Electricity planning outlooks as further context for LTEP 2017 development

Prepared for Discussion with Ministry of Energy

Planning, Legal, Indigenous Relations and Regulatory Affairs

May 24, 2017

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Context and overview

- At the request of the Ministry of Energy, the IESO has analyzed a range of electricity system outlooks to inform the development of the 2017 Long-Term Energy Plan ("2017 LTEP")
  - Assumptions for the analysis are consistent with the document jointly prepared by the IESO and Ministry of Energy entitled: "Ministry of Energy's 2017 Long-Term Energy Plan Modelling Assumptions, April 6 2017"

- The Ministry of Energy expressed interest in considering higher levels of long-term conservation savings, informed by the 2016 Market Achievable Potential ("MAP") study. Higher long-term conservation savings are accordingly reflected in the IESO's analysis, which considers:
  - Conservation savings of 30 TWh by 2032, per the 2013 LTEP and consistent with the 2016 Ontario Planning Outlook (31 TWh by 2035)
  - Conservation savings of 41 TWh by 2032, consistent with the 2016 Market Achievable Potential study (46 TWh by 2035)

- The IESO's analysis is summarized in the following slides, with focus on implications for electricity demand and supply, greenhouse gas emissions and costs

Summary

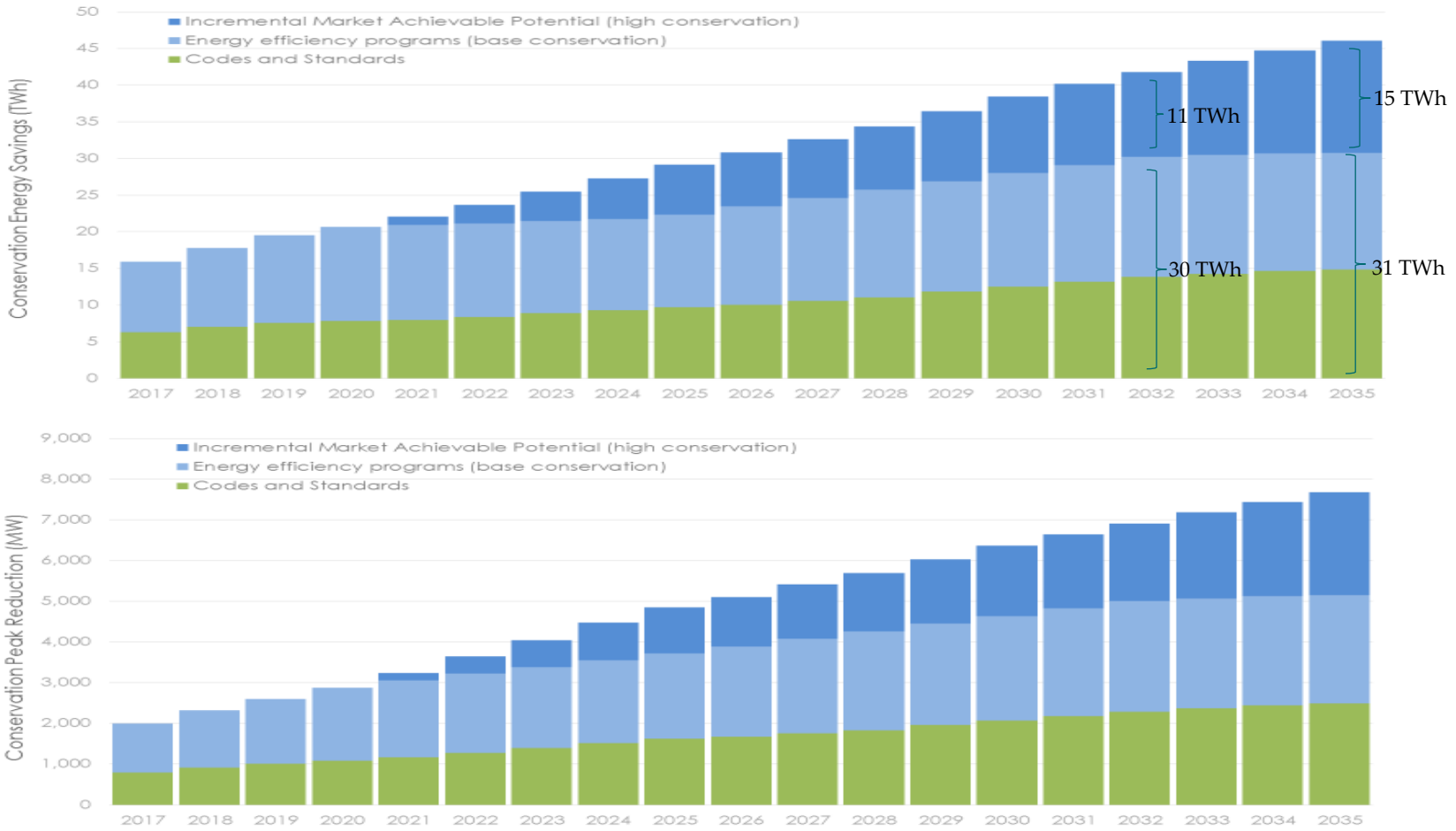
- Higher levels of conservation savings per the Market Achievable Potential as compared to current levels of targeted conservation result in:
  - A reduction in electricity energy demand by about 10%
  - Generally no change in the timing of capacity needs but a reduction in longer-term resource needs
  - Reduction in greenhouse gas emissions by an average of about 0.7 MT per year between 2017 and 2035
  - Average cost for incremental greenhouse gas emission reduction ranging from $100 - $200/tonne
  - Increases in surplus energy by an average of about 2 TWh per year starting in 2021
  - Increases in total system costs by an annual average of about $100M to $200 M per year, but ranges from an increase of $600 M per year in the earlier years of 2021 to a decrease of $300 M per year by 2035
  - Increase in average residential bills by $11/month and industrial rates by $1/MWh to $3/MWh

- Opportunities exist to improve understanding of conservation potential and to enhance the value of this resource:
  - Better targeting and right-sizing conservation could help improve cost-effectiveness and reduce surpluses
  - Better optimizing supply system adaptations to higher levels of conservation could help improve cost-effectiveness and reduce surpluses
  - Opportunities exist to enhance value of conservation by pursuing additional savings through codes/standards and improving allocation/funding of program budgets/expenditures

- The Ministry of Energy could consider reaffirming commitments to current conservation targets in the 2017 LTEP but continue to explore options to best realize higher levels of conservation in view of opportunities for reductions in electricity costs and emissions

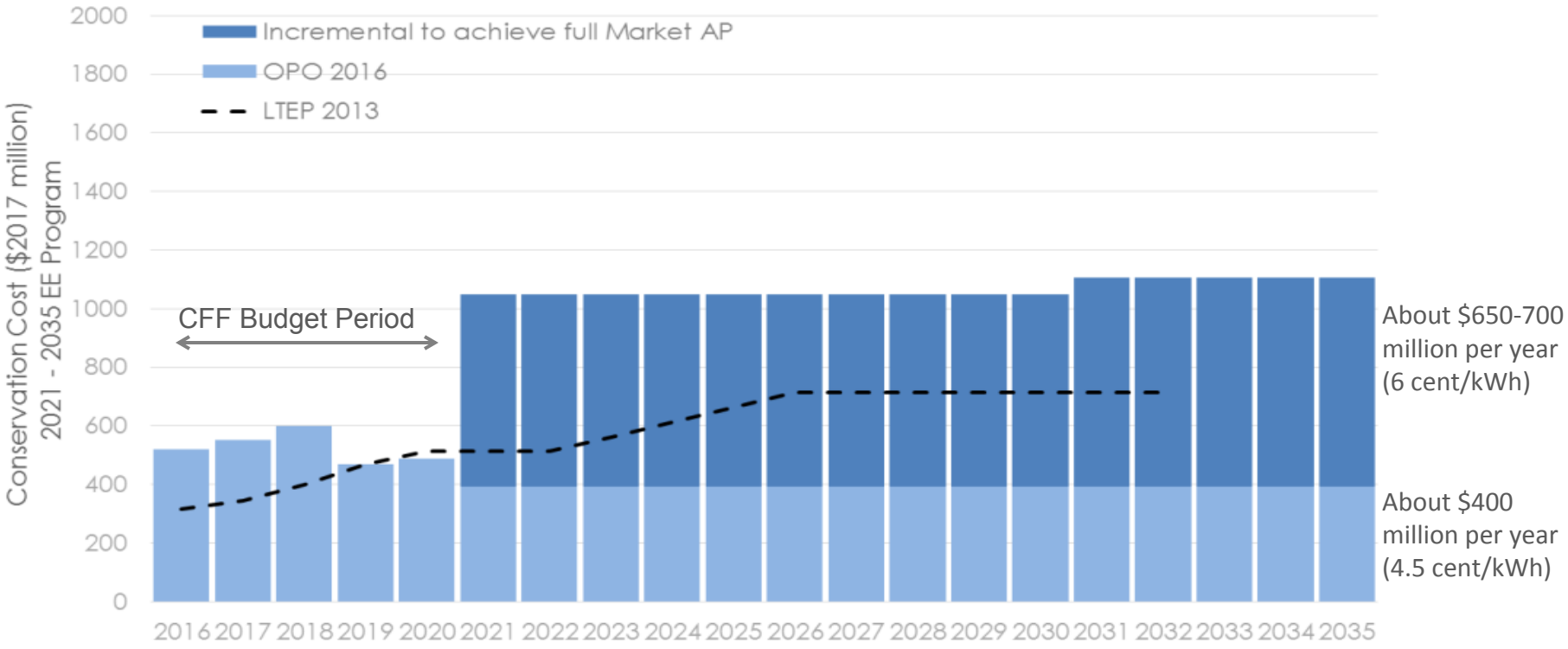
Analysis

The 2013 LTEP established an energy savings target of 30 TWh by 2032 (31 TWh by 2035). The 2016 Market Achievable Potential identified an additional 11 TWh of savings potential (15 TWh by 2035).



