Results

High Electrification

AESO 2024 Long-Term Outlook

MAY 2024

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Overview

- The High Electrification scenario tests the higher-end boundary of load growth driven by accelerated electric vehicle (EV) adoption and electrification of building heating and cooling. Higher industrial load driven by hydrogen production and additional load projects are accounted for as well; however, these represent a lower portion of load growth.
- Key inputs to the load model such as macroeconomic factors and oil sands variables are the same as the Reference Case load forecast. Offsetting elements to load such as energy efficiency and solar distributed energy resources (DER) are also consistent with the Reference Case.
- Considering that EV charging profiles contribute significantly to the increasing variability of hourly load, these frequent ramps up and down are only more exaggerated in the High Electrification scenario.
- Increased load from rapid electrification drives an earlier buildout of baseload generation in the High Electrification scenario when compared to the Reference Case.
- Energy needs are largely served in the mid-term forecast by a large buildout of combined-cycle with carbon capture, utilization and storage (CCUS) units beginning in 2037. Increasing demand in the late term drives an earlier and more substantial buildout of nuclear small modular reactor (SMR) baseload generation compared to the Reference Case.

High Electrification Scenario

The objective of the High Electrification scenario load forecast is to establish an alternative increased load projection, driven by federal policies. This scenario envisions a heightened pace and expansive scale of decarbonization, primarily achieved through the electrification of transportation through an accelerated pace of EV adoption and building heating and cooling electrification. Increased hydrogen production, additional load projects and electrification of heavy industries further contribute to demand growth in the High Electrification scenario load forecast. Additional load projects accounted for in the High Electrification scenario represent projects that are too early in their connection process to be included in the Reference Case. Projects included feature a variety of use-cases including various industrial customer facilities, pipeline electrification, and data centers.[1] This scenario assists in planning for an upper boundary case within the electricity sector.

The baseload forecast that is mostly driven by weather, economics and oil sands outlook is the same as the Reference Case since these elements of the model have remained the same. The offsetting elements of load growth, including energy efficiency and solar DER growth remain consistent to the Reference Case, to isolate the load additives and their impact on peak forecast.

Due to the assumptions outlined above, load growth in the High Electrification scenario is significantly stronger than in the Reference Case, especially following the 2030s. This elevated load growth is seen both in overall energy consumption and peak load. This stark difference in forecast energy demand is responsible for driving an increased and more widely varied build profile in terms of future generation sources.

[1] For more information on the load projects included in the *2024 Long-Term Outlook* (LTO) load forecast see the Load Methodology section.

Load Forecast

In the High Electrification scenario, the compound annual growth rate (CAGR) of energy consumption from 2024 to 2043 stands at 1.9 per cent. In contrast, the Reference Case depicts a modest CAGR of 1.2 per cent over the same period. Energy consumption in 2043 is anticipated to surge by 43 per cent in comparison to the baseline year of 2024. This striking increment sharply contrasts with the projected 26 per cent rise in the Reference Case Alberta internal load (AIL) energy consumption forecast. Furthermore, in the High Electrification scenario, average hourly load grows from 10,146 megawatts (MW) in 2024 to 14,599 MW in 2043, jumping approximately 4,453 MW over the forecasting period.

