



Exploring Canada's Energy Future: Data Visualization Methodology



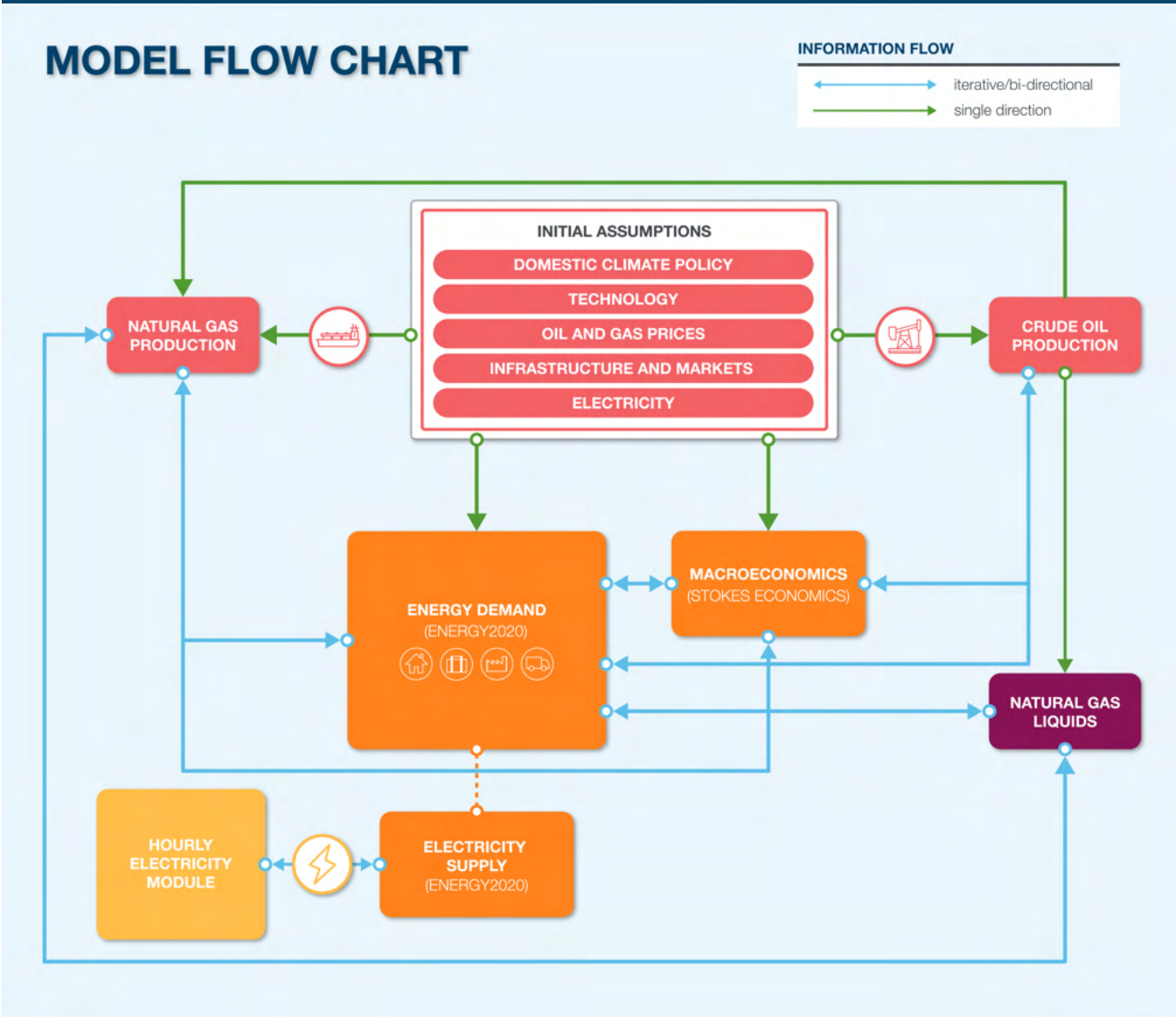
Exploring Canada's Energy Future

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*.

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 interactive components (or modules) which produce integrated, future Canadian energy trends. Figure 1 outlines the system in diagram.

Figure 1



What are the Model's Components?

INITIAL ASSUMPTIONS:

The starting point for Energy Futures analysis is the development of initial assumptions on various aspects of the global and Canadian energy system. Benchmark crude oil and natural gas price assumptions are based on a survey of projections by other forecasting agencies like the International Energy Agency and the U.S. Energy Information Administration, complemented by internal analysis. It is important to note that these assumptions are not predictions of future crude oil and natural gas prices, but necessary inputs for the analytical process.