- Savings identified in 2013 LTEP could be achieved through a combination of programs and codes/standards.
- The 2016 Market Achievable Potential study ("MAP") assumed incremental savings would be achieved through programs only.
- Incremental MAP savings would begin in 2021, following the end of the current CDM Framework.

Achieving conservation savings identified in the Market Achievable Potential study would require an incremental investment of $650M - $700M/year, over and above the $400 M/year of investment needed to achieve current targets.



- The total investment for the current target plus the MAP would be about $1 Billion/year, equivalent to about 5.3 cents/kWh. 2013 LTEP avoided costs range between 5 and 7 cents/kWh

- Estimates are based on available information: 2016 Ontario Planning Outlook (OPO), Market achievable potential (MAP), and Budget constrained achievable potential (BCAP). IESO continues to refine conservation program cost estimates.

By 2035, additional conservation per the Market Achievable Potential study would reduce electricity consumption and peak demand by about 10% compared to demand net of current conservation targets. Electricity demand would be less than what it is today, if the higher conservation amounts were achieved. Ontario would continue to remain a summer peaking jurisdiction in both demand outlooks.

TWh

143 TWh

Case A: Net demand with current conservation target

153 TWh

Case A: Consumption increases by 0.4% annually

Case B: Net demand with conservation per Market Achievable Potential Study

137 TWh

Case B: Consumption decreases by 0.2% annually

MW

24.1 GW

Case A: Net demand with current conservation target

25.2 GW

Case A: Peak demand increases by 0.2% annually

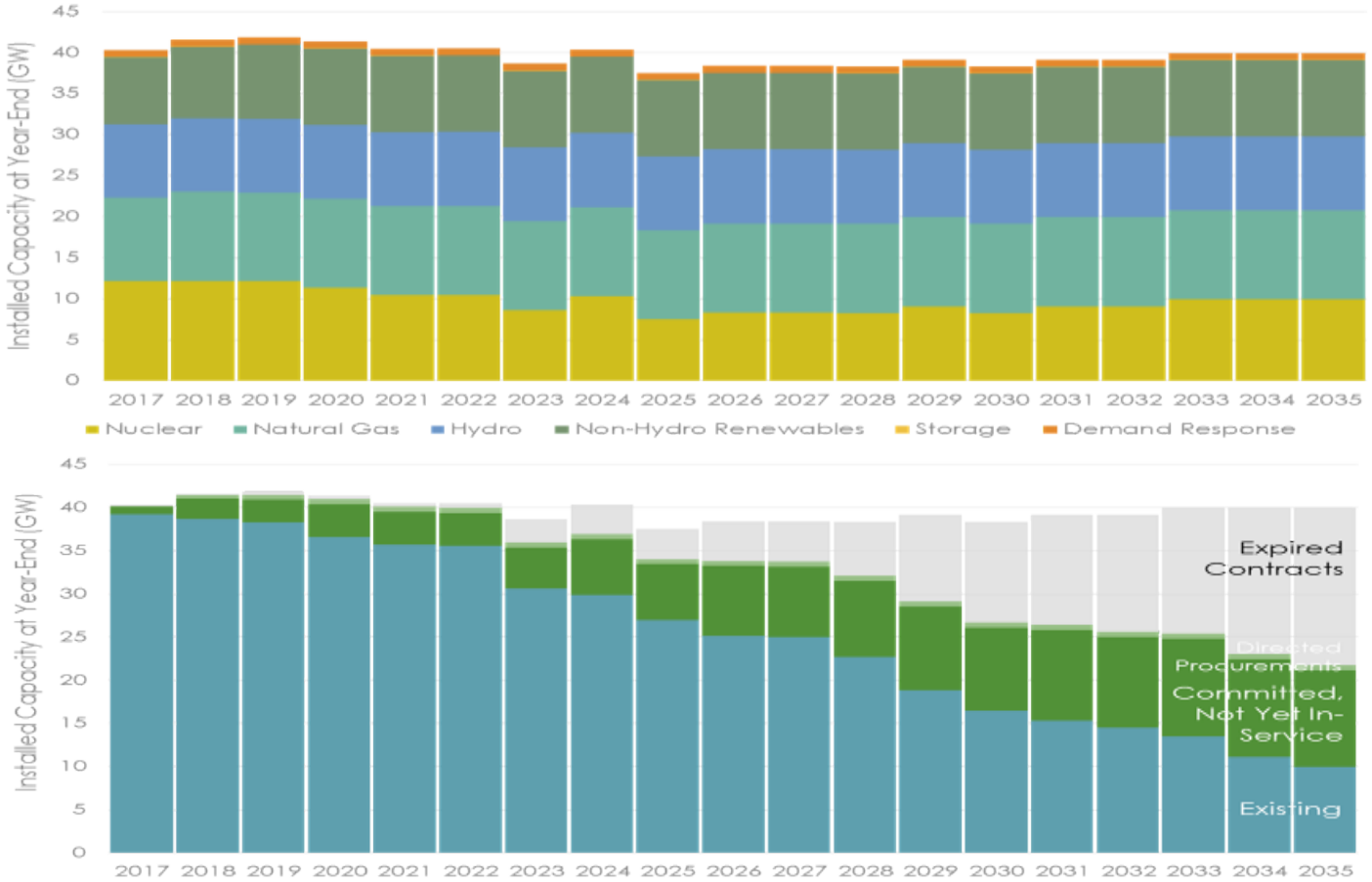
Case B: Net demand with conservation per Market Achievable Potential Study

22.5 GW

Case B: Peak demand decreases by 0.4% annually

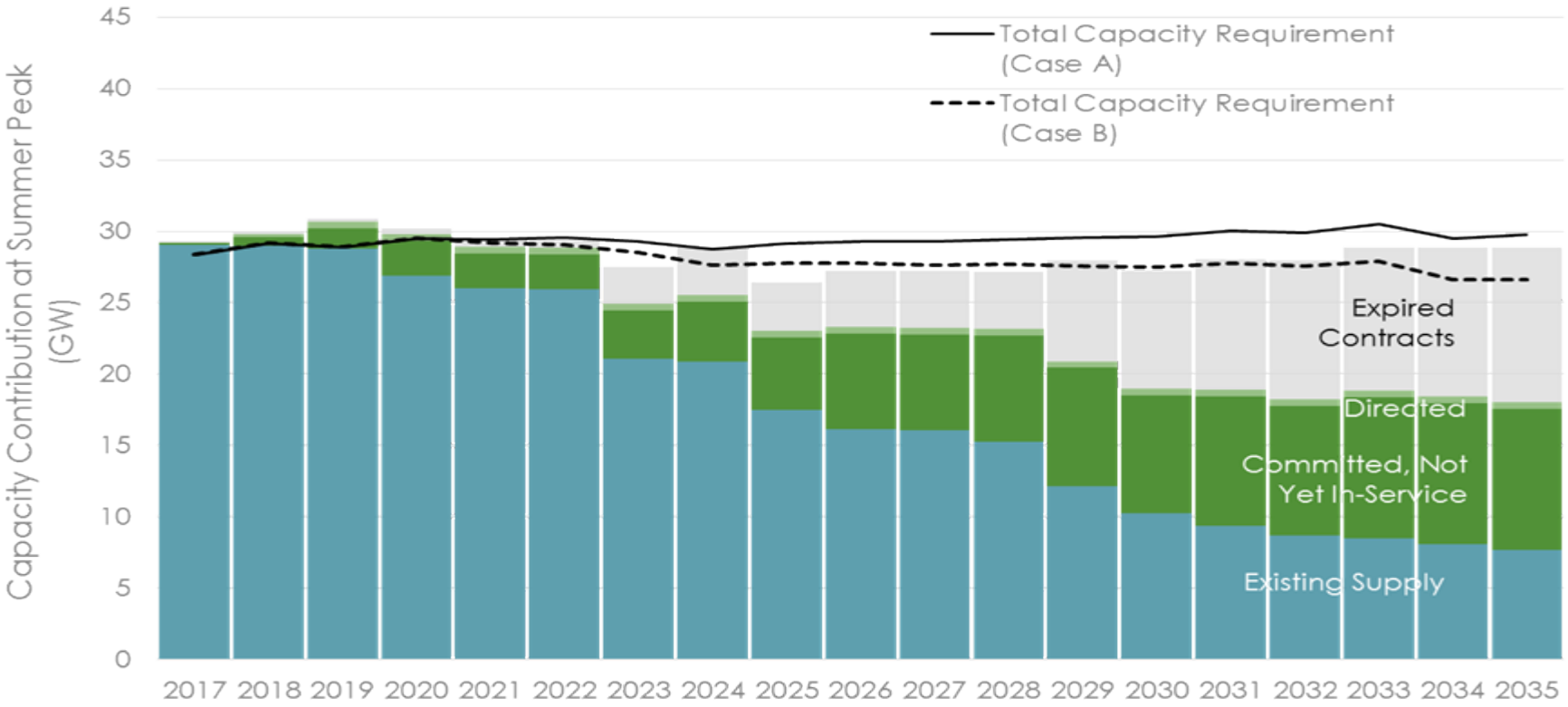
The 2016 Ontario Planning Outlook was the starting point for the Case A net demand forecast and the outlook was updated to reflect the assumptions in accordance with the "Ministry of Energy's 2017 Long-Term Energy Plan Modelling Assumptions, April 6 2017" document, attached in the Appendix.

