Appendix 1 – Existing System & Load

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1 Introduction

The 2023 IRP studies a reasonable range of potential energy futures in Manitoba being driven by the evolving energy landscape. To better understand the impacts of the evolving energy landscape in Manitoba, it is helpful to understand the current energy landscape, how energy is currently used in the province, and how the current electrical and natural gas energy systems operate.

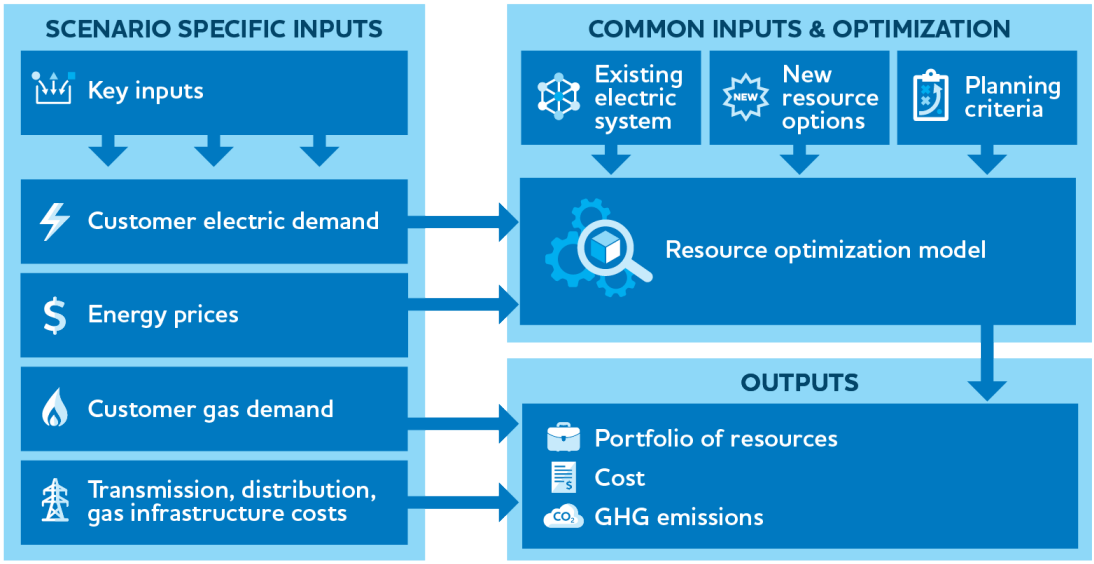


Figure A1.1 – Modelling Process Overview

2 Energy Use In Manitoba

Energy in Manitoba comes from multiple sources including refined petroleum products, natural gas, electricity, biofuels, and others. The following section provides an overview of energy use in Manitoba, including the sources of energy, the related green house gas (GHG) emissions, and energy demand profiles. The evolving energy landscape, in particular decarbonization, may change the type and amount of energy consumed in the province.

2.1 Energy Use

The end-use energy by fuel in Manitoba is shown in Figure A1.2. Manitoba Hydro supplies electricity and natural gas, which contribute to 24% and 28% of the total provincial end-use energy respectively. Refined petroleum products, which are generally used to fuel vehicles, account for 44% of the energy used in the province.

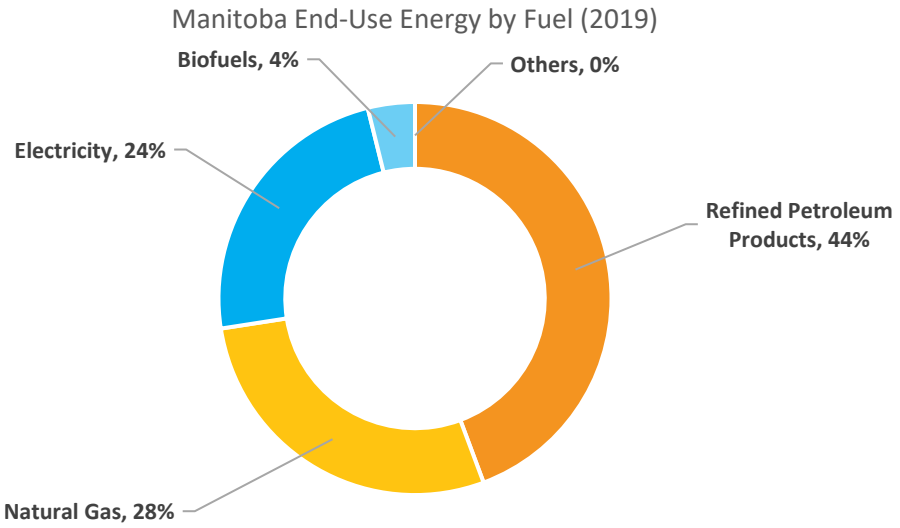


Figure A1.2 – End-Use Energy by Fuel[1]

Figure A1.3 shows how energy use in Manitoba is spread across several sectors, each with their own unique characteristics based on their needs. Residential and commercial sectors primarily use a combination of electricity and natural gas, in large part for space heating, but also for water heating, appliances, electrical equipment, and lighting among other needs. The transportation sector primarily uses refined petroleum products to fuel vehicles. The industrial sector, including agriculture, uses electricity, natural gas, and refined petroleum products to power their operations. In addition, all figures include non-energy uses such as petrochemical feedstock, lubricants, and asphalt.

