

Executive Summary:

Assessment of Hydro Quebec's Updated Electricity Import Proposal and Exploration of Options for Enhancing its Value to Ontario Ratepayers

Prepared for Discussion with Ministry of Energy

July 20, 2017

-- Confidential and Commercially Sensitive --

Hydro Quebec provided a new electricity sales proposal to the IESO on June 22, 2017. The following slides assess the new proposal and explore options for extracting greater value from an agreement with Quebec.

- Ontario regularly trades electricity with Quebec on the open market on a non-firm basis and has entered into electricity trade agreements with Quebec in recent years
- Hydro Quebec submitted an updated electricity import proposal to the IESO on June 22, 2017
 - The new “Amended and Restated Energy Sales and Energy Cycling Agreement” would replace the 2016 Ontario-HQ agreement and would see Ontario import, on a take-or-pay basis, 8 TWh of electricity per year for 20 years beginning in 2018 at the same price but with less flexibility as compared to 2.3 TWh in the current agreement for 7 years beginning in 2017.
- Upon Ministry of Energy request, the IESO has assessed the value of Hydro Quebec’s updated proposal
- The IESO’s assessment focuses on the value to Ontario electricity consumers. Imports from Quebec are evaluated from a number of perspectives including:
 - Impact on electricity supply mix, energy production, surplus energy, emissions, and cost of electricity
 - The conditions under which a trade with Quebec could yield net benefits for Ontario electricity consumers
- The following report summarizes the IESO’s assessment of the updated Hydro Quebec proposal and explores additional opportunities to enhance its value
 - Analysis of options for enhancing the value of the updated proposal are consistent with scenarios developed by the Ministry of Energy for IESO analysis. These are described in the Ministry of Energy document entitled “ON-QC Discussions – Status Update” (July, 2017), as well as later in this report

Summary of findings: on the updated Hydro Quebec proposal as submitted to the IESO

- In the context of the reference long-term supply and demand outlook, the updated proposal in its current form would:
 - Reduce Ontario electricity sector greenhouse gas emissions by an average of approximately 1MT per year, with an implied average abatement cost of \$300/tonne over the planning period. Most of the emission reductions would take place from the mid-2020's or after the expiry of the existing agreement in 2023.
 - Increase surplus energy in Ontario by between 1 TWh and 6 TWh per year. Surpluses would be greatest before the mid 2020's and decrease to between 1 and 2 TWh per year thereafter. Higher surpluses result in higher costs.
 - Increase Ontario's total cost of electricity service by an average of \$200M annually (2017\$)
 - Increase average residential bills by an average \$2.4/month (nominal, pre-OFHP)
 - Not help to meet Ontario's projected capacity requirements, as firm capacity is not offered and that capacity would have to be sought elsewhere
 - Provide break-even value to Ontario ratepayers if priced between \$22/MWh and \$36/MWh, which is less than HQ's proposed price of \$61/MWh (2017\$)

