Yukon Energy State of Play

Submitted to:

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Note: the 24 December 2018 update to the *Yukon Energy State of Play* report reflects revisions to Statistics Canada's *Report on Energy Supply and Demand Cat. No 57-003* released after the original publication date of the report. Volumes of refined petroleum products consumed in the Yukon were underreported in the earlier Statistics Canada's *Report on Energy Supply and Demand* in Table 4-14: Refined petroleum products, terajoules – Yukon.

Introduction

This Yukon Energy State of Play report has been prepared to provide a current understanding of all aspects of the Yukon's energy sector. The report will be used to inform Yukon government officials and partners in the development of an Integrated Yukon Strategy on Climate Change, Energy and the Green Economy.

Based on a review and analysis of existing literature and data, the Yukon Energy State of Play explores the economic challenges and opportunities in the Yukon energy sector. The report begins with an overview of energy uses and sources and presents a comprehensive illustration of the Yukon's energy flow in terms of energy supply and demand. Yukon's energy balance of trade is next presented, followed by a look at Yukon's energy transportation infrastructure. Yukon's capacity to produce energy and the actual volume of energy produced are documented next. Yukon's vast non-renewable and renewable energy potential is considered in the following section.

The tradeoffs involved in choosing among Yukon's future energy supply options are next described followed by a summary presentation of the regulatory, governance and stakeholder landscape for the Yukon's energy sector. An assessment of Yukon's energy pricing situation is also considered. Yukon's greenhouse gas emission levels are presented using brand new data from the Yukon Bureau of Statistics. Renewable energy and energy efficiency initiatives currently underway are outlined in the next section and the report concludes with a look at some issues on the horizon of Yukon's energy sector.

Yukon Energy Overview

Energy is at the centre of the daily lives of all Yukon citizens. We use energy in its various forms throughout the day and the night. Energy is defined as the ability to do work. The work that energy produces can be divided up into several easily recognizable tasks:

- Energy produces light: we use light to see and work.
- Energy produces heat: we use heat to keep warm and to cook food.
- Energy produces motion: we use motion to get from one place to another in cars, on bikes and airplanes.
- Energy produces growth: photosynthesis converts light energy into sugars used by people, animals and plants to grow.
- Energy powers technology: we use energy from primary and secondary sources to make the electricity that powers computers and phones.

Energy comes from many different sources and exists in one of two states, **stored** energy and **kinetic** energy:

Stored energy has the potential to do work and can be contained for use on demand at different times and, if transported, in different places. We store energy in batteries, in tanks of gasoline, and in water held back behind hydro-electric dams.

Kinetic energy is the energy possessed by an object in motion. Kinetic energy moves bikes down the road, makes wind turbines spin and lets kids score hockey goals.

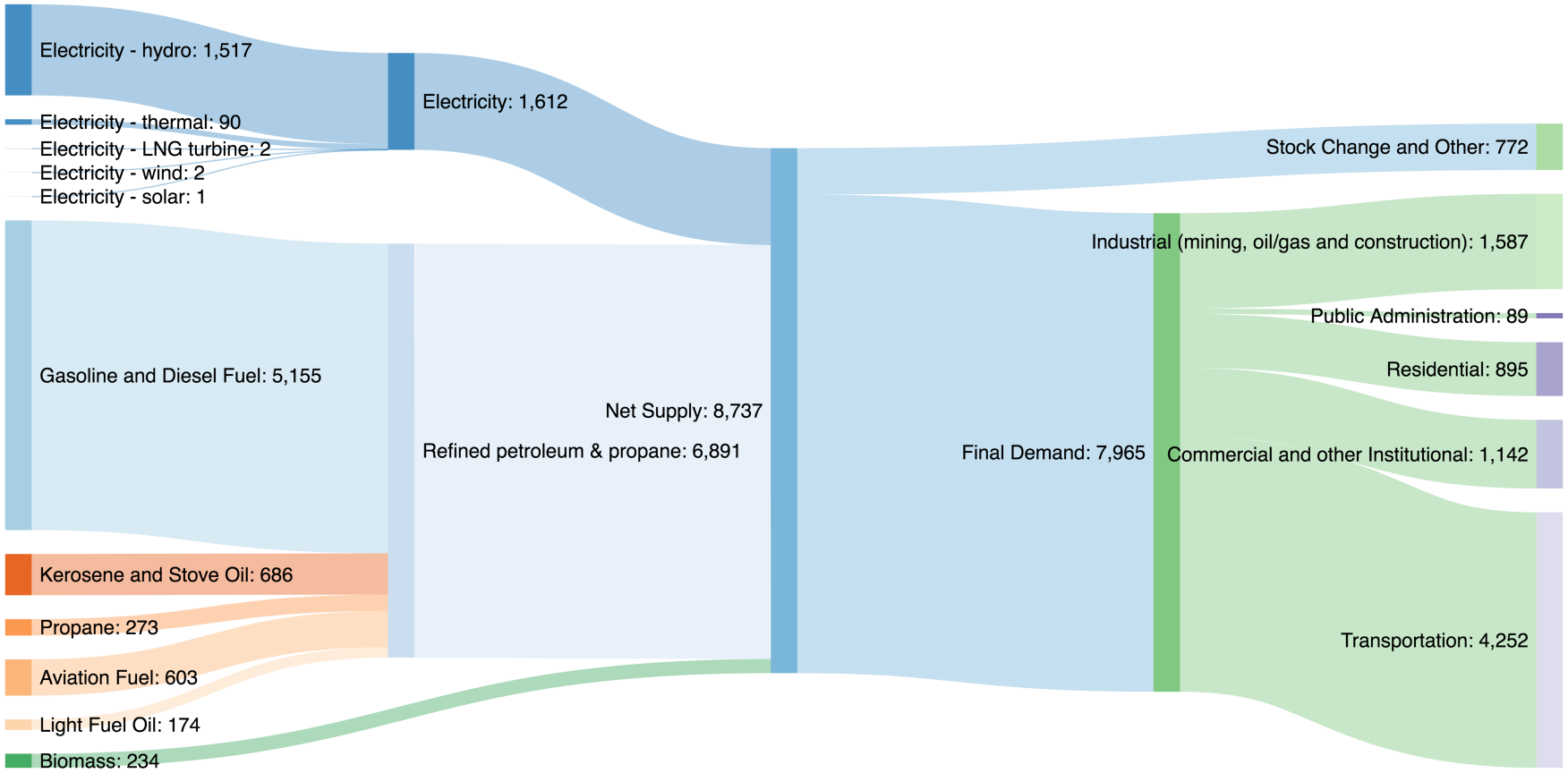
The table below shows the sources of energy in common use in Canada. Sources currently in use in Yukon are notated with the ◣ symbol. Non-renewable energy sources are listed on the left side of the table and renewable sources are listed on the right. Non-renewable sources cannot be replenished while renewable sources can be replenished.

Non-Renewable Energy Sources	Renewable Energy Sources
Coal	◣ Biomass (e.g., wood)
◣ Hydrocarbon gas liquids (e.g., propane)	◣ Geothermal (heat from inside the earth)
Nuclear	◣ Hydropower (flowing water)
◣ Petroleum products (e.g., gasoline, diesel)	◣ Solar (light and heat)
◣ Natural gas	◣ Wind

The diagram on the following page illustrates Yukon's overall energy flow for 2015. The unit of measure used in the diagram is the terajoule. Terajoules are used as the unit of measure since joules can be used to describe both potential and kinetic energy states and can be applied as a unit of measure to all energy sources. One terajoule is equal to 1,000,000,000,000 joules. One joule is:

- the amount of electricity required to light a 1 watt light emitting diode (LED light) for 1 second;
- the amount of heat required to raise the temperature of 1 gram of water by 0.24 °C; or,
- the energy required to lift a medium-size tomato (100 g) 1 metre vertically from the surface of the earth.

Yukon Energy Flow, 2015 [Updated] – terajoules



Source: adapted from Statistics Canada Cat. No. 57-003-X *Report on Energy Supply and Demand in Canada – 2015 Revised* and Yukon Energy, Mines and Resources, *Yukon's Energy Context* (2017).

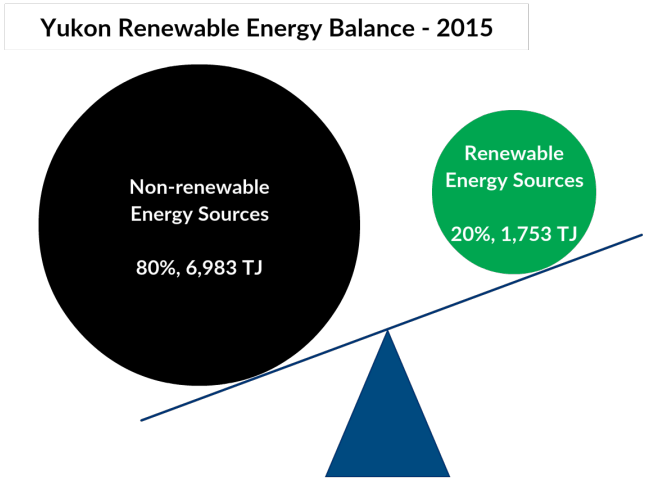
As can be seen from the diagram, in 2015, the net supply of energy in the Yukon was 8,737 terajoules (TJ) and the final demand by economic sector for energy in the Yukon was 7,965 TJ. In conformity with the first law of thermodynamics, which states that energy cannot be created or destroyed, but can only be transferred from one location to another and converted to and from other forms of energy, the diagram also accounts for the 772 TJ not consumed among economic sectors in Yukon in 2015. Energy supplied but not consumed in the year is categorized in the diagram as 'stock change and other'.

Almost all (97%) of Yukon's energy supply is derived from one of two main sources: electricity and refined petroleum & propane products. Electrical energy accounted for about one-fifth (18%) of Yukon's total energy supply in 2015, equivalent to 1,612 TJ. In 2015, almost all (94.2%) of Yukon's electricity was generated in hydro-electric facilities. A further 5.6% of Yukon's electricity was produced with diesel fueled generators. The remaining 0.25% of electricity available in Yukon in 2015 was produced with liquid natural gas (LNG) fueled generators (2 TJ), wind turbines (2 TJ) and solar panels (1 TJ).

Energy from refined petroleum & propane products accounted for almost four fifths (79%) of Yukon's total energy supply in 2015, equivalent to 6,891 TJ. Three quarters (75%) of energy from refined petroleum & propane products was in the form of gasoline and diesel fuels containing 5,155 TJ of energy. Kerosene and stove oil accounted for one tenth (10%) of energy from refined petroleum & propane products. Energy in the form of propane accounted for 4% of energy from refined petroleum & propane products (273 TJ). Aviation fuel and light fuel oil accounted for 12% of energy from refined petroleum & propane products, with supply of 603 TJ and 174 TJ, respectively, in 2015.