Ontario's installed capacity would be about 40 GW over the planning outlook if all existing and planned resources remained available. Some net supply reductions would take place during the refurbishment period in the mid-2020s. 18 GW of existing supply resources will reach the end of their contract term by 2035. These resources provide opportunities for adaptation should, for example, demand trend lower. Nuclear refurbishment off-ramps provide additional flexibility.



- The 2016 Ontario Planning Outlook was the starting point for the supply forecast and the outlook was updated to reflect the assumptions in accordance with the "Ministry of Energy's 2017 Long-Term Energy Plan Modelling Assumptions, April 6 2017" document, attached in the Appendix.

Provided that existing and planned supply resources continued to operate beyond their contract term, Ontario would face capacity deficits in some years and surpluses in other years, depending on the demand outlook. Additional resources would be required to address projected deficits, fewer resources would be required under conditions of capacity surplus.



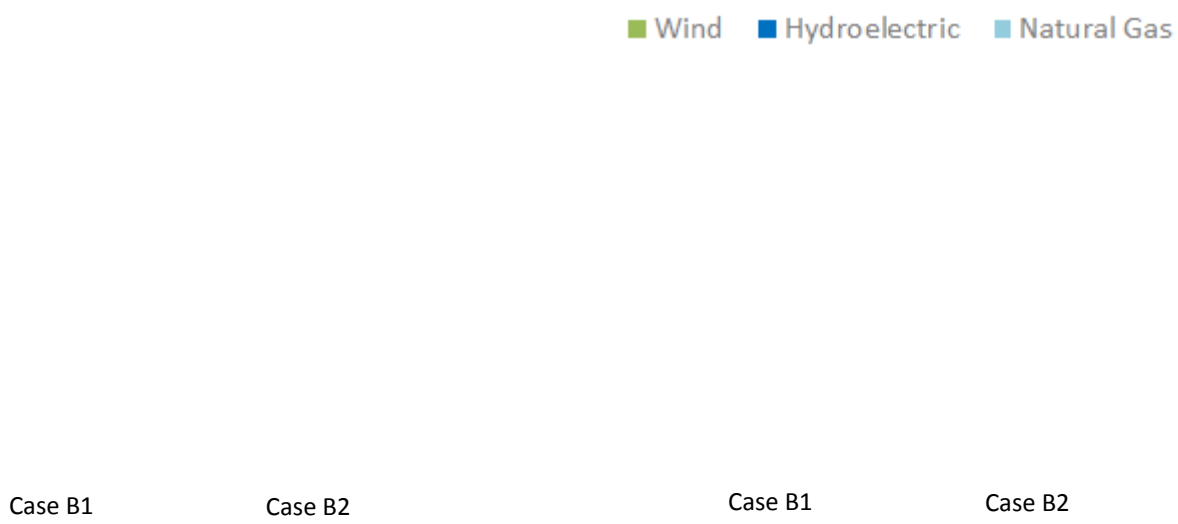
The timing of capacity needs would be generally similar between the two net demand outlooks (i.e. needs would emerge in the early 2020's). The overall need for additional capacity would be lower under the full market achievable potential outlook, in which existing resources would more than meet requirements in some years (i.e. there would be capacity surpluses if no adaptations were taken).

Surplus

Deficit

- **Case A:** Ontario would require about 2 GW of additional capacity throughout the 2020s, declining to about 1 GW following the return to service of all refurbished nuclear units
- **Case B:** Ontario would require between 0.5 GW and 1 GW between 2023 - 2028 . By 2031 and onwards, capacity surpluses of up to 2 GW would need to be addressed

The IESO considered one resource mix to meet the Case A demand outlook, and two indicative resource mixes to meet the Case B demand outlook, which features more conservation. Resource adaptations in the outlook with more conservation are described below.



- **Case A**: Shortfalls starting in the 2020s would be met by gas for modelling purposes
- **Case B**: Where necessary, shortfalls would be met by gas for modelling purpose. To the extent that additional conservation reduced the need for supply resources, investments in supply resources were scaled back from the base case. The IESO looked at two supply mix options to reduce supply surpluses in the higher conservation case:

  - ***Case B1***: Aims to lower surplus energy by not reacquiring a combination of some existing renewables and some existing gas-fired generation, that is, about 3,100 MW wind, 100 MW hydro, and 2,300 MW gas-fired generation installed capacity was removed from service by 2035.

  - ***Case B2:*** Aims to lower GHG emissions by not reacquiring some existing capacity from gas-fired generation, that is, about 2,100 MW of gas-fired generation installed capacity was removed from service by 2035.

Compared to Case A which maintains current conservation targets, the higher conservation Cases B1 and B2 see a reduction of about 5-8 TWh of energy production from gas-fired generation and reduced imports, primarily in 2021 and onwards. In Case B1, renewable energy production decreases by 8 TWh by 2035. There is no change in nuclear production across the conservation outlooks.

The production includes expected imports so the total electricity production forecast exceeds for forecasted Ontario consumer demand

Assuming existing resources continue to operate and planned resources enter service, surplus energy would continue its declining trend over the next few years, driven by nuclear unit retirements and refurbishments. Surplus energy would begin to increase in the mid 2020s with incremental conservation. In Case B2, where only gas-fired generation capacity is removed, SBG would increase to 4-6 TWh. Some of this increase is tempered in Case B1 where both renewables and gas are removed.

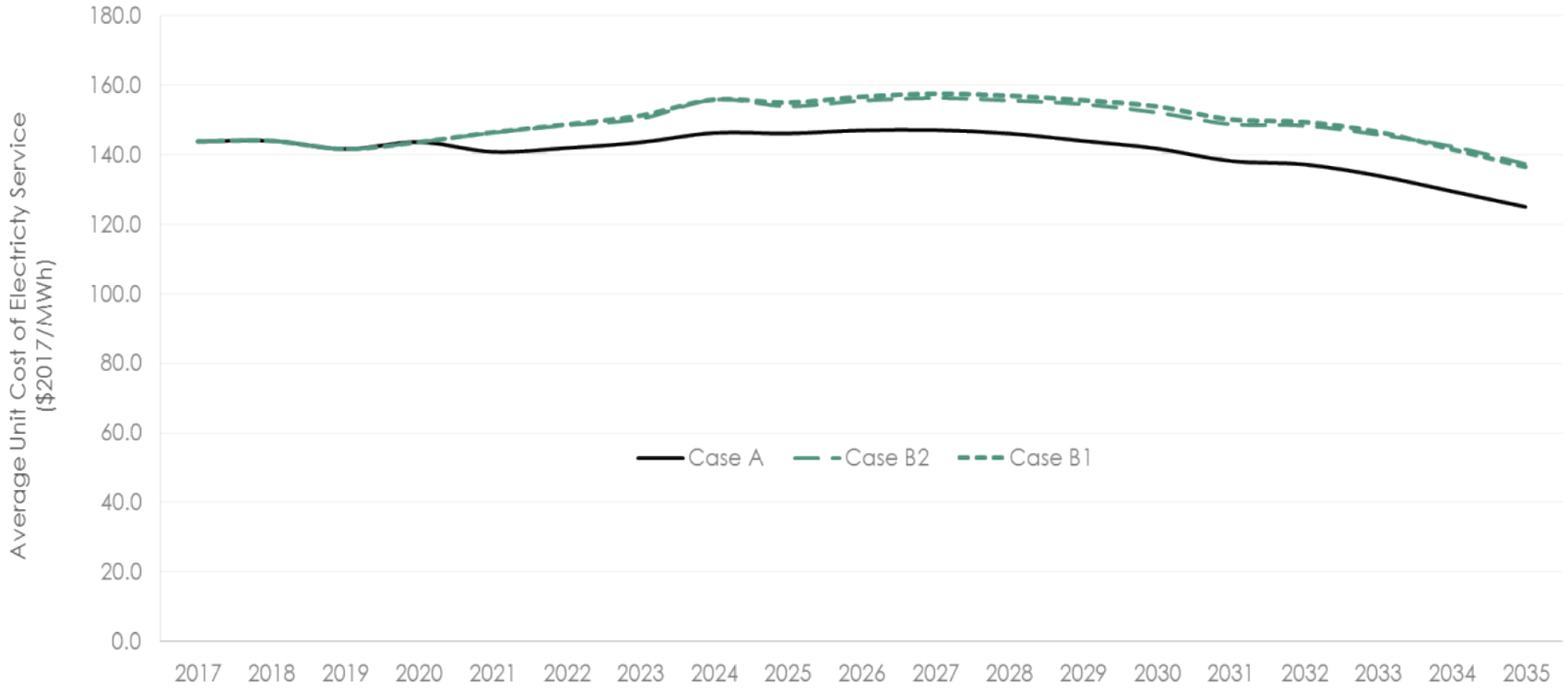
Less gas-fired and renewable supply

Less gas-fired supply

Under the outlooks considered, carbon dioxide emissions by 2035 would remain at levels comparable to those seen in recent years. Outlooks with more conservation would see lower levels of carbon dioxide emissions, by an average of about 0.7 MT per year: this is premised on the assumption that incremental conservation is achieved through measures that do not emit GHGs (such as CHP facilities). The GHG abatement costs associated with higher levels of conservation ranges from $100 - $200/tonne. As context, under the cap and trade program, the carbon price ranges from $18/tonne today to $40/tonne by 2035, averaging $30/tonne throughout the planning period.

