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Environment and Climate Change Canada

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Re: Comments on Regulations Amending the Reduction of Carbon Dioxide Emissions from Coal-fired Generation of Electricity Regulations

The Pembina Institute welcomes the opportunity to comment on the Government of Canada's Regulations Amending the Reduction of Carbon Dioxide Emissions from Coal-fired Generation of Electricity Regulations (coal regulations).

Summary of the Pembina Institute's comments

Globally, coal-fired power is on the decline for several reasons, including the low price of natural gas (a direct competitor to coal), the falling price of wind and solar technologies, increasingly stringent climate policies, and greater regulatory requirements to manage air pollutants. This regulation is an indication that Canada is responsibly planning for the phase-out of coal power. It contributes substantially to Canada's leadership in the Powering Past Coal Alliance and its climate targets.

- Phase-out by December 2029 should be maintained as a minimum for Canada to meet its coal phase-out commitments and continue to lead the Powering Past Coal Coalition.
- Unit-level annual emissions (greenhouse gases and criteria air contaminants) and generation data should be made publicly available in a timely manner.
- The GHG reductions from the coal phase-out will be significantly compromised by coal-to-gas conversions, unless the conversions/retirements take place earlier than the schedule. So it is critical to maintain the stringency of the timeline for extensions allowed for the converted units, and to enable early conversions or retirements.
- This regulation alone is not enough to ensure that Canada meets its target of 90% non-emitting generation by 2030. Additional measures are required to ensure that a significant portion of the retired coal capacity is replaced by renewables, storage, efficiency, and demand side management, instead of natural gas.
- The negotiation of equivalency agreements should be guided by a commitment to greater transparency. Assessments of "equivalent outcome" should require prospective stand-in provincial policy provisions to achieve reductions in GHG emissions and criteria air contaminants that are at least cumulatively equivalent over the federal phase-out period to the business-as-usual case (where the amended federal coal regulations would apply).

Context

Deep decarbonization of the electricity sector is critical to decarbonizing Canada's economy both through direct emission reductions and well as through electrification of various economic sectors — actions that can further support reducing Canada's GHG emissions and meeting its climate commitments. With the continued fall in price of renewable energy technologies and batteries, plus improvements in grid management, the electricity sector has viable and cost-effective alternatives to fossil fuel generation.

Coal and climate

Climate Analytics has reported that the “cost-optimal pathways show that to be in line with the Paris Agreement, the OECD and the EU need to phase out coal the fastest – by around 2030.”¹ With an emissions intensity of 1,034 tonnes of CO₂e / GWh (tCO₂e/GWh), coal is one of the most emissions-intensive fuels for electricity generation.² As a comparison, the average emissions intensity of Canada's grid is 150 tCO₂e/GWh.³

Canada's commitment to coal phase-out by 2030 is consistent with targets by other countries, and is evidenced by the number of jurisdictions signed up to the Canada–U.K.-led Powering Past Coal Alliance.⁴

Canada has also committed to a target of 90% emissions-free electricity by 2030. Canada's electricity sector produces just over 80 Mt of emissions, approximately 12% of Canada's overall emissions in 2016. Coal represents 71% of these electricity emissions, while providing just over 10% of our electricity.⁵ So the phase-out of coal is a critical component of achieving the target of 90% non-emitting generation by 2030⁶.

¹ Climate Analytics, *Implications of the Paris Agreement for coal use in the power sector* (2016).

² Environment and Climate Change Canada, *National Inventory Report 1990–2016: Greenhouse Gas Sources and Sinks in Canada* (2018, Part 3, Annex 13, Table A13-1, 63. (These emissions intensities are national averages.) http://unfccc.int/national_reports/annex_i_ghg_inventories/national_inventories_submissions/items/9492.php

³ Ibid.

⁴ Government of Canada, “Powering Past Coal Alliance Declaration.” <https://www.canada.ca/en/services/environment/weather/climatechange/canada-international-action/coal-phase-out/alliance-declaration.html>

⁵ ECCC, *National Inventory Report 1990 – 2016*.

⁶ Government of Canada, “Powering our future with clean electricity.” <https://www.canada.ca/en/services/environment/weather/climatechange/climate-action/powering-future-clean-energy.html?wbdisable=true>

Declining economics of coal

Coal cannot compete with renewables and natural gas. Investors, developers, and utilities across the globe are largely moving away from coal⁷. A growing list of major banks, including Bank of America, JPMorgan Chase, Citigroup, and Morgan Stanley, are recognizing this and stepping away from investments in coal. Even in the heart of U.S. coal country, utilities are retiring their coal plants earlier. In fact, the 10 largest companies that are retiring coal will be shutting down about 12 GW between 2015 and 2020.⁸