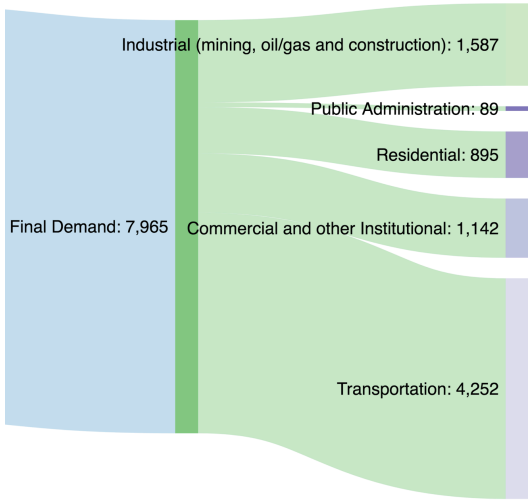
Biomass burned for space heating contributed 3% (234 TJ) of energy to Yukon's overall energy supply in 2015.

The supply of energy can also be thought of in terms of the proportion of energy derived from non-renewable sources relative to renewable sources. As shown in the illustration to the right, four fifths (80%, 6,983 TJ) of Yukon's total energy supply came from non-renewable sources. Out of the 6,983 TJ of energy from non-renewable sources, 99% was derived from refined petroleum products and propane and the remaining 1% came from the generation of electricity with diesel and liquefied natural gas (LNG).



One fifth (20%, 1,753 TJ) of Yukon's total energy supply came from renewable sources in 2015. Out of the 1,753 TJ of energy from renewable sources, 87% was attributable to the generation of electricity from water in Mayo Lake, the Yukon River and Aishihik Lake. The remaining 13% of renewable energy was attributable to biomass burned for space heating.

Green energy is a subset of renewable energy and is comprised of renewable energy sources that have minimal negative impact on the natural and social environment. For example, while all electricity generated with water from Yukon lakes and rivers is renewable, only the portion of electricity from sources that did not cause extensive flooding and habitat loss would be considered 'green'. While a definition of green energy has yet to be adopted for the Yukon, electricity from the run-of-river Whitehorse Dam could be considered more green than electricity from the Aishihik Lake Hydro-electric facility which has caused environmental and cultural damage along the shoreline of Aishihik Lake through flooding.



The right-hand side of the Yukon Energy Flow diagram (partially reproduced to the left) illustrates the demand for energy in Yukon by economic sector in 2015. The total demand for energy in Yukon was 7,965 TJ. The largest demand for energy can be traced to the transportation sector which consumed more than one half (53%) of total Yukon energy in 2015, equivalent to 4,252 TJ of energy. Demand for energy in the commercial and institutional sector accounted for one fifth (20%) of total demand. Energy demand from the residential sector totaled 895 TJ (11%). The industrial sector which includes mining, oil & gas and construction, accounted for 20% (1,587 TJ) of energy demand. The public administration sector accounted for the remaining 1% of energy demand in 2015, equivalent to 89 TJ of energy.

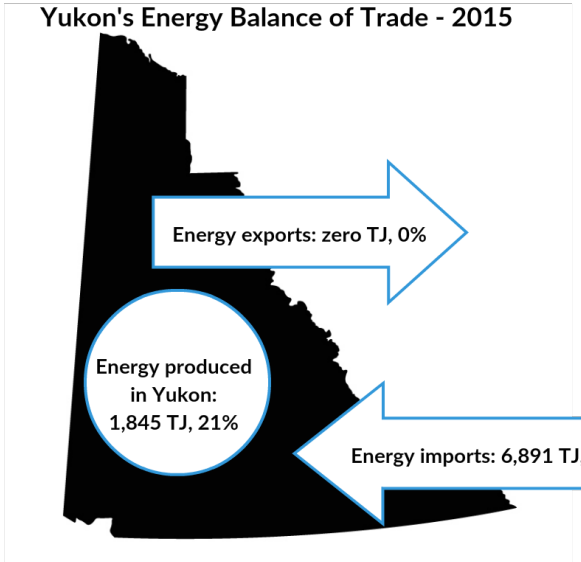
Energy Balance of Trade

The picture to the right illustrates Yukon's energy balance of trade in 2015, estimated with data from Statistics Canada and Yukon Energy, Mines and Resources.

In 2015, Yukon had a negative energy balance of trade, importing 79% (6,891 TJ) of its total overall energy requirements while exporting zero TJ of energy.

As recently as 2005, Yukon was a net exporter of energy, when natural gas was produced at the Kotaneelee field in the far southeast corner of the Yukon. The Kotaneelee field produced 235 billion cubic feet (Bcf) of natural gas for export from operations that ran from 1978 until 2012, all of which was exported.

Due to limited data availability, the 6,891 TJ of energy imports does not include wood pellets used for heat in Yukon residences and at the Whitehorse Correctional Centre. As such, energy forms represented in the energy import total include only refined petroleum and propane products. Data describing exports of renewable energy from Yukon are not available.



*Note: due to limited data availability, energy imports do not include wood pellets used for heat.
Sources: Statistics Canada Cat. No. 57-003-X [2015 Revised] and Yukon Energy, Mines and Resources, *Yukon's Energy Context* (2017).

As Yukon's electricity transmission system is 'islanded' (i.e., not connected to transmission grids in British Columbia, the Northwest Territories or Alaska), Yukon does not currently import or export any electricity. Relatively small volumes of imported diesel (90 TJ) and LNG (2 TJ) fuels were used to generate electricity in 2015.

Energy Transportation Infrastructure

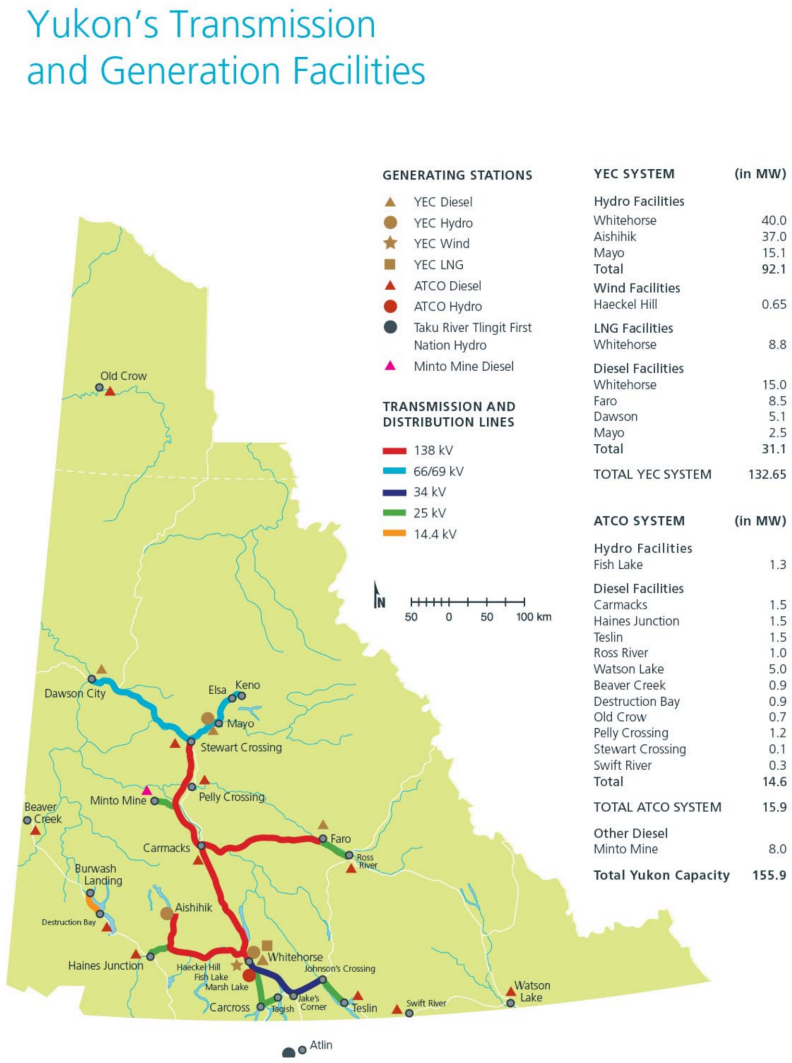
Some forms of energy require transport from the location of production to the location of consumption. Recognizable examples of infrastructure used to transport energy include electricity transmission lines and natural gas pipelines. Road and rail systems are also used to transport storable forms of energy such as biomass and refined petroleum products, including propane.

Yukon's current stock of energy transportation infrastructure consists primarily of the transmission and distribution lines owned and operated by the Yukon Energy Corporation and ATCO Electric Yukon. Yukon's electricity transmission system is illustrated in the map to the right. Major components of the Yukon Energy Corporation's transmission system include:

- 38 kV Whitehorse / Aishihik / Faro (WAF) grid;
- 69 kV Mayo / Dawson transmission line; and,
- 38 kV Carmacks / Stewart transmission line, connecting the WAF grid and the Mayo / Dawson transmission line.

ATCO Electric Yukon is the primary distributor of electricity in the Yukon, operating and maintaining electricity distribution infrastructure in all Yukon communities except for Faro, Dawson and Mayo.

While no pipelines are currently operating in the Yukon, a total of six pipelines have been built in the territory.[1] Four pipelines were built as part of the Canadian American Norman Oil Line (Canol) project during the Second World War, which included the construction of an oil refinery fed by crude oil from Norman Wells, NWT.



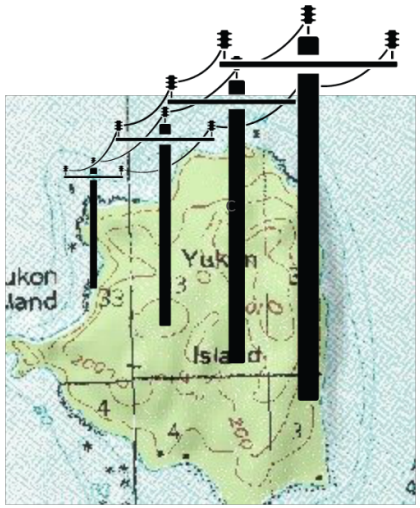
"The Canol system saw the development of a total of 2,600 kilometers (km) of pipeline. A span of 925 km of supply pipeline connected Norman Wells oil to the refinery in Whitehorse. A distribution line connected Whitehorse to Fairbanks (960 km). A secondary supply and distribution line connected Skagway to Whitehorse, via Carcross (175 km), and Skagway to Watson Lake, also via Carcross (425 km)."[2]

A fifth pipeline was built during the Korean War to supply U.S. Air Force bases in Alaska.

The sixth, and only commercially-developed pipeline to have operated in the Yukon, was the Spectra Energy Pointed Mountain pipeline located in the southeast Yukon. Built in 1972 and in operation for 34 years until 2012, the Yukon section of the Pointed Mountain pipeline was only 20 kilometres long. The pipeline was used to transport natural gas from the Kotaneelee field (part of the Liard Basin) to southern markets.

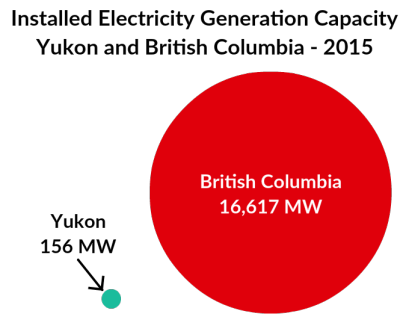
Yukon's extensive road system is used to transport refined petroleum products to all communities except Old Crow. Refined petroleum products are imported into the Yukon from multiple directions on the Alaska Highway (north and the south), the South Klondike Highway and the Haines Highway.

