ATLANTIC CANADA'S ENERGY STORY

ENERGYIQ

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INTRODUCTION

The Atlantic provinces can sometimes be overlooked in the grand scheme of Canada's energy story but take a closer look and you'll find they are a microcosm of our country's energy landscape. From nuclear power plants and crude oil refineries to wind farms and tidal power stations, Atlantic Canada is uniquely diverse in energy resources.

Offshore oil production facilities can be found along the eastern coast of Newfoundland, while New Brunswick is home to the biggest crude oil refinery in Canada. Nova Scotia has a long history of coal mining, but today is making a transition to cleaner energies like hydro and wind. And Prince Edward Island has wholly embraced wind power.

This factbook offers a snapshot of the energy sector in Atlantic Canada. It covers topics such as where natural resources are found for energy production, the process through which energy is turned into electricity, the role of energy exports and imports, how the energy industry impacts the environment, and much more.

The Atlantic Energy Story was produced by Energy IQ, an educational program created and delivered by Canadian Geographic Education. Energy IQ focuses on the demand, production, and transmission of various energy sources in Canada today, with the goal of helping to improve energy literacy across the country among Canadian students and educators.

For more information and resources, visit energyiq.canadiangeographic.ca

OVERVIEW OF THE ATLANTIC PROVINCES

The main types of energy in the Atlantic provinces include: crude oil, hydro, coal, nuclear, natural gas and wind. Biomass and tidal energy also contribute a small percentage to the energy mix. There is also a large refining industry in the Atlantic provinces.

CRUDE OIL

REFINING

HYDRO ELECTRICITY

NATURAL GAS

COAL

NUCLEAR

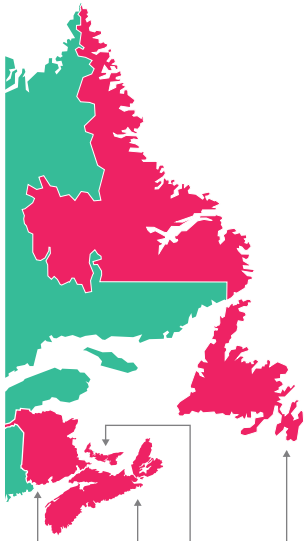
WIND

BIOMASS

TIDAL

FAST FACTS

6.5% OF CANADA'S **TOTAL POPULATION** (2018)



MORE THAN **12,600** people employed in the energy sector

63.2M MEGAWATT HOURS of electricity generated in 2017

9.7% of Canada's total electricity generation

Learn more about how energy is produced in the Atlantic provinces and across the country at energyiq.canadiangeographic.ca

NEWFOUNDLAND & LABRADOR

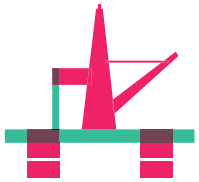
CRUDE OIL & NATURAL GAS

Newfoundland and Labrador is the third-largest crude oil producing province in the country, behind Alberta and Saskatchewan. All oil production takes place on offshore facilities: Hibernia, Terra Nova, White Rose and Hebron. In 2017, the province accounted for 6 per cent of Canada's total oil production.

The province's oil production has been in decline over the past decade, with some ups and downs, but the recent addition of the Hebron offshore oil facility in late 2017 is expected to increase production. The total annual oil production for Newfoundland and Labrador is projected to be more than 80 million barrels (MMb) for 2018.

In addition to offshore oil production, the province has one oil refinery in Come by Chance, N.L., which has a capacity of 115 thousand barrels per day (Mb/d). This is in the mid-range for Canadian refineries, which vary from 12 Mb/d to 300 Mb/d in capacity. The Come by Chance refinery relies on a mix of eastern Canadian crude oil and imports from countries such as the United States, United Kingdom, Angola and Russia. The refinery produces more petroleum products than the province needs and exports much of it to the eastern United States.

There is some natural gas production at offshore facilities and it is used to power the facilities themselves. There are no pipelines or rail facilities in Newfoundland and Labrador that transport crude oil or natural gas, so all imports and exports are done by ship.



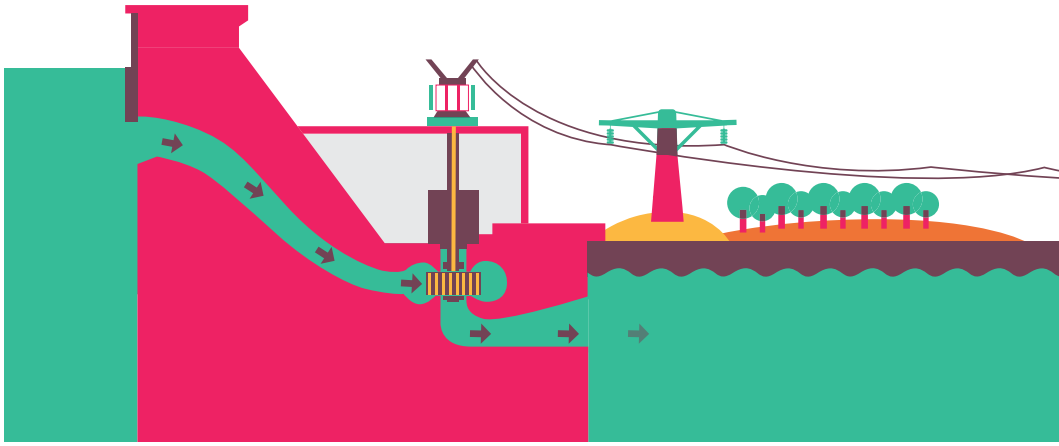
MORE THAN 80 MILLION BARRELS EXPECTED FOR 2018

HYDRO

Hydropower is a significant source of electricity for Newfoundland and Labrador, accounting for about 94 per cent of the total electricity generation in the province. Newfoundland and Labrador is the fifth-largest electricity producing province in Canada, making up 7 per cent of the country's total electricity generation, and has a generating capacity of 7,717 megawatts.

The Upper Churchill Falls generating station is one of the largest hydroelectricity plants in Canada and has a generating capacity of 5,428 megawatts, contributing the majority of the province's hydroelectric power generation.

HYDROPOWER ACCOUNTS FOR 94% OF NEWFOUNDLAND & LABRADOR'S ELECTRICITY GENERATION



MEETING ENERGY NEEDS

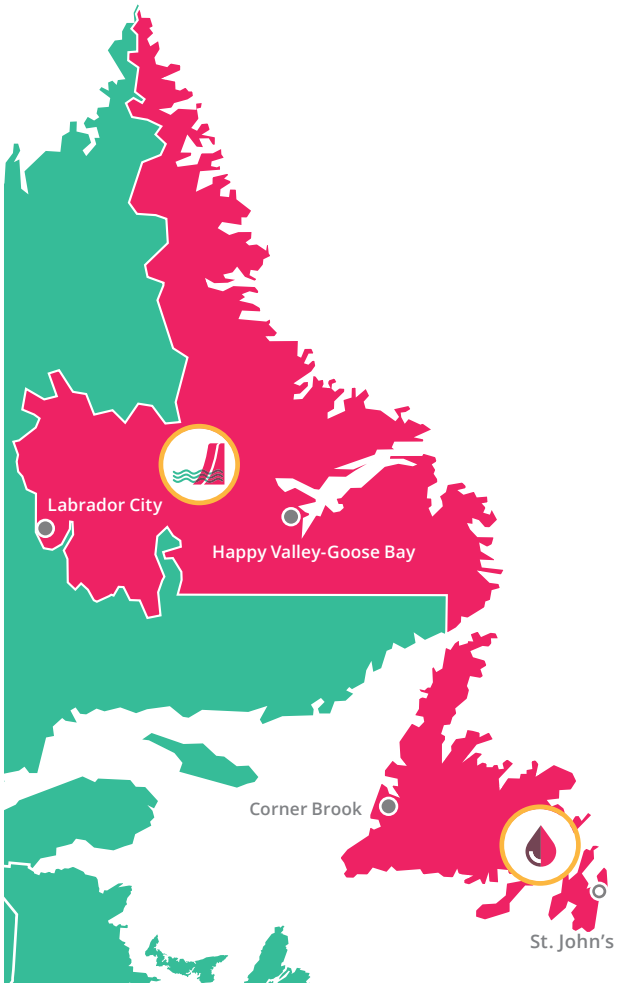
Oil, natural gas, and wind also contribute a small portion to electricity generation. Some remote communities, such as Inuit communities along the northeastern coast of Labrador, rely on shipments of diesel to generate electricity.

Newfoundland and Labrador exports a significant amount of its electricity, more than two-thirds of what it generates. The majority of the province's electricity is exported to Quebec, or to Ontario and the United States via Quebec. In 2018, a new transmission line called the Maritime Link connected Newfoundland's isolated electricity grid to Nova Scotia and the larger continental network.

ECONOMY

Newfoundland and Labrador's energy sector (including oil and natural gas production) generated more than $6.6 billion in GDP (gross domestic product) and employed more than 5,100 people in 2017. The energy sector on its own accounted for nearly 20 per cent of the province's GDP in 2017.

NEWFOUNDLAND & LABRADOR



$6.6 BILLION IN GDP

20% PROVINCIAL GDP

5,100+ PEOPLE EMPLOYED

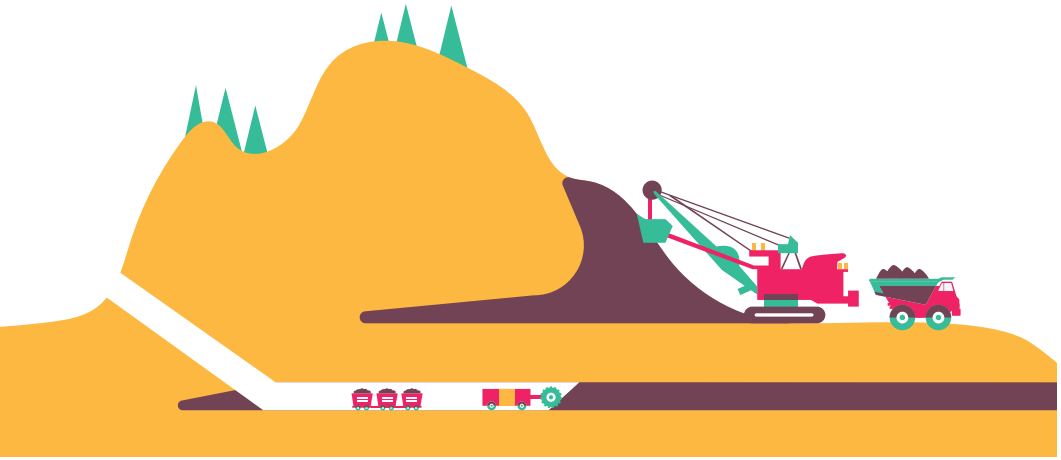
NOVA SCOTIA

COAL

Nova Scotia has a long history of coal mining and was Canada's main coal producer from 1827 until 1945, when production peaked during the Second World War and then went into decline. Coal played an important role in not only Canada's industrialization and urbanization but also contributed to the Industrial Revolution in Great Britain. Changes in the North American markets, as well as the introduction of natural gas, contributed to the decline of coal. Today, a couple of surface and reclamation coal mines are still active, as well as the underground Donkin mine in Cape Breton, which opened in early 2017.

NEARLY 60 PER CENT OF THE ELECTRICITY PRODUCED IN NOVA SCOTIA IS STILL FROM COAL-FIRED GENERATION.

