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Grid-Locked

Risks of unabated gas-fired electricity for a clean grid in Alberta

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The Pembina Institute is a national non-partisan think tank that advocates for strong, effective policies to support Canada's clean energy transition. We employ multi-faceted and highly collaborative approaches to change. Producing credible, evidence-based research and analysis, we consult directly with organizations to design and implement clean energy solutions, and convene diverse sets of stakeholders to identify and move toward common solutions.

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These acknowledgements are some of the beginning steps on a journey of several generations. We share them in the spirit of truth, justice, reconciliation, and to contribute to a more equitable and inclusive future for all of society.

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Executive summary

Alberta's electricity sector has been undergoing significant changes in recent years. In the last five years, the province has retired nearly 87% (5.4 GW) of its coal fleet, while nearly quadrupling its wind and solar capacity during the same period. Consequently, greenhouse gas (GHG) emissions from the electricity sector declined by 8.3 Mt between 2018 and 2021 in Alberta.

However, Alberta is still responsible for nearly half of Canada's electricity emissions and lags the rest of the country in reducing its emissions profile. Emissions from gas-fired generation made up nearly half of Alberta's electricity sector related emissions in 2021 and are rising due to new investments in unabated gas-fired generation. **Gas capacity is expected to increase by nearly 24% in Alberta over the next two years, and gas-fired electricity could emit as much as 20.9 Mt CO_2e in Alberta in 2035.** Unless Alberta takes a different approach, the province's electricity sector emissions could be nearly double that of what the Pembina Institute's low-carbon analyses have found is possible for a net-zero grid in 2035 — making it much harder to achieve economy wide carbon-neutrality by 2050.

Gas-fired electricity can remain a part of a modernized, low-carbon electricity mix if emissions are captured (abated). In its 2023 report *Zeroing In*, the Pembina Institute found that a net-zero grid in Alberta could include between 1.8 GW and 5.2 GW of abated gas capacity in 2035. With the aforementioned planned gas capacity expansion — much of which is new unabated gas plants, and five gas plants (existing and new) with carbon capture projects being explored or already announced — Alberta will have enough gas-fired electricity on its grid to meet its electricity needs. Building more gas projects that do not capture emissions will cement our dependency on an emissions-intensive source of electricity and puts Albertans at risk of covering the costs of stranded assets while making it difficult for Alberta to achieve an affordable and reliable net-zero grid.

Policy and regulatory certainty along with incentives such as the proposed carbon capture, utilization and storage and clean electricity investment tax credits (ITC) are critical for enabling clean energy development, including abated gas. For Alberta to achieve an affordable, reliable, and clean grid by 2035, the Pembina Institute offers the following recommendations:

- **Restrict building gas plants that do not have carbon capture and storage (CCS) and prioritize retrofitting CCS at existing unabated gas-fired**

generation. Alberta already has enough existing and developing gas capacity to meet its needs through 2035 under current and proposed regulations. Priority should be given to retrofitting existing unabated generation sources where practical and cost-effective before constructing new projects.

- **Invest strategically in gas-fired electricity with carbon capture and storage.** Generators can soon leverage the draft carbon capture, utilization and storage ITC, and in the future may be able to use the proposed clean electricity ITC. However, a diverse generating fleet is needed, as overdependence on CCS could inflate costs for consumers while diverting public funds away from other critical abatement options (e.g., energy efficiency, transmission infrastructure).
- **Strengthen provincial carbon policies for electricity.** Alberta's Technology Innovation and Emissions Reduction (TIER) Regulation defines a high-performance benchmark for electricity generation — currently set at 370 t/GWh and declining at a rate of 2% per year — that dictates the volume of electricity emissions that bear a cost from carbon pricing. The Pembina Institute recommends that the electricity benchmark is removed or reduced to 0 t/GWh by 2035. This will ensure all electricity emissions are subject to carbon pricing, providing certainty for investments into clean electricity — including abated gas-fired electricity — and sending a clear economic signal to reduce sector emissions. This would complement the Clean Electricity Regulations by providing a mechanism to offset residual electricity sector emissions with credits or offsets.
- **Accelerate the development of affordable and proven clean energy options.** Government support, both financial and through enabling policies and regulations, for technologies including wind, solar, battery storage, energy efficiency and inter-regional transmission interties will accelerate the transformation. Support is also needed to de-risk early investments in the strategic deployment of longer-term energy storage to help push Alberta toward a decarbonized electricity grid.
- **Monitor consumer affordability.** Finally, we also emphasize that, because energy affordability is a serious issue facing Canadians, government should proactively monitor affordability while we transform the electricity system, so they can more quickly address any issues that might arise.

1. Introduction

Alberta's electricity sector is at a turning point. The province has retired nearly 87% (5.4 GW) of its coal capacity since 2015, with the rest being on track to be converted to natural gas by the middle of next year — six years ahead of the 2030 phaseout goal.[1,2] During the same period, wind and solar capacity has expanded to 4.3 GW and 1.4 GW respectively,[3] with an additional 1.7 GW of wind and 1.7 GW of solar under construction.[4] This benefits Albertans from an emissions reduction perspective — greenhouse gas (GHG) emissions from the electricity sector declined by 8.3 Mt between 2018 and 2021[5] — as well as economically. As of September 2023, corporate investments in renewable energy have brought in $5.5 billion of new construction and nearly 5,900 jobs to Alberta.[6]

Despite this progress, Alberta's emissions from electricity generation remains the highest in Canada. In 2021, Alberta generated 28.4 Mt of electricity-associated greenhouse gas emissions.[7] This is equivalent to almost half of all of Canada's electricity sector emissions (Figure 1). Nearly 49% of Alberta's total electricity emissions were emitted by unabated gas-fired electricity generation, i.e., gas used for electricity without technology like carbon capture and storage (CCS) to reduce greenhouse gas emissions from production (Box 1). Further, to achieve a net-zero grid

[1] Installed coal capacity 2015 from AUC, *2022 Alberta Electric Energy Net Installed Capacity (MCR MW) by Resource*. https://www.auc.ab.ca/annual-electricity-data/; remaining coal capacity from Alberta Electricity System Operator [AESO], "Current Supply and Demand Report" (accessed on November 15, 2023), http://ets.aeso.ca/ets_web/ip/Market/Reports/CSDReportServlet).

