PEMBINA institute

Canada's Energy Policy Simulator

Frequently Asked Questions | Last updated June 2019

1. How does the Energy Policy Simulator work?

The Energy Policy Simulator (EPS) is a system dynamics computer model created in a commercial program called Vensim.[1] The model allows users to control and combine 58 policies that affect energy use and emissions in various sectors of the economy (such as carbon pricing, fuel economy standards for vehicles, regulations on methane leakage from industrial activity, and accelerated technology research and development).

The EPS is designed to operate on a national scale and includes every major sector of the economy. The web-based version of the EPS allows users to test the effects of common climate and energy policies in a user-friendly interface. The downloadable version of the model is distributed with a complete set of input data and reads in all of its input data from external csv files, which are generated by accompanying Excel files. These are included in the model distribution and it is therefore possible to change any of the model's input data without purchasing a commercial version of Vensim. Extensive documentation about the model structure and design is available online.[2]

2. What are the main data sources used in the Canada EPS?

The best available public data, primarily sourced from governmental bodies (e.g., the National Energy Board, Statistics Canada, National Resources Canada and Transport Canada) was used to build the Canada EPS. Input data files are available in the downloadable version of the model.[3] When Canadian data sources were not available, U.S. data were used. Although most U.S. data is used for not-geographically specific data (e.g. technology details) there are a few cases where U.S. data is scaled to the Canadian context (variables relying on U.S. data are clearly documented in the downloadable version of the model). Wherever possible, data was drawn from sources available in early 2016, before the implementation of any Pan-Canadian

[1] Vensim. http://vensim.com/

[2] Energy Innovation, "Energy Policy Simulator Documentation," Policy Solutions. https://us.energypolicy.solutions/docs/index.html

[3] Energy Innovation, *Energy Policy Simulator*. https://us.energypolicy.solutions/eps-archive/eps-1.4.2-canada.zip

Framework on Clean Growth and Climate Change (PCF)[4] policies. In this way, the business-as-usual (BAU) scenario represents emissions in the absence of PCF policies, and their impact can be calculated independently. One notable exception is the policies developed and implemented before 2016 and later included in the PCF, which are included in the BAU scenario.

3. How can I modify the model and/or run it locally on my personal computer or device? How can I modify the assumptions made for the business-as-usual scenario?

The Canada EPS is designed to be used in two ways: through the web interface and through the downloadable version. To download the model and access its full capabilities, you must download Vensim Model Reader software.[5] Vensim is a tool produced by Ventana Systems to create and simulate system dynamics models. While Vensim is sold in several tiers, Ventana Systems offers a free Vensim Model Reader that can read and simulate (but not edit) models.

Directions on how to obtain Vensim Model Reader can be found on the Download and Installation Instructions page[6] (these are for the U.S. version of the model, but the same instructions can be followed for the Canada EPS.). Vensim Model Reader will allow you to run the model on your personal computer, view and adjust all assumptions and input data—including those that went into building the BAU scenario—and customize outputs. Note: to make changes to the structure or function of the model, you need the commercial version of Vensim DSS.[7]

4. What policies are included in the business-as-usual scenario?

The BAU scenario is primarily based on data from early 2016, generally before any PCF policies were implemented. This was done so that the model could be used to estimate the PCF's effect. Therefore, the BAU scenario includes policies that were on the books in early 2016, including Canada's existing federal Renewable Fuel Regulations[8] mandating renewable content in

[4] Government of Canada, *Pan-Canadian Framework on Clean Growth and Climate Change* (2017). https://www.canada.ca/en/services/environment/weather/climatechange/pan-canadian-framework.html

[5] Vensim, "Free Downloads." http://vensim.com/free-download/

[6] Energy Innovation, "Download and Installation Instructions." https://us.energypolicy.solutions/docs/download.html

[7] Vensim, "Purchase Vensim." http://vensim.com/purchase/

[8] Environment Canada, "Revised questions and answers on the Federal Renewable Fuels Regulations: part 1." https://www.canada.ca/en/environment-climate-change/services/canadian-environmental-protection-act-registry/publications/revised-questions-answers-renewable-fuels/part-1.html

gasoline and diesel (represented in the model as roughly equivalent to a low-carbon fuel standard set at 2% stringency) and fluorinated greenhouse gas (F-gas) reductions announced in the Kigali Amendment to the Montréal Protocol.[9] The BAU scenario does not include any of the policies announced in November 2015 in the Alberta Climate Leadership Plan.[10]

