2024 Resource Adequacy Plan

Technical Conference #2

Issue #4: Resource Supply Options

October 2, 2024

newfoundland labrador hydro

Safety Moment

Experts Present Today

- **Robert Collett,** Vice President, Engineering & NLSO
- **Gail Randell,** Director, Major Projects & Asset Management
- **Ryan Cooper,** Mechanical Engineer
- **Samantha Tobin,** Sr. Manager, Resource & Production Planning
- **David Goosney,** Team Lead, Long-Term Resource Planning
- **Grant Outerbridge,** Manager, Electrification & Energy Optimization
- **Phil DiDomenico,** Managing Consultant, Daymark (Virtual)
- **Kathy Kelly,** Vice President and Principal Consultant, Daymark (Virtual)

Agenda – Resource Supply Options

- Electrification, Conservation and Demand Management
- Capacity Assistance
- Combustion Turbines (“CTs”)
- Fuel Considerations
- Hydraulic Resources
- Wind and Solar
- Batteries
- Pumped Storage
- Additional Options Screening
- Cost Estimates

Opening Statement

Desired Conference Outcomes

Newfoundland and Labrador Hydro ("Hydro") aims to address parties issues and questions and provide adequate information in relation to the 2024 Resource Adequacy Plan to achieve consensus on the following topics:

- Hydro has considered an appropriate level of supply options to determine viability.
- Hydro has identified feasible options and modelled those within Hydro's supply stack to determine its recommended expansion plan.
- Hydro's approach to cost estimates for resource options is reasonable and will continue to be refined through Front-End Engineering Design ("FEED").

Electrification, Conservation and Demand Management

Electrification, Conservation and Demand Management

2024 Resource Adequacy Plan - Issues List:

- *NLH explains that it accounted for Electrification, Conservation and Demand Management ("ECDM") activities in its load forecast. For potential future ECDM initiatives, such as time of use rates and critical peak pricing, NLH states these programs have not been historically cost effective and that a third-party firm (Posterity) is working on a "new CDM potential Study to assess the technical, economic, and achievable potential for ECDM activities on the [IIS] from 2025 to 2040." Has NLH given due consideration to ECDM solutions in its analysis for the planning horizon?*

Assessment of 2024 Resource Adequacy Plan:

- *Continue review of ECDM options and structures, and clarify how NLH plans to incorporate learnings over time to inform potential future ECDM investments (#23).*

Electrification, Conservation and Demand Management

- Hydro agrees that Conservation and Demand Management (“CDM”) measures are important to consider as a supply option to meet the Reference Case requirements.
    - A 2024 Potential Study is expected to be completed by Q4 2024 to help inform the next steps and the next Resource Adequacy Plan.
- CDM as a supply option would not be effective during a prolonged Labrador-Island Link outage in winter.
- The Minimum Investment Required Expansion Plan is a holistic approach to system reliability and the resource options put forward in this plan form the basis on which future CDM programming can build.

Electrification, Conservation and Demand Management

- Hydro currently assumes that 50% of light-duty electric vehicles (“EVs”) are managed by 2030.
- In coordination with Newfoundland Power Inc., an EV Pilot Study started during Winter 2023–2024, and will continue for Winter 2024–2025.
  - This study will help identify the best path forward to achieve EV demand management.
  - The outcome of the pilot study will help inform the demand management assumption for future annual updates to the load forecast and the 50% assumption will be modified accordingly.

Capacity Assistance

Capacity Assistance

2024 Resource Adequacy Plan - Issues List:

- *NLH appears to assume between 130 MW and 139.2 MW of Capacity Assistance, including curtailable load. Is this a reasonable assumption?*

Capacity Assistance Assumptions

- With the exception of Memorial University of Newfoundland (“MUN”) curtailable load, all capacity assistance is based on existing resources.
- The Island Interconnected System capacity assistance and curtailable load assumptions used in the 2024 Resource Adequacy Plan are summarized below.

