Yukon Energy Strategy Background Research

Part 3: Analysis of the Yukon Energy Sector

Submitted to:
Yukon Energy Strategy Working Group
Energy Solutions Centre / Energy, Mines and Resources
Box 2703 Whitehorse, Yukon
Y1A 2C6

Submitted by:
Paul Kishchuk, MA
Vector Research
Box 31126 Whitehorse, Yukon Y1A 5P7
paul@vectorresearch.ca
t: 867.668.3164
f: 867.668.3124
c: 867.333.2910

In association with:
Lisa Jacobs, MSW
Contact Research and Communications
6 Cassino Street
Whitehorse, Yukon
Y1A 3B8

July 17, 2007

Yukon Energy Strategy Background Research
Part 3: Analysis of the Yukon Energy Sector

Table of Contents

Background

Energy is a vital part of the day-to-day lives of all Yukon citizens. We use energy in the whole range of our daily activities, from home heating to transportation, from cooking to leisure pursuits. The energy sector provides employment to hundreds of Yukoners. The production, transportation and consumption of energy has major implications for our environment.

The Yukon energy sector is complex. Many forms of energy consumed in the territory have their prices determined in highly competitive world markets. Those same world markets also determine the pace of development of the Yukon's energy resources. The continuing and adequate supply of energy in its various forms affects Yukoners of all ages, of all occupations, in all communities.

While all jurisdictions have various energy-related issues in common, many energy issues are specific to each jurisdiction. For example, endowments of energy resources such as oil, gas and hydro-electric potential vary widely between Canada's provinces and territories. In addition, vast distances between energy sources and consumption locations can result in significant differences in energy costs among jurisdictions. Geographic location is also a factor in the distribution of the impacts of climate change.

The importance, complexity and location-specific nature of energy suggests the need for a comprehensive made-in-Yukon energy strategy. Accordingly, the purpose of this project is to prepare background research that will facilitate the development of a comprehensive Yukon energy strategy. The research has been undertaken in three parts:

> Part 1 consists of a high-level analysis of energy strategies and the associated development processes from British Columbia, the Northwest Territories, Saskatchewan, PEI and Quebec.
>
> Part 2 presents a summary analysis of existing federal and Yukon energy programs and initiatives.
>
> Part 3 presents an overview analysis of the Yukon energy sector through identification of key trends and issues related to energy production, management and use in the Yukon and makes recommendations about the potential scope and process that might work in the Yukon for developing a long term energy strategy.

This paper presents the findings of the Part 3 project work.

Energy Capacity and Potential Supply

Onshore Oil and Gas

With the exception of three producing natural gas wells in the Kotaneelee field, the Yukon's oil and gas resource potential remains largely unexplored and undeveloped. Approximately 75 wells have been drilled in the Yukon to date with most of the wells being drilled in one of three basins: Liard Plateau, Peel Plateau and Eagle Plain. The remaining five basins (Bonnet Plume, Kandik, Old Crow, Whitehorse Trough and North Coast) are virtually unexplored.

Since responsibility for the management and administration of the Yukon's on-shore oil and gas resources was transferred to the Government of Yukon in 1998, a total of five rights dispositions have been undertaken. The first three were held in 1999, 2001 and 2002 and resulted in the issuance of four exploration permits, as described in the table below. The first three permits were issued to Devon ARL in the Eagle Plain region. The fourth permit is owned by Hunt Oil Canada and is located in the Peel Plateau.

Yukon Oil and Gas Dispositions

Disposition Number	Permit Number	Region	Bid ($ million)	Permit Owner	Permit Expiry
One	001	Eagle Plain	8.2	Devon ARL	November 2008*
One	002	Eagle Plain	12.2	Devon ARL	November 2005
Two	003	Eagle Plain	2.9	Devon ARL	March 2007
Three	004	Peel Plateau	1.2	Hunt Oil Canada	January 2008
Five	005	Eagle Plain	0.4	Northern Cross (Yukon) Ltd.	permit pending
Five	006	Eagle Plain	0.5	Northern Cross (Yukon) Ltd.	permit pending
Five	007	Eagle Plain	0.5	Northern Cross (Yukon) Ltd.	permit pending
Five	008	Eagle Plain	0.5	Northern Cross (Yukon) Ltd.	permit pending
Five	009	Eagle Plain	0.5	Northern Cross (Yukon) Ltd.	permit pending
Five	010	Eagle Plain	0.5	Northern Cross (Yukon) Ltd.	permit pending
Five	011	Eagle Plain	0.5	Northern Cross (Yukon) Ltd.	permit pending
Five	012	Eagle Plain	0.9	Northern Cross (Yukon) Ltd.	permit pending
Five	013	Eagle Plain	2.1	Northern Cross (Yukon) Ltd.	permit pending
Five	014	Eagle Plain	5.1	Northern Cross (Yukon) Ltd.	permit pending
Five	015	Eagle Plain	3.6	Northern Cross (Yukon) Ltd.	permit pending
Five	016	Eagle Plain	2.7	Northern Cross (Yukon) Ltd.	permit pending
Five	017	Eagle Plain	2.0	Northern Cross (Yukon) Ltd.	permit pending

Source: Government of Yukon, Department of Energy, Mines and Resources
* Permit Number One conditions were modified in 2004; among the modifications was an extension of the expiry date for Permit Number One to November 30, 2008. Complete details can be found in Yukon Order in Council 2004/234 *Devon Permits Variation Order.*

A fourth rights disposition was attempted by the Government of Yukon in 2004. While one parcel was nominated in the Peel Plateau basin, no oil and gas rights were subsequently issued.

In light of the limited interest shown in the fourth rights disposition, the Government of Yukon modified its approach to the disposition of oil and gas rights. Potential bidders are now afforded an opportunity to identify locations of potential interest through a call for work bid process. Eighteen locations were made available for bid in northern Yukon in June 2007. A total of 13 bids submitted by Northern Cross (Yukon) Ltd. were deemed successful and work to formally issue the permits is currently underway. An additional three rounds of oil and gas dispositions are scheduled to take place before the end of 2008.

Oil and gas dispositions issued by the Government of Canada, prior to the transfer of oil and gas responsibility to the Government of Yukon in 1998, were grandfathered under the Yukon regime. Phillips Petroleum and BP Canada are majority owners of two exploration licenses on Yukon's north coast. A significant discovery licence in the La Biche area in the Liard Basin is jointly held by Encana Corp., Nexen Inc. and Devon Energy Canada.

In the Eagle Plain basin, Northern Cross (Yukon) holds rights to the Chance significant discovery licence (SDL). There are three production-tested oil wells located on the Chance SDL. With financial support from the Government of Yukon, Northern Cross (Yukon) has undertaken work to investigate the feasibility of building a small-scale oil refinery in the Eagle Plain area to process distillate products (e.g., diesel fuels and

heating oils). The feasibility work has considered the installation of a modular processing facility capable of producing 80 m^3 per day. Capacity would be increased in 80 m^3 per day increments until reaching a capacity of 400 m^3 per day. The range and quality of refined products would increase with each incremental addition to the processing facility.

While the production capacity of the modular refinery being contemplated by Northern Cross (Yukon) may at first glance seem very small, it is worth remembering that overall demand for petroleum products in the Yukon is also very small. Annual consumption of distillates (diesel, stove oil, kerosene) totaled 86,900,000 litres in 2006, equivalent to 238,100 litres on a per day basis. A refining capacity of 80 m^3 per day is equivalent to 80,000 litres per day.

In 2005, the North Yukon Oil and Gas Working Group commissioned a study to investigate potential development options for oil and gas resources in the North Yukon. Key findings of the report that relate to the future development of oil and gas resources include:[1]

- Eagle Plain has the greatest potential for development among geological basins in the North Yukon with exploration activity predicted to be focused in the southeastern part of the Eagle Plain basin;
- On the basis of assessment work undertaken by the Yukon Geological Survey, a natural gas resource of 5.39 trillion cubic feet exists at Eagle Plain (enough gas to supply a 20-inch pipeline for more than 20 years);
- Development of the North Yukon gas resource depends on prior construction of major market-bound pipelines (i.e., MacKenzie Valley Pipeline or the Alaska Highway Pipeline);
- A North Yukon Pipeline will be fed by an estimated 873 wells drilled at Eagle Plain (including disturbance-reducing directional wells); and,
- The optimal pipeline route for Eagle Plain gas parallels the Dempster Highway and connects to the MacKenzie Valley Pipeline at Inuvik.