[2] In addition to reducing emissions, coal phase-out has eliminated health costs associated with burning coal, which were estimated to be close to $300 million annually in 2013. Asthma Society of Canada, Canadian Association of Physicians for the Environment, The Lung Association, and Pembina Institute, *A Costly Diagnosis: Subsidizing Coal Power with Albertans' Health* (2013), 2. https://www.pembina.org/pub/costly-diagnosis

[3] AESO, "Current Supply and Demand Report."

[4] AESO, *Long-term Adequacy Report – November 2023,* 21. https://www.aeso.ca/market/market-and-system-reporting/long-term-adequacy-metrics/

[5] Environment and Climate Change Canada, *Canada's Official Greenhouse Gas Inventory,* Table A13-10: Electricity Generation and GHG Emission Details for Alberta. https://data-donnees.ec.gc.ca/data/substances/monitor/canada-s-official-greenhouse-gas-inventory/C-Tables-Electricity-Canada-Provinces-Territories/?lang=en

[6] Business Renewables Centre Canada, *Deal Tracker - Q3 2023*. https://businessrenewables.ca/deal-tracker

[7] *Canada's Official Greenhouse Gas Inventory*, Table A13-10: Electricity Generation and GHG Emission Details for Alberta.

by 2035, the International Energy Agency (IEA) expects unabated gas-fired generation will need to be limited to only 2% of the total generation in G7 countries by the same year.[8] Consequently, investing in new unabated gas assets as the world, and G7 nations in particular, reduces its reliance on unabated gas puts Alberta out of step with global trends and its peer jurisdictions. This may also have repercussions on the province's attractiveness for businesses interested in powering their operations with clean energy in response to their increasingly stringent environmental, social and governance (ESG) goals.

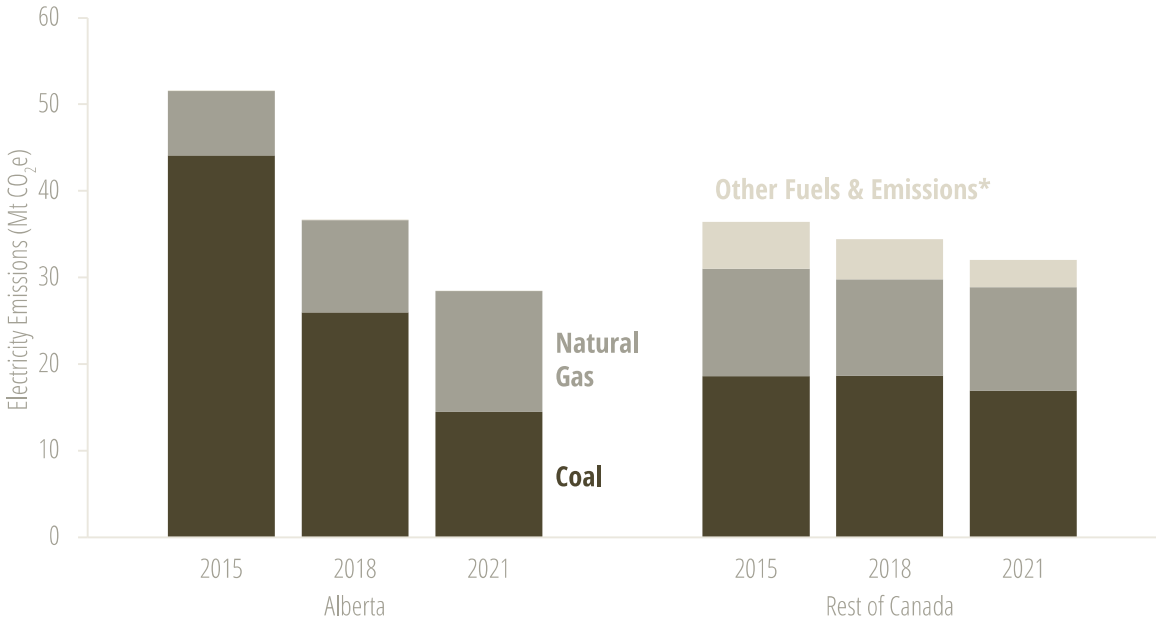

Figure 1. Electricity-associated greenhouse gas emissions in Alberta and the rest of Canada, 2015-2021

Note: Excludes behind-the-fence generation (see Box 2).

* "Other fuels and emissions" includes refined petroleum products (light fuel oil, heavy fuel oil, and diesel), petroleum coke, still gas and other fuels not easily categorized, plus other emissions.

Data source: Environment and Climate Change Canada[9]

This is not to suggest that gas-fired electricity does not have a role on Alberta's grid. In fact, Pembina Institute's modelling shows that all pathways to a net-zero grid by 2035 in Alberta require a diverse mix of generation, including abated gas capacity.[10] Abated

[8] IEA, *Achieving Net Zero Electricity Sectors in G7 Members* (2021), 8. https://www.iea.org/reports/achieving-net-zero-electricity-sectors-in-g7-members

[9] *Canada's Official Greenhouse Gas Inventory,* Table A13-1: Electricity Generation and GHG Emission Details for Canada; Table A13-10: Electricity Generation and GHG Emission Details for Alberta.

[10] Will Noel and Binnu Jeyakumar, *Zeroing In: Pathways to an affordable net-zero grid in Alberta* (Pembina Institute, 2023), 44. https://www.pembina.org/pub/zeroing-in

gas-fired electricity, i.e., gas plants fitted with CCS, is a viable and low-emission alternative to unabated gas-fired electricity. It provides flexibility to the grid without locking in emissions for decades. When deployed in combination with other non-emitting sources like wind, solar, and battery storage, abated gas-fired electricity contributes to a reliable, affordable, and clean electricity grid.

In this report, we review the buildout of unabated and abated gas-fired electricity in Alberta. We examine the trends in gas-fired capacity, and explore the impacts of gas generation on grid affordability, reliability and effectiveness on the path to net-zero electricity emissions by 2035. We also examine the effects of key regulations on supporting abatement of gas-fired generation.