Figure 1: High Electrification – Average AIL Forecast

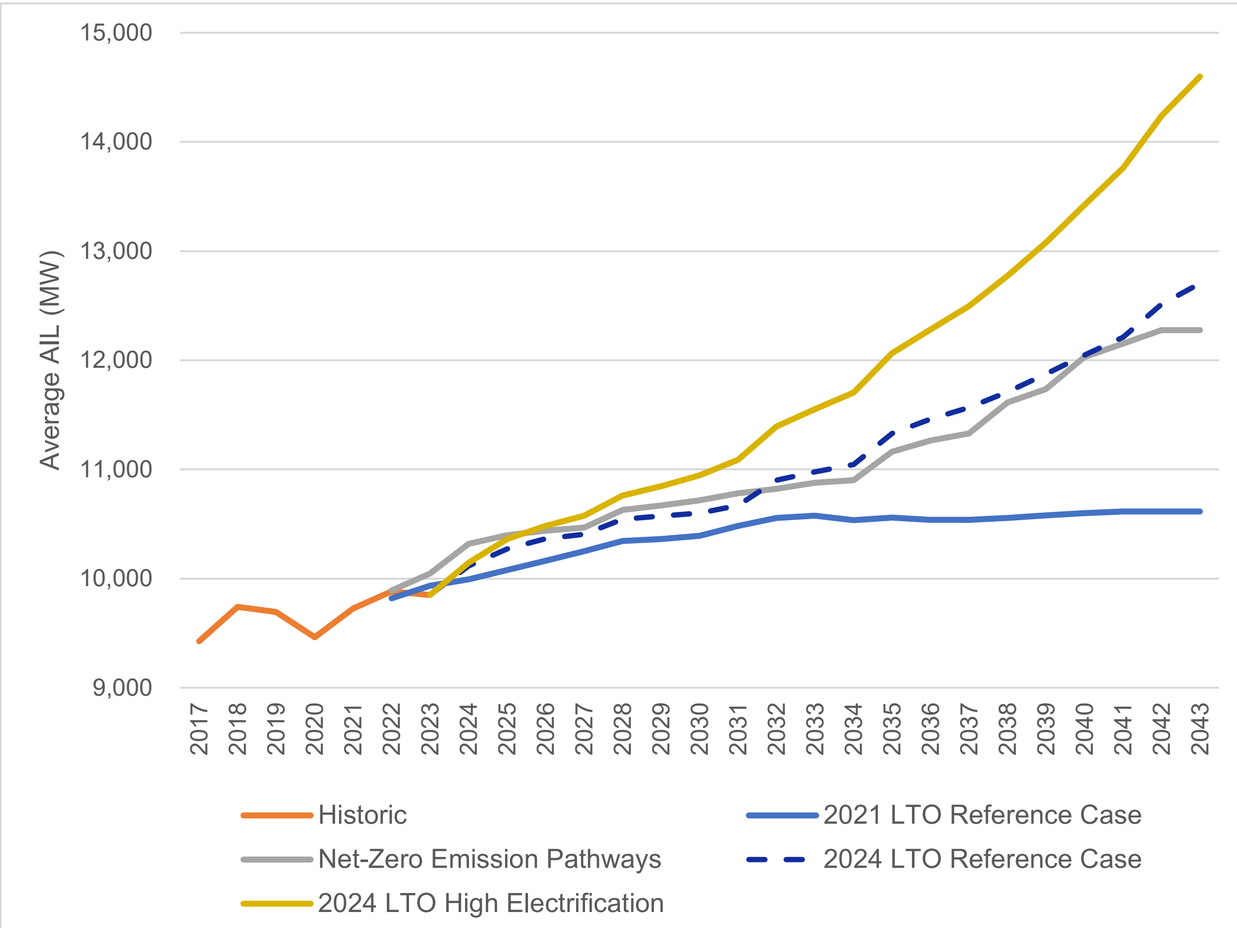
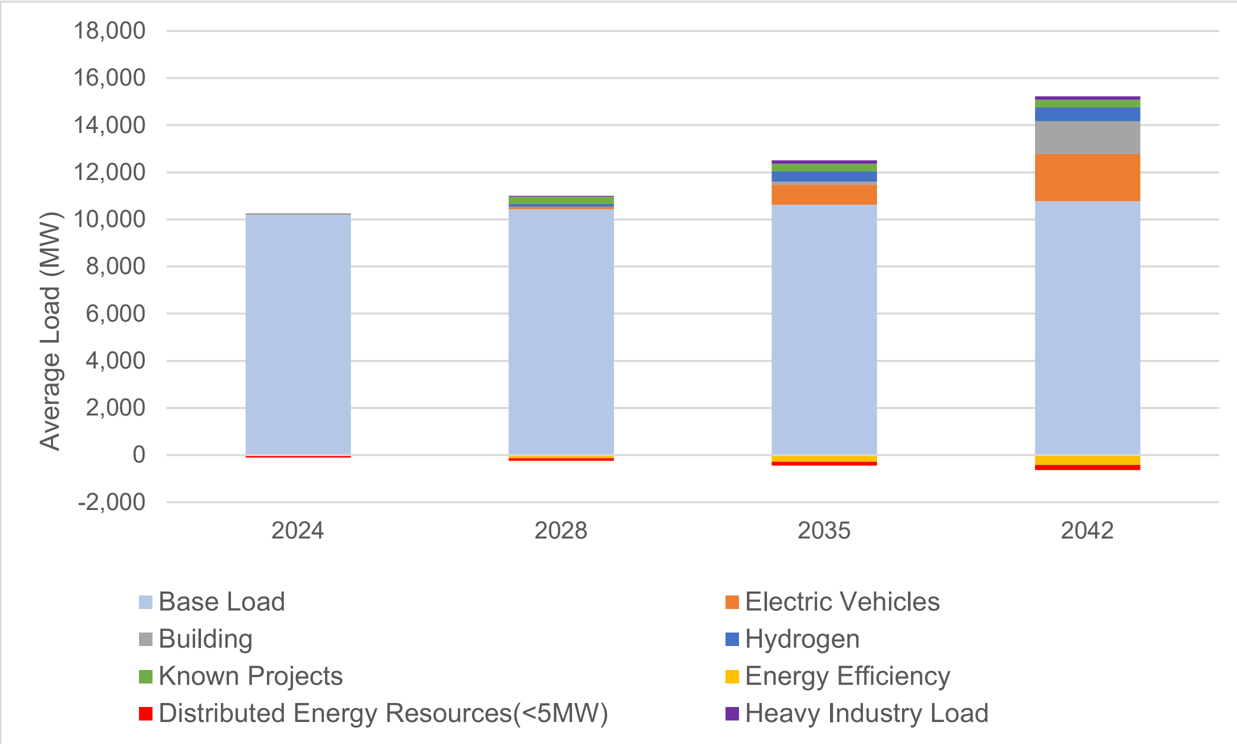


Figure 2 below presents the evolving share of each load component in the High Electrification scenario throughout the forecast period. As expected with this scenario and to a much larger degree regarding the Reference Case, EVs, building heating and cooling and hydrogen production load are the strongest drivers of AIL growth. As such, within the High Electrification scenario, these increased variable loads inevitably contribute significantly more to overall electricity demand.

