Fort Nelson Long-term Resource Plan

DRAFT – February 2024

BC Hydro
Power smart

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1. Executive Summary

The 2024 Fort Nelson Long-term Resource Plan (**FNLTRP**) is BC Hydro's guide for meeting the future electricity needs of our customers in the region over a 20-year planning horizon.

Demand in the Fort Nelson region is showing some growth in 2025 and then relatively flat at about 30 MW onwards through the planning horizon. The Fort Nelson region's load resource balance shows sufficient supply through the planning horizon with two existing sources of power: a natural gas-fired Fort Nelson Generating Station and transmission service via a transmission line from Alberta.

To achieve long-term policy goals and mitigate risk, the FNLTRP prepares for a low-carbon future to reduce or eliminate greenhouse gas emissions at the Fort Nelson Generating Station at the end of the planning horizon. The FNLTRP demonstrates BC Hydro's leadership in advancing low-carbon solutions in a northern climate, strives to gain learning and experience with new technologies, and explores solutions that support First Nations and broader community economic development goals.

Our plan includes two active explorations of promising new technologies in the Fort Nelson area. The first is to advance the First Nations-led Tu-Deh-Kah geothermal pilot project. The second is to investigate the techno-economics of emerging carbon capture technologies at the Fort Nelson Generating Station. The costs for these explorations will be included in a future revenue requirements application.

We will continue to assess and monitor other areas including monitoring jurisdictional progress on renewable fuels, and watching local industrial activities or initiatives in the event collaborative opportunities arise in either the biomass or carbon sequestration space, as well as watching electrification activity in the broader oil and gas sector in the region, including the Montney region and any advancement of the interconnecting to the integrated system. Monitoring will also continue concerning evolving climate policies and regulations, including the Alberta market response and Federal and Provincial legislation. We will also undertake an assessment of the savings potential of demand-side measures.

If events continue as we expect, we'd anticipate the next long-term resource plan completed by 2032. However, we can adjust if anything changes in our monitoring process to signal that we need to advance this timing.

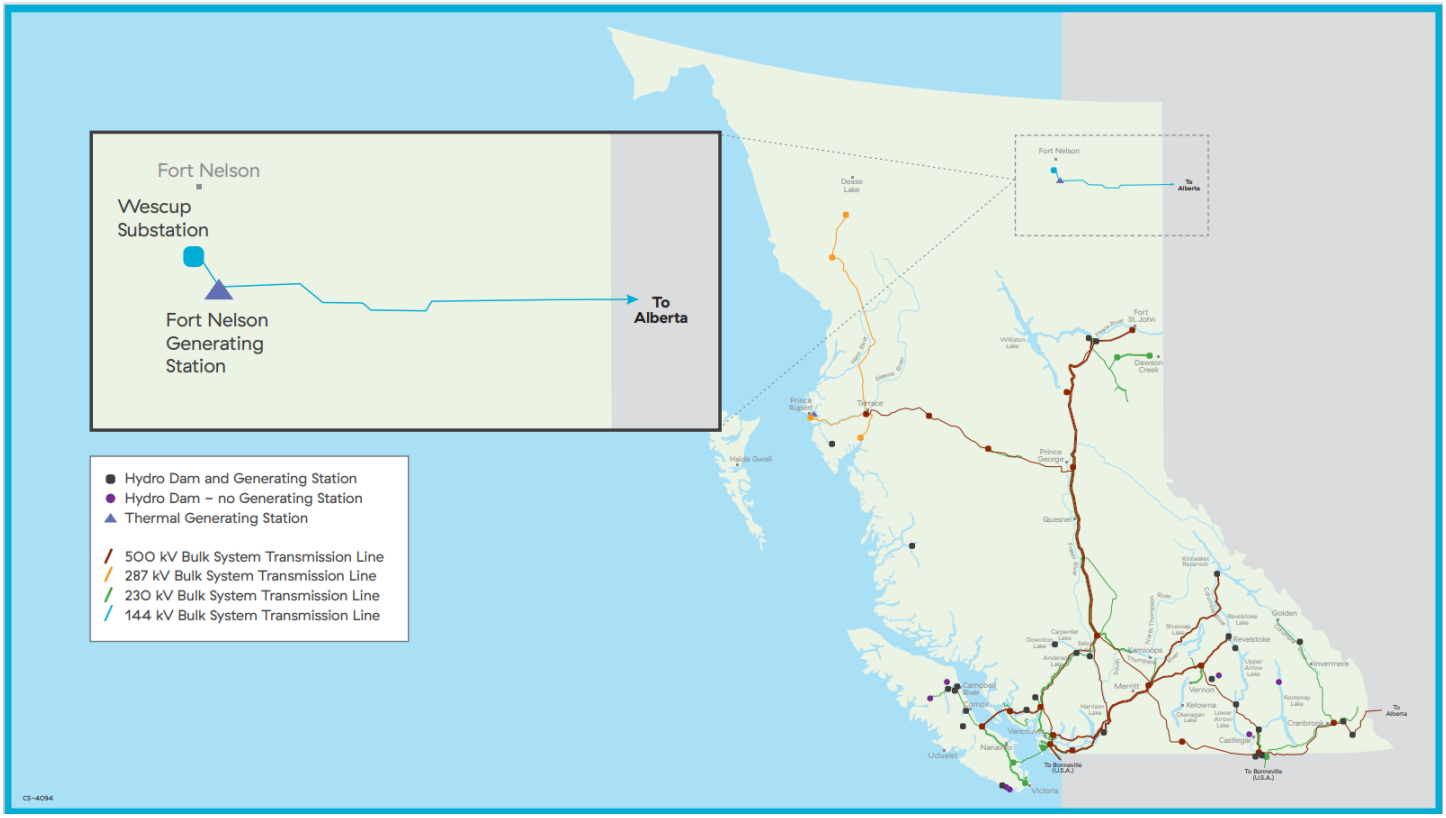
2. Introduction

The 2024 Fort Nelson Long-term Resource Plan is BC Hydro's guide to meeting future electricity needs in the region over a 20-year planning horizon.

2.1. The Fort Nelson region is unique to the BC Hydro system

The Fort Nelson region is located in the northeast corner of the province, as shown in Figure 1Figure 1. The region is unique to BC Hydro in that it is neither part of our integrated power system nor our non-integrated areas. Isolated from the rest of BC Hydro's integrated system but not considered a non-integrated area due to its electric connection to the Alberta system, the region has two sources of electricity supply – the Fort Nelson Generating Station and transmission service via a long transmission line connected to the Alberta Interconnected Electric System. The combined areas of Fort Nelson and the town of Rainbow Lake (in Alberta) are remote from the major load centres of B.C. or Alberta.

Figure 1: The Fort Nelson Region



BC Hydro provides power supply service to the community of Fort Nelson with about 3500 customers, which is comprised of residential, commercial and industrial customers. In addition, there are two First Nations within the Fort Nelson region – the Fort Nelson and Prophet River First Nations. On a peak demand basis, the breakdown is split roughly 53% large industrial, 6% small industrial, and 41% residential and commercial. Currently the Fort Nelson area's peak and energy demand is about 25 MW and 200 GWh/year, respectively.

2.2. Where Fort Nelson finds itself today: the planning environment

2.2.1. The legal and regulatory framework

As a public utility, BC Hydro is regulated by the BC Utilities Commission under the Utilities Commission Act (UCA) and related laws, including the Clean Energy Act (the Legal Framework).