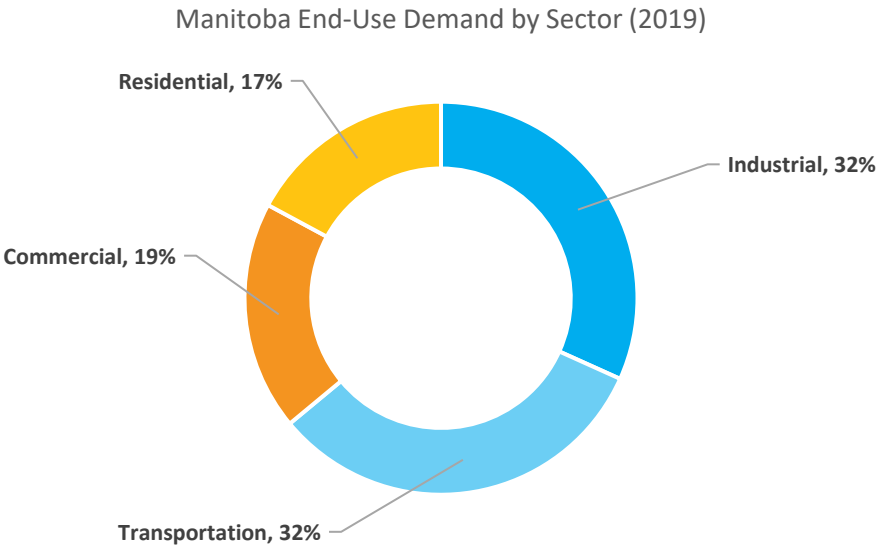


Figure A1.3 – End-Use Energy by Sector[1]

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

2.2 Greenhouse Gas Emissions

In addition to how energy is currently used in Manitoba, it is important to understand the sources of greenhouse gas (GHG) emissions in Manitoba. Future energy decisions may impact some of these existing GHG emissions sources. In Figure A1.4, GHG emissions have been separated into four categories described below. Three of these GHG emission categories are energy dependent and will be directly impacted by future energy related decisions.

Stationary Combustion

These GHG emissions include those from residential, commercial, institutional, and industrial fuel combustion, typically for space heating and industrial processes like furnaces and boilers.

Generation

These GHG emissions include those from current fossil fuel-based electricity generation, which is another form of stationary fuel combustion, but shown separately. Load growth and future resources choices will impact future GHG emissions.

Transportation

These GHG emissions include those originating from fuel combustion in vehicles, such as planes, cars and trucks, trains, boats, farming vehicles, construction vehicles, and off-road vehicles. Moving from gasoline- and diesel-fueled vehicles to zero-emissions vehicles (ZEVs) will directly impact electricity needs and future GHG emissions.

Other

GHG emissions under this category are typically those related to non-combustion agricultural activities, like cattle methane emissions, and waste like landfill methane emissions. This GHG emissions category is not impacted in the 2023 IRP analysis.

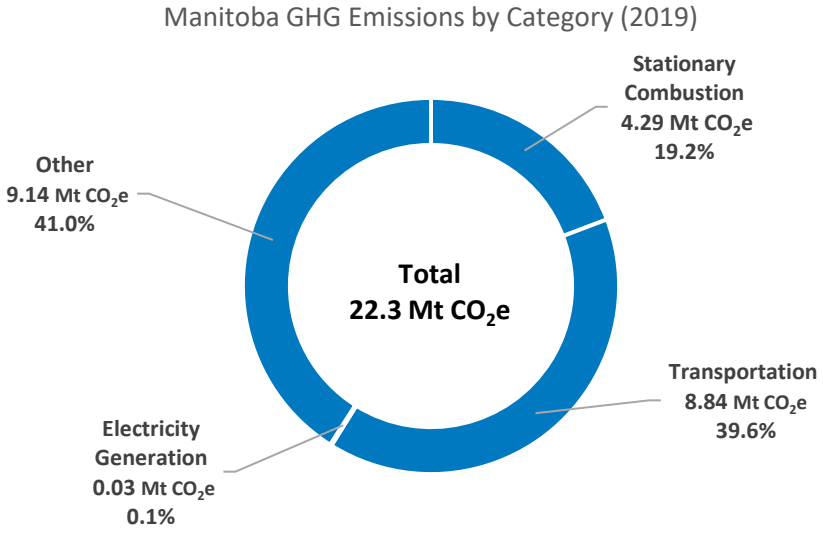


Figure A1.4 – GHG emissions by Category[2]

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

2.3 Electricity and Natural Gas Demand Variability

Variability in electricity and natural gas demand is an important consideration in energy planning as it affects how Manitoba Hydro ensures customers are supplied with electricity and natural gas at the time it is required.