Health costs of coal

Coal is the leading emitter of several air contaminants and persistent toxics that are harmful to human health. Coal-fired power plants are a particularly important source of sulphur dioxide (SO₂), nitrogen oxides (NO_x), fine particulate matter (PM_{2.5}), mercury, and ground-level ozone. Exposure to these pollutants can lead to respiratory ailments, cardiovascular ailments, and premature deaths. As noted in the RIAS, as many as 264 premature mortalities could be prevented from 2017 to 2055 with a national coal phase-out.⁹ Alberta's coal phase-out also represents a lot of saved lives that are not included in the RIAS's scope. Pembina has estimated that an accelerated coal phase-out, including in Alberta, could avoid 1,008 premature mortalities between 2015 and 2035 compared to the 2012 federal coal regulations.¹⁰ We estimate that an accelerated schedule of coal unit retirements and conversions to gas in Alberta could prevent an additional 530 - 670 premature mortalities from 2017 to 2055 compared with the RIAS's policy scenario.¹¹

Transition already underway

The transition away from coal has been going on for several years in Canada. The first jurisdiction to phase out coal in North America was Ontario in 2014. The federal government introduced a coal phase-out in 2012 by requiring that coal units meet an annual emissions

⁷ Pembina Institute, *Canada and coal at COP22: Tracking global momentum to end coal-fired power – and why Canada should lead the way* (2016). <http://www.pembina.org/pub/canada-and-coal-at-cop22>

⁸ S&P Global Market Intelligence, *US coal unit retirements pick up ahead of gas conversions*. https://www.snl.com/InteractiveX/Article.aspx?cdid=A-33957588-9259&mkt_tok=3RkMMJWWfF9wsRojvKvLcO%2FhmjTEU5z17+0IXKG1gIkz2EFye+LIHETpodcMSMJnPhHYDBceEJhq

⁹ Environment Canada, *Regulatory Impact Analysis Statement (RIAS), Reduction of Carbon Dioxide Emissions from Coal-fired Generation of Electricity Regulations* (2012). Available in Canada Gazette Part II, Vol. 146, No. 19. http://publications.gc.ca/collections/collection_2012/gazette/SP2-2-146-19.pdf

¹⁰ Pembina Institute, *Out with the coal, in with the new* (2016). <http://www.pembina.org/pub/out-with-coal>

¹¹ The timeline of the modelled early conversions follows the announcements from TransAlta and ATCO. Health benefits were calculated over the same period as the RIAS (2017–2055). The range exists because the RIAS does not model reduction in coal emissions alone, but the reduction in emissions from phasing coal out *and* building natural gas. Pembina estimated the reduction in emissions from coal alone using two different methodologies that are reflected in the range.

standard of 420 tCO₂e/GWh after fifty years of operations. More recently, the Alberta government implemented a coal phase out by the end of 2030. This transition is global. Many countries around the world are joining the Powering Past Coal Alliance with a firm timeline to end coal-fired electricity generation. Most Canadians recognize the need for the transition; 78% of Canadians support a coal phase-out.¹²

Equivalency agreements

A declaration of equivalent provisions under CEPA 1999 constitutes an independent regulatory action of the Governor-in-Council. For this reason, the assessment and finalization (or rejection) of provincial (or territorial) equivalency agreements covering CEPA regulations occurs through a process that is additional to and separate from the process of implementing the ‘original’ federal regulation from which sub-national jurisdictions may seek an exemption. Given this reality, we acknowledge that it is in one sense premature to offer analysis and recommendations in relation to provincial equivalency agreements that—in respect of the proposed amendments—have yet to be struck and are at this stage mostly speculative.

Nonetheless, at least two provincial governments—Nova Scotia and Saskatchewan—have already signalled their intent to negotiate equivalency agreements in relation to the amended regulations on coal-fired power. Through its 2018-2020 Forward Regulatory Plan, Environment and Climate Change Canada has also indicated that it anticipates provincial requests for equivalency vis-à-vis the proposed amendments. As the content of any such equivalency agreements will determine the on-the-ground reality of coal phase-out in Canada—and indeed the (in)completeness of the 2030 federal phase-out objective—we have included in our analysis below a set of principles to guide federal-provincial negotiations in this sphere.

Just transition for workers and communities

Setting firm timelines for coal-to-gas extensions and for the 2030 phase-out provides clarity and certainty to investors, industry, communities and workers. However, additional support and planning is required for a just transition for communities and workers. The Canadian government’s announcement of a Just Transition Taskforce and allocation of \$35 million in the budget to support workers and communities are great first steps. We look forward to the findings of the taskforce and the creation of a holistic transition plan.

¹² National Surveys on Energy and Environment, *Coal, Natural Gas, and Pipelines: 10 Years of Fossil Fuels in NSEE* (2018). <http://closup.umich.edu/files/ieep-nsee-10-year-fossil-fuels.pdf>

Analysis of regulations

GHG Reductions

- The current proposal to regulate coal-fired electricity would reduce greenhouse gas emissions significantly in Canada. In 2014, the electricity sector accounted for 78 Mt of greenhouse gas emissions¹³. Emissions levels from the electricity sector will decrease by 13 Mt in 2030¹⁴, net of reductions from coal retirements and increase from natural gas additions (Figure 1). In addition the federal coal phase-out also provides an important backstop for the Alberta coal phase-out, which has not been legislated but results in a substantial reduction of 9 Mt (technically in 2031 since Alberta coal phase-out has a deadline of December 2030). Note that there remains a gap of 44 Mt to reach our Paris commitment for 2030.

