YUKON'S ENERGY CONTEXT

An overview of the Yukon territory's energy supply and demand, both renewable and non-renewable, for electricity, heating and transportation in the residential and commercial sectors.

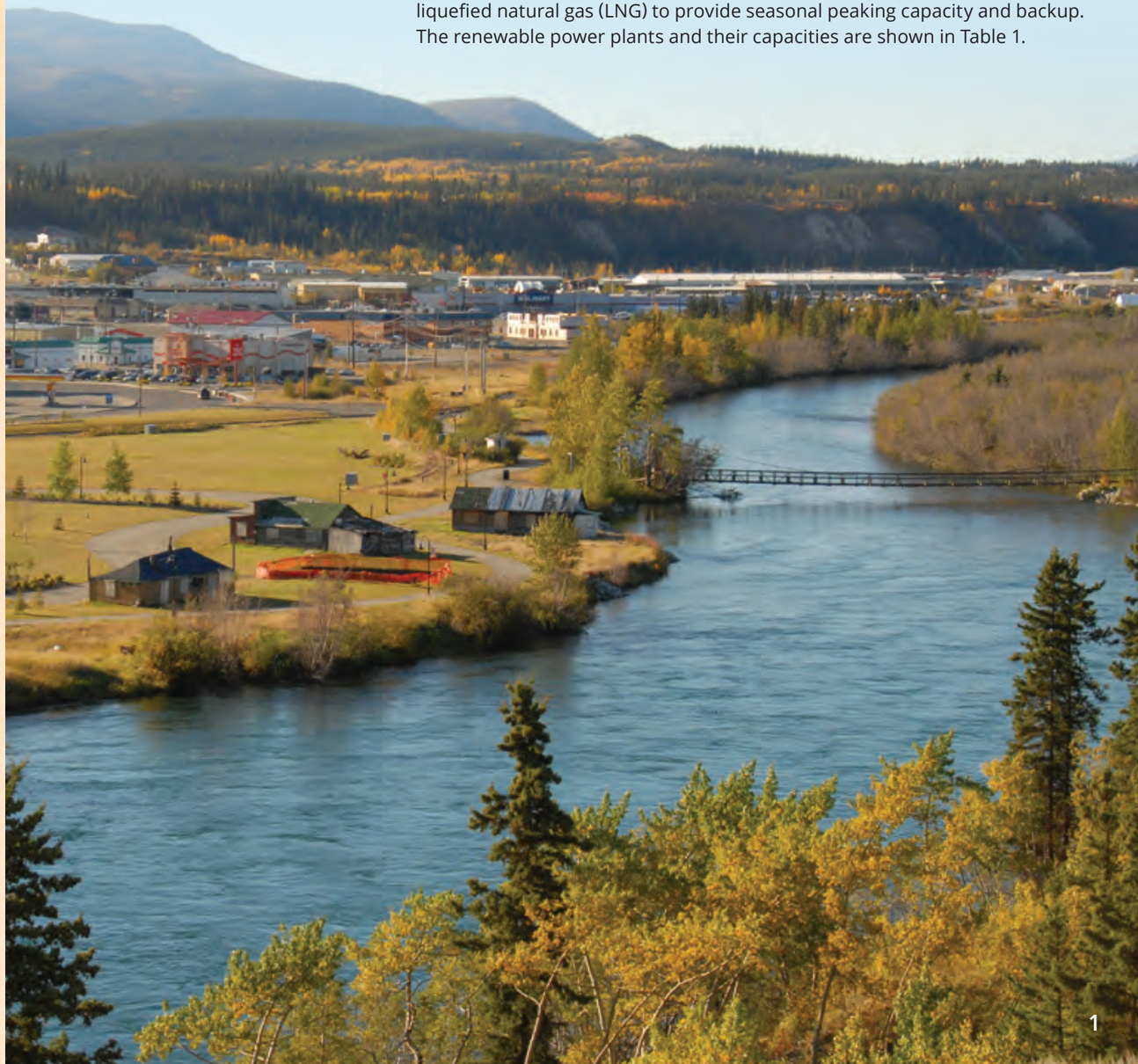
Yukon
Energy, Mines and Resources
Energy Branch

Cover photos: wood chips used as biomass fuel for the Raven Recycling Centre's waste wood boiler and a pickup truck converted from gas to electricity pilot project.

