University of Alberta Future Energy Systems

Yukon Energy Market Profile

Measuring the Costs and Benefits of Energy Transitions

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8-23-2018

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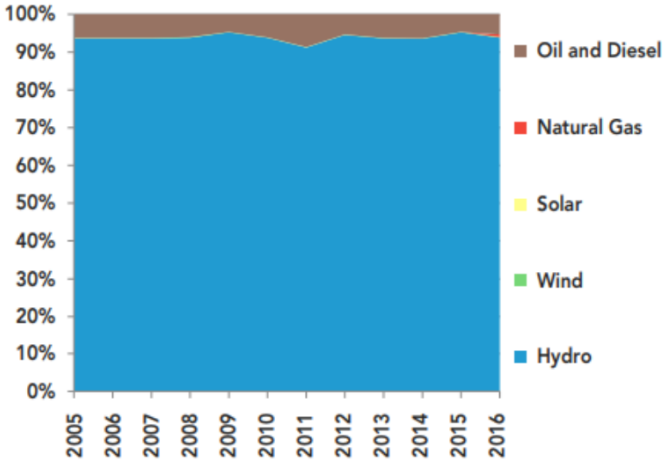
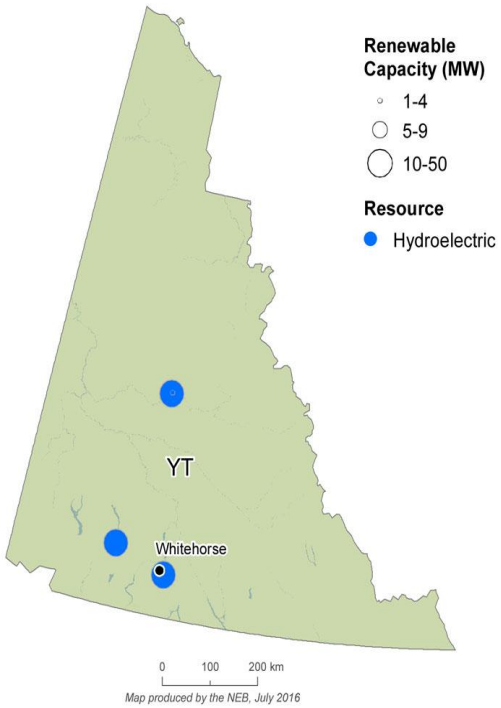
Context

The Yukon territory primarily generates renewable electricity from hydro facilities and, in 2016, had a total renewable capacity of 95 MW while generating 420 GWh, with energy costs of $136/1,000 kWh slightly higher compared to national average of $129/1,000 kWh (NEB, 2017). The northern climate causes some issues with hydroelectricity generation as water levels fall considerably during winter, with generation cut nearly in half at some plants, at the same time that demand is at its highest (NEB, 2017).



Electricity Generation by Source Yukon
Source: NEB, 2017

Generation and transmission are provided primarily by the Yukon Energy Corporation, a crown corporation that operates four hydroelectric facilities and transmission lines that cover most of the province, while distribution is handled primarily by ATCO Electric Yukon, a regulated private company that operates one small hydroelectric facility (NEB, 2018). Five remote communities are not connected to this grid and rely almost entirely on diesel generation, with increased renewable use requiring expensive infrastructure upgrades (NEB 2017).



Renewable Resources and Capacity in Yukon
Source: NEB, 2018a

Demographics

2016 Census Profile (Statistics Canada, 2017)

- **Population:** 35, 874
- **Average age:** 39.1 years
- **Working age distribution:** 70.6%
- **Private dwellings:** 17, 987
- **Private dwellings occupied by usual residents:** 15, 215

Consumption & Trade

Average annual electricity consumption in the Yukon, in 2015, was 10.5 MWh/capita, with commercial sector use highest (0.19 TWh), followed by residential (0.16 TWh) then industrial (0.04 TWh) (NEB, 2018b).

Due to its remote location and sparse population, the Yukon does not share a transmission network with any other province or territory, and thus does not trade in electricity, renewable or otherwise (NEB, 2018b).

Energy Generation Regulations

The Yukon government operates a net metering program, which they refer to as a micro-generation program, for all utility customers including residential, general service, and industrial users, both on the integrated and rural networks, with compensation rates set at $0.21/kWh and $0.30/kWh respectively (Yukon Government, 2017). Capacity limits are imposed at 5 kW for a shared transformer, 25 kW for a single transformer, and projects over 25 kW up to 50 kW considered on a case by case basis. In addition, the government offers two complementary incentive programs to cover capital costs for integrated and rural electrification projects. A report assessing the success of the program states that since launching in 2013, the government has approved over 60 participants and 400 kW of capacity, all of which are solar PV, with a forecast of 4-8 MW of generation by 2025 (Yukon Government, 2016).

