Énergie NB Power

A discussion paper from the utility's perspective

Considering the future of MACTAQUAC

March 2016

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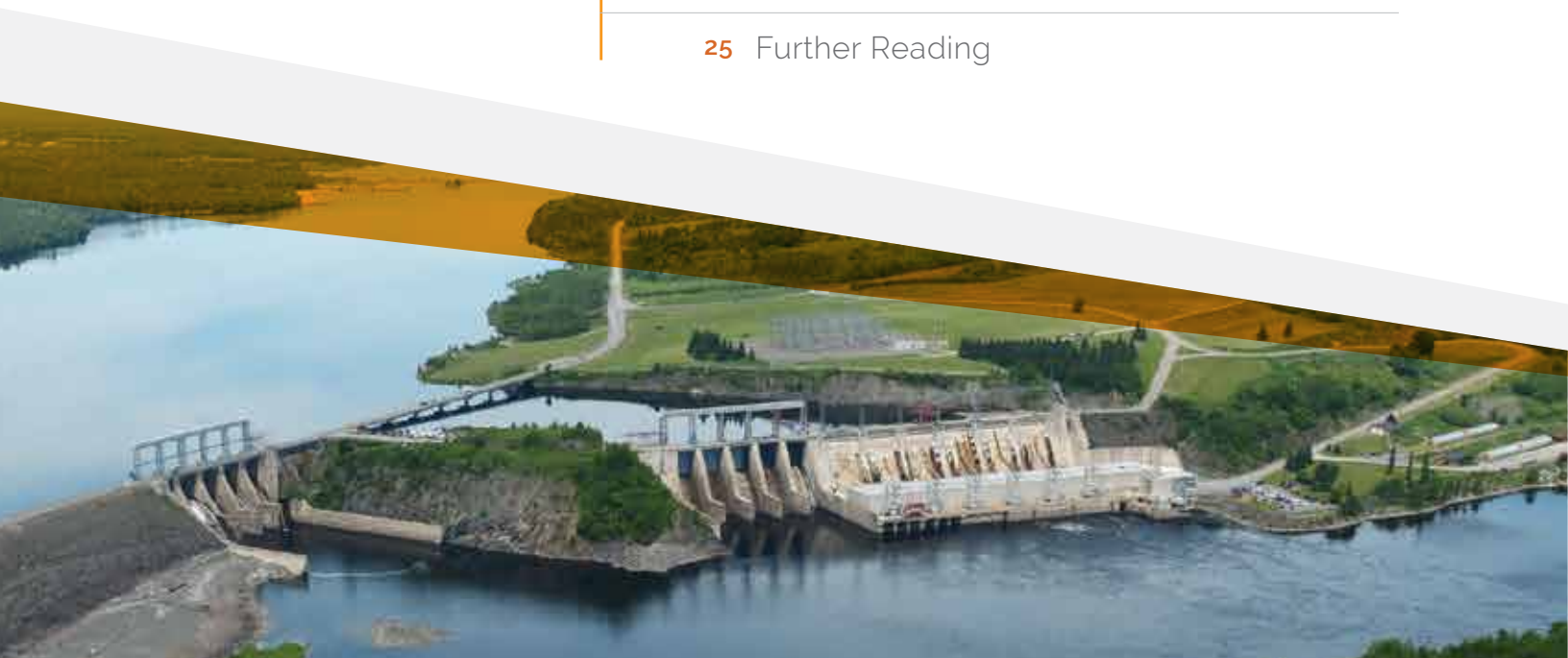


Message from the **CEO**

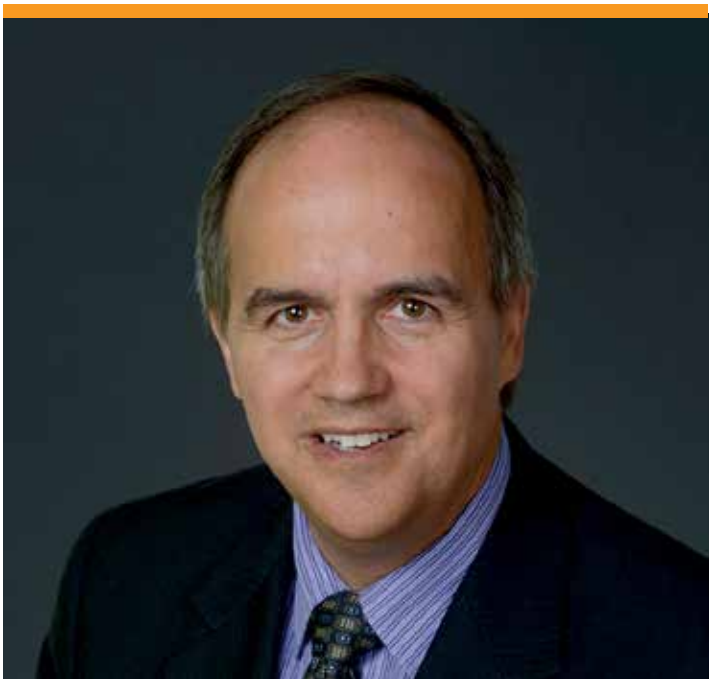
GAËTAN THOMAS President and ceo of NB Power

We have a big decision to make about the future of Mactaquac Generating Station.

The hydroelectric station is the largest of all NB Power's generation facilities on the Saint John River and is expected to reach the end of its operating life in 2030 because of problems with its concrete structures. While we study end-of-life options for the station, we continue to investigate whether we can adopt strategies to prolong the station's operating life beyond the expected deadline and at what cost.

In late 2016, we'll recommend a future path for the station.

As your public utility, we clearly understand that any course of action regarding Mactaquac has deep and far-reaching consequences for all New Brunswickers.



Since 2013, we have been working through a comprehensive research and consultation process that has involved scientists, engineers, environmental experts, First Nations and members of the public. We have published two draft reports on the potential environmental and social impacts of the options under consideration, engaged the Canadian Rivers Institute with the University of New Brunswick to conduct the largest-ever ecosystem study of the Saint John River, and have spoken to thousands of our customers and stakeholders about what's most important to them about the future.