Figure A1.5 shows representative electricity demand and the rolling average highlights the seasonal variation demand throughout the year. Manitoba is a winter peaking province, where the highest demand for electricity is during the winter months (January and February) when many customers use electricity to heat their homes and businesses. On average, the winter peak demand for electricity is approximately 50% higher than in summer.

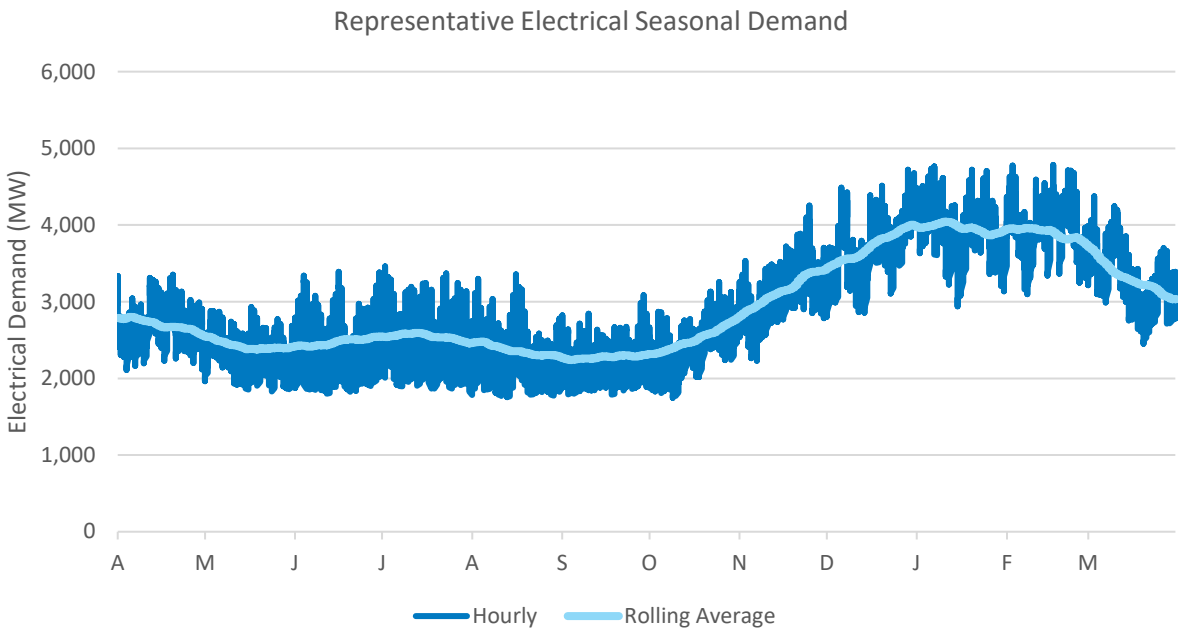


Figure A1.5 – Representative Electricity Seasonal Demand

The hourly electricity demand highlights the daily and weekly variations. Generally, electricity demand can vary by as much as 30% during a single 24-hour period, with the peak demand occurring during the daytime. Figure A1.5 also shows there is a minimum amount of demand at any given time, referred to as the baseload.

Natural gas demand also varies significantly. Figure A1.6 demonstrates how natural gas demand in Manitoba is weather sensitive and seasonal, mostly due to Manitoba's use of natural gas for winter heating needs. Industrial use is also part of the total gas demand; however, this load is more constant throughout the year.