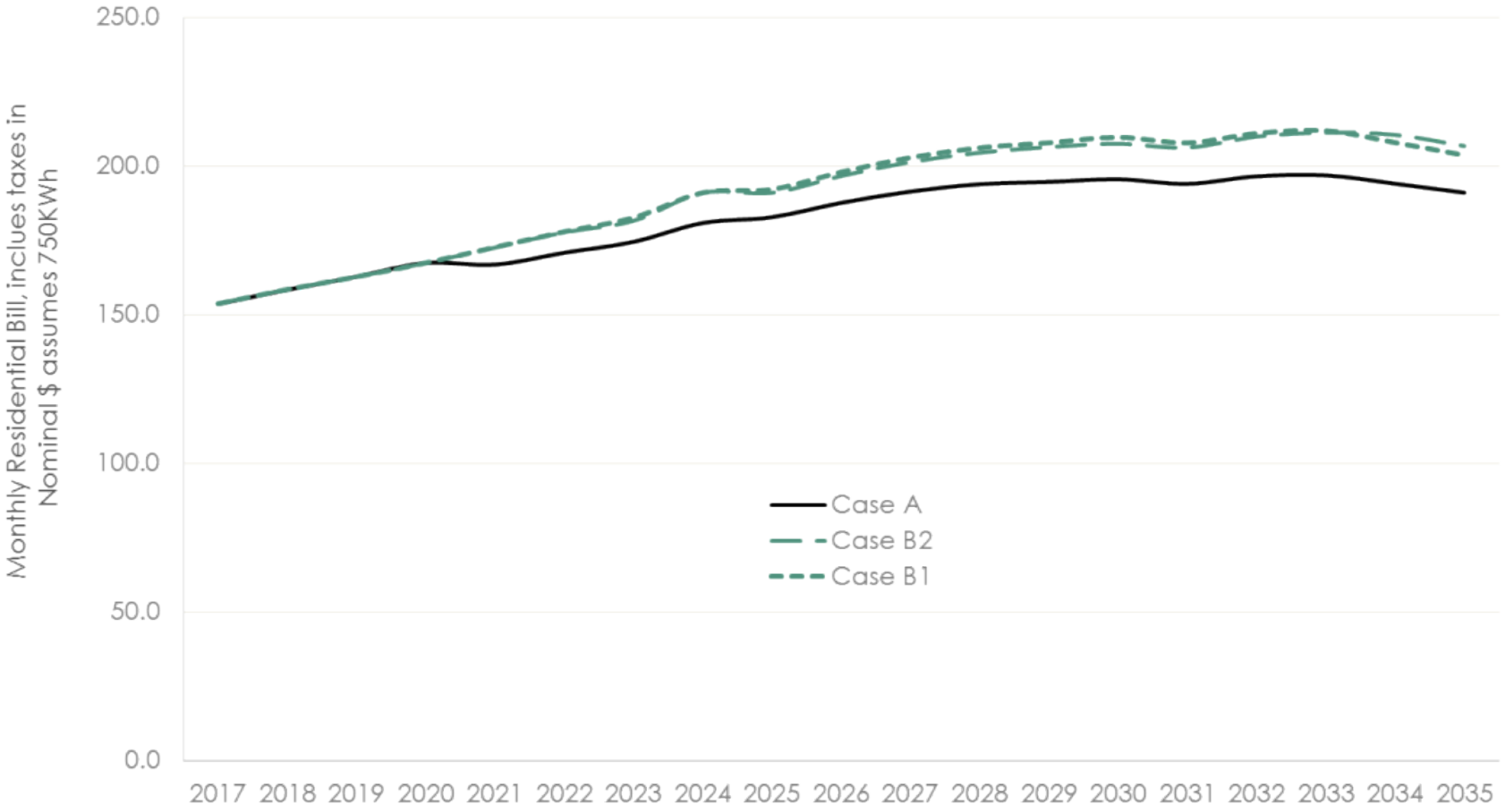
The total cost of electricity service is higher in the higher conservation cases between 2021 and 2030, as the incremental cost of conservation exceeds the avoided cost of supply resources. In the later years, the total cost of electricity service in the higher conservation case is lower than Case A, as the incremental conservation cost is lower than the avoided cost of supply resources.

Although the total cost of electricity service is lower towards the end of the planning period in higher conservation Cases B1 and B2 as compared to Case A, the average unit costs for Case B1 and B2 are higher as the volume declines at a faster rate than the cost reduction.



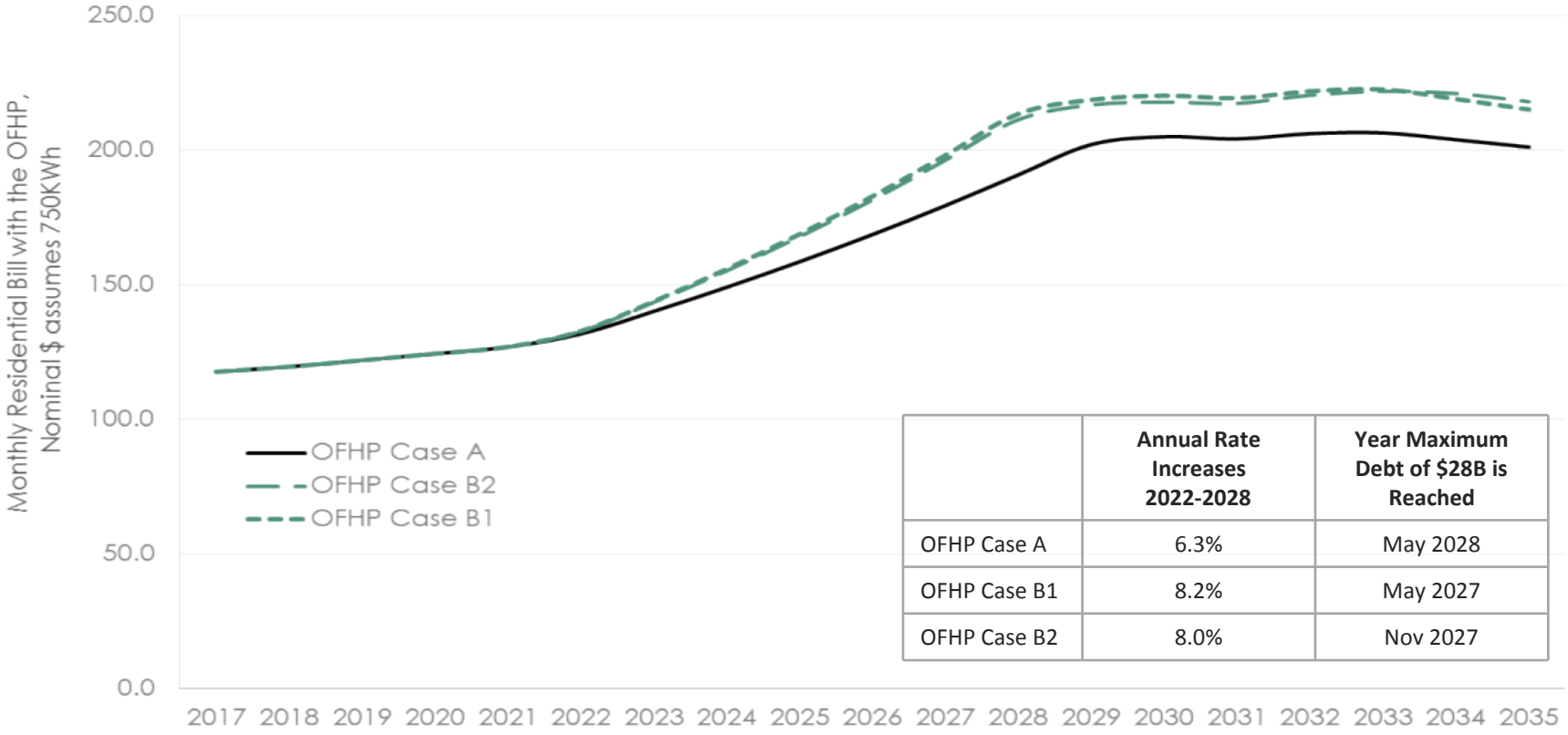
Residential monthly bill without the Ontario Fair Hydro Plan (OFHP) or 8% rebate

Higher conservation cases result in a higher monthly residential bill, by an average of about $11/month in each year between 2021 and 2035. Although the total costs of electricity for the higher conservation Cases B1 and B2 are lower in the later part of the outlook compared to Case A, the lower demand will drive the unit cost upwards and generate a higher monthly bill.