Under the Legal Framework, BC Hydro must submit a long-term resource plan to the Commission in the form and at the times required by the Commission. The Commission may establish a process to review a long-term resource

plan and may accept the plan if the Commission determines that carrying out the plan would be in the public interest.

2.2.2. We have a service agreement with Alberta

BC Hydro has a *System Access Service Agreement for the Fort Nelson Demand Transmission Service (Fort Nelson Demand Transmission Service Agreement)* with the Alberta Electric System Operator. This transmission service is approved by the Alberta Utilities Commission and provided under the Alberta Electric System Operator's tariff rate schedule. Up to 38.5 MW can be supplied from the Alberta Electric System Operator via a 144 kV transmission line from the Rainbow Lake substation in Alberta to the Fort Nelson Generating Station. BC Hydro currently relies on the transmission line for backup service to supply the Fort Nelson area load when the primary source, Fort Nelson Generating Station, is not operating.

In addition, with the transmission line connecting the Fort Nelson Generating Station to the Alberta electrical grid, when there is surplus electricity, BC Hydro's subsidiary, Powerex, markets this surplus electricity to Alberta.

2.2.3. We're working to advance reconciliation with First Nations

BC Hydro recognizes that relationships with First Nations are critical to operating our system. As a Provincial Crown utility, we have an important role to play in supporting the broader societal effort of reconciliation. The Fort Nelson long-term resource plan provides an opportunity for early engagement with First Nations on how to meet our customers' future electricity needs. This helps us understand and reflect First Nations' needs, interests and values in our long-term plan.

The 2024 Fort Nelson Long-term Resource Plan is a strategic level plan. Any projects initiated in response to the FNLTRP are in the early conceptual stage where the specific nature of potential adverse impacts, if any, may not yet be known or identifiable for purposes of consultation. Those future projects will be subject to separate consultation and approval processes before proceeding.

2.2.4. Evolving climate change impacts and policies are causing operational and longer-term planning changes

The risk of climate change-driven wildfires impacting the availability of the transmission line to Alberta is causing us to take a look at the Fort Nelson Generating Station and emergency response planning. BC Hydro acknowledges the impacts on customers from the record-setting fire season of 2023, and we have invested in the Fort Nelson Generating Station to better respond to these events in the future. Increasing the region's resilience to wildfire events will continue to be a part of the Fort Nelson Generating Station asset planning process.

The need for better electricity reliability was an over-riding theme during community engagement, particularly on the heels of the prolonged transmission line outage due to wildfire event and multiple failures of the Fort Nelson Generating Station. Concerns were raised about inadequate back-up supply, costs of outages to customers, and the vulnerability of residents during winter outages in this northern climate.

We also recognize the risk of climate policies affecting the economic viability of local natural gas producers, which in turn may impact the supply of natural gas to Fort Nelson Generating Station. Ensuring a reliable supply of natural gas to Fort Nelson Generating Station remains an important part Fort Nelson Generating Station operations planning. BC Hydro has been engaged with local gas suppliers, processors and customers in the region to discuss gas supply alternatives.

Over the longer-term, BC Hydro is taking action to support Provincial and Federal greenhouse gas emission reduction targets, and the energy transition to a low-carbon B.C. economy. We're working towards clean and renewable solutions across BC Hydro's business, including in Fort Nelson, while keeping rates affordable. Aligning with these efforts, the FNLTRP explores alternatives in the future that would see a reduction in greenhouse gas emissions and/or carbon intensity in Fort Nelson due to future regulations and related efforts.

3.The planning process

BC Hydro consults with First Nations, stakeholders, and the public throughout the plan's development. Engaging is important to ensure the plan is informed by the values and interests of the communities.

We also build the plan using a process that fulfills the requirements outlined previously in section 2.2.1 above, including:

- Establishing planning objectives and planning reliability criteria,
- Determining future customer electricity needs by:
    - developing long-term load forecast scenarios for energy and peak demand;
    - comparing the load forecast scenarios to the existing and committed supply of electricity to determine the timing and volume of any new resources, if needed;
- Considering long-term risks and uncertainties; and
- Establishing a near-term action plan.

Issues related to operational maintenance and sustainment of supply, emergency response to any forced or planned outages, or distribution system planning are outside the scope of the strategic nature of long-term planning.

3.1. How engagement informs the plan

Engaging with the Fort Nelson communities while building the FNLTRP includes discussions with the Fort Nelson and Prophet River First Nations, the Northern Rockies Regional Municipality, industrial stakeholders and the broader public.

Engagement is being undertaken in two general phases and includes gathering input into the plan and then gathering feedback on the draft plan. Through fall 2023, six virtual meetings were held that included representatives of the Fort Nelson communities, along with a broader open community session. Participants were invited to provide their input at the sessions, to fill out an on-line survey, and to visit the Fort Nelson Long-term Resource Plan website where they can sign up for updates and find out more information. Twenty-two people participated in the virtual sessions, and 257 on-line surveys were completed.

Topics we engaged on as we developed the plan included:

- what matters to people about the long-term plan and our planning objectives;
- what long-term risks and uncertainties should be considered as we develop the plan; and
- input on the resource options we are currently looking at to address Fort Nelson Generating Station greenhouse gas emissions.

What we are hearing from the communities are in callout boxes throughout this draft plan. In addition, all public materials can be found on the Fort Nelson LTRP website at www.bchydro.com/FortNelsonLTRP, including the fall engagement report.

NOTE TO READER: We will continue to engage with the communities on the draft plan and consider that feedback as we finalize the plan. The balance of this section will be completed as part of the final FNLTRP.

3.2. Planning objectives and criteria guide our plan to ensure long-term reliable supply

3.2.1. Defining planning objectives helps clarify what's important

Providing safe, reliable, and affordable service is foundational to BC Hydro. Advancing reconciliation with First Nations is also an important goal for BC Hydro, and First Nations' interests are considered within all the planning objectives.

Inherent in long-term resource planning to meet future customer needs is an assessment of various alternatives to meet the anticipated need for electricity. These alternatives will come with various benefits and trade-offs. As such, we establish additional planning objectives to clarify what is important when making choices. The planning objectives for the FNLTRP are aligned with Provincial policy and prudent utility practices, and include:

- Keeping costs low for customers.
- Reducing greenhouse gas emissions.
- Limiting land and water impacts.
- Supporting local communities' economic development.

Engagement input from the virtual sessions suggested these additional objectives seemed reasonable to participants, for a long-term resource plan. Survey responses showed keeping costs low ranked highest, followed by supporting local communities' economic development, limiting land and water impacts and reducing greenhouse gas emissions. Energy security, including being resilient to ongoing climate change impacts was important to participants. There was interest in how to connect the non-serviced or non-integrated communities around Fort Nelson. There was also a desire for BC Hydro to support economic opportunities amongst the First Nations and the broader community.

3.2.2. Planning criteria are established to ensure adequate resources are available to meet future demand

We used planning criteria in developing the plan to ensure Fort Nelson has a reliable electrical system, including adequate generating capability (energy and capacity), and adequate transmission capability to meet customer demand. These planning criteria reflect best electric utility practices and incorporate information about the performance of our electrical system.

The long-term resource plan covers expected load in the Fort Nelson area and how BC Hydro expects to meet from year 4 (fiscal 2028) to year 20 (fiscal 2043), with the first three years as the operational window to manage the supply and uncertainties.