5. What renewable electricity policies are included in the business-as-usual scenario?

Jurisdiction over electricity generation generally falls under provinces and territories in Canada. While several provincial renewable electricity policies are now in place in Canada, not all of these had been passed into law by 2016 — the cut-off year for the EPS model's input data. Thus, all provincial electricity sector policies, with the exception of Alberta's and Saskatchewan's, are included in the EPS' BAU scenario. This includes the B.C. Clean Energy Act (in effect since 2010), Nova Scotia electricity sector regulations (Renewable Portfolio Standard in effect since 2011), Ontario coal phase out and natural gas demand-side management, among others. Alberta and Saskatchewan's renewable electricity policies enacted after 2016 are included in the PCF and PCF Extended policy scenarios. For Alberta, these scenarios include the plan to build 6,200 MW of onshore wind power generation to meet the province's 30% renewable electricity target by 2030. For Saskatchewan, they include the first stages of wind and solar energy procurement announced to meet the province's objective to source 50% of its power from renewables by 2030. Further details on what is included in these policy scenarios can be found in the "ScenarioData.xlsx", found in the downloadable version.[11]

6. Which global warming potentials does the Canada EPS use?

The Canada EPS uses the 100-year GWPs provided by the Intergovernmental Panel on Climate Change (IPCC) in its Fifth Assessment Report (AR5).[12] This information is more recent than that used by Environment and Climate Change Canada for greenhouse gas emissions reporting,[13] which still employs GWP from IPCC's Fourth Assessment Report (AR4). It should be

[9] Government of Canada, *Regulations Amending the Ozone-depleting Substances and Halocarbon Alternatives Regulations SOR/2017-216*. http://www.gazette.gc.ca/rp-pr/p2/2017/2017-10-18/html/sor-dors216-eng.html

[10] Government of Alberta, *Climate Leadership Plan* (2015). https://www.alberta.ca/climate-leadership-plan.aspx

[11] Energy Innovation, *Energy Policy Simulator*. https://us.energypolicy.solutions/eps-archive/eps-1.4.2-canada.zip

[12] IPCC, *Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change* (2013). http://www.ipcc.ch/report/ar5/wg1/

[13] Environment and Climate Change Canada, "Global warming potentials." https://www.canada.ca/en/environment- climate-change/services/climate-change/greenhouse-gas-emissions/quantification-guidance/global-warming- potentials.html

noted that ECCC emissions accounting, reported via Common Reporting Format tables, is nonetheless consistent with the foundational 2006 Guidelines for National Greenhouse Gas Inventories laid out by the IPCC.[14]

7. Why do GHG emissions in the business-as-usual scenario differ from federal government projections?

The BAU scenario in the Canada Energy Policy Simulator projects emissions in 2017 (the starting year for the model) at a considerably higher level than the official government estimates given in either Canada's 2016 GHG Reference Case[15] or in its 3rd Biennial Report (2017) to the UNFCCC.[16] There are several reasons for this; chief among them is the Pembina Institute's use of a more aggressive estimate of methane leakage in the oil and gas sector, which in turn reflects the most recent science on the subject.[17] It also includes emissions from marine bunker fuels in the transport and shipping sub-sector, which are not in official government accounting methodology. Finally, as explained in Question 6, the model also uses the most up-to-date factors (from the IPCC's AR5) to describe the Global Warming Potential (GWP) of different greenhouse gases. This choice moderately inflates the total estimate of carbon dioxide-equivalent emissions. For these reasons, near- and mid-term Canadian emissions in the EPS appear to be higher than would otherwise be suggested by Canada's official historical record of greenhouse gas emissions. To be clear, the Pembina Institute continues to trust in the accuracy of the national emissions inventory as constructed by Environment and Climate Change Canada. The BAU model results of the EPS are, by contrast, illustrative of a high-end estimate for what overall emissions could be, if more comprehensive data (particularly for oil-and-gas-sector methane emissions) were available, and if Canada were to apply the most up-to-date GWP factors (see Q1-2-11 on the IPCC website).[18]

---

[14] IPCC, *2006 IPCC Guidelines for National Greenhouse Gas Inventories – A primer* (2008). https://www.ipcc-nggip.iges.or.jp/support/Primer_2006GLs.pdf

[15] Environment and Climate Change Canada, "Canada's 2016 greenhouse gas emissions reference case." https://www.canada.ca/en/environment-climate-change/services/climate-change/publications/2016-greenhouse-gas-emissions-case.html

[16] Government of Canada, *Canada's Seventh National Communication on Climate Change and Third Biennial Report—Actions to meet commitments under the United Nations Framework Convention on Climate Change* (2017). http://unfccc.int/files/national_reports/national_communications_and_biennial_reports/application/pdf/4623051_canada-br3-nc7-1-5108_eccc_can7thncomm3rdbi-report_en_04_web.pdf