Offshore Oil and Gas

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. Responsibility for management and development of oil and gas resources in the Beaufort Sea continues to be held by the Government of Canada. Beaufort Sea region oil and gas resources are managed under the *Canada Petroleum Resources Act* and the *Canada Oil and Gas Operations Act.* The table below outlines the resource potential of the Beaufort offshore area.

Beaufort Offshore Resource Potential

	Oil (billion barrels)	**Natural Gas** (trillion cubic feet)
Discovered	1.7	12
Potential	5.4	54
Source: Yukon Energy, Mines and Resources, *Yukon Oil and Gas: A Northern Investment Opportunity.*		

[1] Fekete Associates Inc. and Vector Research, *North Yukon Conceptual Oil and Gas Development Scenario and Local Benefits Assessment, 2005* (executive summary).

As part of the 1993 *Canada Yukon Oil and Gas Accord,* the Government of Canada committed to negotiating a shared offshore resource management regime and revenue sharing arrangement with the Government of Yukon. Discussions are currently underway between Yukon Energy, Mines and Resources and the federal Department of Indian and Northern Affairs regarding an enhanced role for the Yukon Government in offshore management in advance of commencement of formal offshore resource negotiations.

Coal

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.

Responsibility for the management of coal resources, including coal bed methane, was transferred to the Government of Yukon from the Government of Canada in April 2003, along with responsibility for mineral resources. A regulatory regime for the management of coal bed methane has not yet been completed by the Government of Yukon. Extensive coal resources have been documented in the Yukon. The table below 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	Characteristics	Potential Resource
Division Mountain	90 km northwest of Whitehorse	high ash, low sulphur, high volatile bituminous B	52.9 million tonnes of coal
Whitehorse Coal	30 km southwest of Whitehorse	low sulphur, moderate to high ash anthracite	12 km of discontinuous seams of mineable thickness (0.6 to 13 metres)
Rock River	southeast Yukon	A to sub-bituminous C	60 million tonnes of coal within 80 metres of surface
Bonnet Plume	northwestern Yukon	high volatile bituminous C, low sulphur	660 million tonnes
Source: Yukon Geological Survey, *Coal,* 2005.			

Electricity

Electricity is produced by two utilities in the Yukon, both regulated by the Yukon Utilities Board. Yukon Energy, owned by the Government of Yukon, is the primary generator of electricity in the territory. The Yukon Electrical Company Limited, a private utility owned by ATCO Electric Limited, is the Yukon's primary distributor of electricity. Both utilities generate electricity from hydro and diesel combustion sources. Yukon Energy also produces a small amount of electricity from wind.

The table below details the generation capacity of the Yukon's two electrical utilities. Total Yukon capacity for electricity generation stood at 127.0 megawatts (MW) in 2006, of which 112.0 MW were owned by Yukon Energy and 15.0 MW were owned by The Yukon Electrical Company Limited. Total hydro-electric generating capacity in the territory stood at 76.3 MW (summer) and 60.0 MW (winter).[2] Total Yukon diesel capacity was 49.7 MW in 2006. Two wind turbines located at Haeckel Hill in Whitehorse (a Bonus

[2] Yukon Energy's Whitehorse dam is a run-of-river facility. As such, water flows are reduced in the winter by 40%. A 46% percent reduction is capacity is also experienced at The Yukon Electrical Company's Fish Lake hydro facility. Territory-wide, hydro-electric capacity is reduced by 21 percent in the winter period.

Energy 0.15 MW unit and a Vestas 0.66 MW unit) provide an additional 0.8 MW of electrical generation capacity.

Several micro-scale hydro facilities also supply electricity at off-grid locations in the Yukon. A facility at Rancheria supplies a highway lodge with a summer capacity of 155 kilowatts. A submersible hydro generator supplies electricity to the Fort Selkirk historic site on the Yukon River on a seasonal basis. Several individual residences are supplied with electricity from micro hydro setups.

Yukon Electricity Generation Capacity (megawatts)

Yukon Energy		The Yukon Electrical Company Ltd.	
Hydro		**Hydro**	
Whitehorse	40.0	Fish Lake	1.3
Aishihik*	30.0	**Diesel**	
Mayo	5.0	Carmacks	1.3
Total	75.0	Haines Junction	1.3
Diesel		Teslin	1.3
Whitehorse	22.6	Ross River	1.0
Faro	5.4	Watson Lake	5.0
Dawson	6.0	Beaver Creek	0.9
Mayo	2.0	Destruction Bay	0.9
Total	36.0	Old Crow	0.7
Wind		Pelly Crossing	0.7
Haeckel Hill	0.8	Stewart Crossing	0.3
		Swift River	0.3
		Total	13.7

Total Yukon Energy Capacity	112.0 MW
Total YECL Capacity	15.0 MW
Total Yukon Capacity	127.0 MW
Total Yukon Hydro Capacity – Summer	76.3 MW
Total Yukon Hydro Capacity – Winter	60.0 MW
Total Yukon Diesel Capacity	49.7 MW
Total Yukon Wind Capacity	0.8 MW

Source: Yukon Energy Corporation *2006 Annual Report*
Note: the recently announced installation of the third turbine at the Aishihik Hydro facility, will add 7 MW of generating capacity to the Aishihik facility.

Far more hydro-electric potential exists in the Yukon than is currently being harnessed. Eighty-two potential hydro sites have been identified and examined in initial studies undertaken by the Northern Canada Power Commission prior to 1987. Subsequent work undertaken by Yukon Energy and the Yukon Development Corporation has identified additional potential sites. Potential sites identified by the Northern Canada Power Commission, Yukon Energy and the Yukon Development Corporation range in size from very small (1-4 MW) to very large (100+ MW).

The most current inventory of potential hydro sites in the Yukon may be found in Yukon Energy's January 2006 20-Year Resource Plan submission to the Yukon Utilities Board (in Appendix B: Hydro Project Options). The 20-Year Resource Plan submission assesses 19 hydro project options on the basis of site location, as well as various rough qualitative and quantitative factors addressed in the initial NCPC and Yukon Energy studies. The analysis is illustrative in nature, it does not recommend any particular options.

Renewable Energy

Renewable energy is energy taken from sources that are replenished by natural phenomena making them essentially inexhaustible. Renewable energy sources include:

- solar;
- wind;
- water;
- tidal/wave action;
- geothermal;
- biofuels (e.g., wood and waste).

In contrast, non-renewable energy sources are not replenishable. Examples of non-renewable energy sources include oil, gas and coal. Note that renewable energy is not always the same as sustainable energy. Associated social and environmental impacts may adversely affect the sustainability of a renewable resource. For example, hydro dams which cause flooding can alter fish habitat which in turn can have adverse effects on fish populations. A distinction is increasingly being made by policy practitioners that only renewable energies which minimize or avoid adverse social and environmental impacts qualifies as higher-order "green" energy.

Renewable energy sources in the Yukon are virtually untapped at the present time. Because green renewable energy is constantly being replenished (e.g., water, geothermal and biomass energy) or is inexhaustible (solar, wind, tidal/wave action) it is not possible to present an indication of the capacity of renewable energy sources for the Yukon.

The Pembina Institute for Sustainable Development has noted, however, that:[3]

"Renewable energy could have many applications in the Yukon, including:

- Solar water heating for homes, offices, or other buildings, during the spring, summer, and fall;
- Solar space heating for homes or offices through passive solar building design techniques;
- Biomass space and water heating for homes, offices, other buildings with individual wood boilers/stoves, or entire communities through district heating systems;
- Hydro, wind, and biomass systems to provide electricity for off-grid communities, working in tandem with existing diesel generators and reducing overall diesel consumption;
- Hydro, wind, biomass, and solar PV systems to provide electricity into the utility grid, thus reducing overall diesel consumption during winter peaking periods; and,
- Hydro, wind, and solar PV electrical systems to provide power for remote applications (e.g., homes, cottages, tourism lodges, camps, communications sites, parks offices, or other electricity uses), providing power into previously un-powered areas, or reducing the consumption of fuel with existing diesel generators."