The planning criterion in Fort Nelson is based on the largest single contingency standard. Put simply, this planning criterion requires that sufficient resources be available to meet the area load with the single largest element of the electricity system (either Fort Nelson Generating Station or transmission line to Alberta) out of service.

In 2018, the Commission ordered that the transmission planning criteria created by the North American Electric Reliability Corporation (NERC) be approved as one of British Columbia's Mandatory Reliability Standards. This planning standard is applicable to the Fort Nelson region[1,2]. Using the current configuration in Fort Nelson as an example to comply with the planning criteria, the following conditions need to be satisfied:

- When any generator is out of service, the remaining generating unit(s) (if any) and transmission line to Alberta need to be adequate to supply the load; and
- When the transmission line to Alberta is out of service, the local generation resource needs to be adequate to supply the load.

For the FNLTRP, any alternatives examined will be required to meet these generation and transmission planning criteria.

4.Load resource balances for Fort Nelson region show sufficient supply over the planning horizon

A load resource balance is a comparison of forecasted customer electricity demand and the resources available to meet that demand over a 20-year planning horizon using the planning criteria outline in the previous section. When only existing and committed resources are included, the load resource balance shows the timing and volume of additional resources required to meet customer demand, if any.

4.1. The Fort Nelson region long-term Load Forecast scenarios

BC Hydro develops Load Forecast scenarios for both energy and peak demand. For Fort Nelson, we have created a mid-load forecast (**April 2023 Reference Load Forecast**) for both energy and peak demand. A High Load Scenario

[1] BCUC Order Number R-27-18, dated June 28, 2018, approved NERC Standard TPL 001-4 -- Transmission System Planning Performance Requirements as one of the Mandatory Reliability Standards (MRS) in British Columbia: https://www.ordersdecisions.bcuc.com/bcuc/orders/en/item/312044/index.do?q=R-27-18

[2] NERC Standard TPL001-4: https://www.nerc.com/pa/Stand/Reliability%20Standards/TPL-001-4.pdf

has been created only for peak demand (**High Load scenario**). A High Load Scenario for energy was not developed because the existing and committed electricity supply resources (a natural gas-fired Fort Nelson Generating Station and a transmission line to Alberta) are constrained by capacity not energy.

As Fort Nelson has a main supply source, the Fort Nelson Generating Station, owned and operated by BC Hydro that is able to meet all of the Reference and High Load, there was no need for a low load forecast. Any decrease in load will continue to be met by the same existing supply options.

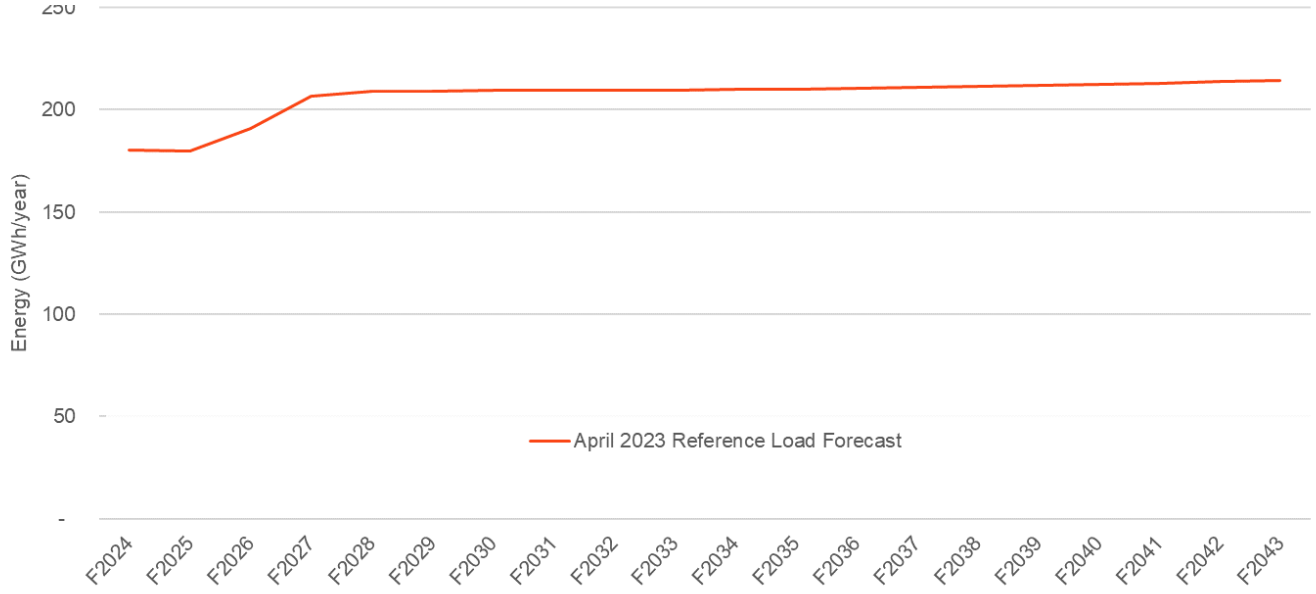
4.1.1. Energy load forecast

An energy Load Forecast is developed as the sum of the forecast for each of the major customer sectors including the residential, commercial and industrial sectors.

- The forecast for the residential sector is the product of the customer accounts and the average use per account. The account projection and the average use per account projection are based on a trend analysis of historical billing data;
- The forecast for the commercial and light industrial sector is developed with a regression model involving historical sales and employment where the history and forecast of employment comes from the Conference Board of Canada Economic Forecast;
- The forecast for the industrial sector is developed on an account-by-account basis; and
- The forecasts for street lighting customers, irrigation customers and BC Hydro's own use within the Fort Nelson area is developed based on a trend analysis.

The April 2023 Reference Load Forecast for energy the Fort Nelson region is presented by Figure 2.

Figure 2: Fort Nelson Energy Reference Load Forecast



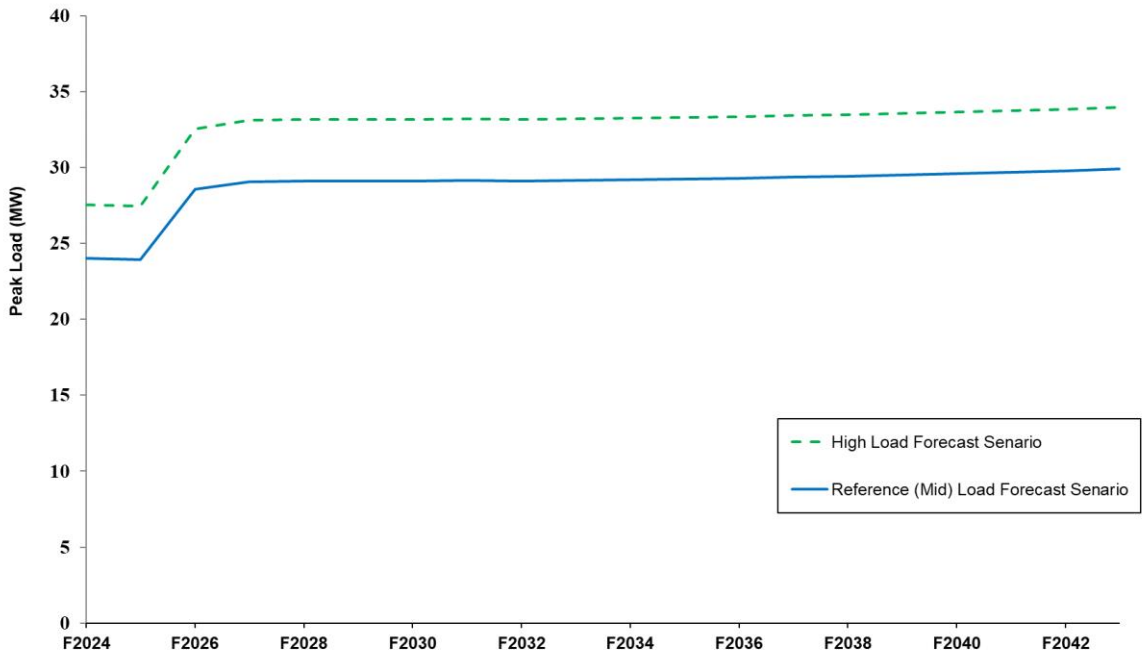
As shown above, the energy demand in the Fort Nelson region is forecast to be below 220 GWh/year until at least fiscal 2043. There is an expected energy growth from fiscal 2025 to 2027, driven by an increase in the demand for electricity from the wood product segment. The April 2023 Fort Nelson load forecast details are provided in Table 1 of Appendix A.