Box 1. Natural gas — not a bridge fuel

Natural gas has been billed as a bridge fuel — a temporary alternative to higher-polluting energy sources to meet energy demand as countries shift to non-emitting sources. Relative to extremely dirty sources of energy such as coal, natural gas emits significantly fewer emissions. However, natural gas combustion still accounts for 48.9% of total electricity sector emissions in Alberta, thus negating a significant amount of the emissions reduction progress achieved through coal phase-out.[11] The advantage of natural gas over coal is further minimized as natural gas is expanded to meet a growing demand that could instead be met through non-emitting sources such as wind and solar. Further, building unabated gas plants can lock in significant emissions for decades to come.

Conversely, abated gas provides a proven alternative to unabated gas. By installing carbon capture and storage, gas plants can capture emissions from the smokestack and transport it via pipeline to a designated underground storage place. In this way, abated gas can continue to operate with few emissions and serve demand when it is needed most; for example, during brief periods when wind and solar output is low.

[11] Natural gas-fired electricity is also subject to significant upstream emissions. For example, leaks, flaring and venting of natural gas (mostly methane) during production and processing was responsible for 3% (20 $MtCO_2e$) of Canada's total greenhouse gas emissions in 2021. *Canada's Official Greenhouse Gas Inventory,* Table A10-3: Relationship between Canada's Economic Sectors and IPCC Sectors, 2021.

2. Trends in gas-fired electricity

2.1 Emitting gas-fired electricity

A vast majority of the existing gas-fired capacity in Alberta is unabated. It also represents the largest share of both installed capacity and generation in Alberta. Cogeneration – the concurrent production of electricity and steam for industrial use from the same source, mostly using natural gas — contributes more to installed capacity (Figure 2) and total electricity generation (Figure 3) in Alberta than does non-cogeneration natural gas capacity. Overall, unabated gas, including cogeneration, made up 61% of the installed capacity and nearly 73% of the total electricity generated in Alberta in 2022.

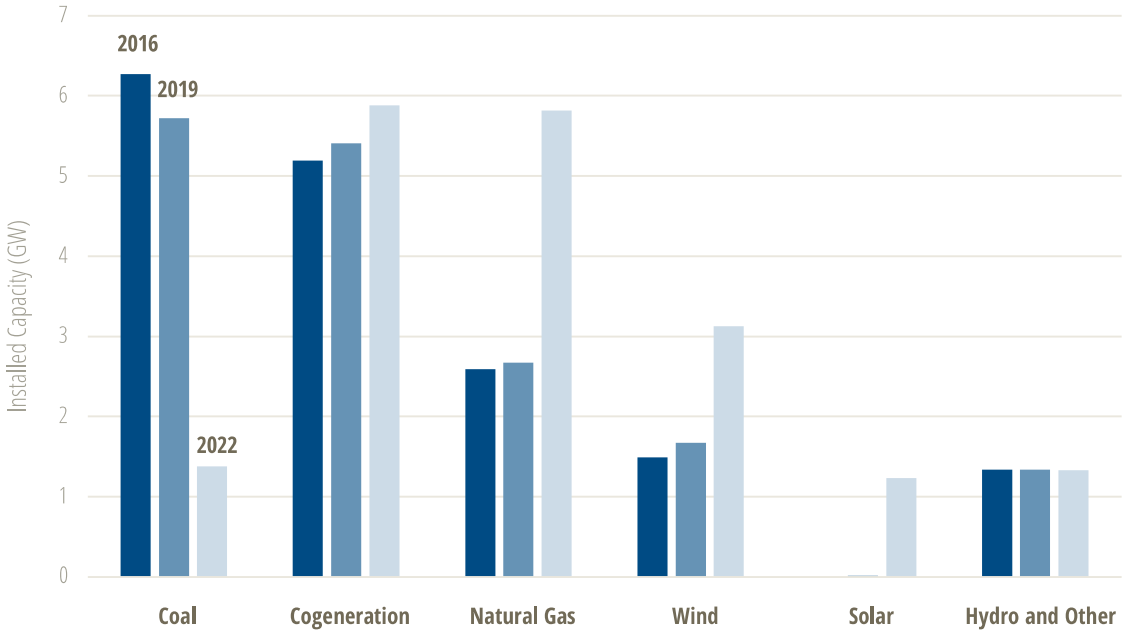

Figure 2. Installed generation capacity by technology, Alberta

Data source: Alberta Utilities Commission[12]

[12] AUC, *2022 Alberta Electric Energy Net Installed Capacity*. Total natural gas capacity in AUC data includes cogen; for this graph, AUC's Total Gas Cogen capacity was subtracted from total Natural Gas capacity to get only non-cogen natural gas capacity.