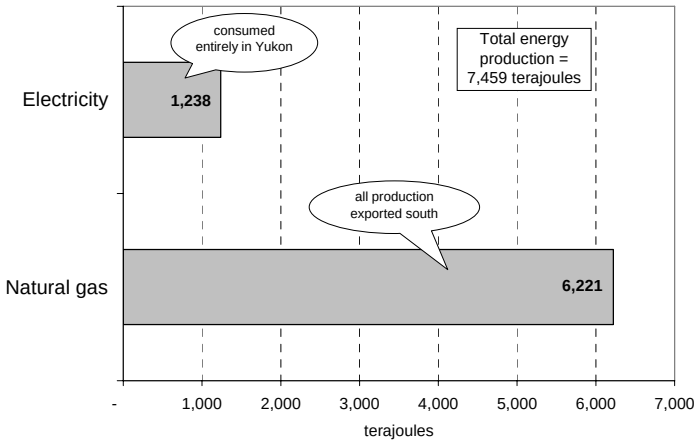
Work undertaken in Haines Junction, Mayo and Whitehorse subsequent to the Pembina Institute's observations above suggests that geothermal space heating is also a viable renewable energy application in the Yukon.

[3] Andrew Pape and Barbara Campbell, (1999), *Economic Development from Renewable Energy: Yukon Opportunities,* Pembina Institute for Appropriate Development, page 5.

Energy Production and Imports

As shown in the figure to the right, energy production in the Yukon was equivalent to 7,459 terajoules in 2005 and was comprised of energy from only two sources. More than four-fifths (83.4%) of the total energy produced in the Yukon, equivalent to 6,221 terajoules, was in the form of natural gas. The remaining 16.6% of energy produced in the territory (1,123 terajoules) was in the form of electricity.

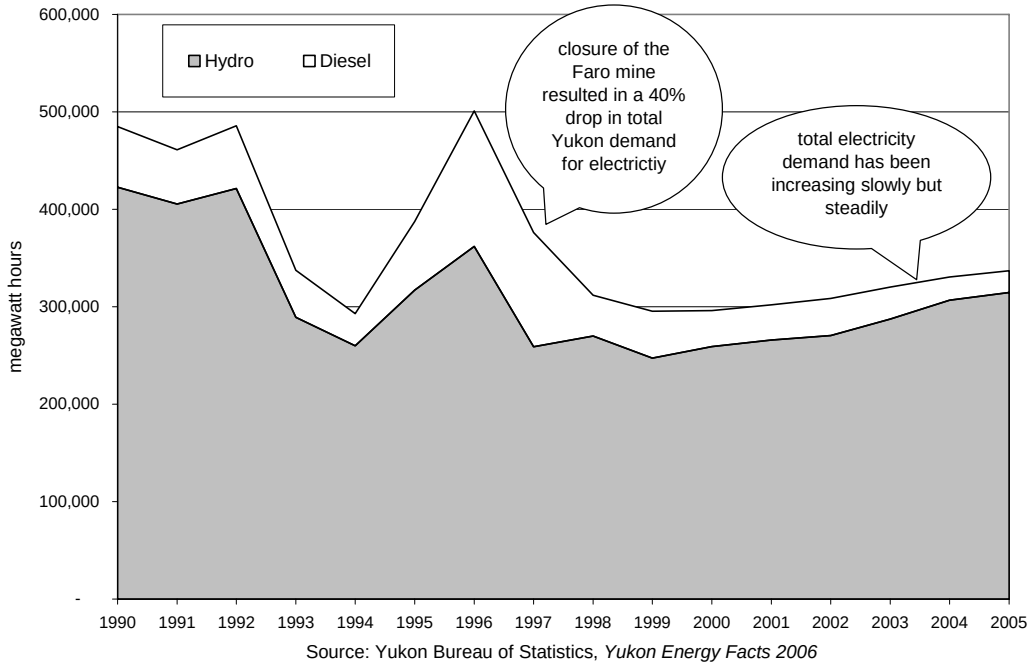
Yukon Energy Production - 2005



Source: Statistics Canada Cat. No. 57-003

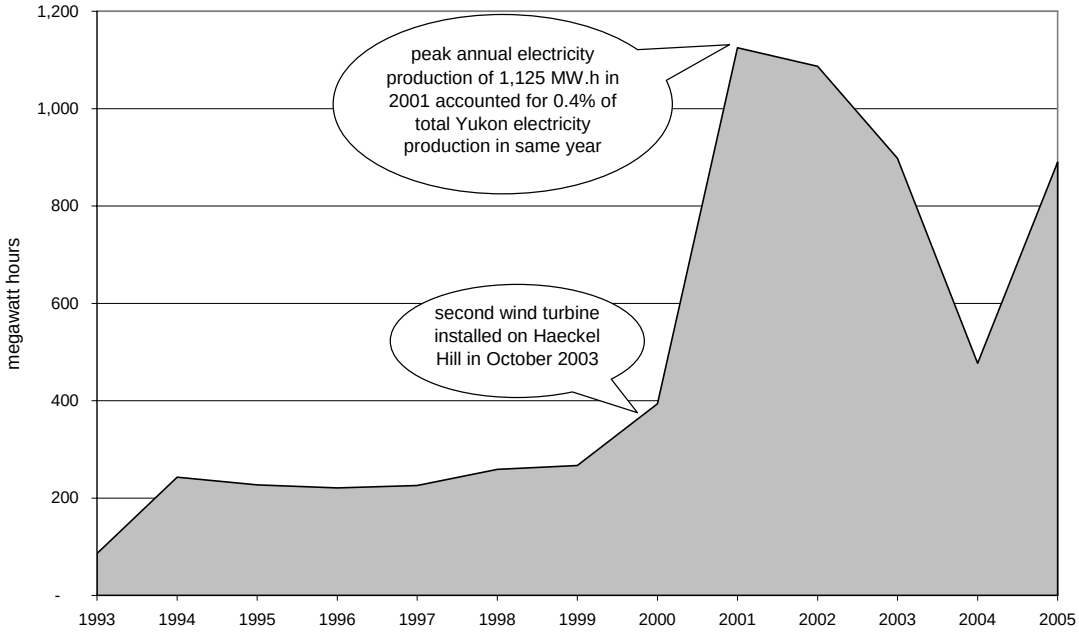
Almost all of the electrical energy produced in the territory (1,157 terajoules) was generated at hydro-electric facilities. Eighty-one terajoules of electrical energy were generated from diesel-powered sources. As the Yukon's electricity transmission grid is not connected to a grid outside the territory, all electricity produced in the Yukon is consumed in the Yukon. The figures on the following page present the annual volume of electricity produced by the Yukon's two regulated electrical utilities: Yukon Energy Corporation and The Yukon Electrical Company Limited.

Yukon Electricity Generation - Hydro and Diesel



Source: Yukon Bureau of Statistics, *Yukon Energy Facts 2006*

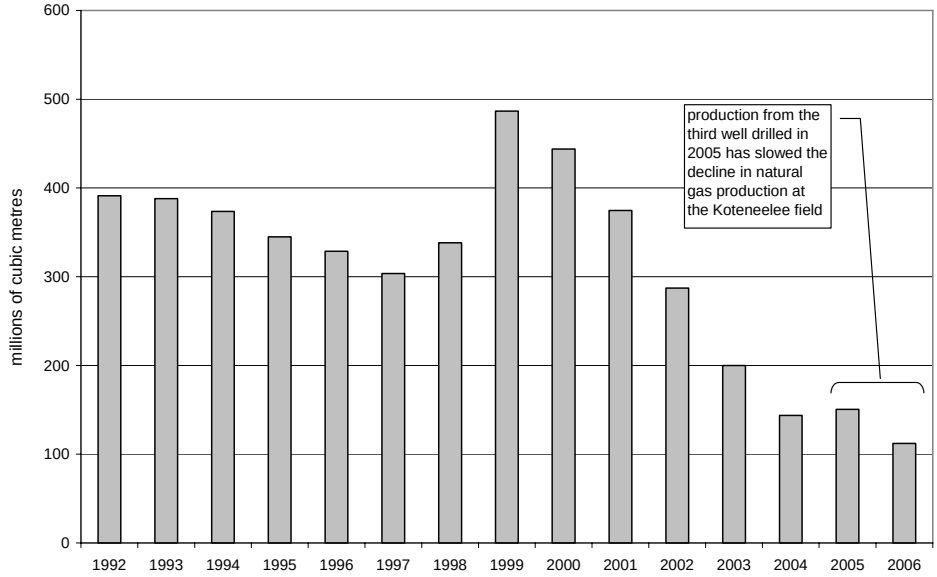
Yukon Wind-Generated Electricity



Source: Yukon Bureau of Statistics, *Yukon Energy Facts 2006*

The figure on the following page presents the annual total volume of natural gas produced in the Yukon from 1992 to 2006. All natural gas production has been from the Kotaneelee field in the Liard basin located in the southeast Yukon. Two natural gas wells were responsible for total Yukon production between 1992 and 2004. A third development well that began producing gas for market in May 2005 is helping to offset the natural decline in Kotaneelee production that began in 2000. None of the natural gas produced in the Yukon has been available for use by Yukon energy consumers because the entire supply was exported from the territory.