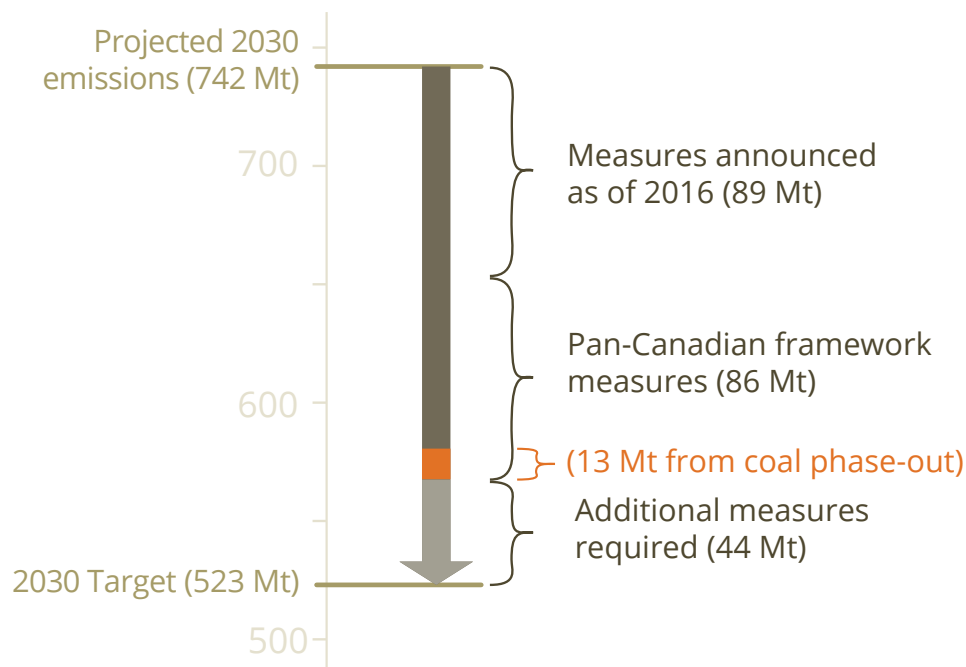


Figure 1. Emissions reductions needed to reach Canada's climate goal (Paris commitment)

Data source: Government of Canada¹⁵

- The impact of delaying the coal phase out by a single year is significant. Indeed, the additional greenhouse gas emissions would be as high as 13 Mt of CO₂ in 2030.

¹³ Environment and Climate Change Canada, Pan-Canadian Framework on Clean Growth and Climate Change, 2016. http://publications.gc.ca/collections/collection_2017/eccc/En4-294-2016-eng.pdf

¹⁴ See Appendix A for the assumptions and scenarios in Pembina's model.

¹⁵ Government of Canada, "Pathway to meeting Canada's 2030 target," *Pan-Canadian Framework on Clean Growth and Climate Change*. <https://www.canada.ca/en/services/environment/weather/climatechange/pan-canadian-framework/pathway-canada-target.html>

- Allowing coal-fired power stations to convert to gas will result in higher emissions than a simple coal phase-out. Compared with a Canada without coal after 2030, the amount of extra emissions resulting from the conversion to inefficient gas technologies in Alberta would fall between 23 Mt and 32 Mt of CO₂ over the 2017-2055 period. Coal-to-gas conversions are beneficial to the environment if they are made ahead of the coal phase-out schedule. Early conversions in Alberta could result in emissions reductions of up to 52 Mt¹⁶ from 2017 to 2055, in addition to the 109 Mt of avoided emissions due to the national coal phase out (Figure 2).¹⁷
- The decision to retire or convert is made on a unit-by-unit basis. However GHG emissions are currently reported on a facility basis. This makes it difficult to monitor unit emissions performance and to discern the effectiveness of these regulations in reducing GHG emissions.