A Note on Yukon's "Islanded" Electrical Grid



Yukon's islanded electricity transmission system presents several challenges for the supply of electricity to Yukoners. All electricity used in the Yukon must be generated in the Yukon as electricity cannot be imported from other jurisdictions. At the same time, it is not possible to 'overbuild' generation capacity to take advantage of economies of scale as it is not possible to export excess electricity to neighboring markets. Yukon ratepayers alone must bear the cost of building and maintaining our self-sufficient electricity supply system. Further, installed generation capacity must be sufficient to meet peak demand even though demand is highly variable within a given day and across the winter and summer seasons.

Lastly, the self-contained nature of the Yukon's electricity supply system means that forms of renewable energy which feature intermittent supply, such as wind, are difficult to integrate into the electricity grid. The electricity supply system must be able to instantaneously meet peak demands for electricity. If the supply of electricity from a renewable source is not available at the instant it is needed, the system must be able, in less than a second, to switch to another source of backup or stored electricity. The required capacity redundancy in turn affects the cost efficiency of renewable energy options.



As for why Yukon is not already connected to the British Columbia electrical grid, the answer is one of scale – the Yukon can neither supply or demand enough electricity to make a connection economic. As illustrated to the left, Yukon's installed electricity generation capacity of 156 MW is less than 1/100th (0.8%) of British Columbia's installed electricity generation capacity of 16,617 MW.

The scale mismatch, for both British Columbia and Alaska, is illustrated in the table to the right, reproduced from the 2016 Midgard report *Yukon Next Generation Hydro and Transmission Viability Study.*[3] Interconnections with both British Columbia and Alaska were found to be not economic in the Midgard study; net costs exceeded net benefits for both export and import to/from British Columbia and Alaska. In response to the December 2017 go-ahead decision for the Site C Hydroelectric Dam by the British Columbia government[4], the Yukon government has tasked the Yukon Development Corporation with checking to see whether the possibility of surplus hydro at Site C alters the economics of a British Columbia grid connection.[5]

Table 2-3: Economic Evaluation of Exporting Electricity from Yukon

Interconnection Option	Net (Present Value) Benefits [$2015]	Net (Present Value) Costs [$2015]	Economic Evaluation (Net Benefits > Net Costs?)
Yukon → British Columbia	+$214M	-$1,689M	NOT ECONOMIC
Yukon → Alaska	+$202M	-$1,394M	NOT ECONOMIC

Table 2-4: Economic Evaluation of Importing Electricity to Yukon

Interconnection Option	Net (Present Value) Benefits [$2015]	Net (Present Value) Costs [$2015]	Economic Evaluation (Net Benefits > Net Costs?)
British Columbia → Yukon	$0M	-$1,556M	NOT ECONOMIC
Alaska → Yukon	$0M	-$1,247M	NOT ECONOMIC

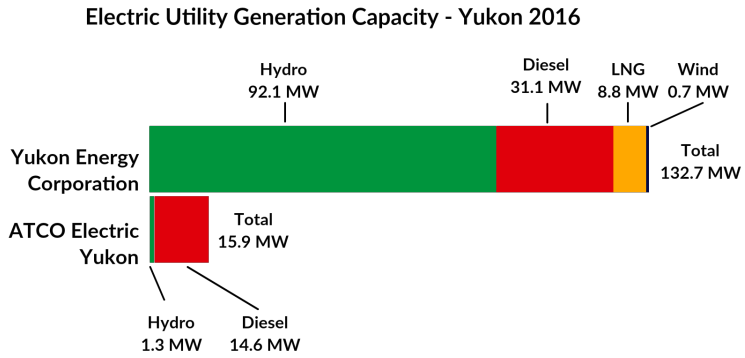
Potential Energy Transportation Infrastructure

One of two large-scale northern energy transportation initiatives under development since the 1970s was discontinued at end of 2017. Imperial Oil Resources Limited, the lead proponent in the Mackenzie Gas Project Joint Venture, announced on 22 December 2017 a decision to dissolve the joint venture with its partners – ConocoPhillips Canada, ExxonMobil Canada and the Aboriginal Pipeline Group – and cease work on the project. Imperial Oil noted that "Mackenzie gas is currently not economically competitive with other sources of supply in North America, due to a combination of factors, including high project costs and the continued growth of low-cost North American unconventional gas supplies."[6] The Mackenzie Gas Project could possibly have provided access for gas from Yukon's Eagle Plain basin into the North American market.

The second energy transportation initiative, the Alaska Highway Gas Pipeline Project, was planned to bring natural gas from Alaska's North Slope alongside Alyeska's Trans-Alaska oil pipeline to Tok, Alaska and then alongside the Alaska Highway and into Alberta. While technically still on the books with permits in place, the likelihood of the project advancing is very slim as "focus has shifted to an all-Alaska pipeline which would export liquefied natural gas to Asian markets."[7]

Yukon Energy Capacity

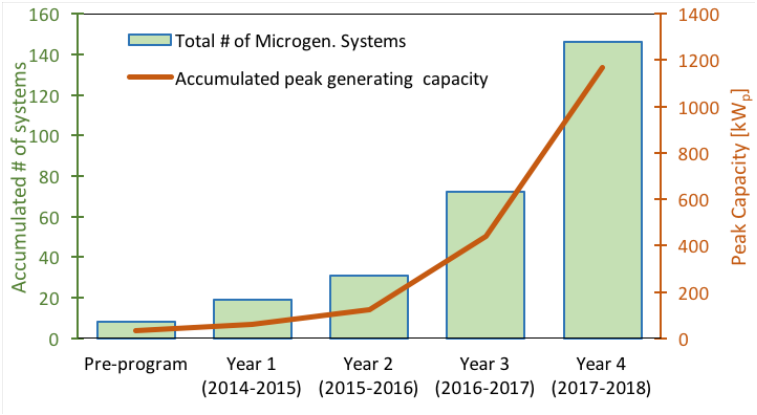
Virtually all of the electricity produced in the Yukon is generated by two utilities, both regulated by the Yukon Utilities Board. The Yukon Energy Corporation (YEC), owned by the Yukon Development Corporation, which is in turn owned by the Yukon government, is the primary generator and transmitter of electricity in the territory. ATCO Electric Yukon, a private utility owned by ATCO Electric Limited, is Yukon's primary distributor of electricity.



YEC generates electricity with a combination of hydro, diesel, liquefied natural gas and wind facilities. In 2016, total YEC generation capacity was 132.65 megawatts. Hydro generation makes up the bulk of YEC's electricity generation capacity with facilities in Whitehorse (40 MW), Aishihik Lake (37 MW) and Mayo Lake (15 MW). YEC's Whitehorse dam is a run-of-river facility. As such, water flows are reduced in winter by 40%.

YEC has 31.1 MW of diesel-fueled electricity generation capacity located in Whitehorse (15 MW), Faro (8.5 MW), Dawson (5.1 MW) and Mayo (2.5 MW). Two LNG-fueled generators with a combined capacity of 8.8 MW are located in Whitehorse next to the Whitehorse Dam. A wind turbine located on Haeckel Hill near Whitehorse provides the YEC with 0.7 MW of wind-generated capacity.

Total ATCO Yukon Electric generation capacity was 15.9 MW in 2016. Summer capacity at the Fish Lake Hydro Facility is 1.3 MW. In winter, capacity at the Fish Lake facility is reduced by 46%. The remaining 14.6 MW of ATCO Yukon Electric's generating capacity is in the form of diesel generators dispersed among Yukon's smallest communities: Watson Lake (5.0 MW), Carmacks (1.5 MW), Haines Junction (1.5 MW), Teslin (1.5 MW), Pelly Crossing (1.2 MW), Ross River (1.0 MW), Beaver Creek (0.9 MW), Destruction Bay (0.9 MW), Old Crow (0.7 MW), Stewart Crossing (0.1 MW) and Swift River (0.3 MW).

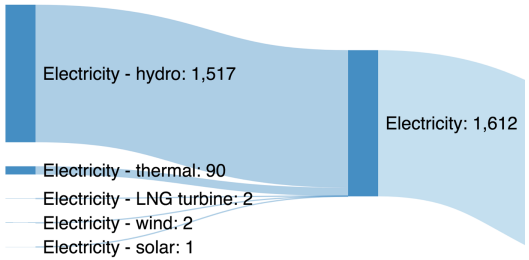


Yukon's solar electric capacity is small but is growing quickly. A micro-generation policy and accompanying production incentive program introduced by the Yukon government in 2013 lets residential and commercial electricity customers generate electricity from renewable sources and sell surplus electricity to the grid. According to the Energy Branch, as of January 2018, 146 solar micro-generators are now connected to a utility grid in Yukon with a combined capacity of 1,173 kW."

In terms of heat energy, the Energy Branch estimates that "four biomass projects with a combined nameplate capacity of over 2 MW are currently installed and operational. A further 2.8 MW and 0.04 Megawatt electric (MWe) are planned for installation in the near future."[8]

With the closure of the Kotaneelee gas plant and facilities in 2012, Yukon currently has no non-renewable energy capacity in place. While a small refinery operated briefly in Whitehorse in the 1940's as part of the Canol project, there are no oil or gas refineries currently located in the Yukon. The Husky Energy Prince George Refinery is the closest oil refinery to the Yukon.

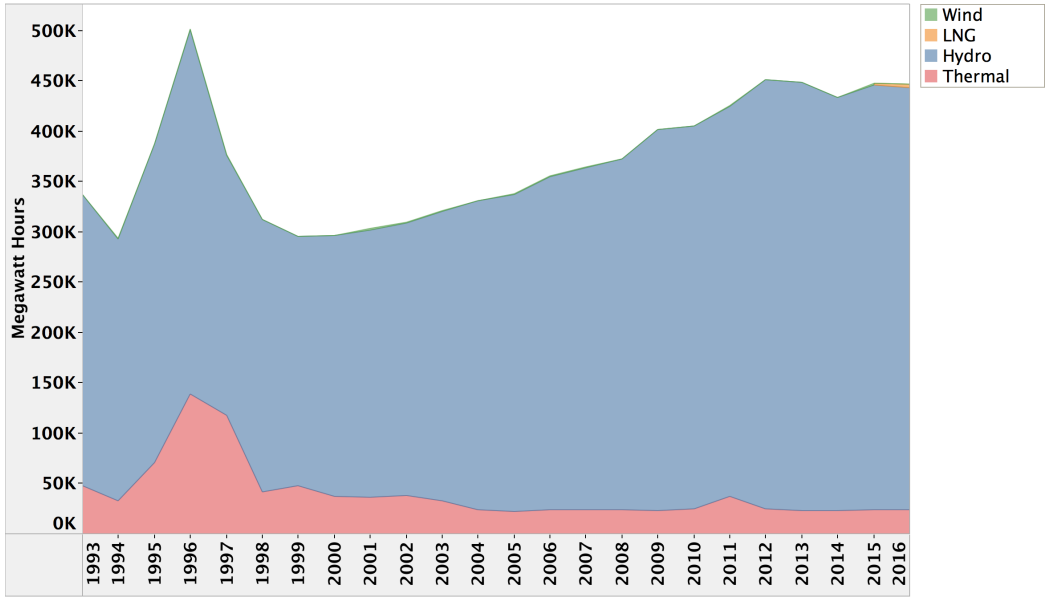
Yukon Energy Production



As shown in the Sankey diagram on page 3, a total 1,612 terajoules of energy were produced in the Yukon in 2015. Almost all (94.2%) of Yukon's electricity was generated in hydro-electric facilities. A further 5.6% of Yukon's electricity was produced with diesel fueled generators. The remaining 0.25% of electricity available in the Yukon in 2015 was produced with liquid natural gas (LNG) fueled generators (2 TJ), wind turbines (2 TJ) and solar panels (1 TJ).

