

Yukon Energy Use Analysis

DRAFT

Submitted to:

Yukon Development Corporation
206A Lowe Street
Whitehorse, Yukon
Y1A 1W6

Prepared by:

Paul Kishchuk, MA

Vector Research

Box 31126 Whitehorse, Yukon Y1A 5P7
paul@vectorresearch.ca
tel. 867.668.3164

May 24, 2004

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I. Preface

The continued development of made-in-Yukon energy solutions requires an expanded and improved understanding of Yukon energy use patterns. While the availability and quality of data which describe energy uses in the Yukon have been increasing in recent years, a comprehensive portrait of Yukon's energy market from a use perspective has not yet been formulated. Accordingly, the purpose of this project is to attempt to begin to fill the Yukon's energy use knowledge gap by summarizing the energy-use results of recently undertaken surveys. The surveys include:

- *Yukon Business Survey (2003)*
- *Survey of Household Expenditures (2001)*
- *Community Housing Survey (1999-2000)*
- *Residential Energy End-use Survey (2001)*
- *Off-grid Residential Energy Use Survey (2003)*

2. Energy Use Grid

As part of the work to formulate an energy-use question in the 2003 Yukon Business Survey an energy use grid was laid out (Table 1). The grid matches seven forms of energy with seven sectors of use. The seven categories of energy sources include: a) gasoline, b) diesel, c) aviation fuel, d) stove/furnace oil (used for space heating), e) propane, f) electricity and g) other. The other category includes fuels in the form of wood, waste oil, solar, geothermal and coal.

The seven sectors of use include: 1) residential, 2) commercial/industrial (goods), 3) commercial/industrial (services), 4) utilities, 5) transportation, 6) institutional, and 7) government. Note that the commercial/industrial (goods) sector includes the agriculture and forestry sub-sectors, the utilities sector includes telecommunications and electricity generation/transmission/distribution and the institutional sector includes hospitals, schools, post-secondary education institutions, seniors residences, etc.

The volumes of each energy source used in the different sectors are calculated using various units of measure. When comparing energy use across sectors for the same form of energy (e.g., electricity consumption in the residential versus the institutional sector) the unit of measure is the same (kilowatt hours). When energy use volumes for different forms of energy are calculated, however, mismatched units of measure prevent accurate comparisons. For example, the number of litres of furnace oil used for space heating cannot be added to the number of kilowatt hours of electricity used for space heating to arrive at a total amount of energy used for space heating in the Yukon.

Table 1: Yukon Energy Use Grid

| Energy Form | Sector of Use ¹ | | | | | | |
|---|----------------------------|--|---------------------------------------|------------------------|----------------|----------------------------|------------|
| | Residential | Commercial/ Industrial: Goods ² | Commercial/ Industrial: Service | Utilities ³ | Transportation | Institutional ⁴ | Government |
| GASOLINE | | | | | | | |
| DIESEL | | | | | | | |
| AVIATION FUEL | | | | | | | |
| STOVE/FURNACE OIL (space heating) | | | | | | | |
| PROPANE | | | | | | | |
| ELECTRICITY | | | | | | | |
| OTHER ⁵ | | | | | | | |

Notes:

- (1) Unit of measure is petajoules.
- (2) Commercial/Industrial: Goods Sector includes agriculture and forestry sub-sectors.
- (3) Utilities includes telecommunications and electricity generation/transmission/distribution.
- (4) Institutional sector includes hospitals, schools, post-secondary education institutions, seniors residences, etc.
- (5) "Other" fuel types include wood, waste oil, solar, geothermal and coal.

To get around the problem of incompatibility between different units of measure, volumes of energy sources are converted to a common unit of measure – the joule. Because the joule is a common unit of measure, it can be described in different ways. For example, 4.2 joules of energy are needed to raise the temperature of 1 g of water by 1 °C. Alternatively, a joule is equivalent to one watt of power produced or used for one second. Thus, 60 joules of energy would be used by a 60-watt light bulb lit for one second. Or, joules can be thought of in terms of British thermal units (Btu’s). One Btu is equal to 1,055 joules, the approximate amount of energy in one match tip. Joules are often expressed in the form of Petajoules (1 Petajoule = 1 x 10¹⁵ joules).