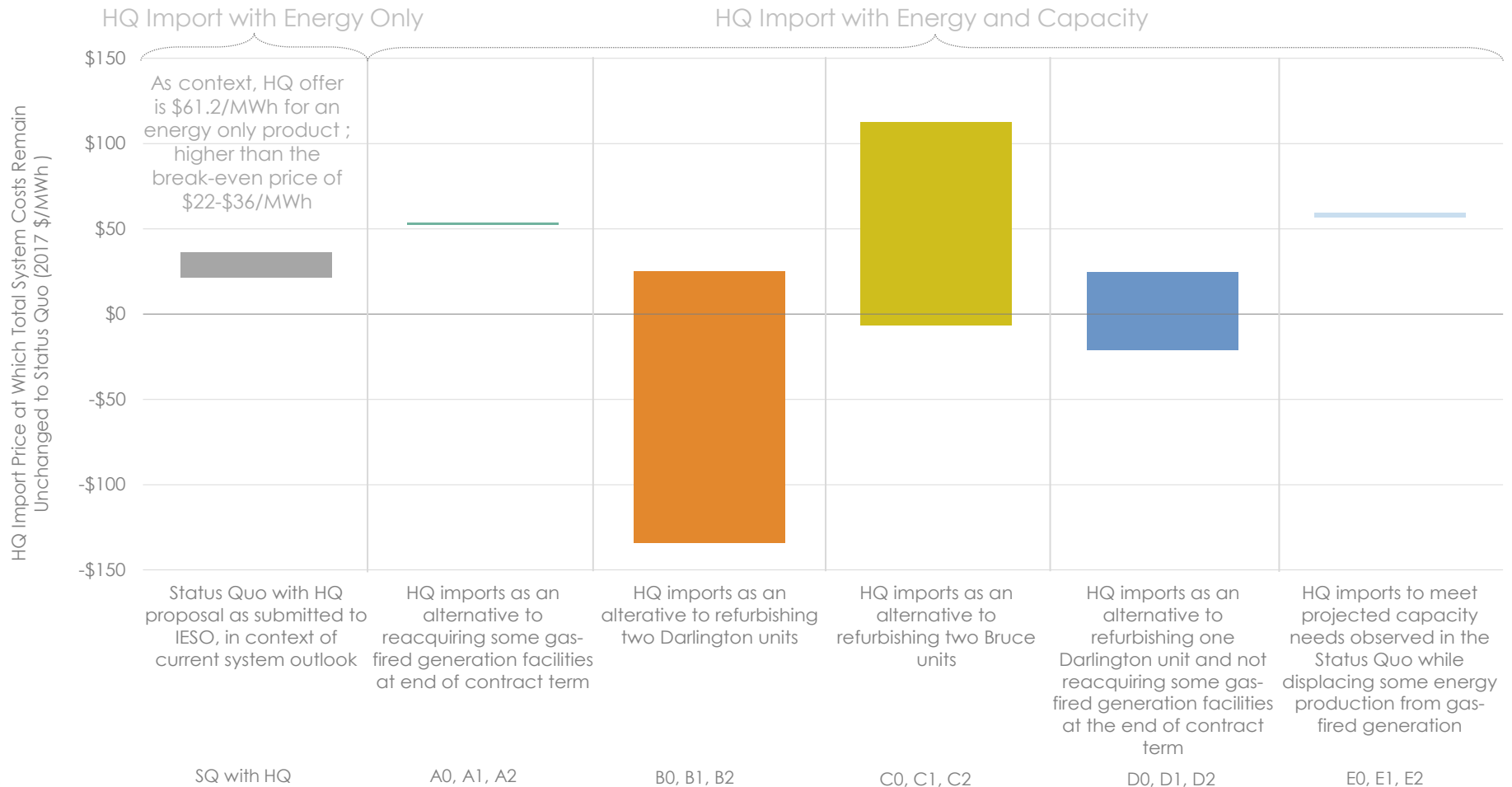
Summary of findings: on opportunities to enhance the value of the updated Hydro Quebec proposal to Ontario

- The value of Hydro Quebec's updated proposal might be enhanced by better aligning it with Ontario's electricity needs, including in terms of firm capacity, volume of energy, timing of delivery, length of term, and price. In general:
 - Imports with capacity or capacity-and-energy are more valuable to Ontario than imports with energy alone
 - Imports which provide flexibility to target the product towards periods of higher value within a given year are more attractive than imports that are take-or-pay and/or have fixed delivery periods
 - Incremental imports starting in the mid-2020's or later can provide potential value, as opposed to starting in 2018
 - The use of firm imports to meet requirements can provide higher value in lieu of new investments (not yet made) rather than to displace already existing resources in the province, whose costs are materially sunk and/or depreciated
 - Firm imports can provide value as alternatives to nuclear refurbishment if they have the same capacity, energy and reliability as the nuclear unit(s) in question, if they have the same start timing and length of term as the refurbished unit(s), and if they are lower in cost
 - In light of the above and consistent with needs identified in the current supply and demand outlook, a Hydro Quebec product with each of the following attributes could provide value to Ontario ratepayers:
 - 1,000 MW firm capacity
 - Up to 4 TWh of annual energy
 - Delivery starting in the mid 2020's
 - A price of about \$60/MWh (2017\$)