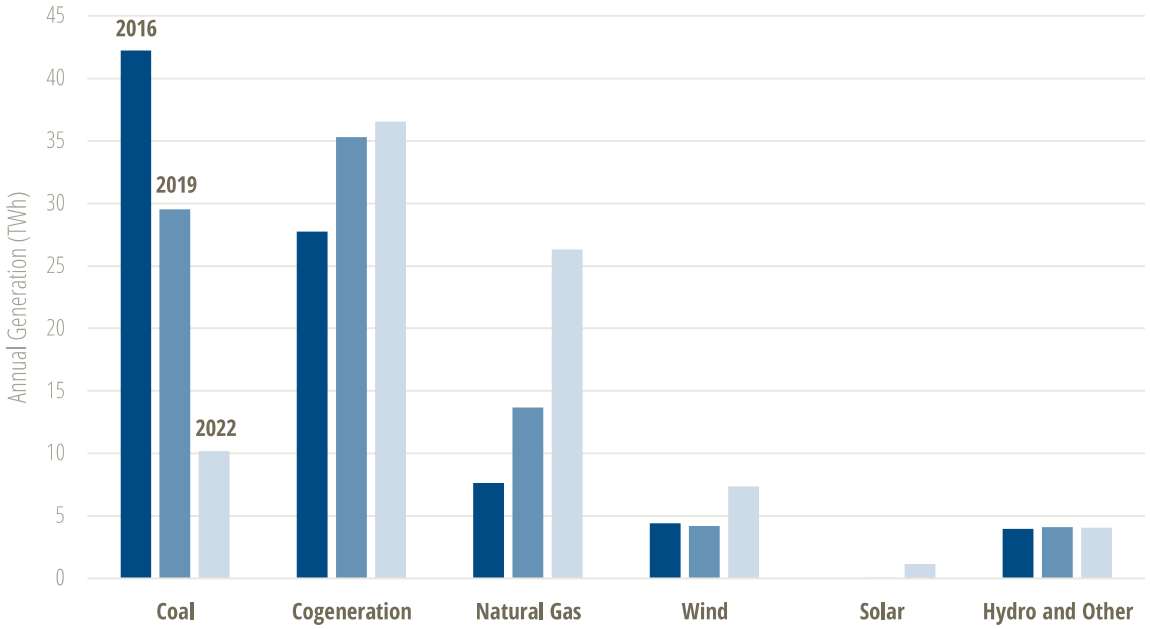

Figure 3. Annual generation by technology, Alberta

Data source: Alberta Utilities Commission[13]

Unabated gas-fired capacity has grown steadily since 2015, with new capacity coming online much faster in recent years. There are 11.8 GW[14] of gas-fired assets in Alberta (including cogeneration) as of November 15, 2023. At least 1.5 GW[15] of new gas capacity — combined cycle, simple cycle, and cogeneration (see Box 2) — was installed between January 2020 and August 2023, more than 10% of the current capacity. During the same period, 2.6 GW of gas-fired steam capacity was installed by converting coal plants to combust gas for electricity generation.[16] In total, 4.1 GW, or nearly 35% of Alberta's current gas capacity, was installed between 2020 and August 2023.

[13] AUC, *2022 Alberta Electric Energy Generation (GWh) by Resource and Interchange.* https://www.auc.ab.ca/annual-electricity-data/; Total natural gas generation in AUC data includes cogen; for this graph, AUC's Total Gas Cogen generation was subtracted from total Natural Gas generation to get only no-cogen natural gas generation.

[14] AESO, "Current Supply and Demand Report."

[15] This includes 0.900 GW Cascade plant, which has not been energized yet but was connected to the grid in August 2023.

[16] Western Electricity Coordinating Council (WECC), *2021-04-30 WECC Resource List*. Spreadsheet. https://www.wecc.org/ReliabilityAssessments/Pages/default.aspx; AESO, *Annual Market Statistics* (2022), 12. https://www.aeso.ca/assets/Uploads/market-and-system-reporting/2021-Annual-Market-Stats-Final.pdf; AESO, *Annual Market Statistics* (2023), 13, https://www.aeso.ca/assets/Uploads/market-and-system-reporting/2022_Annual_Market_Stats_Final.pdf

Box 2. Gas-fired generation technologies[17]

Simple cycle: Simple cycle generation plants use a gas turbine as the primary mover. Simple cycle plants, often referred to as "peaker" plants, can respond to rapidly changing electricity demand by ramping up electricity generation quickly in a short time period. They are used to meet peak power needs on the grid.

Combined cycle: Combined cycle plants use natural gas to generate electricity, while waste heat created in the process is captured and converted into additional electricity.

Cogeneration: Cogeneration is the simultaneous production of electricity and another product, such as heat or steam.

Behind-the-fence generation: Behind-the-fence refers to instances where electricity is generated on-site (for example, at an oilsands facility) to meet the electricity needs of the site. Some of this electricity may also be sold to the grid.

In addition to this existing capacity, Alberta is currently on track to build a significant amount of unabated gas over the next two years. Currently, 2.3 GW of new gas capacity additions[18] are under construction, as of November 2023. An additional 0.5 GW have received regulatory approval with the latest in-service date of June 2025 and another 0.3 GW have received regulatory approval but have not yet confirmed an in-service date (Figure 4). Including both active construction and approved projects with in-service dates up to June 2025, Alberta could potentially see a 2.8 GW increase (up nearly 24% from current capacity) in total gas capacity in the next two years.

[17] AESO, "Glossy of Terms." https://www.aeso.ca/aeso/understanding-electricity-in-alberta/glossary-of-terms/

[18] AESO, *Long-Term Adequacy Report – November 2023*. Genessee 1 and 2 gas-turbine repower will result in a net capacity of 0.822 GW of combined-cycle natural gas. Steam-turbine repowering at the same facilities will account for an additional 0.572 GW of capacity, but will be capped at 0.055 GW each to comply with the current Most Severe Single Contingency value.

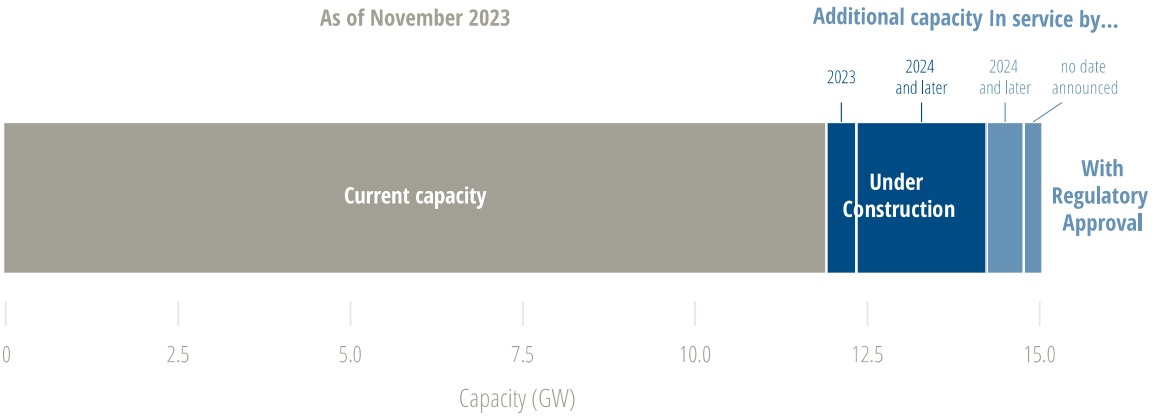

Figure 4. Current and anticipated gas-fired capacity additions in Alberta

Data source: AESO[19]

These numbers indicate a concerning trend whereby a significant amount of the recently added gas capacity, and of those under development, is unabated. This further puts Alberta on a collision course with international expert recommendations to reduce generation from unabated natural gas to only 17% in 2030.[20] Alberta needs to decarbonize and support new generation based on renewable energy sources, battery storage and abated gas.

