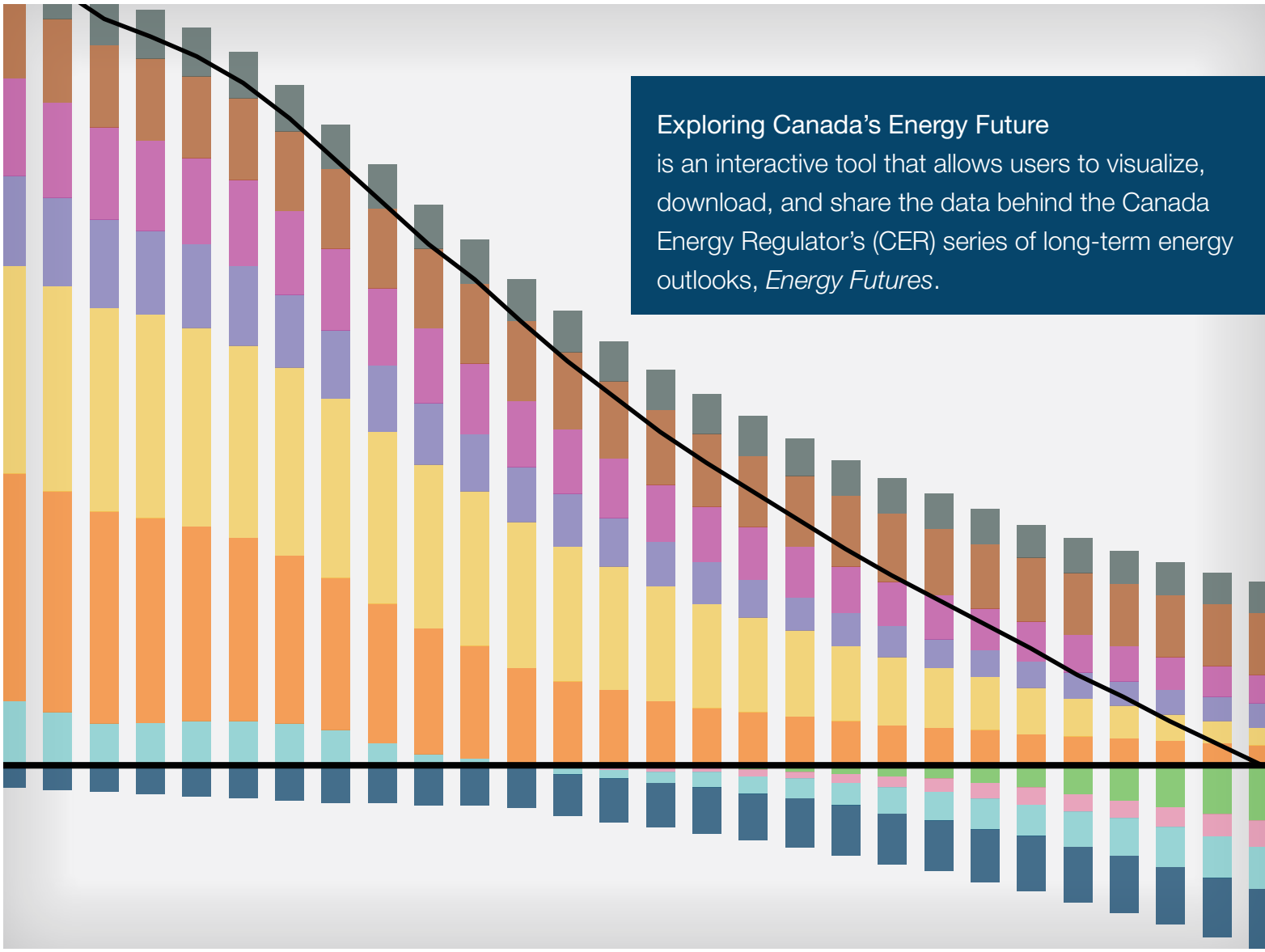
Canada Energy Regulator | Régie de l'énergie du Canada

Exploring Canada's Energy Future: Data Visualization Methodology



Exploring Canada's Energy Future is an interactive tool that allows users to visualize, download, and share the data behind the Canada Energy Regulator's (CER) series of long-term energy outlooks, *Energy Futures*.

Canada

Model Overview

Energy Futures includes a wide range of projections for Canadian energy supply and demand. These projections are the result of a modeling system consisting of several interacting models which produce integrated, future Canadian energy trends. Please refer to Canada's Energy Future 2023 Report Methodology for more detail.

Scenarios

EF2023 contains three scenarios: Global Net-zero, Canada Net-zero, and Current Measures.

Global Net-zero: The Global Net-zero Scenario assumes Canada achieves net-zero GHG emissions by 2050. We also assume the rest of the world reduces GHG emissions enough to limit warming to 1.5°C.

