

Impact of Behind-the-Meter Solar in Ontario



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Project overview

- This report examines four scenarios representing different adoption rates of behind-the-meter (BTM) solar in Ontario from 2021 to 2030
- For each scenario, the impacts of BTM solar adoption on Ontario's Hourly Ontario Energy Price (HOEP) and output from natural-gas fired generation is assessed using a system-wide dispatch model
- BTM solar can provide savings by lowering HOEP during peak demand hours in the summer, reducing the need to procure additional capacity through IESO's Capacity Auction (or other future procurements) and mitigating costs related to carbon prices and gas-fired generation
- BTM solar can also mitigate the need for needed transmission investment required due to the retirement of the Pickering Nuclear Generating Station ("Pickering")

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BTM Solar Uptake Scenarios (MW)

- Power Advisory was asked to analyze different scenarios for BTM solar installation
 - The different scenarios were provided by CanREA
- Base Case Scenario assumes a similar level of adoption as has occurred over the last decade
- High Adoption Scenario brings the ***total installed BTM solar*** to 3GW, nearly 11% of projected summer peak capacity in 2030
- Over the last decade, the driving force for BTM solar installation has been government programs (i.e., the Feed-in tariff (FIT) microFIT program) and net metering, which “buy” output from BTM solar at a prices above wholesale prices (e.g., HOEP)
- Impact of the federal carbon price may drive BTM solar adoption in the future

	Base	Moderate	Medium	High
2022	25	50	100	200
2023	50	100	200	550
2024	75	150	300	900
2025	125	250	500	1250
2026	175	350	700	1,600
2027	225	450	900	1,950
2028	275	550	1,100	2,300
2029	325	650	1,300	2,650
2030	375	750	1,500	3,000

Overview of the Analysis

- Power Advisory was asked to analyze the impact of higher levels of BTM solar adoption on Ontario's grid and wholesale electricity market
- The analysis was done by using a system-wide dispatch model and a Capacity Auction model
 - The dispatch model dispatches installed resources based on an hourly basis using marginal cost offers; for each hour, a market price (i.e. HOEP) is set by the last resource dispatched
 - The Capacity Auction model relies on IESO's forecasts for capacity needs over the next two decades; Power Advisory makes decisions on what resources are expected to remain operational once their current contract expires and what new resources will be added to the supply mix based on our outlook for the Ontario electricity sector
 - The Capacity Auction model sets a clearing price based on the amount of resources procured and their offer and what they are expected to earn in the wholesale market
- In both the dispatch model and the Capacity Auction model, the resource mix was adjusted for each scenario based on the amount of BTM solar installed annually
- Savings from the reduced dispatch of gas resources and carbon prices were modelled based on system-wide average heat rate (i.e. a system-wide efficiency factor for gas plants)
- The carbon price savings were calculated based on the current proposal for a \$50/tonne CO_{2e} ("tonne") carbon price by 2030 and the recently proposed \$170/tonne carbon price by 2030