Nearly 60 per cent of the electricity produced in Nova Scotia is still from coal-fired generation. This accounts for 15 per cent of all coal-fired electricity generating capacity in Canada. The two largest coal-fired generating stations are at Lingan and Trenton. Nova Scotia imports most of the coal needed for its thermal plants. The government of Canada has made it a priority to phase out coal-fired electricity because of coal's greenhouse gas (GHG) emissions. However, coal will continue to be used for metallurgical purposes, such as steelmaking.



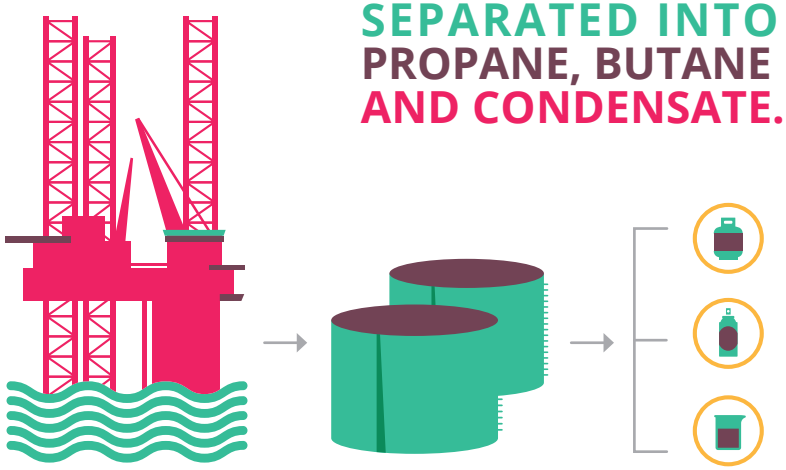
NATURAL GAS

In 2017, natural gas accounted for 14 per cent of the province's electricity generation. About one per cent of Canada's total natural gas production comes from Nova Scotia, averaging 170 million cubic feet per day (MMcf/d), however, the province's natural gas industry is in decline. The province produces a small amount of NGLs (natural gas liquids), which made up less than one per cent of Canada's NGL production.

In recent years, Nova Scotia produced natural gas at its Sable Offshore Energy Project and at its Deep Panuke project, both of which are being decommissioned. Increasingly, natural gas is imported from northeastern United States to meet periods of peak demand in the province.

The Sable project also produced condensate, which is a light crude oil by-product of natural gas production. Point Tupper, one of the largest storage and blending facilities in Atlantic Canada, processes natural gas by separating out propane, butane and condensate. Nova Scotia accounts for less than one per cent of Canada's total crude oil production and has no refineries.

NATURAL GAS CAN BE SEPARATED INTO PROPANE, BUTANE AND CONDENSATE.



NOVA SCOTIA

RENEWABLES

Nova Scotia is innovating and growing its renewable energy mix, which includes wind, hydro, tidal, and a tiny percentage of biomass. The province's installed wind energy capacity is 616 megawatts, accounting for about 12 per cent of Nova Scotia's electricity generation. The majority of Nova Scotia's wind farms are along the coast, with a few exceptions, such as the large 102-megawatt South Canoe wind farm that is built farther inland.

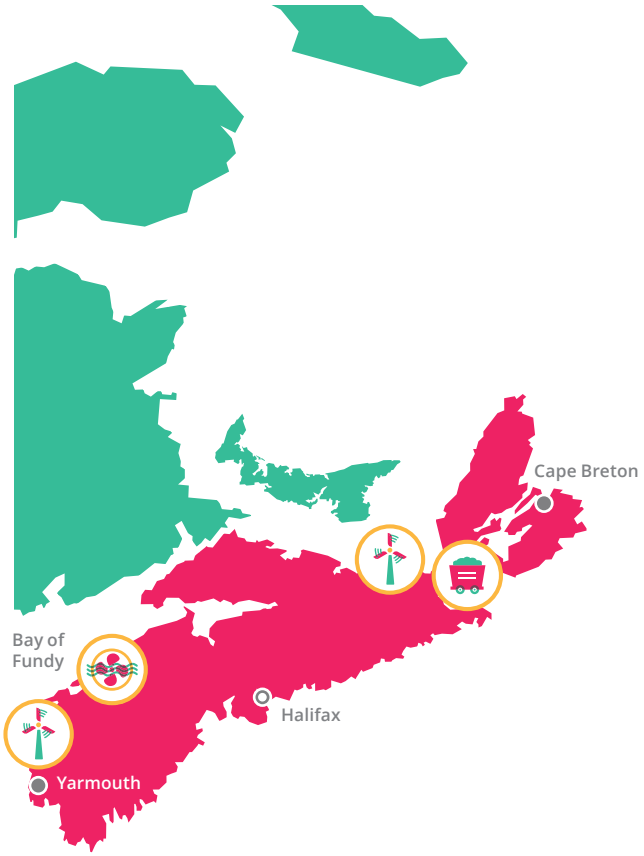
Nova Scotia lacks a major river system to produce a significant amount of hydroelectricity, but it does have a generating capacity of 400 megawatts. In addition, the Bay of Fundy has the highest tides in the world and is home to the Annapolis Tidal Station, North America's only tidal power station. The station was built in 1984 and has a generating capacity of 20 megawatts. Hydro and tidal account for about 9 per cent of Nova Scotia's electricity generation. Nova Scotia also imports a small percentage of its electricity supply from New Brunswick and Newfoundland and Labrador.

THE BAY OF FUNDY HAS THE HIGHEST TIDES IN THE WORLD.

ECONOMY

Nova Scotia's energy sector (including mining, quarrying, and oil production) generated about $900 million in GDP (gross domestic product) and employed more than 2,400 people in 2017. The energy sector accounted for approximately 2.8 per cent of the province's GDP in 2017.

NOVA SCOTIA



$900 MILLION IN GDP

2.8% PROVINCIAL GDP

2,400+ PEOPLE EMPLOYED

NEW BRUNSWICK

NUCLEAR

New Brunswick is unique in Atlantic Canada because it is the only province outside of Ontario that produces nuclear energy. The Point Lepreau Generating Station, near Saint John, has a generating capacity of 705 megawatts, providing about 30 per cent of the province's electricity through nuclear power.

THE POINT LEPREAU GENERATION STATION HAS THE CAPACITY TO POWER MORE THAN 330,000 HOMES PER YEAR

COAL

More than 30 per cent of New Brunswick's electricity is produced through fossil fuels — coal-fired generation makes up 21 per cent, natural gas accounts for 10 per cent, and petroleum products provide 2 per cent.

The Belledune Generating Station, with a capacity of 450 megawatts, is New Brunswick's only coal-fired generating plant and imports its coal from abroad, which arrives by ship at the station's adjacent port terminal. New Brunswick represents 6 per cent of Canada's total coal-fired generating capacity.

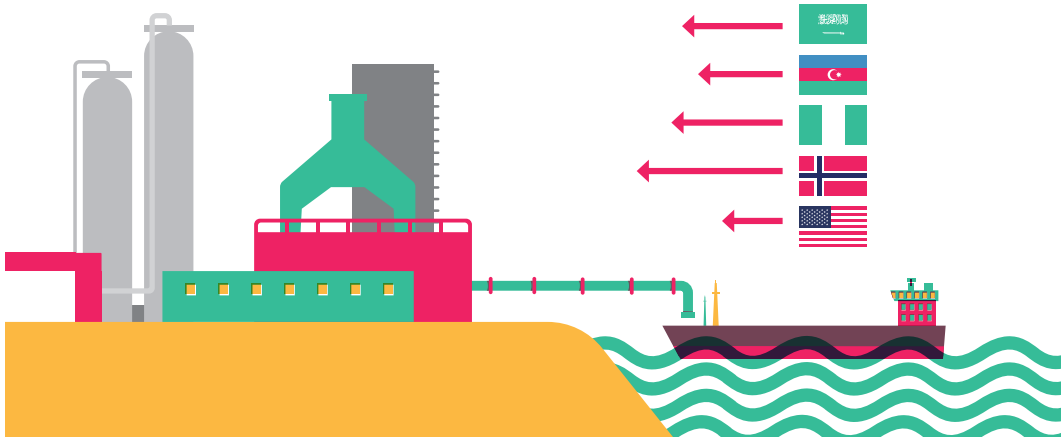
NATURAL GAS

Natural gas production in New Brunswick is small, representing less than one per cent of Canada's total natural gas production. In 2017, the province produced 3.2 million cubic feet per day (MMcf/d) of natural gas at the McCully Field, near Sussex.

Canada's only large-scale LNG (liquified natural gas) terminal Canaport is located near Saint John. When natural gas is cooled to -162 degrees Celsius, it turns into a liquid, which is easier to transport and store. Canaport is a storage and regasification terminal. It stores the province's liquified natural gas, as well as importing from Nova Scotia and northeastern United States. In 2017, Canaport imported about 14.2 billion cubic feet (Bcf) of liquefied natural gas.

PETROLEUM INDUSTRY

New Brunswick doesn't produce any of its own crude oil; however, the province has the largest oil refinery in Canada. Located in Saint John, the refinery has a capacity of 320 thousand barrels per day (Mb/d). It imports crude oil by ship from countries such as Saudi Arabia, Azerbaijan, Nigeria, Norway, and the United States. A portion of its crude oil comes by rail from western Canada or by ship from neighbouring provinces. The refinery produces more petroleum products than the province needs, so much of it is exported to eastern United States.



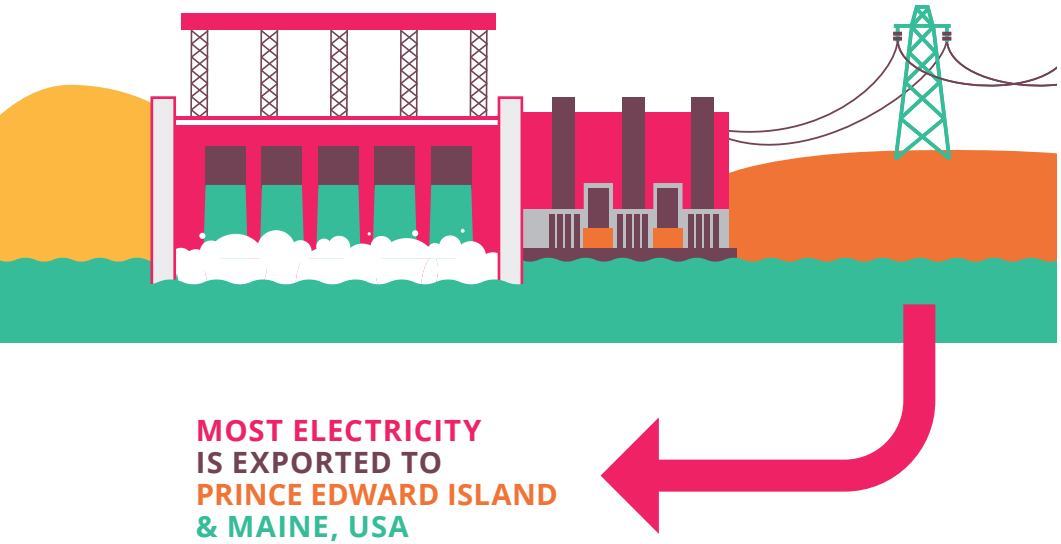
NEW BRUNSWICK

RENEWABLES

About 20 per cent of New Brunswick's electricity generation is from hydropower. The largest hydropower station sits on the Saint John River, upstream from Fredericton. Mactaquac Generating Station uses a run-of-the-river system and has a generating capacity of 660 megawatts. New Brunswick exports most of its electricity to Prince Edward Island and Maine, U.S.