Total Volume of Yukon Natural Gas Production

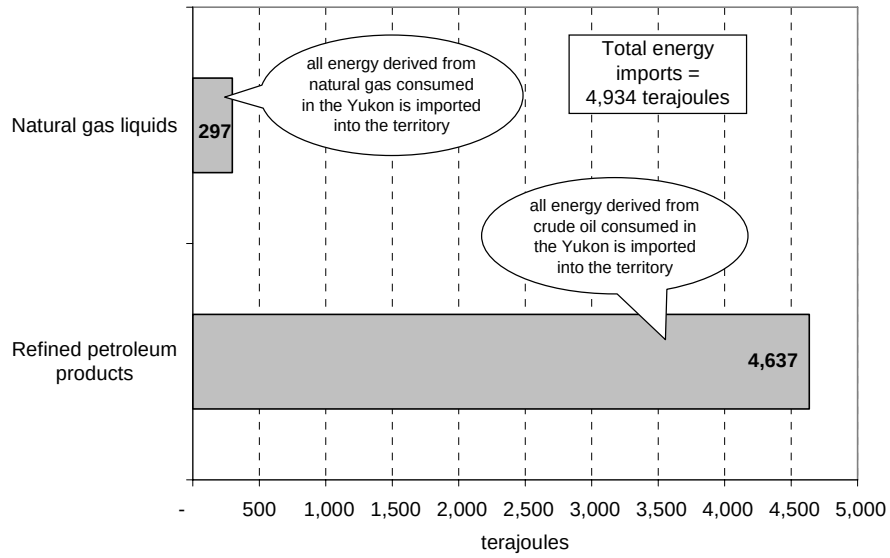


Source: Statistics Canada CANSIM 131-0001

While not captured in the Statistics Canada data, renewable forms of energy are 'harvested' for use in the Yukon. Solar energy is used for space heating, hot water heating and for generating electricity. Geothermal energy is used to prevent municipal water systems from freezing in the communities of Whitehorse and Mayo and for space heating (in combination with heat pumps). Biomass in the form of cordwood and wood chips/pellets is used throughout the territory for residential and institutional space heating purposes. Several micro-scale wind and hydro installations are used to produce electricity in remote locations.

Notwithstanding that the Yukon is a natural gas producing jurisdiction, the territory is not home to a natural gas processing facility. As a result, all energy derived from natural gas consumed in the Yukon is imported into the territory from outside gas refineries. As shown in the figure below, imports of natural gas liquids into the Yukon were equivalent to 297 terajoules in 2005.

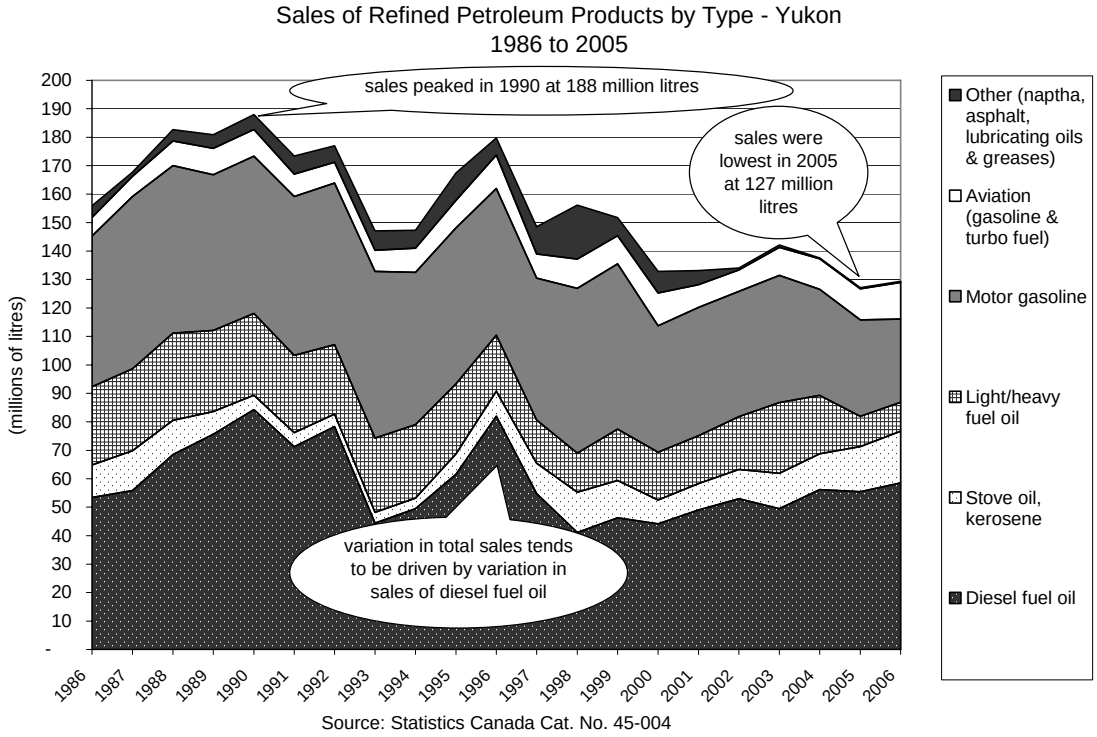
Yukon Energy Imports - 2005



Source: Statistics Canada Cat. No. 57-003

All energy derived from crude oil sources consumed in the Yukon is also imported into the territory. Refined petroleum products are imported from refineries located in western Canada[4] and Alaska[5]. In 2005, a total of 4,637 terajoules of energy from refined petroleum products was imported into the Yukon. The figure below presents the sales volume of refined petroleum products in the Yukon by type over the period 1986 to 2005.

[4] Locations (and owners) of western Canada's six refineries include: Burnaby, B.C. (Chevron Corporation); Prince George, B.C. (Husky Energy); Strathcona, Alberta (Imperial Oil); Edmonton, Alberta (Petro-Canada); Scotford, Alberta (Shell Canada); and, Regina, Saskatchewan (Consumers' Co-operative).
[5] Locations (and owners) of Alaska's six refineries include: Prudhoe Bay (BP Exploration Alaska); Kuparuk (ConocoPhilips Alaska); North Pole (Flint Hills Resources Alaska); North Pole (Petro Star); Valdez (Petro Star) and Kenai (Tesoro).



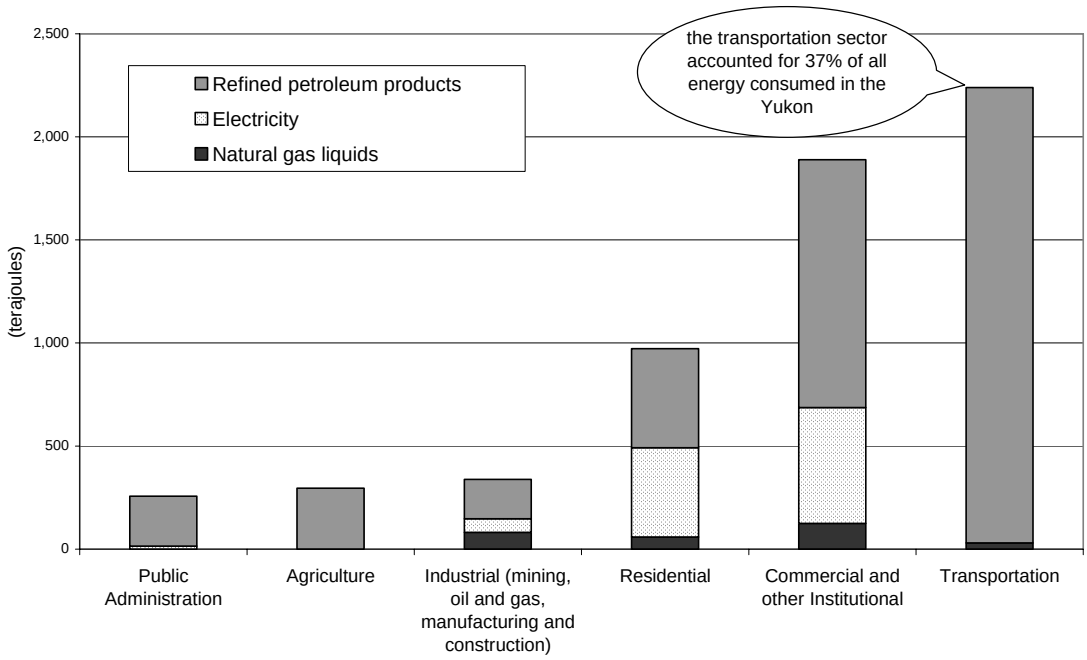
Source: Statistics Canada Cat. No. 45-004

Consumption

The chart below illustrates the pattern of energy consumption in the Yukon by sector and energy type in 2005. Total final demand for energy in the Yukon was 5,993 terajoules in 2005. More than one third of all the energy consumed in the Yukon is consumed in the transportation sector where final demand for energy totaled 2,239 terajoules in 2005. Almost all (99%) of the energy consumed in the transportation sector was in the form of refined petroleum products (primarily gasoline, diesel and aviation fuels).