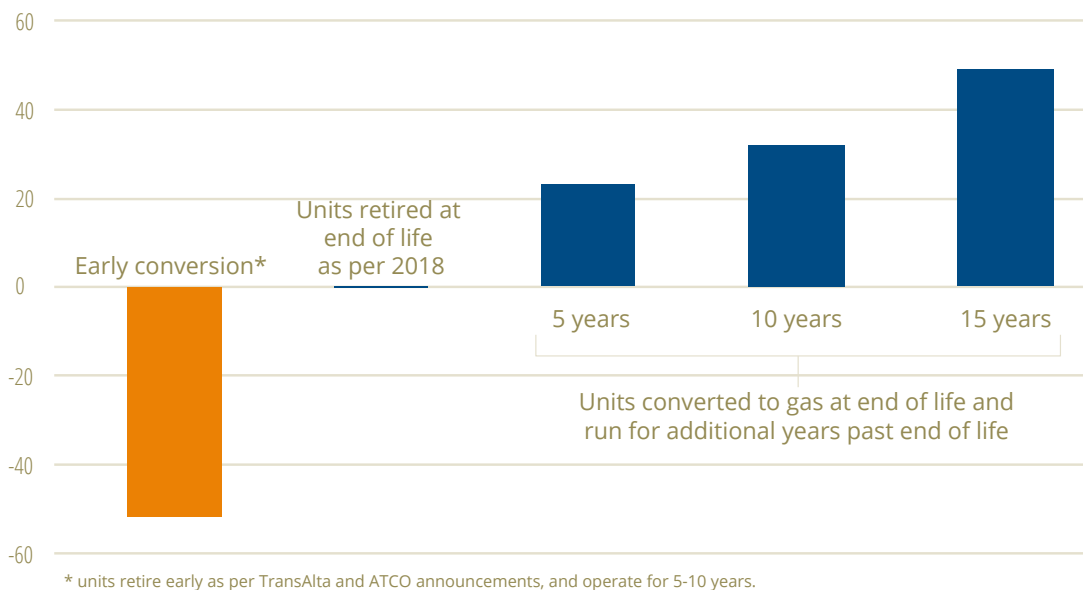


Figure 2. Potential emissions impacts of converting coal units to gas

Data source: Pembina calculations as detailed in the Appendix

Health benefits

- As shown in the Regulatory Impact Assessment Statement, the coal phase out could prevent 264 premature deaths across the country over 2017–2055 period. Following the RIAS’s assumptions, this means between 56 and 71 deaths prevented between 2017 and 2030. Postponing the national coal phase-out to December 2030 instead of December

¹⁶ These reductions assume that coal units are converted to gas following the timelines announced by TransAlta and ATCO. However it should be noted that not all announced conversions may occur or occur as per the announced timeline.

¹⁷ The Pembina Institute’s model predicts a slightly higher emissions reduction than the RIAS, which is 100 Mt.

2029 would have negative health impacts. Similarly any early retirements will result in greater health benefits due to air quality improvement.

Emissions-free electricity

- If all the retired coal capacity is replaced by gas, Canada will miss its target of 90% emissions-free electricity by 2030. The assumptions of the RIAs do not consider the full potential of renewable electricity penetration in the grid. Assuming that only New Brunswick and Nova Scotia will use renewables to partially fill the gap in electricity generation left by retiring coal is not representative of the provinces' commitment to cleaning their grids. However, the Reference case developed in National Energy Board Canada's Energy Future predicts that only 81% of the Canadian electricity grid will be emission-free in 2030.¹⁸ The national coal phase-out must be accompanied with other measures in order to facilitate greater renewable generation and meet the 90% target. An over-investment in gas could result in additional costs for assets that will have to be later retired to meet the 90% target.
- With a national coal phase-out, about 9.8 GW of coal-fired electricity capacity will be retired. The total emissions from the electricity sector will depend greatly on what technologies replace this retiring coal capacity. The details of the replacement technologies, their emissions performance, their capacity factors, and their installed capacity are not explicit in the RIAs. With renewables becoming more cost-competitive, they should account for a majority of the new capacity. Greater capacity factors for renewables, the ability for geographically diverse and resource diverse renewable resources to provide back up for each other, the declining costs of storage, demand side management, and better forecasting tools will enable system operators to manage the grid reliably with greater renewable penetration. Our modelling finds that the coal phase-out results in reductions of 109 Mt of CO₂e when only 12%¹⁹ of the retiring coal capacity is replaced with zero-emission renewable electricity or the increasingly attractive economics of renewable energy compared to natural gas. If higher amounts of renewable electricity were mobilized to replace two-thirds of retired coal capacity, the national coal phase-out would help reduce 155 Mt of CO₂e between 2017 and 2055.

¹⁸ National Energy Board, *Canada's Energy Future 2017: Energy Supply and Demand Projections to 2040*, 2017, p. 8. <http://www.neb-one.gc.ca/nrg/ntgrtd/fttr/2017/pblctn-eng.html>

¹⁹ This assumes that New Brunswick replaces all its coal-fired generation with hydroelectricity imports and Nova Scotia replaces half of its retiring coal-fired generation with hydroelectricity imports.

Carbon capture and storage

The regulations allow for the standard of 420 tCO₂e/GWh to be met through coal with carbon capture and storage. However it should be noted that CCS is the most expensive option available for electricity in Canada (Figure 3).