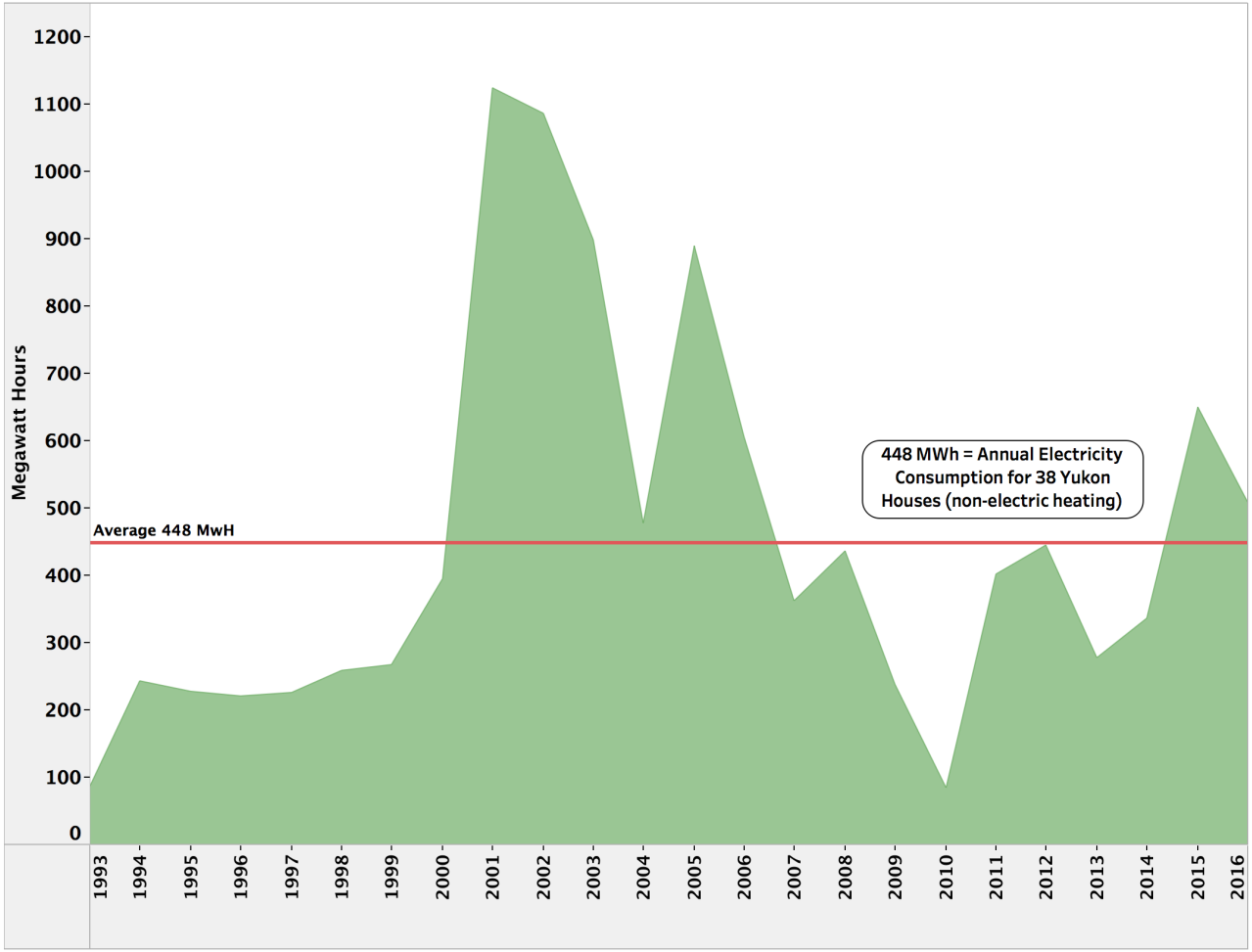
The chart to the right shows the amount of electricity produced in the Yukon between 1993 and 2016 in megawatt hours.[9] During that time period, electricity production peaked in 1996 at 499,962 MWh. The peak in production corresponds with operations at the Faro lead-zinc mine. Electricity production fell off sharply when Faro mine operations ceased in 1998. Since 1999, electricity production in the Yukon has gradually increased and averaged 445,687 MWh per year between 2012 and 2016.

Yukon Utility Electricity Production (megawatt hours)
1993 to 2016



The increase in electricity production since 1999 has been due to three main factors. First, the Yukon's population has grown from 31,070 in 1999 to 38,923 in 2016, an increase of 23%.[10] Second, there has been a switch to installing electric heat in new residential and commercial construction projects. Third, the Minto mine connected to the Whitehorse-Aishihik-Faro transmission grid in late 2008.

Yukon Electricity Production from Wind (megawatt hours)
1993 to 2016



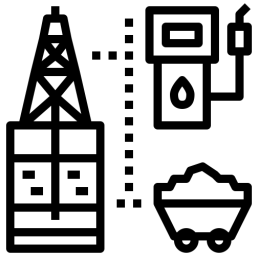
The chart to the left provides a more detailed look at Yukon electricity production from the wind turbines located on Haeckel Hill near Whitehorse. Over the period 1993 to 2016, electricity production has been quite variable, averaging 448 MWh per year. The average Yukon house (with-nonelectric heating) consumes an estimated 11.7 MWh of electricity on an annual basis.[11] Thus, the Haeckel Hill wind turbines have generated enough electricity, on average between 1993 and 2016, for 38 Yukon houses.

Largely due to the Yukon government's 2013 micro-generation policy, a small amount of electricity is produced from solar sources in the Yukon. The Energy Branch has estimated that the 106 solar micro-generators connected to a utility grid in July 2017 are "generating approximately 0.8 GWh per year."[12]

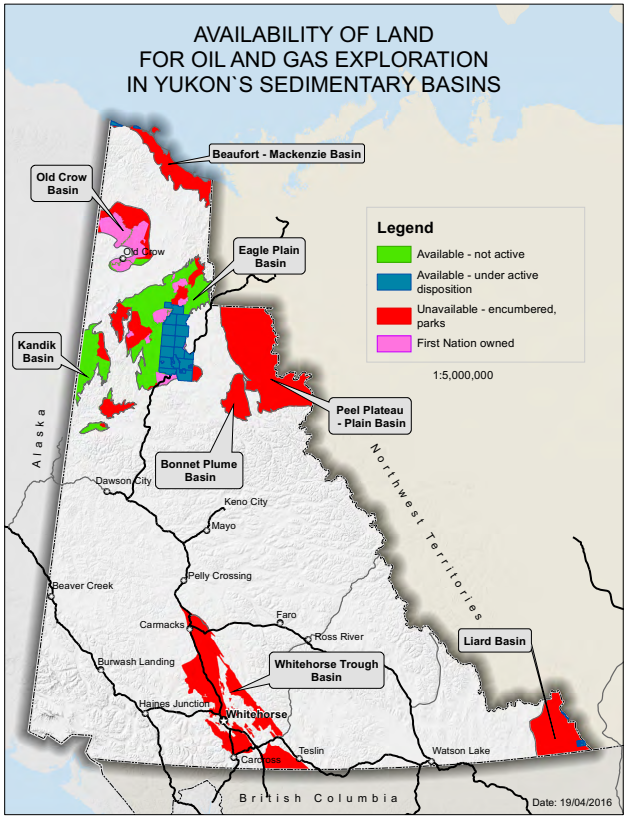
An estimated 13,000 cords of wood, equivalent to 30,000 cubic metres, are harvested each year in the Yukon to heat homes and buildings.

Yukon Energy Potential

Non-renewable Energy Potential



Significant hydrocarbon potential has been established in the Yukon, both onshore and offshore. As noted by Yukon Finance, "Yukon's onshore sedimentary basins contain an estimated 14.77 trillion cubic feet (Tcf) of conventional natural gas and 663 million barrels (MMbbls) of conventional oil. Offshore conventional resources in the Beaufort Sea include an additional estimated 40 Tcf of natural gas and 4,500 MMbbls of oil."[13]



Oil and gas exploration rights are acquired in a different manner than the free-staking approach used for mineral exploration in the Yukon. Rights to oil and gas are obtained through a competitive process. The oil and gas disposition process is initiated when a 'request for posting' is received from an exploration entity. If the requested location is found to be suitable for exploration by the Oil and Gas Resources Branch, a disposition review process is launched. The first step in the disposition review process consists of confidential government to government consultations with affected First Nations in whose traditional territories the request for postings are located. The second step consists of an internal government review. A 60-day public review then follows, where the public can submit comments on specific environmental, socio-economic, and surface access concerns. Following the request for posting review, the next step is a Call for Bids where exploration companies outline the exploration methods to be used and how much they will commit to spending on the exploration project. The disposition process concludes with oil and gas permits being issued to qualified successful bidders.

The most recent request for postings closed on 13 July 2016. Fifteen requests for oil and gas rights were received with 13 located in the Kandik basin and two located in the Eagle Plain basin. In November 2017, the Yukon government discontinued the disposition review process for the 15 requests for oil and gas rights received in response to the July 2016 request for postings. No requests for posting were received in 2017.[14]

A total of 15 oil and gas permits are currently in force in Yukon. All 15 permits are located in the Eagle Plain basin and cover an estimated land area of 513,361 hectares (equivalent to 5,134 square kilometers).

The 1998 transfer of responsibility for management of oil and gas resources to the Government of Yukon did not include oil and gas resources located offshore of the Yukon's north coast. As such, responsibility for management and development of oil and gas resources in the Beaufort Sea continues to be held by the Government of Canada. In December 2016, the federal government designated all Arctic waters, including the Beaufort Sea, off limits to oil and gas licensing. The designation is to be reviewed every five years through a climate and marine science-based life-cycle assessment.

Similar to the situation for oil and gas, the Yukon's coal resources are largely undeveloped. Small volumes of coal have been extracted at the Tantalus mine near Carmacks and the Whiskey Lake deposit near Ross River, both in support of lead-zinc mining processes at the Faro mine. No coal or coal bed methane is being extracted in the Yukon at the present time. The table to the right describes the coal resource at the four locations where significant efforts to develop coal resources in the Yukon have taken place.

Key Yukon Coal Resources

Deposit Name	Location	Potential Resource
Division Mountain	90 km northwest of Whitehorse	52.9 million tonnes of coal
Whitehorse Coal	30 km southwest of Whitehorse	12 km of discontinuous seams of mineable thickness (0.6 to 13 metres)
Rock River	southeast Yukon	60 million tonnes of coal within 80 metres of surface
Bonnet Plume	northwestern Yukon	660 million tonnes

Source: Yukon Energy, Mines and Resources, *Coal,* 2007.

