Results

Decarbonization by 2035

AESO 2024 Long-Term Outlook

MAY 2024

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Overview

- In the Decarbonization by 2035 Scenario, greenhouse gas emitting generators that do not meet the *Clean Electricity Regulations* (CER) emissions performance threshold are restricted to a maximum of 450 runtime hours annually, limiting the options for a reliable baseload fleet at affordable prices.
- The constraints introduced by the CER act as a deterrent for carbon capture, utilization and storage (CCUS) retrofits, as the accelerated declines in the *Technology Innovation and Emissions Reduction* (TIER) *Regulation* high-performance benchmarks for electricity reduce expected revenues from CCUS.
- The CER may incent different generation development, such as hydrogen-fired simple-cycle and new combined-cycle with CCUS, instead of unabated natural gas-fired generation. These technologies are typically higher-cost and have not reached the same level of technological maturity as unabated natural gas-fired technologies.
- After the CER comes into effect, the Decarbonization by 2035 scenario has increased imports and decreased exports compared to the Reference Case, as tighter restrictions on natural gas-fired generation reduce generating capacity and demand increases, necessitating the procurement of additional power from external sources. After the nuclear small modular reactor (SMR) additions in 2041 and 2042, imports and exports return to levels comparable to the Reference Case.

Decarbonization by 2035 Scenario

The Decarbonization by 2035 scenario assumes the federal CER as written in the *Canada Gazette 1* would be binding, and regulatory drivers such as the high-performance benchmarks for electricity and hydrogen prescribed by the TIER *Regulation* would decline to zero by 2035.[1]

The Reference Case load forecast is used as the input for the Decarbonization by 2035 scenario. Load growth in the Reference Case is modest in the 2020s as it is driven by oil sands production and macroeconomic variables including gross domestic product (GDP) and population. Later in the forecast horizon, following the 2030s, load is anticipated to experience an increased rate of growth and intraday variability mainly driven by charging of electric vehicles (EVs) and electrification of building heating and cooling, among other factors.[2]

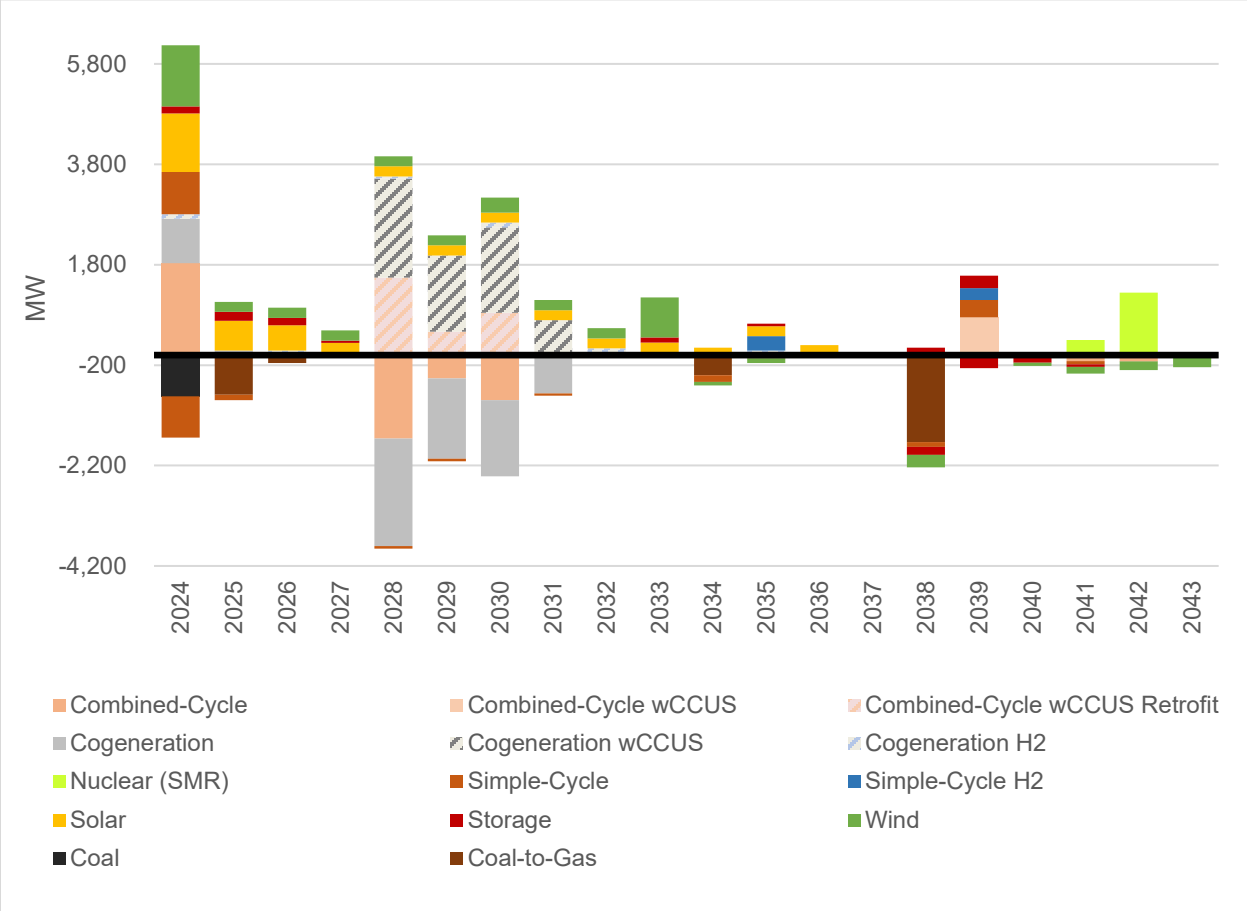
[1] For more information on policy and regulatory assumptions used in the 2024 LTO, see the Policy and Regulatory Drivers section.