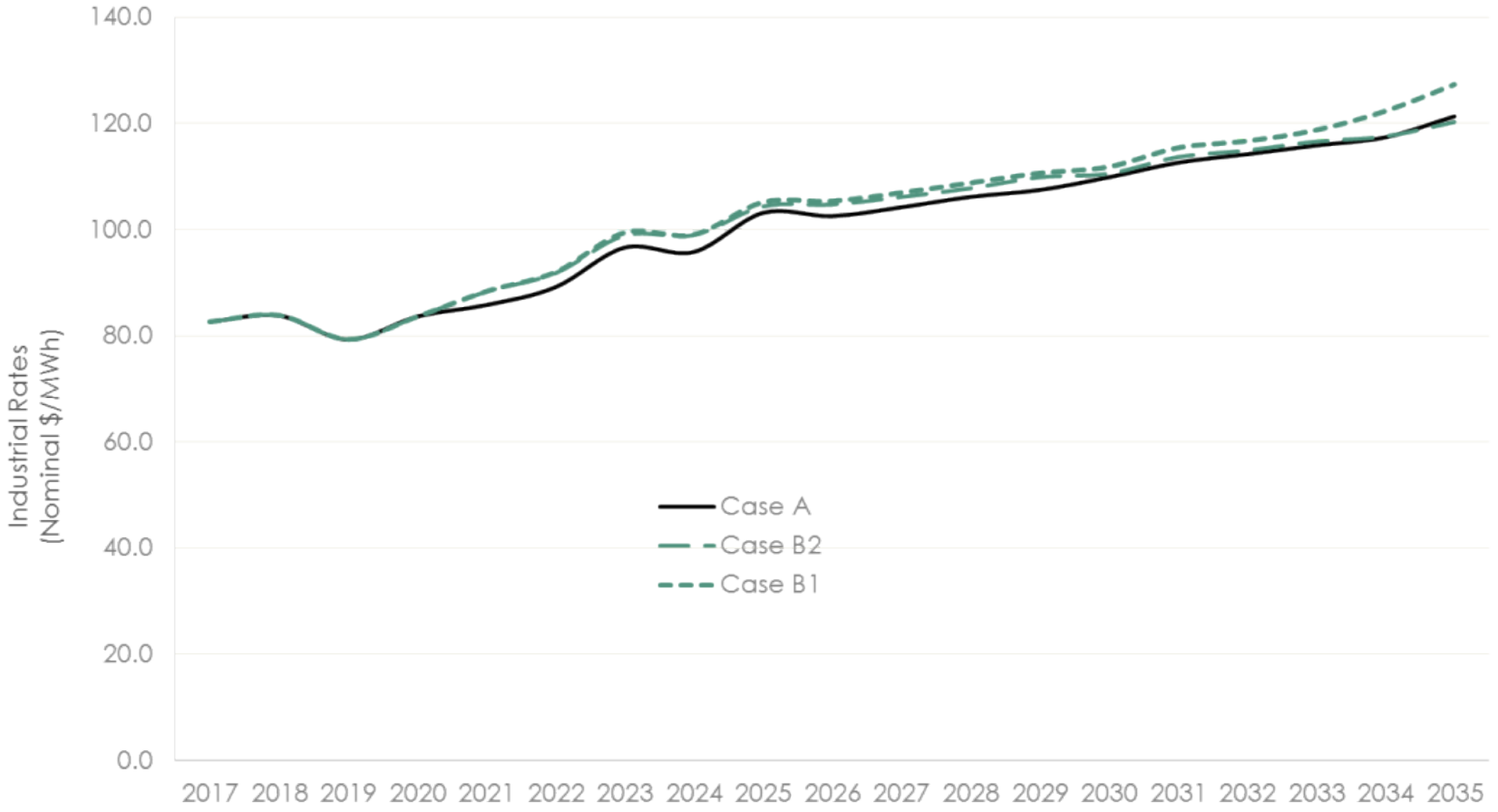
Residential monthly bill with the Ontario Fair Hydro Plan (OFHP)

Higher conservation cases result in a higher monthly residential bill, by an average of about $12/month in each year between 2021 and 2035. Between 2022 and 2028, higher conservation cases see a rate increase of 8% per year while Case A which reflects current conservation targets see a rate increase of about 6% per year. In addition, the $28 billion max debt is reached sooner in the higher conservation cases.

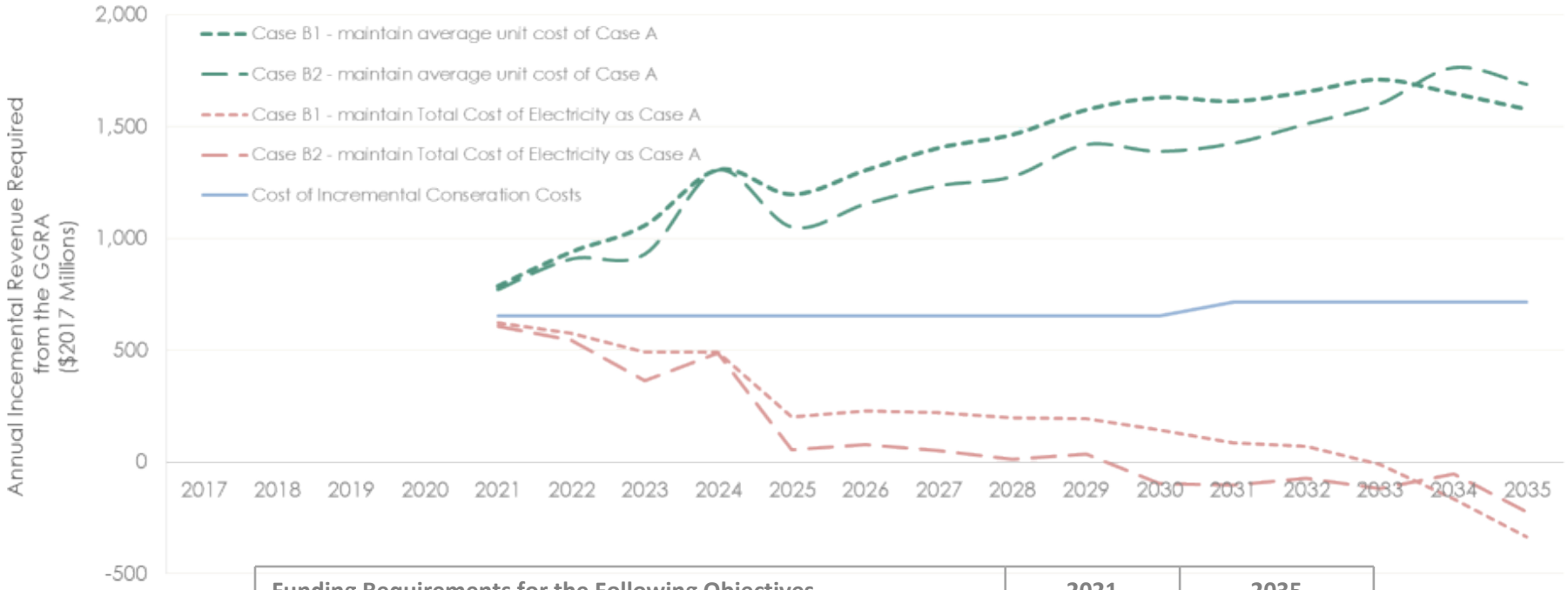


	Annual Rate Increases 2022-2028	Year Maximum Debt of $28B is Reached
OFHP Case A	6.3%	May 2028
OFHP Case B1	8.2%	May 2027
OFHP Case B2	8.0%	Nov 2027

Industrial rates for the higher conservation Cases B1 and B2 are about $1 to $3/MWh higher than Case A, which reflects current conservation targets



To mitigate increases in electricity costs associated with higher conservation savings, funding (such as from the GGRA) of between $800 M/year in 2021 and $1.7 B/year by 2035 would be required. The amount of funding required would vary, depending on the desired objective. Some examples of objectives and associated funding requirements are depicted below.



Funding Requirements for the Following Objectives	2021	2035
Maintain the same average unit cost of electricity service as Case A	$800 M/year	$1,700 M/year
Maintain the same total cost of electricity service as Case A	$640 M/year	-$340 M/year
Cover incremental cost of achieving higher conservation savings only	$655 M/year	$714 M/year

- The above analysis does not consider funding allocation amongst customer classes to ensure that residential bills and industrial rates remain the same as Case A

Further analysis is required to improve our understanding of conservation opportunities, costs, environmental performance, and integration with supply mix options. The Ministry of Energy could consider reaffirming commitments to current conservation targets in the 2017 LTEP, while committing to explore options to maximize the value of conservation. The following are areas for immediate and ongoing attention; they could be explored in the implementation plan and beyond.