Figure 1: High Electrification – AIL Composition: Traditional Drivers vs. Additional Load Sectors in High Electrification Scenario



The acceleration in peak AIL shown in Figure 3 is remarkable in the High Electrification scenario. Projections indicate a rapid rise of around 63 per cent, equivalent to around 7,763 MW, in forecast peak AIL between 2024 and 2043. When observing peak loads, the distinction between the Reference Case and the High Electrification scenarios becomes increasingly significant as we move beyond the 2030s, which is primarily due to the accelerated rate of EV adoption. Moreover, EV charging behaviour is assumed to be managed in the High Electrification scenario like the Reference Case which aligns with the expectation from government and industry that such policies will be implemented to mitigate preventable strain on the electric grid caused by unmanaged EV charging.[2]

The heightened impact of building electrification will also begin to manifest in the early 2040s and is projected to play a pivotal role in the AIL forecast.[3] Considering that EV charging and building heating and cooling load will be a larger portion of load than in the Reference Case, the High Electrification scenario also projects that Alberta will remain a winter peaking province. Lastly, the process of electrifying heavy industries encircling sectors like chemicals, cement, and pulp and paper facilities, alongside the widespread integration of CCUS technologies in these industries further accelerates load growth in this scenario.[4]

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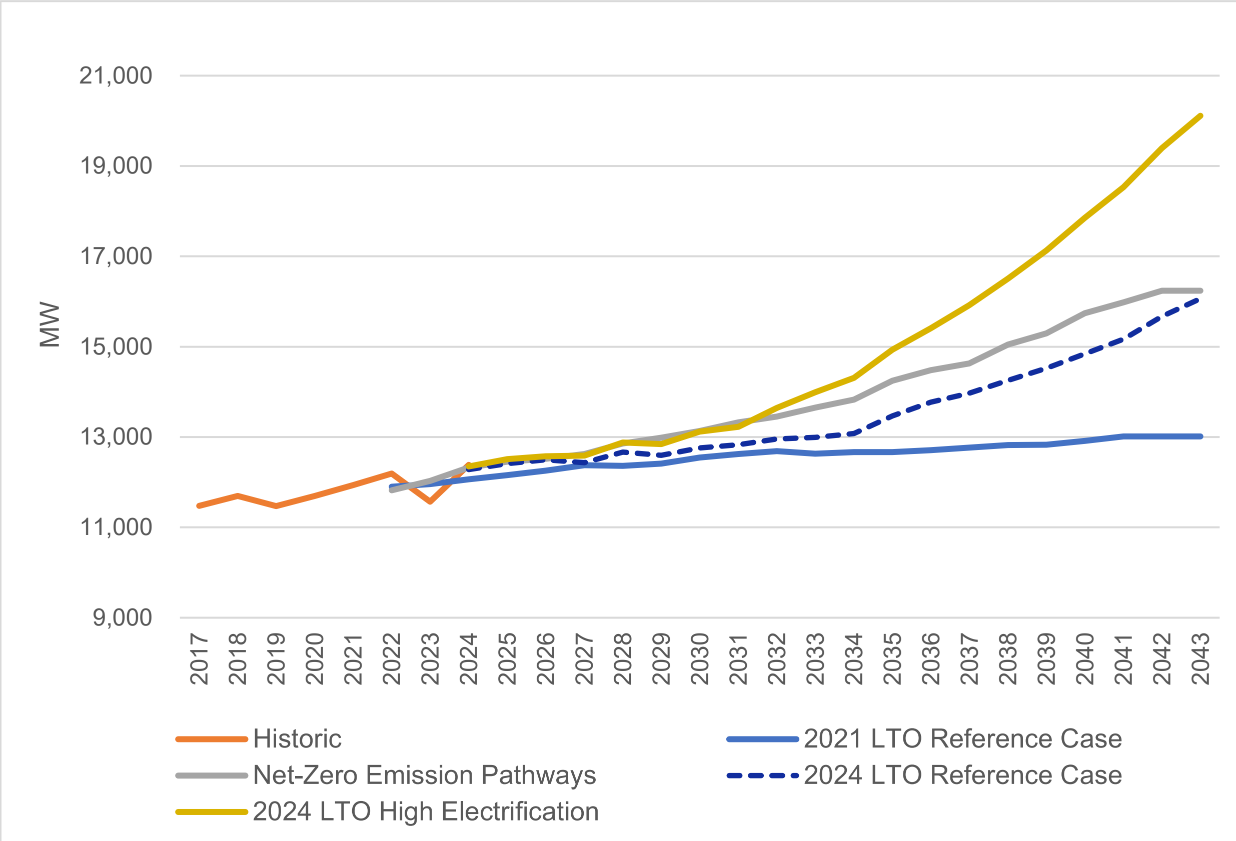
[2] For more information about the managed EV charging assumption used in the 2024 LTO, see the Load Forecast Methodology section.

