PEMBINA institute

Alberta's Energy Policy Simulator

Frequently Asked Questions | Last updated on March 14, 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 50+ 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 jurisdiction 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 Alberta's 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 "Pre-2016 Business-as-usual" scenario included in the Alberta EPS. When Albertan (or 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 Albertan context (variables relying on U.S. data are clearly documented in the downloadable version of the model.)[3] Wherever possible, data was drawn from sources available in early 2016, before the implementation of any policies related to the

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

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

[3] Pembina Institute and Energy Innovation, *Alberta Energy Policy Simulator*. https://us.energypolicy.solutions/eps-archive/eps-1.4.2-alberta.zip

Alberta Climate Leadership Plan[4] or the Pan-Canadian Framework on Clean Growth and Climate Change (PCF).[5] In this way, the "Pre-2016 Business-as-usual" scenario represents emissions in the absence of recent energy and climate policies, and their impact can be calculated independently. Because the EPS is free and open-source, anyone can change underlying assumptions and explore the effect on Alberta's energy system. You can download all the input data files and see every source used in the downloadable version of the model.[6]

3. What policies are included in the "Pre-2016 Business-as-usual" scenario?

The "Pre-2016 Business-as-usual" scenario is primarily based on data from early 2016, generally before any policies from the Alberta Climate Leadership Plan (CLP) or the Pan-Canadian Framework policies were implemented. This was done so that the model could be used to estimate the effect of recent energy and climate policies. Therefore, the "Pre-2016 Business-as-usual" scenario includes policies that were on the books in early 2016.

4. 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 Alberta 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. 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[7] (these are for the U.S. version of the model, but the same instructions can be followed for the Alberta EPS). Vensim Model Reader[8] 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

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

[5] 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

[6] Pembina Institute and Energy Innovation, *Alberta Energy Policy Simulator*. https://us.energypolicy.solutions/eps-archive/eps-1.4.2-alberta.zip

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

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

make changes to the structure or function of the model, you need the commercial version of Vensim DSS.[9]

5. How can I load and modify the "Current policy" scenario?

When loaded for the first time, the web-based version of the Alberta EPS displays three scenarios: the "Pre-2016 Business-as-usual" scenario (top curve), the "Current policy" scenario (bottom curve), as well as a "New scenario" which overlaps the "Pre-2016 Business-as-usual" scenario. The reason is that the EPS was built to derive users' scenarios from the business-as-usual case. You can load and make modifications to the "Current policy" scenario in just one click: click on the "Policy Scenario Selector" dropdown menu in the top-left corner of the webpage and select the "Current policy scenario" (see Figure 1). This will load the scenario, including the "Policy settings" associated with this scenario (Figure 2), which a user can modify. A watch displayed next to a policy setting indicates that an implementation schedule has been set to phase in this policy. In the example of the carbon tax, while the lever indicates it is set at $50 per tonne, an ad-hoc implementation schedule allows for its value to be $20 in 2017, $30 between 2018 and 2020, $40 in 2021 and $50 in 2022. The implementation schedule also discounts the carbon tax by 2% after 2022 to account for the fact the carbon tax is not indexed on inflation (while the EPS assumes a 2% annual inflation rate).

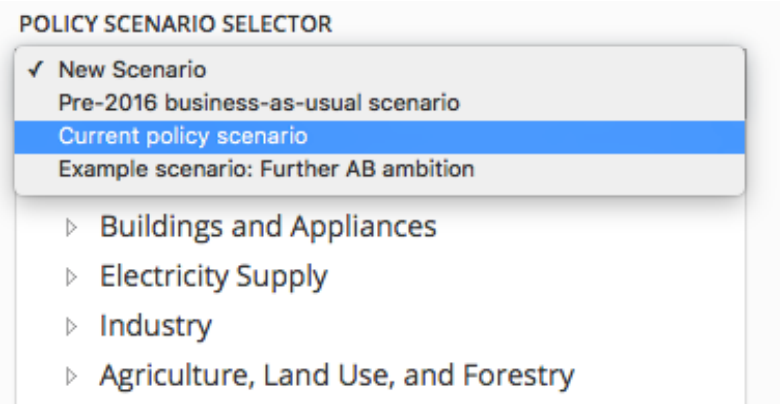

Figure 1. Screenshot of the web-based interface of the AB-EPS: how to select the "Current policy" scenario