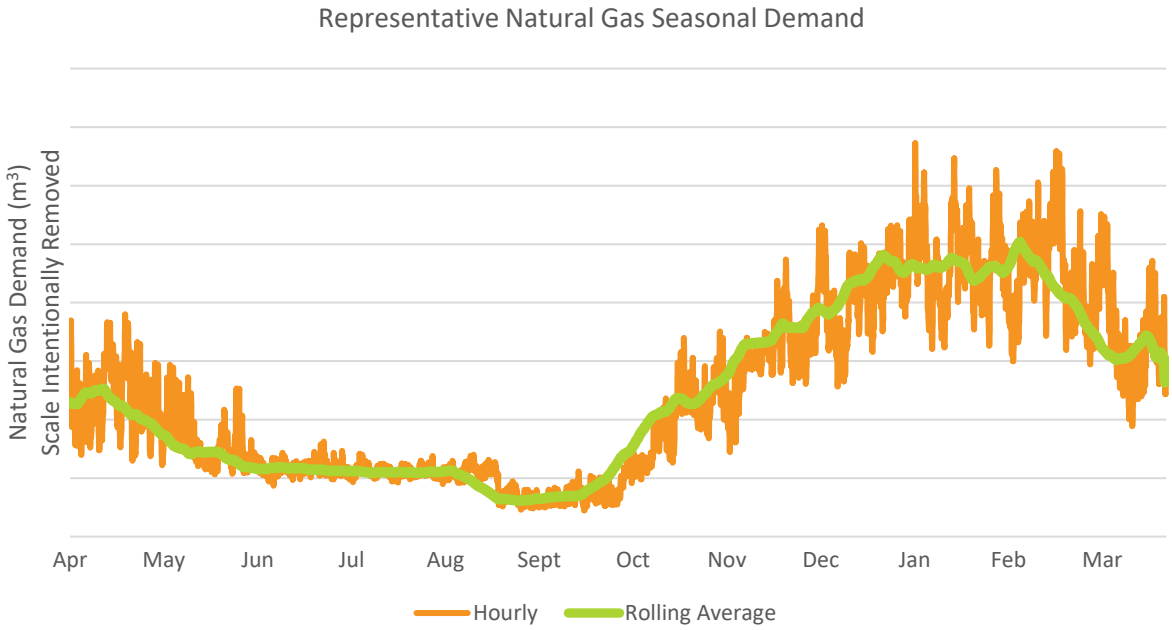


Figure A1.6 – Representative Natural Gas Seasonal Demand

3 Manitoba Hydro's Existing Energy Systems

Manitoba Hydro is a vertically integrated utility that provides both electricity and natural gas to customers. Centra Gas Manitoba Inc. ("Centra") is a wholly-owned subsidiary of Manitoba Hydro. The existing energy systems consists of electricity supply (generation, power purchase agreements, and imports from neighbouring markets), electricity delivery (transmission and distribution), and natural gas supply and delivery. Figure A1.7 provides an overview of Manitoba Hydro's major electricity and natural gas facilities.

Manitoba Hydro's existing systems are continuously assessed to ensure a reliable supply of safe and affordable energy. Ongoing investments through enhancement, replacements, and refurbishments are needed to meet customer requirements, reliability standards, safety and environmental compliance, and evolving regulations.

Figure A1.7 – Major Electrical and Natural Gas Facilities

Available in accessible formats upon request

3.1 Electricity Supply

Manitoba Hydro supplies electricity from multiple resources including:

- 16 hydropower stations,
- 1 natural gas fueled combustion turbine station,
- Power purchase agreements with non-utility generators in Manitoba (two wind farms, one solar farm),
- Diesel generators serving four off-grid communities, and
- Imported electricity through interconnections to neighbouring markets.

Table A1.1 summarizes the installed capacity for each supply resource and underlines the predominately hydropower system.

Table A1.1 – Existing Generation Resource Rated Capacities

Resource	Installed Capacity (MW)
Hydropower (16 stations)	5,768
Interconnections (Import)	1,460
Natural Gas Fueled Combustion Turbines (1 Station)	278
Wind Turbines (2 Wind Farms)	258
Off-Grid Diesel Generation (4 locations)	11
Solar Photovoltaic (1 Solar Farm)	1

Hydropower

The 16 hydropower stations are located throughout Manitoba. Those located on the Winnipeg River include the Pointe du Bois, Slave Falls, Great Falls, Seven Sisters, Pine Falls and McArthur stations. Grand Rapids Generating Station is located on the Saskatchewan River. In northern Manitoba, Jenpeg, Kelsey, Keeyask, Kettle, Long Spruce and Limestone are located on the Nelson River. Wuskwatim is located on the Burntwood River. Lastly, Laurie River I and Laurie River II are located on the Laurie River. Figure A1.8 shows the installed capacity for each hydropower station and how they compare.

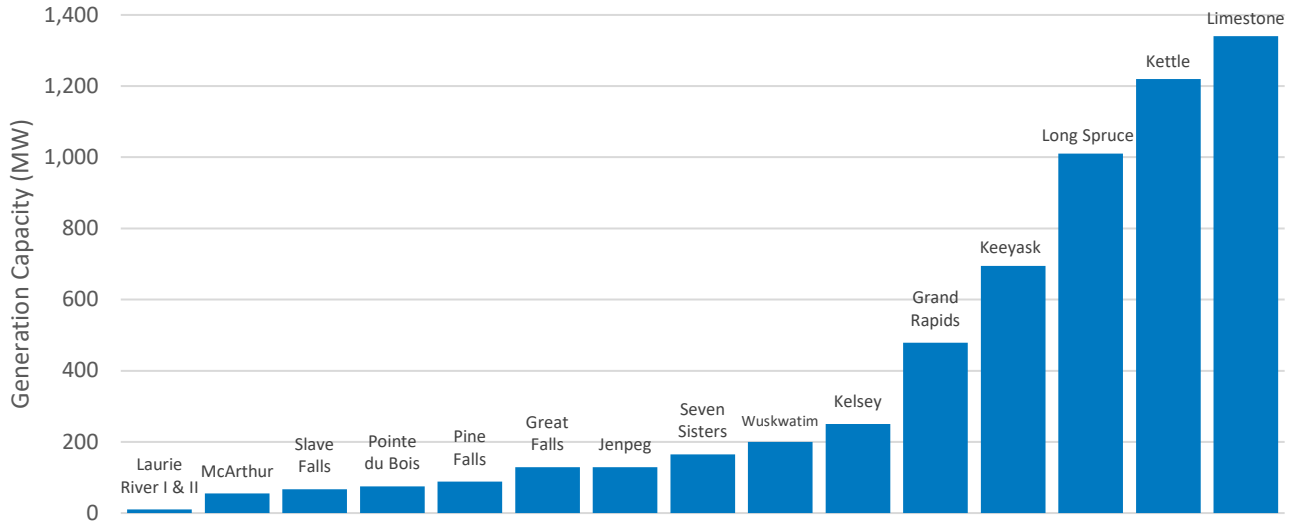


Figure A1.8 – Installed Capacity by Hydropower Station

Thermal

There is one natural gas fueled thermal generating station located in the City of Brandon. There are two operational simple cycle gas turbines at the station; both are powered by natural gas but can also operate on diesel fuel as a back-up. The Brandon generating station is infrequently used for energy generation, however this station serves multiple purposes including:

- provides capacity when electrical demand is high, especially during the winter months,
- enhances reliability of electricity supply during low water conditions, and
- provides a reliable year-round alternative supply during short-term emergencies that may occur either at the hydropower stations or on the transmission system.

Off-Grid Diesel Generation

Due to their off-grid locations, four northern communities are not connected to the Manitoba Hydro transmission grid and are reliant on diesel generated electricity supplied by Manitoba Hydro. The four communities are: Shamattawa (Shamattawa First Nation), Tadoule Lake (Sayisi Dene First Nation), Brochet (Barren Lands First Nation), and Lac Brochet (Northlands Denesuline First Nation).

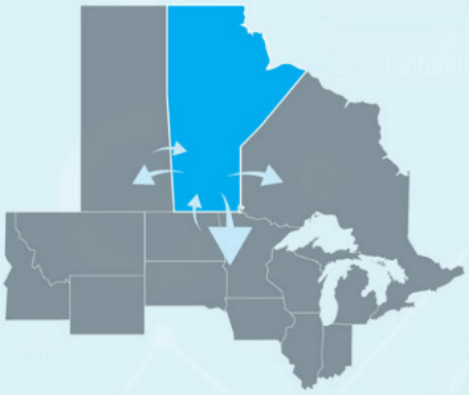
Power Purchase Agreements

Manitoba Hydro purchases electricity from the independently owned St. Leon and St. Joseph wind farms under long-term contracts. This wind energy helps to meet the energy requirements of Manitobans and dependable export contracts, particularly when water conditions are low.

In addition to wind, Manitoba Hydro also has a power purchase agreement with the 1-megawatt Fisher River Cree Nation solar farm. The 3,000 solar panel system is the first Indigenous-owned, utility-scale solar farm in Canada and the largest solar project in Manitoba.[3]

Interconnections

Manitoba Hydro exchanges electricity with neighboring utilities in Saskatchewan, Ontario, and the U.S. through interconnections, which consist of multiple transmission lines linking Manitoba Hydro's system to these neighbouring systems. Figure A1.9 lists the firm import and export capabilities for these interconnections as of 2022.



	Export	Import
United States	2858 MW	1400 MW
Ontario	100 MW	0 MW
Saskatchewan - North	25 MW	60 MW
Saskatchewan – South	290 MW	0 MW

Figure A1.9 – Interconnection Firm Export and Import Capability

Interconnections serve a major role in complementing Manitoba Hydro's predominately hydropower system. Interconnections allow longer-term seasonal diversity exchanges with our neighbours in the United States, which currently represent approximately 10% of Manitoba's winter capacity. However, as the energy landscape evolves in neighbouring markets, the future availability of seasonal diversity exchanges is uncertain.

Interconnections also facilitate the sale of excess electricity to outside markets when supply exceeds Manitoba customers' needs. These export sales, through both firm and opportunity exports, provide an important source of revenue and help to keep rates low for customers in Manitoba. In addition, interconnections help ensure reliability of electricity supply both for Manitoba Hydro and neighbouring utilities. Interconnections allow electricity to be imported during low water conditions in Manitoba and provide a means of managing short term reliability issues when dealing with unexpected system outages.

Finally, interconnections play a role in optimizing the day-to-day operation of the electrical system. Often Manitoba Hydro can import energy from neighbouring markets when market prices are low, preserving water to produce energy when prices are higher. Manitoba Hydro can take advantage of these market dynamics in part because of the flexibility offered by the hydraulic system described in the next section.

[3] https://www.frecdev.ca/1mw-solar-farm/

Manitoba Hydro has made recent additions to enhance interconnection capabilities. A second 500 kV transmission line to the U.S. mid-west was completed in 2020, doubling the quantity of electricity that can be imported and substantially increasing the amount of electricity that can be exported. The Birtle Transmission Project was completed in 2021, increasing transmission capability between Saskatchewan and Manitoba.

Hydraulic System

Manitoba Hydro's hydraulic system is comprised of several major rivers, reservoirs, and hydropower stations. Manitoba is located downstream of two vast drainage basins, shown in Figure A1.10. The Nelson River drainage basin drains a large area from Alberta, Saskatchewan, Manitoba, Northwestern Ontario, and a portion of Northern United States. Rivers from these areas flow into Lake Winnipeg before that water flows out to the Nelson River and into Hudson Bay. The Churchill River basin lies to the north and a large proportion of water from that basin is diverted at Southern Indian Lake along the Burntwood River into the Nelson River. Together the Nelson and Churchill River basins have a total area of 1.4 million km^2 that supplies water used at Manitoba Hydro's hydropower stations.