Wind farms in New Brunswick account for about 7 per cent of electricity generation, with an installed capacity of 314 megawatts across the province. The largest wind farm in Atlantic Canada (also the first to be built in New Brunswick) is located at Kent Hills, near Elgin, and produces about half of all wind energy in the province.

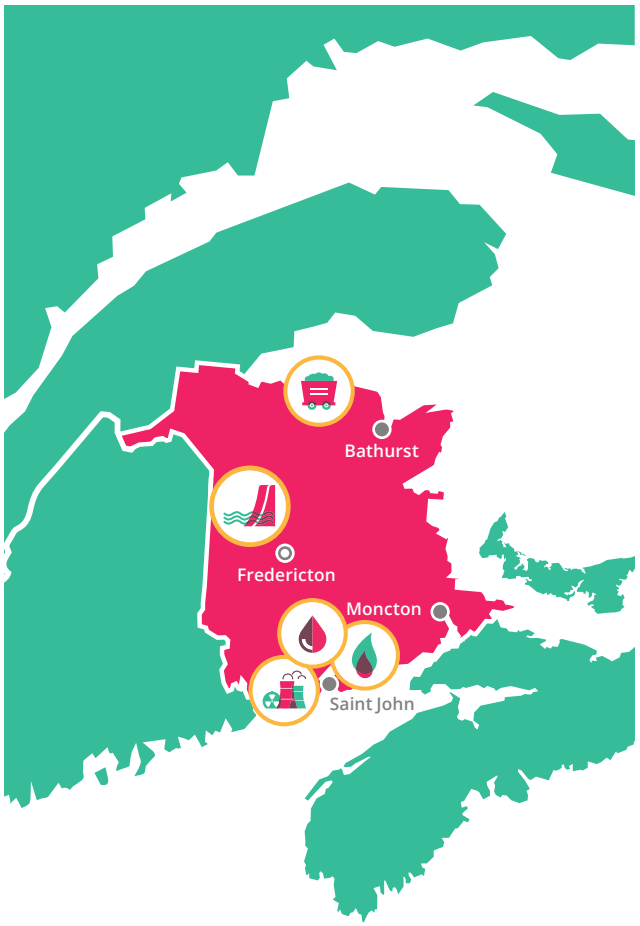
There are also some biomass facilities throughout New Brunswick, which account for about 4 per cent of the province's electricity generation. The Edmundston Pulp Mill is a large biomass facility with a generating capacity of 45 megawatts.



ECONOMY

New Brunswick's energy sector generated more than $2.2 billion in GDP (gross domestic product) and employed about 4,700 people in 2017. The energy sector accounted for about 6 per cent of the province's GDP in 2017.

NEW BRUNSWICK



$2.2
BILLION
IN GDP

6%
PROVINCIAL
GDP

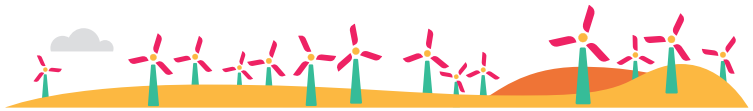
4,700+
PEOPLE
EMPLOYED

PRINCE EDWARD ISLAND

WIND

Prince Edward Island is Canada's smallest province in land mass and doesn't have the same wealth of natural resources that others are able to convert into energy for electricity, heating and fuel. Despite this, Prince Edward Island has been innovative with implementing renewable energy.

Wind energy accounts for 98 per cent of electricity generated on the island and as of 2018, installed capacity stands at 204 megawatts. Wind energy meets about 28 per cent of the island's electricity demand. The West Cape Wind Farm is the largest wind farm in Prince Edward Island, with a generating capacity of 99 megawatts.



MEETING ENERGY NEEDS

Prince Edward Island has a total generating capacity of 366 megawatts and makes up about 0.1 per cent of total electricity production in Canada. There are also some thermal generating facilities on the island that rely on diesel or fuel oil (i.e., distilled petroleum products) for generating power. These facilities exist to meet periods of peak demand or in case energy imports are interrupted.

More than half of the electricity used by the province comes from New Brunswick, which produces most of its electricity from nuclear power, coal, hydroelectricity, and natural gas. The electricity is brought into the province by undersea cables in the Northumberland Strait.

The first offshore well in Canada was drilled off of Prince Edward Island's coastline in 1943, but today the province doesn't produce any crude oil or natural gas, and it has no refineries or LNG facilities. The island does have some pockets of natural gas reserves, but only 20 exploratory wells have been drilled and there has been no further exploration since 2003.

ECONOMY

Prince Edward Island's energy sector generated about $99 million in GDP (gross domestic product) in 2017. The energy sector accounted for about 1.2 per cent of the province's GDP in 2017 and about 300 people were employed in the utilities industry.

PRINCE EDWARD ISLAND

$99 MILLION IN GDP

1.2% PROVINCIAL GDP

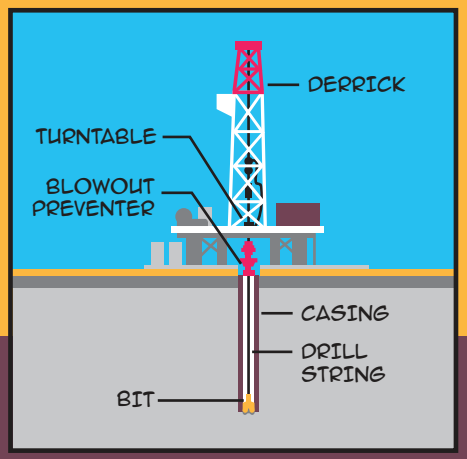
300+ PEOPLE EMPLOYED

CRUDE OIL

CRUDE OIL IS A YELLOW-TO-BLACK LIQUID, AND REFERS TO LIGHT, MEDIUM, AND HEAVY HYDROCARBONS. IT IS FOUND IN UNDERGROUND RESERVOIRS, OIL SANDS DEPOSITS, OR OFFSHORE RESOURCES.

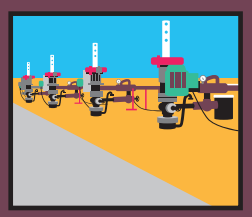
CONVENTIONAL CRUDE OIL

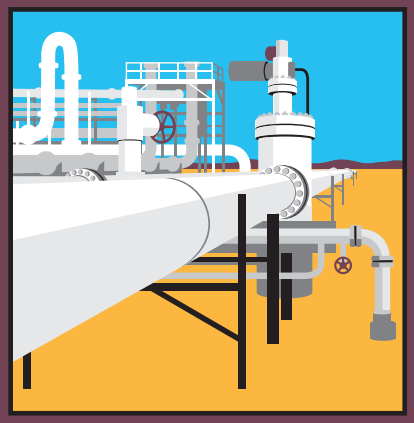
ONCE OIL IS DISCOVERED IN AN UNDERGROUND RESERVOIR, THE SITE IS PREPARED FOR DRILLING. A DRILLING RIG IS USED TO HOUSE THE TOOLS AND PIPES NEEDED TO DRILL HOLES IN THE EARTH AND BRING OIL TO THE SURFACE.



AFTER THE RIG IS REMOVED, THE CREW PUTS A PUMP ON THE WELL HEAD, WHICH PULLS OIL UP THROUGH THE WELL. WHEN COMPLETED, THE WELL BRINGS A STEADY FLOW OF OIL TO THE SURFACE.

THE CRUDE OIL IS THEN KEPT IN STORAGE TANKS OR TAKEN TO REFINERIES TO BE PROCESSED INTO VARIOUS PETROLEUM PRODUCTS.





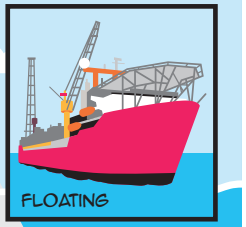
OIL EXTRACTED FROM THE OIL SANDS, KNOWN AS BITUMEN, IS TOO HEAVY AND THICK TO FLOW ON ITS OWN, SO IT'S DILUTED, PUMPED UNDILUTED, OR HEATED. SOME BITUMEN IS FOUND WITHIN 70 METRES FROM THE MINING SURFACE, BUT THE MAJORITY IS FOUND DEEPER UNDERGROUND AND IS EXTRACTED. THE BITUMEN IS THEN PROCESSED INTO LIGHTER, SYNTHETIC CRUDE OIL.

OIL IS PRIMARILY TRANSPORTED BY PIPELINES—CANADA HAS A PIPELINE NETWORK OF MORE THAN 840,000 KILOMETRES. IT IS ALSO TRANSPORTED BY RAIL, TRUCKS, OR TANKER SHIPS TO WHERE IT NEEDS TO GO.

OFFSHORE PRODUCTION

ALL OFFSHORE OIL PRODUCTION FACILITIES CONSIST OF TWO PARTS. THERE IS A PLATFORM, WHICH SITS ON THE SEAFLOOR OR FLOATS ON THE OCEAN SURFACE, AND A TOPSIDE, WHERE THE PRODUCTION OPERATIONS TAKE PLACE.

MOBILE OFFSHORE DRILLING UNITS (MODUS) ARE USED TO ACCESS OIL BENEATH THE OCEAN FLOOR. THEN EITHER OFFSHORE PLATFORMS OR FLOATING PRODUCTION STORAGE AND OFFLOADING (FPSO) VESSELS ARE USED TO EXTRACT AND STORE THE OIL.



IN A FPSO VESSEL SYSTEM, FLEXIBLE FLOWLINES ATTACH TO WELLHEADS IN THE SEAFLOOR, WHICH ALLOWS FOR THE VESSEL TO MOVE AROUND TO ADAPT TO WEATHER CONDITIONS. THE EXTRACTED OIL IS THEN SHIPPED TO SHORE BY SHUTTLE TANKERS.

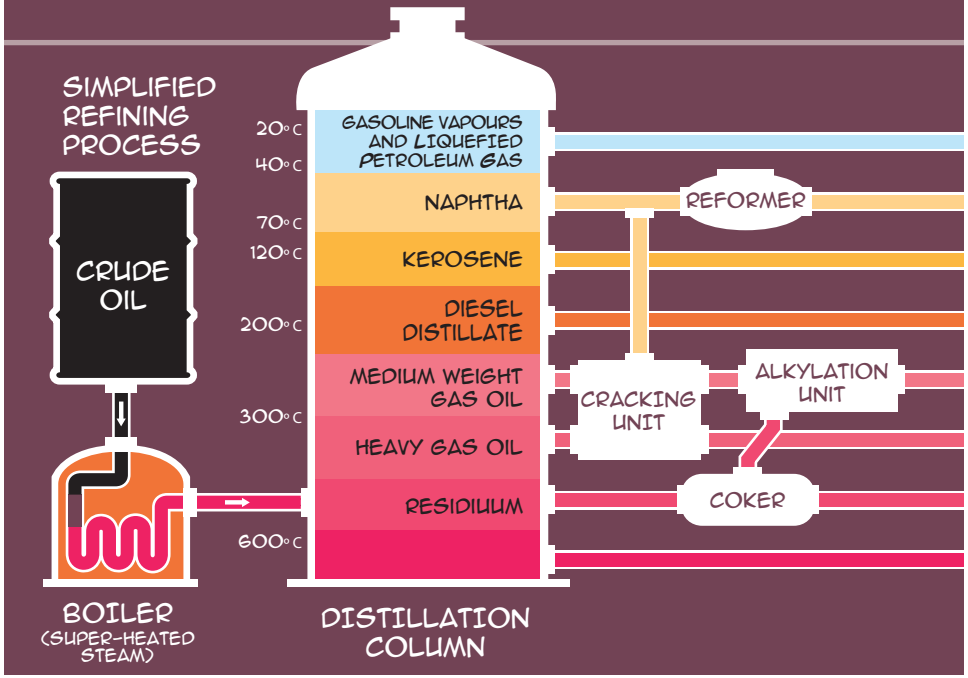
IN A GRAVITY-BASED STRUCTURE (GBS), A PLATFORM IS BUILT ON STEEL AND CONCRETE PILLARS THAT ATTACH TO THE SEAFLOOR AND CONTAIN OIL STORAGE TANKS. THESE TYPES OF STRUCTURES ARE BUILT TO WITHSTAND COLLISIONS WITH ICEBERGS AND STORMS.

