MANITOBA HYDRO
2025 INTEGRATED RESOURCE PLAN AND MAJOR NEW FACILITIES REVIEW
PUB/SB
INFORMATION REQUESTS

July 2, 2026

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PUB/SB-1

Part and Chapter:	Sustainable Brandon MNF Report MEED/MH I-34c MH Fiscal 2026-2028 GRA MFR 33	**Page #:**	19-20, 22
Topic:	Battery Energy Storage Systems		
Subtopic	Benefits to Existing Manitoba Hydro System		

Preamble (if any):

At pages 19-20 of the report, Sustainable Brandon states the IRP plan for a 5 MW battery resource is too small in size and that its build-out is too slow. Page 22 of the report also criticizes that new wind farms are not proposed to be integrated with battery storage.

In section 4 of the report, the author instead proposes, among other things, the build out of multiple battery storage systems over the next ten years, distributed at strategic locations throughout Manitoba.

In its 2025 IRP submissions, including its response to MEED/MH I-34c, Manitoba Hydro explains that its electric system already includes large amounts of energy storage in its existing hydroelectric reservoirs.

Figures 2, 3, and 5 of Minimum Filing Requirement (MFR) #33[1] from the Manitoba Hydro Fiscal 2026-2028 General Rate Application present information regarding Manitoba Hydro's potential energy in reservoir storage for the period April 2022 through January 2025. During this relatively short time period, the energy stored in the major reservoirs affected by Manitoba Hydro's operations (i.e., "MB partial" data from Figure 3 and 5) ranged from a low of 4.7 TWh to a high of 19.8 TWh.

Question:

a) Please explain whether battery storage systems offer additional benefits to Manitoba Hydro's electricity grid system that are not already provided by Manitoba Hydro's hydroelectric reservoirs.

b) Please explain how Manitoba Hydro pairing existing or new wind resources with battery storage systems would differ from Manitoba Hydro pairing existing or new wind resources with its existing hydroelectric reservoirs.

c) Please explain how the additional battery storage recommended in the report would help serve the peak load during multi-day generation or transmission contingencies or prolonged winter cold snap events while at the same time

[1] Reference PDF pages 216-219 of https://www.hydro.mb.ca/docs/regulatory_affairs/pdf/electric/gra_2026_2028/09-0_tab_9_responses_to_mfrs.pdf

avoiding situations where the recharging of these batteries does not contribute to a new peak that must be served during those events.

d) Please confirm whether, and explain how, the proposed battery storage systems located at strategic locations throughout Manitoba would only provide the stated benefits to those specific areas of Manitoba Hydro's electric system or whether they would provide benefits to Manitoba Hydro's grid system as a whole.

Rationale for Question:

To understand how battery storage systems may be differentiated from Manitoba Hydro's existing hydroelectric reservoirs, and how this difference contributes to battery storage systems being viewed as equivalent to combustion turbines in Manitoba Hydro's winter peaking, hydro-dominated, electricity supply system.

Response:

a) Please explain whether battery storage systems offer additional benefits to Manitoba Hydro's electricity grid system that are not already provided by Manitoba Hydro's hydroelectric reservoirs.

As noted in *SB Review* (p. 3), we agree that MH has established "Need For" additional capacity for short periods during winter, beyond what MH hydroelectric reservoirs can supply.

In *Appendix 6 – Resource Options § 2.13*, MH lists a number of benefits that BESS provide:

> *Additional indirect benefits [of batteries] include:*
> - *transmission/distribution asset deferral*
> - *transmission congestion relief*
> - *time shifting of energy*
> - *energy arbitrage*
> - *ancillary services*
> - *frequency regulation*
> - *frequency response*
> - *black start support*
> - *voltage control*
> - *customer services*
> - *power reliability*

- *time of use or demand charge reductions*[2]

Appendix 6 – Resource Options § 2.13 also lists some of the other advantages that BESS have:

- highly flexible
- modular sizing
- low to no transmission costs
- can assist in integrating variable resources
- negligible operating GHG emissions

Battery storage systems are able to collect power from many sources, while hydroelectric reservoirs typically store only the potential energy of the water. Batteries can release energy directly and extremely quickly into the grid when needed. This ability to store power from base-load generation and then, at the right time, deliver power that would otherwise go unused will be a significant and unique benefit to the MH grid system, increasing the overall efficiency and dispatchability of all existing resources, including hydroelectric reservoirs.

b) Please explain how Manitoba Hydro pairing existing or new wind resources with battery storage systems would differ from Manitoba Hydro pairing existing or new wind resources with its existing hydroelectric reservoirs.

Without accompanying battery storage, MH estimates that "[t]he ability of wind to provide firm capacity during the winter coincident peak load in Manitoba is currently about 20% of the installed capacity". (*MH Appendix 6 – Resource Options,* p.3., cited in *SB Review*, p.48.).

Adding battery storage to the existing and any new wind farms would increase their firm capacities. As noted in *SB Review* (p.49), *"[t]o calculate how much that [firm capacity] percentage would increase, we need to estimate the Crucial Parameters of the Supply Deficits….[T]he exact percentage of these wind farms' output that would be transformed from intermittent to firm capacity will be limited, in part, by the storage capacity of the BESS (measured in MWh) and, more importantly, by the Crucial Parameters of the Supply Deficits."*

As noted in *SB Review § 4.1.5. Required Characteristics* (p. 44f ff), these Crucial Parameters of the Supply Deficits are the frequency, depth, and duration of the supply deficits expected during winter months.