Overview of the Results

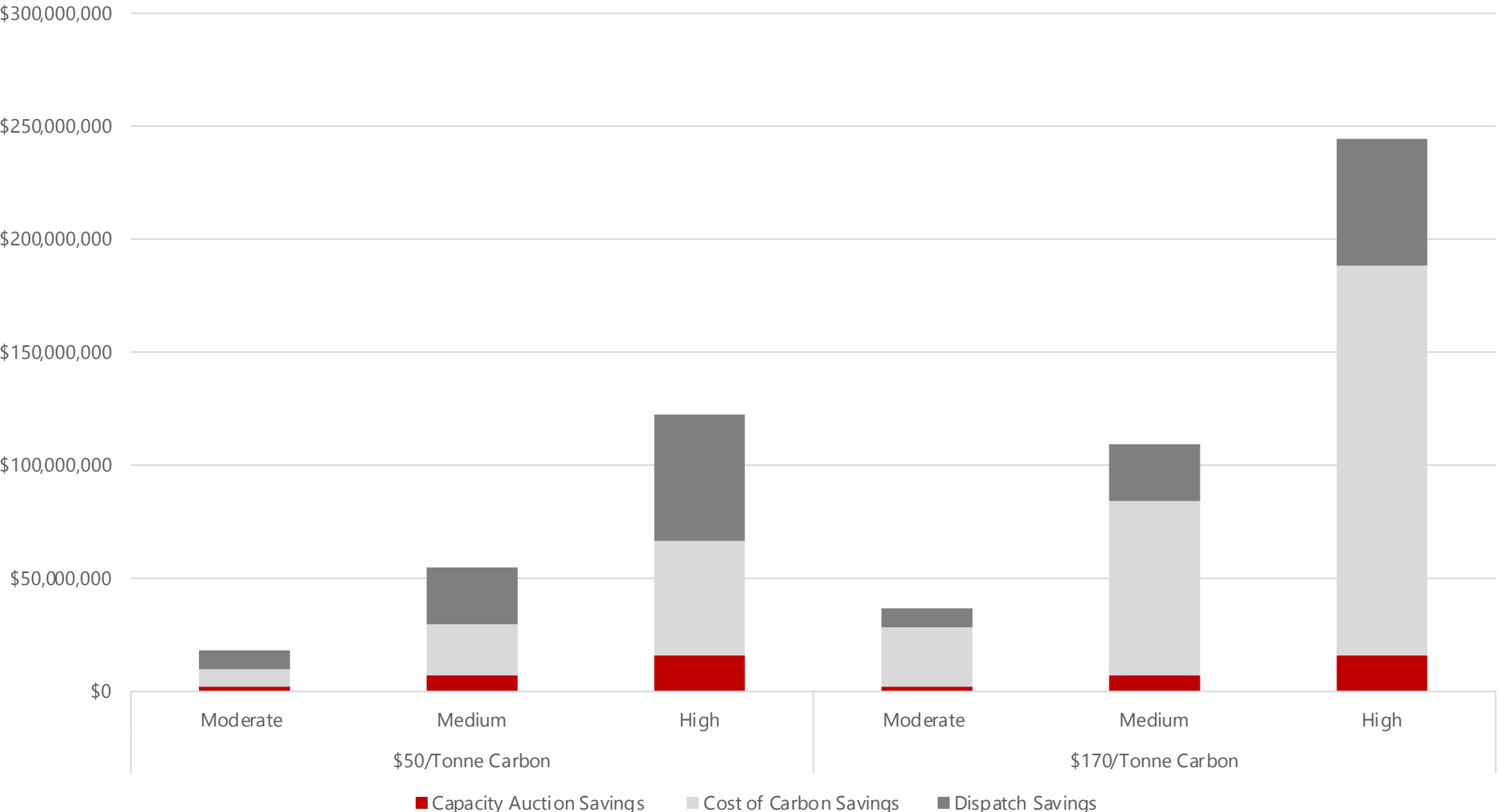
- BTM solar has a limited impact on HOEP
 - Even in the High Adoption Scenario, 3,000 MW of solar is not enough to fully replace gas-fired generators, which will then set the market price in most peak hours
- BTM solar has a meaningful impact on the Capacity Auction and auction clearing prices
 - Annual savings from a lower Capacity Auction clearing price range from \$2 million to \$16 million in 2030
- The dispatch of gas-fired generators is also reduced materially by 2030, particularly in the High adoption scenario
 - By 2030, gas output is reduced by up to 2.6 TWh in the “high” adoption scenario
 - The dispatch savings range from \$8 million to \$56 million in 2030 in the Base and High Scenarios, respectively
- The reduced dispatch of gas-fired generators also provides savings that flow to customers in the form of lower charges related to carbon prices and dispatch of zero marginal cost generation
 - The carbon savings range from \$7 million to \$172 million by 2030 in the Base and High Scenarios, respectively
- The retirement of Pickering in 2026 introduces a transmission constraint in the Greater Toronto Area (GTA)
 - Strategically located BTM solar can reduce this constraint by up to 1,000 MW in 2030 and may reduce the need for additional transmission build-out

Overview of the Results (continued)