Capacity Assistance and Curtailable Load	Firm Capacity (MW)
Corner Brook Pulp and Paper Limited Capacity Assistance: Winter	90
MUN Curtailable Load	21.7
Newfoundland Power Inc. Curtailable Load	12
Vale Capacity Assistance: Diesel Generation	7.5
Total Capacity Assistance and Curtailable Load	**131.2**

Combustion Turbines

CT Generation – Options and Selection Criteria

2024 Resource Adequacy Plan - Issues List:

- *Are any updates needed for the Hatch "CT Options Report" from 2023?*
- *Does the requirement that that the CT be capable of transitioning to a renewable fuel source add to the cost and procurement schedule and, if so, by how much?*
- *Was selection of the Simple Cycle Combustion Turbine ("SCCT") as the preferred option reasonable?*
- *NLH assumes a 5-year lead time due to lead times for power transformers and circuit breakers. Is this reasonable?*

CT Requirements

- Hydro does not plan to update the Hatch “CT Options Report” from 2023.
  - The CT project has moved to the FEED phase and any updates will be reflected in the build application and associated FEED documents.
  - Class 3 cost estimates are being developed as part of FEED and these detailed estimates will be used for all analysis included in the build application.
- Hydro has not included any infrastructure required to accommodate the future transition to renewable fuels in the design.
  - Turbines that met Hydro’s other specifications could transition to one or more renewable fuels without additional cost.

CT Requirements – SCCT Selection

- CTs have been a long-standing resource option and detailed reviews of a variety of engine technologies were considered in previous years (as recent as 2018).
- Although engine technology is evolving, Hydro did not see any changes that justified revisiting previous decisions given the urgent need to progress the CT option.
- For the Minimum Investment Case, Hydro concentrated planning efforts around the specific requirements for a CT including unit configuration, start time, synchronous condenser capability, and fuel supply risk mitigation.

CT – Alternatives and Grey Market Study

2024 Resource Adequacy Plan - Issues List:

- *Has NLH given due consideration to grey market CT generation units? Does the selection of the SCCT selected by NLH affect availability on the grey market? In light of the availability, compatibility with Canadian standards, fuel availability and other challenges pointed put in the Hatch report should NLH consider tendering an international solicitation for a turn-key project or Power Purchase Agreement ("PPA") for the 150 MW CT?*

Assessment of 2024 Resource Adequacy Plan:

- *Justify the assumption that "any new supply would be seven to ten years away from the date of applications for [regulatory] approval" as stated on page 65, lines 12-13 of the RAP Filing. (#14)*
- *Consider directly engaging with vendors of hydrogen-compatible CTs that were not responsive to NLH's initial queries to better assess the availability of such units (#30).*
- *Consider the possibility of a competitive solicitation for a turnkey CT solution (#33).*
- *Provide further support for the assumption of a five-year lead time for power transformers and circuit breakers (#38).*

CT Project Timelines

- Basis for the schedule associated with the Reliability and Resource Adequacy (“RRA”) Expansion Plan Cost Estimate:

Year 1	Year 2	Year 3	Year 4	Year 5	Year 6
Feasibility /FEED	Regulatory Review	EA Process/ Detailed Design	Construction	Construction	Construction/ Commissioning

- Given the supply chain issues, especially around transformers and other major equipment, Hydro chose to use a conservative schedule of six years for project completion (Three years of construction).
- Hydro continues to look for opportunities for schedule efficiency as discussed in the 2024 Resource Adequacy Plan:
  - Hydro has proactively begun Environmental Assessment activities in 2024.
  - Hydro is engaging additional engineering resources to focus on procurement activities while the project team finalizes FEED deliverables for the build application.

Grey Market

- SCCT is the most appropriate engine technology for Hydro's system needs at this time.
- Currently, the transformer is the critical path for the selection of any CT, new or grey market.
- Current procurement timelines for transformers are:
  - 48 months for factories outside China; and
  - 24 months for factories in China.
- Hydro is continuing to communicate with both turbine and transformer original equipment manufacturers to understand delivery times and procurement opportunities.
- Hydro continues to explore any procurement opportunities that would improve project timelines, including the grey market.

CT Alternatives – Hydrogen-Compatible CTs

- Hydro has discussed Hydrogen compatible CTs with General Electric, Siemens, and Mitsubishi.
  - All companies have Hydrogen firing technology that has been proven in combination with natural gas.
  - No company has proven technology at 100% hydrogen at the scale needed for Hydro's requirements.
- Availability and logistics of using hydrogen as a fuel would require additional engineering and planning, making this fuel unattractive when looking at the grey market for expedited project delivery.