Canada Net-zero: The Canada Net-zero Scenario assumes Canada achieves net-zero GHG emissions by 2050, but the rest of the world moves more slowly to reduce GHG emissions.

Current Measures: The Current Measures Scenario assumes limited action in Canada to reduce GHG emissions beyond measures in place today and does not require that Canada achieve net-zero emissions. In this scenario we also assume limited future global climate action.

Definitions and Indicators

Canada's Provinces and Territories

Most visualizations display data at the provincial and territorial level. The table below defines the provincial and territorial acronyms.

ALL	Canada
AB	Alberta
BC	British Columbia
MB	Manitoba
NB	New Brunswick
NL	Newfoundland and Labrador
NS	Nova Scotia
NT	Northwest Territories
NU	Nunavut
ON	Ontario
PE	Prince Edward Island
QC	Quebec
SK	Saskatchewan
YT	Yukon

Categories

Total Demand: The total energy used in the four sectors of Canada's economy: residential, commercial, industrial and transportation. Includes the use of electricity, natural gas, petroleum products such as gasoline and coal, hydrogen and renewable fuels. Also referred to as end-use or secondary demand, it does not include energy used to generate electricity or produce hydrogen.

Electricity Generation: The amount of electricity produced by transforming other forms of energy. In Canada, electricity is generated from a variety of sources, including hydro, other renewables like wind, solar, and biomass, thermal sources like natural gas and coal, and nuclear power.

Oil Production: The amount of crude oil produced in Canada. Crude oil is produced from various areas using different technologies. This includes mined and in situ bitumen from the oil sands, conventional light and heavy oil produced in the Western Canadian Sedimentary Basin and other parts of Canada, condensate, and oil produced from off-shore platforms on the east coast.

Natural Gas Production: The amount of marketable natural gas produced in Canada. Natural gas is produced from various areas using different technologies. This includes tight, shale, coal bed methane, conventional, and natural gas produced along with oil from oil wells (also termed associated or solution gas).

Emissions: Total Canadian greenhouse gas (GHG) emissions for Oil and Gas, Electricity Generation, Hydrogen Production, Transportation, Heavy Industry, Buildings, Agriculture, Waste and Others, Land Use, Land Use Change and Forestry and Direct Air Capture sectors.

Energy Sources

END-USE DEMAND FOR RESIDENTIAL AND COMMERCIAL SECTORS

Biofuels and Emerging Energy: Includes biomass, ethanol, biodiesel, renewable diesel, and renewable natural gas.

Coal: Includes coal, coke, and coke oven gas.

Electricity: End-use electricity that is generated from a variety of sources and technologies. Includes electricity generation from primary sources such as nuclear, hydro, wind, solar, and biomass, and thermal generation from other fuels such as natural gas, coal, and oil.

Hydrogen: End-use hydrogen that is generated from a variety of sources and technologies.

Natural Gas: Total consumption of gas, including some non-marketed producer consumption.

Oil Products: Includes refined petroleum products and natural gas liquids. Specifically, this includes: motor gasoline, diesel fuel, aviation fuel, light fuel oil, kerosene, heavy fuel oil, propane, butane, ethane, petroleum coke, still gas, and non-energy products such as lubricants, asphalt, and petrochemical feedstocks.

END-USE DEMAND FOR THE INDUSTRIAL SECTOR

Biofuels and Emerging Energy: Includes biomass, ethanol, biodiesel, renewable diesel, and renewable natural gas.

Coal: Includes coal, coke, and coke oven gas with and without carbon capture, utilization and storage (CCUS).

Electricity: End-use electricity that is generated from a variety of sources and technologies. Includes electricity generation from primary sources such as nuclear, hydro, wind, solar, and biomass, and thermal generation from other fuels such as natural gas, coal, and oil.

Hydrogen: End-use hydrogen that is generated from a variety of sources and technologies.

Natural Gas: Total consumption of gas with and without CCUS, including some non-marketed producer consumption.

Oil Products: Includes refined petroleum products and natural gas liquids with and without CCUS. Specifically, this includes: motor gasoline, diesel fuel, aviation fuel, light fuel oil, kerosene, heavy fuel oil, propane, butane, ethane, petroleum coke, still gas, and non-energy products such as lubricants, asphalt, and petrochemical feedstocks.

END-USE DEMAND FOR TRANSPORTATION SECTOR

Biofuels: Includes ethanol, biodiesel, bio aviation fuel, and renewable diesel.

Electricity: End-use electricity that is generated from a variety of sources and technologies. Includes electricity generation from primary sources such as nuclear, hydro, wind, solar, and biomass, and thermal generation from other fuels such as natural gas, coal, and oil.

Hydrogen: End-use hydrogen consumed in the transportation sector.