Photo credit: Government of Yukon.

ELECTRICITY

Yukon is home to just over 38 thousand people, 77 per cent of which live in or near to the City of Whitehorse. The remaining 23 per cent live in or near to Yukon's 17 towns, villages and unincorporated communities. All but one of these communities are connected to each other and to the rest of North America by road. All but five of these communities are connected to each other by an electrical transmission network, called the Yukon Integrated System (YIS) but known as the Yukon grid. See Figure 1 which shows Yukon's transmission and generation facilities. The Yukon grid is not connected to the rest of North America. Close to 94 per cent of Yukon's electricity is generated by four hydro plants and with one wind turbine. The remaining 6 per cent is generated by diesel and liquefied natural gas (LNG) to provide seasonal peaking capacity and backup. The renewable power plants and their capacities are shown in Table 1.



Yukon's Transmission and Generation Facilities 2014

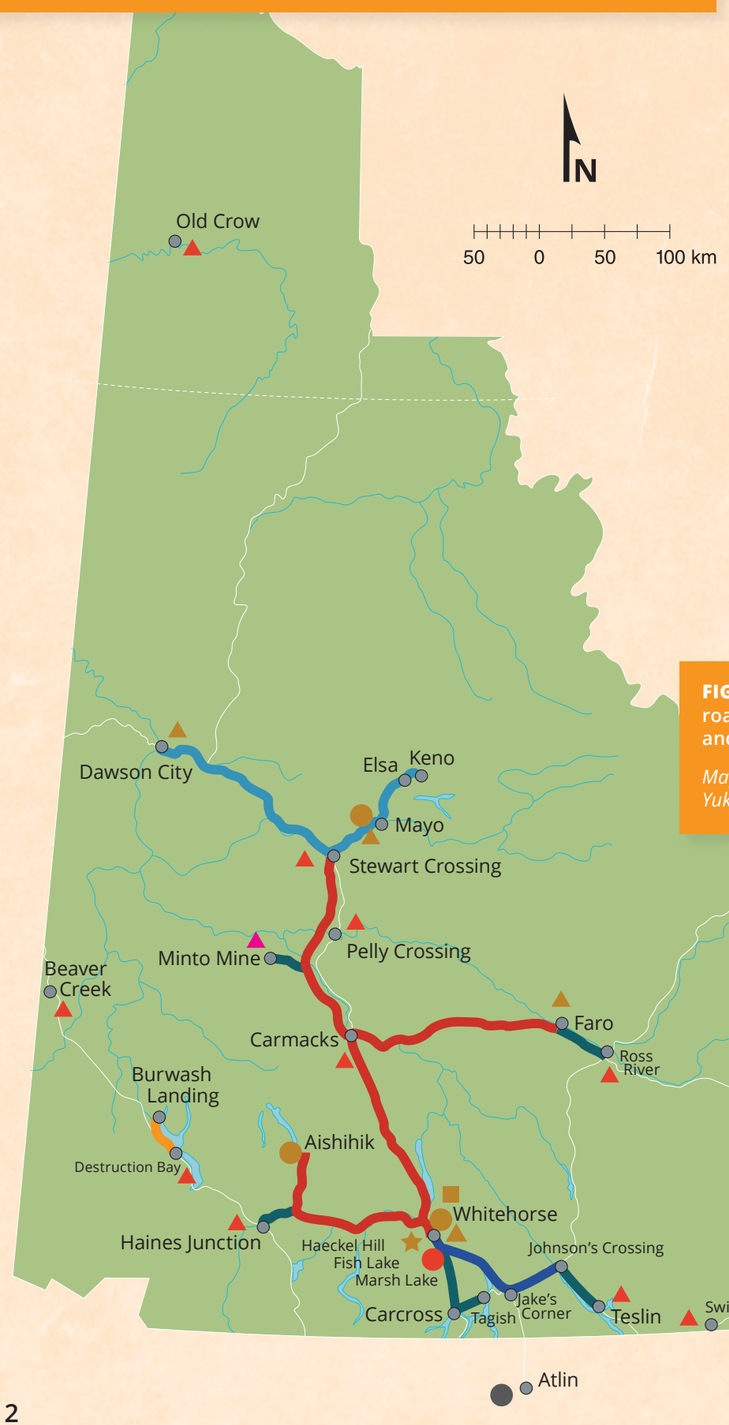


FIGURE 1: Yukon's communities, roads, electrical generation facilities and transmission lines.

Map courtesy of Yukon Energy Corporation.

GENERATING STATIONS

- YEC Diesel
- YEC Hydro
- YEC Wind
- YEC LNG
- ATCO Diesel
- ATCO Hydro
- Taku River Tlingit First Nation Hydro