2.2 Non-emitting gas-fired electricity

While many existing gas-fired plants and additions currently under construction or approved are expected to be unabated, a few projects (existing and new) have announced intentions to install carbon capture and storage to reduce emissions, or have expressed interest in CCS:

- Genesee 1 and 2 have advanced plans for carbon capture.[21]
- Moraine Power Plant (0.5 GW), which recently cleared the federal impact assessment process, will include a carbon capture and storage unit.[22]

[19] AESO, *Long-Term Adequacy Report – November 2023;* does not include Cascade, instead, Cascade is represented under existing capacity.

[20] International Energy Agency, *Net Zero by 2050 – A Roadmap for the Global Energy Sector* (2021), 117. https://iea.blob.core.windows.net/assets/deebef5d-0c34-4539-9d0c-10b13d840027/NetZeroby2050-ARoadmapfortheGlobalEnergySector_CORR.pdf

[21] Genesee units 1 and 2, which are being converted to fire gas instead of coal, have plans for carbon capture technology. Capital Power, "Decarbonization Technology." https://www.capitalpower.com/sustainability/innovation/decarbonization/

[22] Stantec Consulting Ltd. "Project Description Summary: Moraine Power Generation Project (2023)," 8. https://iaac-aeic.gc.ca/050/documents/p84591/153067E.pdf

- Kineticor is developing a plan for a 1.4 GW combined cycle power plant with CCS with over 90% efficiency rate.[23]
- Kiwetinohk is proposing a 0.1 GW natural gas project with a carbon capture pilot project.[24]
- ENMAX is conducting a CCS front-end engineering and design study at its Shepard Energy Centre (0.9 GW).[25]

In addition to these five projects, other industries have also expressed greater interest in CCS and carbon capture, utilization, and storage (CCUS), including the cement, chemicals, fertilizer, and oil and gas sectors. There is also some early-stage exploration of hydrogen blending in gas-fired generation units, and generation units fuelled entirely with hydrogen. For instance, Heartland is exploring the possibility of converting its Battle River Generating Station from natural gas to hydrogen with a net generation capacity of about 0.4 GW; its hydrogen production facility would be equipped with CCS to generate clean hydrogen.[26]

[23] Kineticor, "Greenlight Electricity Centre." https://kineticor.ca/operation/greenlight-electricity-centre/

[24] Kiwetinohk Energy, "The Energy Business in Transition." https://kiwetinohk.com/what/

[25] ENMAX, "ENMAX Energy receives funding for carbon capture feasibility study at Canada's benchmark electricity generation facility." https://www1.enmax.com/news/enmax-energy-receives-funding-for-carbon-capture-feasibility-study

[26] Heartland Generation, *Building a Better Bridge to a Clean Energy Future* (2021), 12, 19. https://assets-global.website-files.com/61b29d60048f5c43f6e03e6f/6303c5fdd71001a6e48516d7_ESG_heartland_19Aug_444PM_low_V2.pdf

3. Gas-fired electricity on a net-zero grid

3.1 Affordability

The Pembina Institute has found that building a net-zero electricity grid by 2035 with a mix of abated gas assets, unabated gas peakers (i.e. plants that can be easily turned on and used during peak demand), and low-cost renewable energy will save Albertans $600 per year on their electricity bills.[27] These findings are consistent with the Alberta electricity Market Surveillance Administrator's observations that renewable energy lowers consumer electricity bills.[28] If it does not support a cleaner grid, Alberta will lock its ratepayers into unnecessary higher costs.

Investing now in unabated gas assets is risky for price stability. Gas prices in Alberta are inevitably linked to global markets and influenced by various external factors that can cause price volatility. This increases the exposure of Albertans' electricity bills to global factors beyond their control.

3.2 Economic competitiveness

As Canada progresses towards a net-zero grid by 2035, many unabated gas-fired generating units won't be able to compete with cost-effective wind, solar, and battery storage solutions. A recent study by Carbon Tracker shows that existing unabated gas capacity in the U.S. and Europe — under varying carbon pricing regimes — is already more expensive to operate than building new renewables.[29] Between 2009 and 2021, the levelized cost of utility-scale wind and solar generation fell by 72% and 90% respectively and, in Alberta and Ontario, new renewable projects are now cost-

[27] *Zeroing In,* 42.

[28] Market Surveillance Administrator, *Quarterly Report for Q1 2023,* 30. https://www.albertamsa.ca/assets/Documents/Q1-2023-Quarterly-Report.pdf

[29] Carbon Tracker, *Put Gas on Standby* (2021). https://carbontracker.org/reports/put-gas-on-standby/

competitive with natural gas plants, even without carbon pricing.[30,31] Therefore, as unabated gas plants become increasingly uncompetitive, and in the worst case scenario, become stranded, ratepayers and taxpayers could end up paying for unused grid infrastructure.[32] For example, Ontario's government has outlined an expedited process to procure capacity that would allow plants that cannot comply with GHG emissions regulations to still be paid even if they are not operating.[33] If Alberta does not support abating plans and clean energy projects, it could face the same sort of decision.

Conversely, abated gas-fired electricity is competitive in the low-carbon economy, especially as the price on carbon continues to rise. One study found that a carbon price of only $105/tonne CO_2e would make it feasible and economically beneficial to install CCUS at the Cascade gas-fired facility in Alberta, which is set to come online in early 2024.[34] Further, the analysis did not consider the potential revenue stream associated with selling carbon, which could make CCUS feasible at a lower carbon price.