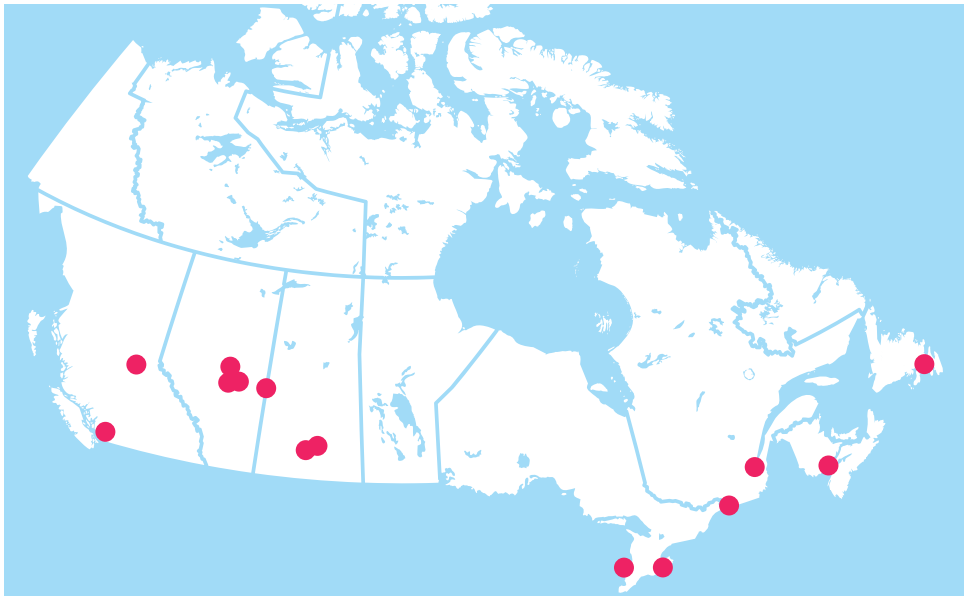
DRILL RIGS AND WELLHEADS ARE FITTED WITH BLOWOUT PREVENTERS TO PREVENT ACCIDENTAL RELEASES OF OIL.

REFINING CRUDE OIL

CRUDE OIL IS TRANSFORMED INTO REFINED PETROLEUM PRODUCTS (RPPS), SUCH AS GASOLINE AND JET FUEL, THROUGH A PROCESS CALLED REFINEMENT. REFINERIES ARE LARGE AND COMPLEX INDUSTRIAL STRUCTURES COMPRISING MANY DIFFERENT PARTS AND PROCESSES THAT PRODUCE DIFFERENT RPPS.

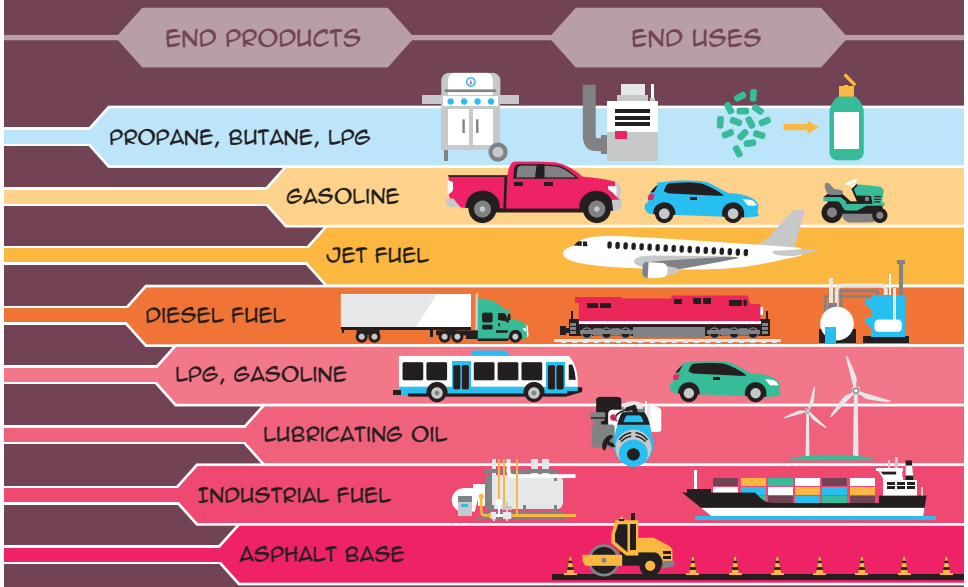
THE COMPONENTS MAKING UP CRUDE OIL EVAPORATE AT DIFFERENT TEMPERATURES, ALLOWING THEM TO BE SEPARATED AND REFINED INTO VARIOUS END PRODUCTS.





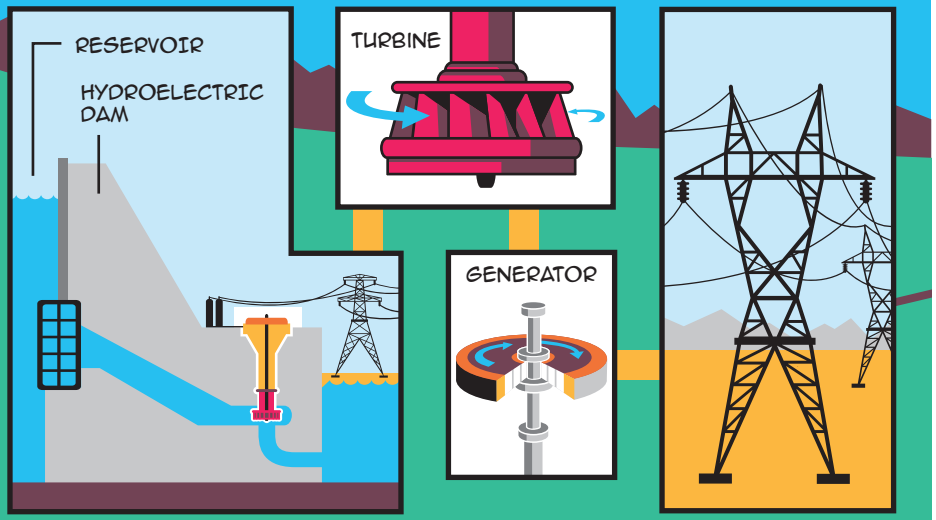
CANADA HAS 14 OIL REFINERIES AND TWO ASHPHALT REFINERIES. EACH ONE IS TAILORED TO THE HEAVINESS OF CRUDE OIL TO BE REFINED AND THE DESIRED END PRODUCTS.

THESE PRODUCTS ARE USED AS FUELS TO GENERATE ENERGY, FEEDSTOCK FOR THE PRODUCTION OF PLASTICS, AND OTHER PETROLEUM-BASED PRODUCTS SUCH AS LUBRICANTS & ASHPALT.



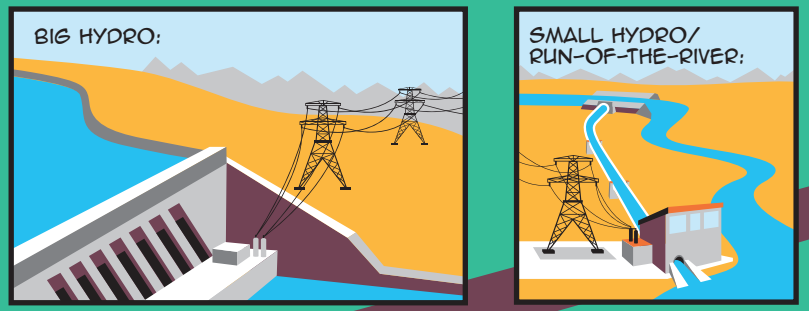
HYDROELECTRICITY

FOR BIG HYDRO PROJECTS, A DAM IS BUILT ON A RIVER TO STORE WATER IN A RESERVOIR. WHEN THE WATER IS RELEASED, ITS KINETIC ENERGY PASSES THROUGH A PENSTOCK (A SET OF CHANNELS OR PIPES). THE WATER TURNS THE BLADES OF A TURBINE, CREATING MECHANICAL ENERGY, WHICH IS THEN CONVERTED INTO ELECTRICITY BY A GENERATOR.

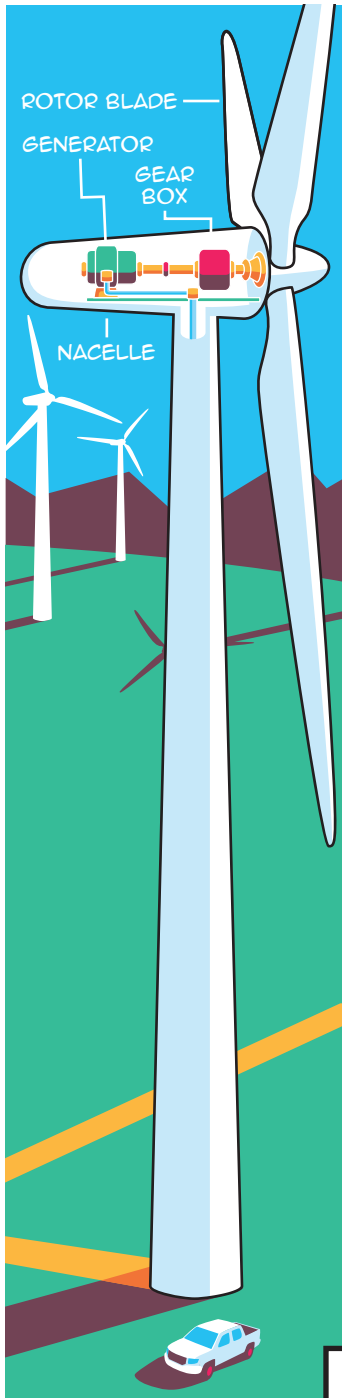


IN A PUMPED STORAGE SYSTEM, WATER IS RELEASED WHEN THERE IS PEAK DEMAND. WHEN DEMAND IS LOW, THE WATER IS PUMPED BACK UP TO THE RESERVOIR USING ELECTRICITY FROM OTHER ENERGY SOURCES. IN RUN-OF-THE-RIVER INSTALLATIONS, THE NATURAL FLOW OF THE RIVER PROVIDES THE NECESSARY KINETIC ENERGY.