- Minto Mine Diesel

TRANSMISSION AND DISTRIBUTION LINES

- 138 kV
- 66/69 kV
- 34 kV
- 25 kV
- 14.4 kV

YEC SYSTEM (in MW)

Hydro Facilities	
Whitehorse	40.0
Aishihik	37.0
Mayo	15.1
Total	**92.1**
Wind Facilities	
Haeckel Hill	0.65
LNG Facilities	
Whitehorse	8.8
Diesel Facilities	
Whitehorse	15.0
Faro	8.5
Dawson	5.1
Mayo	2.5
Total	**31.1**
TOTAL YEC SYSTEM	**132.65**

ATCO SYSTEM (in MW)

Hydro Facilities	
Fish Lake	1.3
Diesel Facilities	
Carmacks	1.5
Haines Junction	1.5
Teslin	1.5
Ross River	1.0
Watson Lake	5.0
Beaver Creek	0.9
Destruction Bay	0.9
Old Crow	0.7
Pelly Crossing	1.2
Stewart Crossing	0.1
Swift River	0.3
Total	**14.6**
TOTAL ATCO SYSTEM	**15.9**
Other Diesel	
Minto Mine	8.0
TOTAL YUKON CAPACITY	**156.6 MW**

Plant Name	Location	Owner	Capacity in Megawatts (MW)
Aishihik Hydro	Aishihik Lake	Yukon Energy Corporation	**37**
Mayo Hydro	Mayo	Yukon Energy Corporation	**15**
Whitehorse Rapids Hydro	Whitehorse	Yukon Energy Corporation	**40**
Fish Lake Hydro	Whitehorse	ATCO Electric Yukon	**1.3**
Haeckel Hill Wind	Whitehorse	Yukon Energy Corporation	**0.6**
TOTAL RENEWABLE CAPACITY			**93.9**

TABLE 1: Yukon's Renewable Electrical Generation Plants.

The five communities not connected to the Yukon grid are served by four micro-grids that are powered 100 per cent by diesel generators. Those plants and their capacity are shown in Table 2.

