adoption;
- use of battery storage; and,
- potential new customer loads.

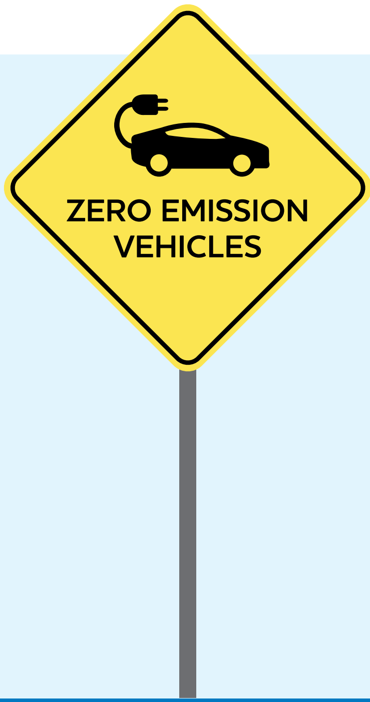
Figure 7.8 – 2023 IRP customer decisions signpost details

The second signpost is customer decisions. Monitoring and anticipating customer decisions is required to ensure customers have the energy they need, when and where they need it. Through the 2023 IRP Engagement, we learned all customer segments are considering energy related decisions which may influence the pace, profile, and location of energy load changes and growth. For some, cost or affordability may be a significant driver of decisions, while for others, climate adaptation and resiliency or working towards net-zero may be important. This information influences the planning for the supply and delivery of natural gas and electricity.

Changes behind the customer meter can have a large influence on future electricity and natural gas loads and also need to be monitored. For example, customers may be considering upgrading their facility or equipment to decrease energy use, switching to different fuels, or electrifying their heating and industrial processes.

Customer feedback from some of Manitoba Hydro's largest natural gas users in round two engagement indicated that some customers are already looking at switching to electricity in their operations to reach net-zero or environmental, social, and governance goals. Some are also interested in using renewable natural gas.

Zero-emission vehicles (ZEVs)



INCLUDES:

- Light duty, medium duty, heavy duty (personal and fleet); and,
- Pace, profile and location of load changes and growth.

PREFERENCES AND ATTITUDES:

- Forecasts for adoption; and,
- Fleet customers setting ZEV targets.

TYPES OF ZEV CHANGES TO MONITOR:

- Charging/fueling availability;
- Range;
- Upfront costs and payback period;
- Vehicle type availability; and,
- Electric, hydrogen, and other new technologies.

Figure 7.9 – 2023 IRP zero-emission vehicles signpost details

The third signpost is dedicated to ZEVs. GHG emissions related to transportation account for approximately nine megatons, or 40 percent of the total of 22.8 megatons of emissions in Manitoba. Reducing transportation emissions is a significant component on the pathway to net-zero.

ZEVs can operate without producing emissions. ZEVs include:

- **battery electric** vehicles that run on batteries that recharge with electricity;
- **plug-in hybrid electric** vehicles that run on smaller batteries that recharge with electricity and also have an internal combustion engine that uses traditional fuels like gasoline; and,
- **hydrogen fuel cell** vehicles that refuel with compressed hydrogen.

Monitoring various aspects of ZEVs including the cost, availability, and ability of light, medium, and heavy-duty ZEVs will be important to ensure we continue to meet customer needs. This includes monitoring changes in the technology, what's influencing decisions to adopt ZEVs, and details of where and how adoption will impact the demand for electricity as well as the grid's ability to deliver energy.

Technologies & markets

INCLUDES:

- Supply, load and storage technologies; and,
- Wholesale markets.

PREFERENCES AND ATTITUDES:

- Technology forecast including cost and commercial availability;
- Competition for project resources including labour and materials; and,
- Energy price forecasts.

DEVELOPMENTS TO MONITOR:

- Utility generation options;
- Alternative fuels;
- Self-generation technology;
- Two-way energy flow (e.g. batteries, vehicle to grid); and,
- Market construct.

Figure 7.10 – 2023 IRP technologies & markets signpost details

The fourth and final signpost is technologies and markets. Technologies refers to the technology Manitoba Hydro and our customers may use to generate, deliver, or store energy, and those used to produce renewable fuels. Market changes include the price of commodities such as natural gas, the availability and cost of renewable fuels, and changes in wholesale electricity markets.

The 2023 IRP learnings identified there are many potential options to meet future energy needs; however, the maturity of those solutions and where they are in development can vary. This IRP includes near-term actions to investigate some of those technologies. Monitoring their development along with a broader list of options will ensure we are investigating the right solutions at the right time.