CT Alternatives – Turnkey or PPA

- Hydro has been in active discussion with proponents, including existing and potential Industrial customers, and there is no immediate opportunity for firm capacity.
- Hydro has economies of scale, existing infrastructure and required expertise to support CT ownership and operation.
- With FEED underway, Hydro believes that a CT build could potentially be achieved on a faster timeline.
- Hydro intends to develop an Expression of Interest (“EOI”) process for capacity as part of determining the next steps to meet the Reference Case requirements.

Fuel Considerations

CT Generation – Fuel Market Study

2024 Resource Adequacy Plan - Issues List:

- *Given the conclusions of the "Fuel Market Study," what are the considerations and mitigations needed to address fuel supply risk related to CT generation?*

Assessment of 2024 Resource Adequacy Plan:

- *Consider alternative fuel options for CT fuel source (#31).*
- *Explain how logistical challenges of fuel supply will be addressed and comment on additional costs associated with maintaining fuel supply reliability (#32).*

Fuel Supply Risk vs. Mitigation

Risk	Mitigation
Quantity of trucks required to fuel CTs is unsustainable (greater than 5 days with both CT Plants at full capacity requires approx. 44 trucks per day).	- Upgrade Holyrood Marine Terminal for diesel delivery. - Expansion plan diversity.
Only **one bidder** on diesel fuel supply contract.	- Upgrade Holyrood Marine Terminal for diesel delivery. - EOI for fuel supply partner. - Expansion plan diversity.
Peaking nature of CT may lead to low consumption of diesel which results in **diesel degradation** (approx. 12-month shelf life without stabilizers).	- Considered cost of burning off fuel in RRA analysis. - EOI for fuel supply partner. - Expansion plan diversity.
Future fuel market may change given the push to renewable fuels resulting in high diesel costs and/or low availability of diesel.	- Consider future shift to renewable fuel when selecting CT equipment. - Considered higher fuel costs in RRA analysis. - Expansion plan diversity.

Fuel Alternatives

- Hydro's proposal with diesel abides by draft Clean Electricity Regulations ("CER"); renewables would be considered in the future only if least-cost option and readily available.
- Fuel Market Study demonstrated that other non-fossil fuel options carry increased risk, with more complex logistical challenges.
- Renewable fuels are new and companies like Braya Renewable Fuels and the wind-hydrogen proponents need firm commitments.
- No company has proven technology at 100% hydrogen at the scale needed for Hydro's requirements. Proven technology requires blending with natural gas/liquified natural gas.
- Logistics of using hydrogen as a fuel would need further consideration given that:
  - Hydrogen is difficult to transport and store.
  - Current wind proponents are not located close to the Avalon load center.

Fuel Logistics Costs

- Hydro is evaluating the upgrade of the existing marine terminal at the site of the Holyrood Thermal Generating Station (“Holyrood TGS”) to facilitate fuel deliveries.
- Hydro is ensuring any turbines considered are capable of conversion to one or more renewable fuels to mitigate the risk of asset stranding. Hydro has not specified the renewable fuel type.
- Hydro does not anticipate any additional cost in the current proposed CT project for this capability as the turbines that meet Hydro’s other requirements already have this capability.

Hydraulic Resources

Hydraulic Resources

2024 Resource Adequacy Plan - Issues List:

- *Regarding NLH's consideration of hydroelectric generation options, has NLH adequately considered potential solutions, including expansion projects, new projects, and uprates, as well as smaller hydro additions?*

Assessment of 2024 Resource Adequacy Plan:

- *Explain assumed timing of potential uprates and how such projects could affect the recommended portfolio (#34).*
- *Identify how the uprate of BDE7 is impacted by the inclusion of BDE8 in the Recommended Portfolio (#36).*

Hydroelectric Generation: Expansion Projects

- Hydro considered two generation expansion options at existing plants:
  - Bay d'Espoir ("BDE") Unit 8 – 154 MW
  - Cat Arm ("CAT") Unit 3 – 68 MW
- Both options would be primarily for capacity and would have minimal energy contribution.

Hydroelectric Generation: New Generation

- Hydro considered three greenfield hydro projects:
  - Round Pond – 18 MW, 139 GWh
  - Island Pond – 36 MW, 186 GWh
  - Portland Creek – 23 MW, 142 GWh
- Provides both capacity and firm energy.
- Hydro continues to evaluate new greenfield hydro projects, as outlined in Hydro's Hydroelectric Refresh Study submitted to the Board of Commissioners of Public Utilities on October 1, 2024.
  - Hydro has identified five capacity options within that study but viability has yet to be determined.
  - This study will inform future evaluation to expand Hydro's supply stack.