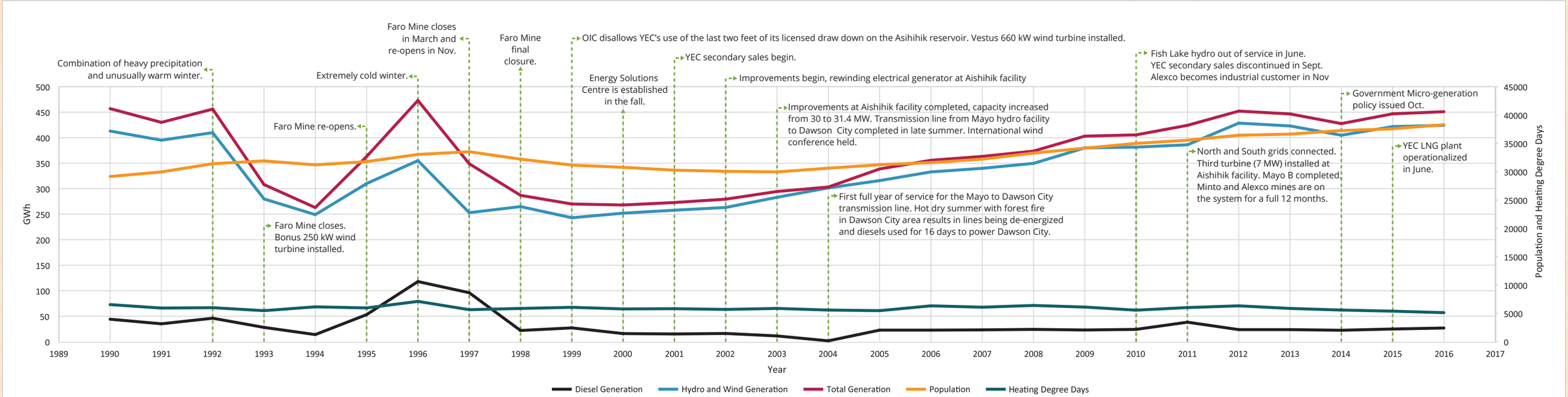
Communities Served	Generation Location	Owner	Capacity in Megawatts (MW)
Beaver Creek	Beaver Creek	ATCO Electric Yukon	**0.9**
Burwash Landing & Destruction Bay	Destruction Bay	ATCO Electric Yukon	**0.9**
Watson Lake	Watson Lake	ATCO Electric Yukon	**5**
Old Crow	Old Crow	ATCO Electric Yukon	**0.7**
TOTAL MICRO-GRID CAPACITY (DIESEL)			**7.5**

TABLE 2: Yukon's Micro-grid plants.

FIGURE 2: Yukon's electrical demand from 1990 to 2016.

Electrical Generation in Yukon (GWh)

The total electrical generation for Yukon from 2010 to 2016 has averaged about 436 GWh per year. In 2015 total Yukon generation was 428 Gigawatt hours (GWh), or 1,540,800 Gigajoules (GJ). By far, most (94 per cent) of that generation was renewable. Figure 2 shows a brief history of Yukon's electrical demand from 1990 to 2015 broken down by thermal (diesel and LNG) and non-thermal (hydro and wind) generation along with milestones for major events that may have impacted the demand.



Year	$/Watt (W) Installed
2014	$5.50
2015	$4.75
2016	$3.50
2017	$3.00

TABLE 3: Average cost for installing solar electric system in Yukon.

An increasing number of Yukon residents are choosing to generate some of their own electricity with micro-generation systems and feed it into their local grid. As of July 2017, Yukon had 106 micro-generators connected to a utility grid with a total capacity of 725 kW, generating approximately 0.8 GWh per year. This number is growing rapidly thanks to the Government of Yukon's Micro-generation Policy and production incentive.