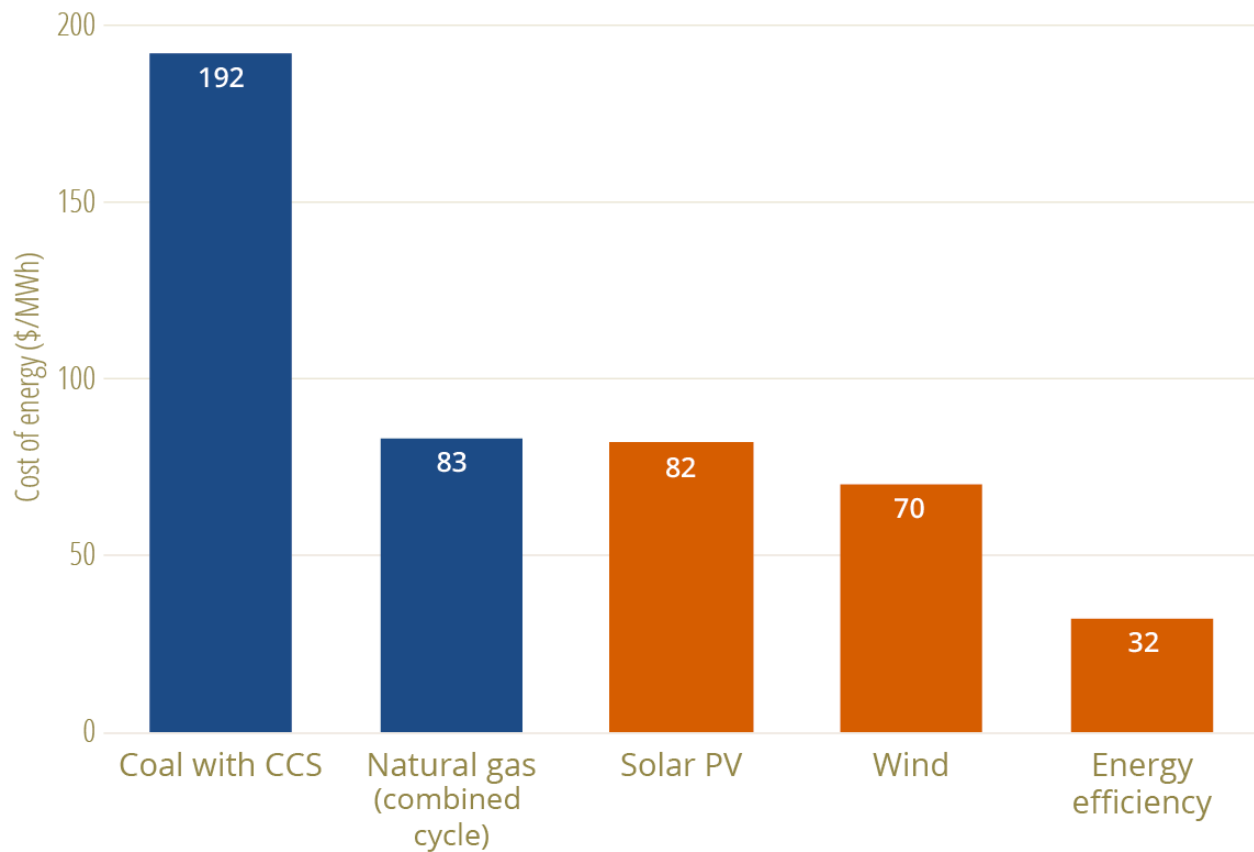


Figure 3: Levelized cost of energy for generation technologies

Data source: Lazard²⁰

In addition, any unit employing CCS will be less efficient than an identical unit lacking CCS, because it takes energy to capture carbon. Figure 4 below, from the National Association of Clean Air Agencies, shows that the loss of efficiency can be substantial. There is a loss of 14 – 41% of electrical output, with most estimates in the 20–30% range.

²⁰ Lazard, *Levelized Cost of Energy Analysis – Version 9.0*, November 2015.

<https://www.lazard.com/media/2390/lazards-levelized-cost-of-energy-analysis-90.pdf>

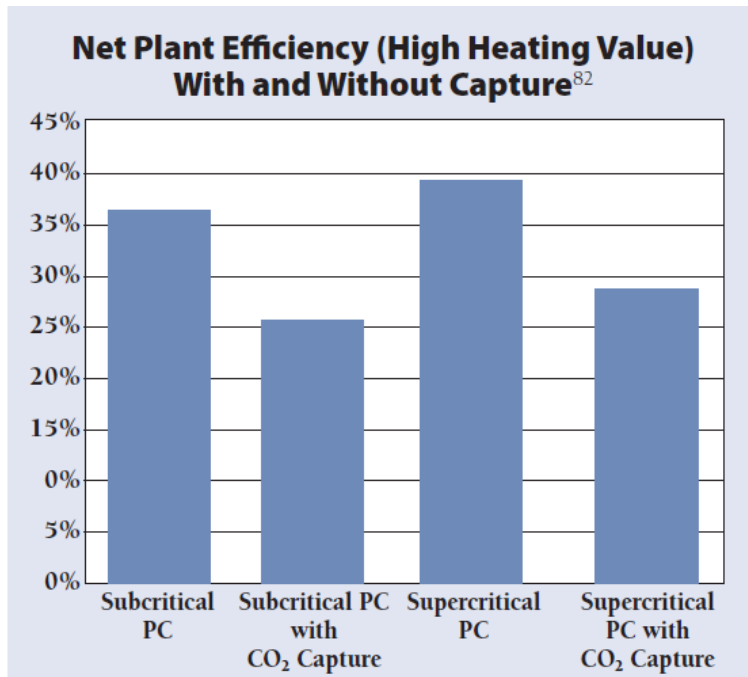


Figure 4: Net plant efficiency with and without carbon capture.