Potential Uprates

- The most effective capacity option is the construction of BDE Unit 8. Based on known information and the timeline to meet adequate supply, Hydro proceeded with BDE Unit 8 FEED.
- Hydro assessed the possibility of uprating BDE Unit 7 by 20 MW; however, there is a balance between the capacity gained by uprating and the efficiency lost within the plant.
  - There are hydrological implications from uprating BDE Unit 7 that require further study.
  - Hydro is already optimally dispatching the existing hydraulic fleet to meet peak demand.
  - The hydrological implications of BDE Unit 8 are well understood.
- Hydro has committed to studying incremental capacity and efficiency potential from existing hydro units as part of the next steps beyond the Minimum Investment Required Expansion Plan.

Wind and Solar

Wind and Solar

2024 Resource Adequacy Plan - Issues List:

- *For potential new wind resources, NLH has assumed a capacity of 100 MW (made up of 24 4.26 MW turbines), that 75 percent of new wind will be off-Avalon and 25 percent on-Avalon, an effective load-carrying capability ("ELCC") of 22%, and a capacity factor of 40%. Are these reasonable assumptions?*
- *For potential new solar resources, NLH has assumed a capacity of 20 MW, zero ELCC, a 20% capacity factor, and no locational characteristics. Are these reasonable assumptions?*

Assessment of 2024 Resource Adequacy Plan:

- *Address whether the scheduling of hydroelectric generation or water release from the 32 hydroelectric facilities on the IIS would offer an economic long-term storage option (#35).*
- *Consider 6-and 8-hour duration battery energy storage systems ("BESS") projects (#37).*
- *Provide additional backup for ELCC figures utilized and consider the dynamic nature of ELCC calculations in the procurement process (#39).*

Wind

- A Capacity Factor of 40% is aligned with existing wind generation.
  - As wind penetration increases, the amount of energy that will need to be curtailed increases, decreasing the effective capacity factor.
  - Hydro continues to study the co-optimization of wind and hydro generation.
- Wind location is a balance of diversity and transmission capacity.
  - Spreading out wind locations provides a diversity of generation, which increases ELCC.
  - Concentrating wind on the Avalon will have a lower ELCC but would decrease the strain on the transmission system.

Wind and Solar

- Wind ELCC of 22% is based on a 2019 study.
  - Based on historic data from existing wind generation (Fermeuse and St. Lawrence).
  - Aligned with the ELCC assumptions of other utilities.
- Solar as a resource option was studied in 2018.
  - Low annual generation due to weak solar resources.
  - Generation profile does not align with a load on a seasonal or hourly basis.
  - Current assumption is an ELCC of 0%, but will be studied as part of the 2025 ELCC Study.

ELCC Study

- Hydro is planning to perform an ELCC study in 2025.
  - Will study BESS in conjunction with wind and solar.
  - Will demonstrate the relationship between:
    - Renewable penetration and ELCC.
    - Battery storage duration and ELCC.
- Hydro will look for consultant guidance on how the ELCC process affects the procurement process.

Batteries

BESS

2024 Resource Adequacy Plan - Issues List:

For potential new BESS:

- *NLH assumes a 5-year lead time due to lead time for power transformers and circuit breakers. Is this reasonable?*
    - Hydro has addressed on a previous slide.
- *For short-duration batteries, NLH considered 20 MW and 50 MW options at a base case ELCC of 60% and high and low case ELCCs of 40% and 80%. Is this reasonable?*
- *For long-duration batteries, NLH considered 20 MW and 50 MW options with durations between 50 and 100 hours, and with only one option being identified as potentially cost-effective, NLH did not consider long-duration BESS as a solution. Is this reasonable?*
- *Should NLH study potential changes to hydroelectric generation schedules in existing dams as an alternative to long-duration battery storage?*

Battery Costs

- Hydro modelled BESS at an ELCC of 40%, 60% and 80%, which is in line with the ELCC range assumed by industry.
  - At 80%, BESS was cost-effective compared to other expansion options, but not at 60% or 40%.
  - Batteries would have limited effectiveness in a shortfall situation but may be effective for capacities of up to 50 MW.
  - Eight-hour batteries would have minimal incremental benefit in a shortfall situation.
  - Batteries likely have a place in Hydro's generation fleet to meet the Reference Case but require further study.