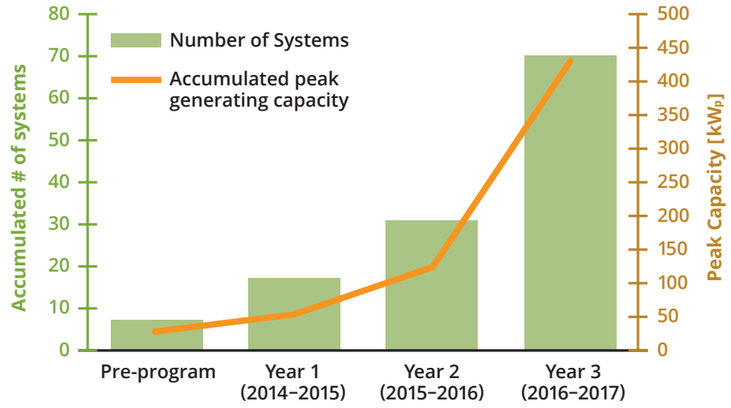
The 2013 Micro-generation Policy and its resulting production incentive program provides the opportunity for residential and commercial electricity customers to generate electricity from renewable energy sources and sell surplus electricity to the grid. Producers also minimize their electricity consumption in order to maximize the amount of electricity they export to the grid.

The scope of the Micro-generation program extends to small-scale (less than 50 kilowatt (kW)) alternative energy systems in both grid-tied and off-grid communities. The program applies to customers in residential, general service, and industrial classes who want to generate electricity primarily for their own consumption. The production incentive is $0.21 per kilowatt hour (kWh) on the Yukon grid and $0.30 per kWh on Yukon's four diesel-powered micro-grids.

Figure 3 shows the number of micro-generation systems and their capacity for all communities in Yukon pre-program and for each year since the program began.

All of the micro-generation systems accounted for in Figure 3 are solar electric systems. Yukon's solar resource is predictable, reliable and becoming increasingly economical, with costs falling each year as shown in Table 3. The Yukon government's Energy Branch has estimated the average installation cost for solar electric systems based on Micro-generation program participant data.

FIGURE 3: Micro-generation system installations in Yukon.



HEATING

Solar electric system data from Micro-generation program participants' systems located near Whitehorse show that on average, energy production rapidly increases during the spring and peaks between April and June. Energy production then gradually tapers off into the winter with only marginal production during December and January.

Yukon's wind resource, though less predictable than its solar resource, is becoming better understood and has the advantage over solar of being available during the winter and at other times when the solar resource is weak. Winds in Yukon are strongest on mountain ridges and in the winter when demand for energy in Yukon is greatest. It is most suitable for development on a commercial scale due to the resource being weaker in Yukon valleys (where most people live) and due to the higher installation and maintenance costs compared to solar electric systems. There are likely less than five wind micro-generating systems in Yukon and only one commercial-scale wind development. Interest in developing commercial scale wind farms is high and growth is expected once the Yukon government's Independent Power Production policy is fully implemented.

All Yukon communities lie within the boreal forest, giving Yukoners access to cordwood for space heating. Approximately 15 to 25 per cent of Yukon homes are heated with wood as either a primary or backup heat source. Most of the wood is from Yukon although an increasing number of homes are heated with wood pellets imported from British Columbia.

Yukon currently harvests 13,000 cords (30,000 m^3) of wood per year to heat homes and buildings in the territory. Approximately 75 per cent of this wood is burned in Whitehorse. Forest harvesting is well below the regulated allowable harvest level established for each region, suggesting a growth of Yukon's forest industry is feasible. Four biomass projects with a combined nameplate capacity of over 2 MW are currently installed and operational. A further 2.8 MW and .04 Megawatt electric (MWe) are planned for installation in the near future. Table 4 lists the currently installed systems and their heating capacities. Figure 4 shows where the current and planned systems are or are planned to be installed.

Facility Name	Feedstock	Heating Capacity (MW)
Kluane First Nation District Heating	Cord Wood (Outdoor wood boiler)	0.59
Raven Recycling	Waste Wood (Pallets)	0.1
Dawson City Water Treatment Plant	Wood Chips	0.72
Whitehorse Correctional Centre	Wood Pellets	0.95
TOTAL		**2.36**

TABLE 4: Commercial-scale biomass heating systems in Yukon.