- Opportunities exist to better understand conservation program savings and identify how best to capture their value:
  - As additional conservation is pursued, costs to achieve savings likely to evolve. Understanding conservation cost curves can help identify what cost-effective achievable potential exists across the full spectrum of measures
  - Currently assume that all incremental savings are achieved through conservation programs. Opportunities may exist to purse savings through codes and standards
  - Opportunities may exist to improve how program budgets/expenditures are allocated and funded over time to improve cost-effectiveness
  - Opportunities exist to "right size" and better target conservation savings to maximize the value this resource provides
- Opportunities exist to further identify and analyze supply responses that would provide most value in conjunction with higher levels of conservation:
  - The supply mix portfolios developed for the avoided supply cases (B1 and B2) provide and indicative illustration of the implications of avoiding certain resources. Avoiding other types of resources or in different amounts would yield different cost implications.
  - Operability issues need to be considered in cases with reduced gas supply

Appendix

Demand Outlooks: 31 TWh Conservation case and 46 TWh Conservation case relative to the 2016 OPO Outlook B

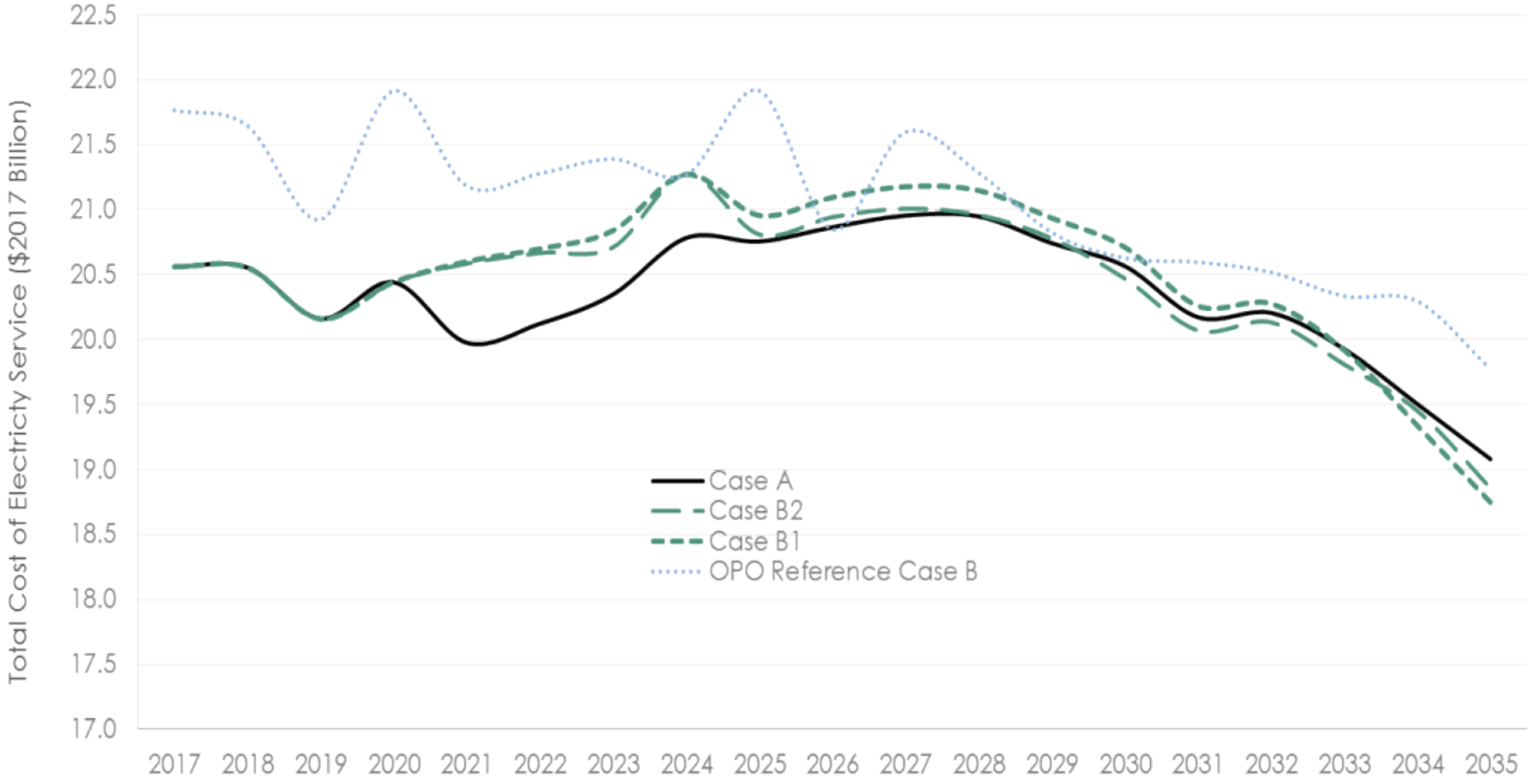
Supply Outlooks: 31 TWh Conservation case and 46 TWh Conservation case relative to the 2016 OPO Outlook B

		Installed Capacity Year End 2035 (GW)
2016 Ontario Planning Outlook		**43**
Reductions	Projected compared to contracted LRP 1	-0.2
	Incremental renewable capacity to meet targets	-0.8
	Incremental DR to meet targets	-0.5
	Available NUG capacity	-0.4
	LRP II procurement suspension	-1
	Elimination of microFIT 5 and 6	-0.1
	EFW procurement suspension	-0.1
Additions	Capacity changes to supply mix	0.3
2017 Long-Term Energy Plan		**40**

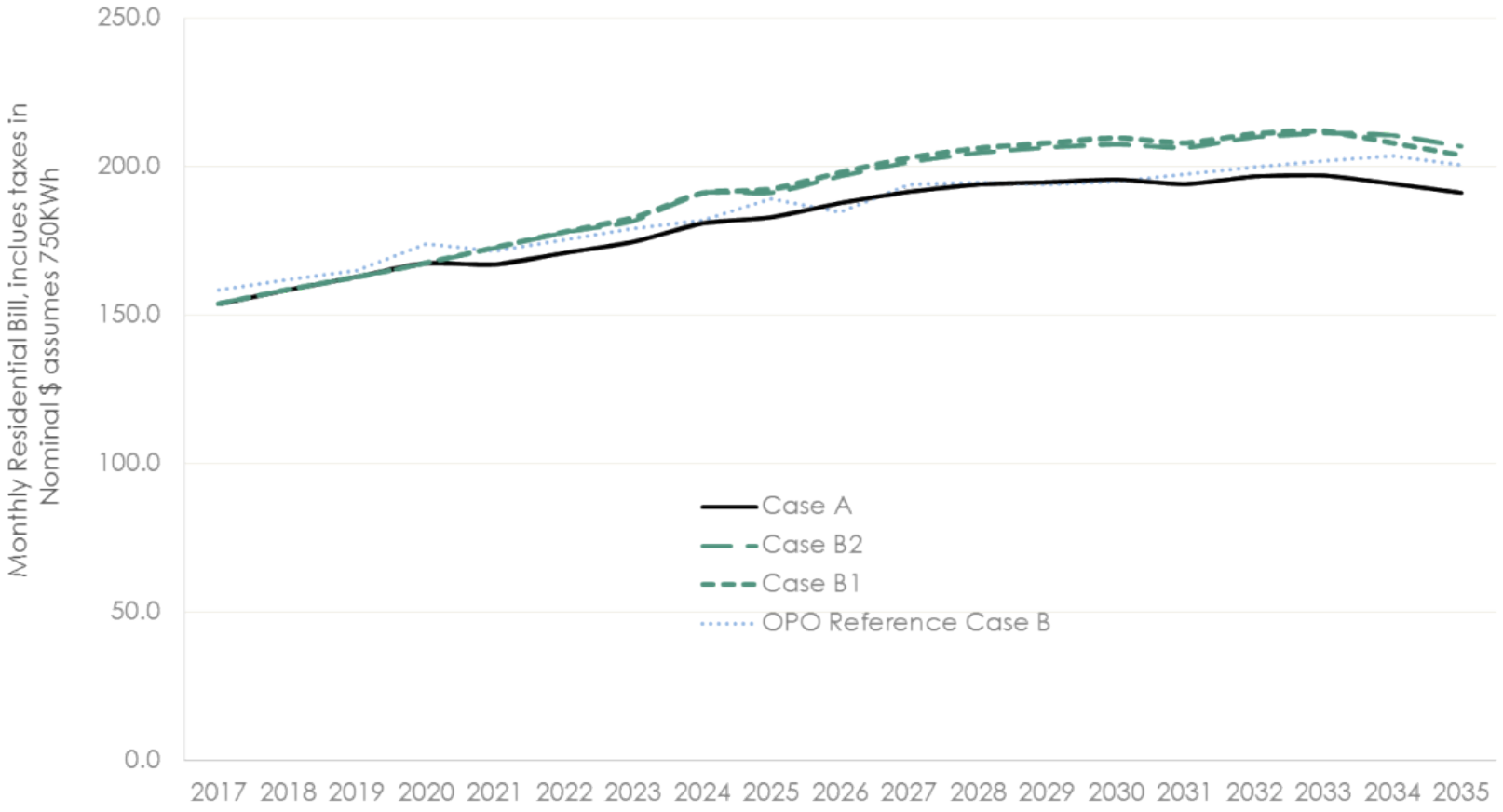
Totals may not add up due to rounding

Emissions Outlooks: 31 TWh Conservation case and 46 TWh Conservation case relative to the 2016 OPO Outlook B