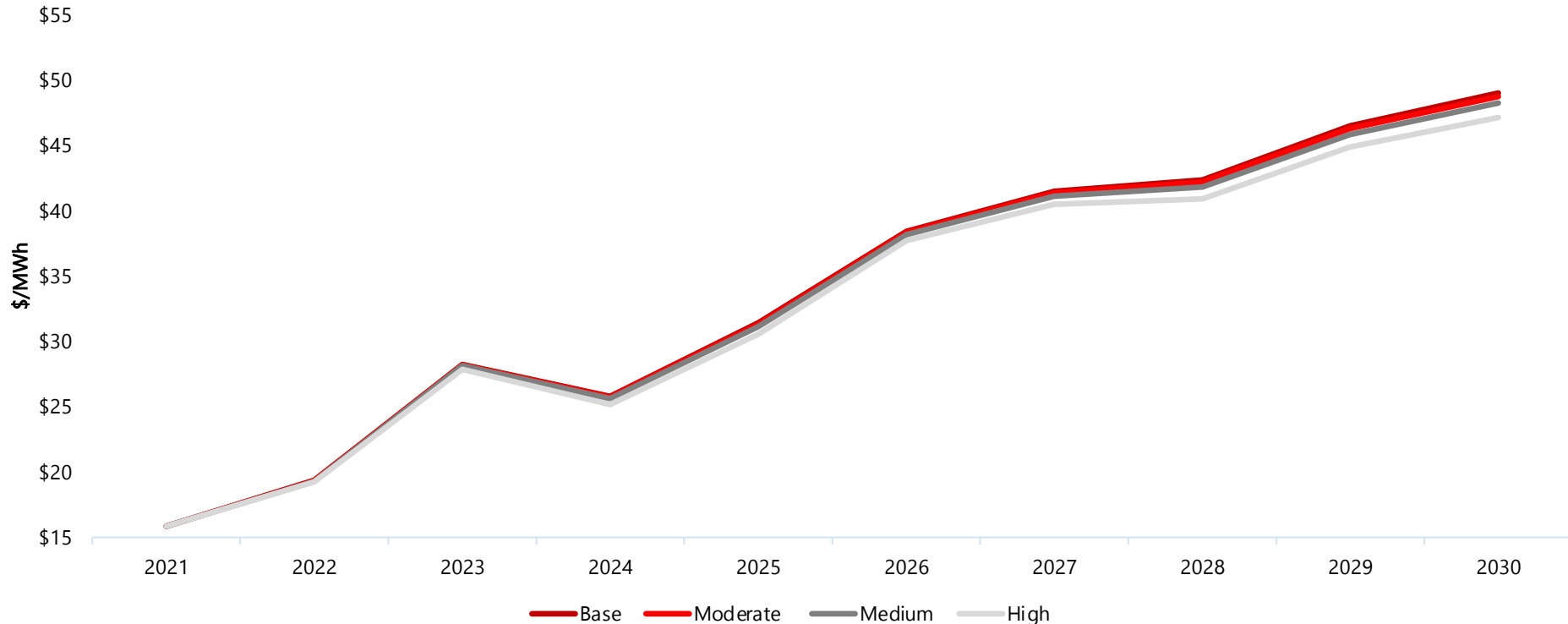
	Base	Moderate	Medium	High
Total Installed BTM Solar (MW)	375	750	1,500	3,000
HOEP Impact (\$/MWh)	-	\$0.27	\$0.77	\$1.88
Summer Resource Adequacy Need Reduction (MW)	-	248	495	990
Capacity Auction Savings (Millions \$)	-	\$2,156,371	\$6,359,630	\$14,345,333
Reduction in Gas-Fired Generation (TWh)	-	0.40	1.17	2.60
Cost of Carbon Savings (Millions \$) with \$50/Tonne	-	\$7,720,635	\$22,721,439	\$50,744,714
Cost of Carbon Savings (Millions \$) with \$170/Tonne	-	\$26,250,159	\$77,252,893	\$172,532,026
Dispatch Savings (Millions \$)	-	\$8,512,495	\$25,051,843	\$55,949,300
GTA Transmission Congestion (MW)	-	1,173	926	431
Total Savings \$50/Tonne Carbon (Millions \$)	-	\$18,316,860	\$54,841,654	\$122,578,544
Total Savings \$170/Tonne Carbon (Millions \$)	-	\$36,846,384	\$109,373,108	\$244,365,856

- The figures in the above table are calculated for 2030 and represent value in the Moderate, Medium and High Adoption Scenarios compared to the Base Case