Further, as the world makes progress toward a net-zero economy by 2050, more and more investors and corporations are seeking to achieve emissions reductions and choosing to invest in regions that support their increasingly stringent environmental, sustainability and governance goals. In fact, companies with net-zero targets are already choosing Canada for its clean energy advantage. For example, Canada's leadership in renewable energy was cited as a determining factor by LG Energy Solutions for its record setting $5 billion investment in a new battery manufacturing

[30] Lazard, *Levelized Cost of Energy Analysis*: Version 15.0 (2021), 9. https://www.lazard.com/research-insights/levelized-cost-of-energy-levelized-cost-of-storage-and-levelized-cost-of-hydrogen-2021

[31] Clean Energy Canada, *A Renewables Powerhouse* (2023), 1. https://cleanenergycanada.org/report/a-renewables-powerhouse/

[32] An asset becomes stranded when it is no longer able to make a return on investment. Natural gas assets can become stranded through economic (rising fuel costs or unfavorable market dynamics) or regulatory factors (policy intervention limiting their operation). Katie Auth, Jacob Kincer and Mark Thurber, *Untangling 'Stranded Assets' and 'Carbon Lock-in'* (Energy for Growth Hub, 2022). https://www.energyforgrowth.org/memo/untangling-stranded-assets-and-carbon-lock-in/

[33] Executive Council of Ontario, "Directive from the Minister of Energy to the Independent Electricity System Operator," October 6, 2022, 6. https://www.ieso.ca/-/media/Files/IESO/Document-Library/corporate/ministerial-directives/Directive-from-the-Minister-of-Energy-20221007-resource-eligibility.ashx

[34] Behnaz Afsahi, Ali Ghavidel, Kevin Grimeau, Ben Huang, Farhana Mustafa, "The Impact of CCUS Infrastructure on the Levelized Cost of Electricity at Cascade," presented at GeoConvention 2021, September 13-15, 2021, 1. https://geoconvention.com/wp-content/uploads/abstracts/2021/67241-the-impact-of-ccus-infrastructure-on-the-levelized-01.pdf

facility.[35] Therefore, ensuring any development of gas is complemented with abatement technologies allows Alberta to remain competitive in the low-carbon economy, while expanding unabated gas-fired electricity and locking in long-term emissions could impact Alberta's ability to attract future ESG investors.

3.3 Reliability

Installing abated gas-fired electricity, along with wind and solar and other technologies, would allow Alberta to decarbonize its grid significantly by 2035 while maintaining reliability, a recent Pembina Institute analysis found. Alberta's grid could include 1.8 GW to 5.2 GW of abated gas capacity in 2035, with the first estimate scenario also including 2.2 GW of more inter-provincial transmission capacity with British Columbia.[36] This means Alberta can improve the utilization of existing assets while reducing the need for some additional generation capacity.[37]

Reducing the reliance on gas-fired electricity and shifting toward a more diverse grid would also increase grid reliability by reducing the risk posed by weather. Extreme weather events, which are becoming more common due to climate change, remain hard to predict and can create uncertainty for gas power plants and put strain on the system. For example, in summer 2023 an extreme heat wave reduced the cooling capacity of gas plants resulting in a loss of approximately 0.600 GW of gas-fired electricity capacity, causing the Alberta Electricity System Operator (AESO) to issue a grid alert.[38]

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[35] Stellantis, "Stellantis and LG Energy Solution to Invest Over $5 Billion CAD in Joint Venture for First Large Scale Lithium-Ion Battery Production Plant in Canada," media release, March 23, 2022. https://www.stellantis.com/en/news/press-releases/2022/march/stellantis-and-lg-energy-solution-to-invest-over-5-billion-cad-in-joint-venture-for-first-large-scale-lithium-Ion-battery-production-plant-in-canada

[36] *Zeroing In* spreadsheet data; the Near Zero Emissions+ scenario includes 1.8 GW of abated gas and 2.2 GW of B.C. interties, while the Near Zero Emissions scenario includes 5.2 GW of abated gas.

[37] *Zeroing In*, 3.

[38] Other contributing factors included an intertie outage in British Columbia, higher-than-expected demand, and low wind availability (which was predicted a day in advance, prompting reserve assets to become available). Natasha Bulowski, "The real story behind Alberta's power alert," *National Observer,* August 31, 2023. https://www.nationalobserver.com/2023/08/31/news/real-story-behind-alberta-power-alert

3.4 Emissions

Canada is one of 196 nations that have committed to limiting global warming to 1.5°C by 2050. A net-zero grid by 2035 is critical to achieving this target as it will allow Canada to mitigate existing emissions from the sector (60.4 Mt in 2021) and provides the foundation necessary for decarbonizing other emitting sectors such as transportation and buildings.

In 2022, gas-fired electricity emitted an estimated 22.8 Mt of emissions in Alberta, including behind-the-fence generation.[39] Three plausible scenarios for a 2035 electricity system in Alberta, based on existing capacity, expected buildout of gas assets, and the current proposed frame for the federal Clean Electricity Regulations, are illustrated in Figure 5.

With a low capacity factor (10%) and 20-year end of prescribed life (EoPL),[40] emissions from natural gas-fired generation would fall by nearly 90% to 3.2 Mt per year in 2035. In a median scenario, with a 30% capacity factor and a 20-year EoPL, nearly 9.5 Mt of emissions per year would be left on the grid in 2035.

However, if Alberta's natural gas-fired assets continue to operate at approximately the same capacity factor as they did in 2021 (66%), even with best-in-class emissions intensities for new assets (370 tCO_2/GWh) and with an EoPL of 20 years, natural gas assets would continue to emit nearly 20.9 Mt of greenhouse gas emissions in 2035 — the year Alberta is supposed to achieve net-zero.

Further, these emissions only include existing and under-construction facilities. The emissions could rise further if the unabated gas-fired plants with regulatory approval or additional unabated plants that have just been announced, applied for connection, and/or regulatory approval are accounted for.[41]

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[39] Assumes a 299 t/GWh emissions factor for cogeneration plants, based on historic oil and gas emissions reported to Alberta Environment: Government of Alberta," Alberta Oil Sands Greenhouse Gas Emission Intensity Analysis," (2021). https://open.alberta.ca/opendata/alberta-oil-sands-greenhouse-gas-emission-intensity-analysis. All other natural gas generation assumes a 490 t/GWh emissions intensity (2020 data): *Canada's Official Greenhouse Gas Inventory* (2023).

For more, please see: *Zeroing In*, Appendix B.1.3.

[40] Capacity factor is the amount of time a gas plant runs compared to its theoretical maximum running time. Twenty years is the EoPL suggested under the draft CER.