[2] For more information on the 2024 LTO Reference Case load forecast, see Reference Case Results section. For more information the 2024 LTO load forecasting methodology, see the Load Forecasting Methodology section.

Generation Outlook

The Decarbonization by 2035 scenario results in approximately 25,000 megawatts (MW) of capacity additions and retrofits between 2024 and 2041. For the purposes of the 2024 LTO, retrofits are counted as a retirement of an existing facility and an addition of a retrofitted facility. Importantly, the capacity additions may not match the capacity retirements, as CCUS decreases the output of a facility.[3] Most of these additions and retrofits are cogeneration with CCUS (5,944 MW), solar (4,260 MW), wind (3,718 MW) and combined-cycle with CCUS (3,605 MW). As with the other scenarios, additions occur predominantly in between 2024 and 2030, coinciding with the majority of combined-cycle and cogeneration CCUS retrofits. In this scenario, 599 MW and 516 MW of hydrogen-fired cogeneration and simple-cycle, respectively, are added throughout the forecast horizon. Additionally, this scenario includes 1,160 MW of storage by 2040. Late in the forecast, 1,500 MW of nuclear small modular reactor (SMR) is built as baseload generation.

Figure 1: Decarbonization by 2035 – Capacity Additions and Retirements



[3] For more information about CCUS additions and retrofits in the 2024 LTO, see the Emerging Technology Drivers section.