Source: National Association of Clean Air Agencies²¹

This implies that emissions of other air pollutants (especially particulate matter, nitrogen oxides, sulphur oxides, and mercury) from a unit retrofitted with CCS will increase per unit of electrical output (e.g., tonnes/GWh) compared to a unit without CCS, unless the unit is equipped with additional emissions controls.

In OECD countries like Canada where cheaper, lower-emitting options exist for generation, coal with CCS is difficult to justify.

Equivalency agreements

The following principles are key to uphold when considering the equivalency agreements:

- In considering and negotiating the use of any equivalency agreement, the federal government should uphold, develop, and apply the reporting and oversight commitments it made in the Pan-Canadian Framework. These commitments include collaborating to better measure and report on emissions, reporting regularly on policy implementation, engaging external/independent analysis and advice, and periodic review. In particular, once Cabinet issues a declaration of equivalency, the provincial or territorial programs and policies that substitute for stood-down CEPA regulation must be monitored. Given the lack of substantive oversight and public reporting of provincial performance under existing and previous EAs, there is a need for more

²¹ National Association of Clean Air Agencies, *Implementing EPA's Clean Power Plan: A Menu of Options* (2015), 7-15. http://www.4cleanair.org/sites/default/files/Documents/Chapter_7.pdf

rigorous monitoring, evaluation, and reporting by both orders of government. At minimum, the federal government should conduct a collaborative mid-term review (i.e. after 2½ years) of any finalized equivalency agreement.

- Equivalency agreements should achieve GHG emissions reductions that are incremental to the business-as-usual scenario in the subnational jurisdiction or economic sector in question, over the time period for which it was negotiated. In other words, the agreement should cumulatively lead to equivalent (or fewer) GHG and criteria air contaminant emissions as would be anticipated under the federal regulatory regime. Equivalency agreements offer a degree of flexibility in achieving regulatory objectives, but ultimately must support material progress towards Canada's Paris pledge and the objective of the federal rule for which they substitute. They should not be justified or relaxed on the basis of previously existing provincial or territorial mitigation actions.

Nova Scotia

In the case of Nova Scotia, an existing Order-in-Council and corresponding equivalency agreement are already in place covering the 2012 regulation on coal-fired power for the period 2015-2019.²² The Nova Scotia equivalency agreement was granted after the province established a series of multi- and single-year caps on GHGs from its electricity sector. Although equivalency agreements are technically limited to a five-year term under CEPA 1999 (after which they may be jointly renewed or allowed to terminate), the caps were set for the decade following the legal term of the agreement (specifically, the 2021-2030 period). Since then, the Government of Canada and the Nova Scotia government have announced a preliminary agreement-in-principle to negotiate an equivalency agreement in respect of the federal decision to phase out coal by 2030. This preliminary agreement, signed in late 2016, was not publicly released, but reportedly recognized the province's decision to price carbon. It also confirmed that Nova Scotia will be afforded the flexibility to continue operating its coal fleet beyond 2030.²³

As equivalency negotiations relating to the amended federal regulation advance, we urge the federal government to ensure that provincial emission reductions go beyond what would occur under the existing agreement (during the period ending in 2030). Negotiations on equivalency for the amended regulation should treat the business-as-usual scenario as the one in which the amended federal regulation would otherwise apply.

²² Government of Canada, "Order Declaring that the Reduction of Carbon Dioxide Emissions from Coal-fired Generation of Electricity Regulations Do Not Apply in Nova Scotia," *Canada Gazette, Part 2* (Nov. 2014). <http://gazette.gc.ca/rp-pr/p2/2014/2014-12-03/html/sor-dors265-eng.html>

²³ "Nova Scotia reaches Climate Change Agreement," Premier's Office (Nov. 21, 2016). <https://novascotia.ca/news/release/?id=20161121003>

Saskatchewan

There is no existing equivalency agreement for Saskatchewan. However, the provincial utility (SaskPower) has provided an indication of the government's strategy through its commitments to (i) source 50% of its generating capacity from renewables by 2030 and (ii) achieve a 40% annual reduction in sectoral GHG emissions from 2005 levels by 2030.²⁴ Though an equivalency agreement has not been finalized, the provincial government has passed regulations establishing multi-year cumulative caps on sectoral emissions.²⁵ These regulations in effect substitute the unit-by-unit approach of the proposed (and existing) federal rule for one that permits SaskPower to achieve emissions reductions on a fleet-wide basis. The reductions in GHGs and Criteria Air Contaminants anticipated from Saskatchewan's policy commitments should be measured against the reductions from the federal regulations (to be determined through modelling of the anticipated counterfactual scenario).