I want to thank every single person who has taken the time to contribute to this conversation in person, in writing and online. We have been overwhelmed by the generosity of New Brunswickers and others who have shared their stories, insights and concerns about this project. Your feedback is an essential part of the process and will inform our recommendation later this year.

Any recommendation about Mactaquac must also be considered within the context of New Brunswick's future energy needs, and NB Power's mandate to provide safe, reliable electricity at low and stable rates.

It is with these last two points in mind that we offer this discussion paper. I hope that the facts contained here will encourage even more informed dialogue among New Brunswickers, building on a foundation for a strong and durable solution for the future.

Introduction

The purpose of this document is to shed light on the factors that NB Power will consider in the business and technical analysis of the future of Mactaquac Generating Station.

This is not meant to be a definitive or detailed assessment or a business case recommending the selection of any particular path.

It is rather intended to help New Brunswickers understand the kinds of choices ahead and create a shared understanding of the potential risks and benefits of each.

It will also provide a brief update on ongoing due diligence studies to determine the potential feasibility of extending the current 2030 end-of-service date.

Finally, it will explain the process by which NB Power will select a way forward in 2016.

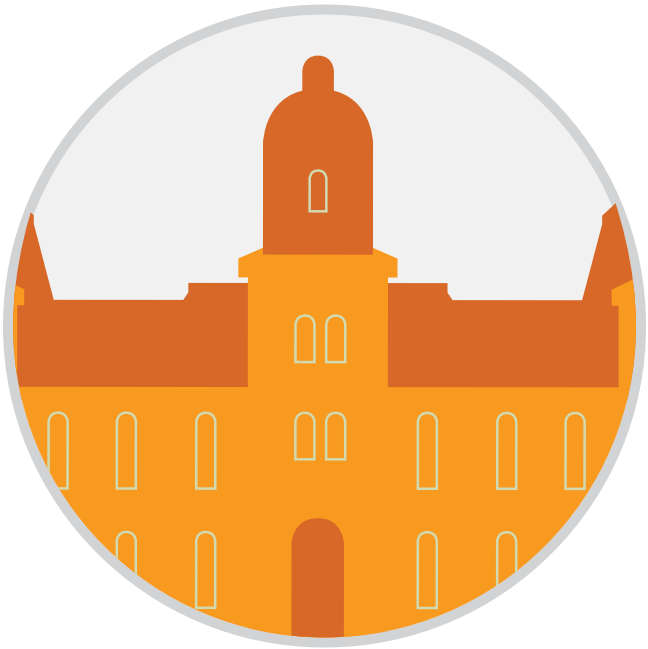
The final business case and technical analysis is a work in progress as NB Power gathers refined cost estimates related to the business, engineering, science, environmental and social aspects of the project.

Mactaquac is one of 13 generating stations in New Brunswick, supplies about 12 per cent of the province's energy needs and contributes to the stability of the province's electricity grid. It is one of seven NB Power hydro stations in New Brunswick.

As a public utility, NB Power follows policy direction set by the Government of New Brunswick. Expressed fully, this mandate is to provide safe, reliable, cost-effective, environmentally responsible electricity at competitive rates.

Within that policy context, there are several key considerations NB Power must factor into the business and technical analysis of the three options. These key considerations include: **energy policy, financial considerations, replacement services, external factors and risk.**

The eventual path forward must demonstrate that, in considering these elements, NB Power has selected the best-cost solution that meets the reliability, environmental and financial targets set by its owners, the people of New Brunswick (represented by Government), and its financial regulator, the New Brunswick Energy and Utilities Board.



Key Considerations:

- Energy Policy
- Financial Considerations
- Replacement Services
- External Factors
- Risk

Overview

New Brunswick's changing energy landscape

Every morning, somewhere in New Brunswick, a finger flicks a switch and a room floods with light. Phones and tablets charge. Warmth rises from baseboard heaters to protect and comfort. Meanwhile, mostly unseen and unheard, the force of the 673-kilometre long Saint John River spins through giant turbines at the Mactaquac Generating Station creating electricity to power our lives.

When the Mactaquac Generating Station was built nearly half a century ago, it provided cost-effective, local energy to New Brunswick's modernizing forest and manufacturing industry. We needed homegrown electricity to power mills, factories and homes. Our ability to harness the river and pivot from a farm and labour economy into the industrial age symbolized a province on the move. It is safe to say the decision-makers of the 1960s could not imagine the actual change that would come.

In 2016, our economy is again in transformation, from natural resource and industrial-based to technology and service-based. Workers who used to carry hammers and wrenches now carry smartphones and laptops too. Our remaining mills are run by sophisticated computer systems, powered only partly by the NB Power grid and the rest through biomass or other sources. The world of energy is also changing, with heat pumps, rooftop solar panels, wind power, home energy dashboard systems, battery storage, electric vehicles and other innovations, giving our customers greater options to manage their electricity use now and into the future.

Also in 2016, the Mactaquac Generating Station is at a crossroads. Problems with the station's concrete mean it is expected to reach the end of its life around 2030. NB Power has sketched out three broad options for the station, which include rebuilding, removing power generation while retaining the dam, or removing all structures and allowing the river to return to its natural flow. Meanwhile, experts continue to explore whether enhanced maintenance and additional investments could stretch that timeline and help the station achieve its intended lifespan.

Later this year, NB Power will recommend a preferred path for Mactaquac's future.

Questions for NB Power

As a public utility, NB Power follows policy direction set by the Government of New Brunswick and must account for its actions and decisions to its financial regulator, the New Brunswick Energy and Utilities Board. This mandate is to provide safe, reliable, cost-effective, environmentally responsible electricity at competitive rates.

During the last several months, NB Power has received thousands of comments and questions from New Brunswickers about the Mactaquac project. Hundreds of people attended open house sessions and thousands more shared their thoughts and concerns online. In that ongoing discussion, many customers have asked the very questions NB Power must ask itself.