Total Annual Savings by 2030

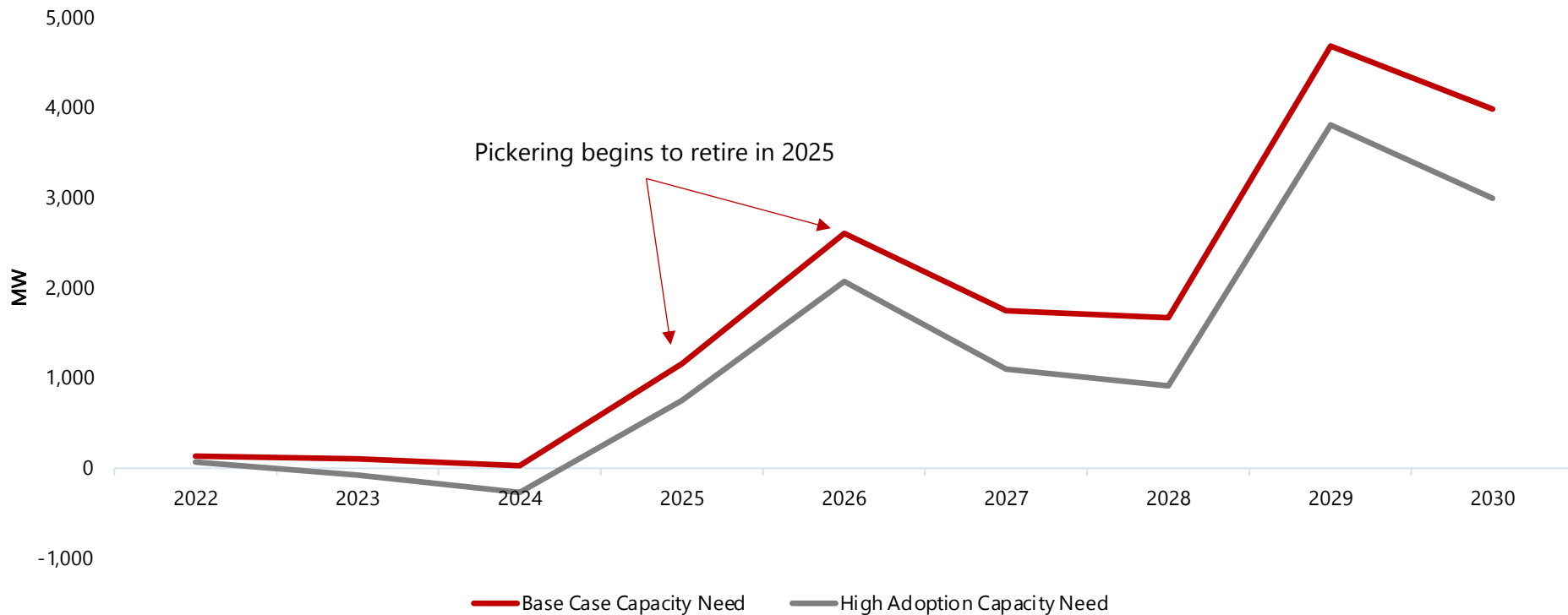


Impacts of BTM Solar PV Adoption on HOEP



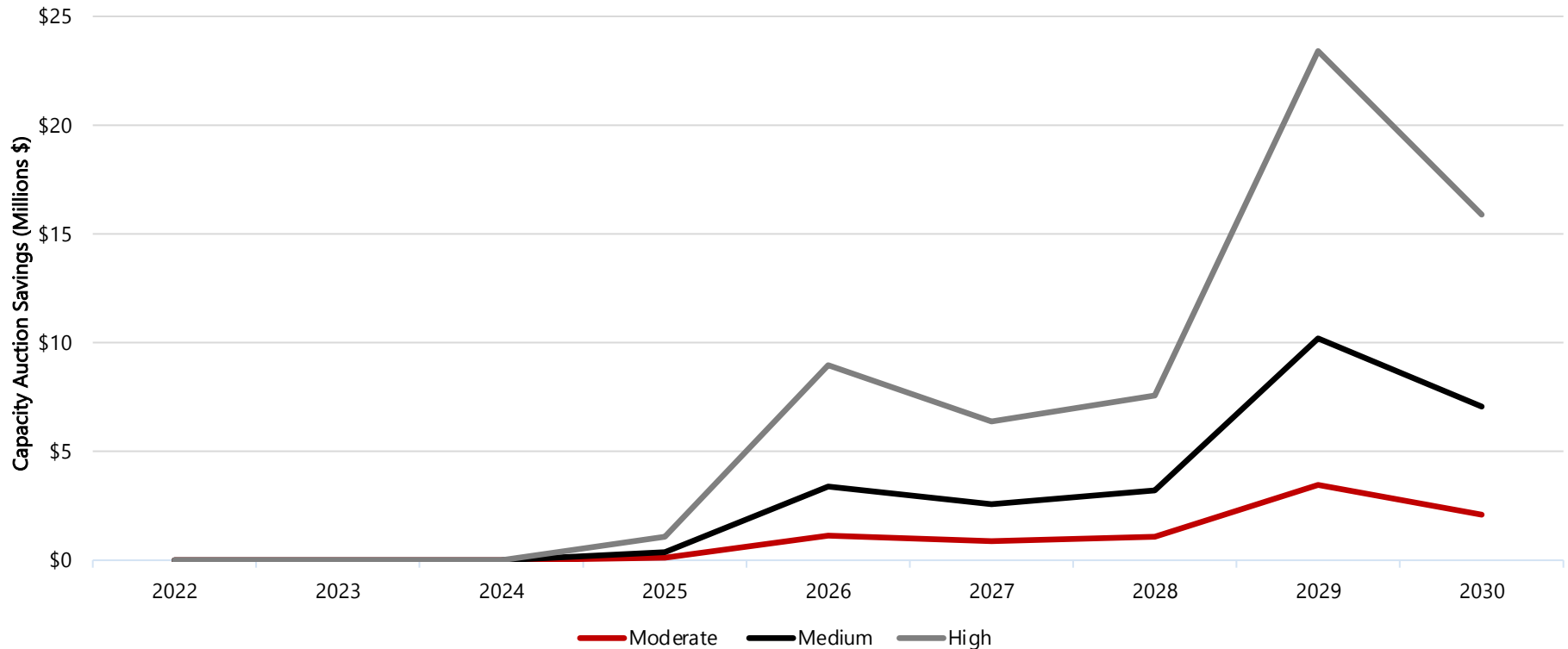
- 3 GW of BTM solar is not enough to fully replace gas-fired generators, which will then set the price in most peak hours
- The impact (reduction) on average HOEP in 2030 in the High Adoption Scenario is around \$2/MWh
 - While the price impact may be limited, BTM solar may help reduce extreme price hikes due to resource constraints, particularly once Ontario moves to Locational Marginal Prices (LMPs)