[41] Nearly 4 GW of unabated and abated gas mix has either been announced or has applied for connection and/or regulatory approval: AESO, *Long-term Adequacy Report – November 2023,* 13–20.

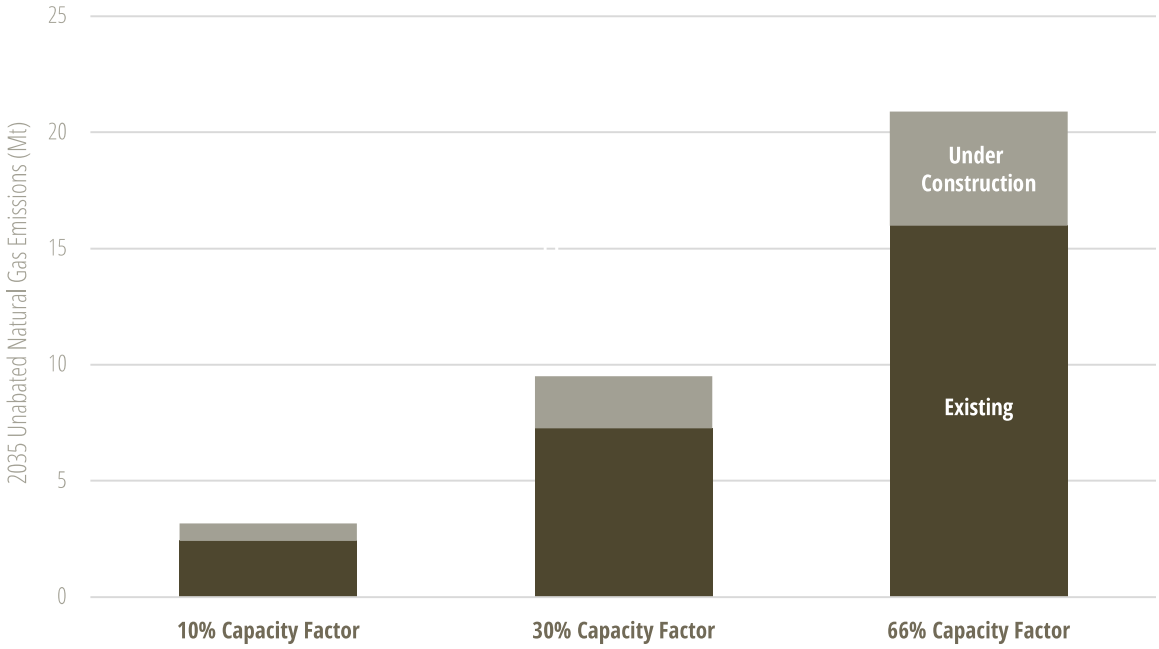

Figure 5. Emissions scenarios for natural gas-fired electricity in Alberta in 2035, based on 20-year EoPL and different capacity factor scenarios

Data source: WECC[42]; AESO[43]; ECCC[44]

Note: projections include gas-fired steam, which may get a different EoPL than other gas-fired generation.

[42] *2021-04-30 WECC Resource List.*

[43] AESO, *Long-term Adequacy Report – November 2023,* 21.

[44] *Canada's Official Greenhouse Gas Inventory*, Table A13-10: Electricity Generation and GHG Emission Details for Alberta; based on 2021 natural gas power emissions intensity, i.e., 464 t/GWh.

4. Key regulations supporting abated gas-fired electricity

The electricity sector is well positioned to lead on using CCS to abate emissions. But despite some demonstrated successes, CCS is in early development stages and needs to be supported by regulatory certainty and incentives that encourage further innovation. Without policy certainty and support, there is the danger of potentially repeating the mistakes of early-stage CCS projects that failed. For example, the Pioneer CCS project was under consideration for the Keephills 3 coal power plant unit. After completing a preliminary study, the developers determined in 2012 that, although the technology worked and the cost was in line with their expectations, carbon markets of the day could not generate sufficient revenue to make the project viable.[45] But industrial carbon pricing has come a long way, especially in Alberta. As the Alberta government recently put it, "The approach to supporting the electricity transition should complement carbon pricing, where at $170 per tonne of CO_2 equivalent, the non-emitting technologies are generally already less expensive than emitting ones."[46] One thing that remains the same, however, is the critical need to provide policy and regulatory certainty, along with complementary incentives where needed.

Regulations and proposed policies that have a significant role to play in this are:

- Emissions regulations, such as the federal Clean Electricity Regulations (CER)
- Carbon pricing, currently achieved through the provincial Technology Innovation and Emissions Reduction (TIER) system
- Federal Clean Electricity and Carbon Capture Utilization and Storage investment tax credits (ITCs)
- Broadly applied carbon contracts for differences to help de-risk carbon credit revenues for low-carbon projects.

[45] TransAlta, *Project Pioneer: Final report on Project Pioneer* (2013), ii. Available at https://www.globalccsinstitute.com/archive/hub/publications/98046/project-pioneer-summary-report.pdf

[46] Government of Alberta, *Government of Alberta Submission to Government of Canada on Draft Federal Electricity Regulations*, November 3, 2023, 7. https://www.alberta.ca/system/files/epa-government-of-alberta-submission-on-draft-federal-electricity-regulations.pdf

4.1 Emissions regulations

The CER will set a physical emission standard for electricity in Canada and therefore plays an important role in incentivizing clean electricity generation. The recently announced draft CER introduced an emissions standard of 30 t/GWh that will apply to emitting electricity starting in 2035.[47] In setting this emissions limit, the CER encourages the application of CCS in gas-fired facilities by providing certainty to generators that Canada is committed to achieve a net-zero grid.

The draft CER applies differently to new and existing emitting assets.

- **New gas-fired facilities,** built after January 1, 2025, could operate until 2035 per business-as-usual, and then, starting that year, they can continue operating as long as they achieve a 95% CCS rate with an emission intensity of 30 t/GWh.
- **Existing gas-fired units**, defined as a unit built before January 1, 2025, could continue operating until 20 years after the commissioning date without complying with the physical emission standard. This flexibility was designed to prevent existing units, which were commissioned before the financial implications of the CER would need to be considered, from facing undue financial burden and being stranded by government policy. Importantly, the existing gas-fired facilities can continue operating even after they reach their end of prescribed life by installing CCS.