CAN A NEW MACTAQUAC PAY FOR ITSELF?

NB Power must clearly understand and be able to prove that a rebuild is the best-cost solution when other factors are considered. The facts must demonstrate to the public and to NB Power's regulator, the Energy and Utilities Board, that the cost of a new station will not place unreasonable financial burden on ratepayers now or into the future.

HOW CAN THE POWER SYSTEM OPERATE WITHOUT MACTAQUAC?

Mactaquac produces renewable electricity, which must be replaced in kind to meet provincial legislative requirements on renewables if the station is not rebuilt. Also, the station offers secondary services that help the grid remain stable and efficient even as variable renewable resources such as wind farms are integrated into the regional system. The costs of replacing both renewable energy and secondary services must be considered in the financial analysis for any plan to remove the station.

WHAT OTHER CHOICES DO WE REALLY HAVE?

All of the options before us are expensive, with far-reaching social and environmental impacts extending across generations. As part of its research, NB Power is also working with independent experts on due diligence studies to determine whether the station can operate beyond 2030, perhaps even to its intended end-of-life by making operational adjustments and investments along the way. **Should this approach be deemed technically feasible, work will continue to understand the potential financial, environmental, social, First Nations and engineering impacts.**

The final business and technical analysis must provide answers to these questions, and further, point to a recommendation that customers of NB Power and all New Brunswickers, current and future, can live with and afford.

In making this recommendation, NB Power must also act as a steward of the environment and broader community outside New Brunswick, acknowledging that the Saint John River is a shared resource enjoyed by many users who live here and outside the province. In fact, regulatory approvals will be contingent on NB Power demonstrating this stewardship.

History

"Mighty Mactaquac" makes power for progress

On Saturday, June 22, 1968, hundreds of New Brunswickers watched in their Sunday best as then-premier Louis Robichaud pushed the button to start the third generating unit of the brand-new station. "Mighty Mactaquac," as the newspapers called it, was officially supplying power, power for progress.

Mactaquac roared to life at a time when New Brunswick businesses were beginning to thrive, especially those in the power-hungry wood, pulp and paper business. The population grew as people arrived to work in the mills and factories. More people meant a growth in electricity demand to power their workplaces and homes. New Brunswick's electricity grid expanded to fill the gap.

At the time, the Mactaquac Generating Station was the largest single engineering project in the history of New Brunswick. The project promised more energy on the grid, more jobs through increased productivity of businesses and more outdoor recreational area around the newly created headpond.

Before all of this could happen, many communities were changed forever. Hundreds of residents, mostly farmers, saw their homesteads moved or demolished after they had been bought out by the New Brunswick Electric Power Commission. With some communities flooded and gone, others were born. The Town of Nackawic, the Mactaquac Provincial Park and Kings Landing are some examples of what came after the flood, and locals and visitors adjusted their lives to the new reality.

For NB Power, Mactaquac is more than a generating station. It delivers essential services that support a safe and reliable power grid. In the unlikely event of all generating stations in the province going offline, Mactaquac's generators can deliver enough power to kick-start the grid. The headpond also acts as a short-term reserve in case NB Power needs extra capacity to meet peak demands. Mactaquac is also the "hydro brain" where operators manage NB Power's seven hydro stations that over the course of a year generate renewable energy that equates to about 25 per cent of what is consumed in New Brunswick.

However since the 1980s a chemical reaction called Alkali Aggregate Reaction (AAR) has caused the concrete portions of the powerhouse and spillways to swell and crack. The earthen dam, a rock-filled structure sealed with clay, does not have AAR. Engineers have been able to help relieve the problem temporarily but Mactaquac is currently expected to reach the end of its useful life by 2030.

Above: Former New Brunswick premier Louis J. Robichaud with former NB Power chairman H. Graham Crocker during opening ceremonies, June 22, 1968.

Right: View of the river and Snowshoe Island before the construction of Mactaquac Generating Station.

Below: Construction of Mactaquac Generating Station lasted three years.

Public Considerations

Public engagement and the decision-making process

All New Brunswickers have a stake in the eventual decision about Mactaquac. The cost will likely be paid for by customers through power rates and other forms of public financing. The Saint John River is a shared natural resource with environmental and aesthetic value. The station has created a community of landowners who value the natural beauty and recreational opportunities of the dam's reservoir. For these reasons and others, NB Power has invited all of its customers to be part of the discussion about the future.

Dozens of scientists and other experts are studying the potential environmental, scientific and social impacts of this decision, with the results captured in two draft reports, the Comparative Environmental Review (CER) and Social Impact Comparative Review (SICR), which are published online (www.mactaquac.ca).

The University of New Brunswick's Canadian Rivers Institute is conducting the largest-ever aquatic ecosystem study of the Saint John River to capture baseline data and model what might happen in each of the three end-of-life options proposed for the station in peer-reviewed studies. The full scope of their research is available online (http://canadarivers-gis.maps.arcgis.com/home/index.html).

New Brunswickers have been invited to comment on the draft CER and SICR reports and the project in general, and thousands have already shared their thoughts and feelings in person, in writing or through an online survey (www.mactaquaction.ca). The feedback received will be compiled into a final 'what was said' report to be made public later this year.

In addition, the interests and rights of First Nations are being considered through a separate engagement.

It is important to note that the scientific, environmental and social factors will influence the cost of the project and therefore will be considered as part of the business case. As those elements are gathered they are being fed into a cost-benefit and technical analysis. This work is in progress and must be complete prior to any recommendation being made.

This process is unique to NB Power and to Atlantic Canada. In fact, this may be the first time residents have ever been consulted on this scale, on a pending infrastructure decision, in the history of New Brunswick.

What is the goal of the public engagement process for Mactaquac?

To gather broad, values-based input from New Brunswickers to inform NB Power's recommendation in late 2016.

What is NB Power's promise to the public for this engagement?