Impact of BTM Solar PV Adoption on Resource Adequacy



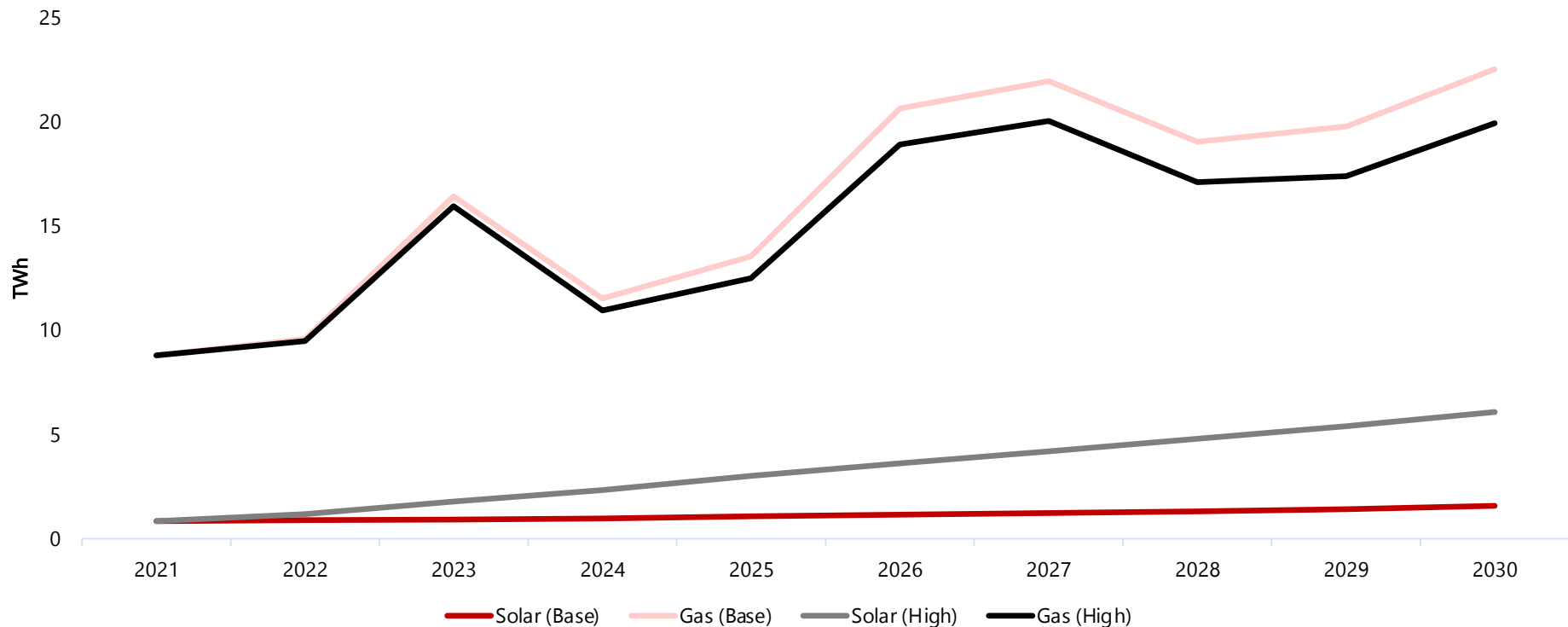
- IESO is forecasting a material need for new capacity, beginning most notably in 2026 after the full retirement of Pickering
- BTM solar is not able to fully alleviate this need – particularly in the winter months – but can mitigate the capacity gap in the High Adoption Scenario
- By 2030, the capacity gap can be reduced by nearly 1,000 MW in the High Adoption Scenario

Impacts of BTM Solar on Capacity Auction Prices



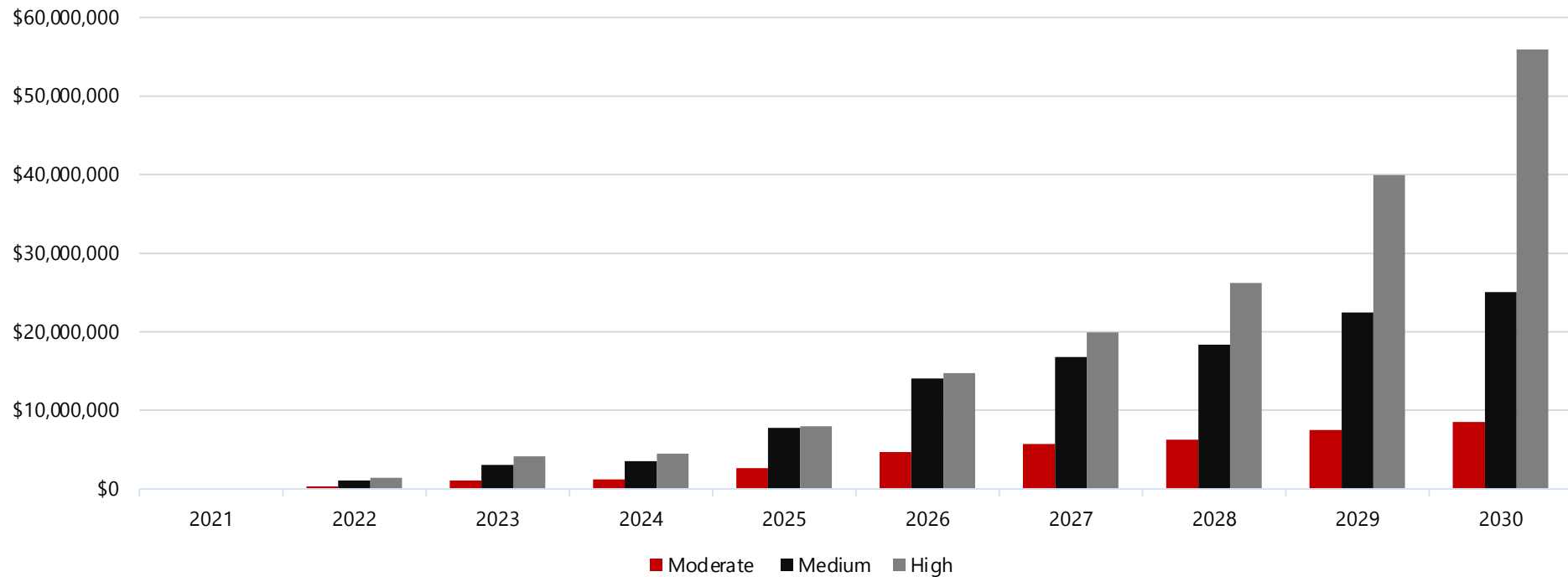
- In the High Adoption Scenario, the Capacity Auction clearing price drops by nearly \$32/MW day in the summer auction
- A lower clearing price provides material savings for all ratepayers
 - Those savings range from \$2 million to nearly \$16 million annually by 2030