[2] It is unclear why these are called "indirect benefits". They directly benefit MH and its customers and further MH's mandate to provide reliable power. (Sentence reformatted as bullet points.)

c) Please explain how the additional battery storage recommended in the report would help serve the peak load during multi-day generation or transmission contingencies or prolonged winter cold snap events while at the same time avoiding situations where the recharging of these batteries does not contribute to a new peak that must be served during those events.

The full answer to this question can only be provided once we have received the requested data from MH on the size, timing, duration and frequency of the past demands. We are expecting that data in the last week of July.

d) Please confirm whether, and explain how, the proposed battery storage systems located at strategic locations throughout Manitoba would only provide the stated benefits to those specific areas of Manitoba Hydro's electric system or whether they would provide benefits to Manitoba Hydro's grid system as a whole.

Usually, they would provide benefits to Manitoba Hydro's grid system as a whole.

If, however, there was a significant disruption to the grid system as a whole (for example, if an ice storm or forest fire temporarily disabled one or more of the MH's major transmission lines) each battery storage system would act as a short-term "shock absorber," supplying power to their particular region until either the power stored in the batteries was completely discharged, or the grid disruption could be repaired. In this way, distributed battery storage systems would enhance the overall resiliency of the Manitoba Hydro grid.

On the other hand, if the gas turbines centralized in Brandon suffered a significant disruption (damage to the gas pipeline or electrical transmission line, or fire in the turbine facility, for example), the loss would be to the entire Manitoba Hydro grid.

PUB/SB-2

Part and Chapter:	Sustainable Brandon MNF Report MNF Attachment 2.1 PUB/MH I-49e & CC/MH III-7c	**Page #:**	28, 29, 45
Topic:	Alternative to Combustion Turbines		
Subtopic	N/A		

Preamble (if any):

Page 28 of the report states:

> We are recommending two initiatives instead of the combustion turbines (CTs) proposed in the MNF:
>
> > 5.1. multiple, mid-sized Battery Energy Storage Systems (BESS) distributed at strategic locations throughout Manitoba
> >
> > 5.2. incentives sufficient to make it worthwhile for Manitoba's major electricity users to significantly increase their peak shaving and load shifting actions
> >
> > […]
> >
> > 5.3. In the Alternative: build only 1 combustion turbine, fueled by biodiesel, to start

At page 29, the author clarifies that the above proposal includes approximately 10 battery storage systems, with at least one system installed each year for the next 10 years. Page 45 of the report also clarifies that the expected battery storage fleet's discharge rate should be approximately 750 MW to 1,000 MW.

Attachment 2.1 of Manitoba Hydro's major new facilities filing provides updated supply and demand tables based on updated assumptions, including those related to scheduled outages and new contracted diversity agreements. In response to PUB/MH I-49e and CC/MH III-7c, Manitoba Hydro also provides cumulative installed capacity tables for development plans P5A, P3, and P7.

Question:

a) Please confirm, or otherwise explain, whether the ten battery storage systems being recommended in the report are approximately 100 MW in individual size.

b) Please explain whether the alternative recommendation for one combustion turbine is a recommendation to support Manitoba Hydro's IRP development plans such as short-listed plan P7, which includes fewer combustion turbines compared to Manitoba Hydro's recommended plan P5A.

Rationale for Question:

To better understand the recommendations included in Sustainable Brandon's report.

Response:

a) Please confirm, or otherwise explain, whether the ten battery storage systems being recommended in the report are approximately 100 MW in individual size.

Yes; each would be approximately 100 MW in individual size.

b) Please explain whether the alternative recommendation for one combustion turbine is a recommendation to support Manitoba Hydro's IRP development plans such as short-listed plan P7, which includes fewer combustion turbines compared to Manitoba Hydro's recommended plan P5A.

No, SB's Alternative Recommendation (AR) should not be understood as a recommendation to support plan P7. SB's AR differs from plan P7 in a number of ways, including:

- The AR includes the addition of only one combustion turbine to the two already existing at the Brandon Generating Station (BGS).
    - Descriptions of plan P7 refer to "combustion turbines" (plural). (See, for example, *2025 Integrated Resource Plan*, p.50.)
- It appears that plan P7 proposes the use of Simple Cycle Combustion Turbines (SCCTs). The AR leaves open the possibility of using either a SCCT or a Combined Cycle Combustion Turbine (CCCT).
- The AR proposes the combustion turbine be located at the most feasible site of biomethane in Manitoba–the Brady landfill–rather than at the BGS as is apparently proposed in plan P7.
- The AR proposes that a BESS be integrated with and installed at the same time as the combustion turbine; plan P7 does not.
    - Depending on the capacity of the BESS, it is possible that this would enable MH to use the BGS as a true back-up facility, reserved primarily for drought conditions, rather than being run every year, as is the current practice. This is the practice recommended in the AR, but is not mentioned as a possibility in plan P7.
- The AR indicates that the infrastructure required to use FAME biodiesel as a fuel must be integrated into the design and be operational on the in-service date of the combustion turbine. Plan P7 does not propose the use of FAME biodiesel.
    - The AR indicates that "vaporization technology must be included in the design and installation" of the combustion turbine to ensure the emissions

from FAME biodiesel are comparable to the emissions from natural gas. Plan P7 does not include this provision.

- To ensure that the FAME biodiesel could be used year-round, the storage tank(s) would need to be insulated, and excess heat from the combustion turbine would need to be used to keep the FAME biodiesel above its cloud point (see *SB Review*, p. 24).