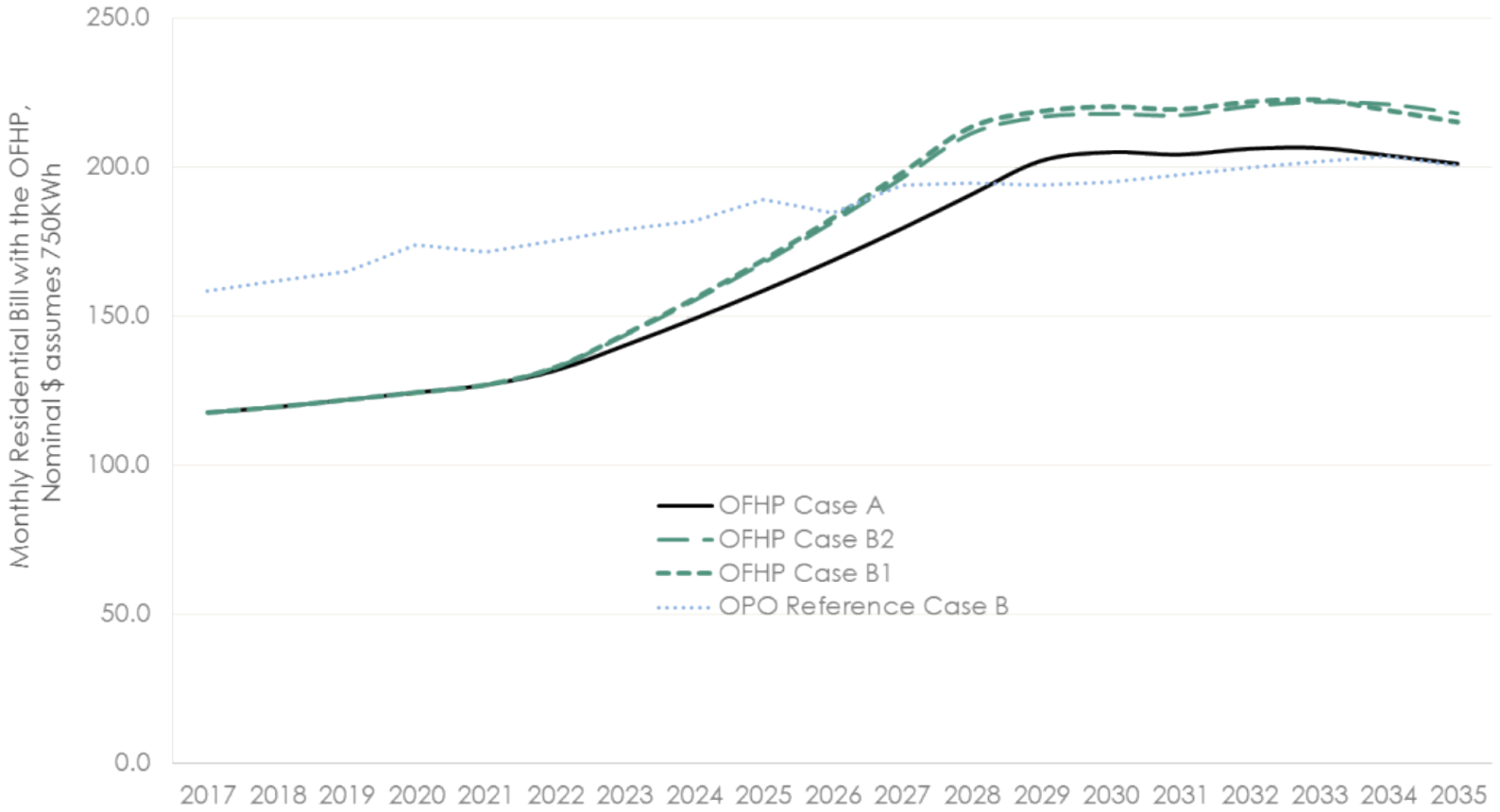
Total Cost Outlooks: 31 TWh Conservation case and 46 TWh Conservation case relative to the 2016 OPO Outlook B indicates the overall lower costs in the near term as the updated cases assume the smoothed OPG nuclear rates. For the 2029 to 2035 period, the updated forecasts are lower than the OPO due to lower repowering costs for expired contracts recognizing the lower levels of capital required for existing assets such as wind and solar.



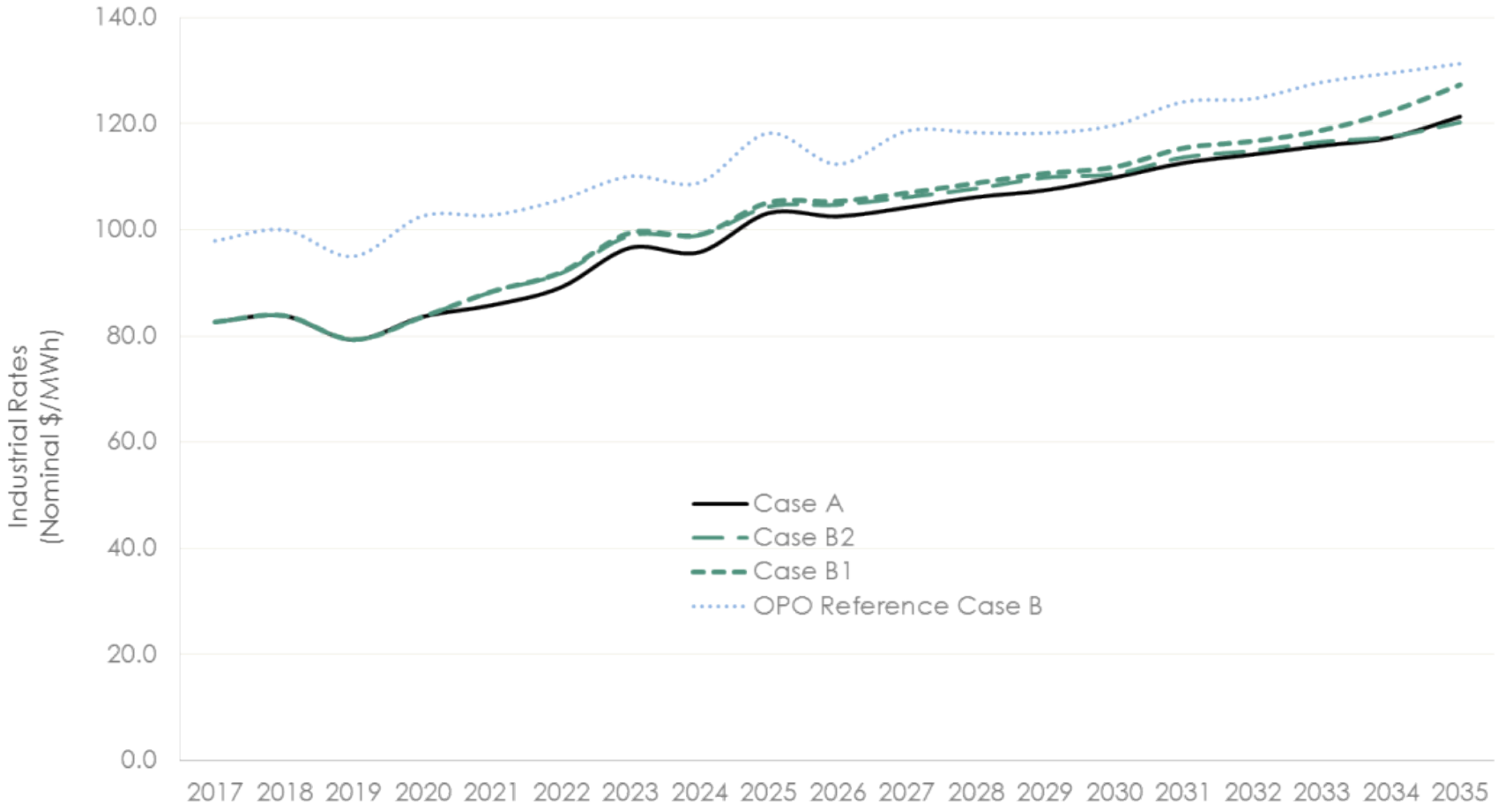
Average Residential Bills Outlooks: 31 TWh Conservation case and 46 TWh Conservation case relative to the 2016 OPO Outlook B indicates that the Case A is below the OPO, while the Conservation cases are above the OPO projection



Average Residential Bills Outlooks: 31 TWh Conservation case and 46 TWh Conservation cases with the OFHP relative to the 2016 OPO Outlook B, indicates the OFHP monthly bills will exceed the OPO forecast after 2028 when repayment of the $28 Billion debt is required



Industrial Rates Outlooks: 31 TWh Conservation case and 46 TWh Conservation case relative to the 2016 OPO Outlook B indicates that all the updated cases are below the OPO outlook



Ministry of Energy's 2017 Long-Term Energy Plan Modelling Assumptions, April 6 2017 Document (1)

MINISTRY OF ENERGY'S 2017 LONG-TERM ENERGY PLAN MODELLING ASSUMPTIONS

This document summarizes the modelling assumptions for the reference outlook to inform the Ministry of Energy's 2017 Long-Term Energy Plan ("2017 LTEP").

The document reflects the IESO's understanding of the assumptions to be assumed for the 2017 LTEP based on IESO/ENERGY discussions between February and April 2017 and comments received from ENERGY staff on April 1, 2017.

In order to proceed with analytics, the IESO is seeking Ministry sign off on this document no later than Friday April 7, 2017

Section 1 – Assumptions

Outlook Timeframe

- The IESO will model the LTEP for the period 2017 to 2035 to align with the timeframe presented in the 2016 Ontario Planning Outlook (OPO).

Demand

- It is the IESO's understanding that ENERGY's preference is to consider a single demand outlook as the reference forecast. The reference demand forecast for the 2017 LTEP will be OPO Outlook B with the addition of electric vehicle (EV) demand assumptions per Outlook D (i.e., 2.4 million EVs by 2035).
- It is the IESO's understanding that ENERGY's preference is to consider a range of sensitivities around the reference demand forecast, with the range of sensitivity starting in 2026. Therefore, two sensitivities will be developed around the reference demand forecast to illustrate higher and lower ranges beginning in 2026:
  - The lower range will have similar assumptions to OPO Outlook A.
  - The higher range will assume higher household growth, higher new square footage growth in various commercial buildings, and greater growth in the industrial sector.
- Detailed energy/costing analysis will not be performed for the low and high demand sensitivities. Instead, their implications may be described qualitatively.