Natural Gas: Includes compressed natural gas and liquefied natural gas used in cars, buses, trucks, and ships.

Oil Products:

- **Aviation Fuel:** A refined petroleum product used to power aircraft.
- **Gasoline:** A refined petroleum product used in internal combustion engines.
- **Diesel Fuel:** A refined petroleum product used in diesel engines.
- **Other Oil Products:** Includes heavy fuel oil, liquefied petroleum gas, and lubricants.

ELECTRICITY GENERATION

Biomass and Geothermal: Includes solid biomass fuels with and without CCUS such as wood pellets, as well as geothermal sources.

Coal: Electricity generated by coal-fired power plants with and without CCUS.

Hydro: Electricity generated by hydro power plants, in addition to minor contributions from wave and tidal power stations.

Natural Gas: Electricity generated by a variety of technologies using natural gas with and without CCUS, including steam generation units, gas turbine and combustion engine plants, and combined cycle units.

Nuclear: Electricity generated by nuclear power plants.

Oil: Electricity generated by a variety of technologies using fuel oil, including steam turbines and combustion turbines.

Solar: Includes electricity generated using photovoltaic systems or concentrated solar thermal systems.

Wind: Includes electricity generated by wind turbines.

NATURAL GAS PRODUCTION

Total: The amount of marketable natural gas produced in Canada. Natural gas is produced from various areas using different technologies.

Coalbed Methane: Natural gas that is trapped within coal seams.

Conventional: Natural gas that can flow into a well at commercial rates without the extensive use of technology after the well is drilled.

Shale: Natural gas trapped within shale.

Solution Gas: Natural gas produced along with oil from oil wells. Also termed associated gas.

Tight: Gas produced from low permeability sandstone, siltstone, limestone or dolostone reservoirs.

CRUDE OIL PRODUCTION

Total: The amount of crude oil produced in Canada. Crude oil is produced from various areas using different technologies.

C5+ (Pentanes Plus): A liquid like a very light oil, extracted during natural gas production at processing plants.

Condensate: A liquid like a very light oil, extracted during natural gas production at gas wells.

Conventional Heavy: Heavy crude oil that can flow into a well at commercial rates without the extensive use of technology after the well is drilled.

Conventional Light: Light crude oil that can flow into a well at commercial rates without the extensive use of technology after the well is drilled.

In Situ Bitumen: Recovered through wells, typically using steam or solvents to reduce the bitumen's viscosity.

Mined Bitumen: A combined mining and upgrading operation where oil sands are mined from open pits, then bitumen is separated from the sand and upgraded by coking or hydroprocessing.

Benchmark Prices

Benchmark prices are common reference prices for oil and gas that are used by buyers and sellers of the commodities.

GAS PRICES

Henry Hub: Henry Hub is the benchmark pricing point for natural gas futures traded within Canada and the United States, with other prices typically trading at a difference relative to Henry Hub. The hub is located in Louisiana at the interconnection of numerous natural gas pipelines.

NIT (Nova Inventory Transfer): The Nova Inventory Transfer, or NIT, is the main price used for natural gas traded in western Canada. It is a virtual trading point, which means this price can be used to trade gas anywhere on the NGTL pipeline system.

OIL PRICES

West Texas Intermediate (WTI): A key North American benchmark price for light, sweet crude oil produced primarily from inland Texas and priced at Cushing, Oklahoma.

Brent: A key global benchmark price for light, sweet crude oil produced from oil fields in the North Sea.

Western Canadian Select (WCS): A western Canadian price for bitumen and heavy sour crude oil blended with condensate or sweet synthetic oil. It is priced at Hardisty, Alberta, and is often used to represent prices for western Canadian heavy crude oils.

EMISSIONS

Total: Total Canadian greenhouse gas (GHG) emissions.

Oil and Gas: All GHGs associated with the oil and gas sector including upstream, downstream, and transmissions and distribution emissions.

Electricity Generation: All GHGs associated with electricity generation.

Hydrogen Production: All GHGs associated with hydrogen production.

Transportation: All GHGs associated with transport.

Heavy Industry: All GHGs associated with heavy industry including mining, smelting and refining, pulp and paper, iron and steel, cement and lime, and chemicals and fertilizers.

Buildings: All GHGs associated with buildings in the residential and commercial sectors.

Agriculture: All GHGs associated with crop production, animal production, and energy use in agriculture.

Waste and Others: All GHGs associated with waste, coal mining, light manufacturing, construction, and energy use in forestry operations.

Land Use, Land Use Change and Forestry: All GHGs associated with natural lands and human activities that alter these lands.

Direct Air Capture: All GHGs associated with the direct air capture industry which removes CO_2 from the atmosphere and stores it underground.

Units

ENERGY UNITS

Petajoule (PJ): A measure of energy that is a quadrillion (10^{15}) joules.