Battery Considerations

- Long-duration battery storage technology is a new technology, and it would not be appropriate to rely on for system reliability.
  - Hydro will continue to monitor developments in this technology as it matures.
- Optimization of existing hydro resources would not be a reasonable alternative to long-duration batteries.
  - Batteries provide additional capacity.
  - Batteries have the additional benefit of being able to absorb additional energy from renewables.

Pumped Storage

Pumped Storage

2024 Resource Adequacy Plan - Issues List:

- *Are any updates needed for the Hatch study addressing potential development of new pumped storage using existing infrastructure? Why?*
- *Is NLH's plan to further study pumped storage options reasonable?*
- *Should NLH perform a more in-depth economic comparison of short duration batteries and pumped storage?*

Pumped Storage Considerations

- Pumped storage has potential to be paired with large quantities of renewable generation, such as wind.
- Hatch studied the potential for pumped storage at existing locations and two locations were identified as having potential:
  - Hinds Lake; and
  - Star Lake.
- Further analysis would be required to determine the viability at these locations, such as:
  - Transmission requirements;
  - Impact to existing operations; and
  - Hydrology.
- Further study on pumped storage, including at greenfield sites, will be prioritized with evaluation of the other resource alternatives in Hydro's supply stack based on viability.
- If determined feasible, Hydro would conduct an economic comparison of pumped storage versus other alternatives.

Additional Options Screening

Additional Options Screening

2024 Resource Adequacy Plan - Issues List:

- *NLH screened out as potential options combined-cycle combustion turbines and and small modular nuclear reactors. While legislation currently prohibits nuclear, would nuclear be a viable option if there were no legislative prohibition? Was it reasonable to exclude these options?*

Assessment of 2024 Resource Adequacy Plan:

- *Elaborate on the definition of "base-loaded" and explain if generation output is being limited, and if so explain further selection of diesel-fired generation (#40).*
- *Explain whether and how reciprocating internal combustion engines (“RICE”) units were evaluated as a supply option (#29).*

Base Loaded vs. Peaking Units

- There is no dividing line between “base loaded” and “peaking” units. Rather, it describes a spectrum of unit characteristics:
  - **Base Load:** continuous generation, low energy cost, less flexibility, higher capital costs.
    - Examples: Nuclear, Holyrood TGS, Combined Cycle Combustion Turbine (“CCCT”), Hydro (high capacity factor).
  - **Peaking:** flexible generation, fast response times, high energy cost, low capital costs, possibly limited generation.
    - Examples: SCCTs, BESS, RICE, Hydro (low capacity factor).
- A unit’s generation is not limited in the model with the exception of hydro expansion options.
  - Results are checked to ensure that CER are being followed.

CT Alternatives – SCCT vs. CCCT

- Hydro intends to use CTs primarily to meet peak loads and to provide reserves.
- As a result, smaller, more flexible units are preferred to larger, more efficient units.
- Lack of access to natural gas and compliance with CER prevent Hydro from using CTs for base load generation.

Property	SCCT	CCCT
Start Time	Shorter	Longer
Flexibility	Higher	Lower
Efficiency	Less Efficient	More Efficient
Size	Smaller	Larger
Generation	Peak	Base

Additional Options Screening: RICE

- RICE have higher costs with few benefits for our system:
  - Larger footprint for same MW.
  - Engine capacities will be lower, requiring more individual engines.
  - Higher efficiency but higher maintenance and oil consumption/disposal costs can eliminate any high-efficiency fuel cost savings.
  - Emissions are higher on a ppm basis.
  - No synchronous condenser capability.
- Utilities are increasingly using RICE units for grid-connected generation.
  - Hydro continues to monitor this trend.

Additional Options Screening: Nuclear

- Nuclear options are prohibited by provincial legislation.
- Nuclear options have high capital costs as reported by other provinces.
  - Cost of small modular reactors is estimated between $10 million to $17 million per MW.
- Nuclear plants are designed for "base load" operation and, as such, have a steady year-round output.
- Nuclear does not match the Island Interconnected System current supply requirements, as Hydro is looking for solutions that can provide dynamic amounts of supply for peaking purposes.