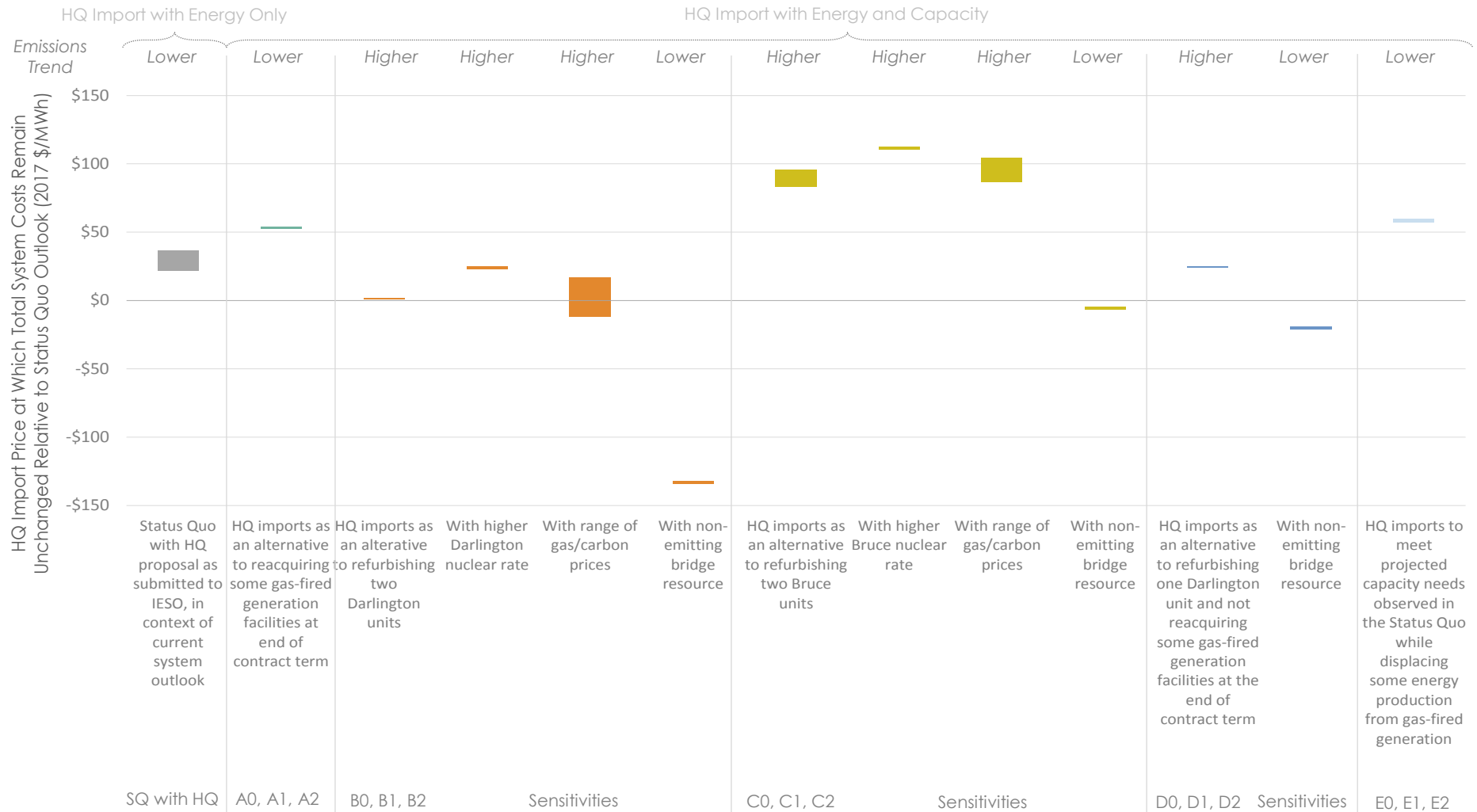
The IESO considered a range of scenarios, sub-scenarios and sensitivities in its analysis of Hydro Quebec import options. These are summarized in the tables below and are described in greater detail later in this report. 28 combinations were analyzed in total, including the reference/Status Quo outlook, the updated Hydro Quebec proposal and various options for enhancing its value.