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

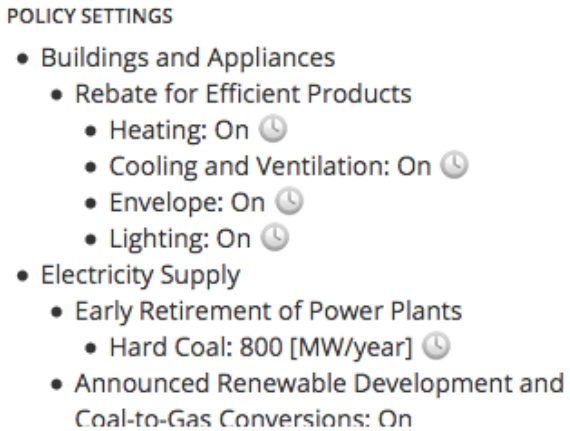

Figure 2. Screenshot of the web-based interface of the AB-EPS: policy settings associated with a given scenario are loaded in the bottom-left corner of the webpage

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

The Alberta EPS uses the 100-year Global Warming Potential (GWPs) provided by the Intergovernmental Panel on Climate Change (IPCC) in its Fifth Assessment Report (AR5).[10] This information is more recent than that used by Environment and Climate Change Canada for greenhouse gas emissions reporting,[11] which still employs GWPs from IPCC's Fourth Assessment Report (AR4). It should be 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.[12]

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

The "Pre-2016 Business-as-usual" scenario in the Alberta Energy Policy Simulator projects emissions in 2017 (the starting year for the model) at a slightly higher level than the official government estimates for recent years.[13] One main reason for this is the fact the model uses the most up-to-date factors (from the IPCC's AR5) to describe the GWP of different greenhouse

[10] 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/

[11] 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

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

[13] Environment and Climate Change Canada, *National Inventory Report* (2018). https://www.canada.ca/en/environment-climate-change/services/climate-change/greenhouse-gas-emissions/sources-sinks-executive-summary-2018.html

gases (see previous question). This choice moderately inflates the total estimate of carbon dioxide-equivalent emissions. For this reason, near- and mid-term Albertan 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. When applying GWPs from the AR4, the results from the Alberta EPS align with the latest historical estimate from Environment and Climate Change Canada (ECCC) for 2016[14] as well as the 2016 emissions forecast[15] — the latest forecast produced by ECCC that does not consider recent energy and climate policies — as shown in the below graphic.

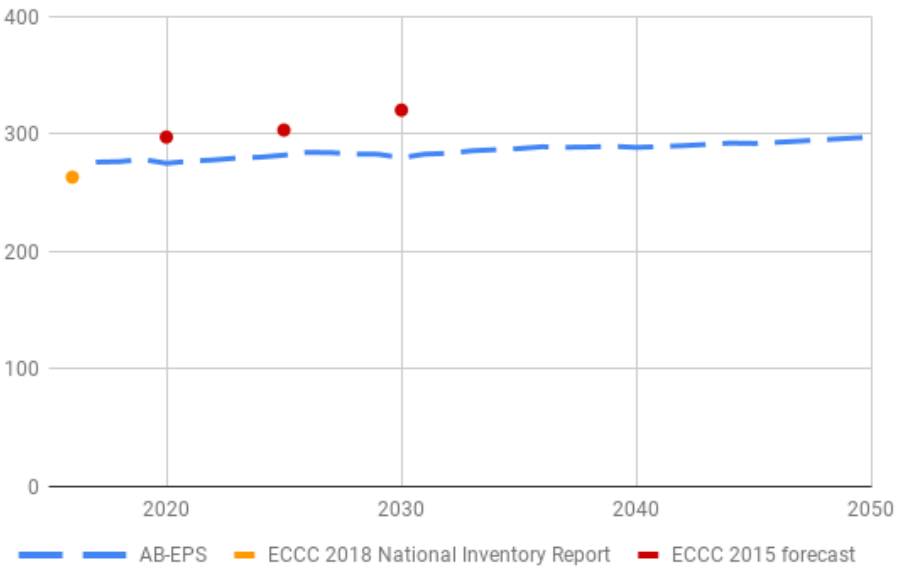

Figure 3. Comparison of the emissions predicted by the EPS with data from ECCC using Global Warming Potentials from the fourth Assessment Report

8. How was 2050 emissions reduction target 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 for Canada. The core EPS model structure is designed to produce future projections of emissions and other variables.