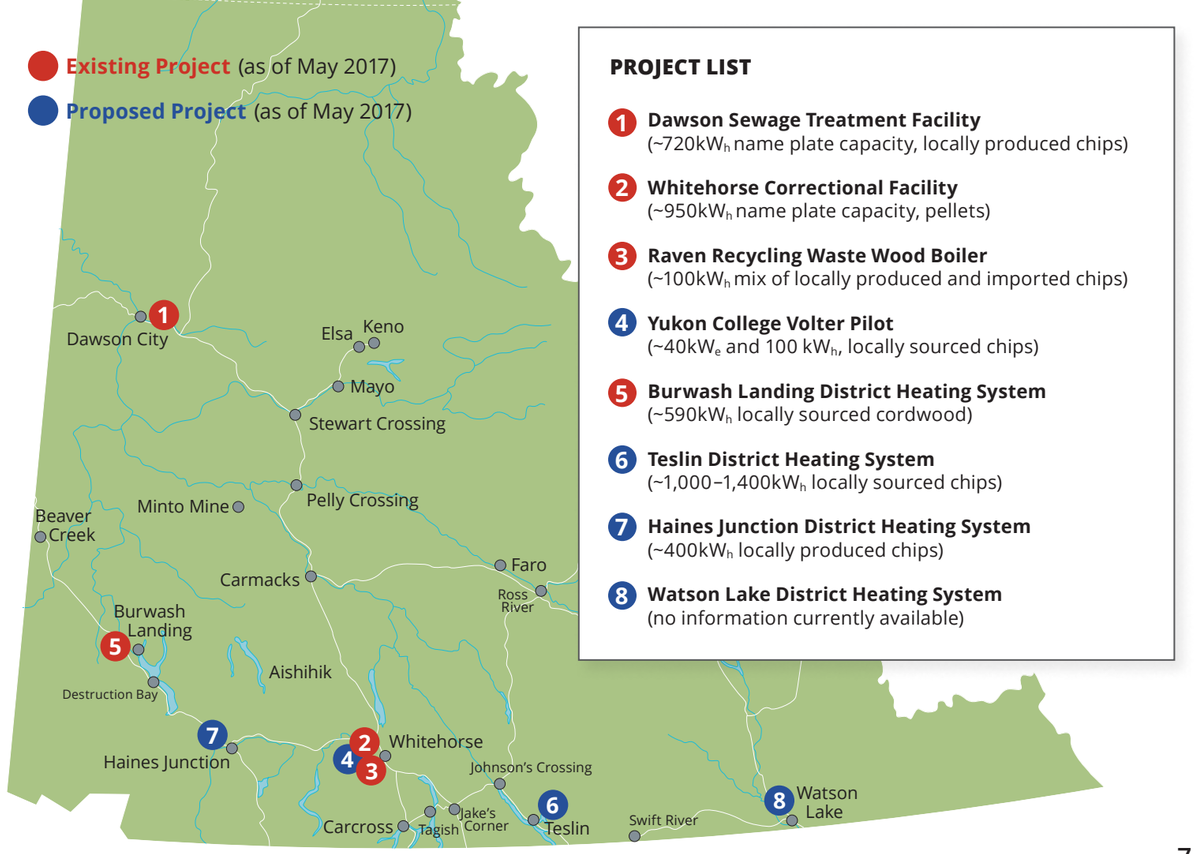
The Yukon government would like to encourage more wood heating in Yukon and released its Yukon Biomass Energy Strategy in February 2016. The strategy aims to reduce Yukon's dependence on fossil fuels, reduce heating costs for Yukoners, reduce greenhouse gas emissions, create new jobs in the local forest and heating industries, and move the territory towards sustainable renewable energy use and greater energy self-sufficiency.