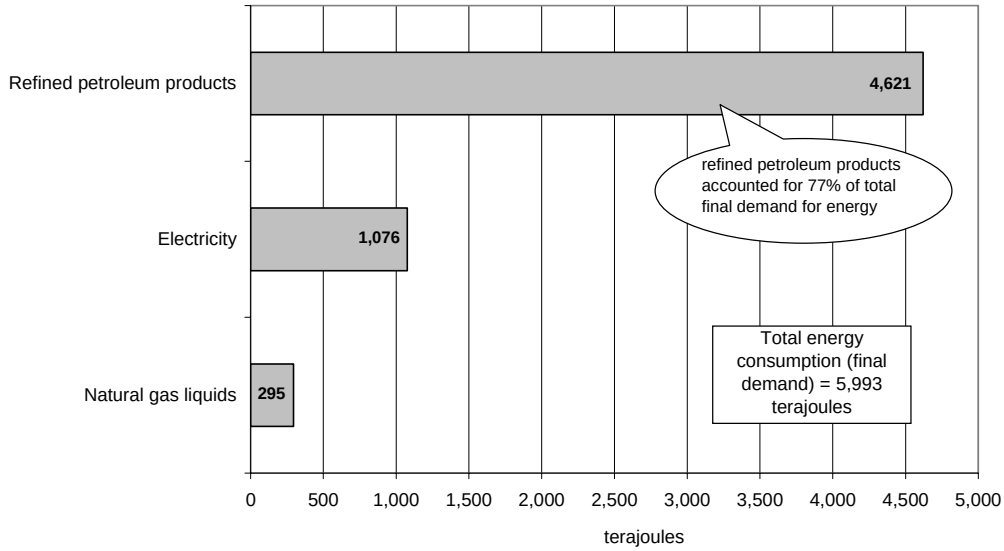
Final demand for energy in the “commercial and other institutional” sector accounted for approximately 32% of energy consumption in the Yukon in 2005, equivalent to 1,889 terajoules. The “commercial and other institutional” sector was the largest consumer of electricity in the territory, where final demand for electricity was equivalent to 562 terajoules. The remaining third of final demand for energy in 2005 was split between the residential, industrial, agriculture and public administration sectors, which together consumed 1,864 terajoules of energy in 2005.

Yukon Consumption of Energy by Sector and Energy Type - Yukon 2005



Source: Statistics Canada Cat. No. 57-003.

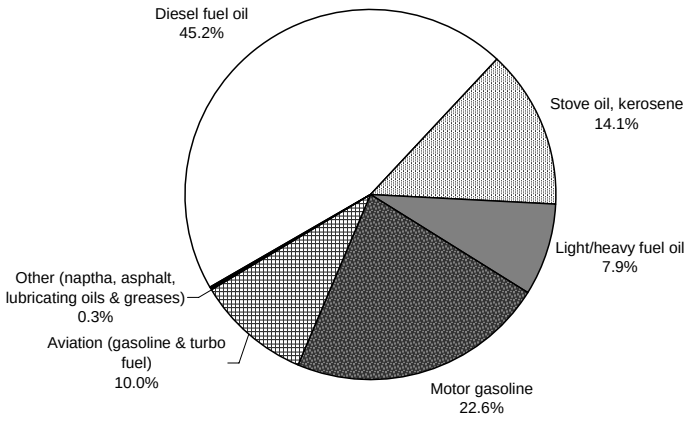
Yukon Final Demand for Energy by Energy Type - 2005



Source: Statistics Canada Cat. No. 57-003

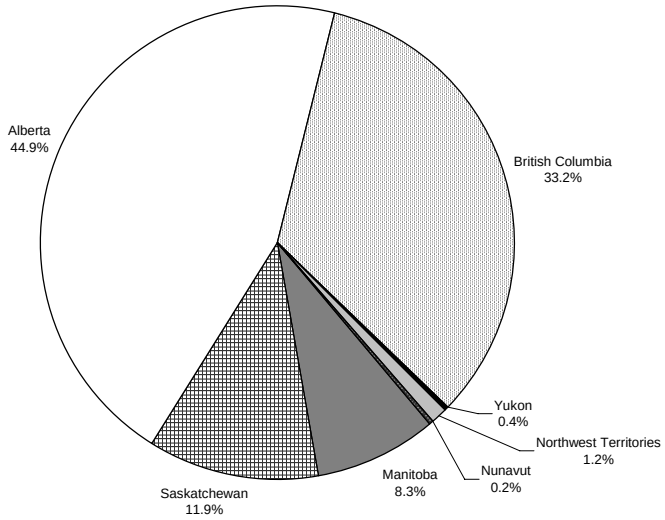
More than three-quarters of final demand for energy in the Yukon (77%) relates to refined petroleum products. The figure below illustrates the demand for refined petroleum products in Yukon by product type in 2006. The largest share of demand is attributable to diesel fuel oil which accounted for 45.2% of total demand. Demand for motor gasoline was next largest at 22.6%, followed by stove oil and kerosene at 14.1%.

Demand for Refined Petroleum Products in Yukon by Product Type - 2006
Source: Statistics Canada Cat. No. 45-004



To provide a perspective on the scale of demand for refined petroleum products in the Yukon relative to markets in western and northern Canada, the chart below presents the sales volume of refined petroleum products in each northern and western jurisdiction relative to the total sales of in all seven jurisdictions. As can been seen from the chart, with a relative share of 0.4%, the sales volume of refined petroleum products in the Yukon is tiny compared to the total sales in all northern and western Canadian jurisdictions.

Relative Sales Volume of Refined Petroleum Products in Western and Northern Canada 2005 - All Products
Source: Statistics Canada Cat. No. 57-601

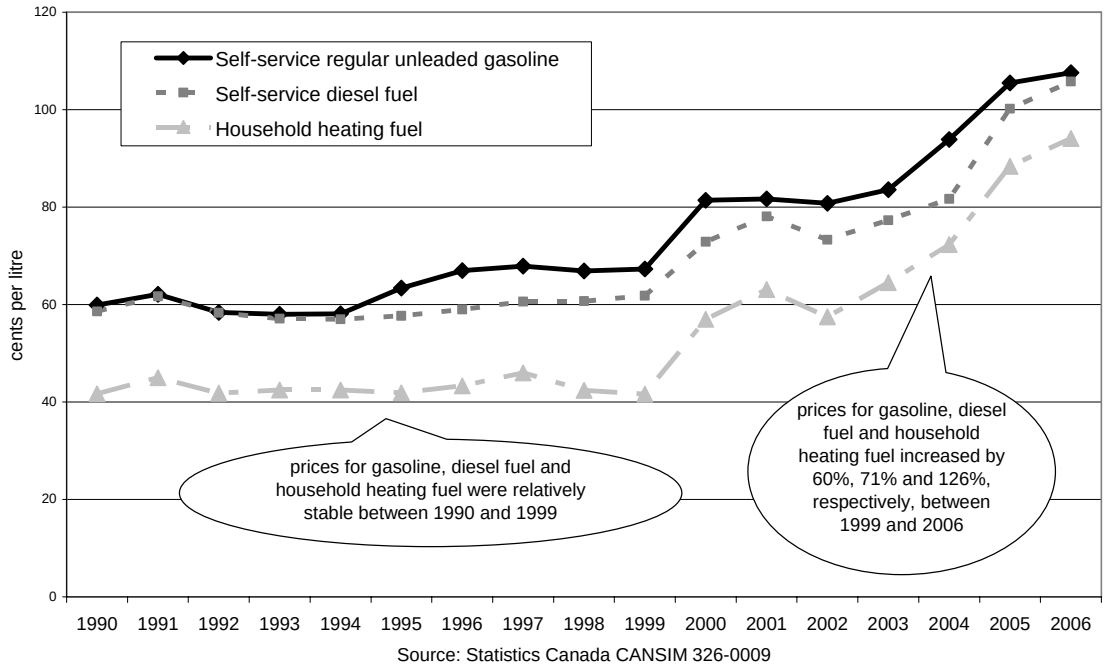


On the basis of Statistics Canada data for energy consumption (final demand) in the Yukon, 83% of the energy consumed in the Yukon in 2005 was derived from non-renewable sources. Out of the total 5,993 terajoules of energy consumed in 2005 in the Yukon, 296 terajoules were consumed in the form of natural gas liquids (primarily propane), 81 terajoules were in the form of electricity generated with diesel fuel and 4,621 terajoules were in the form of refined petroleum products.