[3] For more information about electrification of building heating and cooling in the 2024 LTO, see the Load Forecast Methodology section.

[4] For more information about assumptions on electrification of heavy industry in the 2024 LTO, see the Load Forecast Methodology section.

Figure 2: High Electrification – Peak AIL Forecast



More specific information about each load component in the High Electrification scenario is provided in the respective modules for EVs, load projects, building electrification and heavy industry.[5] Similar to the Reference Case, Figures 4 and 5 demonstrate how variable loads will exacerbate steep ramp up and down of load across the hours of each day. Due to the accelerated pace of the electrification of transportation and building heating and cooling, this scenario features an even larger gap between base load and overall AIL as well. This gap is sometimes mitigated by the DER offset during the afternoon hours but returns as EV charging ramps up later in the night and into the early morning hours.

[5] For more information on the different components of load methodology in the 2024 LTO, see the Load Forecast Methodology section.

Figure 4: High Electrification – Winter Peak Week (January 2035): Sensitivity of AIL Peak to Key Load Modifiers

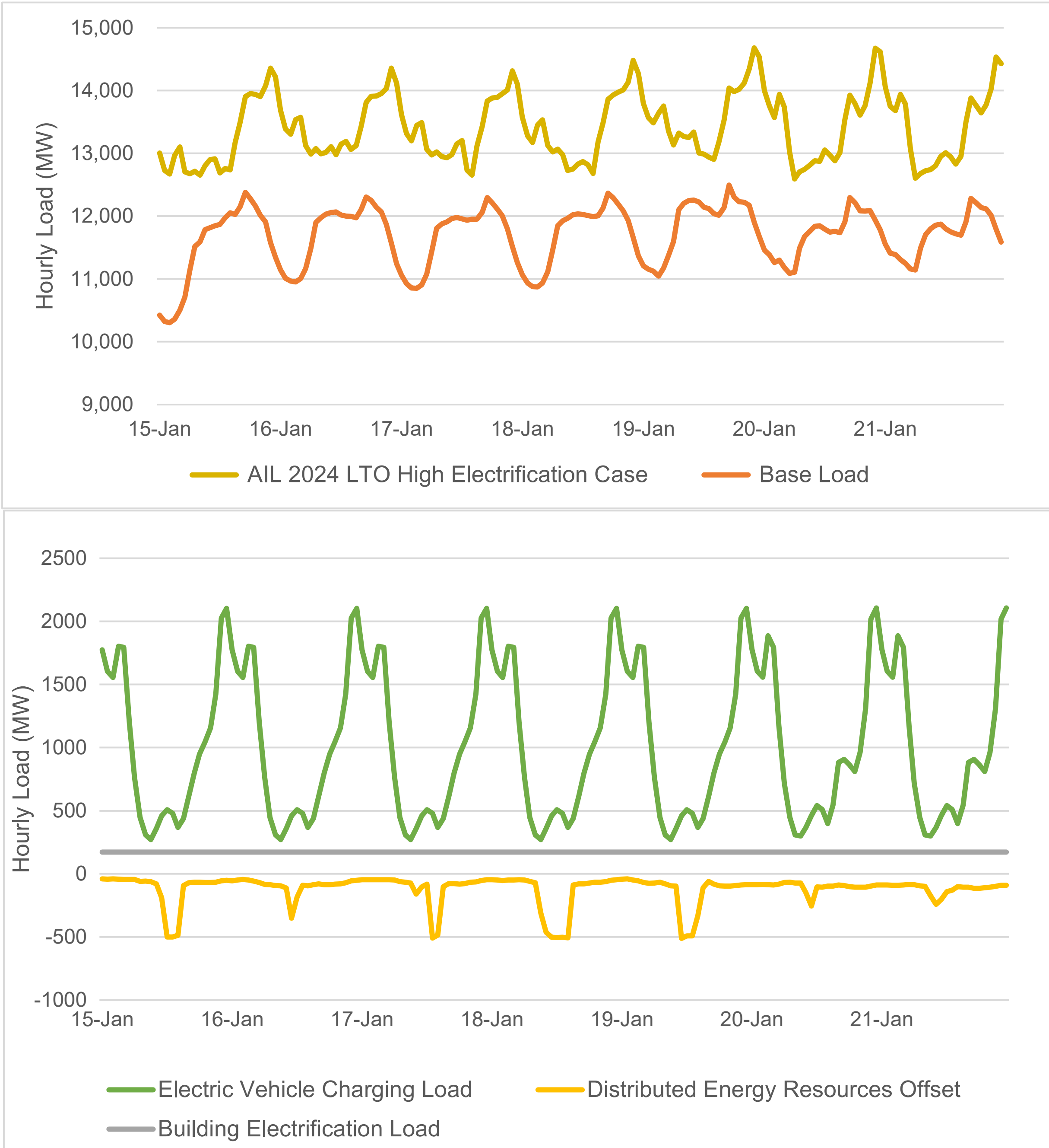


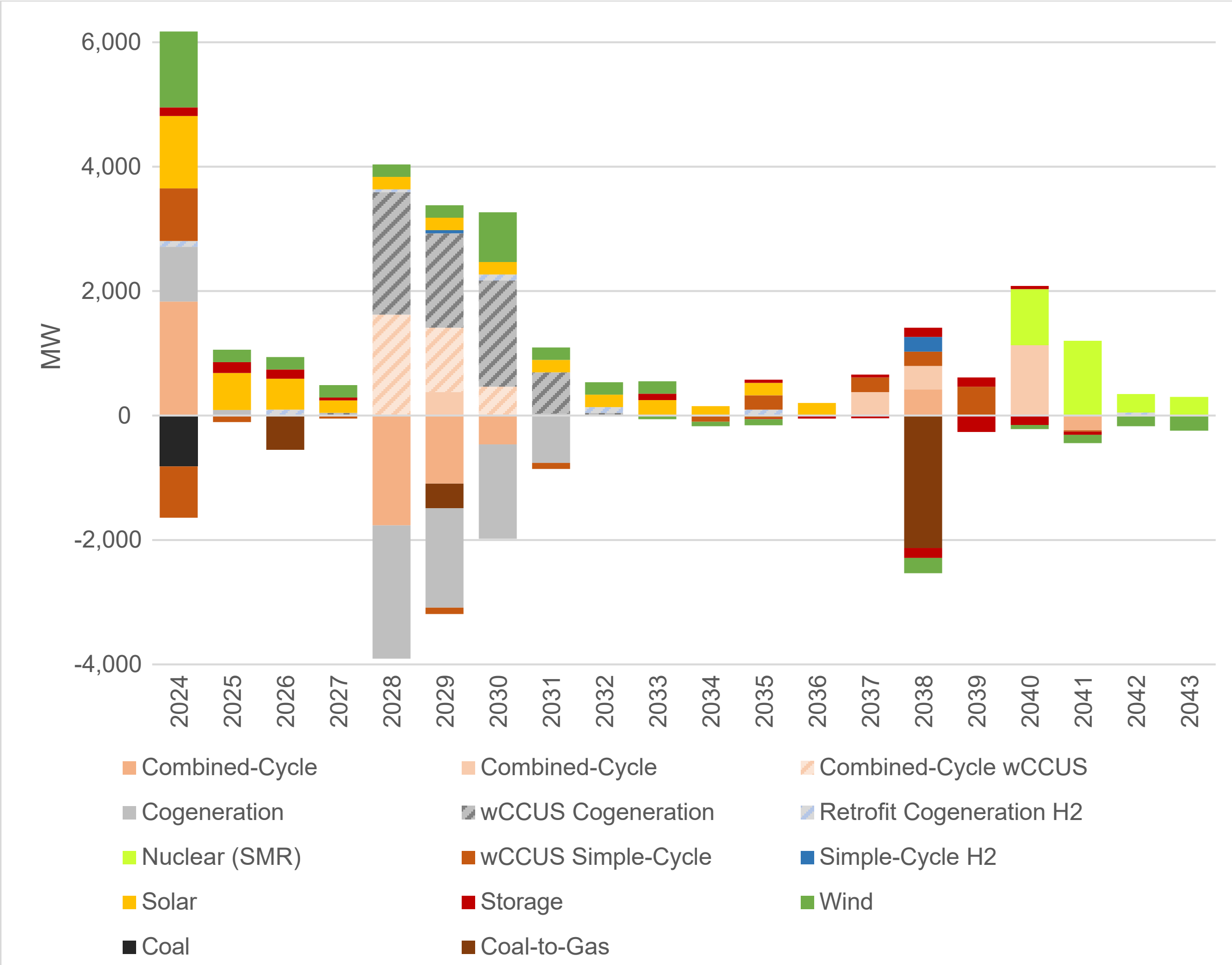
Figure 5: High Electrification – Summer Peak Week (July 2035): Sensitivity of AIL Peak to Key Load Modifiers

Like the Reference Case, load growth in the High Electrification scenario is driven by elements of the energy transition including electrification of transportation, building heating and cooling and industrial processes and increased hydrogen production. In turn, this exacerbates peak load growth as well as intraday load variability which have the potential to cause strain on the Alberta grid in the long-term. While energy efficiency and DERs continue to offset load growth, they have a comparatively smaller effect in the High Electrification scenario. The upper boundary of load expansion explored in the High Electrification scenario provides a useful case study when planning for the future of Alberta's electricity grid.

Generation Outlook

To meet the additional energy demand present in the High Electrification scenario, the AESO's long-term capacity expansion modelling shows a distinct two-stage buildout of resulting dispatchable baseload generation at earlier points in the forecast horizon when compared to the Reference Case.