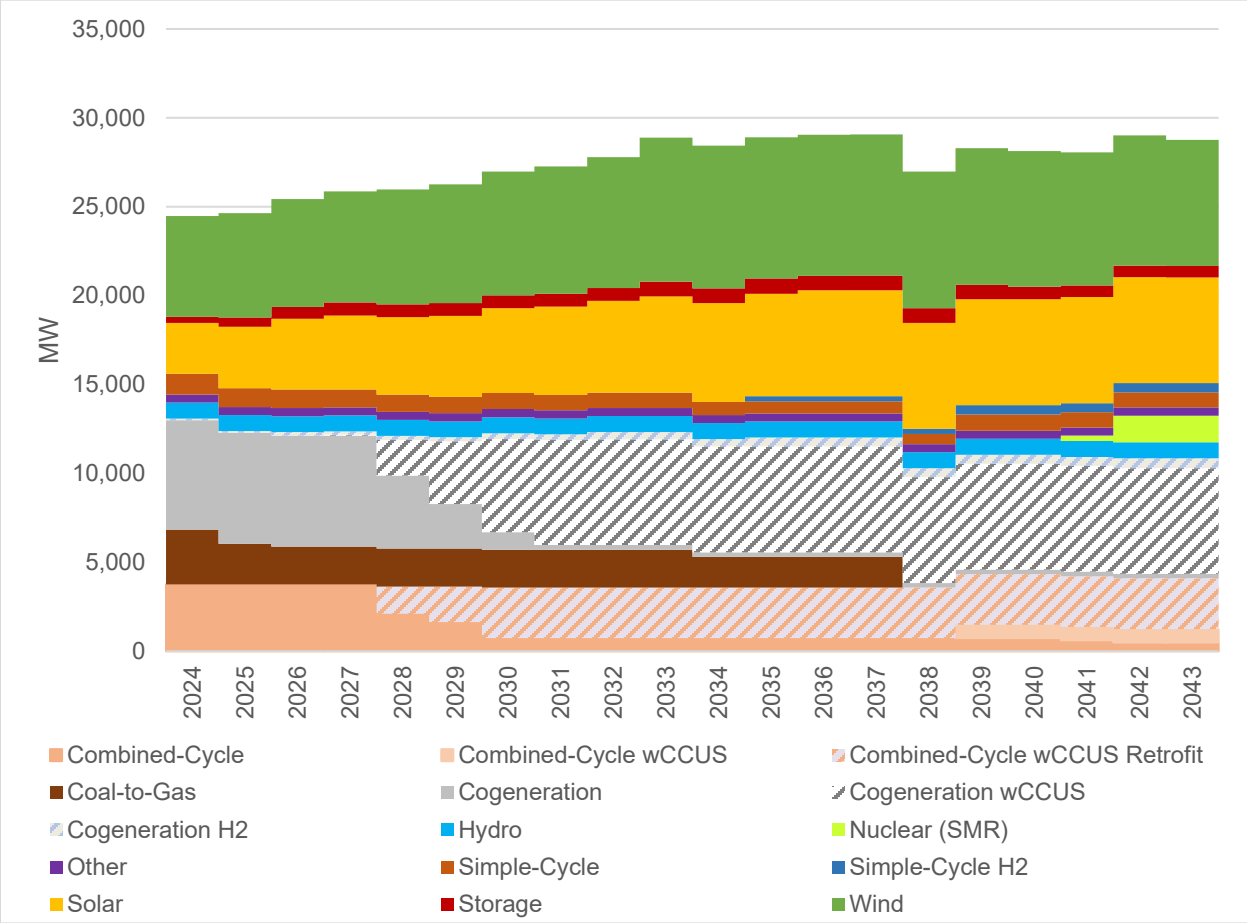
Until 2028, the Decarbonization by 2035 scenario results in a similar short-term generation build as the Reference Case. From 2028 to 2030 the Decarbonization by 2035 scenario expects fewer CCUS retrofits on the existing combined-cycle fleet. This difference can be attributed to the steeper decline in TIER's high-performance benchmark for electricity, which reduces some expected revenues from carbon abatement.

Although the decline in the high-performance benchmark for electricity would similarly reduce revenue for renewable generation, an equal amount of wind capacity is added in the Decarbonization by 2035 as compared to the Reference Case. However, there is an additional 150 MW of storage in the Decarbonization by 2035 scenario that supports smoothing out peaks in wind and solar generation.

The Decarbonization by 2035 follows a similar retirements schedule as the Reference Case, with the majority of retirements occurring between 2024 and 2030, aligning with the most cogeneration and combined-cycle CCUS retrofits. Compared to the Reference Case, the coal-to-gas retirement schedule shifts slightly, with some additional units retiring in 2038. This is largely due to the CER limit on runtime hours for unabated natural gas-fired units beginning in 2035. As such, there is significant value in keeping these large assets available for when more efficient units have maxed out their runtime. Generally, the coal-to-gas assets have low-capacity factors in the later years, as they are competing with new, more efficient combined-cycle generation.

After the final coal-to-gas retirements in 2038, the Decarbonization by 2035 scenario expects moderate additions of combined-cycle with CCUS, hydrogen- and natural gas-fired simple-cycle, including sub-25 MW reciprocating engines not limited by the 450-hour limit, and energy storage, including 100 MW of 10-hour compressed air energy storage. In 2041 and 2042, 1,500 MW of nuclear SMR generation, 500 MW less than the Reference Case, is added to help cover baseload demand.