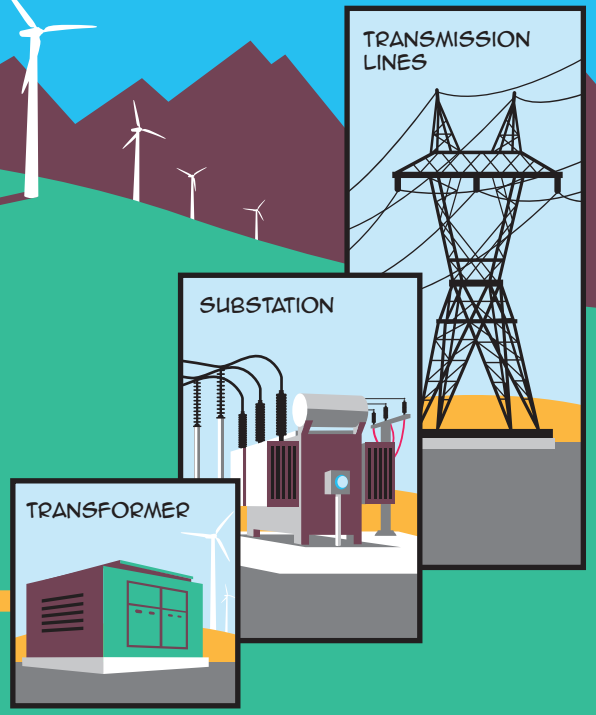
HYDROELECTRICITY IS A RENEWABLE SOURCE OF ENERGY BECAUSE WATER IS NOT USED UP IN THE ENERGY PRODUCTION PROCESS.



WIND



A WIND TURBINE CATCHES THE KINETIC ENERGY FROM A BLOWING BREEZE, CAUSING THE PROPELLER BLADES TO TURN AND CREATE MECHANICAL ENERGY. THE TURBINE IS CONNECTED TO A GENERATOR, WHICH CONVERTS THE MECHANICAL ENERGY INTO ELECTRICITY.

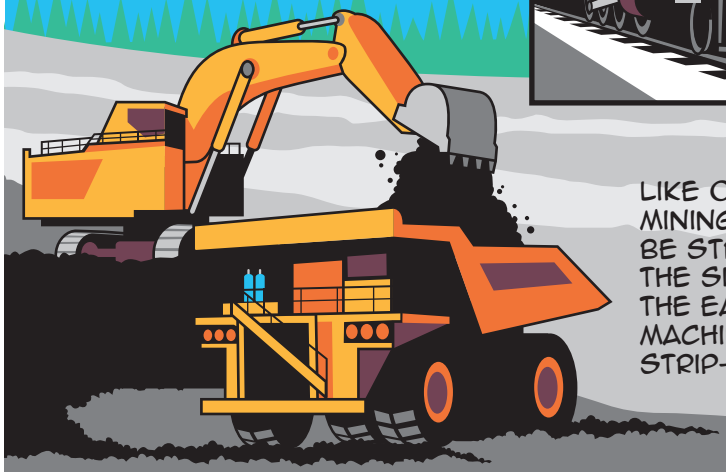


A TRANSFORMER INCREASES THE ELECTRICITY TO A HIGHER VOLTAGE, TRANSMITTING IT TO A SUBSTATION THAT INCREASES THE VOLTAGE AGAIN SO THAT IT CAN TRAVEL OVER LONGER DISTANCES THROUGH THE ELECTRICITY GRID.

WIND ENERGY IS RENEWABLE, BUT IT IS ALSO INTERMITTENT, MEANING THAT IT IS NOT ALWAYS AVAILABLE.

COAL

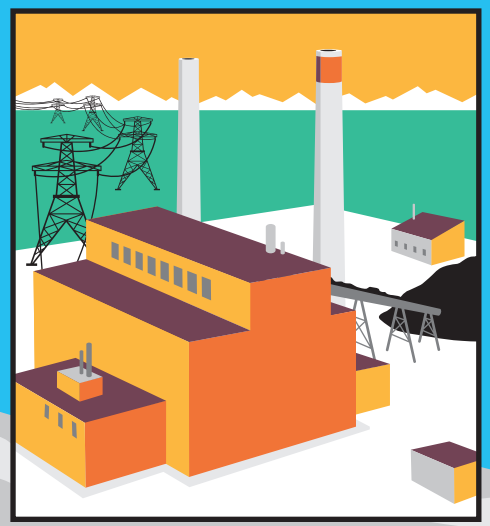
COMMERCIAL MINING IN CANADA DATES BACK TO THE EARLY *1800S*.

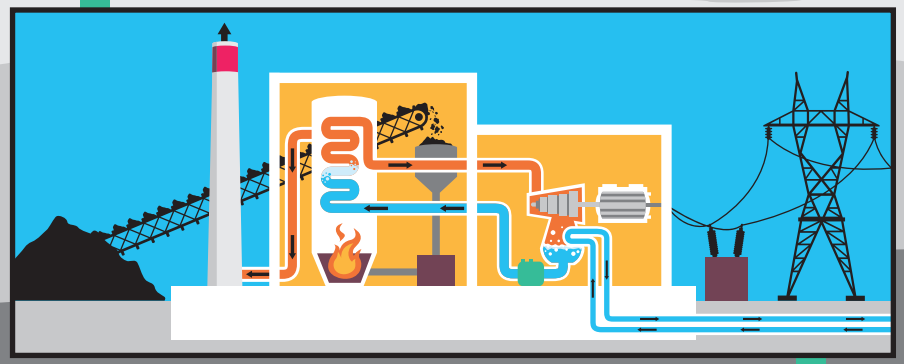


LIKE OIL SANDS MINING, COAL CAN BE STRIPPED FROM THE SURFACE OF THE EARTH BY MACHINE, CALLED STRIP-MINING...

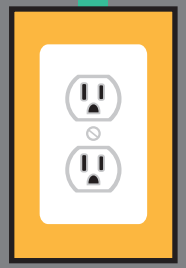
...OR DUG UP BY MINERS WHO BLAST AND BURROW DEEP UNDERGROUND INTO BURIED COAL DEPOSITS OR "SEAMS."

ONCE OUT OF THE GROUND, COAL IS TAKEN TO A POWER PLANT WHERE IT IS BURNED TO HEAT WATER TO MAKE STEAM. THE PRESSURE CREATED BY THAT STEAM SPINS A TURBINE, WHICH IN TURN SPINS MAGNETS INSIDE A GENERATOR.



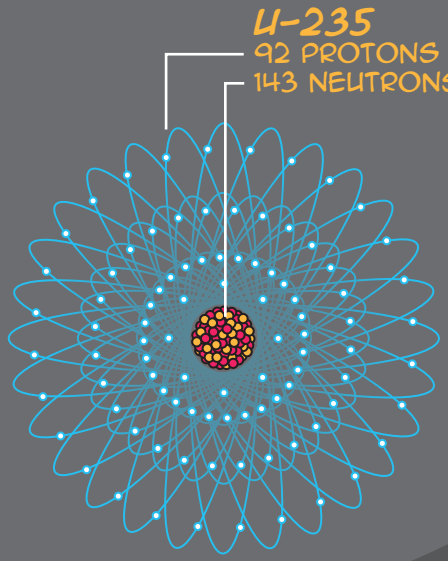


THIS GENERATOR CONVERTS THAT MECHANICAL ENERGY INTO THE KIND OF ELECTRICAL ENERGY WE USE EVERY DAY.

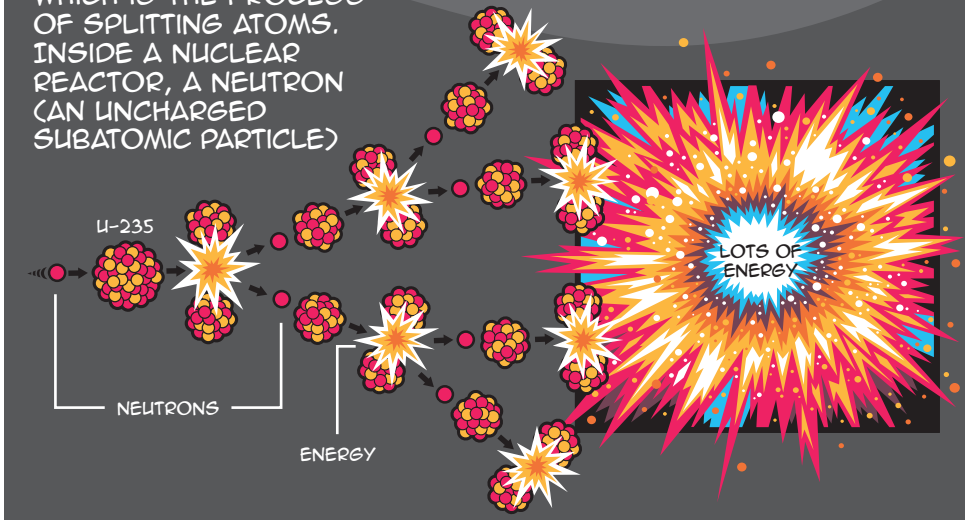


NUCLEAR

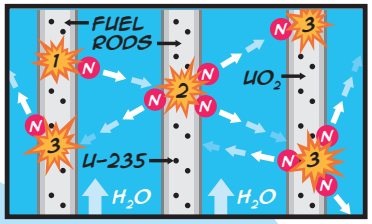
URANIUM IS A HEAVY METAL THAT IS MINED AND PROCESSED TO SERVE AS FUEL FOR NUCLEAR REACTORS. IT IS A RADIOACTIVE ELEMENT AND THE ISOTOPE URANIUM -235 CAN BE USED TO PRODUCE NUCLEAR ENERGY. ISOTOPES ARE VARIATIONS OF THE SAME ELEMENT, WITH AN ATOM HAVING A DIFFERENT ATOMIC WEIGHT DEPENDING ON THE NUMBER OF NEUTRONS IN ITS NUCLEUS.



NUCLEAR ENERGY IS CREATED THROUGH NUCLEAR FISSION, WHICH IS THE PROCESS OF SPLITTING ATOMS. INSIDE A NUCLEAR REACTOR, A NEUTRON (AN UNCHARGED SUBATOMIC PARTICLE)



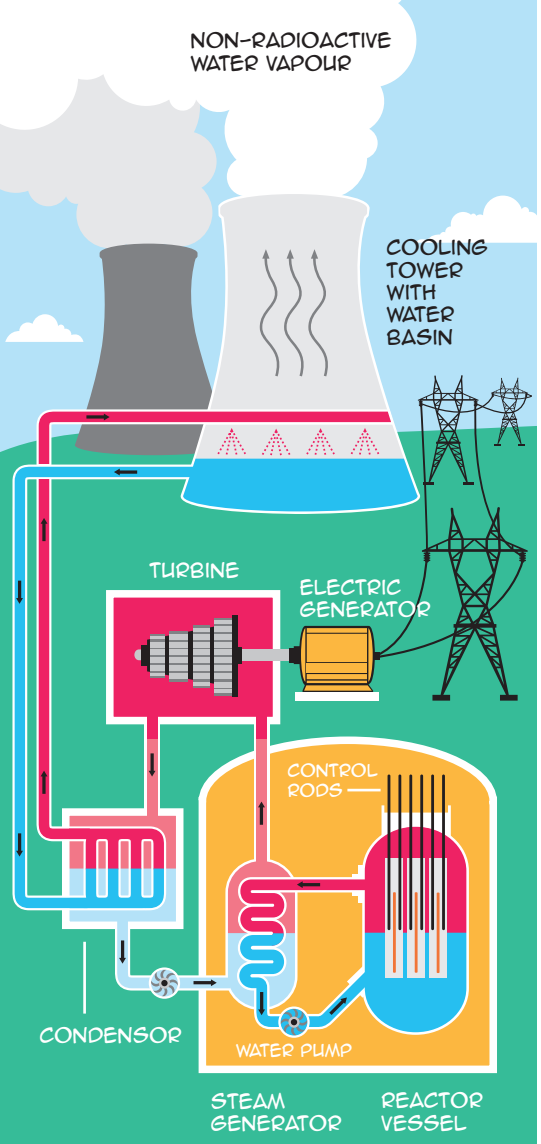
IS FIRED AT THE NUCLEUS OF THE ISOTOPE U-235. THIS EXTRA NEUTRON IN THE NUCLEUS MAKES THE ISOTOPE HEAVIER AND HIGHLY UNSTABLE. TO RELEASE THAT ENERGY, THE ISOTOPE SPLITS INTO TWO SMALLER ELEMENTS. IT ALSO RELEASES A FEW NEUTRONS IN THE PROCESS. THESE NEUTRONS GO ON TO COLLIDE INTO OTHER U-235 ISOTOPES, CAUSING A CHAIN REACTION (I.E., A NUCLEAR REACTION).