4.1.2. Peak demand load forecasts

To create a peak demand load forecast, we take the sum of the base load (mostly comprised of residential and commercial loads) and the industrial sector loads. The base load, consisting of residential, commercial, and some minor load from streetlighting, irrigation, and BC Hydro's own use, is developed using a trend analysis based on historical data. The industrial sector peak forecast is developed on account-by-account basis.

The April 2023 Peak Demand Reference Load Forecast and High load scenario for the Fort Nelson Region are presented in Figure 3.

Figure 3: Fort Nelson Region Reference and High Load Scenarios for peak demand



The Reference Load Forecast scenario reaches 30 MW by fiscal 2043, with the High Load Forecast scenario to be 34 MW in fiscal 2043. There are only minor differences between the Reference and High Load Forecasts due to limited additional industrial activity planned in the region over the period of fiscal 2024 to 2043.

- From fiscal 2025 to 2026, there is:
    - an expected 5 MW load growth for the Reference Load Forecast scenario, driven an increase in the demand for electricity from the wood product segment, and
    - an expected 6 MW load growth for the High Load Forecast, driven by a higher forestry-sector load growth.
- From fiscal 2024 to 2043, there is a 6 MW load growth for both the Reference Load Forecast and High Load Forecast.
- From fiscal 2026 to 2042, the load in the Fort Nelson region remains relatively flat under both load scenarios.

4.2. BC Hydro's existing and committed resources in the Fort Nelson region

Existing and committed resources are quantified so that they can be compared to the load forecasts, and we can determine the timing and volume of any new resources, if needed.

4.2.1. Fort Nelson's existing resources

Existing resources are resources that are currently operating and are expected to continue to operate into, if not to the end of, the planning horizon. For Fort Nelson these are the Fort Nelson Generating Station and the Fort Nelson Demand Transmission Service Agreement with the Alberta Electric System Operator provided by the Transmission line connected to Alberta. Demand-side measures provide energy savings.

The Fort Nelson Generating Station

The Fort Nelson Generating Station is a natural gas-fired facility and was first commissioned in 1999. Fort Nelson Generating Station completed a major upgrade in 2012 to increase the generating capacity from 47 MW to 73 MW. These upgrades also enabled the Fort Nelson Generating Station to run in combined cycle through the addition of a steam cycle to improve overall efficiency and a duct burner to increase the sustainable maximum power output.[3] This upgrade also reduced greenhouse gasses from 481 tCO_2/GWh to 444 tCO_2/GWh on average. In December 2021, BC Hydro completed a project at the facility to replace the gas turbine.

Fort Nelson Generating Station consists of two generating units, G1 is a gas turbine-generator with 44 MW dependable generation capacity and G2 is a steam turbine-generator with an additional 26 MW dependable generation capacity. The steam turbine generator uses waste heat from the gas turbine generator and cannot operate on its own.

Transmission supply from Alberta

Transmission supply from Alberta is provided by the Alberta Electric System Operator to BC Hydro under the terms of their tariffed service and is transmitted by a transmission line connected to the Alberta Interconnected Electric System. Under the Fort Nelson Demand Transmission Service Agreement between BC Hydro and Alberta Electric System Operator, this agreement can provide up to 38.5 MW of supply capacity to Fort Nelson.

The transmission line connecting to Alberta is a single 209 km long transmission line. It was constructed in 1991 with wood poles, having an expected, average pole lifespan of 40 to 50 years. During the 2023 wildfires, multiple structures of the transmission line to Alberta were damaged on both sides of the B.C. and Alberta border and have now been repaired or completely replaced. Taken in total, the lifetime of this transmission line can be extended beyond 2050 through regular maintenance programs.

Demand-side Measures

Demand-side measures programs available for customers in the integrated system are also available to Fort Nelson customers, including programs for Indigenous customers and low-income customers. In recent years, residential and commercial customers in Fort Nelson have participated in demand-side measures programs, and we expect continued participation from Fort Nelson customers in the future. Demand-side measures savings have been relatively small and would not be material to the Load Resource Balances. New incremental energy savings from participation in demand-side measures programs in fiscal 2023 totaled approximately 80 MWh.

[3] The term combined cycle refers to a system that incorporates a gas turbine, a steam turbine, a heat recovery steam generator where the heat of the exhaust gases is used to produce steam and one or more electric generators. The shaft power from the gas turbine and that developed by the steam turbine both run the generator(s) that produce electric power.

4.2.2. Fort Nelson's committed resources

Committed resources are those resources that have received the necessary internal authorizations to proceed to implementation as well as any required regulatory approvals and are expected to begin operating during the planning horizon. There are no committed supply-side resources in the Fort Nelson region.

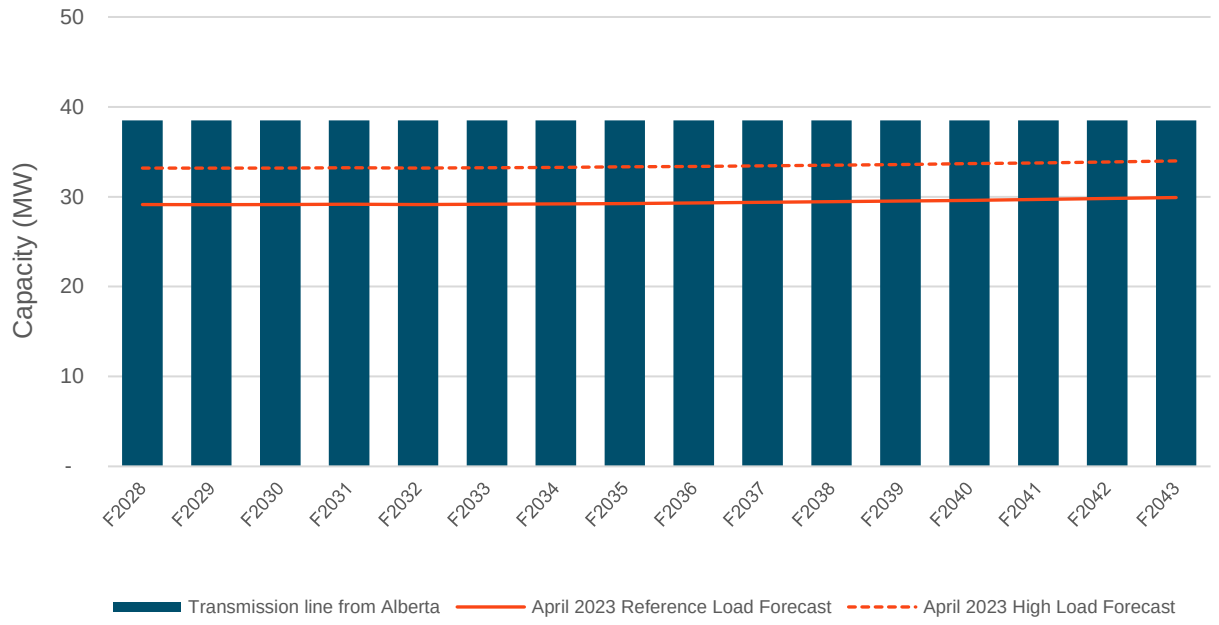
4.3. Resulting load resource balances

By comparing existing supply resources described above to the future electricity needs of our customers, as outlined by the Load Forecast, we establish if and when we will need additional energy and capacity resources.