WE WILL	Share information.
	Listen to and acknowledge the concerns and aspirations of those affected.
	Provide feedback on how public input will influence our recommendation.

What topics can be influenced through public feedback?

Common values identified during the engagement process will be reflected in the option selected. For example, reflecting what's most important to New Brunswickers in the areas of cost, environment, community impacts, cost and sources of renewable energy, and potential economic activity.

Feedback we receive can influence the process and techniques by which we consult with New Brunswickers. For example, reflecting identified preferences around online tools, face to face meetings, submitting written comments and other methods of contact.

New information uncovered during the engagement process will be considered.

What topics cannot be influenced by public feedback?

NB Power must continue to provide safe, reliable electricity at low and stable rates.

NB Power must operate in compliance with environmental regulations.

We are respectful of First Nation's rights and interests.

A recommendation must be made by the end of 2016.

Policy and Technical Considerations

As a public utility, NB Power will have to weigh many considerations before arriving at a recommendation for the future of Mactaquac Generating Station.

The ways that NB Power addresses these considerations will influence the volume of work created by the project, how the electricity grid will adapt, and perhaps most importantly, the final business case for one option over another. As such, they must be weighed along with all the other social, environmental and scientific elements of the decision.

These key considerations include: **energy policy, financial considerations, replacement services, external factors and risk.**

Energy Policy

NB POWER'S MANDATE

As a Crown utility, NB Power has reporting relationships with both the Province of New Brunswick and its regulator, the New Brunswick Energy and Utilities Board (EUB), which are grounded in the *Electricity Act* and in mandate letters from the Minister of Energy and Mines.

The EUB is an independent Crown agency established by the Legislature to regulate the electricity, natural gas, pipeline, motor carrier industries and set maximum fuel prices for the province.

NB Power management also reports to an independent Board of Directors comprised of utility, business and environmental experts with diverse career interests and backgrounds.

The Province of New Brunswick has given NB Power a clear mandate to provide electricity safely, reliably and with financial and environmental accountability. Specifically, NB Power is directed to provide safe and reliable service at low, stable and predictable rates for customers with definite targets for the development of renewable energy in New Brunswick.

Because of this, **NB Power must seek a best-cost solution that meets safety, reliability, environmental and financial goals.**

RENEWABLE ENERGY

The Province of New Brunswick has a legislated Renewable Portfolio Standard requiring NB Power to develop renewable energy resources to meet 40 per cent of in-province electricity sales by 2020. This renewable energy is limited to solar, wind, hydroelectric, ocean-power, biomass, biogas, and sanitary landfill gas. The energy currently produced by Mactaquac is hydroelectric, and meets the requirement of the province's policy.

Because of this, **any reduction in the energy produced by Mactaquac must be replaced by other eligible renewable energy.**

POWER SYSTEM RELIABILITY

NB Power is required by legislation to maintain the adequacy and reliability of the integrated power grid. Adequacy in this case means a system that is planned and built with a sufficient combination of transmission systems, structures and power plants that allow for reliable power supply for customers.

Reliability standards, approved by the EUB, are a kind of 'building code' for the grid. They establish rules for the planning, design and operation of the bulk power system, ensuring it operates safely and securely and without adding unreasonable risk to the North American grid. This secure system allows New Brunswick to reliably import and export electricity at prices that help to reduce rates for New Brunswick customers.

NB Power plans, maintains and operates its assets including Mactaquac in accordance with these various standards.

Because of this, **all options for the future of Mactaquac must allow for the reliable operation of the electricity system.**

Financial Considerations

CORPORATE STRUCTURE AND ACCOUNTABILITY

To understand how NB Power could fund a major capital project such as Mactaquac, it may be helpful to first explain how the company functions within the laws and regulations that define it.

The Province of New Brunswick, by way of the executive council (Premier and Cabinet) can set policy direction, approve programs, projects, capital loans and energy resource plans. The Provincial Legislature, by way of a vote on the floor, can approve legislation related to the utility.

At least once every three years, NB Power must submit an Integrated Resource Plan (IRP) to the Minister of Energy and Mines explaining how it will meet energy demand according to the principles of least-cost service, economic and environmental sustainability and risk management.

In addition to forecasting energy demand over the long term, the IRP also seeks to establish a development plan that responds to the *Electricity Act* and operates under the following policy objectives:

- to provide low and stable rates;
- to ensure a reliable power system; and
- to meet the requirements of a Renewable Portfolio Standard (RPS).

The New Brunswick Energy and Utilities Board (EUB), has the authority to set power rates, require financial reports of various kinds, and approve large capital projects on behalf of customers. All submissions to the EUB are public, as are any hearings it calls into NB Power applications.

NB Power must submit an annual strategic, financial and capital (construction or other improvements) investment plan covering the next 10 fiscal years to the EUB. That plan must include a schedule showing each capital project contemplated that has a total projected capital cost of $50 million or more and the related projected annual capital expenditures for each project.

In addition, NB Power must seek permission from the EUB for a capital project expected to cost $50 million or more. The utility must not spend more than 10 per cent toward a capital project before it has been approved by the EUB, with exceptions approved by NB Power's Board of Directors in certain circumstances, including in matters of safety and reliability.

Finally, any of the end-of-life options contemplated for Mactaquac could be subject to a provincial or federal environmental impact assessment as described in legislation. This public process would compel NB Power to find ways to lessen potential impacts of the project on people and the environment.

Because of this, **NB Power must account for its decisions through a variety of checks and balances defined in legislation and is prevented from taking unilateral action on a project of this size and type.**

FINANCING OPTIONS AND POWER RATES

In 2011, NB Power mapped out a financial plan that will allow for flexibility on the decision about Mactaquac Generating Station through long-term debt repayment and incremental rate increases. These

plans have been included in recent submissions to the EUB on NB Power's 10-Year Plan 2017-2026, and in support of NB Power's 2015 rate increase application. At this time, NB Power is forecasting the need for annual two per cent rate increases until 2021.