Scenario	Role of Hydro Quebec Import
A	Alternative to reacquiring some gas-fired generation facilities at the end of contract term
B	Alternative to refurbishing two Darlington units
C	Alternative to refurbishing two Bruce units
D	Alternative to refurbishing one Darlington unit and not reacquiring some gas-fired facilities at the end of contract term
E	Helps meeting projected capacity shortfalls in the status quo outlook while displacing some production from gas-fired resources
Sub-Scenarios	Size, Delivery Timing and duration of Hydro Quebec Import
0	8 TWh energy and 1 GW firm capacity, for 20 years, beginning in 2023
1	8 TWh energy and 1 GW firm capacity, for 20 years, delivery aligned with the timing of when gas-fired generation facilities are no longer reacquired at contract expiry or when foregone nuclear refurbishments are retired
2	Up to 8 TWh energy and up to 1 GW firm capacity, for 20 years, delivery aligned with resource needs (a variation of Sub-Scenario #1)
Sensitivity	Description of Sensitivity
Gas/Carbon Price	Lower and higher natural gas and carbon prices
Nuclear Costs	Higher nuclear costs at Darlington and Bruce
Bridging Resources	Where resources are required to bridge the difference between Ontario resources removed and Quebec imports added in, two types of book ends are examined – in one case, the bridge is natural gas-fired generation; in the other case, a combination of wind and storage resources as a proxy for a non-carbon emitting resource

The “break-even” represents the price of a Hydro Quebec import product at which the total cost of electricity service in Ontario would remain unchanged relative to the Status Quo outlook, after considering applicable costs and/or cost savings and key sensitivities. A lower break-even price indicates lower value to Ontario, a higher break-even indicates higher value. The figure below summarizes indicative break-even prices across the range of scenarios and sensitivities considered.



The ranges illustrated on the previous slide are disaggregated in the figure below to show the effects of key sensitivities, including around timing of delivery, natural gas and carbon prices, nuclear rates and cost of resources to bridge any difference between Ontario resources removed and Quebec imports added in



The estimated ranges of break-even prices are also summarized in the table below, along with corresponding changes in cumulative carbon emissions compared to the reference Status Quo outlook

HQ Import with Energy Only	Scenario	HQ Import Price at Which Total System Costs Remain Unchanged (Break-even) Relative to Status Quo Outlook (\$2017/MWh)**	Cumulative Change in Emissions over Break-even Period Relative to Status Quo Outlook (MT CO ₂)***
HQ Import with Energy and Capacity	Status Quo with HQ proposal as submitted to IESO, in context of current system outlook	\$22 to \$36	-29 to -19
	A. HQ imports as an alternative to reacquiring some gas-fired generation facilities at end of contract term	\$52 to \$54	-34 to -33
	B. HQ imports as an alternative to refurbishing two Darlington units	With gas resource as bridge: -\$12 to \$25 With non-emitting resource as bridge: -\$134	With gas resource as bridge: +49 to +56 With non-emitting resource as bridge: -11
	C. HQ imports as an alternative to refurbishing two Bruce units*	With gas resource as bridge: \$83 to \$112 With non-emitting resource as bridge: -\$6	With gas resource as bridge: +49 to +55 With non-emitting resource as bridge: -13
	D. HQ imports as an alternative to refurbishing one Darlington unit and not reacquiring some gas-fired generation facilities at the end of contract term	With gas resource as bridge: \$24 to \$25 With non-emitting resource as bridge: -\$21	With gas resource as bridge: +29 to +31 With non-emitting resource as bridge: -7
	E. HQ imports to meet projected capacity needs observed in the Status Quo while displacing some energy production from gas-fired generation	\$57 to \$60	-25 to -27

* Off-ramp of last two Bruce units cannot be exercised until 2027 and so an agreement cannot be made today.

** Bridge resources are included when the amount of supply removed is greater than the amount of import added in. Two cases are examined: one where gas is the bridge resource and another where a non-emitting resource (wind/storage) is the bridge.

*** Positive (+) values denote increase in emissions, negative (-) values denote decrease in emissions.

Analysis supporting the previous slides can be found in the full report, which is organized as follows.

Section	Subject	Slides
-	Executive Summary	4 - 11
1	Overview of the current electricity system outlook as context for assessing electricity import options from Quebec	12 - 36
2	Overview of the June 22, 2017 Hydro Quebec amended energy sales and cycling agreement ("Updated HQ proposal")	37 - 39
3	Assessment of the Updated Hydro Quebec proposal as submitted to the IESO, in the context of the current electricity system outlook	40 - 52
4	Assessment of indicative options for enhancing the value of the Updated Hydro Quebec proposal to Ontario Ratepayers: as an alternative or complement to existing electricity resources in Ontario	53 - 111
5	Observations and insights	112 - 120
6	Appendix	121 - 135