Saskatchewan is also the only province to have outfitted a coal-fired unit (Boundary Dam 3) with CCS. The federal regulations allow for coal units to meet the performance standard through CCS. Within the equivalency agreement, we recommend that the performance of the existing unit and any future CCS retrofits should exceed that of a modern natural gas combined-cycle facility in terms of GHG emissions as well as criteria air contaminants. Pursuant to criterion set out in paragraph 2(c) of the proposed federal amendments (replacing subsection 3(5) of the current regulation), equivalency agreements should also outline expectations for reporting and verification of the permanent storage of carbon dioxide emissions.

Recommendations

- **Phase-out timeline:** Phase-out by December 2029 should be maintained as a minimum for Canada to meet its coal phase-out commitments and continue to lead the Powering Past Coal Coalition.
- **Data:** Annual unit GHG and CAC emissions data and annual generation data should be made available to the public to ensure transparency and allow for public scrutiny of the units.
- **RIAS:** The RIAS should include the impacts of coal-to-gas conversions. It should also outline further details on the assumptions regarding the forecasted generation mix, particularly the amount of combined cycle and simple cycle and coal-to-gas converted generation over the timeline of the analysis. Data from the modelling conducted for the RIAS should be made available to the public.

²⁴ Government of Saskatchewan, *Prairie Resilience: A Made-in-Saskatchewan Climate Change Strategy* (2015),

²⁵ Government of Saskatchewan, *The Management and Reduction of Greenhouse Gases Act*, Saskatchewan Gazette, Part 2 (Dec. 6, 2017), 967-972. <http://www.publications.gov.sk.ca/freelaw/documents/gazette/part2/2017/G2201750.pdf>

- **Equivalency agreements:** The negotiation of equivalency agreements should be guided by a commitment to greater transparency. Assessments of “equivalent outcome” should require prospective stand-in provincial regulatory regimes to achieve reductions in GHG emissions and criteria air contaminants that are at least cumulatively equivalent to the business-as-usual case (where the amended federal coal regulations would apply) over the same period.

Appendix A: Modelling impacts of the regulation

The Pembina Institute modeled the emissions from coal plants and the replacement generation over the period of analysis in the RIAS, 2017 to 2055. Although the initial intent was to try to replicate RIAS's modelling, Pembina's model also includes the health and climate impacts of different scenarios for how plants might be retired and converted to gas.

Model Results

Table 1: GHG emissions in the business-as-usual scenario

	GHG emissions in 2030 (Mt CO ₂ e)	Cumulative GHG emissions between 2017 and 2055 (Mt CO ₂ e)
Business As Usual (includes 2012 Federal coal regulations and Alberta's coal phase out by the end of 2030)	63	2,506

Table 2: GHG benefits of different scenarios (with business-as-usual scenario as a baseline)

	In 2030 (Mt CO ₂ e)	Over the 2017 – 2055 period (Mt CO ₂ e)
Policy scenario	- 13	- 109
Coal phase out with coal-to-gas conversions (5 years life)	- 9	- 86
Coal phase out with coal-to-gas conversions (10 years life)	- 10	- 77
Coal phase out with coal-to-gas conversions (15 years life)	- 10	- 60
Early coal-to-gas conversions in AB	- 9	- 161

Table 4: Avoided premature deaths additional to the BAU scenario

	2017 – 2055
2018 Amended federal coal regulations	264
2018 Amended federal coal regulations with phase-out by December 2030	[193 – 209]
Early coal-to-gas conversions in AB	[804 – 993]

Scenarios

Business As Usual / Baseline scenario: It includes retirement of coal plants as per the 2012 federal regulation, “Reduction of Carbon Dioxide Emissions from Coal-fired Generation of Electricity Regulations,” and the phase-out of coal in Alberta by 2030 as per Alberta’s Climate Leadership Plan²⁶ (that is, Alberta coal plants are retired in December 2030).

National coal phase-out / Policy / 2018 federal regulations scenario: This models the scenario in the Regulatory Impact Assessment Statement (RIAS). It includes the baseline scenario together with 2018 amendment to the federal coal regulations. Its schedule follows the same schedule as the baseline scenario, except that all plants with an end of life after December 2029 are retired in December 2029.

Coal-to-gas conversion scenarios: These build on the policy scenario, and include the conversion of coal units in Alberta to gas-fired units. The variations of the scenario modeled are:

- Coal phase out with coal-to-gas conversions (5/10/15 years) – These scenarios include the conversion of coal plants to gas at their scheduled end of life, with the units assumed to operate for 5/10/15 years beyond their end of life.
- Early coal-to-gas conversions in Alberta – This scenario models the TransAlta and ATCO announcements for mothballing and conversion of units.

²⁶ Government of Alberta, “Phasing out coal pollution.” <https://www.alberta.ca/climate-coal-electricity.aspx>

Methodology and assumptions

Emissions intensity and capacity factor for coal-to-gas conversions

These depended on the scenario considered:

- Coal-to-gas conversions with five-year extension: 700 t CO₂e / GWh annual intensity for five years at a 30% capacity factor
- Coal-to-gas conversions with ten-year extension: 610 t CO₂e / GWh intensity for ten years at a 30% capacity factor
- Coal-to-gas conversions with fifteen-year extension: 610 t CO₂e / GWh intensity for fifteen years at a 30% capacity factor
- Early coal-to-gas conversions in Alberta: All units are assumed to operate at 30% capacity factor and follow the schedule below as per the conversion announcements by TransAlta and ATCO.