[17] Matthew R. Johnson et al., "Comparisons of Airborne Measurements and Inventory Estimates of Methane Emissions in the Alberta Upstream Oil and Gas Sector," *Environmental Science and Technology* 51 (2017). https://pubs.acs.org/doi/abs/10.1021/acs.est.7b03525

[18] IPCC Task Force on National Greenhouse Gas Inventories, "FAQs." https://www.ipcc-nggip.iges.or.jp/faq/faq.html

8. Why does the 2030 target differ from the one in Canada's Nationally Determined Contribution submission?

The absolute levels of Canada's emissions targets usually vary over time, as changes in underlying historical data are incorporated into each new annual GHG inventory report Canada submits to the United Nations. This is because national targets are usually expressed as percentage reductions below a baseline year (e.g., 30% below 2005 levels). Aside from this shifting baseline, the national 2030 Paris target (as displayed in the Canada EPS, at a level of 545 Mt) still differs from its value in Canada's 2017 NDC submission to the Secretariat of the United Nations Framework Convention on Climate Change (517 Mt).[19] As explained in Question 7, this is because the Canada EPS uses a unique methodology, including updated global warming potentials for non-CO_2 greenhouse gases from the Fifth Assessment Report from the International Panel on Climate Change. The simulator also includes some types of emissions and sequestration that were not included or were handled differently in the government's analysis, for example, bunker fuels, biomass fuels, higher estimates of methane leakage from oil and gas operations. The target used is identical to the government's target after accounting for these methodological differences. Calculation of the 2030 and 2050 targets, adjusted based on EPS methodology from the original government targets, is explained in the "WebAppData" file.[20]

9. How were the 2030 and 2050 targets calculated?

In the simulator, Canada's emissions targets display was adjusted to account for methodological differences between Canada's official emission inventory (as calculated by the federal government) and the way the EPS calculates projections. The core EPS model structure is designed to produce future projections of emissions and other variables. However, given differences in both the baseline/BAU scenario and the level of national GHGs in 2017 (the start-year for the model run), it becomes necessary to calculate adjusted 2030 and 2050 emissions targets (corresponding to 30% and 80-90% below adjusted 2005 levels, respectively). This step ensures analyses and comparisons of policy packages are made on an "apples-to-apples" basis within the simulator. To implement the adjustment, the Pembina Institute constructed a back-cast of EPS baseline emissions to 2005, then recalculated the targets for 2030 and 2050 based on this adjusted figure for the climate-target reference year. This calculation was done using the proportional difference between the EPS' baseline emissions and government-reported emissions in 2017, and can be seen in the "WebAppData.xlsx" file.[21] For reference, the back-

[19] NDC Registry, "Canada." https://www4.unfccc.int/sites/NDCStaging/Pages/Party.aspx?party=CAN

[20] Energy Innovation, Energy Policy Simulator. https://us.energypolicy.solutions/eps-archive/eps-1.4.2-canada.zip

[21] Energy Innovation, *Energy Policy Simulator.* https://us.energypolicy.solutions/eps-archive/eps-1.4.2-canada.zip

cast level of national emissions (excluding Land Use, Land-Use Change, and Forestry) in 2005 was 796 Mt. In comparison, the National Inventory Report 2017 (used for Canada's NDC submission under the Paris Agreement) reports 738 Mt for national emissions in 2005.

10. Which policies are included in the Pan-Canadian Framework scenario?

The PCF scenario represents the emissions trajectory expected when including already announced PCF policies, including carbon pricing, F-gas emissions reductions from industry, phasing out coal by 2030, the federal clean fuel standard, etc. The PCF scenario includes no assumed improvement beyond what has already been announced. For example, the carbon pricing policy increases from $20/tonne in 2019 to $50/tonne in 2022, then holds constant at $50/tonne thereafter. For PCF policies that are expected to be negotiated via provincial equivalency agreements (such as the coal phase-out in New Brunswick and Saskatchewan, and methane regulations in B.C., Alberta and Saskatchewan) it was assumed that equivalency agreements will deliver similar outcomes as the federal policies, and the federal policies were therefore modeled as stated in the PCF. It is important to note the EPS works in inflation-adjusted financial units, so the carbon pricing policy lever used in the PCF (and PCF Extended) policy scenario has been adjusted to reflect Canada's current policy reality under the federal Greenhouse Gas Pollution Pricing Act, 2018, which established Canada's "backstop" national carbon pricing system and does not index price levels to inflation.[22] A file (ScenarioData.xlsx) explains each policy, stringency and implementation schedule used to build the PCF scenario.[23]