Additional Options Screening: PPAs and Other

2024 Resource Adequacy Plan - Issues List:

- *NLH did not include market purchases as a resource option. Is that appropriate, or should these options be explored? Considering NLH's stated intention to "explore the availability of firm supply solutions," when could the results of such exploration be relevant for conducting revised resource analyses?*
    - Hydro has addressed the potential for firm imports as a resource option in Technical Conference #1 on September 17, 2024.
- *NLH did not consider the potential extension of existing PPAs (totaling 20 MW firm capacity) in its expansion plans. Was that reasonable?*
- *Are there any other new supply resources considerations that should be addressed by NLH, beyond those considered in the RAP filing?*

Assessment of 2024 Resource Adequacy Plan:

- *Explain further whether existing PPAs contain any renewal rights, and the rates, terms, and conditions of these rights (#41).*
- *Consider the pursuit of competitive solicitation for energy and capacity, including offers from parties in other provinces, allowing for direct comparison to utility self-build options. (#42).*

Additional Option Screening – PPAs and Other

- Hydro's existing PPAs do not contain renewal rights.
- Existing PPAs, should they be extended beyond current expiration dates, would supplement the 400 MW of wind requirements in 2034 as identified in the Minimum Investment Required Expansion Plan.
    - Existing PPAs can be extended under the Energy EOI process.
- An EOI process is expected to commence in 2025, which will seek to determine energy and capacity options on the Island Interconnected System.

Cost Estimates

Resource Supply Options – Cost Estimates

2024 Resource Adequacy Plan - Issues List:

- *Has NLH reasonably captured available subsidies in its cost assumptions (e.g., tax credits)?*
- *Regarding the cost estimates of the various supply resource options:*
  - *Are the costs (capital, variable O&M, fixed O&M) reasonably captured?*
  - *Given Daymark's conclusions regarding the assumed capital costs for hydro (low compared to industry benchmarks) and CTs, (high compared to industry benchmarks) are any revisions or sensitivities needed?*
  - *NLH's cost estimates are the Association for the Advancement of Cost Engineering ("AACE") Class 5 estimates. Given that Class 5 estimates are associated with the lowest confidence level, is NLH's range (-50% to +100%) sufficient, or should the potential for higher cost overruns be tested?*

Resource Supply Options – Cost Estimates

Assessment of 2024 Resource Adequacy Plan:

- *Address cost assumptions for BESS projects (#24).*
- *Evaluate CT capital cost estimates for accuracy and reasonableness relative to market (recommendation #25).*
- *Provide backup for CT cost estimates and consider Daymark's feedback on the cost assumptions of these units (recommendation #26)*
- *Consider additional sensitivities in which hydro costs are in excess of those estimated and modeled (#27).*
- *Provide additional information about potential tax credits, and include sensitivities to determine if these impact selected supply options (#28).*

Available Subsidies

Available options:

- Investment Tax Credits (“ITCs”)
- Canada Infrastructure Bank (“CIB”)

- Subsidies were not considered in Hydro’s Expansion Plan.
- Subsidies will not be considered in cost estimates within build application(s); however, Hydro will include a sensitivity for ITCs.
  - Details for ITCs are not yet known.
- Hydro is exploring rates with CIB; however, Hydro already obtains low market rates for borrowing through the Government of Newfoundland and Labrador.

Cost Estimate Comparison

Category	Cost Component	Units	Hydro Estimate	NREL ATB[2]	S&L[3]	AESO	Daymark Comments
Thermal	Capital	*$/kw*	$3,204	N/A	$2,179	$1,662	*Reasonable*[1]
	Fixed O&M	*$/kw-yr*	$20.00	N/A	$8.90	$64.42	*Reasonable*
	Variable O&M	*$/MWh*	$6.00	N/A	$7.73	$5.17	*Reasonable*
Hydro	Capital	*$/kw*	$3,345 - $19,055	$4,804 - $31,862	$9,598	N/A	*Reasonable*[4]
	Total O&M	*$/kw-yr*	$44 - $204	$44.73 - $301.90	$45.51	N/A	*Reasonable*
Wind	Capital	*$/kw*	$2,082	$2,177 - $3,132	$2,020	N/A	*Reasonable*
	Fixed O&M	*$/kw-yr*	$48.00	$46.32 - $60.70	$44.86	N/A	*Reasonable*
	Variable O&M	*$/MWh*	$0.00	N/A	N/A	N/A	*N/A*
Solar	Capital	*$/kw*	$1,659	$2,062	$2,038	N/A	*Reasonable*
	Fixed O&M	*$/kw-yr*	$26.00	$36.74	$27.45	N/A	*Reasonable*
	Variable O&M	*$/MWh*	$0.00	N/A	N/A	N/A	*N/A*
Battery	Capital	*$/kw*	$2,221 - $2,740	$2,851	$2,366	N/A	*Reasonable*
	Fixed O&M	*$/kw-yr*	$89 - $110	$38.34 - $140.57	$54.28	N/A	*Reasonable*
	Variable O&M	*$/MWh*	$0.00	N/A	N/A	N/A	*Reasonable*[5]