In addition to advancing CCS, the draft CER also offers significant flexibilities for some types of gas-fired electricity. Simple cycle plants can continue to operate up to 450 hours a year, or up to 150 kt emissions a year. This flexibility will play an important role in meeting energy demand during brief periods of the year when wind and solar outputs are low.

These key design aspects of CER help promote abated gas-fired electricity, while offering necessary flexibilities to peaking gas, and help Alberta set itself up to achieve a net-zero grid.

4.2 Carbon pricing

Carbon pricing is a critical policy for supporting CCS. Currently, Alberta's TIER carbon pricing system applies to facilities that emit over 100,000 tonne CO_2e emissions per

[47] Government of Canada, *Clean Electricity Regulations*, Canada Gazette Part I, 157 (33), 2023. https://www.gazette.gc.ca/rp-pr/p1/2023/2023-08-19/html/reg1-eng.html

year.[48] But, for each electricity facility that is subject to TIER, the carbon pricing ($65/t CO_2e in 2023) only applies a cost to emissions that are above the "good-as-best gas" emission intensity benchmark, which is currently set at 370 tonnes CO_2e per GWh.[49] That is, gas-fired electricity only pays the carbon price on emissions that are above 370 t/GWh. This benchmark is currently set to drop at a rate of 2% per year until 2030. Our analysis shows that, while it is not enough to reach net-zero electricity on its own, increasing the carbon price and lowering the high-performance benchmark is highly effective for promoting CCS and thus lowering electricity emissions.[50] Further tightening this rate would make these projects more viable.

4.3 Targeted financing and other supports

In addition to regulatory certainty, financial incentives will play a significant role in enabling the development of abated gas-fired electricity in Alberta. For example, the clean electricity investment tax credit proposed under this year's budget offers a 15% credit for investments into clean electricity technologies.[51] This would include CCS for existing and new gas-fired facilities and is in addition to other incentives for CCS-related investments offered under this year's budget. These incentives will help reduce initial investment cost for generators who are interested in installing CCS at their gas-fired facilities.

Additionally, the Alberta government can provide support, both financial and through enabling policies and regulations, to incentivize technologies in early stages of development that are critical for a net-zero grid, including abated gas and long-duration storage. However, it is critical that the government takes a technology-neutral approach in administering incentives to ensure lowest-cost solutions are achieved. In doing so, Alberta can accelerate its transition toward a diversified clean energy portfolio — including renewables, energy storage, and abated natural gas generation — without sacrificing affordability.

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[48] Alberta Environment and Protected Areas, *TIER Regulation Fact Sheet,* (2023), 1. https://www.alberta.ca/system/files/custom_downloaded_images/ep-fact-sheet-tier-regulation.pdf

[49] Government of Alberta, *Technology Innovation and Emissions Reduction Regulation*, (2023), AR 133/2019, 64. https://kings-printer.alberta.ca/570.cfm?frm_isbn=9780779843916&search_by=link.

[50] Scott MacDougall, *Pembina Institute Input to Government of Alberta's 2022 TIER Review: Comments and recommendations* (Pembina Institute, 2022). https://www.pembina.org/pub/pembina-institute-input-government-albertas-2022-tier-review

[51] Government of Canada*, Budget 2023: A Made in Canada Plan* (2023), 79-81. https://www.budget.canada.ca/2023/pdf/budget-2023-en.pdf

One recent example of promoting cost-effective and clean energy generation is the successful implementation of the Renewable Energy Program by the Alberta government in 2016. Under this program, the government offered "a series of reverse auctions for contracts-for-differences which provided successful proponents with a project-specific guaranteed price for power generation…" As a result, the province has earned $75.5 million from these deals, spurring increased private investments into Alberta's renewable energy market and encouraging more than three-quarters of wind and solar development in Canada last year.[52]

[52] Sara Hastings-Simon, Andrew Leach, Blake Shaffer, and Tim Weis, "Alberta's Renewable Electricity Program: Design, results, and lessons learned," *Energy Policy* 171 (2022). https://doi.org/10.1016/j.enpol.2022.113266

5. Recommendations

New unabated gas-fired electricity assets present a significant and growing risk to an affordable, reliable, and clean electricity grid in Alberta. To mitigate these risks, Alberta should prioritize abating gas-fired electricity, along with accelerating the deployment of renewable energy, storage, efficiency measures, and transmission infrastructure. The Pembina Institute recommends the following:

- **Restrict building gas plants that do not have CCS and prioritize retrofitting CCS at existing unabated gas-fired generation.** Alberta already has enough existing and developing gas capacity to meet its needs through 2035 under current and proposed regulations. To reduce post-2035 electricity sector emissions, priority should be given to retrofitting existing unabated generation sources where practical and cost-effective before constructing new projects.
- **Invest strategically in gas-fired electricity with carbon capture and storage.** Capture of gas-fired electricity emissions will be necessary to decarbonize the electricity sector. Generators can soon leverage the draft carbon capture, utilization and storage ITC announced under this year's federal budget, and in the future may be able to use the proposed clean electricity ITC. However, a diverse generating fleet is needed, as overdependence on CCS could inflate costs for consumers while diverting public funds away from other critical abatement options (e.g. energy efficiency, transmission infrastructure).
- **Strengthen provincial carbon policies for electricity.** Alberta's Technology Innovation and Emissions Reduction Regulation defines a high-performance benchmark for electricity generation — currently set at 370 t/GWh and declining at a rate of 2% per year — that dictates the volume of electricity emissions that bear a cost from carbon pricing. The Pembina Institute recommends that the electricity benchmark is removed or reduced to 0 t/GWh by 2035. This will ensure all electricity emissions are subject to carbon pricing, providing certainty for investments into clean electricity — including abated gas-fired electricity — and sending a clear economic signal to reduce sector emissions. This would complement the Clean Electricity Regulations by providing a mechanism to offset residual electricity sector emissions with credits or offsets.
- **Accelerate the development of affordable and proven clean energy options.** Wind, solar, battery storage, and energy efficiency are the most cost-effective solutions to deliver a reliable clean grid. Inter-regional transmission interties, particularly between jurisdictions with high fossil fuel use and those