Energy Prices

The figure below illustrates price trends for motor fuel (gasoline and diesel) and household heating fuel in Whitehorse over the period 1990 to 2006. While prices for all three fuel types were relatively stable from 1990 to 1999, prices for all three increased significantly between 1999 and 2006. During that period, prices for gasoline, diesel fuel and household heating fuel increased by 60%, 71% and 126%, respectively. With more than three quarters of the energy consumed in the Yukon consumed in the form of refined petroleum products, all of which are imported into the territory, Yukon energy consumers have been strongly affected by recent price increase in refined petroleum products.

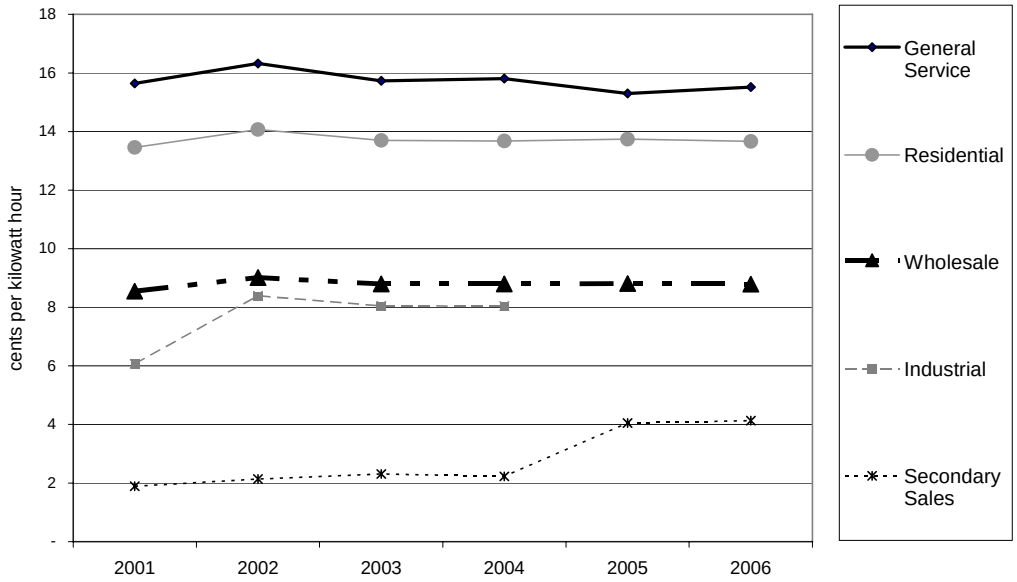
Retail Motor Fuel and Residential Heating Fuel Prices - Whitehorse
1990 to 2006



Source: Statistics Canada CANSIM 326-0009

In contrast to the situation for refined petroleum product prices, Yukon electricity consumers have enjoyed stable electricity rates over the past six years. Electricity price stability has, however, largely been a byproduct of the effects of the Rate Stabilization Fund and the fact that the Yukon Utilities Board has not been presented with a general rate application in more than ten years. With the recently announced winding down of the Rate Stabilization Fund and an indication that a general rate application will be filed by Yukon Energy in 2008, both factors may soon have a much greater bearing on electricity prices in the Yukon.

Yukon Electricity Prices

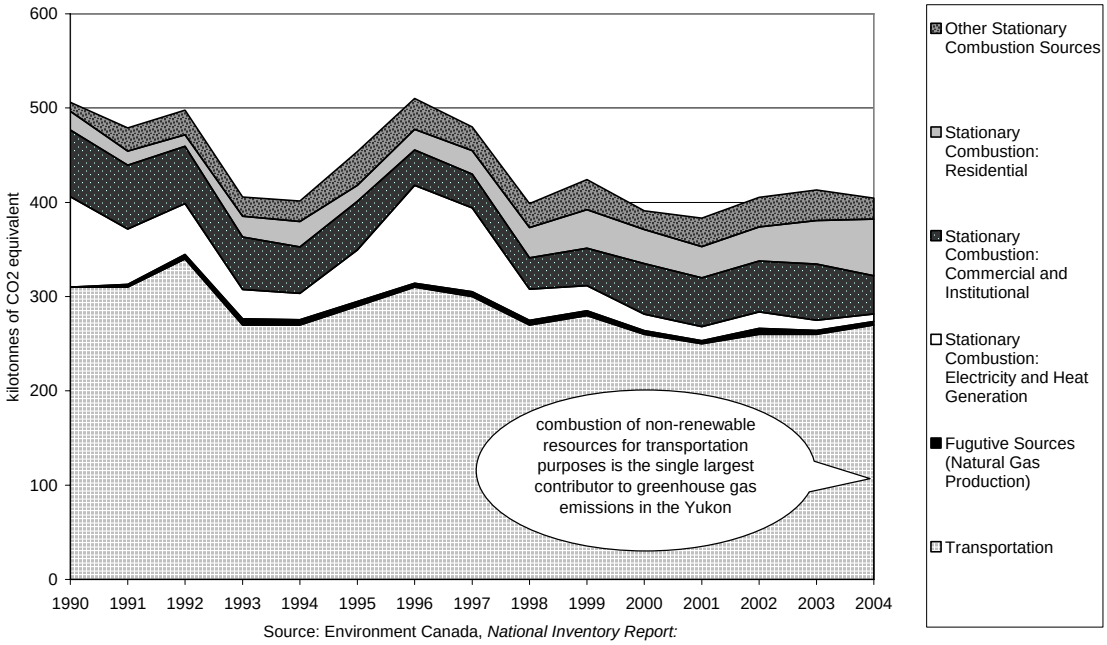


Source: Yukon Energy Corporation, *Yukon Energy Corporation 2006 Annual Report*
Note: Prices shown for the general service category are weighted averages of the prices charged to commercial, municipal and government (federal and territorial) customers.

Greenhouse Gas Emissions

The consumption of energy from non-renewable sources results in the emission of greenhouse gases. The chart on the following page presents greenhouse gas emissions from energy use in the Yukon by source over the period 1990 to 2004, measured in kilotonnes of carbon dioxide (CO_2) equivalent. Combustion of non-renewable energy forms is the single largest contributor to greenhouse gas emissions in the Yukon. In 2004, two thirds (66.8%) of total greenhouse gas emissions in the Yukon, equivalent to 260 kilotonnes of carbon dioxide, were attributable to transportation sources (cars, truck, buses etc.). Just under one third (32.4%) of greenhouse gas emission were attributable to the combustion of non-renewable energy forms with stationary devices (e.g., space heating equipment). Less than 1% of greenhouse gas emissions were attributable to fugitive sources (natural gas production).

Yukon Greenhouse Gas Emissions from Energy Use by Source
1990 - 2004



Source: Environment Canada, *National Inventory Report: Greenhouse Gas Sources and Sinks in Canada 1990 - 2004,* 2006.

Infrastructure

The energy infrastructure in a given jurisdiction is typically comprised of four types:

- *Electricity infrastructure* such as generation facilities and transmission lines;
- *Processing infrastructure* such as natural gas and oil refineries;
- *Pipeline infrastructure* for the movement of oil and natural gas and their derivatives; and,
- *Transportation infrastructure* that provides efficient means of moving energy resources such as rail lines and ports.