Cost Estimates – Hydraulic Resources

- It is reasonable that hydraulic estimates are below industry benchmarks:
  - BDE Unit 8 and CAT Unit 3 are brownfield sites that would require significantly less capital investment in dams, transmission lines, and civil works for the intake and tailrace.
  - Since the new units at BDE Unit 8 and CAT Unit 3 are sharing facilities with the existing plants, there will be lower operating and maintenance costs relating to staffing, services, maintenance, etc.
  - Hydro costs are highly site-specific, which makes it difficult to benchmark against others in the industry.

Cost Estimates – Combustion Turbines

- CT capital cost comparison against screening-level benchmarks:

	Hydro Estimate ($/kW)	Hydro Revised ($/kW)	AESO Benchmark ($/kW)	S&L Benchmark ($/kW)
Hydro Estimate	3,204	2,382	1,663	2,180
Comparison		-34.5%	43.2%	9.3%

- The Class 5 cost estimate for CTs is higher than industry benchmarks as a result of several factors:
  - Alberta Energy System Operator (“AESO”) benchmark based on Class 4 estimate.
  - AESO construction timeframe is three years compared to Hydro assumed six years.
  - Hydro terminal station is expected to be larger than the AESO estimate.
  - Inclusion of civil work required on-site, contingency, owner’s cost and sync condenser capabilities.

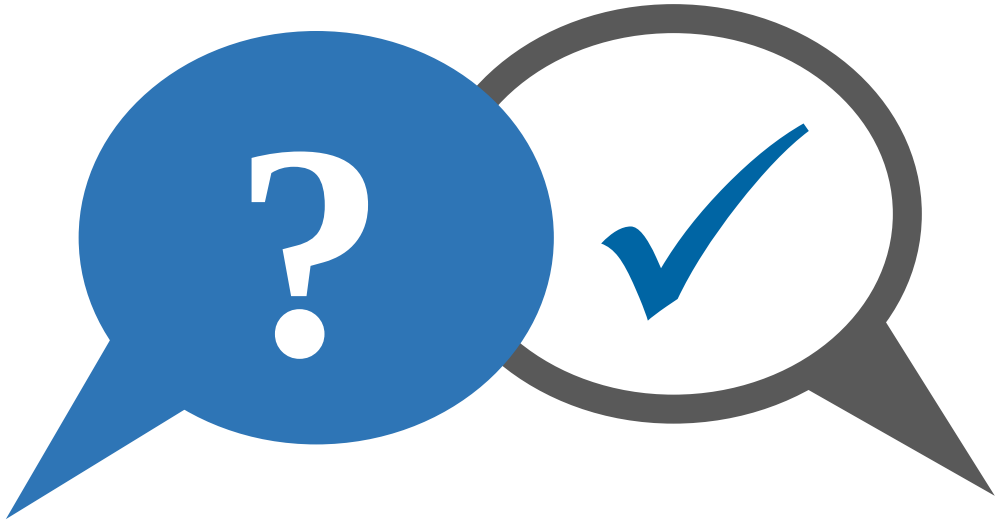
Cost Estimates

- Based on AACE guidance, Class 5 estimates are appropriate for screening-level studies.
- Modelling to be updated with Class 3 AACE estimates for BDE Unit 8 and 150 MW CT included within build applications.
    - Sensitivities will be run using P90 estimates to capture the possibility of cost overruns.

Resource Supply Options: Hydro's Position

- Comprehensive analysis of viable supply sources examined.
- Hydro continues to seek diverse supply options to fit the needs of the system.
- At a screening level, the cost assumptions have been deemed appropriate in comparison to industry benchmarks.
- Costs of BDE Unit 8 and the CT will be advanced in the build application.
- The Minimum Investment Required Expansion Plan provides the basis on which all future planning can build.

Questions?



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