- Plan P7 also omits consideration of Economic Diversification Benefits (*SB Review* § 3.4.4.1, p. 26) or the Benefits to Manitoba's Agricultural Sector (*SB Review § 3.4.4.2,* p. 27) that could be realized from the use of FAME biodiesel.

PUB/SB-3

Part and Chapter:	Sustainable Brandon MNF Report Appendix 7.1	**Page #:**	8, 57 16
Topic:	Alternative Recommendation		
Subtopic	Biomethane		

Preamble (if any):

On page 57 of the report, Sustainable Brandon outlines an alternative proposal for only one combustion turbine, which is to be located at the site of Manitoba's largest source of biomethane (e.g., the Brady Road Resource Management Facility), with infrastructure required to use FAME (fatty acid methyl esters) biodiesel as a fuel.

On page 8 of the report, Sustainable Brandon states:

> It is our understanding that these carbon credits and Manitoba-based offsets are essential for MH to proceed with the MNF while complying with the Government of Manitoba's Mandate Letter and current Federal and Provincial policies related to climate change and energy.

On page 16 of Appendix 7.1, Manitoba Hydro states:

> Some combustion turbine resource options are modelled with the ability to generate electricity using a non-fossil fuel or biofuel source, with the assumption that a credit system is in place. When non-fossil fuels or biofuel fuels are sourced it is assumed that the pipeline fuel consumed can be paired with a purchase of a credit so no net GHG emissions are produced…
>
> For the 2025 IRP, it is assumed that a credit system is in place that follows internationally recognized GHG accounting principles. The use of non-fossil fuel credit frameworks (i.e., book-and-claim systems) is a solution to the barriers of using non-fossil fuels or biofuels, including:
> - For many applications it is not economically or technologically feasible to transport, distribute, and store non-fossil fuels (e.g., biofuels) separately from existing fossil fuel transportation, distribution, and storage infrastructure.
> - The need for new dedicated pipelines, storage facilities, and other infrastructure.
> - When blending occurs, the non-fossil fuel content of the fuel becomes uncertain.
> - Relying on 100% non-fossil fuel sources in Manitoba at utility scale.

In its response to MEED/MH I-6h, Manitoba Hydro states:

> Should biomethane be developed in Manitoba, Manitoba Hydro considers blending of biomethane into existing natural gas transmission and/or distribution infrastructure to likely be the most practical approach for most use cases.

Question:

Please provide Sustainable Brandon's views as to whether the proposed approach of blending biomethane into the existing Centra Gas pipeline system and claiming credits

that would be used by the combustion turbine facility is an acceptable approach and, if so, whether that means proximity of the combustion turbines to the source of biomethane is not a significant consideration. If Sustainable Brandon has any concerns with this approach, please identify them.

Rationale for Question:

To understand any concerns with the use of carbon offset credits to reduce the GHG emissions from the combustion turbines.

Response:

In the *2025 Integrated Resource Plan* (p.70), MH lists item 9 in its Near Term actions as:

> **2025 IRP NTA Nine:** Explore alternative fuels, credits, and Manitoba-based offsets to combustion turbine GHG emissions and further investigate the direct use (blending or full replacement) of alternative fuels, such as hydrogen.
>
> Reaching a net-zero future in Manitoba will require the use of alternative fuels, credits and offsets. This NTA involves conducting technical studies, cost analyses and leveraging technical experts to investigate effective use of low-carbon fuels for use in dispatchable generation and direct applications, including blending or full replacement in space heating. It also includes evaluating roles of biomethane credits or similar mechanisms that could be applied to both utility operations and industrial natural gas users. This NTA will support reducing emissions from continued use of natural gas.

This section of the IRP is, perhaps, more ambiguous than it could be. The phrases “use of…credits” and “evaluating roles of biomethane credits or similar mechanisms that could be applied to both utility operations and industrial natural gas users” do not make it clear that it is the producer (and seller) of the clean fuel which earns the credit, not the consumer (and buyer).

This allocation of the credits is outlined in the Government of Canada’s Clean Fuel Standard (https://www.canada.ca/en/environment-climate-change/services/managing-pollution/energy-production/fuel-regulations/clean-fuel-regulations/regulatory-design.html#toc4) and detailed further in Canada’s Greenhouse Gas Offset Credit System (https://www.canada.ca/en/environment-climate-change/services/climate-change/pricing-pollution-how-it-will-work/output-based-pricing-system/federal-greenhouse-gas-offset-system.html).

The utility can buy the Renewable Thermal Certificates (RTCs) (or, more informally, the “biogas attributes”) from the producer of the biomethane and then use those as credits, but it would incur a cost in buying those credits.

The City of Winnipeg owns what appears to be the only potential large-scale point source of biomethane in Manitoba–the Brady Road Resource Management Facility. Currently, the landfill gas (LFG) Brady emits is collected via a piping system and flared. The City of Winnipeg, with support from the Federation of Canadian Municipalities' Green Municipal Fund, assessed options for turning this landfill gas into a source of revenue. (See https://greenmunicipalfund.ca/case-studies/how-turn-landfill-gas-source-energy.) This study explored four options:

1. Generating electricity in an on-site facility, then selling it to Manitoba Hydro.
2. Processing the LFG into pipeline-quality renewable natural gas (RNG) [referred to in MH materials as "biomethane"], then selling it on the open market.
3. Processing the LFG into a low-grade fuel and supplying it to the University of Manitoba.
4. Selling raw LFG to an independent power producer.