Table 3: Schedule and assumptions for early conversions of coal units to gas

Unit	End of Life	Year mothballed	Year converted to gas	Years of operation of converted unit	Average emissions intensity (t CO ₂ e/GWh)
Milner 1	2019		2020	7	700
Battle River 3	2019		2019	5	700
Battle River 4	2019		2020	10	700
Sundance 1	2019	2018 (retired)	N/A	0	700
Sundance 2	2019	2018 + 2019	2023	5	700
Sundance 3	2023	2018 + 2019	2022	9	700
Sundance 4	2026	2019	2022	10	700
Sundance 5	2026	2018	2022	11	700
Sundance 6	2027		2022	13	700
Battle River 5	2028		2020	15	700
Keephills 1	2029		2022	13	700
Keephills 2	2029		2022	13	700
Sheerness 1	2029		2020	15	700
Sheerness 2	2029		2020	15	700
Genesee 2	2029		2029	5	700
Genesee 1	2029		2029	5	700
Genesee 3	2029		2029	10	610
Keephills 3	2029		2029	10	610

Replacement of retired coal capacity

The assumptions around replacement capacity are the same as the ones used in the RIAS. In the Pembina model coal-fired electricity is replaced with 12 % of zero-emission renewable electricity. The remaining 88 % of retiring coal-fired generation is replaced with natural gas-fired electricity (at a 460 t CO₂e / GWh emissions intensity, national average in 2015²⁷). This ratio is based on the following details from the RIAS:

- New Brunswick replaces its coal capacity with hydro imports.
- Nova Scotia replaces half of its coal capacity with hydro imports, the rest with natural gas-fired electricity.
- Alberta and Saskatchewan replace 100 % of their coal-fired electricity with natural gas-fired generation. This assumption is not representative of our current reality in which provinces have renewables targets.

The model takes into account a 0.9 % increase per year in electricity demand as predicted in National Energy Board's Canada's Energy Future.²⁸ The additional demand is assumed to be met by the same generation mix of 12 % renewables and 88 % gas.

We have not made the distinction between electricity coming from new and efficient gas-fired power stations and increased generation coming from existing plants when coal-fired power stations retire. This makes our analysis conservative as new gas-fired generation will likely emit less than the current national average intensity of 460 t CO₂e / GWh.

Excluded units

The Boundary Dam unit 3 (SK) plant is not included in the calculations because it is equipped with carbon capture technologies. The Coleson Cove (NB) plant is not included in the calculations because it burns a mix of heavy oil and petcoke, not coal. The Brandon Power plant (MB) is not included in the calculations because it is considered as a backup plant.

Health impact estimates

The emissions and health impacts of electricity generated from supercritical coal units were assumed to be the same as from subcritical units. This assumption is expected to have little impact on the analysis given the small number of supercritical coal-fired power stations in Canada (e.g. in Alberta they account for 15% of provincial coal capacity).

²⁷ Environment and Climate Change Canada, *National Inventory Report 1990 – 2015 Greenhouse Gas Sources and Sinks in Canada*, 2017.

²⁸ National Energy Board, *Canada Energy Futures 2017*, 2017.

To estimate the number of saved lives due to the retirement of coal power plants, results from the RIAs were extrapolated. The relationship between electricity generation from coal and the number of related premature mortalities was assumed to be linear. Instead of taking a national average, our model differentiates the magnitude of the health impacts from coal for each province.

Data sources

The model uses data from the following sources:

- Environment Canada, Regulatory Impact Analysis Statement (RIAS), Reduction of Carbon Dioxide Emissions from Coal-fired Generation of Electricity Regulations (2012). Available in Canada Gazette Part II, Vol. 146, No. 19. http://publications.gc.ca/collections/collection_2012/gazette/SP2-2-146-19.pdf
- Environment Canada, Regulatory Impact Analysis Statement (RIAS), Regulations Amending the Reduction of Carbon Dioxide Emissions from Coal-fired Generation of Electricity Regulations (2018). Available in Canada Gazette Part I, Vol. 152 (2018). <http://gazette.gc.ca/rp-pr/p1/2018/2018-02-17/html/reg3-eng.html>
- TransAlta, TransAlta announces Accelerated Transition to Clean Energy, media release, December 6, 2017. <https://www.transalta.com/newsroom/news-releases/transalta-announces-accelerated-transition-clean-energy/>
- Geoffrey Morgan, “Alberta could be coal-free years ahead of deadline as ATCO plans transition to natural gas by 2020,” Financial Post, May 10, 2017. <http://business.financialpost.com/g00/commodities/energy/alberta-could-be-coal-free-years-ahead-of-deadline-as-atco-plans-transition-to-natural-gas-by-2020?i10c.encReferrer=aHR0cHM6Ly93d3cuZ29vZ2xlLmNhLw%3D%3D&i10c.ua=1>
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