For example, there are few operational examples of small modular reactors, hydrogen-fueled generating stations, or natural gas generation with carbon capture and storage. Similarly, there is some information about the availability and cost of renewable natural gas within and outside of Manitoba, but there is still much to learn about its full potential.

There is also a near-term action to further study the evolving role of energy markets and the signpost to monitor energy markets will help inform such study.

7.5. 2023 IRP ROAD MAP IMPLEMENTATION RISKS

When implementing the 2023 IRP road map there are risks that need to be considered due to continued uncertainty about the energy landscape in Manitoba and how it may change. Monitoring signposts can help us identify when to take action to mitigate some risks and ensure we are focusing on the most important actions to support our customers.

Near-term actions need to be fully planned and will require financial and human resources, including people with the right skills, ability, and time to carry out the work. Implementing the 2023 IRP road map is one of several priorities identified in Manitoba Hydro's Enterprise Plan and the near-term actions will need to be prioritized and considered for resourcing along-side other initiatives. It may not be possible to progress all actions.

Manitoba Hydro is not alone in anticipating significant growth in electricity needs, either due to the energy transition, from economic development, or some other combination. Changes in the use of natural gas are also anticipated. Other electric and natural gas utilities across Canada and around the world are also anticipating significant change. Building out energy systems and decarbonizing heating, transportation and industrial processes will require materials, equipment, and people with the expertise, education, and training to support this work. With increased demand from many utilities for these same resources, there could be increased competition for materials and labour, contributing to higher than anticipated prices or longer than anticipated project timelines.

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NEXT STEPS – LOOKING BEYOND THE 2023 IRP

While the 2023 IRP is complete, integrated resource planning will continue to move forward for Manitoba Hydro with implementing the 2023 IRP road map, completing new IRP analysis as needed, and preparing for the next IRP. Along the way, we will also continue the conversation we started with the energy planning community, including interested parties and our customers.

Our immediate next step is to implement the 2023 IRP road map including prioritizing, planning, and scheduling the near-term actions, as well as developing a process for monitoring and reporting on the signposts. The energy planning community will continue to play a role in this work, participating in the planning and execution of near-term actions.

New analysis may also be needed before the next IRP. The 2023 IRP established there is a great deal of uncertainty in the timing, pace, and scale of change in the energy transition. By monitoring the signposts identified in the plan, we will assess when there are material changes that may require new analysis in advance of work starting on the next IRP. We will share progress of near-term actions, the monitoring of signposts, and outcomes of new analysis, carrying on the transparency established throughout development of the 2023 IRP. The frequency and timing of those communications will be determined with consideration of the pace of change in the changing energy landscape.

As for the next IRP, the timing will be determined based on many factors including the pace of change in the energy landscape. The 2023 IRP reflected a broad scope due to Manitoba Hydro's current planning situation. In the future, as decisions are made or as drivers such as policy change, the IRP process will evolve to ensure its outputs meet Manitoba's energy planning needs. Feedback from interested parties and our customers will be sought and used to improve and evolve the IRP process.

Because an IRP provides early insight into potential decisions such as infrastructure requirements, in future, the IRP may support multi-year rate applications to the PUB by informing decisions related to energy related assets. The road map, including near-term actions, are the steps that Manitoba Hydro will undertake to prepare for such decisions.

GLOSSARY

TERM	DEFINITION
3Ds	Three forces driving change in the energy landscape: **DECARBONIZATION:** The act of moving away from energy that produces carbon dioxide and other greenhouse gases (GHGs). **DIGITALIZATION:** Advancement in technology that is changing customer preferences and expectations of how they interact with their energy provider. **DECENTRALIZATION:** The increase of options for energy beyond those offered by utilities, many of which still rely on the power grid to allow two-way flow of electricity.
Asset life	Represents the weighted average life of the various components of a resource. This does not necessarily indicate the maximum life of a project as a resource may last longer with additional major capital investment in component refurbishment or replacement. In the case of energy efficiency, this is the average of each of the various individual measures.
Average energy	The average amount of electrical energy that a resource can produce based on a range of flow conditions. For hydropower options this is the average amount of energy produced based on 110 years of flow history. For non-hydropower options this represents the energy that would be expected under the same average of all flow conditions. For thermal resources this is determined as part of the modelling process and will vary depending upon a range of factors. For variable renewable resources this is equal to their average energy production.
Average of all flow conditions	A composite value from modelling over the full range of historic water flow conditions.
Behind-the-meter (BTM)	Equipment on the customer side of the electrical meter.