Fort Nelson Generating Station is able to provide up to approximately 480 GWh/year of energy capability. With the forecasted energy demand for the Fort Nelson area load less than 220 GWh/year (Figure 2), there is an estimated energy surplus of approximately 260 GWh/year based on the April 2023 Reference Load Forecast. Therefore, the existing energy resources are expected to be sufficient to meet Fort Nelson's load demand throughout the 20-year planning period.

Figure 4 displays the Capacity Load Resource Balance, considering a single-contingency event involving the loss of the Fort Nelson Generating Station, where the supply would be delivered by the transmission line from Alberta.

Figure 4: Fort Nelson Capacity Load Resource Balance



The chart demonstrates that, under both the Reference load forecast and High load scenario, the load in the Fort Nelson region will not exceed the 38.5 MW capacity provided by the current Fort Nelson Demand Transmission Service Agreement with the Alberta Electric System Operator. Therefore, the existing capacity resources are expected to be sufficient to meet Fort Nelson's load requirement before fiscal 2043.

The Capacity Load Resource Balance details are provided in Table 2 of Appendix A.

5. There are risks and uncertainties

Although the Load Resource Balances show sufficient supply over the planning horizon (and therefore no identified need to invest in additional resources), there are risks and uncertainties to the future demand and supply of electricity to Fort Nelson that we need to consider. The following section, and this LTRP, focusses on the most significant long-term supply risk and uncertainty for the region.

5.1. Preparing for a low carbon future

The global energy transition towards clean and renewable sources of energy is underway. The pace of that transition and the policies that will chart the path could change rapidly. Climate policies are advancing to limit the use or availability of natural gas fueled generation resources that would otherwise produce greenhouse gas emissions. In the future, this may create restrictions in how we are able to use Fort Nelson Generation Station to provide reliable energy and capacity. Concurrent with climate policy and regulation risk are BC Hydro's own corporate goals to take a leading role in supporting the Provincial energy transition through the use of clean electricity. Preparing for a low-carbon future, whether driven internally through our corporate goals, or externally through policy and regulation, is the focus of this long-term resource plan, as it is the most pressing uncertainty facing Fort Nelson's long-term supply.

One example of a potential climate policy that could limit the availability of Fort Nelson Generating Station is the proposed Federal Clean Electricity Regulations requirements. In its April 2022 budget announcement, the Federal Government committed to achieving a net-zero electricity system by 2035. Draft Clean Electricity Regulations were released in summer 2023. These are now undergoing review and consultation, and final Regulations are expected in 2024. As future policy and regulations remain uncertain, the FNLTRP will consider the scenario where the Clean Electricity Regulations are enacted as currently drafted. This scenario serves as a proxy for other greenhouse gas constrained futures or climate action.

Engagement input suggested consistent, reliable supply with sufficient backup power as a primary consideration, along with climate change impacts and wildfire damage to infrastructure. Other uncertainties to be considered included the potential for industrial growth, particularly in the oil and gas sector; the role BC Hydro will play; and the impacts on increasing costs to customers, including related costs of living.

5.1.1. Fort Nelson Generating Station operations under the proposed Clean Electricity Regulations

The Fort Nelson Generating Station, as it is currently configured, cannot meet the emission standard prescribed by the proposed regulation. In other words, it could not be used as a primary electricity supply resource. The proposed federal Clean Electricity Regulations would require all fossil-fueled generation units above 25 MW to meet one of the following criteria by 2035, or be retired:

- Reduce emission intensity below 30 tonnes per GWh of generation, potentially through the use of renewable fuels rather than conventional natural gas (for context, Fort Nelson Generating Station emitted approximately 444 tonnes per GWh on average over the last 5 years);
- Install carbon capture and sequestration equipment; and/or

- Limit operations to only up to 450 hours per year and up to 150 kilotonnes of CO2 emission in a calendar year, however, operation during emergency situations is not included in the 450-hour limit (for context, Fort Nelson Generating Station operated approximately 7300 hours per year on average over the last 5 years).

While the proposed regulation would come into effect federally in 2035, it would apply to Fort Nelson Generation at the end of the planning horizon (2042)[4].

5.1.2. Supply-side Resource Options in Fort Nelson under the proposed Clean Energy Regulation

We expect the Fort Nelson Generating Station and the Fort Nelson Demand Transmission Service together to provide a reliable supply of power to the Fort Nelson region up until 2042. We also expect the interconnection to Alberta to continue to be in place and to provide a dependable source of power beyond 2042. However, by 2042, we need to have in place either an alternative source of primary power to Fort Nelson Generating Station or a solution to address the related greenhouse gas emissions from the facility.

We conducted an assessment of the supply options that could be available in Fort Nelson by 2042. This assessment sought to:

- Evaluate and prioritize resource options in terms of their alignment with our planning objectives;
- Characterize the lead times for resource options. Lead times for the resource options indicate when a decision prior to 2042 must be made on an optimal supply option; and
- Characterize the key uncertainties and risks associated with the resource options, in terms of technological maturity and barriers to successful development of these resources, if they were to be advanced. The nature of these uncertainties and risks will inform an appropriate action plan to gain relevant insights about the resource option and to reduce the risks for future development.

Resource options with sufficient alignment with our planning objectives will be considered deserving of greater effort to investigate. We combined this information with additional high-level assessment about lead times and uncertainty to determine where further investigation could be advanced for the purposes of making an informed future decision on which supply option is optimal in 2042. Engagement results are also informing our assessment and consideration of the resource options.

Our initial analysis indicates there isn't a preferred supply path that currently exists – all involve trade-offs among our planning objectives and have costs and degrees of technological and market uncertainty.

As the various resource options have lead times as long as approximately 10 years, we have until about 2032 to decide about the electricity supply solution in Fort Nelson. By 2032, we can gather better intelligence to inform the selection of the preferred supply alternative(s) and outline the approach to bringing online the chosen supply option(s) in a new long-term resource plan.

[4] The draft Clean Electricity Regulation includes a provision to allow operation of some thermal generation beyond 2035 to the end of the economic life. BC Hydro understands the economic life of Fort Nelson Generating Station to extend to 2042.

5.1.3. Assessment of supply options

Information related to resource options relative to our objectives, community engagement, and the commercial readiness of technology will be important when the time comes for us to make actual resource selections.

In the tables below, we lay out our assessment of each resource option. We outline summary information about each resource type and provide actions that may be needed to acquire relevant information to inform our future decisions. Where applicable, commentary is provided from our early engagement results as we gathered input into the FNLTRP.