From the same public consultation process, an Independent Power Producer (IPP) policy was created which outlines how an individual/corporation can produce power exclusively for sale to the territorial grid, rather than to offset personal use. Through a Standing Offer Program (SOP), the territory, in conjunction with Yukon Power and ATCO Electric Yukon, will put out a call for power to projects with a nameplace capacity between 30 kW and 1,000 kW per project, to a max of 10,000 MWh/year for the Yukon Integrated System (Yukon Power) and 2,100 MWh/year for the Watson Lake system (ATCO) (Yukon Government, 2015a). While a policy document has been released as of October 2015, it is unclear if the program has officially launched as there appear to be no current IPP agreements in place.

Policy, Legislation, & Targets

In 2009 the Energy Strategy for Yukon was released and outlined priorities for the territory's energy landscape including:

- Increase renewable energy supply in Yukon by 20% by 2020.
- Develop a policy framework for geothermal energy.
- Support and demonstrate renewable energy projects in communities off the electrical grid to reduce diesel use.
- Conduct pilot studies to assess the feasibility of renewable energy initiatives.
- Promote renewable energy sources for heating and transportation (Yukon Government, 2009).

A number of supporting strategy and policy documents have been written to promote biomass, microgeneration/net metering, and independent power production. Updates have been released every 2-3 years, with the most recent in 2015 outlining how the government continues to promote renewables while meeting their target five years early through the addition of one new hydro facility and an additional turbine at another, along with upgraded biomass heating and solar water heating (Yukon Government, 2015b).

Renewable Projects Overview & Dataset

A dataset of 5 operational energy projects has been compiled for the Yukon from one primary source: Government of Canada - Renewable Energy Powerplants, 1 MW or more. All of these projects are hydroelectric, with no commercial solar, biomass, or wind identified above 1 MW. Wind and biomass projects under 1 MW do exist, but were not inventoried, and net metering/microgeneration participants are also not included.

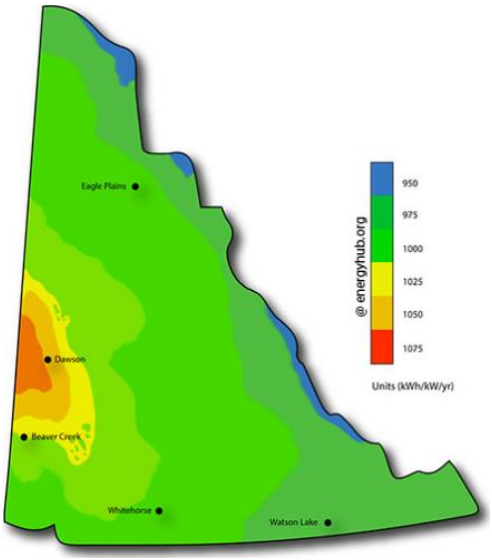
The Yukon has no major projects underway at the moment, but given the success of its net metering/microgeneration program and the existence of an IPP policy framework, new developments may be coming soon.

Potential Energy Summary

The Yukon has a wide range of geographic features, from mountain peaks to volcanoes to forest to tundra and a northern coastline, all of which support hydro, geothermal, wind, biomass and solar energy potential (World Atlas, 2018).

Solar

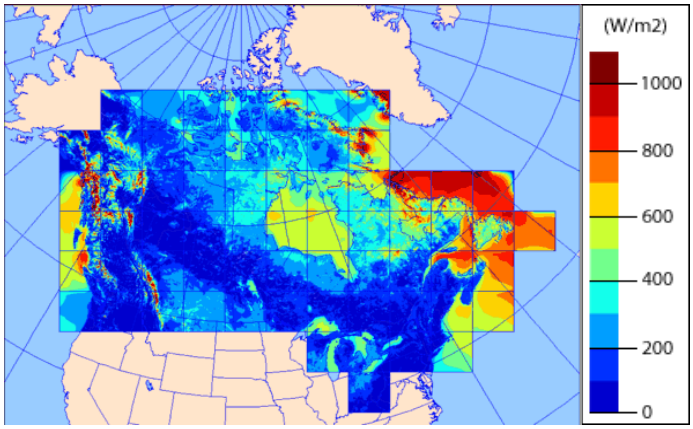
Yukon territory receives a grade F for their raw solar potential, with a 5 kW system generating an average 4,855 kWh, due to the high latitude. While the raw potential is limited, the policy and incentive environment is generous with both microgeneration/net metering and rebate programs supported by the territorial government, especially in remote communities that currently depend on diesel generation (EnergyHub.org, 2018)