Figure 2: Decarbonization by 2035 – Total Capacity



Like the other scenarios, total capacity in the Decarbonization by 2035 scenario is primarily comprised of wind, solar, and cogeneration and combined-cycle with CCUS. In the Decarbonization by 2035 scenario, wind and solar reach 43 per cent of total capacity by 2030, increasing to 51 per cent by 2038, similar to the Reference Case. By 2039, the Decarbonization by 2035 scenario includes 484 MW and 465 MW more abated combined-cycle and hydrogen-fired simple-cycle, respectively, than the Reference Case. This scenario indicates that the constraints introduced by the CER may incent different generation development, such as hydrogen and new combined-cycle with CCUS, whereas the Reference Case had more unabated combined- and simple-cycle. These technologies incented by the CER are typically higher-cost technologies that have not reached the same level of technological maturity as unabated natural gas-fired technologies.

Figure 3: Decarbonization by 2035 – Total Wind, Solar and Storage Capacity

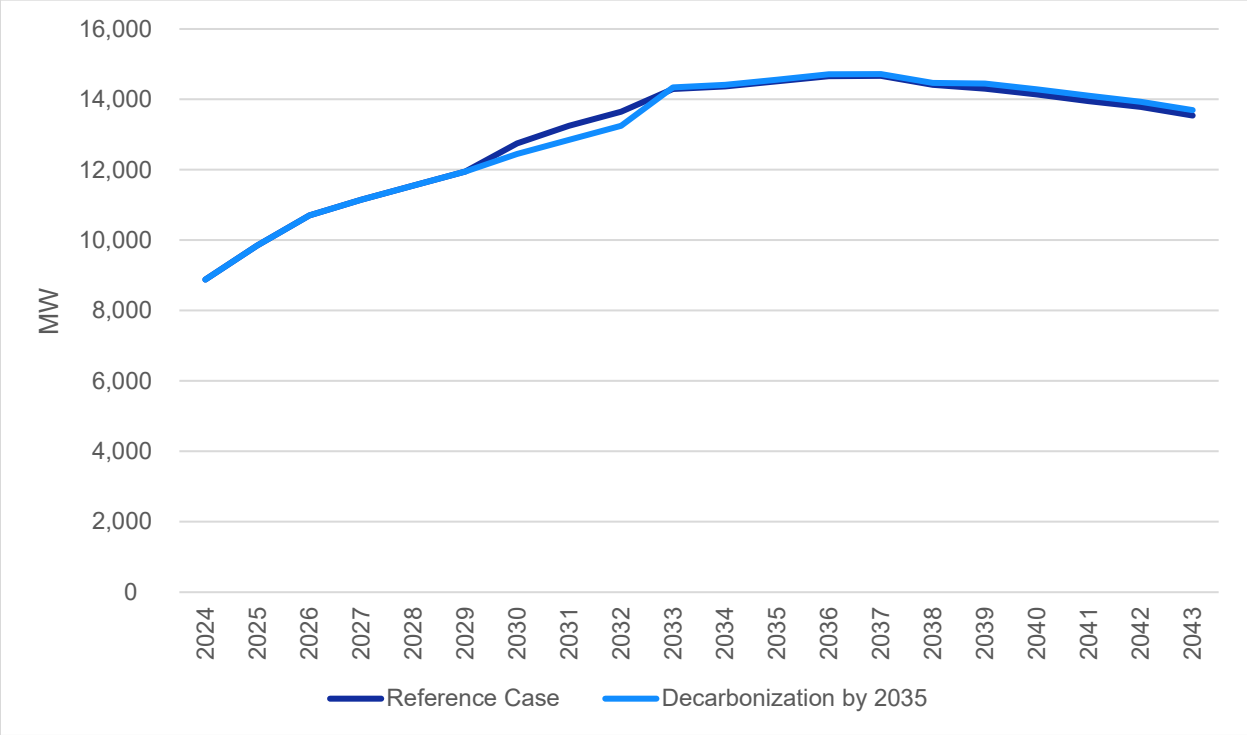
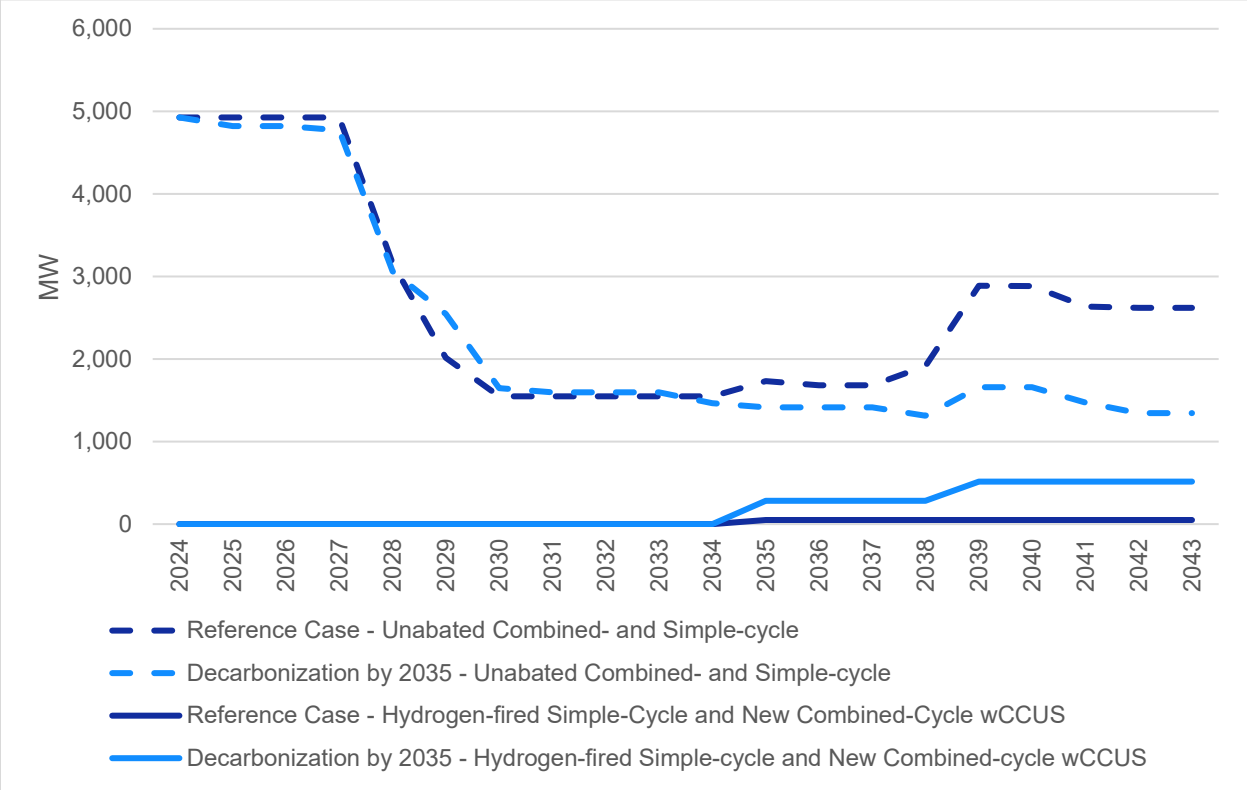