Figure 6: High Electrification – Capacity Additions and Retirements



The High Electrification scenario results in approximately 29,000 MW of capacity additions and retrofits between 2024 and 2043, the largest of the capacity builds of the 2024 *Long-Term Outlook* (LTO) scenarios and almost 3,500 MW greater than the Reference Case. 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.[6] Most of these additions and retrofits are cogeneration with CCUS (5,944 MW), combined-cycle with CCUS (5,383 MW), solar (4,260 MW) and wind (3,618 MW). Like the other scenarios, additions predominantly occur prior to 2030 coinciding with the majority of cogeneration and combined-cycle retrofits. Unlike the other

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

scenarios, the High Electrification scenario includes notable mid-to-late term additions. This includes 2,700 MW of nuclear small modular reactors (SMRs) built between 2040 and 2043, 900 MW greater and two years earlier than the Reference Case. Renewable additions in the High Electrification scenario are almost identical to the Reference Case, with 100 MW less wind and 50 MW more storage built over the forecast period and no difference in capacity additions for solar. Throughout the forecast, the High Electrification scenario relies more heavily on abated and unabated natural gas-fired generation.

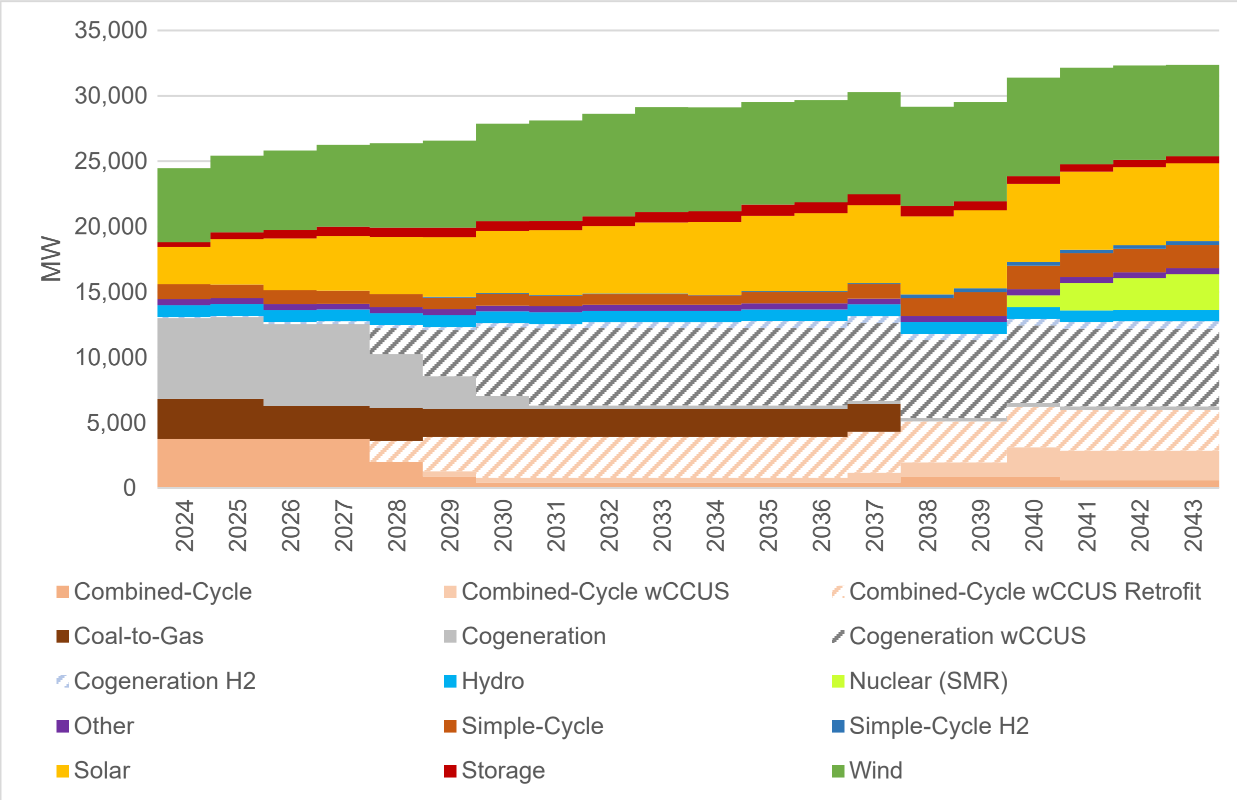
Approximately 1,900 MW of combined-cycle with CCUS is built in the 2037 to 2040 timeframe alongside an additional 418 MW of unabated combined-cycle generation. The High Electrification scenario also results in an additional unabated peaking unit in this timeframe over and above the peaking build profile from the Reference Case, bringing five unabated simple-cycle units online between 2035 and 2039. This initial buildout of baseload generation occurs three years earlier than in the Reference Case, where only one unabated combined cycle is built in 2040, to serve the diverging load profile in the High Electrification scenario.