Renewable Energy Potential

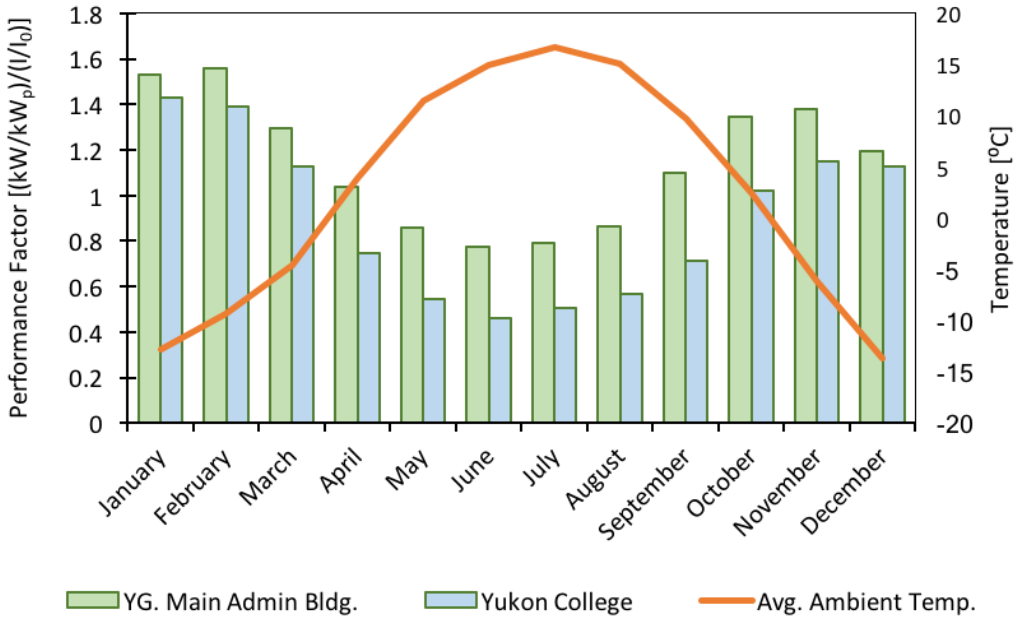
Yukon is home to extensive renewable energy resources in the form of solar, wind, biomass and geothermal. At Yukon's current population level of 38,500 people, Yukon's renewable resource potential far, far exceeds the volume of energy needed to meet Yukon's energy light, heat, transportation and technology needs. Significant work has been completed in the last few years to identify and evaluate the potential of Yukon's key renewable energy sources: solar, wind, biomass, geothermal and hydro.

Solar

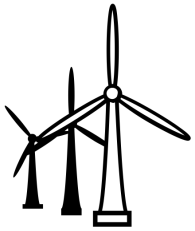
As part of the work for the 2016 Resource Plan prepared by the Yukon Energy Corporation, Solvest compiled an inventory of potential Yukon solar sites for grid-scale electricity generation. Criteria used to evaluate the sites included solar irradiance profiles, proximity to existing transmission infrastructure and communities, topography, land ownership and openness of land. Four potential sites were identified: Haines Junction, Whitehorse Copper, Takhini and Canyon. On the basis of site visits and a topography review, the Whitehorse Copper and Haines Junction sites were found to hold the most development potential. The study found that while the solar resource in Yukon is lower in comparison with other parts of Canada, it is comparable to some countries that have implemented grid-scale solar projects such as Germany and Japan. Another key finding of the study is that solar potential in the Yukon is quite high in the late winter and spring months, when hydro generation potential is at its lowest.[15]

Solar energy is both free and non-rival in supply, meaning that use of the solar resource by an electrical utility or by an individual does not limit use of the resource by another utility or individual. Thus, the solar resource available in the Yukon can be harvested at an unlimited number of grid-scale or microgeneration facilities.

Recent cold-climate research undertaken by the Energy Branch found that solar photovoltaic systems can perform better in Yukon than specified by manufacturers. As illustrated in the chart to the right, "…performance increases of up to 40% above the rated peak power can be achieved during the cold winter months".[16]



Wind



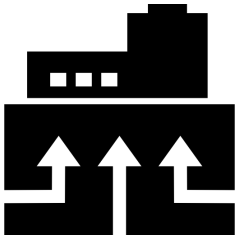
An inventory of wind energy sites was also completed for the *Yukon Energy 2016 Resource Plan* by CBER. As part of the inventory, wind potential studies previously completed for specific known sites were reviewed, including Aishihik, Tehcho (Ferry Hill), Whitehorse and Mount Sumanik. The 2016 Resource Plan inventory expanded on the mesoscale (large scale) wind mapping work previously completed and identified potential wind energy sites across the Yukon. On the basis of wind speed, distance to transmission infrastructure, road access and land ownership, seven sites were selected for conceptual design and economic analysis including: Miller's Ridge (near Carmacks), Kluane Lake (near Destruction Bay), Cyprus Mine (near decommissioned Faro Mine), Thulsoo Mountain (near the Aishihik Generating Station), Sugarloaf Mountain (near Carcross), Tehcho (near Stewart Crossing, formerly Ferry Hill) and Mount Sumanik (near Whitehorse).

For wind potential to result in electricity generation capacity, a site requires relatively high wind speeds, which in Yukon generally occur at higher elevations. Higher elevation sites, however, are more prone to rime icing on wind turbine blades in Yukon's cold northern climate than lower elevation sites. Only the Kluane Lake site is at a low elevation. Even with the effects of rime icing on wind energy potential taken into account, all seven sites show an average of three-quarters of the expected electricity production occurring between October and April. Thus, all seven sites present a generation profile complementary to the Yukon's energy needs which are higher in the winter months of October to April due to increased requirements for space heating and lighting. [17]

Biomass

Approximately 13,000 cords (30,000 cubic metres) of wood are harvested annually in Yukon to heat homes and buildings, providing approximately 17% of Yukon's total consumption of energy for heat. Currently, much of the 30,000 m^3 in cordwood is harvested in the Haines Junction area from beetle-killed trees and trucked to the Whitehorse area. The harvest level of 30,000 m^3 is well within the 0.1% of the Yukon's forested land base of 38 million hectares that has so far been identified for harvest through regional forest management planning efforts. On average, 112,000 hectares of Yukon forests are consumed by forest fires every year, representing nearly 200 times more wood than is currently harvested for energy use in the Yukon.[18]

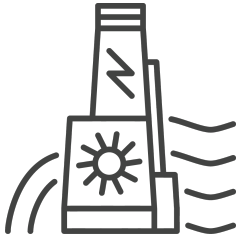
Geothermal



The Yukon has significant potential for geothermal electricity generation and direct use of heat, as Yukon features some of the highest temperature resources in Canada. The Canadian Cordillera passes through the territory and hot sedimentary aquifers offer potential in the eastern Yukon for high temperature geothermal project development. The geothermal potential of the Yukon implies more than 1,700 MW of indicated resources at a depth of less than 5,000 metres (using a 5% recovery factor). Approximately 100 MW of resource potential was identified as readily available at a depth of less than 2,000 metres.[19]

Assessment work completed for the *Yukon Energy 2016 Resource Plan* considered two sites based on geothermal resource potential and proximity to transmission lines: Vista Mountain near Whitehorse and McArthur Springs near Stewart Crossing. Both sites feature low to medium temperature resources, with groundwater temperatures below 150 degrees centigrade. A key advantage of geothermal-generated electricity is its constancy (non-intermittency) of output, making it suitable to supply base load on Yukon's electricity transmission grid.

Hydro



A screening assessment of potential small hydro sites in Yukon and northern British Columbia was completed by Knight Piesold as part of the Y*ukon Energy 2016 Resource Plan*. The assessment included a review of prior reports prepared on small hydro by the Yukon Energy Corporation, the Yukon Electrical Company Limited and other companies over the last 50 years. A pre-feasibility study for the Atlin Hydro Expansion was also included in the assessment. The *Yukon Energy 2016 Resource Plan* considered the hydro site assessment work completed in 2015 for the Yukon Development Corporation's Next Generation Hydro project.

The screening assessment report begin with 49 potential hydroelectric sites, characterized as both storage and run-of-river. After an initial screening based on redundancy, location in restricted areas and distance from existing or proposed transmission lines, 22 sites remained for further study. On the basis of more detailed analysis, which included a review the site hydrology and project layout, modelling of energy output and cost-benefit analysis, a short list of five sites were selected for more detailed review. The five sites include: Anvil Creek, Drury Lake, Finlayson River, Tutshi Lake (Windy Arm) and the Wolf River. The Atlin Hydro Expansion at Pine Creek in BC was added to the list on the basis of work completed separately. The Wolf River and Anvil Creek projects would be considered run-of-river plants and the remaining four would have storage.

Electrical Energy Potential

The Yukon Energy Corporation completed an update to its Resource Plan less than a year ago in March 2017. The Plan, comprised of a 387-page main report and a series of 34 technical appendices, provides a comprehensive and thorough assessment of Yukon's electricity needs over the next 20 years. As part of the resource planning work, a total of fifteen resource options were assessed on the basis of technical, financial, environmental, social and economic attributes at the prefeasibility level. Resource options assessed include:

- Hydro storage enhancements
- Hydro uprating and refurbishments
- Small hydro
- Wind
- Geothermal
- Solar
- Biomass
- Biogas
- Waste to energy
- Natural gas
- Diesel
- Pumped storage
- Energy storage
- Demand side management
- Transmission

Prefeasibility studies that considered the technical and financial attributes of the potential projects were completed for each resource option listed above. The technical attributes assessed included monthly average energy, monthly firm energy, installed capacity, dependable capacity, project life, in-service lead time and dispatchability. Financial attributes assessed included the levelized cost of energy and the levelized cost of capacity. Lists of "best potential projects" for each resource were then identified and sorted onto two action plans, one for the short-term and one for the long term. The short-term action plan resource options are presented in the table on the following page.

Resource Options Recommended in the Yukon Energy Corporation's Short-Term Action Plan

Year	Option	Description
2018	Demand Side Management	Energy efficiency incentives and conservation measures for residential, commercial and government class consumers of electricity.
2019	Additional LNG Engine	A third engine with a capacity of 4.4 MW installed at the Whitehorse LNG Facility.
2020	Aishihik Hydro Uprate	Uprating (aka re-runnering) increases the efficiency of existing hydro turbines by installing more efficient components to generate more electricity with the same amount of water.
2020	Whitehorse Hydro Uprate	Uprating (aka re-runnering) increases the efficiency of existing hydro turbines by installing more efficient components to generate more electricity with the same amount of water.
2020	Battery Storage	A 4 MW installation of lead acid batteries near the Takhini substation 30 kilometres north of Whitehorse.
2020	Southern Lakes Enhanced Storage Project	An expansion in the storage range on the Southern Lakes system, which provides water storage for the Whitehorse generating station, by decreasing the licensed low supply level by up to 10 cm and increasing the licensed (post-peak) upper allowable limit by up to 30 cm.
2022	Mayo A Refurbishment	Replacement of the two turbine units in the Mayo A plant (built in 1951) with a new single new turbine unit.
2022	Mayo Lake Enhanced Storage	An expansion in the storage range on Mayo lake, which provides water storage for the Mayo Hydroelectric Facility, by decreasing the licensed low supply level, initially by 50 cm and later by a further 50 cm.
2022	Independent Power Producer (IPP) Standing Offer Program	The Standing Offer Program follows from the Yukon government's 2015 IPP Policy and envisions 10 GWh/year of firm energy provided by IPPs, starting in 2022.