Figure A1.10 – Drainage Basin Map

Inflows to the hydraulic system can vary considerably from year to year. As depicted in Figure A1.11, inflows vary significantly between flood and drought and large reservoirs in the Manitoba Hydro system can be used to moderate this inflow variability to a limited extent. In addition, reservoirs can be used to store energy, in the form of water, to be released later when needed.

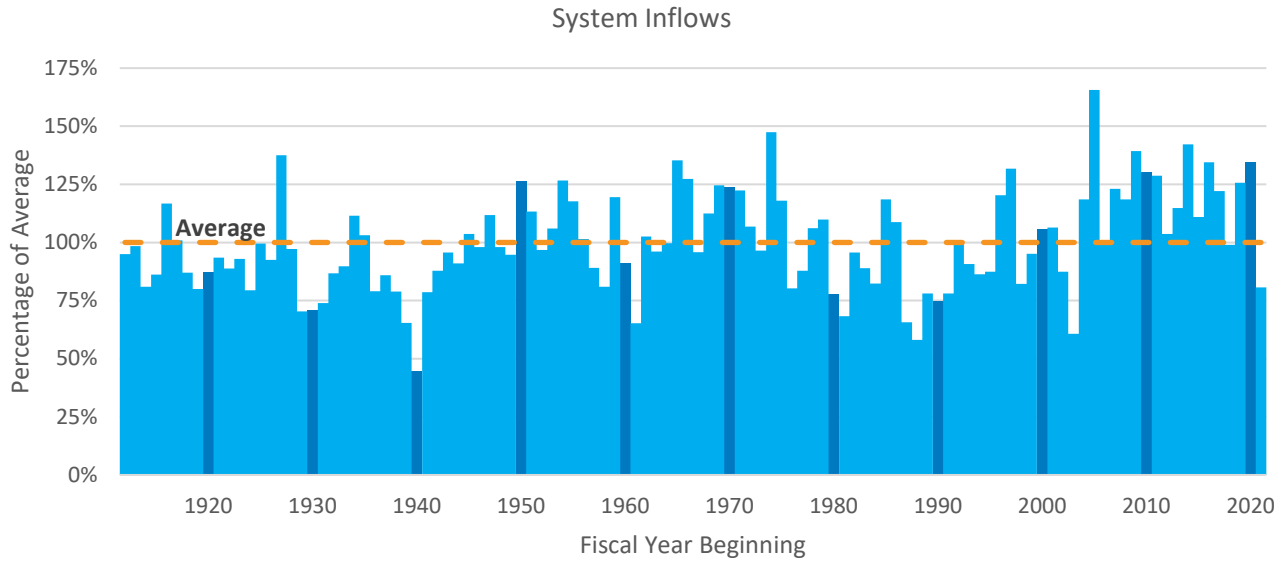


Figure A1.11 – System Inflows from 1912 to 2021

Lake Winnipeg is the largest reservoir in Manitoba and provides about half of system storage on the hydraulic system. The Churchill River Diversion (CRD) was created to increase water flow to larger generating stations on the Lower Nelson River. Most of the water flow of the Churchill River is diverted at Southern Indian Lake into the Nelson River. All projects that use water to produce power are subject to the Manitoba Water Power Act (WPA) and its Regulations.

3.2 Electricity Delivery

Transmission and distribution systems deliver electricity to customers. Manitoba Hydro delivers electricity to more than 608,000 customers over 11,045 km of transmission lines and 75,320 km of distribution lines. The transmission system moves electricity from generating stations around the province ranging from 33 to 500 kilovolts (kV). The voltage is then reduced by large transformers at electrical stations, where it is moved through the distribution network to customers. The transmission and distribution systems are described in more detail in the following sections.