TERM	DEFINITION
Brownfield site	A previously developed industrial site that may be underutilized or is no longer being used.
Capacity	The maximum amount of electricity that can be made by generators at any particular time and is generally measured in megawatts (MW).
Capacity factor	The ratio of expected or average energy produced by a resource option on an annual basis to the maximum possible energy produced during continuous operation.
Carbon capture and storage (CCS)	The capture and storage of carbon dioxide from emissions to prevent it from entering the atmosphere.
Customer self-generation	The generation of electricity by customer-owned and operated equipment to produce electricity which serves all or a portion of the customer's electricity needs.
Demand response (DR)	The reduction of customer electrical demand by the customer or directly by a utility in times of high demand. A utility may contract with customers with large electrical loads to provide demand response as a resource to manage peak electrical demand. Demand response is a type of demand side management
Demand side	Related to the demand for, or consumption of, electricity located on the customer side of the electrical meter.
Dependable energy	The amount of electrical energy supplied during the equivalent of the lowest system flows on record (dependable flow conditions).
Dependable flow conditions	Waterflow in the hydraulic system (comprised of several major rivers, reservoirs, and hydropower stations) that is consistent with the conditions during the worst historical drought.
Dispatchable resource	A resource with an assured fuel or input energy supply which can be started or stopped on command and whose output can be increased or decreased on demand to follow load. Examples include hydropower units, thermal generators, and batteries.
Distributed generation	Decentralized energy generation and delivery system that is located closer to the point of consumption, typically behind the meter or near the end-user premises. It can involve the production of electricity, heat, or both, through small-scale, modular, and often renewable energy technologies.

TERM	DEFINITION
Dual fuel	A heating system which is operated by a combination of fuels. For the 2023 IRP, dual fuel typically refers to systems employing an air source heat pump and natural gas furnace.
Efficiency Manitoba plan	An extrapolation of Efficiency Manitoba's 2020-23 Efficiency Plan that extends throughout the 20-year planning horizon
Electric vehicle (EV)	For the 2023 IRP, electric vehicle refers to a subset of zero emission vehicles which use grid electricity as a source of fuel. EVs include battery electric vehicles (BEV) and plug-in hybrid electric vehicles (PHEV).
Electricity generation GHG emissions	GHG emissions directly attributed to the generation of electricity.
Emissions-intensive trade-exposed (EITE)	A descriptor of industries which emit large quantities of GHG emissions and compete internationally, such as iron and steel, pulp and paper, food and beverages, cement and concrete, and forest products industries.
End use energy	Energy directly used by individuals or organizations for various purposes. It represents the final stage of energy consumption, where energy is converted to meet specific needs or perform specific tasks. Examples of end-use energy include energy used for lighting, heating, cooling, transportation, appliances, industrial processes, and other applications at the point of consumption.
Energy efficiency/ demand side management (DSM)	Energy efficiency, also referred to as demand side management in the 2023 IRP, is the practice of optimizing energy consumption by using technologies, strategies, and practices that require less energy input to perform a specific task or achieve a desired result. It can involve adopting energy-efficient appliances, implementing energy-saving techniques, and enhancing systems and processes to minimize energy losses and improve overall energy performance.
Firm capacity	A guaranteed level of capacity that is intended to be available at all times during the timeframe being planned for.
Firm energy demand	Customer load which a utility is obligated to serve under normal operating conditions and defined equipment failures or other events.
Firm export capability	The amount of transmission capacity that is available and must be available for the export of electrical energy during a certain period of time.

TERM	DEFINITION
Firm import capability	The amount of transmission capacity that is available and must be available for the import of electrical energy during a certain period of time.
Installed capacity	The maximum amount of electricity that a generating station can produce under specific conditions designated by the manufacturer. Alternative terms include rated capacity and nameplate capacity.
Intermittent resource	A generating resource that is not dispatchable due to the fluctuating nature of the energy source. This term typically applies to wind and solar resources. An alternative term is Variable Renewable Resource.
Interruptible	Customer load which, by agreement that offers payments or preferential rates, a utility is not obligated to serve.
Levelized cost of energy	A standard simplified cost metric for comparing resources based on the cost of producing a unit of energy ($/MWh). It is the present value of a resource's capital cost, fixed and variable operating costs, fuel costs, and taxes, divided by the present value of the average expected energy produced over the life of a resource. This simplified metric does not allocate costs for capacity and should only be used when comparing the cost of energy between similar resources.
Levelized cost of winter capacity	A standard simplified cost metric for comparing a resource based on the cost of providing a unit of capacity ($/kW-yr.). It is the present value of a resource's capital cost, fixed operating costs, and taxes, divided by the present value of the firm winter capacity provided over the life of a resource. This simplified metric does not allocate costs for energy produced and should only be used when comparing the cost of capacity between similar resources
Net system cost	Manitoba Hydro's costs for electricity and natural gas service including capital and operating costs for new and existing resources; electrical generation, transmission, and distribution infrastructure; electrical generation fuel costs; water rentals; import costs; export revenues; natural gas distribution costs; and customer natural gas costs. Excludes financing costs for new capital spending.
Net-zero	A target, or a descriptor of a target, in which GHG emissions from defined activities are reduced to zero or are offset by other emissions reductions. This may be physical emissions reduction or removal, or credits representing such reductions.