In 2009, the majority (approximately 65 per cent) of space heating in Yukon buildings was provided by oil, 9.5 per cent by propane, 17.5 per cent by wood and 8 per cent by electricity. However, on the Yukon Integrated System, there is a trend to switching from oil to electricity. This trend started in the commercial sector, particularly in new construction, but is now extending to the residential sector for a number of reasons: insurance companies have implemented new rules and are requiring replacements of oil tanks which are considered cumbersome enough to make the switch to an electric heating system more convenient; owners of rental units or social housing appreciate the reduced maintenance and increased safety of electric heating systems; and small, super-insulated homes require much less heat, making it difficult to find fossil fuel heating systems small enough to operate efficiently within them.

In Yukon's diesel-powered communities, the utilities are discouraging the use of electric space heating due to the high costs of providing electricity on those micro-grids.

In 2015 Yukon's total energy used for space heating was approximately 2 million GJ, with 25 per cent of that being provided by renewable sources.

FIGURE 4:
Existing and Proposed Biomass Projects



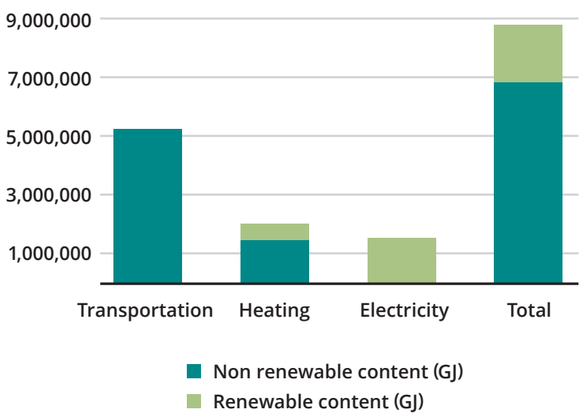
TRANSPORTATION

The City of Whitehorse operates Yukon's only public transit system. There is no inter-community public transit service. Electric vehicles are new to Yukon, with less than one per cent of Yukon's fleet being comprised of electric vehicles. No public charging infrastructure is in place at this time.

In 2015, Yukon's total energy used for transportation was 5,184,753 GJ.

TOTAL ENERGY USE

FIGURE 5: Total Yukon energy consumption for transportation, space heating and electricity in 2015 for the residential and commercial sectors (GJ).



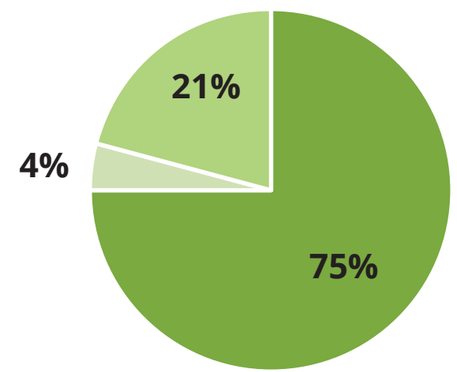
Yukoners' total energy use for transportation, heating and electricity in the residential and commercial sectors in 2015 was approximately 8,727,609 GJ per year: 59 per cent of that was used by the transportation sector, 23 per cent by the heating sector and 18 per cent by the electrical sector. With approximately 25 per cent of the heating energy, 94 per cent of the electrical energy and close to none of the transportation energy being provided by renewable resources, about 22 per cent of the total energy used was provided by renewable energy sources (see Figure 5).

GREENHOUSE GASES

In 2015, 560 kilotonnes of carbon dioxide equivalent (CO_{2e}) emissions were produced by Yukoners using energy. By far the largest amount of that came from the transportation sector (373.5 kilotonnes, 75 per cent), followed by heating (103.8 kilotonnes, 21 per cent), then just 19.3 kilotonnes, or four per cent by the Yukon's electrical sector. (See Figure 6.)

The Yukon government has begun working on a new strategy for Yukon that addresses the relationship between energy, economy and climate change for all of Yukon. This work is being undertaken in partnership with Yukon First Nations, communities, businesses, and other stakeholders and Yukoners.

FIGURE 6: Yukon's 2015 Greenhouse Gas Emissions for residential and commercial sectors.



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