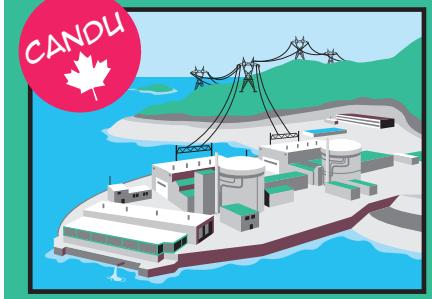


THE NEUTRONS RELEASED IN THE REACTION MOVE AT SPEEDS THAT MAKE IT DIFFICULT FOR THEM TO HIT OTHER ISOTOPES. TO MAKE SURE THE NUCLEAR REACTION CAN CONTINUE, THE NEUTRONS NEED TO BE SLOWED DOWN, OR "MODERATED." WATER IS USED AS A MODERATOR.

NEUTRONS BOUNCE OFF OF WATER'S HYDROGEN NUCLEI AND LOSE ENERGY WITH EACH COLLISION.

NUCLEAR REACTORS ALLOW FOR CONTROLLED NUCLEAR FISSION. CONTROL RODS, MADE FROM A MATERIAL THAT ABSORBS NEUTRONS, ARE RAISED OR LOWERED INTO THE NUCLEAR REACTOR TO CONTROL THE RATE OF FISSION. NUCLEAR FISSION PRODUCES A LARGE AMOUNT OF ENERGY, WHICH IS DISSIPATED AS HEAT.

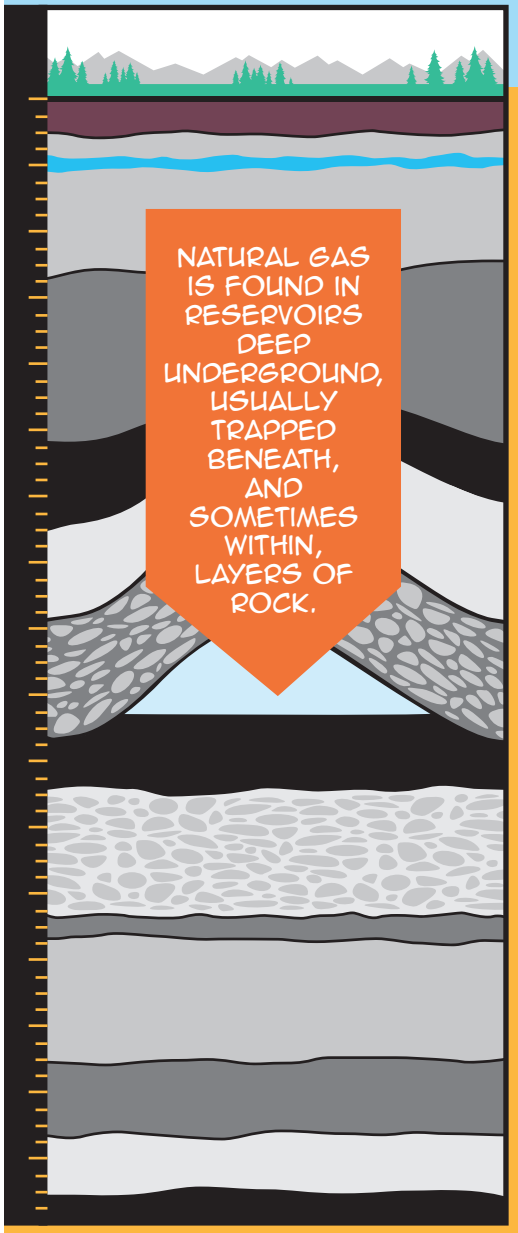




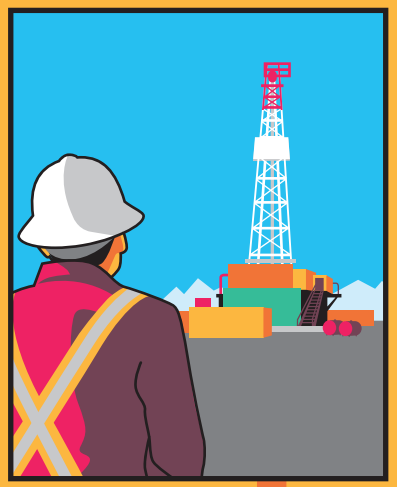
THIS HEAT BOILS WATER AND CREATES STEAM TO POWER THE GENERATORS THAT PRODUCE ELECTRICITY.

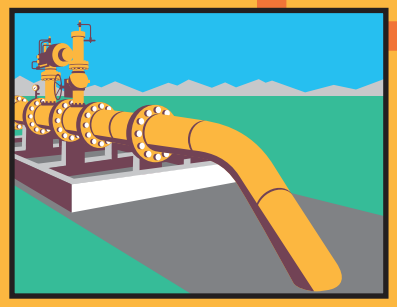
CANADA HAS DEVELOPED ITS OWN UNIQUE NUCLEAR REACTOR TECHNOLOGY, CALLED CANDU, WHICH IT HAS EXPORTED TO THE WORLD.

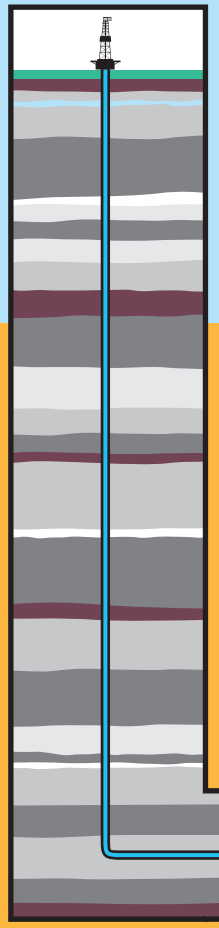
NATURAL GAS



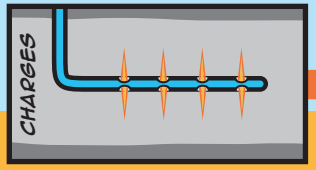
TO EXTRACT ***CONVENTIONAL NATURAL GAS***— GAS TRAPPED IN POROUS SANDSTONE AND LIMESTONE FORMATIONS— WELLS ARE DRILLED INTO THE EARTH, AND THE GAS FLOWS TO THE SURFACE THROUGH THE WELL.

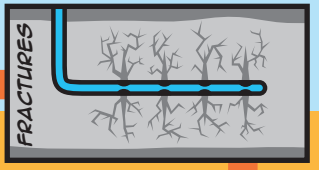






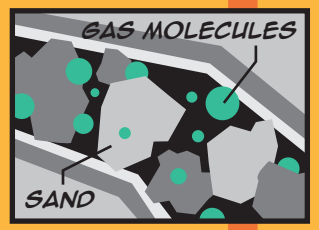
TO EXTRACT ***UNCONVENTIONAL NATURAL GAS***— LOCKED WITHIN SHALE ROCK FORMATIONS— HORIZONTAL WELLS ARE DRILLED DEEP INTO THE EARTH AND A SERIES OF CHARGES ARE SENT DOWN THE WELL TO MAKE SMALL FRACTURES IN THE ROCK IN A PROCESS KNOWN AS HYDRAULIC FRACTURING.



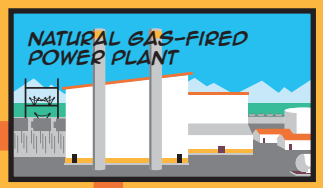


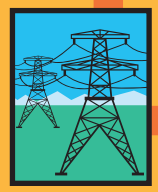
NEXT, A PRESSURIZED MIXTURE OF WATER, SAND AND CHEMICALS IS SENT DOWN THE WELL TO HOLD OPEN THE CRACKS IN THE ROCK.

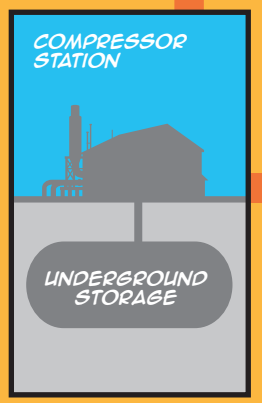
THEN THE GAS, WHICH IS LIGHTER THAN THE FLUID MIXTURE, RISES UP THROUGH THE WELL TO THE SURFACE.

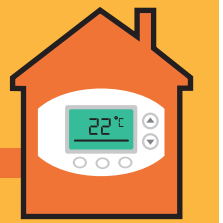


EITHER WAY, NATURAL GAS CAN BE USED TO GENERATE ELECTRICITY, AND HEAT HOMES.