Impact of BTM Solar PV Adoption on Gas Dispatch



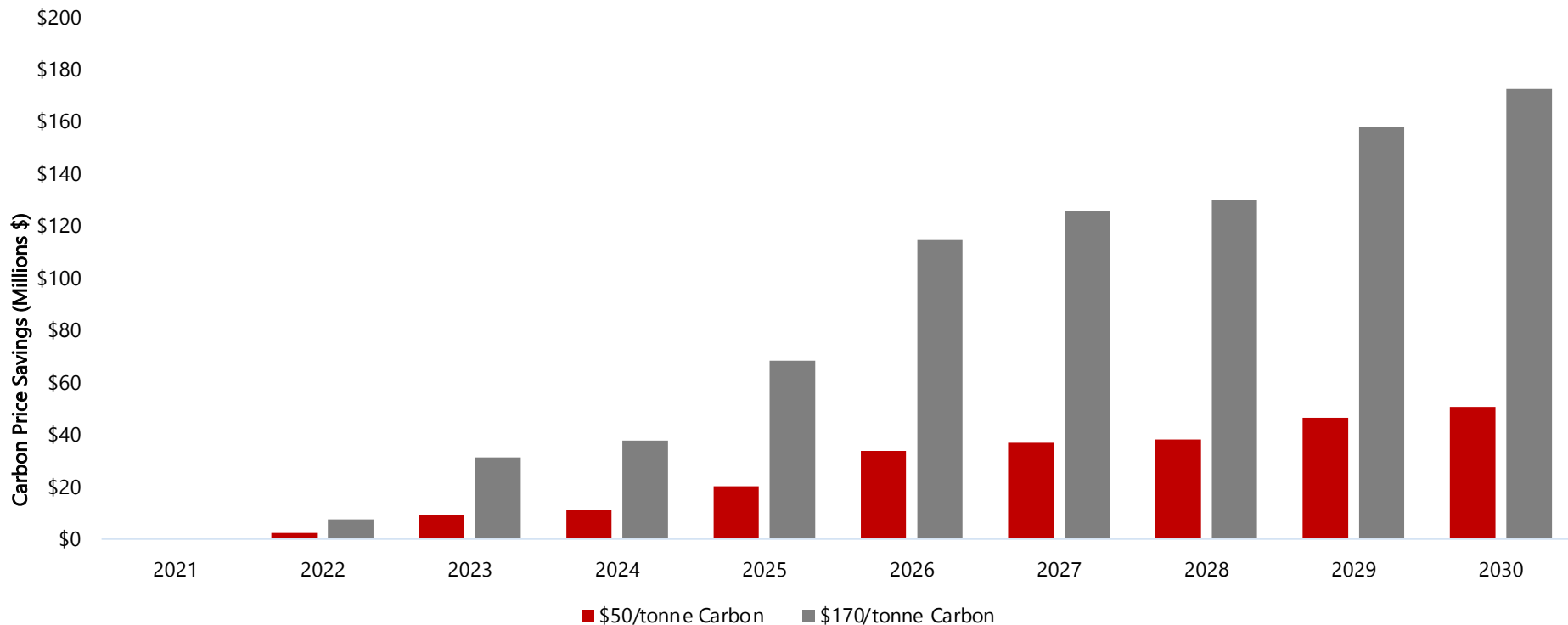
- BTM solar can directly reduce the dispatch of (and need for) gas-fired generators on the Ontario grid
- In the High Adoption Scenario, output from gas-fired generators falls by more than 2 TWh annually by 2030
 - More aggressive time-shifting of hydroelectric output and greater energy storage would likely result in even less gas-fired generation in 2030