11. What policies are included in the PCF Extended to Mid-Century scenario?

The PCF Extended to Mid-Century scenario increases the ambition of the PCF scenario by assuming that PCF policies do not stagnate when they reach their announced end dates (by 2030 or earlier). Instead, they strengthen at a constant rate through 2050, or until their full potential is realized, whichever comes first. For example, the carbon pricing policy increases at the same rate of $10/tonne per year from $10/tonne in 2018 to $330/tonne in 2050. A file (ScenarioData.xlsx) explains each policy, stringency and implementation schedule used to build the PCF Extended scenario.[24]

---

[22] Government of Canada, *Greenhouse Gas Pollution Pricing Act* S.C. 2018, c. 12, s. 186. https://laws-lois.justice.gc.ca/eng/acts/G-11.55/

[23] Energy Innovation, *Energy Policy Simulator*. https://us.energypolicy.solutions/eps-archive/eps-1.4.2-canada.zip

[24] Energy Innovation, *Energy Policy Simulator*. https://us.energypolicy.solutions/eps-archive/eps-1.4.2-canada.zip

12. What policies are included in the youth policy design winner scenario?

The youth policy design winner scenario was developed by a Canadian university student as part of the Pembina Institute's youth energy policy design competition[25] in Spring 2019. Students were asked to create an optimal policy package designed to ensure Canada meets its climate goals in 2030 and beyond. The winning scenario includes a carbon price that increases to $330/tonne by 2050, a zero emissions vehicle sales mandate of 100% by 2040, and annual retrofitting of 0.5% of commercial buildings starting in 2019, among other policies. The accompanying report explaining this scenario is available here. A file (ScenarioData.xlsx) also explains each policy, stringency and implementation schedule used to build the youth policy design winner scenario.[26]

13. How can land use emissions reductions contribute to Canada's targets?

Under international standards, countries must be consistent in the inclusion or exclusion of all terrestrial carbon fluxes when reporting emissions and targets. If reductions in emissions from forest management are included, then so must be the increase in emissions from other terrestrial carbon fluxes such as forest fires, forest die-backs, and melting permafrost. Canada's 2030 and 2050 emissions targets do not include the impacts, either as CO_2 source or sink, of land use. The policy lever to improve land use management only considers potential improvements, so any emission reductions resulting from improved management must be netted against the increases from these other emission sources, which are out of the scope of the EPS model.

14. What assumptions does the EPS make about economic growth?

The EPS is an energy model, not an economic model, so it deals with first order economic variables, and makes no assumptions about second order variables such as Gross Domestic Product (GDP). There are, however, some economic growth assumptions embedded in various input data variables used to design the business-as-usual scenario. An example of this is expected oil and gas production growth. All data used is thoroughly cited and freely available

[25] Pembina Institute, *2019 Youth Energy Policy Design Competition*. https://www.pembina.org/event/2019-youth-energy-policy-design-competition

[26] Energy Innovation, *Energy Policy Simulator*. https://us.energypolicy.solutions/eps-archive/eps-1.4.2-canada.zip

for download.[27] The EPS offers a few first order economic outputs to investigate the financial implications of policy scenarios, with financial outputs including first order cash flow between actors, changes in capital expenditure, marginal abatement cost curves, among others.

15. How does the EPS model carbon pricing?

The EPS models the effect of a carbon price on the economy through the elasticity of production with respect to fuel cost.[28] It takes a broad approach to modeling the effect of a carbon price in order for this approach to be applicable to other jurisdictions in other versions of the model. The EPS therefore does not model the complexity of Canada's carbon pricing regulations that institute a performance benchmark for emissions-intensive and trade-exposed industries, such as the Industrial Incentive Program in B.C. and the Carbon Competitiveness Incentive Regulation in Alberta. Nevertheless, while individual companies may be paying a lower average carbon price under these systems than under the flat carbon price modeled by the EPS, the marginal cost of reducing one tonne of carbon emissions is similar under the two approaches. For this reason, the EPS approach is a good proxy to estimate the overall emission reductions achievable by pricing carbon in Canada. It is important to note that cogeneration and the conversion of coal plants to gas plants is not sensitive to carbon pricing in the EPS. It is also important to note that the EPS works in inflation-adjusted units and assumes a 2% annual inflation rate, whereas Canada's carbon tax is not indexed to inflation. For this reason, policy packages in which we have modeled a carbon price, we have discounted the price by 2% per year to account for this difference.

If your question is not answered here, please feel free to ask us at policysolutions@pembina.org.

[27] Energy Innovation, *Energy Policy Simulator*. https://us.energypolicy.solutions/eps-archive/eps-1.4.2-canada.zip

[28] Energy Innovation, "Fuels." https://us.energypolicy.solutions/docs/fuels.html#carbon-tax