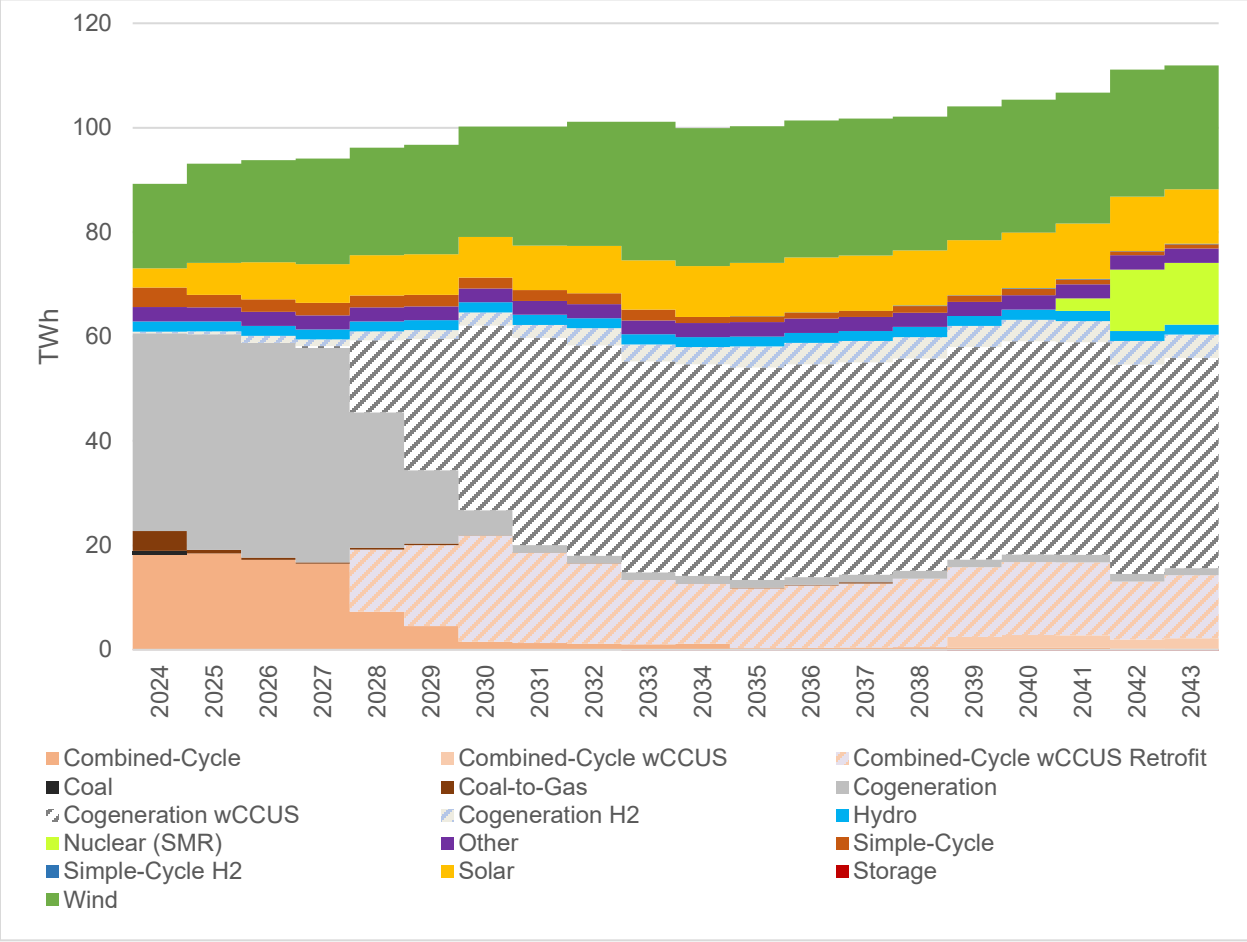
Figure 4: Decarbonization by 2035 – Total Unabated Natural Gas- and Hydrogen-fired Capacity