Based on the available data, it is not yet clear if Brady could produce enough biomethane to meet MH's target of purchasing 1 million m^3 of biomethane in 2035, rising to 7 million m^3 in 2048 (*Attachment 2.2 – Project Description*, p. 16). In addition to purchasing the biomethane, MH and/or Centra Gas would need to purchase the Renewable Thermal Certificates (RTCs) it needed from the entities producing the biomethane if they wanted to use those RTCs as offsetting credits against their burning natural [fossil] gas to produce electricity.

If MH or Centra Gas were to pursue this option, they would not be burning unmixed biomethane at the BGS. The gas in the pipeline would be some as-yet-undetermined mixture of natural gas and biomethane. Given the volume of natural gas in the Centra Gas system, the percentage that would be biomethane would likely be very small.

PUB/SB-4

Part and Chapter:	Sustainable Brandon MNF Report PTC-2 Power Team Report	**Page #:**	24 12
Topic:	Alternatives Not Adequately Considered		
Subtopic	FAME diesel fuel		

Preamble (if any):

On pages 23 and 24 of the report, Sustainable Brandon states:

> There are two types of commercially available non-fossil diesel:
>
> - Hydrogenation-Derived Renewable Diesel (HDRD)—also referred to as Renewable Hydrocarbon Diesel. Government and industry sources typically refer to this fuel as "renewable diesel".
>
> - For clarity, we will refer to this fuel as "renewable (HDRD) diesel".
>
> - FAME (fatty acid methyl esters) diesel. Government and industry sources typically refer to this fuel as "biodiesel".
>
> …
>
> We cannot find any indication in its submissions that MH considered the option of FAME biodiesel as a fuel in its consideration of Alternatives To the proposed MNF.

Per page 12 of Power Team Consulting's report, Manitoba Hydro is considering the GE Frame 7F.05 and Siemens SGT6-5000 gas turbine models for the Brandon generating station.

Question:

a) Please confirm whether FAME diesel is a suitable fuel for GE Frame 7F.05 or Siemens SGT6-5000 models, and whether there are any concerns or restrictions with its use.

b) Please confirm whether there are any concerns with the long-term storage of FAME diesel, as would be required for the Brandon generating station where operation is intermittent and the preferred fuel is natural gas.

Rationale for Question:

To understand whether FAME diesel is an acceptable alternative to renewable diesel for combustion turbine operation.

Response:

a) Please confirm whether FAME diesel is a suitable fuel for GE Frame 7F.05 or Siemens SGT6-5000 models, and whether there are any concerns or restrictions with its use.

Yes, it is a suitable fuel for both models. Both the Siemens and GE websites confirm that the turbines being considered can accept FAME biodiesel as a fuel.

On its website, Siemens states:

> *High Fuel Flexibility: The SGT6-5000F is able to burn a wide range of fuels including natural gas, LNG, syngas, ethane, propane, Arabian Super Light crude oil, distillate oil, condensate, Arabian Extra Light crude oil, biodiesel, alcohols, Jet-A oil, and kerosene.*
>
> *The engine offers dual fuel capability and tolerates fuels within a wide Wobbe range.*
>
> *The combustion system is able to handle different fuel compositions, e.g. contents of hydrogen sulfide (H_2S) of up to 4,000 ppm, or hydrogen (H_2) of up to 30 vol%. Its system can switch over quickly between fuel gas and fuel oil and vice versa.*
>
> *Fast fuel switchover: With the SGT6-5000F combustion system there is no need to shut down when switching from gas to liquid fuel and vice versa.*
>
> *Robust combustion system: The annular combustion system is able to handle a wide range of fuels and creates a stable combustion with uniform flow and temperature distribution.*[3]

On its website, GE states;

> *The 7F technology is core to GE Vernova's Gas Power portfolio of products and services….In terms of fuel flexibility, the 7F.04 gas turbine is the only turbine in its class to burn Arabian Super Light (ASL), 15% C2, +20/-10% Modified Wobbe Index (MWI)....A 7F.05 can also balance renewables by load-following at 40 MW/min ramp rates while maintaining emissions compliance. Industry-leading Dry Low NOx 2.6 combustion system lowers emissions, offers flexibility on a wide range of natural gas or distillate [liquid] fuel….Upgradable liquid fuel systems for greater reliability, efficiency, and safety…Can be fitted with our Live Outage service, a digitized platform to help create a better outage experience….Synchronous condenser solutions to support grid stability*

[3] Siemens Energy. (n.d.). *SGT6-5000F heavy duty gas turbine for 60Hz power generation.* https://www.siemens-energy.com/global/en/home/products-services/product/sgt6-5000f.html#/

without fuel burn, inertia and fault current contribution, as the grid moves towards higher renewable penetration.[4]

And:[5]

GE Vernova gas turbines are a great choice for a variety of industries and applications. Featuring unmatched fuel flexibility, ability to complement renewables, and fast installation/startup time, our aeroderivative and heavy-duty gas turbines offer proven, industry-leading performance….

Gas turbines are highly fuel-flexible machines capable of operating on a wide range of liquid and gaseous fuels. The specific fuel used depends on the turbine's configuration, the application, and what's available at the site.

Fuels broadly fall into several categories, including crude oils, refined petroleum products, natural gas and gas-derived fuels, and alternative or low-carbon options such as hydrogen and biofuels.