The tables are designed to outline what we know, and where learning more could help us in making a future decision. Near-term actions result when active explorations and creation of new knowledge are required to confront uncertainties around the viability, performance or cost of a promising resource option. In these cases, expenditures are expected in future BC Hydro revenue requirements applications. In many cases learning more means further monitoring, assessments, and openness to collaborative opportunities, which will not result in a specific near-term action.

Geothermal

Geothermal resources convert thermal energy in the steam or hot water from deep underground reservoirs into electricity in above ground turbines. The development of these resources depends on identifying hot fluids in permeable subsurface structures, drilling wells into these reservoirs, collecting the hot fluids at the surface, utilizing the heat energy in these fluids to drive a turbine, and returning the cooled fluids to the reservoir.

Areas around Fort Nelson have the potential for geothermal development, and the Fort Nelson First Nation is in process of undertaking foundational exploratory research and studies for their Tu-Deh-Kah geothermal project.

Table 1 provides the assessment of the geothermal resource compared with the planning objectives and other characteristics.

Table 1: Resource characteristics of geothermal

Geothermal				
	Keep costs[5] low	**Reduce GHG emissions**	**Limit land/water impacts**	**Support economic development**
Planning objectives	$90-180 / MWh, with wide range depending on site-specific uncertainties of capital cost.	Potentially 0 GHG, uncertainty about co-produced natural gas from geothermal wells.	Impact primarily from new ~10 km line to connect geothermal to Fort Nelson grid.	Enables new avenues for industrial co-development using surplus heat. Opportunities for local ownership and involvement in clean energy generation.
Lead time	~ 7 years for greenfield infrastructure.			

[5] Cost refers to the levelized cost of energy, which is the break-even cost to generate the electricity over the life of a generation asset.

Technical maturity	Fully mature technologies with many similar facilities in operation around the world, although novel in Canada.
Level of development risk	These options are not available for development. Geothermal viability depends on proving the geothermal resource, which is currently underway. Size of geothermal potential in terms of MW is dependent on further exploration and evaluation of geothermal reservoir. High confidence that ~10 MW is achievable, but additional geothermal resources up to ~50 MW require further study.

Engagement input from the virtual sessions and the survey suggests geothermal resources as one of the leading choices with support amongst the communities for continued exploration. Some reasons from the survey for geothermal included it being locally available and providing community and environmental benefits, with a few survey respondents expressing concerns about its cost and feasibility.

After completing this early assessment, we believe active exploration is warranted related to local geothermal resources. A decision on advancing geothermal resource development should be informed by further investigations into:

- the technical viability of developing low-emission geothermal power in light of the high proportion of natural gas contained in the geothermal reservoir;
- the local capability of geothermal generation to provide dependable generation and grid support services in islanded mode; and
- the total resource potential of the geothermal reservoir to power some or even all of the load on the Fort Nelson system and provide a full replacement alternative to Fort Nelson Generating Station in 2042.

We propose to undertake a near-term action related to this resource, which will focus on collaboration with Independent Power Producer and Fort Nelson First Nation proponents of the Tu-Deh-Kah geothermal project to advance a pilot project which will, by 2032, confirm the performance and total potential of the local geothermal resources. As appropriate, we will engage early with the First Nations and the public that may be potentially affected.

Carbon Capture and Sequestration (CCS)

Carbon capture and sequestration is a process in which a relatively pure stream of carbon dioxide from industrial sources is separated, treated and transported to a storage location, generally deep underground in geological formations. Carbon capture is the trapping of the carbon emissions after they have been emitted but before they enter the atmosphere. Carbon sequestration is the storage of removed or captured carbon in various environmental reservoirs.

Table 2 provides the assessment of carbon capture and sequestration compared with the planning objectives and other characteristics.

Table 2: Resource characterization of carbon capture and sequestration

Carbon capture and sequestration				
	Keep costs low	**Reduce GHG emissions**	**Limit land/water impacts**	**Support economic development**
Planning objectives	$100 – 400 / MWh after accounting for costs and avoided GHG tax from existing FNG facility. Costs are uncertain.	potentially 0, but likely ~10% leakage from flue gas represents ~10 kT of GHG per year.	Land impact from new surface pipe (linear asset) to move compressed CO_2 to sequestration site. Potential elimination of any surface impacts if carbon can be utilized rather than stored.	Some potential for collaboration with gas producers and processors to create a cluster of low GHG natural gas suppliers.
Lead time	Range of ~ 4-8 years depending on engineering for existing FNG facility and development sequestration infrastructure.			
Technical maturity	Emerging Technologies. One commercial approach to capture of flue gases available today, but novel approaches are under development.			
Level of development risk	Primary risk is viability of geological storage. Fort Nelson saline aquifers are promising but unproven. Costs and risks can be reduced if cluster of GHG storage activities can share common infrastructure.			

Engagement input from the virtual sessions and the survey suggests support for continued exploration of carbon capture and sequestration. There was a suggestion that opportunities for carbon capture and utilization[6] also be explored. Some reasons in the survey for carbon capture and sequestration suggested that it is locally available, uses existing infrastructure, and is reliable and practical. A few survey respondents raised concerns about cost and prudency.

After completing this early assessment, we believe active exploration is warranted related to the technology challenges and economics of integrating carbon capture technologies applied to the existing Fort Nelson Generating Station.

Carbon capture of post-combustion emissions from a natural gas fueled power plant is the obvious first step towards developing a CCS solution. While the development of carbon capture technologies is of interest to large emitters all over the world, the application of these emerging technologies to flexible thermal generation facilities like Fort Nelson Generating Station is a question that can only be addressed based on a detailed understanding of the context and operations of Fort Nelson Generating Station. In particular:

- What forward-looking carbon capture technology is appropriate to the operating regime of Fort Nelson Generating Station in the 2040 timeframe?

[6] Carbon utilization involves converting carbon dioxide captured from industrial or atmospheric sources into value-added products.

- What scale of carbon capture equipment is appropriate to meet potential new regulations (such as the Clean Electricity Regulation) in the future timeframe this will be developed?

- What are the costs and performance characteristics are expected when incorporating carbon capture into an existing facility?

The near-term action related to this resource will be to actively explore the options and approaches to incorporating forward-looking carbon capture technologies into Fort Nelson Generating Station. The results of these explorations will yield engineering and feasibility studies that form a detailed implementation plan for installing carbon capture technologies. As appropriate, we will engage early with First Nations and the public that may be potentially affected.

In addition to this near-term action, BC Hydro will monitor and engage with gas producers and processors in the Fort Nelson to assess the viability of shared infrastructure for future sequestration or utilization of captured carbon.

Renewable Natural Gas (RNG)

Renewable natural gas is a pipeline-quality gas that is interchangeable with conventional natural gas. Generally, renewable natural gas is a biogas, or a gaseous product of the decomposition of organic matter that has been processed to purity standards.

Table 3 provides the assessment of the use of renewable natural gas compared with the planning objectives and other characteristics.

Table 3: Resource characterization of renewable natural gas

Switch to Renewable Natural Gas				
	Keep costs low	**Reduce GHG emissions**	**Limit land/water impacts**	**Support economic development**
Planning objectives	$80 – 200 / MWh after accounting for costs of RNG fuel, upgrade at existing Fort Nelson Generating Station to use alternative fuels, and avoided carbon tax. High degree of uncertainty.	0 GHG	Variable impacts depending on source. Conversion of local biomass into RNG will have impacts, while delivery of remote sources may involve impacts related to transport.	Uncertain and will depend on the source of RNG.
Lead time	~5-7 years for development of new sources of RNG based on organic wastes and biomass.			
Technical maturity	Range of maturity levels. Local source technologies are in the relatively early stages. Remote sources using digestion of organic wastes is mature. Green hydrogen is another renewable fuel that is considered in this category for which production is reaching maturity, but delivery at the early stage.			
Level of development risk	A pathway for local production of RNG is unavailable. The delivery and storage mechanisms to access remote sources will not be available at Fort Nelson Generating Station, depending on the evolution of the RNG market in BC.			