Total Energy Production and Sources

Combined-cycle and cogeneration, with and without CCUS, comprise most of the generation in the Decarbonization by 2035 scenario. Natural gas-fired generation supplies roughly 55 to 70 per cent of generation throughout the forecast timeframe, decreasing to approximately 50 per cent in 2042 and 2043, coinciding with nuclear SMR additions. Beginning in 2029 and continuing throughout the forecast, the majority of natural gas-fired generation is abated. This is roughly equivalent to the Reference Case, although the Decarbonization by 2035 scenario has slightly less unabated natural gas-fired generation. Similarly, wind and solar generation in the Decarbonization by 2035 scenario is roughly the same as in the Reference Case, comprising approximately one-third of generation throughout the forecast, reaching a maximum of 36 per cent from 2033 to 2037. Late in the forecast, nuclear SMR begins to displace some natural gas-fired generation.

Figure 5: Decarbonization by 2035 – Alberta Annual Energy

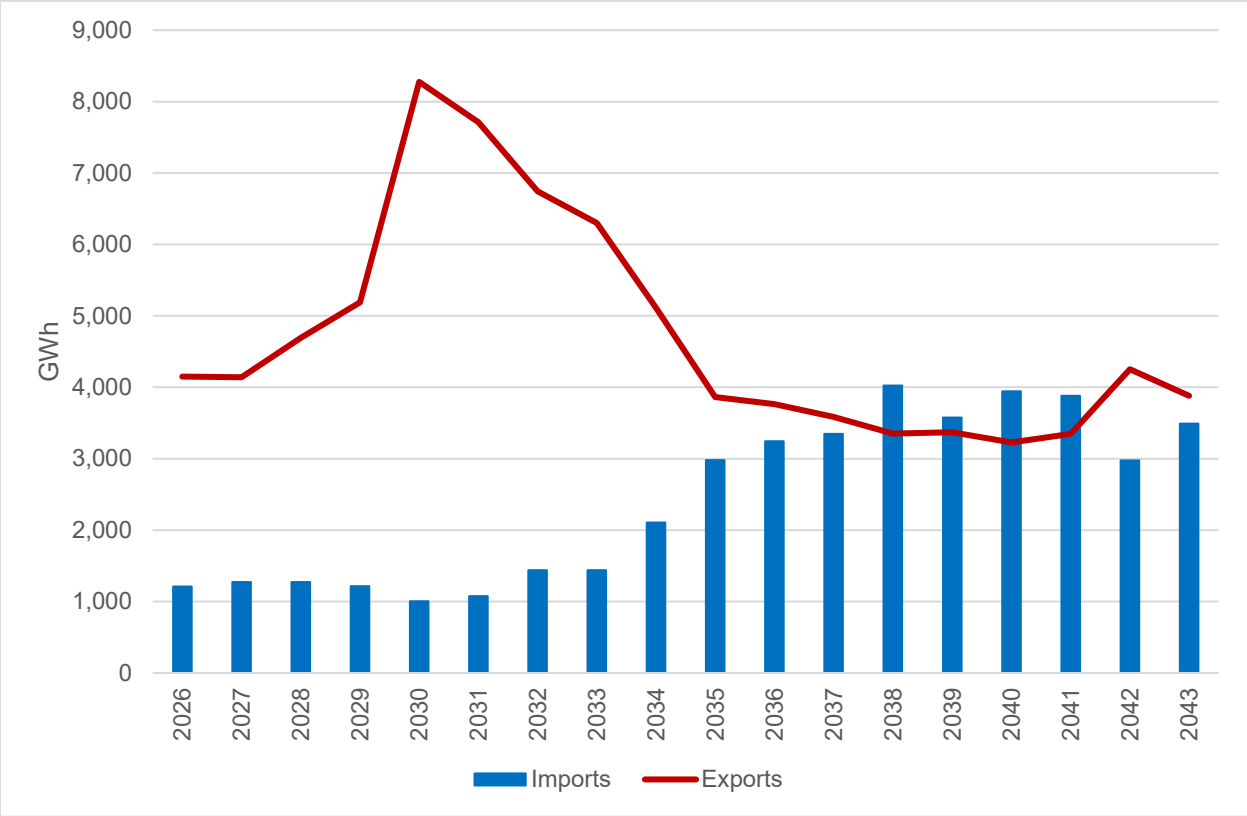


Intertie Utilization

In the Decarbonization by 2035 scenario, there is a significant increase in exports between 2024 and 2030 as renewables are added to the system. After 2030, exports decrease and imports increase as the declining TIER high-performance benchmark for electricity increases carbon costs, thus increasing the cost for natural gas-fired generators to produce power. As the CER comes into effect in 2035, tighter restrictions on natural gas-fired generation results in diminished surplus available for export. Concurrently, the growing

reliance on imported electricity emerges from higher domestic demand and reduced generation capacity, which necessitates the procurement of additional power from external sources to meet local demand. After the nuclear SMR additions in 2041 and 2042, imports and exports even out to levels comparable to the Reference Case.

Figure 6: Decarbonization by 2035 Intertie Utilization



Results Summary

The Decarbonization by 2035 scenario assumes that the CER as written in the *Canada Gazette 1* would be binding. As such, any natural gas-fired generators that do not meet the emissions performance standard are restricted to 450 runtime hours annually, limiting the options for a reliable baseload fleet at affordable prices. The constraints introduced by the CER may incent different generation development, including delaying the deployment of CCUS. Compared to the Reference Case, the Decarbonization by 2035 scenario has fewer CCUS retrofits and more hydrogen-fired simple-cycle and new combined-cycle with CCUS units that are added in the latter 10 years of the forecast. These technologies are typically higher-cost and have not reached the same level of technological maturity as unabated natural gas-fired technologies. After the CER comes into effect, the Decarbonization by 2035 scenario has increased imports and decreased exports compared to the Reference Case. Tighter restrictions on natural gas-fired generation reduce generating capacity and demand increases, necessitating the procurement of additional power from external sources. After the nuclear SMR additions in 2041 and 2042, imports and exports return to levels comparable to the Reference Case.

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