Conservation and Demand Response

- The 2013 LTEP targets 30 TWh of energy efficiency by 2032 and assumes that the near term target set in the Conservation First Framework and Industrial Accelerator Program of 8.7 TWh will be achieved by 2020.
- The IESO understands that ENERGY is seeking analysis on modeling a higher than 2013 LTEP conservation target within the OPO Outlook B. Based on discussions with the ADM and Michael Lyle, the IESO will perform analysis assuming 1) the 2013 LTEP conservation targets and 2) a higher conservation target.

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- The 2013 LTEP included a Demand Response target which includes Time-of-Use (TOU), Industrial Conservation Initiative (ICI) and demand response (DR) auction combined to meet 10% of peak demand by 2025. It is the IESO's understanding that ENERGY requests to eliminate the demand response target that was established in 2013 LTEP for the 2017 LTEP base case. The IESO will assume for the 2017 LTEP base case that TOU and ICI will continue to persist throughout the planning horizon and any DR currently procured through the DR auction would continue to be available in future auctions. Should there be capacity needs moving forward, additional demand response could be procured through the capacity auction.

Supply

- The IESO will assume the nuclear schedule that is consistent with OPO, which reflects OPG's current business plan and the amended Bruce refurbishment agreement:
  - Bruce as per the schedule in the finalized ABPRIA;
  - Pickering continued operations to 2022/2024 (Note from ENERGY: In March 2017, OPG Board approved operation of all six units to 2024 subject to system needs and project economics. As such, the additional two years is considered a supply option/scenario rather than a base case);
  - Darlington as per the finalized refurbishment schedule.
- It is the IESO's understanding that ENERGY does not want to consider operation of all six Pickering units to 2024 as part of the analysis. The IESO will assume Pickering continued operations to 2022/2024 for the base case.
- The IESO will reflect the October 2016 Ontario-Quebec Electricity Trade Agreement.
  - Energy 2.3 TWh per year (2017 to 2022 inclusive) Quebec to Ontario;
  - 500 MW capacity per winter December to March (2016/17 to 2022/23 inclusive) Ontario to Quebec; and
  - 500 MW capacity Quebec to Ontario in return for delivery of 500 MW to Quebec in 2015/16 as part of original capacity swap.
- The IESO will reflect recently contracted new resources e.g. Chaudiere Falls Gatineau No.1 and Hull No.2 waterpower contracts.
- The IESO will assume the suspension of Large Renewable Procurement II and Energy From Waste Procurement as a result of the September 2016 direction.
- The IESO will assume FIT 5 and microFIT 2017 are the remaining renewable programs to be procured that are not yet online or contracted.
- The 2013 LTEP set renewable capacity targets of 10.7 GW for non-hydroelectric by 2021 and 9.3 GW for hydroelectric by 2025. The IESO will assume the elimination of hydro and non-hydro renewable targets and that there will be no further renewable procurements beyond FIT 5 and microFIT 2017 in the 2017 LTEP reference outlook.

Costs

Ministry of Energy's 2017 Long-Term Energy Plan Modelling Assumptions, April 6 2017 Document (2)

- The IESO will assume natural gas price forecast per the Sproule projection as of February 2017. Further updates to the gas price forecast will lengthen modelling timelines. The IESO will assess a lower and higher gas price forecast for sensitivity.
- The IESO will include new higher contracted price information for existing NUG contracts.
- The IESO will assume carbon cost as the reserve price (i.e., the floor price) projection in the 2017 LTEP base case, and the "updated CA-QC-ON Bloomberg Nov 2016" projection for the sensitivity.
  - Note that the reserve price projection is slightly different from the OPO forecast; it now includes the actual floor price for the March 2017 cap and trade allowance auction as notified in January 2017, and this value is inflated by 5% as per the cap and trade regulations and added an assumed inflation factor of 2%.
  - The "updated CA-QC-ON Bloomberg Nov 2016" projection has been provided to IESO via ENERGY.
  - See Appendix for the carbon price projection values.
- The IESO will assume OPG nuclear rates to be consistent with the revised OPG Rate Smooth received from Tim Christie on March 13, 2017. The IESO will use the OPG nuclear outage data received from Tim Christie on March 10, 2017, and the nuclear production data received from Tim Christie on March 13, 2017. No change to Bruce Power nuclear prices from OPO.
- The IESO will assume OPG hydro rates to be consistent with the data received from Tim Christie on March 23, 2017.
- Upon contract expiry, for modelling purposes, the IESO will assume the assets will continue to be available for the duration of the planning outlook (i.e. similar to Outlook B in OPO). This recognises that the system can benefit from a portion of ongoing value from these assets with some re-investment, rather than requiring complete new build to meet the demand. The results of the "Benefits Case Assessment of the Market Renewal Project" prepared by the Brattle Group indicates that the cost based methodology used in the 2016 OPO would generate slightly lower results than the market based methodology pricing for these assets after contract expiry. The capacity market will be the implementation mechanism that achieves these cost based values for these assets after contract expiry.

For the 2017 LTEP, the following assumptions will be used for costing expired contracts:

	Contract Expiry Cost Assumptions
Natural Gas	The contract information converted to a generic gas plant with re-investment proportions assumptions per Hatch Report.
Wind	Based on LRP I, with a discounted capital cost re-investment assumption for end of life components and accounting for on-going value from the balance of the asset. This cost assumption is lower than that used in 2016 OPO.
Solar	Based on LRP I, except that future investments for end of life components that need to be replaced decline in cost to recognise technological improvements. This cost assumption is lower than that used in 2016 OPO.

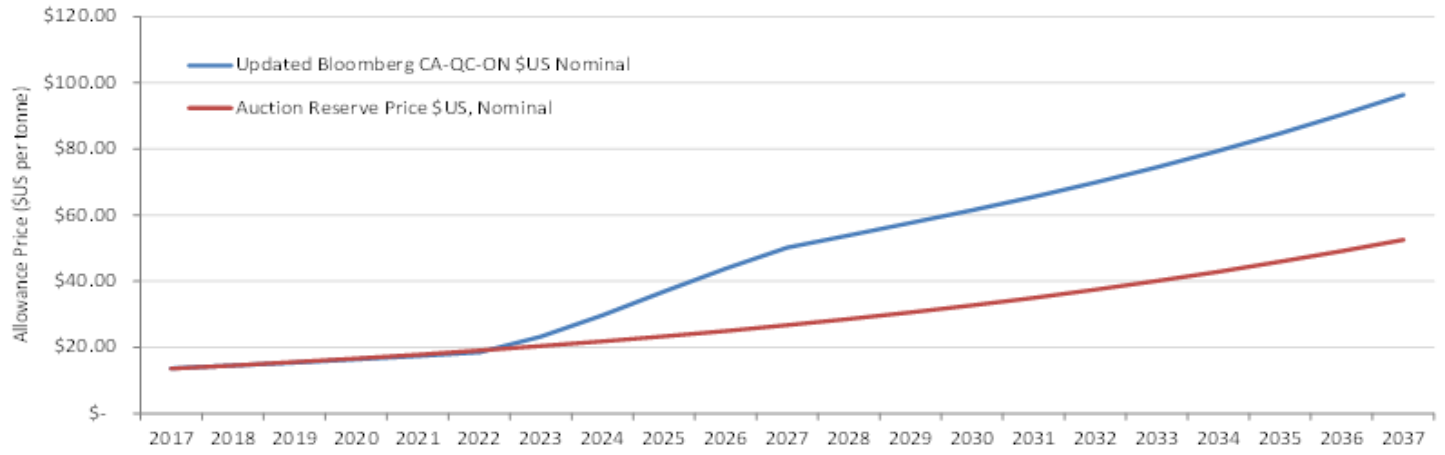
Industrial Rates and Residential Bills

- The industrial rates and residential bill impacts will not reflect recycling of proceeds from the Cap and Trade program.
- The residential bills will be the base bills, prior to the application of the Ontario's Fair Hydro Plan.
- Application of the Ontario's Fair Hydro Plan to the residential bills will require specific guidance and direction from ENERGY.

Ministry of Energy's 2017 Long-Term Energy Plan Modelling Assumptions, April 6 2017 Document (3)

Appendix Carbon price projection

	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037
															Assume same rate of increase as that observed from 2029 to 203						
Updated CA-QC-ON ($US, Nominal) - Bloomberg Nov 2016 (Provided by ENERGY)	$13.62	$14.47	$15.39	$16.34	$17.37	$18.47	$23.21	$29.67	$36.85	$43.85	$50.13	$53.87	$57.60	$61.43	$65.50	$69.85	$74.49	$79.44	$84.71	$90.34	$ 96.33
Auction Reserve Price (aka Floor Price) ($US, Nominal) - Derived from Feb 2017 Auction Reserve Price, which is inflated by 5% plus inflation each year. Inflation assumed to be 2%. Reserve price is determined prior to each auction, and is taken as the higher of the CA and QC reserve price, converted to the same currency. The prevailing reserve price in a given year will depend on the exchange rate, as well as the inflation in each of the two jurisdictions.	$13.57	$14.52	$15.54	$16.62	$17.79	$19.03	$20.36	$21.79	$23.32	$24.95	$26.69	$28.56	$30.56	$32.70	$34.99	$37.44	$40.06	$42.87	$45.87	$49.08	$ 52.51



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