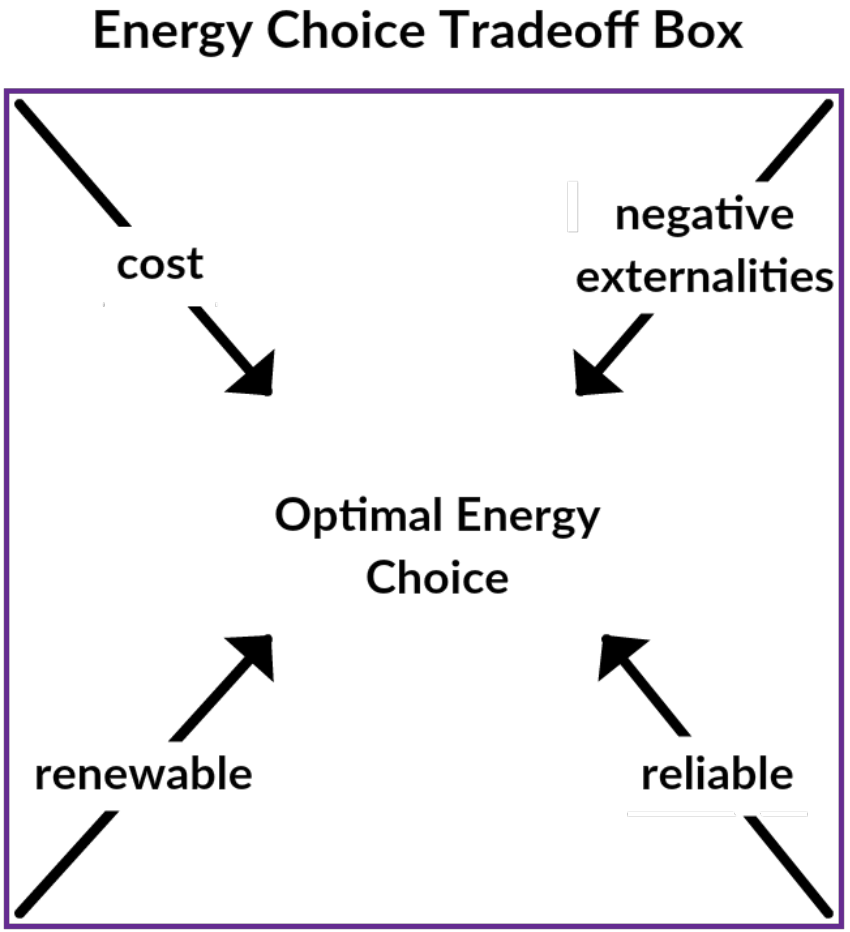
Advancement of one or more of the long-term resource options noted in the table below is contingent on how various economic growth scenarios play out over the long term:

Resource Options Recommended in the Yukon Energy Corporation's Long-Term Action Plan

Year	Option	Description
2022	Thulsoo Mountain Wind	Installation of wind farm with 20 MW capacity on Thulsoo Mountain (located near the Aishihik Generating Station); contingent on high economic growth scenario.
2023 or 2025	Drury Lake Small Hydro	8.1 MW facility with storage on Drury Lake (located between Carmacks and Faro); contingent on medium or high economic growth scenario.
2026	Diesel Generation 10 MW	10 MW diesel generator installed at a location on the Whitehorse-Aishihik-Faro grid; contingent on very low economic growth scenario.

Yukon Energy Choices

The Yukon has been endowed with enough renewable and non-renewable energy potential to readily become energy self-sufficient many times over. As the Yukon economy continues to grow and Yukoners strive for energy self-sufficiency, four factors will shape Yukoners' energy choices: cost, reliability, renewability and negative externalities. Choosing among potential energy sources will require making tradeoffs among the four factors, as illustrated in the picture to the right.



The production, storage, transport and consumption of non-renewable and renewable energy can create **negative externalities**, a side effect or a cost that is borne by someone other than the owner of the energy. For example, water storage dams built to produce hydro-electricity can cause flooding and reduce habitat for animals and fish. Batteries used to store electricity contain heavy metals that can contaminate waste facilities and groundwater upon disposal. Pipelines that leak oil cause point-source environmental damage. Burning wood with insufficient oxygen releases cancer-causing particulates into the air.

The supply of energy needs to be **reliable**. People expect car engines to start at the turn of a key and lights to come on at the flick of a switch. Notwithstanding that all petroleum-derived fuels consumed in the Yukon are imported over long distances, and that Yukon's electrical grid is isolated from electrical energy sources in other jurisdictions, the energy reliability bar has been set very high in Yukon.

In Yukon, **renewable** energy is preferred over energy from non-renewable sources. The Yukon Electricity Values Survey was conducted in 2016 by the Yukon Bureau of Statistics on behalf of the Yukon Energy Corporation as part of the research for the *Yukon Energy 2016 Resource Plan*. Survey respondents were asked to rank three future energy sources – fossil fuels (petroleum products), renewable energy and energy conservation – in order of preference. Close to two-thirds (59.2%) of responding households chose renewable energy as their preferred future energy source. About one-third of households (31.0%) preferred energy conservation as a future energy source, while only 4.6% of households preferred fossil fuels (petroleum products, as a future energy source.[20]

Yukon Electricity Values Survey respondents were also asked to rank four energy factors – cost, environmental protection, reliability and social responsibility – in order of importance. Environmental protection was ranked first by almost half (44%) of respondents, followed by cost at 23% and reliability at 21% and social responsibility at 8%.[21]

The **cost** of energy is also important. A recent study by the Fraser Institute found that "in 2013, the share of the average Canadian family's expenditures devoted to all energy goods was 5.8%."[22] With shorter winter days, longer transportation distances and colder temperatures, the percentage of expenditures made by Yukon families on energy goods is certainly higher than 5.8%. And because people use energy in so many different forms and for so many different reasons, even small changes in energy affordability affects the pocketbooks and quality of life for all Yukon families. Businesses and commercial / industrial enterprises are also sensitive to changing energy costs.

When respondents to the Yukon Electricity Values Survey were asked to rank five factors that would influence the selection of a home heating system, cost was the most important factor, chosen first by 45% of respondents. Safety was ranked second (15%) and environmental concerns ranked third (11%). Comfort and ease of maintenance were ranked fourth and fifth, at 10% and 7%, respectively.

Energy Sector Regulation, Governance and Stakeholders

The supply and (to a lesser extent the consumption) of energy in the Yukon is regulated under a variety of statutes and regulations. The table below identifies energy activities subject to regulation in the Yukon, the relevant statutes and regulations, and the agencies responsible for administering the statutes and regulations.

Regulation of Energy-Related Activities

Activity	Regulated under:	Administered by:
Non-renewable energy		
Oil and gas rights (onshore)	*Oil and Gas Act*, Disposition Regulation	Energy, Mines and Resources, Oil and Gas Management Branch
Oil and gas exploration (onshore)	*Oil and Gas Act*, Geoscience Exploration Regulation, Drilling and Production Regulation, License Administration Regl'n	Energy, Mines and Resources, Oil and Gas Management Branch
Oil and gas production (onshore)	*Oil and Gas Act*, Drilling and Production Regulation, License Administration Regulation; *Environment Act*, Air Emissions Permit (for flaring)	Energy, Mines and Resources, Oil and Gas Management Branch
Oil and gas rights, exploration and production (offshore)	*Canada Petroleum Resources Act*, *Canada Oil and Gas Resources Act*	National Energy Board, Natural Resources Canada, Indigenous and Northern Affairs Canada
Sale of refined petroleum products	*Fuel Oil Tax Act*	Yukon Finance
Storage of petroleum products	*Environment Act* Storage Tank Regulation	Community Services, Protective Services
Handling of petroleum products	*Territorial Lands (Yukon) Act* Land Use Permit	Energy, Mines and Resources, Lands Branch
Coal exploration	*Territorial Lands (Yukon) Act*, Land Use Regulation	Energy, Mines and Resources, Lands Branch
Coal mining	*Lands Act*, Coal Regulation	Energy, Mines and Resources, Minerals Management Branch
International and interprovincial oil and gas transmission (except Alaska Highway Gas Pipeline)	*Northern Pipeline Act*	National Energy Board
Oil and gas transmission (Alaska Hwy Gas Pipeline)	*Northern Pipeline Act*	Natural Resources Canada, Northern Pipeline Agency
Uranium exploration	*Quartz Mining Act*	Energy, Mines and Resources, Minerals Management Branch
Uranium mining	*Atomic Energy Control Act Uranium & Thorium Mining Reg.*	Atomic Energy Control Board of Canada
Renewable energy		
Timber cutting (fuelwood)	*Territorial Lands (Yukon) Act*, Timber Regulation	Energy, Mines and Resources, Client Services and Inspections
Waste stream biomass (incineration)	*Forest Protection Act*, Forest Protection Regulation	Community Services, Protective Services
Release of Air Pollutants	*Environment Act*, Air Emissions Regulation	Yukon Environment, Environmental Programs
Water use	*Waters Act*	Yukon Water Board
Deposit of waste in water	*Waters Act*	Yukon Environment, Environmental Programs, Water Resources
Electrical energy		
Electricity generation	*Public Utilities Act*	Yukon Utilities Board
Electricity transmission	*Public Utilities Act*	Yukon Utilities Board

Given the extent to which energy is at the centre of the day-to-day lives of all Yukoners, it should not be surprising that a very wide range of agencies, organizations and stakeholders have an interest in the Yukon's energy file. The various governments, agencies and organizations with a stake in Yukon's energy future are described in the table below:

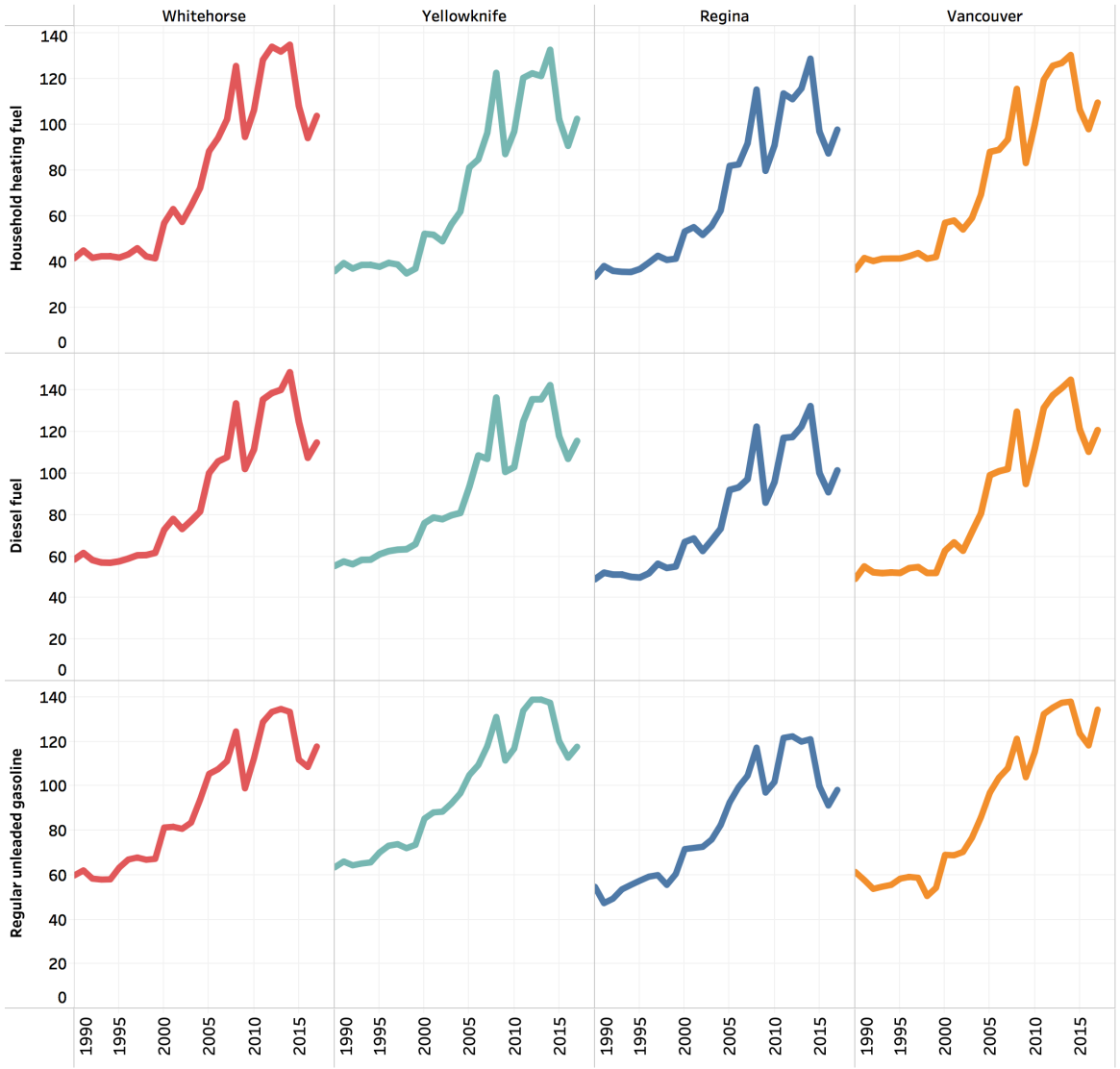
Yukon Energy Sector Governance and Stakeholders

	Energy Role(s)	Serves…	Energy Type
Yukon Government Departments and Agencies with a Leading Role on the Energy File			
Energy, Mines and Resources	rights issuer for oil and gas	Yukon public and resource industries	oil and natural gas
Yukon Energy Corporation	monopoly generator and transmitter of electricity, electricity planning	Yukon ratepayers	electricity, district heat
Energy, Mines and Resources – Energy Branch	energy policy and storefront for energy program delivery, energy planning	Yukon public	oil, natural gas, electricity, water, biomass, wind, solar, geothermal, coal, uranium, energy efficiency
Economic Development	energy investment facilitator	Yukon public, national and international investors	biomass, electricity, oil, natural gas, coal, uranium
Yukon Government Departments and Agencies with a Supporting Role on the Energy File			
Yukon Development Corporation	owner of the Yukon Energy Corporation, electricity bill subsidy provider	Yukon public and YG	oil, natural gas, electricity, water, biomass, wind, solar, geothermal, coal, uranium
Yukon Housing Corporation	storefront for housing related energy efficiency	Yukon public, YG departments with community based-staff	energy efficiency
Highways & Public Works	YG building owner, large energy consumer	Yukon public	biomass, energy efficiency
Yukon Cold Climate Innovation Centre	funding partner for applied energy research	Yukon public	renewable energy
Education	energy curriculum large energy consumer	Yukon schools and households with children	energy efficiency, furnace oil
Finance	fuel tax authority	Yukon public	petroleum-based fuels (gasoline, diesel, propane)
Justice	oversees the Yukon Utilities Board, signs energy certificates	Cabinet	electricity, natural gas
Community Services	Building Safety Bulletins Section 64 - Renewable Energy Systems	Yukon public	renewable energy
Climate Change Secretariat (Yukon Environment)	YG lead on climate change response, monitoring of emissions from energy	Yukon public and YG	emissions from all forms of energy
Yukon College	large energy consumer, early innovator (Volter biomass system)	Yukon public	biomass

	Energy Role(s)	Serves…	Energy Type
Yukon Government Committees and Working Groups			
Deputy Ministers' Energy Roundtable	to coordinate new energy initiatives, respond to energy proposals	Cabinet	all energy forms
Yukon Integrated Climate Change, Energy and Green Economy Strategy Team	to develop the Yukon Integrated Climate Change, Energy and Green Economy Strategy	YG departments with an energy role	all energy forms
Bioenergy Development Committee	to develop a bioenergy development framework for YG	Yukon public with an interest in biomass	biomass for heat
Yukon Energy Partners Community of Practice (YEP)	information sharing among Yukon agencies with energy interests	YG departments and Yukon-based agencies with an energy role	all energy forms
Outside YG Players: governments and organizations			
Yukon First Nation governments	potential rights holders potential funding partners	citizens of individual Yukon First Nations	all forms of energy
Non-self-governing First Nations	potential partners	First Nation members	all forms of energy
ATCO Electric Yukon	primary distributor of electricity in Whitehorse and several Yukon communities	Yukon ratepayers in most Yukon communities	electricity electrical energy efficiency (demand and supply side)
Incorporated Yukon municipalities	potential supplier of waste feedstock large energy consumers	residents of Yukon municipalities	municipal solid waste
Chance Oil and Gas Limited	holds development rights to Eagle Plain oil and natural gas resources	Yukon industry Yukon consumers	oil and natural gas
North Yukon Oil and Gas Working Group	First Nation and government advisory body	northern Yukon First Nations and residents	natural gas and oil
TransCanada Pipeline	holds permits for construction of Alaska Highway gas pipeline	Canadian industry shots Canadian consumers	natural gas
Federal Energy Ministers	development of a federal/provincial/ territorial energy strategy	Canadian public	all energy forms
Northern Climate Exchange	entry point for the study of climate change in the North	Yukon public Northerners	emissions from all forms of energy
Yukon Conservation Society	environmental advocacy group	Yukon public	all energy forms
Utilities Consumer Group	ratepayer watchdog	Yukon ratepayers	electricity
Yukon Forest Products Association	industry champion for forest resource development	forest industry operators	biomass (pellets, chips, logs)
Yukon Environmental and Socio-economic Assessment Board	coordinating agency for environmental and socio-economic assessments under the *Yukon Environmental and Socio-economic Assessment Act*	all Yukon residents project proponents	all energy forms

Energy Pricing

Comparative Petroleum Product Prices (cents per litre)
Selected Cities - 1990 to 2017
Source: Statistics Canada CANSIM 326-0009.



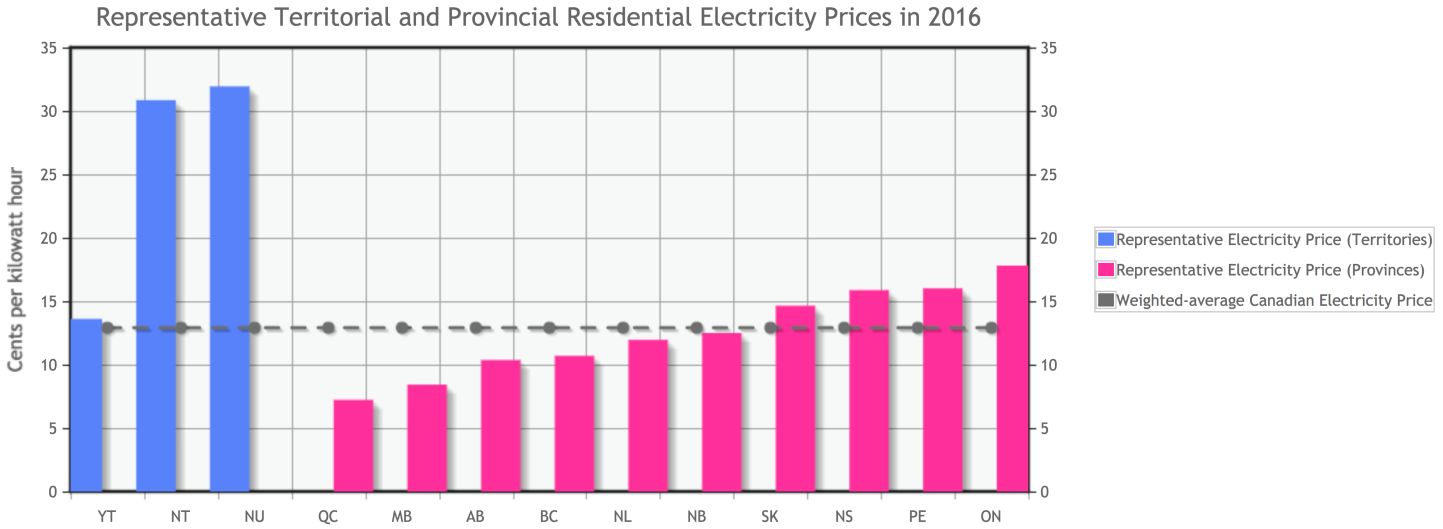
Consumers of refined petroleum products in the Yukon are price takers as prices are determined in competitive markets located outside the territory and, indeed, outside of Canada.

The extent to which prices for refined petroleum products are determined outside the territory is illustrated in the chart to the left. The chart presents Statistics Canada data for the price (in cents per litre) of household heating fuel, diesel fuel and regular unleaded gasoline in Whitehorse, Yellowknife, Regina and Vancouver over the period 1990 to 2017.

As shown in the chart, price movements for each of the three types of fuel are essentially the same whether comparing the same fuel type for different cities (scanning across) or comparing different fuel types for the same city (scanning down).

A very comprehensive examination of heating costs for various types of heating appliances can be found on the Yukon Housing Corporation's website: http://www.housing.yk.ca/energycosts.html.

Electricity prices in the Yukon are not determined in a competitive market but instead are prescribed by the Yukon Utilities Board though a complex system of production-type cross-subsidies, consumer class cross-subsidies, rate riders and income tax rebates. Electricity ratepayers in the Yukon, however, continue to benefit from legacy electrical generation and transmission infrastructure built to support mine operations. The chart below, prepared by the National Energy Board, presents representative territorial and provincial residential electricity prices for the year 2016. The representative price for electricity in the Yukon, 13.6 cents per kWh, is only slightly above the Canadian average electricity price of 12.9 cents per kWh.



▼ Source and Description

Source: Hydro-Québec (for all provinces); Yukon Energy (for Yukon); Arctic Energy Alliance – Fuel Cost Library (for NWT); Quilliq Energy Corporation (for Nunavut)

Source: https://www.neb-one.gc.ca/nrg/ntgrtd/mrkt/snpsht/2017/02-03hghcstpwr-eng.html

Notwithstanding that the Faro mine closed 20 years ago in January 1998, the bill subsidy introduced at the time of mine closure to dampen the rate shock effects from the loss of the single largest electricity consumer in the territory remains in place. Currently known as the Interim Electrical Rebate, the measure offsets a maximum of $26.62 a month for the first 1,000 kilowatt hours of electricity use, equivalent to approximately $319 in annual savings per residential customer. The rebate is administered by the Yukon Development Corporation with a $3.5 million grant from the Yukon government.