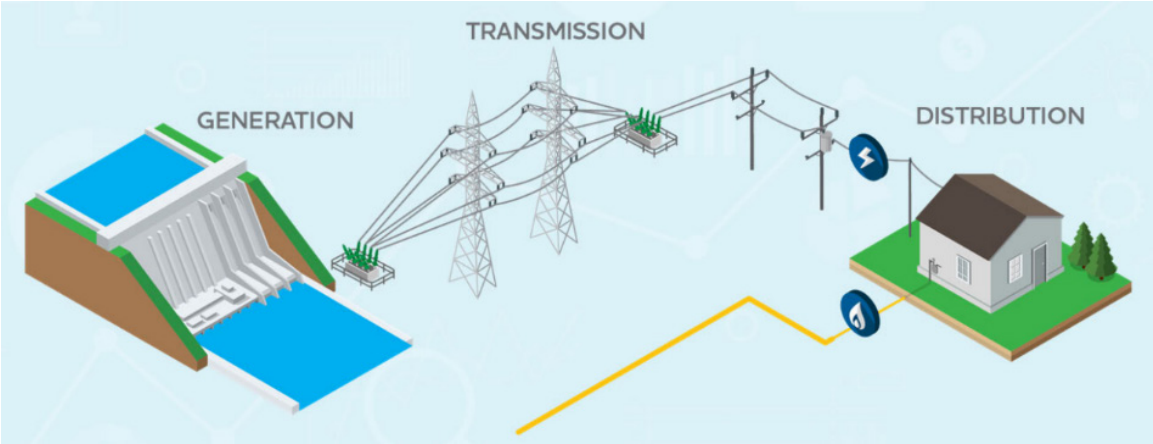


Figure A1.12 – Energy Delivery System

Transmission System

The Manitoba Hydro electrical transmission system has two major components, the high voltage direct current (HVDC) and alternating current (AC) systems.

The HVDC transmission system moves electricity generated at Manitoba Hydro's largest generating stations on the Lower Nelson River located in northern Manitoba to southern Manitoba. The HVDC system allows electricity to be transmitted efficiently over long distances with less loss of energy than AC transmission.

The Nelson River HVDC transmission system includes three lines called Bipole I, Bipole II, and Bipole III. Bipoles I and II provide 1,854 MW and 2,000 MW of transmission capacity respectively. Bipole III was completed in 2018, provides 2,000 MW of additional transmission capacity, and is an independent and physically separate HVDC system from Bipoles I and II. This alternative route significantly reduces the risk of potential severe weather events on the HVDC system and increases the reliability of electricity delivery to customers.

The AC transmission system moves electricity from northern generators to the HVDC transmission system, from the HVDC system to the southern AC system, and from other generators throughout the province that are not connected to the HVDC transmission system to transmission stations and load points. The AC transmission system is connected to transmission and distribution stations where power is delivered to end-use customers. Most customers receive their electricity through the distribution system, though some larger industrial loads will have their electricity delivered at a high voltage directly from the transmission system. There are also transmission interconnections that allow power exchanges with neighbouring power systems.

Distribution System

Manitoba Hydro's distribution system serves more than 608,000 customers across the province.

Many critical components of the electrical distribution system were installed during urban and rural electrical expansion that occurred between 1945 to 1960 and much of that infrastructure is still in service today.

Manitoba Hydro is continuously adding new distribution system capacity to accommodate population and economic growth. This includes constructing and upgrading distribution stations and distribution supply centres (DSC), upgrading existing distribution lines, and constructing new circuits.

Distribution Critical Components:

Underground Cables: 10,000 km

Subsurface Utility Chambers: 2,200

Duct Lines: 240 km

Pad Mount Transformers: 23,500

Wood Poles: 1.1 Million

Overhead Conductors: 75,000 km

Overhead Transformers: 165,000

Street Light standards: 70,000

Stations/DSC: 115

3.3 Natural Gas Supply & Delivery

Natural gas is an essential source of energy in Manitoba. It is an economic, reliable, and safe energy solution, and a key source of firm dispatchable energy backed by long duration storage for serving Manitoba Hydro customers' energy needs. The Manitoba Hydro natural gas system consists of over 10,800 km of main and 7,500 km of service pipeline to supply 293,000 customers throughout 130 communities across southern Manitoba.

Most of the natural gas used in Manitoba comes from Western Canada by way of a large capacity 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. This access to the integrated North American natural gas market facilitates adapting to changes in Manitoba natural gas demand.

Manitoba Hydro conducts ongoing work needed to maintain safe and reliable operation, preserve regulatory compliance, and meet customers' needs. System betterment projects are performed to maintain system reliability and safety, as well as to support the continued operation of the existing system. System betterment projects include plant relocates, integrity work, capacity upgrades, measuring and regulating stations, and inline inspections. System expansion projects are driven by market demand for natural gas service.

4 Manitoba Hydro's Existing Rate Structures

Manitoba Hydro's electricity and natural gas rates are set based on the estimated costs of providing service to different groups of customers (customer classes). Electric and natural gas rate structures are regulated by the Public Utilities Board of Manitoba (PUB). The PUB is an independent provincial regulatory agency that considers both the impact to customers and the financial requirements of the utility in approving rates.

4.1 Electricity Rate Structures

Manitoba Hydro's electricity rates are among the lowest in the country.

Rate structures differ by customer class and include a combination of energy, demand, and basic monthly charges that recover the rolled-up costs associated with generation, transmission, distribution, and customer service.

1. Basic Monthly Charge – The fixed charge each month ($/month) intended to recover customer related costs that do not vary based on energy use.
2. Energy Charge – The charge per unit of energy consumed each hour ($/kWh).
3. Demand Charge – The charge per maximum amount of power used in a month ($/kVA of monthly billing demand).

Demand charges are intended to recover the cost of serving a customer's highest usage. Manitoba Hydro only has demand charges for larger commercial and industrial customers; for customer classes without demand charges, these costs are recovered through energy charges.