Unless private lending or investment options exist, are competitive and are permitted under legislation, it is most likely that this project will be financed through a long-term borrowing arrangement with the Province of New Brunswick. This loan would have to be approved by Government through an order-in-council and would be added to NB Power's net debt.

This borrowing arrangement comes at a price. NB Power pays the Province of New Brunswick a debt-portfolio management fee on the outstanding debt at the end of March each year. The rate is currently 0.65 per cent of the debt.

In addition, because any of the three end-of-life options would exceed the EUB's capital project threshold of $50 million, NB Power would be required to submit a detailed project financing plan for regulatory approval at the appropriate time. This plan will include suggested methods to repay the money NB Power will have to borrow for the project, which could include future rate increases for utility customers.

Typically, these costs are recovered over a long period of time, sometimes decades, to protect customers from rate shock, to maintain the utility's mandate of low and stable rates and to reflect the time frame over which the value of the investment is realized.

Ultimately, it will be up to the EUB to determine when and whether the project costs associated with Mactaquac are passed onto customers through rates, along with the method and terms of repayment.

Since fiscal 2015-2016, NB Power has been required to seek approval for its rates annually through the EUB, regardless of the rate change. This requires NB Power to provide evidence supporting its request in writing and during public hearings. This process makes NB Power's finances fully transparent for the first time.

Because of the projected capital expense associated with Mactaquac, **NB Power is working now to ensure budget flexibility to manage future costs. If the capital project costs are passed onto ratepayers, the EUB will determine the extent and length of the impact on rates through a public process.**

MANAGEMENT, CONSTRUCTION & LABOUR COSTS

The recommended approach for Mactaquac will require defined and somewhat predictable amounts of project expenses, including construction materials and skilled labour. Also, NB Power will require additional resources to support procurement, engineering, project management, contract execution, management and administration along with site oversight of work safety, environmental impacts and work quality.

It is important to note that while more study can improve the accuracy of technical estimates, predicting the price of labour, financing rates, material and services five to 15 years in the future is much more subject to uncontrollable and unpredictable factors.

NB Power will continue to refine cost estimates as engineering plans become finalized, seeking efficiencies and best practices through project management oversight and in accordance with provincial procurement, labour and environmental legislation.

Replacement Services

MACTAQUAC AND THE NORTH AMERICAN POWER GRID

Mactaquac Generating Station is one link in an energy chain that stretches across New Brunswick and North America through connections with Quebec, Maine and the Atlantic Provinces. This integrated power system is made up of generating stations (which produce power), substations (which convert power) and power lines that transport electricity between regions and carry electricity to customer homes and business.

NB Power has a diverse mix of generating stations and power purchase agreements from hydro, nuclear, coal, natural gas, oil-fired thermal and combustion turbines, biomass and wind as shown in our system map (pg. 16). The corresponding tables show the current makeup of generation in the system, including when some plants and power purchase agreements are scheduled to retire.

NB Power's 2014 Integrated Resource Plan also describes the balance of the integrated power system and its future development needs and opportunities (https://www.nbpower.com/media/102794/irpjuly2014-english.pdf).

Mactaquac's generation capacity is approximately 670 megawatts, and as a run-of-the-river station, its production is defined by natural flows and the limited water storage capacity in the headpond.

During much of the year, Mactaquac is able to use all the available water to obtain the highest possible power production from the river. The station's output is highest during the spring freshet and following autumn rains, during traditionally high river flows.

The flows in the river are dictated by geography and weather. For these reasons, the opportunities for increased energy production are limited to technical efficiency improvements in design, and increasing the capacity of the turbines and generators. The turbine type and size would be optimized to the site's characteristics and the power system's needs. This could result in small increases in generation, and only during periods of high river flow.

On average, Mactaquac produces approximately 1.6 terawatt-hours of energy per year, which would need to be replaced by equivalent, eligible renewable energy if the station is not rebuilt.

Because of this, **any of the options for Mactaquac must be evaluated as a component or components of the integrated power system.**

Existing Generation

Generating Capacity Thermal	
Coleson Cove	972 MW
Belledune	467 MW
Total Thermal	**1,439 MW**

Generating Capacity Hydro	
Mactaquac	668 MW
Beechwood	112 MW
Grand Falls	66 MW
Tobique	20 MW
Nepisiguit Falls	11 MW
Sisson	9 MW
Milltown	3 MW
Total Hydro	**889 MW**

Generating Capacity Nuclear	
Point Lepreau	660 MW

Generating Capacity Combustion Turbine	
Millbank	397 MW
St. Rose	99 MW
Grand Manan	29 MW
Total Combustion Turbine	**525 MW**

Total Generating Capacity	
Thermal	1,439 MW
Hydro	889 MW
Nuclear	660 MW
Combustion Turbine	525 MW
Total Generating Capacity	**3,513 MW**

Power Purchase Agreements (PPAs)	
Kent Hills (Wind)	150 MW*
Caribou Mountain (Wind)	99 MW*
Lamèque (Wind)	45 MW*
Bayside (Natural Gas)	285 MW
Grandview (Natural Gas)	90 MW
Twin Rivers (Biomass)	39 MW
St. George (Hydro)	15 MW
Edmundston (Hydro)	9 MW*
Other Renewable	6 MW
Total	**738 MW**

Number of Lines	
Distribution Lines	20,815 km
Transmission Lines	6,849 km

Exporting and Importing Capacity	
Export Capacity	2,137 MW
Import Capacity	2,378 MW

Number of Customers	
# of Direct Customers	352,208
# of Indirect Customers	45,425
Total Customers	**397,633**

*Nameplate Capacity: This capacity may not be fully available during times of peak demand

Generation Retirements

Description	Fuel Type	Capacity (MW)	End-of-life date
Grand Manan	Diesel	29	2026
Bayside PPA	Natural Gas	285	2027
Grandview PPA	Natural Gas	90	2030
Mactaquac	Hydro	668	2030
Millbank	Diesel	397	2031
St. Rose	Diesel	99	2031
Twin Rivers PPA	Biomass	39	2032

- Nuclear
- Hydro
- Wind
- Thermal
- Combustion Turbine
- Terminal
- Interconnection
- 345 kV Lines
- 230 kV Lines
- 138 kV Lines

SOVEREIGNTY AND SECURITY OF ENERGY SUPPLY

New Brunswickers would agree that electricity is an essential service, especially during the winter months when more than 60 per cent of us heat our homes with energy from the power grid. As such, electric power has evolved in New Brunswick with different combinations of public and private ownership, with government and regulatory oversight.