Note that for each sector of use, the total amount of energy used can be broken down according to the type of use. Table 2 presents a type of use classification developed by Natural Resources Canada.

Table 2: Types of Energy Use

| | |
|---|------------------------------|
| residential sector | commercial sector |
| . space heating | . space heating |
| . space cooling | . space cooling |
| . appliances | . water heating |
| . lighting | . auxiliary equipment |
| . water heating | . auxiliary motors |
| | . lighting (incl. street) |
| | |
| industrial sector | transportation sector |
| . mining | . small cars |
| . pulp and paper | . large cars |
| . iron and steel | . pass. Light trucks |
| . smelting/refining | . freight light trucks |
| . cement | . medium trucks |
| . chemicals | . heavy trucks |
| . petroleum refining | . motorcycles |
| . other manufact. | . School bus |
| . forestry | . urban transit |
| . construction | . inter-city bus |
| | . air |
| | . passenger rail |
| | . freight rail |
| | . marine |
| | . off-road |
| Source: adapted from <i>Energy Use Data Handbook, 1990 and 1995 to 2001</i> , Natural Resources Canada, 2003. | |

3. Survey Descriptions

Yukon Business Survey

The Yukon Business Survey is a census-type survey of business owners in the Yukon. The survey is well established, having been conducted by the Yukon Bureau of Statistics in seven of the last eleven years (most recently in 2003). The survey is framed according to the North American Industry Classification System (NAICS). Each running of the *Yukon Business Survey* has included a standard series of questions, the results of which have been used to compile a business directory and to profile the operations of Yukon businesses. A variety of additional questions have been included in each running of the survey, on a fee-for-service basis.

The questions shown below were included as an additional question in the 2003 running of the Yukon Business Survey:

For many Yukon businesses energy costs are a significant part of the cost of doing business in the Yukon. We would like to have a better understanding of the significance of this cost and the types of energy used in the day-to-day running of your business.

26. What were your total energy expenditures for your most recent fiscal year?

\$ _____

26a. Of this expenditure, what percent was spent on:

electricity: ____%

stove/furnace oil: ____%

propane: ____%

wood: ____%

diesel: ____%

gasoline: ____%

aviation gas: ____%

other: ____% (*please specify*): _____

No direct costs - included in lease/rent

Survey of Household Spending

The Survey of Household Spending is a sample-based survey of the dwelling characteristics, household equipment and spending habits of private Canadian households. The survey is carried out by Statistics Canada in all ten provinces and three territories. Personal interviews are used to collect the data. As the Survey of Household Spending is conducted in the north only every second year (in order to reduce response burden for northern households) the most recent data available for the Yukon relates to the 2001 reference year.

As described in Statistics Canada's *User Guide: Survey of Household Spending 2001* survey respondents were asked about the following in the most recent running of the survey in the Yukon:

Dwelling characteristics and household equipment

Principal heating equipment - the type of heating equipment chiefly used to heat the dwelling in winter (e.g., steam or hot water furnaces, forced hot air furnaces, other hot air furnaces, heating stoves, electric heating and other heating).

Principal heating fuel - the principal winter fuel used in the principal heating equipment is given here (e.g., oil or other liquid fuel, piped or bottled gas, electricity, wood or other fuels).

Principal heating fuel for hot water - the type of fuel used for the running hot water supply (e.g., oil or other liquid fuel, piped gas, electricity or other fuels such as bottled gas or wood).

Principal cooking fuel - the main fuel for the range or stove on which the household does most of the cooking (e.g., piped gas, electricity or other cooking fuels). "Other" includes oil or other liquid fuel, bottled gas and wood.