- *Crude oils*
  - *Arabian Extra Light (AXL) crude oil*
  - *Arabian Super Light (ASL) crude oil*
  - *Heavy crude oil Light Crude Oil (LCO) Medium crude oil*
- *Refined petroleum products*
  - *Distillate Oil #2 (DO2)*
  - *Heavy Fuel Oil (HFO)*
  - *Kerosene (Jet A or Jet A-1)*
  - *Naphtha*
- *Natural gas and gas-derived fuels*
  - *Ethane (C2)*
  - *Lean methane*
  - *Liquid Natural Gas (LNG)*
  - *Liquefied Propane Gas (LPG)*
  - *Natural Gas (NG)*
  - *Sour gas (H2S)*
  - *Steel mill gases*

[4]GE Verona. (n.d.). *GE Verona 7f features and benefits.* https://www.gevernova.com/gas-power/products/gas-turbines/7f

[5] GE Verona. (n.d.). *What is a gas turbine, and how does it work?* https://www.gevernova.com/gas-power/resources/education/what-is-a-gas-turbine

- *Syngas*
- *Alternative and lower-carbon fuels*
  - *Biodiesel*
  - *Condensate or Natural Gas Liquids (NGL)*
  - *Dimethyl Ether (DME)*
  - *High H2*
  - *Hydrogen blends*
  - *Methanol / ethanol (alcohol)*

In order to use diesel (whether FAME biodiesel, renewable HDRD diesel, or fossil diesel) the turbine would need to be "dual fuel" as this term is commonly used in the turbine industry, as quoted in the *SB Review* (p. 49):

> *Dual fuel gas turbines are advanced power generation systems capable of operating on both natural gas and liquid fuels, offering flexibility and efficiency in energy production. These turbines integrate combustion technologies that allow seamless switching between fuel types, making them ideal for industries requiring reliable and adaptable power solutions. Key components include compressors, combustion chambers, and turbines designed to optimize performance across varying fuel inputs.*[6]

In *Volume 2 - Major New Facilities* (p. 16), MH noted that it could comply with relevant government policies, including *"the dual-fuel combustion turbines announced in Manitoba's Speech from the Throne, and Canada's Clean Electricity Regulations….Manitoba Hydro's recommended 10-year development plan, including combustion turbines, continues to represent a development plan capable of supporting a future which complies with both previously mandated/enacted government policies, as well as the new policies which were more recently introduced."*

There *may* be some ambiguity in MH's literature on whether MH intends to ensure the manufacturer will configure the proposed turbines to use both natural gas and FAME biodiesel. The *2025 Integrated Resource Plan* describes the turbines as "natural gas/biomethane (on pp.14, 15, 18, 36, 40, 42, 44, 46, 62, and 66). Because both natural gas and biomethane are gases, they *may* not be proposing that the turbines will be "dual fuel" configured as that term is commonly used in the industry.

The *PTC Report* reduces that ambiguity somewhat. § 5.1 (p. 12) states:

> "*Summary of generation equipment selection process and decision" notes that "Hatch undertook the initial gas fired generation equipment screening*

[6]Intel Market Research. (February 13, 2026). *Dual Fuel Gas Turbine Market Growth Analysis, Dynamics, Key Players and Innovations, Outlook and Forecast 2026-2034.* https://www.intelmarketresearch.com/dual-fuel-gas-turbine-market-32943

and short listing for MH. Factors assessed by Hatch in evaluating gas turbines included:

- *Sufficient capacity to provide economies of scale and avoid too many small turbines.*
- *Avoid the largest gas turbine models such that there is some redundancy in equipment selected.*
- *Screen for equipment that offer synchronous condenser operation.*
- *Other screening data including budgetary price, equipment general arrangement drawings, performance data on natural gas and diesel, spare parts, emission guarantees, estimated delivery time and fast start / ramp capability (not start to base load in <10 minutes).*

PTC endorses these as the appropriate parameters to include in the screening evaluation, in consultation with MH who can advise on the economic impacts of differences in plant heat rate and output.

The screening narrowed in on F / G Frame gas turbines, specifically Siemens SGT6-5000F (version unknown), General Electric (GE) 7F.05, and Mitsubishi (MHI) 501G (PTC interprets this last model to be the 501GAC as the current offering is only air cooled). PTC agrees that these are appropriate options in that they all have outputs between 200 and 300 MW, meaning three units will meet the desired generation of about 750 MW (note that 500 MW was originally targeted). Furthermore, the cost of smaller gas turbines is far higher on a $/MW basis than what is available from proven, larger F/G-frame technology. The largest gas turbine models become more costly with premium heat rates because of higher firing temperatures and greater use of exotic alloy metals. Therefore, the selection of this technology likely represents the most economical option for a simple cycle gas turbine power station on a $/MW basis."

The Hatch evaluation noted the factors it assessed included "performance data on natural gas and diesel", although it did not note whether the gas and liquid systems could "operate at equal capacity" and permitted "seamless switching between fuel types".

All indications are that the turbines being considered are dual-fuel (capable of using both liquid and gaseous fuels equally). For greater certainty, in our Information Request (IR) SB/MH IV.14, we asked for clarification on this matter and expect to receive an answer from MH on the IR prior to the end of July.

Concerns & Restrictions with Use

Unlike renewable (HDRD) diesel, FAME biodiesel is not a drop-in replacement fuel for fossil diesel. Some modifications of either the GE and or Siemens turbines may be required; the manufacturers will be able to specify what modifications, if any, would be needed.