TERM	DEFINITION
Net-zero ready	A resource or load which has low associated GHG emissions which may be eliminated or offset by future adaptations such as the use of alternative fuels (e.g. hydrogen replacing natural gas in a generator) or the addition of carbon free energy sources (e.g. solar panels added to a building).
Nominal capacity	The approximate installed capacity rating of a generation plant based on normal operating conditions.
Non-firm capacity	Generating capacity that lacks a guarantee of continuous availability under all conditions.
Non-utility generation	A source of electricity connected to the electrical transmission and distribution system but not owned by an electric utility.
Non-wires solutions / non wires alternatives (NWS/NWA)	An inclusive term for electrical grid investments that eliminate or defer the need to construct or upgrade components of generation, transmission, or distribution systems. Examples can include demand response, dynamic retail pricing, customer self-generation, energy storage, conservation or energy efficiency measures, and distributed generation.
Opportunity energy	Surplus energy quantities Manitoba Hydro has available for Opportunity Exports after meeting firm load and export commitments.
Opportunity exports	Short-term economic Opportunity Energy sales entered into with external loads.
Opportunity imports	Short-term economic energy purchases entered into with external suppliers to reduce production costs or to replenish energy in storage.
Peak demand	The single greatest demand requirement for electricity (MW) or natural gas (m3) within a specific time period (e.g. year). Manitoba's annual peak demand for both electricity and natural gas occurs during the winter due to customer heating needs.
Planning reserve margin	The margin of additional Firm Capacity in excess of Firm Energy Demand which must be provided in order to protect against capacity shortfalls resulting from the breakdown of generation and transmission equipment or increases in peak load due to extreme weather conditions
Power (electrical)	The rate at which electricity is produced by a generator typically measured in megawatts (MW). It is an alternative general term for capacity.

TERM	DEFINITION
Provincial GHG emissions	GHG emissions from sources within the province of Manitoba; for the 2023 IRP, Provincial GHG Emissions metrics focus on energy use related source categories, which include electricity generation, other forms of stationary combustion, and transportation.
Regional GHG emissions	A broader GHG perspective that estimates the net impact of Manitoba Hydro's system operations on the regional electricity generation sector. This metric includes net GHG emission changes from fossil-fuel electricity generators in the US, Ontario, and Saskatchewan in addition to GHG emissions from all of Manitoba Hydro's fossil-fuel generators.
Scenario	A specific energy future using a combination of key inputs. Each scenario is intended to represent a possible future and multiple scenarios taken together represent a reasonable range of possible futures.
Seasonal coefficient of performance (SCOP)	For a heat pump, refrigerator, or air conditioning system, the ratio of heating or cooling output over the electrical input averaged over a heating or cooling season.
Seasonal diversity exchange	The sharing of resources that allow utilities whose peak loads occur in different seasons of the year (winter peak vs. summer peak) to exchange surplus generating capacity with each other during their respective off-peak seasons.
Sensitivity	The study of the impact of changing a single variable in a complex analysis.
Supply side	Related to the supply or production of electricity located on the utility's side of the electrical meter.
Time of use/time varying rates (TOU, TVR)	Time-of-Use, or Time-Varying Rates, refer to rates for electrical consumption which are not fixed but vary to reflect the changing cost to produce and deliver electricity to customers. Examples include time-of-use rates with predefined daily, weekly, or seasonal patterns, and rates that are not pre-defined, but which vary with power system conditions including critical-peak pricing rates, peak time rebates, variable-peak pricing rates, and real-time pricing rates.
Variable renewable resource	A generating resource that is not dispatchable due to the fluctuating nature of the energy source. This term typically applies to wind and solar resources. An alternative term is Intermittent Resource.
Wholesale energy/markets	A centrally operated bulk power market for the purchase and sale of electricity across a specified region.

TERM	DEFINITION
Winter firm capacity	The power generated or avoided (in the case of demand side management) by a resource during Manitoba's peak demand hours through the winter months.
Zero-emissions vehicle (ZEV)	A vehicle that can function with no operating GHG emissions. Examples include battery-electric, plug-in hybrid electric, and hydrogen fuel cell vehicles as well as those fueled by alternative fuels such as biodiesel.

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