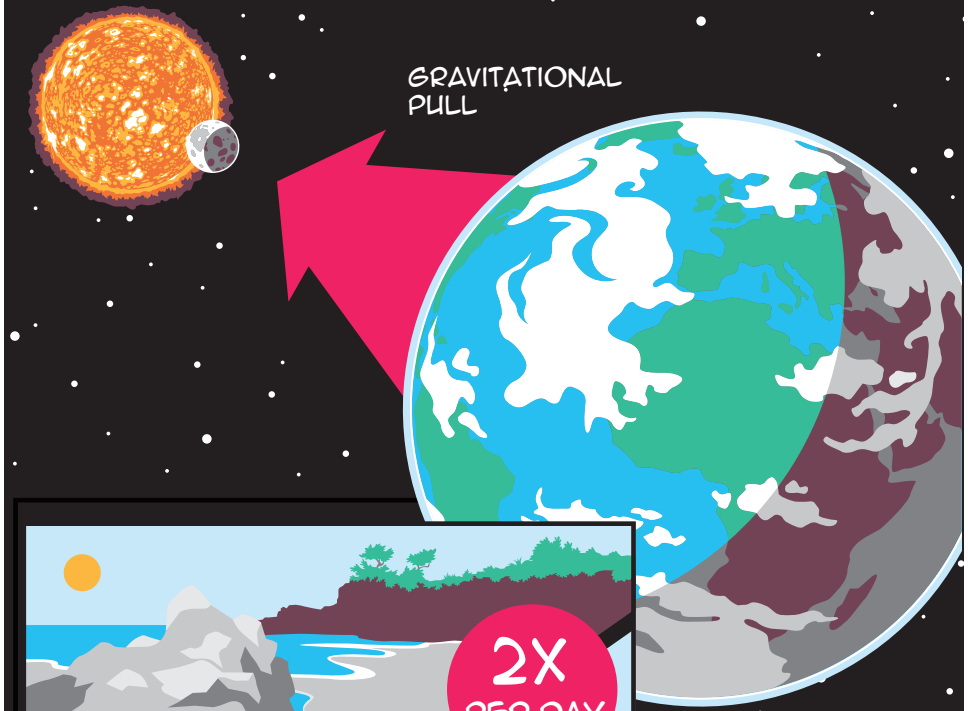




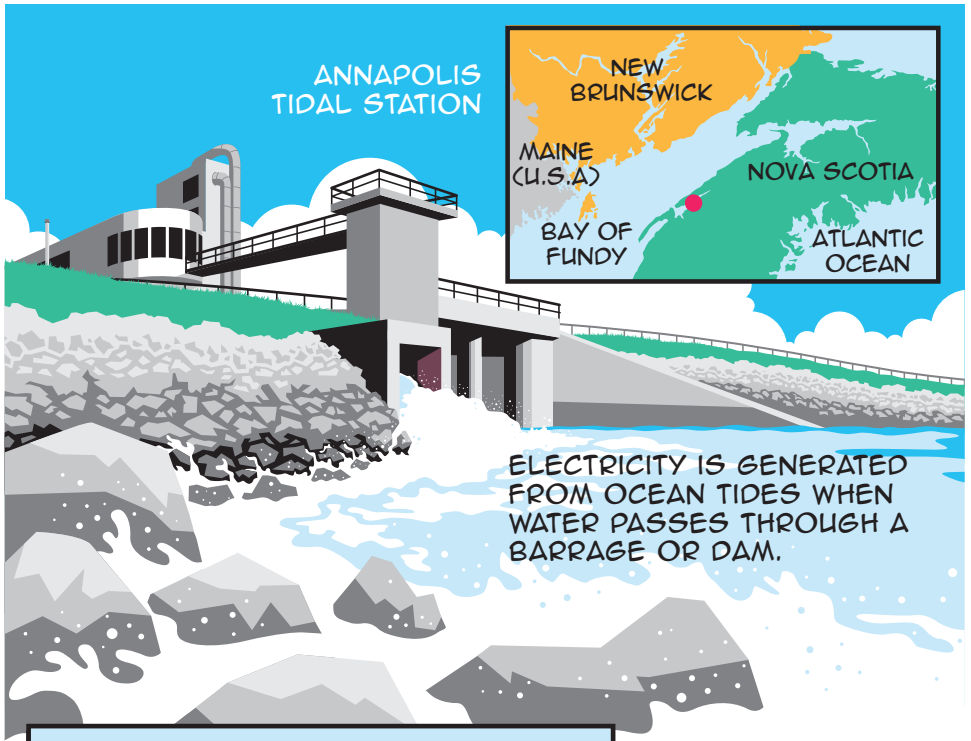


TIDAL

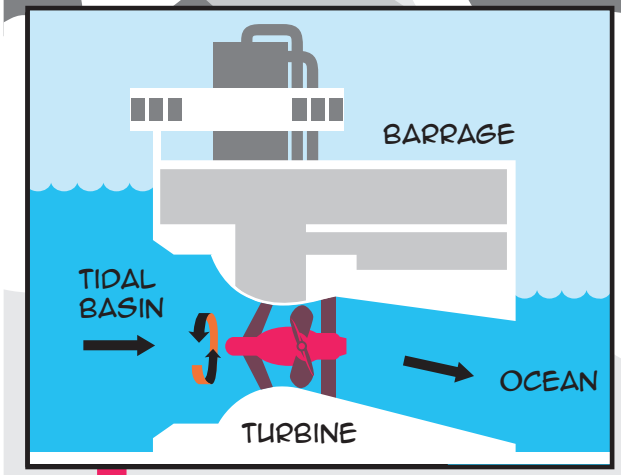
TIDAL ENERGY HARNESSES THE POWER OF OCEAN TIDES, WHICH ARE CAUSED BY THE GRAVITATIONAL PULL OF THE MOON AND SUN, AS WELL AS THE ROTATION OF THE EARTH. TIDAL ENERGY IS RENEWABLE, MEANING THAT THE WATER USED FOR ENERGY PRODUCTION IS NOT USED UP IN THE PROCESS.



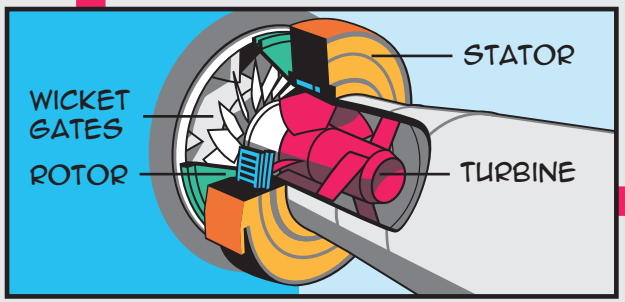
TIDAL POWER STATIONS ARE INSTALLED ALONG COASTLINES IN AREAS WITH A LARGE TIDAL RANGE. TIDAL ENERGY IS RELIABLE BECAUSE TIDES HAPPEN TWICE A DAY—TWO LOW TIDES AND TWO HIGH TIDES WITHIN ABOUT 24 HOURS.

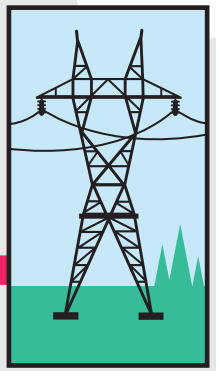


ELECTRICITY IS GENERATED FROM OCEAN TIDES WHEN WATER PASSES THROUGH A BARRAGE OR DAM.



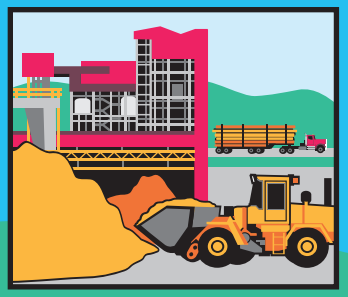
THE CHANGE BETWEEN LOW TIDE AND HIGH TIDE CAUSES WATER TO FLOW THROUGH A TURBINE. THIS KINETIC ENERGY TURNS THE TURBINE, WHICH IN TURN POWERS A GENERATOR, CONVERTING MECHANICAL ENERGY INTO ELECTRICITY.

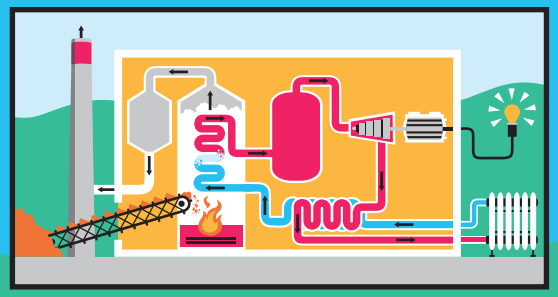




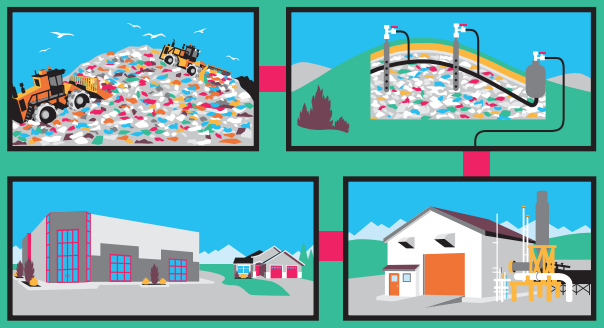
BIOMASS

BIOENERGY BEGINS WITH BIOMASS, WHICH IS ANY ORGANIC MATERIAL THAT HAS STORED ENERGY FROM THE SUN IN A CHEMICAL FORM, SUCH AS TREES, HAY, AND EVEN HOUSEHOLD GARBAGE.



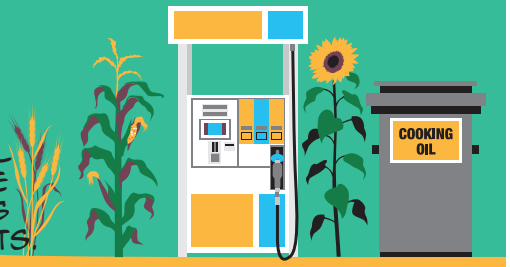


ELECTRICITY: WOODCHIPS, SAWDUST OR OTHER ORGANIC MATERIALS ARE COLLECTED AND COMPRESSED INTO PELLETS. THE PELLETS FUEL A BOILER USED TO PRODUCE STEAM. IT TURNS TURBINES, WHICH SPIN MAGNETS IN A GENERATOR, CONVERTING MECHANICAL ENERGY INTO ELECTRICITY.



LANDFILL GAS CAPTURE: METHANE FROM CAPPED LANDFILLS IS COLLECTED, PROCESSED AND UPGRADED, THEN TRANSMITTED BY PIPELINE TO HOMES AND BUSINESSES.

LIQUID BIOFUELS: BIOETHANOL IS CREATED BY FERMENTING AND DISTILLING BIOMASS SUCH AS STRAW, CORN OR GRAINS. BIODIESEL IS DERIVED FROM VEGETABLE AND ANIMAL FATS, INCLUDING USED OIL FROM RESTAURANTS.



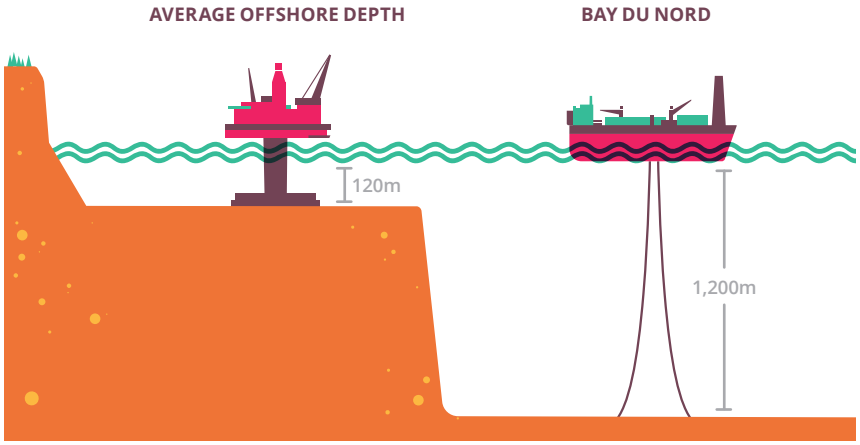
ENERGY POTENTIAL & FUTURE

Canada's energy landscape is constantly shifting and changing. Traditional sources of energy production continue to promise new possibilities and renewable resources are slowly becoming more mainstream.

Crude oil and natural gas exploration in the Atlantic provinces suggests that there are plentiful oil and natural gas reserves that remain untapped. Nova Scotia's offshore resource potential is estimated at more than eight billion barrels of oil and 120 trillion cubic feet of natural gas. Onshore, more than 125 exploration wells have been drilled and about one-third of these wells yielded promising results. Three large-scale LNG (liquid natural gas) projects have been approved by both the provincial government and the National Energy Board of Canada.