A second tranche of baseload generation is estimated to build beginning in 2040 with nuclear SMRs as the technology of choice in the 2040s due to forecast declining capital costs.[7] This nuclear SMR buildout is a full two years earlier than in the Reference Case. By 2043 there are nine total nuclear SMR units, each with 300 MW capacity, three more than forecast in the Reference Case. Burgeoning demand in the last years of the forecast period drives the buildout of this baseload nuclear SMR fleet as the difference in load profiles between the Reference Case and High Electrification scenario reaches its maximum in 2043.

Capacity retirements in the High Electrification scenario are similar to the Reference Case, with the majority of retirements occurring between 2024 and 2035, aligning with most cogeneration and combined-cycle CCUS retrofits. Coal-to-gas retirements are slightly delayed in the High Electrification scenario compared to Reference Case, with additional units operating until 2038. The extended operation of these units is likely deemed necessary to serve baseload needs as load grows past 2030. The retirement of these coal-to-gas converted units coincides with the first build of additional combined-cycle with CCUS units in 2037.

[7] For more information on nuclear SMRs in the 2024 LTO, see the Emerging Technology Drivers section.

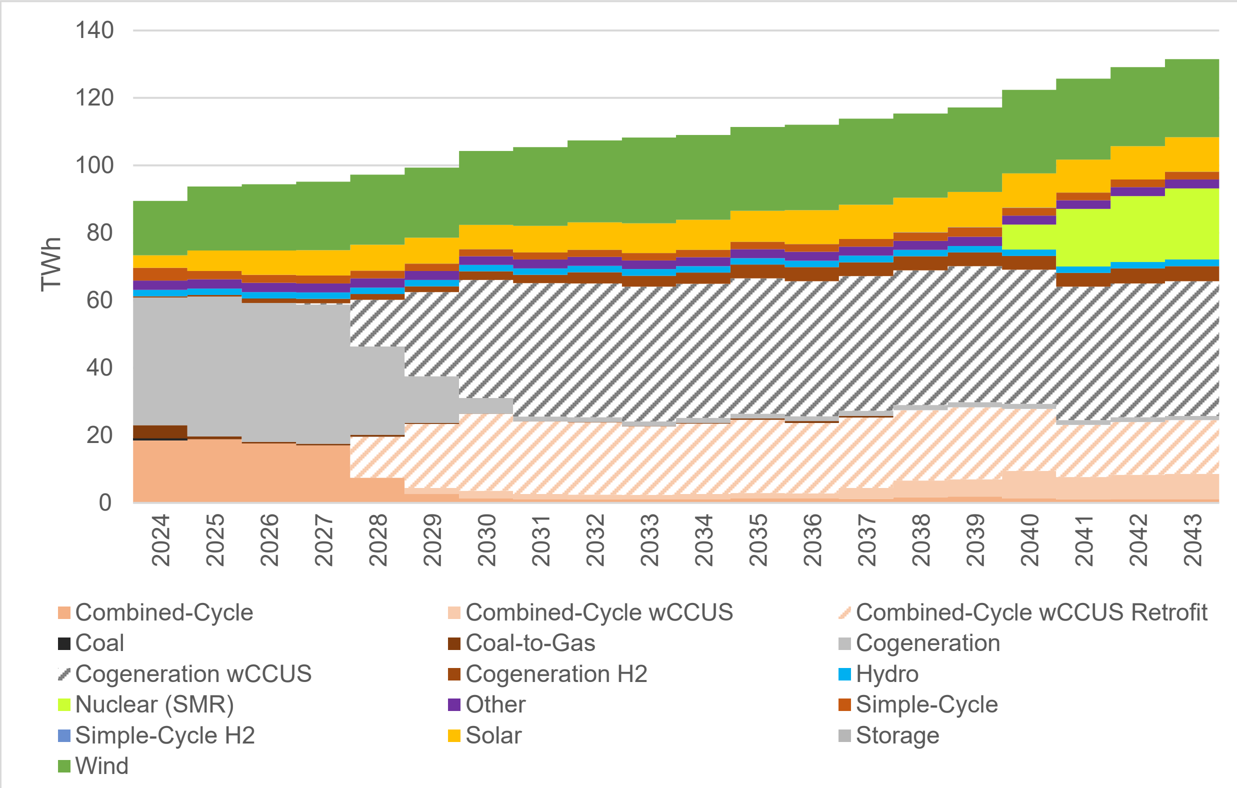
Figure 7: High Electrification – Total Capacity



Total Energy Production and Sources

The majority of generation in the High Electrification scenario is from natural gas-fired, both abated and unabated, and wind generation. Natural gas-fired generation, both abated and unabated, provides approximately 60 to 70 per cent of total generation throughout the majority of the forecast, decreasing to just over 50 per cent beginning 2041, coinciding with the first nuclear SMR additions. After 2029, almost all natural gas-fired generation is abated. This is similar to the generation trend in the Reference Case, although the decrease in natural gas-fired generation at the end of the forecast timeline occurs earlier in the High Electrification scenario due to the earlier addition of nuclear SMRs. Similarly, wind and solar generation is roughly equivalent to the Reference Case, comprising approximately 30 per cent of generation throughout the forecast horizon with slight declines in the late term as wind facilities begin to retire.