In addition, as noted in *SB Review* (p. 25), we are recommending additional modifications to reduce emissions**:**

> **Perhaps the biggest drawback to using FAME biodiesel instead of natural gas in a CT [combustion turbine] is the emissions, particularly of NOx. Fortunately, pre-, during-, and post-combustion technologies exist to reduce harmful emissions from biodiesel combustion.**
>
> **Pre-combustion options include liquid-fuel vaporization systems, such as those from LPP Combustion. During-combustion options include water or steam injection. Post-combustion options include Selective Catalytic Reduction (SCR).**
>
> **The *SB Review* included 3 relevant references on emissions reduction measures as footnotes on the bottom of p. 25:**
>
> - **LPP Combustion. (n.d.). *EU Emissions Compliance.* https://www.lppcombustion.com/eu-emissions-compliance**
> - **GE Verona. (n.d.). *Water injection for NOx reduction.* https://www.gevernova.com/gas-power/services/gas-turbines/upgrades/water-injection-for-nox-reduction**
> - **Schreeg, S. (n.d.). *How to Minimize NOx Emissions in Gas Turbines.* SVI Bremco. https://svi-bremco.com/blog/how-to-minimize-nox-emissions-in-gas-turbines/**

b) Please confirm whether there are any concerns with the long-term storage of FAME diesel, as would be required for the Brandon generating station where operation is intermittent and the preferred fuel is natural gas.

Properly managed, there should be no concerns with the long-term storage of FAME diesel for use at the BGS.

Both fossil diesel and FAME biodiesel are limited in how long they can be stored.

> *Under ideal conditions, [fossil] diesel fuel can remain usable for over a year. But in real-world storage conditions, especially over long periods, diesel breaks down faster than most people expect….Stored diesel fuel in clean, tightly sealed storage tanks can stay stable for 18 to 24 months….Oxidation, air exposure, and high temperatures quickly degrade fuel and form harmful sludge.*
>
> - *Water contamination leads to microbial growth that can clog filters and damage engines…..*
> - *Fuel additives like stabilizers, biocides, and demulsifiers help extend the storage life of diesel.*[7]
>
> *FAME [biodiesel]...should provide six months of storage capability before unacceptable degradation occurs, but this depends on storage conditions (WWFC 2009). Heat and sunlight can accelerate the oxidation process. FAME biodiesel should not be stored in systems that contain copper, brass, bronze, lead, and tin. Those metals will accelerate the aging process and will contribute to higher sediments. Also avoiding exposing the biodiesel fuel to oxygen during the storage can help to extend shelf life…..FAME [biodiesel] may contain risky impurities, and its tendency to pick up and [dis]solve water is also higher than that of traditional [fossil] diesel fuels. This raises consideration of measures to prevent microbiological growth….Methyl esters have been used for many years as cleaners and solvents. It should not be surprising, then, that biodiesel will have a tendency to dissolve sediments and residues that might accumulate over time in storage tanks. The released sediments then can lead to filter plugging. Therefore, when storing FAME biodiesel it is*

[7] Taylor, A. (February 9, 2026). *How Long Will Diesel Fuel Last? Shelf Life & Storage Guide.* **Fuel Ox.** *https://www.fuelox.com/how-long-will-diesel-fuel-last-shelf-life-storage-guide/.* See also:

- Worldwide Power Products. (n.d.). *How Long Does Diesel Fuel Last & Tips To Store It For Longer. https://www.wpowerproducts.com/blog/generator-engine-fuels/how-long-can-you-store-diesel/*
- Bjornstad. E. (March 19, 2026). *How Long Does Diesel Last In A Tank?* **Bell Performance.** https://www.bellperformance.com/bell-performs-blog/how-long-does-diesel-fuel-last-in-a-storage-tank

> *advisable to clean the storage tank if has been used previously for other fuels…*[8]

The annual consumption of FAME biodiesel in Manitoba is more than 25 million litres (see *SB Review*, p. 24), mainly blended with fossil diesel as fuel for transportation and heavy equipment. Therefore, a ready supply of FAME biodiesel can be easily bought and sold in Manitoba.

No more than six months of FAME biodiesel should be bought and kept in storage by MH. If any remains at the end of the winter season, it should all be sold into the Manitoba marketplace in spring or early summer (when it is in demand in the transportation industry) and the supply restocked each year in fall, ensuring the FAME biodiesel used by MH is less than 6 months old when it is needed.

A new biodiesel delivery system would probably not be needed at the BGS. MH indicates that diesel has only ever been consumed in these turbines for testing. The diesel delivery system used for testing could be dedicated exclusively to FAME biodiesel, rather than a mixed FAME biodiesel/fossil diesel fuel regimen. A larger storage tank may well be needed.