Thousand barrels of oil equivalent per day (Mboe/d): A measure of energy normalized to the equivalent energy content of a barrel of crude oil. One barrel of oil equivalent is equal to 6.123 gigajoules.

Gigawatt hour (GW.h): A measure of energy normalized to the equivalent energy content of a barrel of light crude oil. One barrel of light oil equivalent is equal to 6.123 gigajoules.

VOLUMETRIC UNITS

Thousand barrels per day (Mb/d): Number of barrels of crude oil produced per day.

Thousand cubic metres per day ($10^3m^3/d$): Number of cubic metres of crude oil produced per day. One barrel of oil is equal to 0.159 cubic metres.

Billion cubic feet per day (Bcf/d): Number of cubic feet of natural gas produced per day.

Million cubic metres per day ($10^6m^3/d$): Number of cubic metres of natural gas produced per day. One cubic foot of natural gas is equal to 0.0283 cubic metres.

EMISSIONS UNITS

Megatonnes of carbon dioxide equivalent ($MTCO_2e$): A measure of emissions for megatonnes of carbon dioxide equivalent (CO_2e). CO_2e is a measure of how much GHGs contribute to global warming relative to carbon dioxide.

Sectors

Residential: This is the energy consumed by Canadian households. It includes energy used for space and water heating, air conditioning, lighting, large appliances, and other energy-using devices like televisions and computers.

Commercial: A broad category including offices, stores, warehouses, government and institutional buildings, utilities, communications, and other service industries. It also includes energy consumed by street lighting and pipelines. Buildings use energy for space and water heating, air conditioning, lighting, appliances and other devices. Pipelines use energy to power pumps or compressors that move oil and natural gas through pipelines.

Industrial: This sector includes heavy industry, oil and gas, light manufacturing, forestry, fisheries, agriculture, construction, mining, waste, and others.

Transportation: Includes passenger and freight on-road transportation, as well as air, rail, marine, and non-industrial off-road travel, such as recreational all-terrain vehicles and snowmobiles. Demand in the transportation sector includes foreign transportation energy used on Canadian soil, airspace and waters.

Data Sources

ENERGY DEMAND

The primary source for historical energy demand data is Statistics Canada's Report on Energy Supply and Demand and associated data tables. These values are disaggregated at an end-use level using NRCan's National End-use Database. The dataset is also supplemented with data from Environment and Climate Change Canada, and various provincial and territorial sources such as the Alberta Energy Regulator, BC Hydro, Alberta Electric System Operator, and Ontario's Independent Electric System Operator.

ELECTRICITY GENERATION

The primary source for electricity generation data comes from Statistics Canada. It is supplemented by additional data from provincial governments, utilities, and system operators, as well as industry associations (such as CanREA).

CRUDE OIL AND NATURAL GAS PRODUCTION

Data for crude oil and natural gas production comes from a variety of sources. These include CER analysis of Divestco well data, provincial and territorial governments, the Alberta Energy Regulator, and Canadian Association of Petroleum Producers.

GREENHOUSE GAS EMISSIONS

Data for greenhouse gas emissions comes from Canada's official greenhouse gas inventory prepared by Environment and Climate Change Canada. The inventory is prepared and submitted annually as a report to the United Nations Framework Convention on Climate Change. The report covers anthropogenic (human-caused) emissions by source as well as emissions removals by sinks (eg. afforestation, wetland restoration, land reclamation, etc.)

OIL AND GAS PRICES

The global oil and natural gas price assumptions in the two net-zero scenarios in EF2023 come from the International Energy Agency (IEA) World Energy Outlook (WEO) 2022 report. The IEA's Net Zero Emissions by 2050 Scenario is the source of price assumptions for our Global Net-zero Scenario. The IEA's WEO2022 Announced Pledges Scenario is the source of global price assumptions for our Canada Net-zero Scenario. We base our global price assumptions in the Current Measures Scenario on a review of projected prices by various other organizations. In all scenarios, we make assume differentials from these global prices to estimate Canadian prices like WCS and NIT.

Technology Used

The Energy Futures visualization is a JavaScript ES6 application and uses the React library for the front-end user interface (UI). The layout of the visualization incorporates React components from the Material-UI library, and the charts incorporate components from the nivo library. The application retrieves data from a CER database using a GraphQL API. Finally, the application connects to the Bitly API to create shortened URLs to support users in sharing links to the visualization.

Access to Data

Data may be downloaded through the Exploring Canada's Energy Futures online tool. As well, the full data sets, in addition to the visualization source code, may be downloaded from the Government of Canada's Open Data site.

The Canada Energy Regulator (CER) works to keep energy moving safely across the country. We review energy development projects and share energy information, all while enforcing some of the strictest safety and environmental standards in the world. To find out how the CER is working for you visit us online or connect on social media.