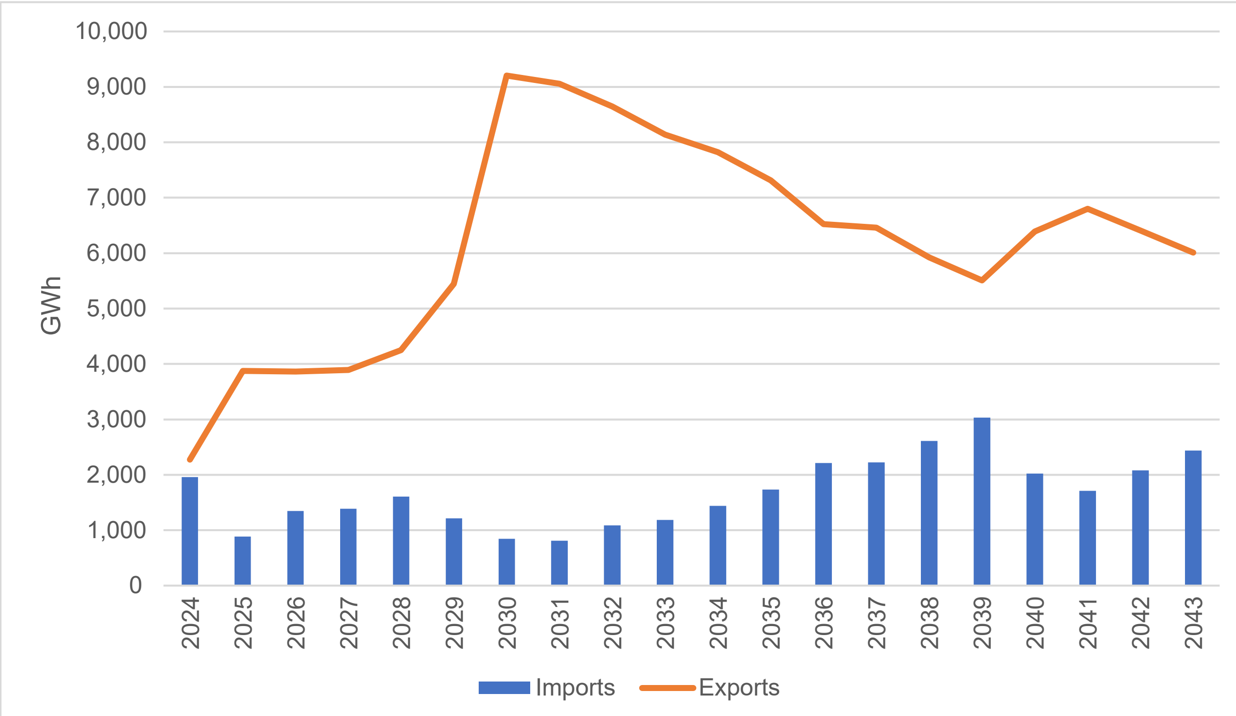
Figure 8: High Electrification – Alberta Annual Energy



Intertie Utilization

The High Electrification scenario forecasts a similar trend in imports as the Reference Case but shifted to an earlier timeframe. While total imports over the forecast horizon are roughly equivalent between the Reference Case and the High Electrification scenario, the High Electrification scenario forecasts, on average, 477-gigawatt hour (GWh) more imports between 2030 and 2040. Imports in the High Electrification scenario decline beginning in 2040, aligning with the first nuclear SMR units, and are, on average, 823 GWh less than the Reference Case to the end of the forecast horizon. However, Alberta acts as a net-exporter for all years in the High Electrification scenario despite the annualized increase in load growth compared to the Reference Case.

Figure 9: High Electrification – Annual Average Imports and Exports



Results Summary

In the High Electrification scenario, increased load from rapid electrification drives an earlier and more substantial buildout of baseload generation compared to the Reference Case. Unlike the other 2024 LTO scenarios in which capacity additions are concentrated in the initial seven years of the forecast, the High Electrification scenario forecasts notable baseload additions beginning in 2037, including substantial additions of new combined-cycle with CCUS units and nuclear SMRs. Compared to the Reference Case, the High Electrification scenario relies more on natural gas-fired generation, both abated and unabated, and coal-to-gas retirements are delayed, with additional units operating until 2038 likely to serve increasing load post-2030. The High Electrification scenario forecasts nuclear SMR additions 900 MW greater and two years earlier than the Reference Case. Imports and exports in the High Electrification scenario are similar to the Reference Case until the end of the forecast timeline when imports decrease and exports increase, coinciding with the nuclear SMR additions. Despite the annualized increase in load growth, Alberta is forecast to be a net-exporter for all years in the High Electrification scenario.

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