Some utilities offer optional time-of-use or critical peak pricing rates which means that prices will vary based on season or time of day. These types of time varying rates are a means of providing prices signals to customers about the cost of providing energy service to them; by sending these pricing signals customers will have more information to help them make important decisions about their energy consumption and energy-related investments. With the exception of its largest customer classes (General Service Large), Manitoba Hydro does not have the advanced metering in place at this time to be able to offer such programs to other customer classes.

Manitoba Hydro's electricity customer classes are described in Table A1.2.

Table A1.2 – Electricity Customer Classes & Rate Structures[4]

Customer Class	Rate Structure, includes
Residential The residential class is comprised of all housing types and includes individual metered apartment blocks, seasonal cottages, and farmhouses.	Basic Monthly Charge ($/month) Flat Energy Rate ($/kWh)
General service small (GSS) The GSS class is for non-residential service where the transformation is provided by Manitoba Hydro and demand is less than 200 kVA.	Basic Monthly Charge ($/month) Declining Block Energy Rates ($/kWh) Demand Charge for recorded demand greater than 50 kVA

[4] Current and historical rates can be found at https://www.hydro.mb.ca/accounts_and_services/rates/historical_rates/

General Service Medium (GSM) The GSM classes are for services where the recorded demand exceeds 200 kVA and the transformation is provided by Manitoba Hydro.	Basic Monthly Charge ($/month) Declining Block Energy Rates ($/kWh) Demand Charge for recorded demand greater than 50 kVA
General Service Large (GSL) The GSL classes are for services where the transformation is provided by the customer. There are three GSL classes that are distinguished based on the voltage used to serve the customers: GSL 750 V-30 kV, GSL 30-100 kV, GSL >100 kV.	Flat Energy Rate ($/kWh) Demand Charge ($/monthly recorded demand kVA)
Area & Roadway Lighting (A&RL) The A&RL class includes both roadway lighting, installed by agreement for public authorities, and sentinel lights used for security lighting of private or public areas.	Flat Rate ($/month)
Diesel Within the off-grid communities served by diesel generation, Manitoba Hydro serves three types of customer classes: residential, general service, and government & First Nation education.	Basic Monthly Charge ($/month) Energy Charge ($/kWh)

4.2 Natural Gas Rate Structures

Natural gas rates are comprised of three parts:

1. Basic Charge – The fixed charge that helps pay for services like meter maintenance, meter reading, billing, and record keeping.
2. Gas Commodity Charge – The natural gas Centra (or an independent natural gas marketer) buys on customers' behalf. This cost is passed on to customers without markup.
3. Delivery Charge – The cost to deliver natural gas to customers. It includes the cost associated with transporting gas to Manitoba, as well as the costs associated with distributing natural gas to customers within Manitoba. Depending on the customer class delivery charges may include a fixed (demand charge) in addition to a variable (volumetric charge).

In addition, the federal carbon charge is applied to the natural gas volumes consumed by customers.

In Manitoba, customers can choose to buy natural gas from Centra (a subsidiary of Manitoba Hydro) or from an independent natural gas marketer. Centra's Gas Commodity rate is adjusted each gas quarter for increases or decreases to the forecast cost of natural gas supply. Manitoba Hydro earns no profit on the sale of gas commodity.

Natural gas rates are separated into different classes depending on the type of customer and their energy needs as shown in Table A1.3.

Table A1.3 – Natural Gas Customer Classes & Rate Structures[5]

Customer Class	Rate Structure, includes
Small General Service Class (SGC) For residential and commercial customers with annual natural gas consumption less than 680,000 m^3 through one meter	Basic Monthly Charge ($/month) Gas Commodity Charge ($/$m^3$) Delivery Charge ($/m^3)
Large general service Class (LGC) For customers with annual natural gas consumption less than 680,000 m^3. As a general guide LGC customers receive gas through one meter of the type and capacity not commonly installed for individual residences.	Basic Monthly Charge ($/month) Gas Commodity Charge ($/$m^3$) Delivery Charge ($/m^3)
High volume firm For customers with annual natural gas consumption greater than 680,000 m^3, through one meter.	Basic Monthly Charge ($/month) Gas Commodity Charge ($/$m^3$) Delivery Charge: Volumetric ($/$m^3$) Demand ($/m^3/month)
Mainline firm For customers with annual natural gas consumption greater than 680,000 m^3, through one meter, at more than medium pressure, served directly from the transmission system or through dedicated distribution facilities.	Basic Monthly Charge ($/month) Gas Commodity Charge ($/$m^3$) Delivery Charge: Volumetric ($/$m^3$) Demand ($/m^3/month)
Interruptible service For customers with annual natural gas consumption greater than 680,000 m^3, and is available only in situations where, in the sole opinion of Centra, a benefit exists for Centra or other Customers. Service may be interrupted with notice.	Basic Monthly Charge ($/month) Gas Commodity Charge ($/$m^3$) Delivery Charge: Volumetric ($/$m^3$) Demand ($/m^3/month)

END OF APPENDIX

[5] Current and historical rates can be found at https://www.hydro.mb.ca/accounts_and_services/rates/historical_rates/