This policy context allows NB Power to purchase electricity from a variety of public and private generators.

In exchange, NB Power must operate its stations in an environmentally responsible manner, and provide a safe, secure and reliable supply of energy to customers.

Mactaquac Generating Station's central location in New Brunswick makes it less vulnerable to service interruptions and transmission constraints that might occur with external energy sources. Because the power is generated here, and NB Power has the flexibility to adjust its output, the risks of disruption in service are relatively low.

While all energy sources transported on transmission lines are subject to some risk of delivery interruptions, those risks may be considered higher for sources located outside New Brunswick. This is due to greater distances, changing rules for transmission system usage and jurisdictional challenges.

There is value in the sovereign arrangement between NB Power, the river and its customers because of the security of supply it offers to the grid. This intangible value is difficult to measure.

Because of this, **future scenarios for the station should consider this value, both the intangible (the feeling of safety and security for customers) and tangible (actual risk of service interruptions due to power purchased from outside New Brunswick).**

ADDITIONAL SERVICES PROVIDED BY MACTAQUAC

The power grid is a constantly flowing and changing entity as generating stations push electrons onto wires to smooth demand that can come in peaks and valleys at the flick of a customer switch. As a rapid-response generator, Mactaquac Generating Station is a big help in ensuring the grid is stable and reliable.

HERE'S HOW:

OPERATING RESERVES

The station can turn on quickly to deliver standby power in the event of a sudden service interruption somewhere else in the system. For example, if Point Lepreau Nuclear Generating Station or another station has to shut down quickly, Mactaquac can increase production and customers will not experience any change in service. This is known as an operating reserve. Mactaquac is presently the largest supplier of operating reserve on the system.

REGULATION AND LOAD FOLLOWING

Mactaquac also supplies regulation (minimizing the gap between power generation and demand on a minute-by-minute basis to maintain nominal values on the grid) and load following (flexibility to adjust output to manage hour-to-hour trends in changes in demand), which allows for the most efficient use of the electricity flowing through the system and reliable connections with other jurisdictions. These services are important to help integrate variable energy supplies (e.g. wind, solar) to the grid.

REACTIVE SUPPLY AND VOLTAGE CONTROL

The generators at Mactaquac can provide or absorb reactive power and help maintain appropriate local voltages. This is a complicated way of saying that Mactaquac helps maintain system voltage, which helps to support the quality, efficiency and reliability of electricity.

SYSTEM BLACK START

Reliability standards and good practice require NB Power to have a plan in place to be able to restore its system following a complete loss of power on the system. NB Power's current plan restarts the system by first energizing Mactaquac.

FREQUENCY RESPONSE AND INERTIA

The station's governor response (rapid ability to increase, lessen or stall output as needed) and inertia (tendency to sustain its rotation) help maintain system frequency, contributing to reliability and power quality. Without these services, the system might not be able to support its intensive network of connections.

Because Mactaquac provides essential reliability and stability services to the grid, **the business case will account for the need for these services by including the cost of facilities and operating conditions that could provide sufficient similar services.**

External Factors

ENVIRONMENTAL, ABORIGINAL AND SOCIAL IMPACTS

As mentioned earlier, environmental and social topics are being addressed in detail in other reports and aboriginal engagement is occurring through a separate process. However, NB Power recognizes that the potential impacts of aboriginal, environmental and social considerations will result in financial cost.

It's impossible to know in advance what those mitigation measures might be, but the Comparative Environmental Review and Social Impacts Comparative Review final reports will suggest possible outcomes, and best efforts will be made to include reasonable allowances in the cost estimates for each of the three options.

Risk

Good business practice and regulatory guidance require NB Power to follow risk management principles in planning any large project, especially one the size and scope of Mactaquac.

Some aspects, like the cost of concrete and construction materials, can be measured and costed immediately, others are more complex. Uncertainties exist around the future market price of materials, labour services, renewable electricity, the emergence of new and improved technology, interest rates for capital and borrowing and to some degree, government energy policy. So how do we account for those uncertainties? Most utilities, including NB Power, bundle these matters in the category of risk, and apply generally accepted risk management principles to assess and analyse their impacts.

These principles are relevant with respect to risks that include, but are not limited to, the following:

- The capital investment is more or less expensive than expected.
- The time required for new infrastructure is longer than anticipated.
- Electricity market prices are higher or lower than expected.
- New technologies arise or existing technology improves significantly.
- Facility operating costs are higher or lower than expected.
- Interest rates are higher or lower than expected.
- Changes in climate that impact design or load requirements.
- Future climate change policies lead to higher/lower costs for production of electricity from fossil fuels than expected, creating changes in demand for renewables.
- Inflation is higher or lower than expected.
- Fuel costs are higher or lower.
- The forecast for in-province electricity demand is higher or lower.

Part of NB Power's analysis of the impacts on the utility will involve identifying, assessing and prioritizing these types of risks to evaluate the robustness of the plan.

Options Considerations

Option 1 - Repower

- This option would require construction of a new powerhouse, switchyard, fish passage facility and spillway. Existing concrete structures would be partially removed following construction.
- Estimated length of construction would be up to **10 YEARS**.
- Project will require average equivalent of **500 FULL-TIME EMPLOYEES** during construction period.