In New Brunswick, the Frederick Brook, Dawson Settlement, and Hiram Brook shales are estimated to have about 78 trillion cubic feet of recoverable natural gas and about 2 million barrels of crude oil.

And Newfoundland and Labrador's first remote deep-water project, Bay du Nord, was approved in 2017 and if a final investment decision is made to proceed, production could begin in 2025. This project could open up access to the Flemish Pass basin, which has reserves of approximately 300 million barrels of oil. Bay du Nord would sit 500 kilometres from shore and reach approximately 1,200 metres to the sea floor—10 times deeper than existing offshore facilities in the region.



Nova Scotia, New Brunswick, and Newfoundland and Labrador have a moratorium on hydraulic fracturing, which restricts the development of oil and natural gas in that region until more research can be done into the potential associated risks with hydraulic fracturing.

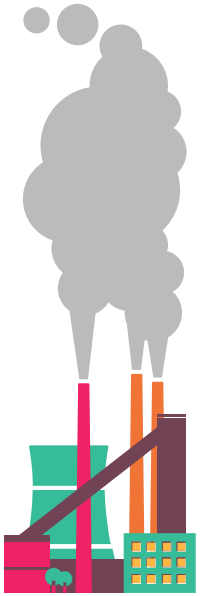
Renewable energy is growing and becoming more cost-efficient and energy-efficient. Hydropower is expected to dominate in Newfoundland and Labrador for electricity generation. The Lower Churchill Falls project, near Upper Churchill Falls in Labrador, is in the process of constructing two additional generating stations, including the large Muskrat Falls station with a generating capacity of 824 megawatts.

Nova Scotia's renewable energy is predicted to grow in its energy mix, mainly through wind and biomass. In addition, experiments in harnessing tidal energy continue to progress. As part of its Renewable Energy Standard, Nova Scotia plans to increase the share of renewables in its energy mix, bringing it to 40 per cent by 2020.

New Brunswick's energy mix will remain diverse in both fossil fuels and renewables, with a slight growth expected in wind and solar energy. Similar to Nova Scotia, New Brunswick also aims to increase its share of renewables to 40 per cent by 2020. And in Prince Edward Island, wind generation is projected to keep growing.

ENVIRONMENTAL IMPACTS

The development, production, and transmission of energy can impact the environment in various ways, but not all impacts are equal. The emission of GHGs contributes to climate change. The Atlantic provinces emitted more than 43.5 megatonnes of carbon dioxide equivalent (a measurement for GHGs) in 2016, which accounted for about 6 per cent of Canada's total GHG emissions.



CANADA HAS COMMITTED TO PHASING OUT COAL-FIRED ELECTRICITY BY 2030

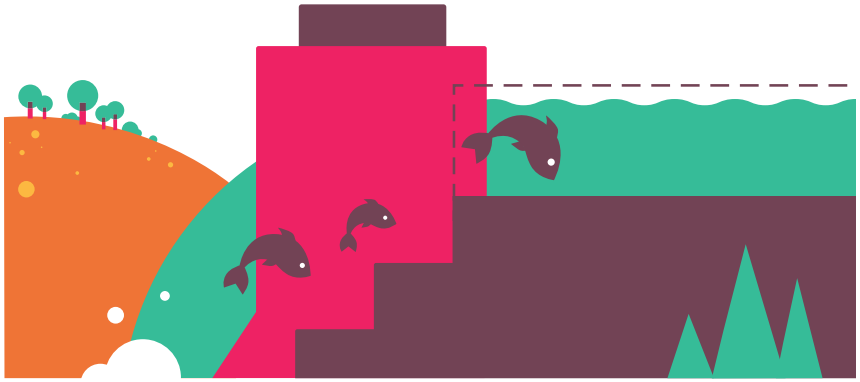
For all of Canada in 2016, the transportation sector made up 25 per cent of all GHG emissions. The oil and gas sector made up between 21 to 26 per cent (depending on how downstream pipeline activities are counted), and electricity accounted for 11 per cent, the majority of which was coal-generated. There is a challenge in reducing GHG emissions while the demand for energy continues to grow, but advances in energy production and efficiency are helping to reduce Canada's GHG emissions.

Out of all energy sources, coal emits the most GHGs when burned. In addition, vast sections of land are stripped of vegetation and disturbed during the mining process. In 2016, coal was responsible for 75 per cent of electricity-related GHG emissions in Canada. The government of Canada has committed to phasing out coal-fired electricity generation across the country by 2030.

While crude oil also accounts for significant GHG emissions (less than coal), the emission intensity has decreased in recent years due to technological innovation and improvements in efficiency. However, there are issues with importing crude oil from abroad. Other countries may have lower standards for acceptable emissions or have less efficient production, and the transportation of crude oil can also add to GHG emissions. Natural gas is another step down from coal and crude oil — it produces the least amount of GHG emissions out of all the fossil fuels.

Nuclear power is neither a fossil fuel nor a renewable energy. Although nuclear power doesn't produce greenhouse gases, it can pose a risk to the environment with the challenge of ensuring safe long-term storage of hazardous waste. There are also associated emissions and environmental impacts when it comes to the mining of uranium and the construction of nuclear power plants.

On the side of renewables, the infrastructure for hydroelectricity requires large swathes of land that can alter river ecosystems, causing long-term changes to the natural landscape and impacting the migration of fish species. There are some ways to mitigate the negative impact on wildlife, such as with fish ladders that allow fish to migrate around obstacles. Another issue with hydroelectricity is the decomposition of plants in dam reservoirs, which releases methane gas and contributes to global warming.



There are no emissions from wind energy, but the manufacturing, transportation and installation of wind turbines produces some greenhouse gas emissions. Wind farms can also be harmful to wildlife, specifically when birds and bats collide with wind turbines. This can be mitigated by careful selection of wind farm sites and by pausing the operation of turbines during periods of low wind. Tidal energy is similar to wind in that it doesn't contribute directly to climate change but can impact wildlife. Research into how best to harness ocean energy is still ongoing.

ENERGY QUIZ

For more fun puzzles and quizzes, visit energyiq.canadiangeographic.ca

Test your knowledge of Atlantic Canada's energy resources.

1) At what temperature does natural gas turn into a liquid (LNG)?

A) -33 degrees Celsius
B) -208 degrees Celsius
C) -60 degrees Celsius
D) -162 degrees Celsius

2) Which province has a long history of coal mining?

A) Newfoundland and Labrador
B) New Brunswick
C) Nova Scotia
D) Prince Edward Island

3) Where would you find the only nuclear power plant outside of Ontario?

A) Saint John, N.B.
B) Sydney, N.S.
C) Moncton, N.B.
D) St.John's, N.L.

4) TRUE or FALSE: The first offshore well drilled in Canada was off the coast of Prince Edward Island.

A) True
B) False

5) Where is the largest wind farm in Atlantic Canada?

A) Nova Scotia
B) New Brunswick
C) Prince Edward Island
D) Newfoundland and Labrador

6) Approximately how many people are employed in the energy sector in Atlantic Canada?

A) 5,000
B) 7,500
C) 23,000
D) 12,600

7) What percentage of New Brunswick's electricity is generated through hydropower?

A) 17%
B) 34%
C) 60%
D) 20%

8) On which body of water is the Annapolis Tidal Station located?

A) Minas Basin
B) Gulf of Saint Lawrence
C) Bay of Fundy
D) St. Lawrence River

9) TRUE or FALSE: Nova Scotia produces 30 per cent of its electricity from coal-fired generation.

A) True
B) False

10) What percentage of Canada's total electricity production does Newfoundland and Labrador generate?

A) 2%
B) 12%
C) 7%
D) 23%

WORD SEARCH PUZZLE

Z	E	K	T	W	R	E	M	C	V	R	V	P	Q	M	T
D	S	F	B	C	B	O	L	E	O	B	A	Q	U	I	S
B	L	E	C	O	U	I	S	N	G	K	U	N	O	W	H
P	E	S	O	S	O	M	Z	N	A	A	F	F	W	M	P
P	O	H	N	E	N	Y	F	B	R	K	W	Q	E	S	R
E	O	R	D	H	T	C	O	T	X	N	F	A	S	A	Z
V	S	U	E	M	J	I	N	A	B	P	D	Z	T	X	P
N	R	O	N	S	C	C	D	S	L	O	H	F	C	T	Q
C	A	D	S	A	Y	O	S	A	Y	U	M	T	A	E	E
E	B	P	A	R	A	F	O	F	L	R	R	I	P	U	B
A	R	E	T	E	R	C	P	L	P	O	E	R	E	B	E
R	S	M	E	A	B	G	F	K	P	B	P	Z	E	X	G
U	N	I	T	E	D	S	T	A	T	E	S	S	G	L	A
E	A	H	E	B	R	O	N	W	E	D	M	N	O	D	Y
B	S	N	P	H	E	A	S	N	U	C	L	E	A	R	H
K	A	H	S	P	C	R	N	O	P	Z	P	X	I	B	E

Questions

1) What type of energy is unique to Nova Scotia? (5 letters)

2) What is the name of Newfoundland and Labrador's newest offshore oil facility? (6 letters)

3) What type of energy does the Belledune Generating Station use? (4 letters)

4) What is the name of the largest wind farm in Prince Edward Island? (8 letters)

5) What type of energy does the Point Lepreau Generating Station use? (7 letters)

6) What is the name of Canada's only large-scale LNG terminal? (8 letters)

7) This light crude oil by-product is produced from natural gas extraction. (10 letters)

8) What is the typical unit of measurement for electricity generating capacity? (8 letters)

9) Petroleum products are refined from this type of energy. (8 letters)

10) What country receives the majority of Atlantic Canada's energy exports? (12 letters)

ANSWER KEY

Answers To Energy Quiz (Pg 38):

1) D – -162 degrees celcius
2) C – Nova Scotia
3) A – Sait John, N.B.
4) A – True
5) B – New Brunswick
6) D – 12,600
7) D – 20%
8) C – Bay of Fundy
9) B – False
10) C – 7%

Answers To Word Search (Pg 39):

Z	E	K	T	W	R	E	M	C	V	R	V	P	Q	M	T
D	S	F	B	C	B	O	L	E	O	B	A	Q	U	I	S
B	L	E	C	O	U	I	S	N	G	K	U	N	O	W	H
P	E	S	O	S	O	M	Z	N	A	A	F	F	W	M	P
P	O	H	N	E	N	Y	F	B	R	K	W	Q	E	S	R
E	O	R	D	H	T	C	O	T	X	N	F	A	S	A	Z
V	S	U	E	M	J	I	N	A	B	P	D	Z	T	X	P
N	R	O	N	S	C	C	D	S	L	O	H	F	C	T	Q
C	A	D	S	A	Y	O	S	A	Y	U	M	T	A	E	E
E	B	P	A	R	A	F	O	F	L	R	R	I	P	U	B
A	R	E	T	E	R	C	P	L	P	O	E	R	E	B	E
R	S	M	E	A	B	G	F	K	P	B	P	Z	E	X	G
U	N	I	T	E	D	S	T	A	T	E	S	S	G	L	A
E	A	H	E	B	R	O	N	W	E	D	M	N	O	D	Y
B	S	N	P	H	E	A	S	N	U	C	L	E	A	R	H
K	A	H	S	P	C	R	N	O	P	Z	P	X	I	B	E

1) tidal
2) Hebron
3) coal
4) West Cape
5) nuclear
6) Canaport
7) condensate
8) megawatt
9) crude oil
10) United States

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