Current Yukon electrical generation capacity is described in detail on page six of this report. While our current electricity generation capacity of 130 MW is sufficient to meet the current needs of Yukon residents and industry, continued population growth and industrial development will necessitate the expansion of the Yukon's electrical infrastructure. Because the Yukon's electricity and generation system is completely isolated from southern generation and transmission infrastructure, the need for additional generation capacity is becoming more immediate. Indeed, as noted by Yukon Energy in its 20-year Resource Plan filed with the Yukon Utilities Board in 2006:

> "Forecast load growth, pending retirement (absent substantial Life Extension investment) of three Mirrlees diesel units (11.4 MW) located in YEC's Whitehorse diesel plant, and new capacity criteria adopted by Yukon Energy, together create an immediate need for new WAF generation capacity to serve peak winter load requirements in the near term through to 2012."[6]

The 20-Year Resource Plan, approved by the Yukon Utilities Board in January 2007, presents a variety of near term project options available to Yukon Energy to address the pending generation shortfall. The project options are presented in detail in Yukon Energy Corporation's *20-Year Resource Plan: 2006-2025.*

[6] Yukon Energy Corporation, *20-Year Resource Plan: 2006-2025, Summary of Proposed Actions,* page 3.

In terms of electricity transmission, Yukon Energy owns and operates two transmission systems in the Yukon: the Whitehorse-Aishihik-Faro (WAF) grid and the Mayo-Dawson (MD) grid. The WAF grid consists of 510 km high voltage line (primarily 138 kV) which connects the Aishihik hydro facility with Whitehorse, Carmacks and Faro. Other communities, including Haines Junction and Ross River, are connected by 25 kV lines. The 223 kilometer 69 kV MD line runs from Mayo to Dawson with a step-down at Stewart Crossing. Keno and Elsa, located to the northwest of Mayo, also receive electricity from the Mayo hydro facility via a 69 kV transmission line.

The Yukon Electrical Company Limited owns and operates a 34.5 kV system southeast from Whitehorse. The system connects the communities of Teslin, Carcross, Tagish, Marsh Lake, Jakes Corner and Johnson's Crossing to the WAF grid.

As part of its 20-Year Resource Plan, Yukon Energy also proposed to construct a new 138 kV transmission line 172 kilometres in length between Carmacks and Stewart Crossing. The transmission line would connect the WAF and MD transmission grids and is to be developed in two stages. Stage One would connect Carmacks to Pelly Crossing in conjunction with a spur line to Sherwood Copper's Minto Mine. Stage Two, contingent on favourable market conditions, is to connect Pelly Crossing to the Mayo-Dawson grid at Stewart Crossing. The Yukon Utilities Board granted approval to proceed with construction of Phase One of the project in May 2007. Phase One of the Carmacks to Stewart transmission line project is projected to be completed in 2009.

With regard to the three other types of energy infrastructure typically found in a given jurisdiction – processing, pipeline and transportation – Yukon's stock is very limited. There are no natural gas or oil refineries located in the Yukon. Refined petroleum products are imported from refineries located in western Canada and Alaska.

Yukon's pipeline infrastructure currently consists of a single 20-inch pipeline running from the Yukon's three producing gas wells in the Kotaneelee field to the Westcoast Transmission system in Northern, British Columbia. As noted earlier, further development of the Yukon's oil and gas resources, and the accompanying development of additional pipeline infrastructure, will require access to major market-bound pipelines (i.e., the proposed MacKenzie Valley Pipeline or the proposed Alaska Highway Pipeline).

Similar to the situation for processing infrastructure, the Yukon has little in the way of transportation infrastructure necessary for the efficient movement of energy resources such as rail lines and ports. The White Pass and Yukon Route rail line that connects Whitehorse to Skagway has not carried freight since its closure in 1982.[7] The Yukon has no direct access to ports within its boundaries.

Energy Sector Stakeholders

The table on the following page identifies stakeholders with an interest in the Yukon energy sector who could potentially be consulted in the course of developing a Yukon Energy Strategy. As noted at the outset, energy is vital to the day-to-day lives of all Yukon citizens. As such, it is recommended that all stakeholders listed be involved in the development of a Yukon energy strategy.

[7] The Skagway to Carcross portion of the White Pass and Yukon Route rail line is currently in operation as a tourist attraction on a seasonal basis.

Stakeholder List – Yukon Energy Sector

ORGANIZATION/AGENCY NAME	CONTACT NAME	CONTACT POSITION	E-MAIL	PHONE	ADDRESS
Governments					
Yukon EMR: Policy	Ed Van Randen	Director, Energy/Resource Policy	Ed.Vanranden@gov.yk.ca	667-5032	Box 2703 Whitehorse, Yukon Y1A 2C6
Yukon EMR: Oil and Gas	Deb Wortley	Rights Disposition Manager	Deb.Wortley@gov.yk.ca	667-3512	Box 2703 Whitehorse, Yukon Y1A 2C6
Yukon EMR: Pipeline	Brian Love	Director, Pipeline Branch	Brian.Love@gov.yk.ca	667-3566	Box 2703 Whitehorse, Yukon Y1A 2C6
Energy Solutions Centre	Colin Mcdowell	Director, Energy Solutions Centre	Colin.Mcdowell@gov.yk.ca	393-7070	Box 2703 Whitehorse, Yukon Y1A 2C6
Yukon Executive Council Office	Ian Church	YG Senior Science Advisor	Ian.Church@gov.yk.ca	667-5431	Box 2703 Whitehorse, Yukon Y1A 2C6
Yukon Housing Corporation	Juergen Korn	R & D Project Manager	Jeugen.Korn@gov.yk.ca	667-3790	Box 2703 Whitehorse, Yukon Y1A 2C6
Yukon Environment	Mike Connor	Director, Policy/Planning	Mike.Connor@gov.yk.ca	667-5634	Box 2703 Whitehorse, Yukon Y1A 2C6
Environment Canada	Daniel Lindsey	Yukon Manager	Daniel.Lindsey@ec.gc.ca	667-3401	91782 Alaska Highway Whitehorse, Yukon Y1A 5B7
Indian and Northern Affairs	Shari Borgford	Director - Strategic Invest.	borgfords@inac-ainc.gc.ca	667-3331	300 Main St. Room 415C Whitehorse, Yukon Y1A 2B5
Natural Resources Canada	Carol Buckley	DG, Office of Energy Efficiency	n/a	(613) 947-0703	580 Booth St. 18th Floor Ottawa, Ontario K1A 0E4
National Energy Board	Glenn Booth	Planning, Policy and Coordination	gbooth@neb-one.gc.ca	(403) 299-3621	444 Seventh Avenue SW Calgary, Alberta T2P 0X8
City of Whitehorse	Sabine Schweiger	Environmental Coordinator	sabine.schweiger@whitehorse.ca	668-8312	2121 2nd Ave. Whitehorse, Yukon, Canada Y1A 1C2
Association of Yukon Communities	Tom Paterson	Executive Director	ayc@northwestel.net	668-4388	#15-1114 1st Avenue Whitehorse, Yukon Y1A 1A3
Council of Yukon First Nations	Joan Graham	Executive Assistant	joan.graham@cyfn.net	393-9200	11 Nisutlin Drive Whitehorse, Yukon Y1A 3S4
Kwanlin Dun First Nation	Ken Hodgins	Executive Director	khodgins@kdfn.yk.ca	633-7860	35 McIntyre Drive, Whitehorse, Yukon Y1A 5A5
NGOs					
Yukon Conservation Society	Karen Baltgalis	Executive Director	ycs@ycs.yk.ca	668-6637	302 Hawkins Street Whitehorse, Yukon Y1A 1X6
Northern Climate Exchange	Michael Westlake	A/Coordinator	mwestlake@yukoncollege.yk.ca	668-8862	500 College Dr. Box 2799 Whitehorse Yukon Y1A 5K4
Utilities Consumers' Group	Roger Rondeau	President	info@ucgyk.ca	633-5210	Box 9300 29 Wann Road Whitehorse, Yukon Y1A 4A2
Yukon Sustainable Energy Assoc.	Josee Bonhomme	President	jb@northwestel.net	(867) 993-6433	Box 1605 Dawson, Yukon YOB 100
Alaska Hwy Aboriginal Pipeline Group	Dave Porter	Spokesman	n/a	(250) 779-3181	Box 9 Lower Post, BC V0C 1W0
Energy Suppliers					
Yukon Energy Corporation	David Morrison	President and CEO	david.morrison@yec.yk.ca	393-5400	Box 5920, Whitehorse, Yukon Y1A 6S7
Yukon Electrical Company Limited	James Grattan	Manager of Customer Service	James.Grattan@atco.com	633-7000	100 - 1100 1st Avenue Whitehorse Yukon Y1A 3T4
Cdn. Assoc. of Petroleum Producers	n/a	n/a	communication@capp.ca	(403) 267-1100	Ste 2100, 350 7th Ave. S.W. Calgary, Alberta T2P 3N9
Yukon Chamber of Mines	Joanne Hainer	Executive Officer	jhainer@ycmines.ca	667-2090	3151 B - 3rd Avenue Whitehorse, Yukon Y1A 1G1
Solterra Energy Services	Bill Kendrick	Owner	kendrick@yknet.ca	668-7119	Box 3957 Whitehorse Yukon Y1A 5M6
Lessoway Moir Partners	Lee Fleming	P. Eng.	joym@lmp.ca	393-2905	107A Copper Road Whitehorse, Yukon Y1A 2Z7
Boards					
Yukon Council Economy/Environment	Mike Connor	Secretariat (Environment)	ycee@gov.yk.ca	667-5634	Box 2703, Whitehorse, Yukon Y!A 2C8
Yukon Minerals Advisory Board	Gordon Moffatt	Secretariat (EMR)	gordon.moffatt@gov.yk.ca	667-8861	Box 2703, Whitehorse, Yukon Y!A 2C9
Regulators					
Yukon Utilities Board	Deana Lemke	Executive Secretary	yub@northwestel.net	667-5058	Box 31728 Whitehorse, Yukon Y1A 6L3
Yukon Water Board	Judi White	Manager	ywb@yukonwaterboard.ca	456-3980	106-419 Range Road Whitehorse, Yukon Y1A 3V1