Energy Policy	When compared to others, must be best-cost solution that meets environmental and financial targets. Provides eligible renewable energy under the Renewable Portfolio Standard.	Maintains reliable operation of the integrated power grid. Environmental Impact Assessment would identify mitigation measures.
Financial Considerations	Requires Government and EUB approval for project cost and financing. Would allow for continued production from headpond, avoiding or at least deferring the cost of decommissioning.	Capital and operating, management and administration costs during and after project phase will be considered. Length and method of repayment to be determined by EUB.
Replacement Services	Would satisfy all technical and renewable energy requirements currently provided by Mactaquac.	Sovereignty and security of supply values would not be impacted.
External Factors	Environmental, social and aboriginal considerations are being explored through CER, SICR, First Nations engagement process and through CRI studies on the Saint John River and headpond.	Additional costs could include investments to lessen potential social and environmental impacts during construction.
Risk	The capital investment is more or less expensive than expected. The time required for new construction and decommissioning of structures is longer than anticipated.	New technologies arise or existing technology improves significantly during construction. Energy demand changes significantly. Interest rates are higher or lower than expected.

Option 2 - Retain the Headpond

- This option would require replacement of concrete spillways to maintain downstream flow control, and construction of fish passage facility.
- Existing concrete structures would be partially removed.
- Estimated length of construction would be up to **7 YEARS**.
- Project will require average equivalent of **300 FULL-TIME EMPLOYEES** during construction period.

Energy Policy	When compared to others, must be best-cost solution that meets environmental and financial targets. No power produced. Eligible renewable energy under RPS must be built in-province or secured through power purchase agreements with external parties. Reliable operation of integrated power grid is possible with some investments to allow for ancillary services.	May require construction of extra spillway capacity to manage downstream flows during spring freshet. Environmental Impact Assessment would identify mitigation measures.
Financial Considerations	Requires Government and EUB approval for project cost and financing. Length of repayment to be determined by EUB. No possibility of return on investment through power production.	NB Power would maintain financial responsibility and liability for care, control and maintenance of non-power producing asset indefinitely with no chance of return on investment. Capital costs and operating, management and administration costs during and after project phase will be considered.
Replacement Services	All technical, ancillary and renewable energy services now provided by Mactaquac would have to be secured elsewhere and factored into final cost.	Tangible and intangible value of sovereign energy supply and security of supply to be evaluated.
External Factors	Environmental, social and aboriginal considerations are being explored through CER, SICR, First Nations engagement process and through CRI studies on the Saint John River and headpond.	Additional costs could include investments to lessen potential social and environmental impacts during construction.
Risk	The capital investment is more or less expensive than expected. The time required for new construction and decommissioning of structures is longer than anticipated. Interest rates are higher or lower than expected.	Loss of renewable energy source could result in impacts to federal/provincial GHG emissions targets as replacement energy will have to be found. May allow for future addition of a generating station.

Option 3 - Restore the River

- This option would require removal of the power-house, main spillway, and diversion sluiceway and associated infrastructure. The earthen dam would be decommissioned and removed.

- Estimated length of construction would be up to **4 YEARS**.
- Project will require average equivalent of **150 FULL-TIME EMPLOYEES** during construction period.

 Energy Policy	When compared to others, must be best-cost solution that meets environmental and financial targets. No power produced. Eligible renewable energy under RPS must be built in-province or secured through power purchase agreements with external parties.	Reliable operation of integrated power grid is possible with some investments to allow for ancillary services. Environmental Impact Assessment would identify mitigation measures.
 Financial Considerations	Requires Government and EUB approval for project cost and financing through rates. Length of repayment to be determined by EUB.	No possibility of return on investment through power production. Capital costs and operating, management and administration costs during project phase will be considered.
 Replacement Services	All technical, ancillary and renewable energy services now provided by Mactaquac would have to be secured elsewhere and factored into final cost.	Tangible and intangible value of sovereign energy supply and security of supply to be evaluated.
 External Factors	Environmental, social and aboriginal considerations are being explored through CER, SICR, First Nations engagement process and through CRI studies on the Saint John River and headpond.	Additional costs could include investments to lessen potential social and environmental impacts during decommissioning phase.
 Risk	The capital investment is more or less expensive than expected. Interest rates are higher or lower than expected.	Loss of renewable energy source could result in impacts to federal/provincial GHG emissions targets as replacement energy will have to be found.

Update on Due Diligence Studies

While evaluating the three end-of-life options for Mactaquac, NB Power continues to explore ways to continue operation of the current concrete facilities beyond 2030, perhaps even to the intended service life of the 1968 project. These have been been referred to as due diligence studies throughout the process.

Approaches under consideration include varying degrees and means of rehabilitation of the existing structures combined with increased maintenance and associated costs. Should such an extension be found to be both technically and economically feasible, NB Power will assess whether or not this is a prudent course of action by comparing it to the three options that have been under study.

Given the importance of the technical and economic implications, this exploration is proceeding on two fronts each with a different origin and using different teams of experts. One team is minimizing interventions on the civil works and putting more emphasis on the necessary interventions with the mechanical equipment. The other team's approach evolved from the notion of a full in situ rebuild of the station. The full in situ rebuild, a section-by-section replacement of all concrete in its current location, was considered and was not found to be feasible. However, a partial in situ rebuild was determined to be worthy of evaluation. Under this approach only some of the concrete around key mechanical components would be replaced. The remainder would be left in place. Other civil and mechanical work would be performed to extend the life of the assets.

In both cases, the generation capacity and energy production would be similar to the current values. During construction there would be loss of generation capacity as units are taken out of service and replaced over multiple years. The loss of energy production would be tempered by the fact that for most of the year there is not enough water flow to take advantage of more than four units at any one time for energy production.

As these two approaches evolve, it is possible that the two will converge into one as NB Power further assesses their potential benefits or drawbacks. Also, each analysis will help to technically and economically validate the other.

Should this approach be deemed technically feasible, work will continue through 2016 to understand the potential financial, environmental, social, First Nations and engineering impacts. NB Power will keep the public informed as it develops.

Framework for a Durable Decision

Balancing technical, financial, social and environmental factors

NB Power is working to make a sound and lasting decision about the future of Mactaquac. It must make good business sense for NB Power and be something that all New Brunswickers, current and future, can live with and afford.