SCENARIOS:

Our Energy Futures projections use scenarios to illustrate the differences in climate and energy policies, technological development, and infrastructure and market conditions such as whether new pipelines or LNG export facilities go ahead.

OIL SUPPLY:

This module provides crude oil production projections for the various regions and crude types in Canada, based on our price assumptions. It includes an oil sands module, and non-oil sands deliverability module for western Canada, and analysis of other regions in Canada.

GAS PRODUCTION:

This module estimates the production of natural gas throughout Canada. The module relies upon oil and natural gas price assumptions as well as a crude oil production estimate from the oil supply module. The module includes the Western Canadian Sedimentary Basin natural gas deliverability model, as well as trend analysis for other producing regions (e.g. New Brunswick).

MACROECONOMICS:

Macroeconomic projections for each of the scenarios were provided by Stokes Economic Consulting Inc. Stokes developed unique projections of key macroeconomic indicators such as gross domestic product, exchange rate, and industry gross output for each of the scenarios, based on the price assumptions and output of the CER's supply and demand models.

DEMAND AND ELECTRICITY:

The demand and electricity projections are developed using ENERGY2020: a detailed energy model created by Systematic Solutions Incorporated. It creates projections for energy demand and electricity generation based on historical energy data for parameters such as supply, demand, economic growth, efficiency, prices, and investment.

NATURAL GAS LIQUIDS:

This module provides estimates of NGL supply and demand in Canada. The module simulates various categories of liquids: ethane, butane, propane, condensate and pentane plus. For each liquid, the module provides estimates of production, supply and demand at the individual provincial/territorial level.

REFINERY BALANCES:

This module estimates the disposition of crude oil throughout Canada. Specifically, it reconciles estimates of supply with demand and exports of heavy and light crude oil. It also tracks refinery feedstock requirements and sources within Canada's major refining regions.

COAL:

This module estimates the production and disposition of coal in Canada. The module relies upon energy demand data from ENERGY2020, historical production data from NRCan, and information on proposed coal mining projects.

Additional Information

For additional information on the Energy Futures series, see the [CER Energy Futures Index](#)

Definitions and Indicators

Canada's Provinces and Territories

All 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
NT	Northwest Territories
NS	Nova Scotia
NU	Nunavut
ON	Ontario
PE	Prince Edward Island
QC	Quebec
SK	Saskatchewan
YT	Yukon

Supply and Demand 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, and renewable fuels. Also referred to as end-use or secondary demand, it does not include energy used to generate electricity.

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 and solar, 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).


Energy Sources


For detailed technical definitions for these and other energy terms, see the [Definitional Cross Reference](#) created for the North American Cooperation on Energy Information.


END-USE DEMAND FOR RESIDENTIAL, COMMERCIAL, INDUSTRIAL SECTORS


 **Biofuels and Emerging Energy:** Includes biomass, ethanol, biodiesel, 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, and solar, and thermal generation from other fuels such as natural gas, coal, and oil.


 **Hydrogen:** Consumption of 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. amount of electricity generated by hydro power plants.

END-USE DEMAND FOR TRANSPORTATION SECTOR

 **Biofuels:** Includes ethanol, biodiesel, and hydrogenation derived 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, and solar, 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 such as wood pellets, as well as geothermal sources.



Coal: Electricity generated by coal-fired power plants.



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, 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 and Wind: Includes electricity generated using photovoltaic systems or concentrated solar thermal systems and 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.

Units

ENERGY UNITS

- **Petajoule:** A measure of energy that is a quadrillion (10^{15}) joules. According to Statistics Canada, a petajoule is the approximate amount of energy it takes to run the Montreal Metro for one year.
- **Barrel of light oil equivalent (boe):** 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.
- **GW.h:** A measure of electric energy that is a billion (10^9) watt hours of electric energy per year. One GW.h is equal to 0.0036 petajoules and 0.0016 Mboe/d.

VOLUMETRIC UNITS

- **Thousand barrels per day (Mb/d):** Number of barrels of crude oil produced per day.
- **Thousand cubic metres per day ($10^3\text{m}^3/\text{d}$):** 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 ($10^6\text{m}^3/\text{d}$):** Number of cubic metres of natural gas produced per day. One cubic foot of natural gas is equal to 0.0283 cubic metres.

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 manufacturing, forestry, fisheries, agriculture, construction, mining, and oil and natural gas extraction. In 2013, 81 per cent of industrial energy was consumed by a number of energy-intensive industries like iron and steel, aluminum, cement, chemicals and fertilizers, pulp and paper, petroleum refining, mining, and oil and natural gas extraction.



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 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.

ELECTRIC 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 CanWEA and CanSIA).

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.

Technology Used

The Energy Futures visualization is a JavaScript ES6 application and uses the React.js 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 the GraphQL query language. 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](#).