Energy Regulation

The supply and (to a lesser extent) the consumption of energy in the Yukon is regulated under a variety of statutes and regulations. In consequence, energy regulation will be an important aspect in the development of a Yukon Energy Strategy. 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 Regulation	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, Indian 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 Highway 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 and Thorium Mining Regulations*	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 Branch
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

Trending Issues in the Energy Sector

On the basis of an evaluation of the findings of Parts 1, 2 and 3 of the project, this section identifies energy issues which appear be surfacing (or trending) in the jurisdictions examined.

A "traditional" energy strategy could be characterized as having three main elements, with varying weights placed on each element:

1. adequate and reliable supply of energy;
2. stable and reasonable energy prices; and,
3. environmental sustainability.

On the basis of the five energy strategies examined, the focus has clearly shifted towards the third element – environmental sustainability. Evidence of the shift in focus can be found in the use of terms and concepts such as *renewable energy*, *energy conservation, alternative energy, greenhouse gas reductions and energy efficiency*, which permeate the strategies examined. The shift in focus is also evidenced in more subtle ways such as variations on a requirement to blend carbon emitting gasoline with biofuels and initiatives to reduce greenhouse gas emissions within traditional energy industries (e.g., oil and gas exploration).

In short, the contemporary energy strategies examined may be characterized as much by what is not contained in them as by what is contained in them. Relatively few words are spent on the concepts of *adequate and reliable supply of energy* and *stable and reasonable energy prices.*

By association, the strategies examined were generally limited in their comprehension of the structural and historical factors that have created the energy circumstances now faced in each jurisdiction. The strategies examined, to a large degree, were focused on tertiary energy uses (or reductions in use), rather than the primary development and production of energy.

Examined together, the strategies and initiatives display a sort of "fractured myopia". All jurisdictions feature their efforts to address the effects of a national and global issue – greenhouse gas emissions and climate change. At the same time, the strategies and initiatives contain little discussion around how jurisdictions can work together to solve some of the supply side issues that contribute to greenhouse gas emissions.

The strategies examined, as well as existing federal initiatives, do seem to recognize that the involvement of communities and First Nations are an important factor in energy planning and implementation. The strategies and initiatives also seem to focus on moving forward with measures that are "doable". For example, portfolio expansions into renewable energy are being lead with tried and true technologies such as wind and biofuels. Governments are committed to leading by example through increased energy efficiency in public buildings and the greening of vehicle fleets. Independent power production from renewable sources is being encouraged with subsidies and federal tax measures.

Yukon Energy Sector Issues

At a general level, the Yukon's current energy circumstances are characterized by three key factors:

1. Energy consumption in the Yukon continues to consist primarily of imported refined petroleum products. At the same time, the Yukon market for refined petroleum products remains far too small to reasonably contemplate, given economies of scale considerations, that energy self-sufficiency can be realized in the near term with current technologies.

2. On April 1, 2003, the Yukon gained full control over the development of its natural resources and sole responsibility for initiating development of the energy infrastructure required to support future resource development. With all existing major pieces of energy infrastructure in the Yukon paid for by the federal government, future resource development hinges on sustained recognition by the Government of Yukon that it is the lead act on the energy infrastructure stage.

3. The existence of significant surplus hydro-electric capacity on the WAF grid since 1998 has created a vapor lock around demand side management (DSM) and energy efficiency initiatives involving electricity. Notwithstanding that Yukon Energy's 20-Year Resource Plan is virtually silent on DSM, the Plan anticipates that the vapor lock is soon to break and goes a long way to addressing how to supply the electricity that will inevitably be needed.

In consideration of the factors described above, and the findings of the background research, it is recommended that a Yukon energy strategy focus on the following issues:

- Energy conservation and efficiency initiatives (including renewable energy) that focus first on reducing energy use from non-renewable sources and later on electrical energy use (as surplus hydro-electric capacity diminishes);
- Community engagement in the management, development and conservation of energy resources in the Yukon;
- Recognition that self-governing First Nations in the Yukon have a statutory role to play in the development of future energy infrastructure in the territory (via the "Strategic Investments" clauses found in Final Agreements involving potential Yukon Development Corporation and Yukon Energy Corporation activities in Traditional Territories);
- Innovation and technology relevant to the Yukon's latitude and energy import circumstances;
- Greenhouse gas reduction initiatives which recognize that two-thirds of the Yukon's greenhouse gas emissions are transportation-sourced;
- Energy infrastructure development as an economic development lever; and,
- Implementation of regulatory regimes (resource management and environmental) that do not unnecessarily encumber future energy infrastructure development efforts.

References

Environment Canada. (2007). *National Inventory Report: Greenhouse Gas Sources and Sinks in Canada 1990 – 2004.*

Fekete Associates Inc. and Vector Research. (2005). *North Yukon Conceptual Oil and Gas Development Scenario.* Prepared for North Yukon Oil and Gas Working Group.

Kishchuk, P. (2003). *Yukon Energy Sector Assessment 2003.* Prepared for Yukon Development Corporation.

National Energy Board. (2005). *Outlook for Electricity Markets*.

Pape, A. and Campbell, B. (1999). *Economic Development from Renewable Energy: Yukon Opportunities.* Pembina Institute for Appropriate Development.

Statistics Canada. (2007). *Energy Statistics Handbook.* Cat. No. 57-601.

Statistics Canada. (2007). *Report on Energy Supply-demand in Canada.* Cat. No. 57-003.

Statistics Canada. (2007). *Supply and Disposition of Refined Petroleum Products in Canada*. Cat. No. 45-004.

Yukon Bureau of Statistics. (2006). *Yukon Energy Facts 2006*.

Yukon Development Corporation. (2002). *The Lure and Lore of Wood*.

Yukon Development Corporation. (2001). *The Power of Water*.

Yukon Development Corporation. (2001). *The Winds of Change*.

Yukon Economic Development. (1997). *Yukon Energy Resources: Hydro, Oil and Gas, Coal, Wind, Wood, Alternatives* (six-part series).

Yukon Economic Development. (2006). *Yukon Economic Outlook 2006*.

Yukon Energy Corporation. (2007). *Yukon Energy Corporation 2006 Annual Report.*

Yukon Energy, Mines and Resources. (2005). *Yukon Oil and Gas: A Northern Investment Opportunity.*

Yukon Energy, Mines and Resources. (2006). *Yukon Oil and Gas: A Northern Investment Opportunity 2006 Updates.*

Yukon Energy Corporation. (2006). *20-Year Resource Plan: 2006-2025.* Submission to the Yukon Utilities Board.

Yukon Executive Council Office. (2005). Permit / Authorization Guide for Activities in the Yukon. Development Assessment Branch.