We know that the most durable decisions – those deemed most acceptable in the long term – successfully balance the following factors: They must be technically feasible, financially viable, socially acceptable and environmentally responsible. NB Power has put forward three very different options for the future of Mactaquac to gather information on each of these factors from various sources.

Our ongoing engagement with First Nations is helping to inform us of our obligations and our opportunities for better relationships with these river-based communities.

Research and public feedback will help determine the social impacts through the Social Impact Comparative Review process.

Environmental aspects will be considered through scientific studies from the Canadian Rivers Institute and the Comparative Environmental Review process.

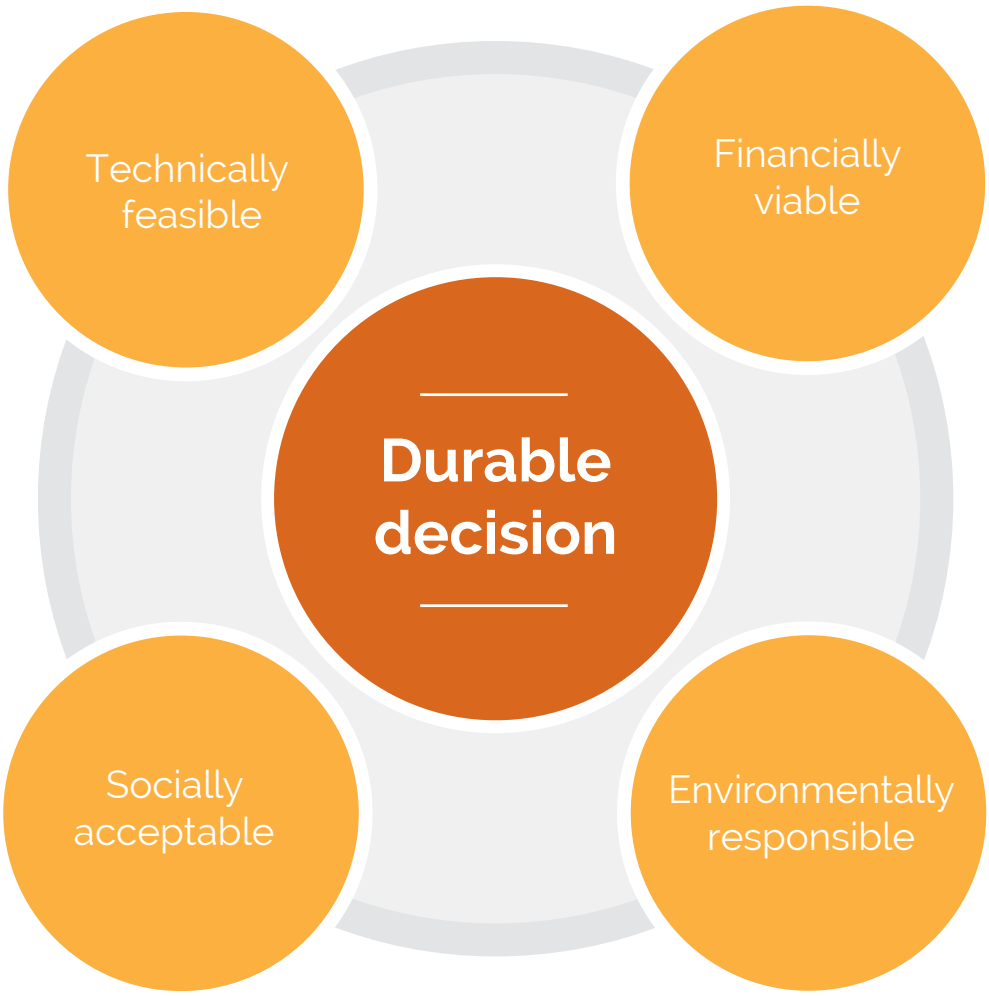
The financial and technical viability will be first considered by NB Power and its Board of Directors, and then by the Province of New Brunswick and ultimately its regulator, the New Brunswick Energy and Utilities Board.

For the Mactaquac decision process, NB Power will consider a fact-based methodology that seeks to balance these four factors as expressed through the CER, the SICR, the public engagement process and the final business and technical analysis.

NB Power will continue to study the business case and refine the potential technical solutions to the situation at Mactaquac, keeping in mind that society, and more specifically the legal and regulatory requirements, will require an environmentally and socially responsible solution.

The eventual path forward must demonstrate that, in considering these elements, NB Power has selected the best-cost approach that meets the reliability, environmental and financial targets set by its owners, the people of New Brunswick, and its regulator, the New Brunswick Energy and Utilities Board.

By the end of 2016, NB Power will seek to arrive at a responsible decision for Mactaquac Generating Station that meets the present and future needs of New Brunswick's energy system and reflect the values of the New Brunswickers who own it.



Further Reading

Comparative Environmental Review Report,
prepared for NB Power by Stantec Consulting Ltd, September 2015.
http://www.mactaquac.ca/cer-documents/

Social Impact Comparative Review,
prepared for NB Power by Dillon Consulting, September 2015.
http://www.mactaquac.ca/wp-content/uploads/2015/09/SICR_Mactaquac_Project_Sept2015.pdf

A Social Ecological History of the Saint John Watershed,
prepared for NB Power by Thrive Consulting, September 2015.
http://www.mactaquac.ca/wp-content/uploads/2015/09/A_Social_Ecological_History_of_the_Saint_John_Watershed_Sept_2015.pdf

NB Power Strategic Plan 2011-2040,
https://www.nbpower.com/media/1598/d-html-en-about-publications-2011-2040-strategic-plan-en.pdf

Integrated Resource Plan 2014,
https://www.nbpower.com/media/102794/irpjuly2014-english.pdf

NB Power's 10-Year Plan 2017-2026,
https://www.nbpower.com/media/169786/2017-26-ten-year-plan-en.pdf