Engagement input from the virtual sessions and the survey suggests support for continued exploration of renewable natural gas. Expressed reasons in the survey for renewable fuels included that they use existing infrastructure, are reliable and practical, and provide environmental benefits.

After completing this early assessment, we believe further monitoring is warranted related to the use of renewable natural gas at the Fort Nelson Generating Station. The trajectory of the renewable natural gas market in B.C. is at a turning point. Whether the supply of renewable natural gas within B.C. grows rapidly with many new sources being developed, or whether much of the growth of new sources happens in lower cost jurisdictions with delivery to B.C., will influence the technical and financial viability of renewable natural gas supplied to Fort Nelson.

We will continue to monitor the continental renewable natural gas supply market, as well as local trends on the cost of delivered renewable natural gas at sufficient volumes to Fort Nelson. With intelligence related to likely supply pathways and delivery costs to Fort Nelson, we expect to be prepared to make an informed decision on renewable natural gas by 2032.

Biomass

Wood-based biomass electricity is generated from the combustion or gasification of woody organic materials – standing timber, pulp, logs, roadside debris, or sawmill wood waste, with the heat being used to drive a steam turbine, and in turn, a generator.

Table 4 provides the assessment of the biomass resource compared with the planning objectives and other characteristics.

Table 4: Resource characterization of biomass

Biomass				
Planning objectives	**Keep costs low**	**Reduce GHG emissions**	**Limit land/water impacts**	**Support economic development**
	$150-200 / MWh, depending on available fuel types and costs.	Potentially 0 or negligible GHG, with uncertainty about GHGs from any cofiring with fossil fuels.	Forest impacts to supply fuel to a biomass facility and new line to connect to the Fort Nelson grid.	Enables industrial co-development of high-value forestry operations that produce waste products for use at biomass facility. Opportunities for local ownership and involvement in clean energy generation.
Lead time	~7 years for greenfield infrastructure			
Technical maturity	Fully mature technologies			

Level of development risk	Biomass resources will not be viable for development. Biomass generation depends on co-development of new large-scale forestry activities, which are not currently committed. Size of biomass potential in terms of MW is dependent on availability of sufficient wood wastes from forestry activities.

Engagement input from the virtual sessions and the survey suggests mixed support for the biomass resource. Some reasons in support of biomass included that it is a local resource and would provide community benefits, while some concerns regarding land impacts and insufficient forest sector activity.

After completing this early assessment, we believe further monitoring is warranted related to the Biomass resource. There is uncertainty in the potential for a biomass facility fueled by wood wastes to be a catalyst for a resurgence in the local forestry sector and the concomitant development of the local economy. In the absence of a vibrant forestry sector and their necessary waste products, a biomass generation facility in Fort Nelson is not likely to be viable.

We will monitor any proposed or potential forestry sector activities in the region and engage – as opportunities arise - with future regional economic development planning processes to advance interests in a large-scale biomass facility that may also advance the community's economic development objectives. With intelligence on the likelihood of a vibrant forestry sector to support a biomass generation facility, we'll be in a position to make an informed decision on a suitably sized biomass generation facility by 2032.

New transmission to connect Fort Nelson to BC Hydro's integrated grid

Connecting Fort Nelson to BC Hydro's integrated system would mean building a new long transmission line between the BC Hydro's existing integrated system in the Peace Region to the community of Fort Nelson.

Table 5 provides the assessment of new transmission connection to the BC Hydro grid compared with the planning objectives and other characteristics.

Table 5: Resource characterization of connecting to the BC Hydro integrated grid

Connect to BC Hydro integrated grid				
	Keep costs low	**Reduce GHG emissions**	**Limit land/water impacts**	**Support economic development**
Planning objectives	~$500/MWh, for $1B capital and OMA cost of new line, plus $70/MWh of additional generation resources to serve local load. Less if a North Montney line is constructed.	0 GHG	Impacts - from 400 km of new line.	Potential to electrify and invigorate gas exploration and development.
Lead time	~10 years, with extensive regulatory, consultation and assessment requirements			

Technical maturity	Fully mature technologies
Level of development risk	New transmission will not be acceptable due to environmental impacts, land availability or First Nations protected areas.

Engagement input from the virtual sessions and the survey suggests some interest for connecting to the BC Hydro integrated system. Some reasons in support of a transmission connection included community economic and environmental benefits, improved reliability, and the ability of connecting some areas not serviced by BC Hydro.

After completing this early assessment, we believe further monitoring is warranted related to new transmission to connect Fort Nelson to the BC Hydro's integrated grid. In particular, the independent development of new transmission that extends the BC Hydro integrated grid from existing facilities from the South Peace region into the gas producing regions of the Montney could improve the alignment of this option by reducing costs and the environmental impacts of incremental transmission.

We will continue to monitor independent transmission developments to identify any opportunities such that any incremental expansion of transmission all the way to Fort Nelson could be done in a less costly fashion. With intelligence as to the incremental costs of expanding transmission from the Montney region to Fort Nelson we'll be able to make a decision by 2032 on this option.

Solar and Wind

Solar and wind resources are intermittent resources that convert solar and wind energy into electricity using photovoltaic cells for solar and using the conversion of kinetic energy from moving air. Co-ordinating solar or wind with battery resources to jointly provide firm power is a topic of increasing focus amongst utilities.

Table 6 provides the assessment of the solar and wind resource compared with the planning objectives and other characteristics.

Table 6: Resource characterization of solar and wind

Solar and Wind (energy only)				
	Keep costs low	**Reduce GHG emissions**	**Limit land/water impacts**	**Support economic development**
Planning objectives	$150-200 / MWh, although intermittent energy resources can not provide dependable supply to Fort Nelson. Addition of batteries to provide dependable capacity is cost-prohibitive	0 GHG	Impacts - from transmission lines up to 100 km in length to access good quality wind resources.	Opportunities for local ownership and involvement in clean energy generation

Lead time	~7 years
Technical maturity	Fully mature technologies.
Level of development risk	Low risk, however only poor-quality wind and solar resources have been identified within a ~50km radius of the existing grid infrastructure.

Engagement input from the virtual sessions and the survey suggests general agreement that solar and wind may be unlikely options given the quality of resources, their intermittency, and lack of light during high demand periods. A few comments suggested more study in this area may be warranted.

Information on the poor-quality of the solar and wind resource indicates additional intelligence gathering is not expected to yield much better information.

We'll continue to monitor these resource options.

Single Cycle Gas Turbine units < 25 MW

The proposed federal Clean Electricity Regulations would apply to generating units that are 25 MW or greater in size. An option for Fort Nelson is therefore to replace the existing turbine with two or more single-cycle gas turbines that are less than 25 MW in size.

Table 7 provides the assessment of the <25 MW single cycle gas turbine units as a resource option compared with the planning objectives and other characteristics.