Spending habits

In 2001, how much did your household spend on?:

- a) fuel for principal accommodation (e.g., oil, gas, propane, wood)
- b) electricity for principal accommodation

Community Housing Survey

During the fall and winter of 1999-2000, the Yukon Housing Corporation undertook a sample-based survey of householders in all Yukon communities except for Old Crow, Pelly Crossing and Faro. The face-to-face survey, administered by the Northern Research Institute, gathered data on dwelling adequacy, affordability and suitability with a focus on the condition of housing in the Yukon at the community level. The following energy-use related questions were asked as part of the Community Housing Survey:

- 11. What type of fuel do you use most to heat the dwelling?
 - 11.1 Do you prefer using this fuel most of the time to heat your dwelling?
 - 11.2 If no, what type of heating fuel would you prefer to use most of the time?
 - 11.3 Why would you prefer to use this type of fuel most of the time?
- 12. What other fuel is used for heating the dwelling?
- 13. What type of heating system is used most of the time?
- 14. What other heating sources are used in this dwelling?
- 15. How much do you pay for heat, not including electrical heat, per year?
- 23. Do you have electricity in your dwelling?
 - 23.1 If yes, what is the source of the electricity?
- 32. How much do you pay for electricity for your dwelling per year? (owners)
- 36. How much do you pay for electricity for this dwelling per year? (renters)

Residential Energy End-Use Survey

Designed as a supplement to the Yukon Housing Corporation's Community Housing Survey, the Residential Energy End Use Survey was commissioned by the Energy Solutions Centre and implemented by the Yukon Bureau of Statistics in June 2001. Through telephone interviews with 719 randomly selected households in all Yukon communities, the survey gathered data on housing characteristics, heating equipment, appliances, lighting, hot water heating and vehicle plug-ins. The focus of the survey was on electricity use. The following key energy-use related questions were asked as part of the Residential Energy End Use Survey:

3. Who pays the electric bill for this dwelling?
4. Who pays the heating bill for this dwelling?
5. Do you heat in part or solely with fuel oil?
If yes - how old is your oil fired furnace or boiler? _____yrs
6. Does your furnace or boiler have a high efficiency burner (e.g. Riello)?
7. Do you have a propane fired furnace or boiler?
If yes - how old is it? _____ yrs
If yes, is it high efficiency?
8. Do you have your furnace/boiler serviced/tuned-up on an annual basis?

Off-grid Residential Energy Use Survey

The Off-Grid Residential Energy Use Survey was a census-type survey commissioned by the Energy Solutions Centre and carried out by the Yukon Bureau of Statistics in the winter of 2003. Through telephone interviews with 254 householders with dwellings (houses, cabins) located off the electrical grid, the survey collected data on space heating, lighting, appliances and small-scale electricity generation (generators, solar, wind and micro-hydro). The following key energy-use related questions were asked as part of the Off-Grid Residential Energy Use Survey:

12. what energy source do you use for cooking?
13. is your cooking appliance also used for heating?
14. what kinds of heating systems are in place (wood stove; boiler and hot water radiators; furnace and hot air system; free-standing or monitor-type; electric baseboard; other)?`
15. which heating system is used most often?
16. which light sources are used for lighting this dwelling?
17. which light source is used most often?
18. where do you get your water?
i) what energy source do you use for pumping water?
19. what system do you use most to heat water?
i) what fuel or energy source do you use for heating domestic hot water?
20. which appliances do you use (fridge, dishwasher, freezer, clothes washing machine, clothes dryer)?
i) what fuel/energy source is used to power each appliance?
21. what small electrical appliances do you have?
- 21a. what tools or equipment do you operate (related to your commercial operations or to hobbies)?
22. do you have a telephone or radio-telephone?
i) if yes, how do you power it and recharge batteries?

4. Survey Results and Findings

Section 2 of this paper presented an energy use grid for the Yukon and section 3 described five recently-completed surveys which included energy-related questions. This section of the paper looks at the extent to which the energy use information gathered through the five surveys can be used to begin to paint a comprehensive portrait of Yukon's energy market from a use perspective.

Yukon Business Survey

Of the five surveys considered in this analysis, the Yukon Business Survey is the most comprehensive in terms of the number of sectors which the data collected might potentially describe energy use in the Yukon. Because the survey is framed according to the North American Industry Classification System (NAICS), individual survey responses can easily be grouped into broad industry categories including commercial/industrial (goods), commercial/industrial (services), utilities and institutional.