Average Annual Solar Energy Generation per kW Installed
Source: https://solarpanelpower.ca/solar-power-maps-canada/

Wind

The Yukon government has completed extensive review of wind potential at seven preferred sites across the province and found approximately 10 MW of feasible capacity at each site (Yukon Energy, nda). The sites include: Cyprus Mine, Kluane Lake, Miller's Ridge, Sugarloaf Mountain, Thulsoo Mountain, Tehcho, and Mount Sumanik. The territory offers wind prospecting, a service to monitor and assess the wind potential at sites where a property owner is considering installing wind generation (Yukon Government, 2017b). Icing is a serious issue for most wind sites, as this phenomenon occurs more often at higher elevations (Yukon Government, 2015c).



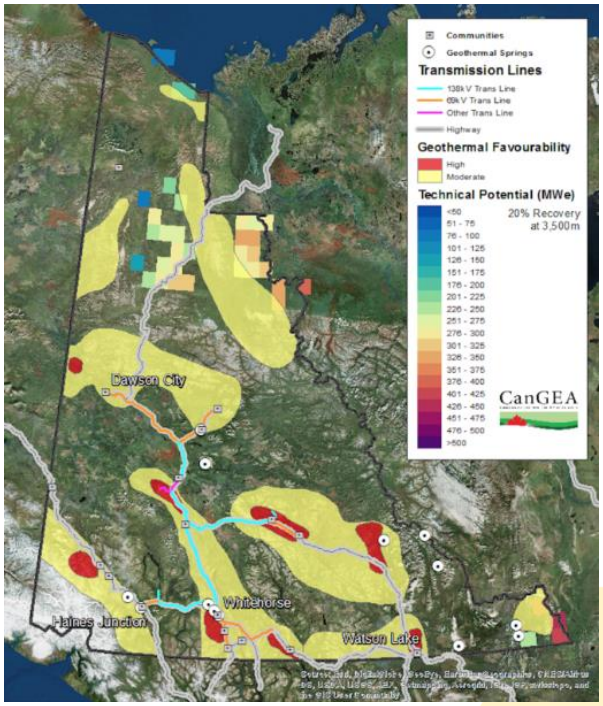
Annual Mean Wind Speed at 50 m Height
Source: http://www.windatlas.ca/maps-en.php

Geothermal

With mountainous and volcanic terrain, the Yukon has undeveloped geothermal generating potential. The Geologic Survey of Canada makes no MW estimates but includes the Yukon in its list of high heat geothermal resource potential sites, along with the suggestion that it would be ideal for remote and northern communities to utilise (Grasby et al., 2012). CanGEA takes a more quantitative approach, estimating technical potential at 5% recovery, at depths of 1.5 km and 3.5 km to range from 92 to 724 MW (2016).

Biomass

The Yukon Government has not yet explored the use of biomass for electricity production, only heat, but generation is an eventual goal of the territory's Energy Strategy. While no estimates are made for MW generation or biomass feedstocks, the Strategy does note that ~30,000 m^3 of the Yukon's forest resources are harvested annually for heating (Yukon Government, 2016b).



Geothermal Favourability in Yukon
Source: https://www.cangea.ca/Yukon-Geothermal-Resource-Estimate-Maps.html

Hydroelectric

While the Yukon has a handful of large scale legacy hydro projects, the construction of these has usually been the direct result of a high demand industrial operation, generally a mine. With fewer mines, and the closing of the Faro mine, the territory suggests new hydro potential will be developed on the smaller side (Yukon Government, 2011). A 2016 study commissioned by Yukon Energy and completed by Knights Piesold identifies six small hydro sites including run of river, storage, and pumped storage potential, all in a total of ~70 MW (Yukon Energy, ndb). In contradiction of these small hydro projects, a recent CBC article suggests the government is looking at six sites for a new dam project, with total potential of all sites approximately 413 MW (CBC News, 2015). No estimates were found of the total territorial potential, but these references suggest it is, and remains, well in excess of demand.

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