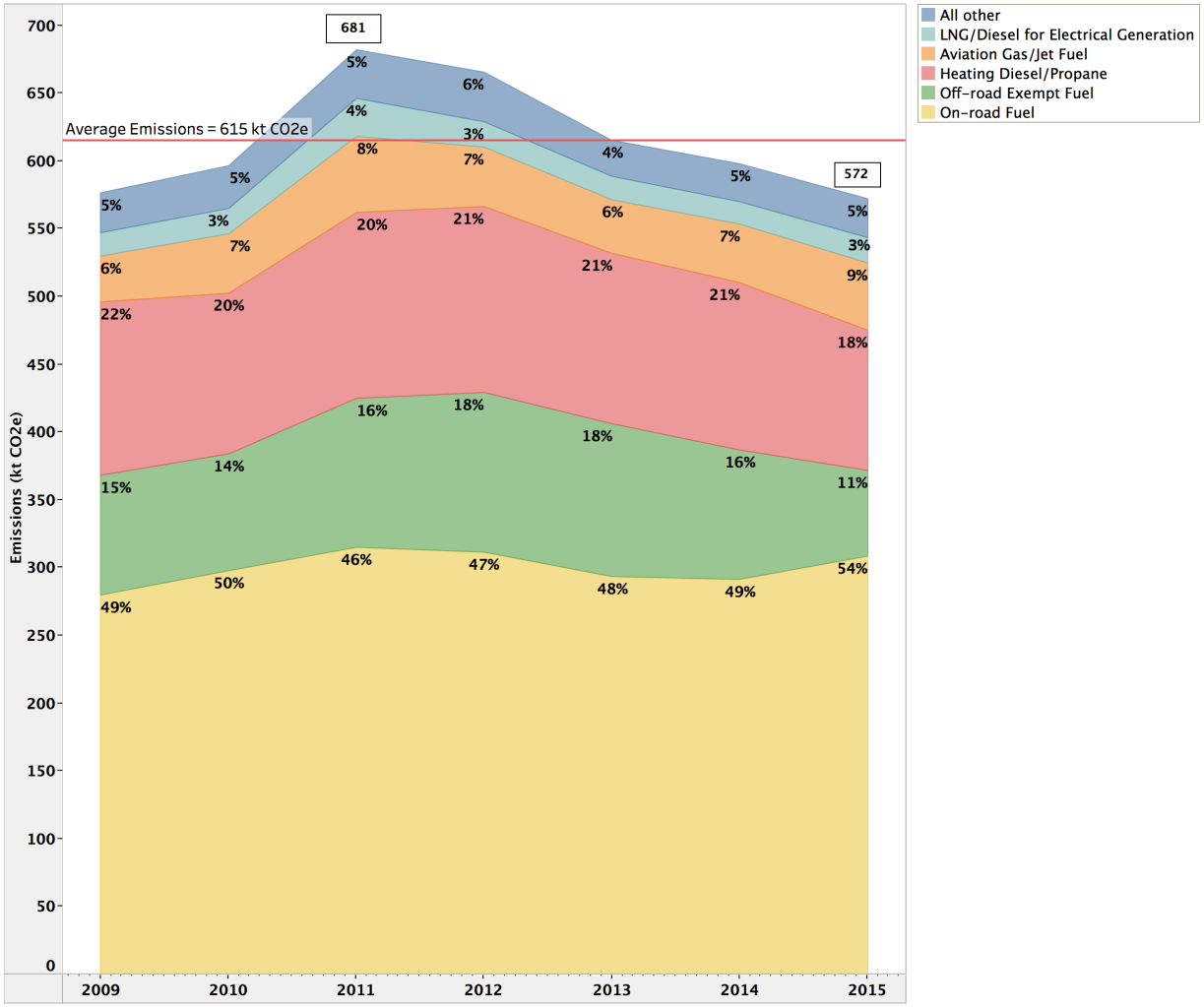
Yukon Greenhouse Gas Emissions

The chart to the right illustrates Yukon's greenhouse gas emissions from petroleum-based fuels, measured as kilotons of CO_2 equivalent, over the period 2009 to 2015, by fuel type and type of use. The chart presents a brand-new data set calculated by the Yukon Bureau of Statistics using fuel tax data from Yukon Finance.

As can be seen from chart, over the seven-year period from 2009 to 2015, total Yukon greenhouse gas emissions peaked in 2011 at 681 kt CO_2e and have declined steadily, falling to 572 kt CO_2e in 2015. Yukon greenhouse gas emissions from petroleum-based fuels averaged 615 kt CO_2e between 2009 and 2015.

In 2015, consumption of gasoline and diesel for on-road transportation uses accounted for approximately half (54%) of total GHG emissions in Yukon. In 2015, 11% of total GHG emissions in Yukon were attributable to off-road consumption of gasoline and diesel. Heating uses of diesel and propane were associated with 18% of total GHG emissions. Consumption of aviation fuels (avgas and jet fuel) accounted for 9% of total emissions. Three percent of Yukon's total GHG emissions resulted from the generation of electricity with liquefied natural gas (LNG) and diesel.

Yukon GHG Emissions by Fuel Type - kilotons of CO2 equivalent
2009 to 2015
Source: Yukon Bureau of Statistics



Note: The 'All other' category includes Industrial Processes and Product Use, Agriculture and Waste as defined in the Government of Canada's *National Inventory Report*.

Renewable Energy and Energy Efficiency Initiatives

A variety of renewable energy initiatives are currently underway in the Yukon. ATCO Electric Yukon is currently working on projects intended to displace diesel-generated electricity with electricity generated from renewable sources in three Yukon communities:[23]

- In Old Crow, ATCO Electric Yukon is working with the Vuntut Gwitchin First Nation and its partner to explore the feasibility of a 300 kW solar power and battery storage project.
- In Burwash Landing, ATCO Electric Yukon, the Kluane First Nation and the Yukon government are collaborating on a wind generation project planned to displace up to 300 kW of existing diesel power generation.
- In collaboration with the Town of Watson Lake and the Liard First Nation, ATCO Electric Yukon has funded a prefeasibility study for a 2.4 MW hydro-electric generation facility on the Tootsee River.

Northern Energy Capital has proposed a $14 million investment to install three 900 kW turbines capable of producing 6.2 GWh of electricity per year. The Yukon Environmental and Socio-economic Assessment Board recommended approval of the project in August 2017.[24]

Nomad Contracting and Electrical Services has proposed to build a commercial solar farm in the Mount Sima Industrial Subdivision. The solar farm is planned to have a capacity of 30 kW and is expected to produce 33 MWh per year.[25]

Construction of the projects noted above is contingent on completion of a Power Purchase Agreement and the forthcoming setting of the power purchase rate under terms of the Yukon Government's Independent Power Production policy.

The Ta'an Kwäch'än Council's Da Daghay Development Corporation is investigating geothermal heat flow in the Whitehorse area in partnership with the Yukon Geological Survey. A deep well was drilled near the Takhini Hot Springs on Settlement Land of the Ta'an Kwäch'än Council to directly measure ground temperature in late 2017.

The Energy Branch of the Yukon Department of Energy, Mines and Resources delivers two programs intended to encourage the adoption of renewable energy technologies.

- The **Micro-generation Program** allows customers in residential, general service and industrial classes to offset electrical consumption by connecting renewable energy technologies to homes or businesses. If surplus electricity is generated, it may be exported to the grid. Annual reimbursement is paid at the rate of $0.21 per kWh for customers on the Yukon Integrated (Hydro) System and $0.30 per kWh in communities served with diesel generation.

- The **Wind Prospecting Service** helps Yukoners determine if wind speeds are high enough to generate electricity from wind on a consistent basis at their home or business.

Three programs are currently offered by the Energy Branch to encourage energy conservation and efficiency:

- The **Good Energy Program** delivers a variety of measures designed to promote energy efficiency and the use of renewable energy systems in Yukon homes and businesses, including:
    - Quick Start Home Energy Kits;
    - the Refrigerator Retirement Program;
    - rebates on the purchase of Energy Star approved appliances;
    - home energy assessments;
    - grants for home energy renovations and super-insulated new homes; and,
    - grants for small scale renewable energy generating systems.

- The **Commercial Energy Incentive Program** promotes energy efficiency upgrades in Yukon commercial and institutional buildings by providing rebates for:
    - LED lighting upgrades of commercial and institutional buildings; and,
    - thermal enclosure upgrades to multi-use residential buildings and mixed-use buildings.

- The **StartPoint Energy Audit** analyses the energy demand and consumption for buildings as well as the effects of weather, occupancy and operating schedules while taking into account the building type and construction, climate zone and energy expenses. The audit also provides recommendations for actions to improve energy efficiency and indicate whether a more comprehensive audit should be undertaken.

Issues on the Horizon of Yukon's Energy Sector

A variety of issues are on the horizon for producers and consumers in Yukon's energy sector. The issues are described briefly below:

Yukon Carbon Tax: While design details are not yet available, Yukon will introduce a carbon tax in 2018. The new tax will be accompanied by a tax rebate measure for lower-income Yukoners, however, the likely effects of the new tax on Yukon's energy sector are not yet known.

Electricity Rate Increases: Interim approval for an electricity rate increase was granted to the Yukon Energy Corporation by the Yukon Utilities Board in September 2017. The Yukon Energy Corporation's first rate increase since 2013 saw rates increase by 5.5% effective 1 September 2017. The Yukon Energy Corporation rate increase is on top of the 3.5% boost to electricity rates previously granted to ATCO Electric Yukon.[26]

Interim Electrical Rebate: Notwithstanding that the Faro surplus has been erased through demand growth, the Interim Electrical Rebate (originally called the Rate Stabilization Fund) turns 20 in 2018. If it was politically difficulty to remove the $3.6 million annual subsidy before the Faro surplus ran out, it will be especially difficult to do so as electricity rates continue to rise.

Natural Gas Oversupply: the surplus of natural gas that prompted Imperial Oil to pull the plug on the Mackenzie Gas Pipeline Project is expected to balloon even larger, further diminishing the likelihood of new natural gas exploration activity in the north.

Mines on Line? with construction of Victoria Gold's Eagle Gold Mine expected to start in the spring of 2018, and Alexco Resources recent re-start announcement for the Bellekeno Mine, electricity demand from the Yukon's mining sector may increase sharply in 2018. Mining projects will present both opportunity (in the form of increased revenues) and challenges (in the form of firm operational constraints in a post-Faro surplus environment) for the Yukon Energy Corporation.

Independent Power Production: when the Yukon government's Independent Power Production Policy is implemented, the renewable energy supply gates will swing open wider and bring a sharpened focus to the challenges of integrating intermittent electrical energy from renewable sources into a sub-arctic islanded electricity transmission system.

Renewable Technology Shifts: as solar photovoltaic and battery technologies continue to improve, so does the potential for advancing renewable energy projects in the Yukon.

Eagle Plain Lawsuit: In 2015, the Yukon government announced that, following on the recommendations of the Select Committee on Hydraulic Fracturing, it would permit fracking-enabled shale gas development only in the Liard basin. Chance Oil and Gas (formerly Northern Cross Ltd.), holder of multi-million-dollar exploration permits in the Eagle Plain basin, then launched a multi-billion-dollar lawsuit against the Yukon government.[27] Sorting out Chance's claims, either in or out of court, will be the first high-stakes test of Yukon's resource management responsibilities transferred from the federal government in 2003.

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Footnotes

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