[14] Environment and Climate Change Canada, *National Inventory Report* (2018). https://www.canada.ca/en/environment-climate-change/services/climate-change/greenhouse-gas-emissions/sources-sinks-executive-summary-2018.html

[15] Environment and Climate Change Canada, *Climate change: second biennial report* (2016). https://www.canada.ca/en/environment-climate-change/services/climate-change/greenhouse-gas-emissions/second-biennial-report.html

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 2050 emissions target (corresponding to 80-90% below adjusted 2005 levels). 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 target for 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.[16]

Note that the 2050 emissions reductions target is not adjusted for any provincial share of the overall national target. We have not made any assumptions of what an appropriate share of emissions would be for the province of Alberta, but it should be noted that the adjusted target included in the EPS reflects the target for the country as a whole.

9. What policies are included in "Current policy" scenario?

The Current policy scenario represents the emissions trajectory expected when including enacted policies as of February 2019. This scenario includes:

- The phase-out of coal for electricity generation by 2029
- The conversion of a portion of coal units to natural gas
- The development of renewable energy to meet the target of 30% of generation by 2030
- The reduction in methane emissions to achieve a 40-45% decrease in emissions by 2025 (federal regulations)
- Carbon pricing according to the provincial scheme and the federal backstop in 2021 and 2022
- Existing energy efficiency programs

A file (ScenarioData.xlsx) explains each policy, stringency and implementation schedule used to build the "Current policy" scenario.[17]

10. What policies are included in the "Example: Further Alberta ambition" scenario?

The "Example: Further Alberta ambition" scenario builds off the "Current policy" scenario to illustrates additional emissions reductions that could be expected from more stringent and

[16] Pembina Institute and Energy Innovation, *Alberta Energy Policy Simulator*. https://us.energypolicy.solutions/eps-archive/eps-1.4.2-alberta.zip

[17] Pembina Institute and Energy Innovation, *Alberta Energy Policy Simulator*. https://us.energypolicy.solutions/eps-archive/eps-1.4.2-alberta.zip

supplementary policies. The following policies were added to the scenario on top of those enabled in the "Current policy" scenario:

- A renewable portfolio standard ensures Alberta produce 50% of renewable electricity by 2030
- A low-carbon fuel standard achieves a 15% carbon emissions reduction by 2030 in the transportation sector by increasing the integration of biofuels
- A 100 megatonne limit on oilsands emissions is enacted, capping emissions from the sector at 2025 levels[18]
- An electric vehicle sale mandate of 30% by 2030 for light- and heavy-duty vehicles
- Enhanced investment in public transit
- Net-zero energy-ready new residential and commercial buildings in 2030

This example scenario is used to illustrate the affect of additional policies, and does not constitute a proposed scenario for Alberta. Some of the suggested policies derive from the Pembina Institute's Energy Policy Leadership in Alberta document,[19] however this scenario does not reflect all recommendations due to constraints inherent to an energy model such as the EPS (for example the EPS does not model the effects of some suggested policies on the economy or the biodiversity).

A file (ScenarioData.xlsx) explains each policy, stringency and implementation schedule used to build the "Example: Further Alberta ambition" scenario.[20]

11. How can land use emissions reductions contribute to national 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

[18] While the Oil Sands Emissions Limit Act was passed by the Government of Alberta in 2016, it was not translated into regulation as of March 2019. For this reason, this policy is included in the "Example: Further Alberta ambition" scenario rather than in the "Current policy" scenario.

[19] Pembina Institute, *Energy Policy Leadership in Alberta* (2019). https://www.pembina.org/pub/energy-policy-leadership-alberta

[20] Pembina Institute and Energy Innovation, *Alberta Energy Policy Simulator*. https://us.energypolicy.solutions/eps-archive/eps-1.4.2-alberta.zip

netted against the increases from these other emission sources, which are out of the scope of the EPS model.

12. 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, sourced from the National Energy Board forecast. All data used is thoroughly cited and are freely available for download.[21] 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.

13. How does the EPS model carbon pricing?

Broadly, the EPS generically models the effect of a carbon price on the economy through an elasticity of production with respect to fuel cost.[22] The EPS does not model the complexity of the Alberta carbon pricing regulation, including the Carbon Competitiveness Incentive Regulation (CCIR) that institutes a benchmark for industries concerned by high emissions-intensity and trade-exposure. Nevertheless, it should be stressed that while individual companies may be paying a lower average carbon price under the CCIR than a under a flat carbon tax, the marginal cost of reducing one tonne of carbon emissions is similar in the two approaches. For this reason, the EPS approach is a good proxy to estimate the ballpark of emissions reduction achievable by pricing carbon.

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

[21] Pembina Institute and Energy Innovation, *Alberta Energy Policy Simulator*. https://us.energypolicy.solutions/eps-archive/eps-1.4.2-alberta.zip

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