[8]Technology Collaboration Programme on Advanced Motor Fuels. (n.d.). *Fuel Information: Fatty Acid Esters (Biodiesel): Production, Distribution and Storage.* **IEA (International Energy Agency)**. https://iea-amf.org/content/fuel_information/fatty_acid_esters/production

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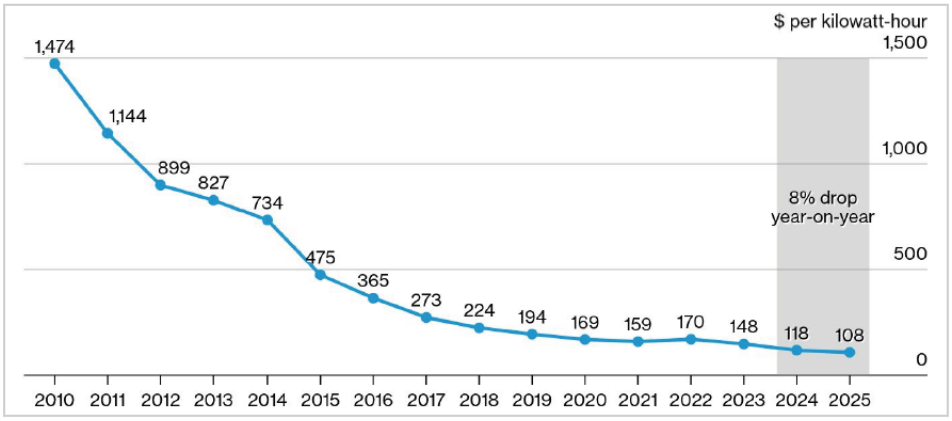
Part and Chapter:	Sustainable Brandon MNF Report	**Page #:**	35
Topic:	Battery Storage Prices		
Subtopic	Declining Cost of Battery Storage		

Preamble (if any):

On page 35 of the report, Sustainable Brandon provides Figure 10:[9]



On page 45 of the report, Sustainable Brandon states:

> Therefore, a BESS with a 100 MW discharge rate and a 5-hour duration would have a storage capacity of 500 MWh.

On page 45 of Appendix 6 in Figure A6.21, Manitoba Hydro provides the cost of 100 MW of 5-hour battery storage as $297 million (without transmission) in 2024 Canadian dollars, which works out to approximately US$430/kWh (assuming an exchange rate of 1.4).

Question:

Please provide any reasons that may explain why Manitoba Hydro's battery energy storage costs are substantially higher than the Bloomberg report provided by Sustainable Brandon as Figure 10 in its report.

[9] Chart source: Maisch, M. (December 9, 2025). *BNEF: Lithium-ion battery pack prices fall to $108/kWh, stationary storage becomes lowest price segment.* **ESSNews**. https://www.ess-news.com/2025/12/09/bnef-lithium-ion-battery-pack-prices-fall-to-108-kwh-stationary-storage-becomes-lowest-price-segment/. Maisch cites its source for this chart as "BloombergNEF" and adds a note: "Volume-weighted averages. Historical data has been adjusted to real 2025 dollars. Sectors include vehicles & stationary storage."

Rationale for Question:

To understand the differences between Manitoba Hydro's and Bloomberg's prices for battery storage.

Response:

We cannot say with certainty why the figures provided by MH and BloombergNEF[10] differ, in part because MH did not provide a source or sources for its battery energy storage cost estimate.

At least a portion of the difference appears to be because BESS prices have dropped significantly since 2024. The timing of when information was collected by MH for *Appendix 6 - Resource Options*, and when the BloombergNEF report was released and reported on, may also have played a role:

- Although *Appendix 6 - Resource Options* is dated February 2, 2026, the cost estimate on page 45 would almost certainly have been compiled before then. The way MH's Figure A6.21 (p. 45) is written suggests that it relied on 2024 prices.
- SB's Figure 10 (*SB Review*, p. 35) is taken from an article published on December 9, 2025, which summarizes the BloombergNEF report. The crucial quote regarding battery storage pricing as of 2025 is found below Figure 10, also on page 35 of the *SB Review*:
    - *"Global average prices for turnkey battery storage systems fell by almost a third year-over-year [2024 to 2025], with sharp cost declines expected to continue. In 2025, the global average price of a turnkey battery energy storage system (BESS) is US$117/kWh, according to the* Energy Storage Systems Cost Survey 2025 *from BloombergNEF (BNEF), published last week [December 10, 2025]. That was a 31% decline from 2024 numbers.*[11]
        - Assuming an exchange rate of 1.4, US$117/kWh = CAN$164/kWh.

[10] This source should be referred to as "BloombergNEF" or "BNEF" (short for "Bloomberg New Energy Finance") rather than "Bloomberg." BloombergNEF is part of the larger Bloomberg LP, but has a particular focus on the energy transition, with an emphasis on financial issues.

- See: BloombergNEF. (n.d.). *About: Our Mission.* https://about.bnef.com/about/)

[11] Colthorpe, A. (December 16, 2025.) *Battery storage system prices continue to fall sharply, BNEF and Ember reports find.* **Energy Storage News.** https://www.energy-storage.news/battery-storage-system-prices-continue-to-fall-sharply-bnef-and-ember-reports-find/

Although we did not quote it in our Review, BloombergNEF also issued a press release about its report on its website on February 18, 2026. It reads, in part:

> *Clean power costs sent mixed signals in 2025. According to BloombergNEF's* Levelized Cost of Electricity 2026 *report, the cost of battery storage projects plummeted to new lows in 2025 even as most other clean power technologies became more expensive.…*
>
> *BNEF's data shows that the global benchmark cost for a four-hour battery project fell 27% year-on-year to $78 per megawatt-hour (MWh) in 2025 – a record low since BNEF began tracking costs in 2009. Lower pack prices, increasing competition among manufacturers and improved system designs all contributed to the rapid decline. Falling battery costs are also accelerating the buildout of co-located renewable projects. In 2025, developers added 87 gigawatts of combined solar and storage, delivering power at an average of $57/MWh.…*
>
> *"Cheaper costs due to manufacturing overcapacity from the electric vehicle market and better system designs are transforming the economics for large energy storage projects," said Amar Vasdev, lead author of the report and senior energy economics associate at BloombergNEF. "The levelized cost of electricity for a four-hour system is now below $100/MWh in six markets. As costs continue to drop, we expect battery storage to strengthen solar project revenues, support broader renewable deployment and accelerate the shift toward storage-led system balancing over fossil-fuel-based peaking capacity."*[12]