Table 7: Resource characterization of < 25 MW Single Cycle Gas Turbines

Single Cycle Gas Turbines < 25 MW				
Planning objectives	**Keep costs low**	**Reduce GHG emissions**	**Limit land/water impacts**	**Support economic development**
	~$150 / MWh with carbon tax, and uncertainty on cost of fuel delivered	~100 kt / year	Uses existing infrastructure at Fort Nelson Generating Station	Maintains existing employment at Fort Nelson Generating Station site
Lead time	~3 years, using existing infrastructure			
Technical maturity	Fully mature technologies			
Level of development risk	Leverages existing site and infrastructure			

Engagement input from the virtual sessions focused on options that reduced greenhouse gas emissions. Although small units were not ranked in the top three options, input from survey respondents suggests, favouring the use of natural gas. Respondents noted it was reliable, local, available and may be the best resource for the Fort Nelson region.

The assessment shows advancing these units is not consistent with BC Hydro's corporate goal to provide clean power by the Fort Nelson Generating Station after end-of-life. However, smaller units could be considered as a partial solution, and their advancement will be informed by our monitoring and investigations of other options prior to the next LTRP.

5.1.4. Assessment of Demand-side Measures (DSM)

Fort Nelson customers have access to demand-side measures programs that are available to customers in the integrated system and have participated in our programs. Savings from demand-side measures have been relatively small to date; however, there is an opportunity to examine whether additional savings opportunities exist through targeted DSM programs.

Table 8 provides the assessment of the demand-side measures resources compared with the planning objectives and other characteristics.

Table 8: Resource characterization of demand-side measures

Demand-side measures				
Planning objectives	**Keep costs low**	**Reduce GHG emissions**	**Limit land/water impacts**	**Support economic development**
	DSM is typically a lower cost resource, although there can be a range of costs by program	0 GHG	Negligible	DSM programs will reduce customer bills and improve affordability of energy in the region
Lead time	~2 years to design and launch new programs, with several years of increasing customer program uptake to reach full program potential			
Technical maturity	Fully mature technologies			
Level of development risk	Low			

Demand-side measures are sufficiently aligned with our planning objectives, The specific conservation opportunities for Fort Nelson customers have not yet been examined.

We will undertake an assessment of the demand-side measures potential in the Fort Nelson area prior to selecting resources as part of a future long-term resource plan to better understand the savings potential to inform potential resource portfolios to replace Fort Nelson Generating Station.

6. Near-term Actions

BC Hydro is preparing for a future with reduced greenhouse gas emissions that would see the Fort Nelson region powered primarily by clean energy resources. In order to gather the information needed to make a decision on the preferred resource options for the next long-term resource plan, expected by 2032, a number of activities are required to monitor, assess and research the resources options available.

We are proposing two near-term actions, outlined in Table 9. These include the active investigation of two resource options, which will benefit from additional testing out of the resources through research or experimentation. Pursuing these investigations will allow us to make more informed decisions by 2032. Expenditures for the two near-term actions are expected in future BC Hydro revenue requirements applications. These activities demonstrate BC Hydro's climate action leadership and will help advance technology learning and experience that can have broad-reaching influence, translating to other areas.

In addition to the two near-term actions listed above, the assessment of the resource options outlined in Section 5 show monitoring will continue in the areas of biomass, renewable natural gas, transmission connections, sequestration and utilization initiatives, and additional renewable resources (solar, wind). We'll also undertake an assessment of demand-side measures prior to the next Fort Nelson long-term resource plan.

Table 9: Near-term actions

Near-term Action	Description
Support the advancement of a geothermal pilot project	2024 and onwards: Monitor geothermal independent power producer's progress towards a workable technical solution to the problem of natural gas in the reservoir. 2025 – 2032: Pilot geothermal generation of up to 10 MW to confirm: Viability and sustainability of geothermal resource for long-term operation with minimal greenhouse gas emissions. Grid support functions of geothermal generation in islanded mode. Cost-effectiveness of geothermal resources in Fort Nelson context. 2030-2032: Evaluate total sustainable geothermal generation potential from Clarke Lake reservoir. As appropriate, we will engage early with First Nations and the public that may be potentially affected.
Investigate the potential use of carbon capture technology at Fort Nelson Generating Station	2024 – Literature review and forward-looking assessments of carbon capture approaches for combined cycle gas-turbine facilities. 2025 – Engineering and Feasibility studies to determine appropriate scale and approach to carbon capture at Fort Nelson Generating Station 2026-2031 – Investigate what would be required, and if favourable, advance a pilot for carbon capture technology (possibly at a sub-scale level) at Fort Nelson Generating Station. As appropriate, we will engage early with First Nations and the public that may be potentially affected.

Appendices

7. Appendix A: April 2023 Fort Nelson Load Forecast

Table 1 April 2023 Energy and Peak Load Forecast after Adjustments for Rate Impacts and No Demand-Side Management

Fiscal year	Reference (GWh)[7]	Reference/Mid (MW)[8]	High (MW)
F2024	180	24	28
F2025	180	24	27
F2026	191	29	33
F2027	207	29	33
F2028	209	29	33
F2029	209	29	33
F2030	209	29	33
F2031	210	29	33
F2032	209	29	33
F2033	210	29	33
F2034	210	29	33
F2035	210	29	33
F2036	211	29	33
F2037	211	29	33
F2038	211	29	34
F2039	212	30	34
F2040	212	30	34
F2041	213	30	34
F2042	214	30	34
F2043	214	30	34

[7] **Energy Demand (GWh)**
The energy demand forecast captures the total consumption of energy (or sales) in a given year.
[8] **Peak Demand (MW)**
The peak demand forecast estimates the highest consumption of electricity in a one-hour period over the course of a year.

Table 2 Fort Nelson capacity Load Resource Balance before planned resources

Capacity LRB for Fort Nelson

(MW)		F2024	F2025	F2026	F2027	F2028	F2029	F2030	F2031	F2032	F2033	F2034	F2035	F2036	F2037	F2038	F2039	F2040	F2041	F2042	F2043
Existing and Committed Heritage Resources																					
FNG	DC	70	70	70	70	70	70	70	70	70	70	70	70	70	70	70	70	70	70	70	70
Sub-total	(a)	70	70	70	70	70	70	70	70	70	70	70	70	70	70	70	70	70	70	70	70
Existing and Committed IPP Resources																					
		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sub-total	(b)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Regional Supply Capacity	(c) = a+b	70	70	70	70	70	70	70	70	70	70	70	70	70	70	70	70	70	70	70	70
Transmission Capability	(d)	38.5	38.5	38.5	38.5	38.5	38.5	38.5	38.5	38.5	38.5	38.5	38.5	38.5	38.5	38.5	38.5	38.5	38.5	38.5	38.5
Demand - Total Net Requirement for Fort Nelson																					
April 2023 Reference Load Forecast	(e)	24	24	29	29	29	29	29	29	29	29	29	29	29	29	29	30	30	30	30	30
Existing & Committed DSM	(f)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Regional Surplus Supply/Tx	**(g) = c+d-e+f**	**84**	**85**	**80**	**79**	**79**	**79**	**79**	**79**	**79**	**79**	**79**	**79**	**79**	**79**	**79**	**79**	**79**	**79**	**79**	**79**
Sensitivities																					
April 2023 High Load Forecast	(h)	28	27	33	33	33	33	33	33	33	33	33	33	33	33	34	34	34	34	34	34
Regional Surplus Supply/Tx based on High Load	(i) = e+d-h+f	81	81	76	75	75	75	75	75	75	75	75	75	75	75	75	75	75	75	75	75