System-Wide Savings from Reduced Gas Dispatch



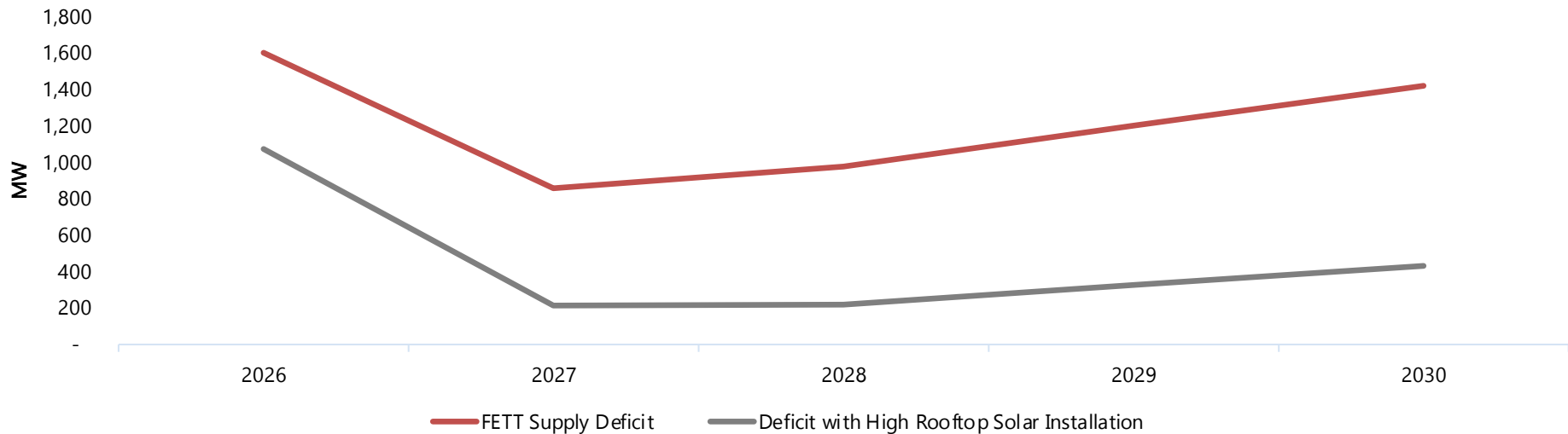
- Reducing the dispatch of higher marginal cost gas-fired generation with zero marginal cost solar provides system-wide savings in the real-time energy market
- These savings reach more than \$55 million annually by 2030 in the High Adoption Scenario
- The savings are calculated using a system-wide heat rate and \$3/MMBtu gas price
 - A higher gas price or reduced dispatch of less efficient gas plants will increase savings from reduced dispatch

Impact of BTM Solar PV Adoption on Carbon Costs



- The introduction of carbon prices increases the cost of output from gas-fired generators – and, inversely, increases system-wide savings from resources that mitigate their dispatch
- In the High Adoption Scenario, the savings from reduced carbon price charges range from \$50 million to \$172 million *annually*, depending on the level of carbon price
 - Currently, gas-fired generators are largely exempt from carbon prices, but Power Advisory has modelled an approach where there is no exemption from carbon pricing by 2030

Impacts of BTM Solar PV Adoption on Transmission System



- The Flow East Towards Toronto (FETT) interface is expected by IESO to increasingly face congestion once Pickering fully retires in 2026
 - It is not clear if additional investments will be required to address the constraint, but the IESO has indicated this to be the case
- Strategically located BTM solar can mitigate this congestion and limit the need for full-scale transmission upgrades, at least for the summer months
 - Hydro One is currently planning to update the FETT interface by 2026 with a \$50 million investment
 - BTM solar can potentially defer this investment (or subsequent investments that are also being considered) and allow the introduction of locational marginal prices (LMPs) to send a more direct signal to consumers or incent strategically located BTM investments in the GTA



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