BloombergNEF was not the only source reporting this marked decline in battery storage costs. As the Calthorpe source notes above, EMBER also reported a sharp decline. EMBER describes itself as "a global energy think tank that aims to accelerate the clean energy transition with data and policy".[13] In a study titled "How cheap is battery storage?"[14], they noted:

> *This report provides the latest, real-world evidence on the cost of large, long-duration utility-scale Battery Energy Storage System (BESS) projects. Drawing on recent auction results from Saudi Arabia, India and Italy, along with in-depth interviews with project developers, suppliers and analysts across global markets, it captures the most up-*

[12] BloombergNEF. (February 18, 2026). *Battery Storage Costs Hit Record Lows as Costs of Other Clean Power Technologies Increased: BloombergNEF.* https://about.bnef.com/insights/clean-energy/battery-storage-costs-hit-record-lows-as-costs-of-other-clean-power-technologies-increased-bloombergnef/

[13] EMBER. (n.d.), *About us. https://ember-energy.org/about/#history*

[14] Rangelova, K. *et al.* (December 11, 2025). EMBER. https://ember-energy.org/app/uploads/2025/12/How-cheap-is-battery-storage.pdf

to-date picture of battery capex and the Levelised Cost of Storage (LCOS) as of October 2025….

Ember's assessment…shows:

- *All-in BESS project capex of $125/kWh. Across global markets outside China and the United States, the total capex to build a long-duration (4 hours or more) utility-scale BESS project is around $125/kWh, of which around $75/kWh is for the core equipment shipped from China and around $50/kWh to install and connect the battery.*

- *A levelised cost of storage (LCOS) of $65/MWh. An all-in capex of $125/kWh leads to a cost of $65/MWh to move electricity, based on the latest real-world project parameters. This low LCOS is not only the result of cheaper batteries—longer lifetimes, higher efficiencies and lower financing costs thanks to clearer revenue models like auctions have all helped to push the LCOS down sharply….*

After a 40% fall in 2024 in battery equipment costs, it's clear we're on track for another major fall in 2025.

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Part and Chapter:	Sustainable Brandon MNF Report	**Page #:**	52
Topic:	Effects of BESS at Suggested Locations		
Subtopic	Economics of solar and battery combination installations		

Preamble (if any):

On page 52 of its report, Sustainable Brandon states:

> If the Department of National Defence owned the BESS and solar array(s):
>
> - Neither Manitoba Hydro nor the Province of Manitoba would need to increase its debt to cover the capital costs (although, of course, ultimately this debt would be borne by Canadian citizens).
> - The Base would reduce its operating costs because at least some of the electricity it requires would be generated on base.

Question:

If Sustainable Brandon has performed calculations that show a military base (or any commercial customer) could reduce its operating costs with a solar array and a battery, please provide those calculations.

Rationale for Question:

To better understand the economics of operating behind-the-meter solar generation and battery storage.

Response:

We have not performed these calculations, but performing them would be straightforward. The following parameters would need to be known or estimated:

- The cost per kWh or MWh of electricity the Base currently draws from Manitoba Hydro's grid.
- The size and configuration of the proposed solar array.
    - We would propose that the best configuration would be bifacial vertical panels, oriented east-west, so that peak production would occur in the morning and evening, with level production during the daylight hours between these two peaks.
        - Estimating the output of a solar array with this configuration can be done with commonly available software tools.

- The size of the array (in MW) would depend on the space the Base had available for the array and the funds it had available to build it.

- If the Base had an agreement to provide firm power on demand during MH's winter deficits, these parameters would need to be known:
  - The size of the Battery Energy Storage System (BESS), in MWh.
    - Note: The size of the battery array can be much larger than the size of the solar array. For example, a 1 MW array could be paired with a 100 MWh BESS. Prior to the first discharge required by MH, the Base could charge the BESS to its full capacity from the solar array. It could then recharge the BESS from electricity supplied by MH between those required discharges.
  - The rate agreed with MH for guaranteed supply ("firm capacity") during these deficits.
  - An estimate of how much guaranteed electricity ("firm power", in MW) MH would require during these deficits, on average, per year.
    - Note: The actual amount of firm power required by MH would vary from this average each year.

- The electricity use pattern of the Base.
  - This parameter is relevant only if the solar array produces more electricity than the Base needs and more than can be stored in the batteries until it is needed by the Base for its own use. In this case, MH could purchase this electricity at the rate it pays customers for surplus solar array output.

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Part and Chapter:	Sustainable Brandon MNF Report	**Page #:**	
Topic:			
Subtopic			

Preamble (if any):

The Sustainable Brandon MNF Report indicates on its cover page that it was prepared with Bruce Duggan and submitted by Sustainable Brandon.

Sustainable Brandon's application to intervene sought approval of Mr. Bruce Duggan as an independent expert.

Use of "we" and "our" throughout the report may suggest broad or collaborative authorship.

Question:

Please confirm whether the views and recommendations presented in the report are those of Sustainable Brandon, or of Mr. Bruce Duggan.

Rationale for Question:

To understand the nature of the recommendations and the source of the views and opinions presented in the report.

Response:

The views and recommendations in the report are Bruce Duggan's and Sustainable Brandon's.