The Yukon Business Survey is by design a census-type survey. This means that attempts were made to contact all firms known to have been operating (on the basis of business license registrations) during the reference period for the survey. An advantage of the census approach to survey design is that with a high response rate, the reliability of the data collected is correspondingly high. A disadvantage of a census approach to survey design is that when the response rate is low, the survey responses cannot be accurately "grossed-up" using the responses received since they may not be representative of the total survey population.

A total of 2,204 firms responded to the 2003 Yukon Business Survey. Unfortunately, the number of firms that responded to the first part of the energy use question (1,322) was low producing a response rate of 59 percent. The number of firms which responded to the second part of the question, which asked for a breakdown of energy expenditures by form of energy, was even lower (1,061), producing a response rate of 48 percent. In light of the low response rate and the corresponding potential for inaccurate results, analysis of the survey data which could be used to describe the energy use patterns of Yukon businesses was not undertaken.

Survey of Household Spending

The Survey of Household Spending is one of four surveys considered in this analysis which focuses on the residential sector (the first column in the energy use grid described in section 2). While the design of the survey does not allow for a comprehensive description of energy use in the residential sector (e.g., volumes of energy use by form of energy measured in petajoules), it does provide an indication of

the principal form of energy used for space heating, water heating and cooking. Results, in percentage terms, from the 2001 Survey of Household Expenditures for the Yukon are shown in Table 3.

Table 3: Energy Use Characteristics of Yukon Households

| | |
|---|-------|
| Principal heating equipment | |
| Steam or hot water furnaces | F |
| Forced hot air furnaces | 60.0% |
| Other hot air furnaces | F |
| Heating stoves | 18.2% |
| Electric heating | F |
| Other | F |
| Principal heating fuel | |
| Oil or other liquid fuel | 61.6% |
| Piped gas | F |
| Bottled gas | F |
| Electricity | F |
| Wood | 21.0% |
| Other | F |
| Principal heating fuel for hot water | |
| Oil or other liquid fuel | F |
| Piped gas | F |
| Electricity | 81.4% |
| Other heating fuel or no running hot water | F |
| Principal cooking fuel | |
| Piped gas | F |
| Electricity | 90.6% |
| Other cooking fuel | F |
| Note: F=suppressed; less than 30 households reporting. Source: Statistics Canada, <i>Survey of Household Spending 2001</i> . | |

As its name might suggest, the Survey of Household Expenditures also provides an indication of how much Canadians spent on fuel and electricity for use in their principal residences. Results from the 2001 running of the survey are shown in Table 4.

Table 4: Yukon Household Fuel and Electricity Expenditures

| | |
|--|---------|
| Average household expenditure on fuel | \$1,122 |
| Average household expenditure on electricity | \$1,216 |
| Note: fuel includes oil, gas, propane, wood, etc. Source: Statistics Canada, <i>Survey of Household Spending 2001</i> . | |

Note that the aggregate nature of the data does not allow for the accurate conversion of expenditure data into volumes of energy use (measured in petajoules). With regard to spending on fuel, the absence of a breakdown between different fuel forms (e.g., oil, gas, propane, wood, etc.) means that fuel expenditure cannot be parted out among the different fuel forms, each of which holds a different volume of energy per dollar. And while electricity is a homogeneous energy form, the fact that the effective price of

electricity in the Yukon varies with the amount consumed would limit the accuracy of a conversion from average spending to volumes of energy use.

Community Housing Survey

Comprehensive community-level housing data was collected via the Community Housing Survey is that it provides reliable data at the community level. The near-exclusive focus of the energy-use questions on space heating, however, limits its value in describing overall patterns of energy use in the Yukon. In addition, the survey analyses published by the Yukon Housing Corporation do not present baseline information from the survey (e.g., average annual space heating cost per household). Rather, the published analyses show, for each community surveyed (as well as Yukon-wide), the results of crossing the combined fuel and electricity costs with various dwelling features. The table titles shown below illustrate the nature of the analysis contained in the survey reports prepared for each community which participated in the survey:

- Annual energy cost per square foot
- Annual energy cost Versus dwelling size
- Annual energy cost Versus dwelling type
- Annual energy cost per square foot Versus age of the dwelling
- Annual energy cost Versus dwelling's main window type
- Annual energy cost Versus dwelling's main window pane type
- Annual energy cost Versus dwelling's wall thickness
- Annual energy cost Versus dwelling's main heating fuel
- Annual energy cost Versus dwelling's main heating system
- Annual energy cost Versus heat loss prevention measures
- Percentage of dwellings with an energy related repair need
- Annual energy cost per square foot Versus energy related repair need

Residential Energy End-use Survey

In addition to providing slightly more detailed information on space heating in Yukon homes than can be found in the Survey of Household Expenditures, the Residential End-Use Survey provides a comprehensive illustration of the patterns of electricity use in Yukon households. Survey responses were categorized according to whether the household was located in a community supplied with electricity from either a diesel-fired source or hydro-electric source. Unfortunately, for the purposes of describing energy-use volumes, the Residential Energy End-use Survey is of limited use since it contains no information on the volumes of furnace oil, propane or electricity consumed in Yukon households, either in terms of expenditures or quantities used. Some energy-use findings from the survey are shown in Table 5.

Table 5: Space Heating Fuel Types

| | Hydro community | Diesel community |
|--|-----------------|------------------|
| Percentage of respondents who heat in part or solely with fuel oil | 72.4 | 76.6 |
| Percentage of respondents who have a propane-fired furnace or boiler | 10.3 | 9.1 |
| Source: Energy Solutions Centre, <i>Residential Energy End-use Survey</i> , December 2003. | | |

Off-grid Residential Energy Use Survey

With a focus on households not connected to the Yukon's existing electricity distribution network, the results of the Off-grid Residential Energy Use Survey relate to a very small subset of the residential energy-use sector. Similar to the Residential End-Use Survey, because Off-grid Residential Energy Use survey did not ask questions about the volumes of forms of energy consumed (either in terms of expenditures or quantities used) it is of limited use for outlining total energy use in the residential sector. Some energy-use findings from the survey, based on the responses of the 85 households who indicated that their off-grid dwelling serves as their main residence, are shown in Table 6 below:

Table 6: Off-grid Residential Energy Use (main residences)

| |
|---|
| <ul style="list-style-type: none"> Propane is used for cooking by most (84%). |
| <ul style="list-style-type: none"> Most have a wood stove (84%), and the majority rely on it most for heating (63%). 90% use wood heat of some kind or another. Free standing heaters are second after wood stoves, but much less popular. |
| <ul style="list-style-type: none"> More than 2/3 use AC lights and fixtures for lighting and half rely on them for most of their light. Other popular forms of lights are propane lamps and DC bulbs and fixtures, used by about 30%. |
| <ul style="list-style-type: none"> Pumping water is done more often using 120/240 AC pumps (39%) than by gasoline-powered pumps (30%). |
| <ul style="list-style-type: none"> Propane is the most popular energy source for heating water (62%) followed by wood (40%). Hot water tanks are the most popular hot water heating system, followed by kettles or pots on the stove and in-line demand heaters. |
| Source: Energy Solutions Centre, <i>Off-grid Residential Energy Use Survey</i> , 2003. |

5. Conclusion and Suggestions for Future Work

The purpose of this analysis has been to examine five recently undertaken energy related surveys to assess their usefulness in filling in the Yukon's energy-use knowledge gap. Out of the five, the 2003 Yukon Business Survey held the broadest potential for estimating energy use as it could be applied to several energy use sectors.

Unfortunately, the low response rates specific to the energy-use question contained in the survey precluded any further analysis of the data. The four other surveys all focused on the residential sector. In the absence of survey question which could result in data that could be used to pinpoint energy-use volumes by form of energy, all are of limited

use in estimating energy use in the Yukon. Accordingly, it is the conclusion of this analysis that the survey data collected to date is of limited use in estimating energy use volumes in the Yukon.

Should there be further interest in assessing Yukon energy use volumes it is suggested that the scope of the analysis be expanded to look beyond survey data to include administrative data such as:

- the Public Buildings Energy Tracking System (PBETS) database maintained by the Energy Solution Centre
- tax collection reports generated via administration of the *Fuel Oil Tax Act* by the Department of Finance
- internal Yukon Energy sales reports