Community Energy Plan

Town of Faro, YT

Prepared for

Town of Faro and Government of Yukon, Department of Energy, Mines and Resources, Energy Solutions Centre

Prepared by

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The Pembina Institute

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PEMBINA institute

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Pembina's Community Services group is a not-for profit consultancy on a mission to help communities advance sustainable energy solutions. Our staff's commitment and Pembina's mission create an innovative and unique approach to helping communities reduce greenhouse gas emissions, create energy plans that are sustainable and meet governance obligations. We strive to act as a bridge between a diverse set of stakeholders through identifying common solutions.

Cover image: Erica Ward

Community Energy Plan

Town of Faro, YT

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Executive summary

The Town of Faro (62° 13’ 59”N, 133° 19’ 59” W) is located in south central Yukon, Canada, along the Pelly River, 365 km northeast of Whitehorse on the Campbell Highway. Its 185 occupied dwellings provide home to 372 year-round inhabitants.

An energy and emissions inventory was established for the year 2012 based on a variety of sources. A community energy survey, completed by 21% of households, provided basic information on residential energy costs, transportation and home energy systems. Data on energy use in municipal buildings and fleet was provided by the Town of Faro, while data on energy use by territorial buildings was provided by the Yukon Government’s Energy Solutions Centre. Electricity consumption by residential and commercial customers was obtained from Yukon Energy data, but no data was available on fossil fuel or wood burning in the commercial sector; this is a gap in this inventory.

From this analysis, a portrait of energy use in Faro emerges. In 2012, the community as a whole used an estimated total of 21,959 MWh of energy. Of this, 36% is used for transportation (2% for municipal fleet, 34% for private vehicles), 38% in residential buildings, 10% in municipal facilities, 12% in territorial buildings, and 4% for electricity use by the commercial sector. 30% of the energy used in the community comes from the combustion of fuel oil, 22% from electricity, 12% from wood, 25% from gasoline, 10% from diesel used for transportation, and 1% from propane.

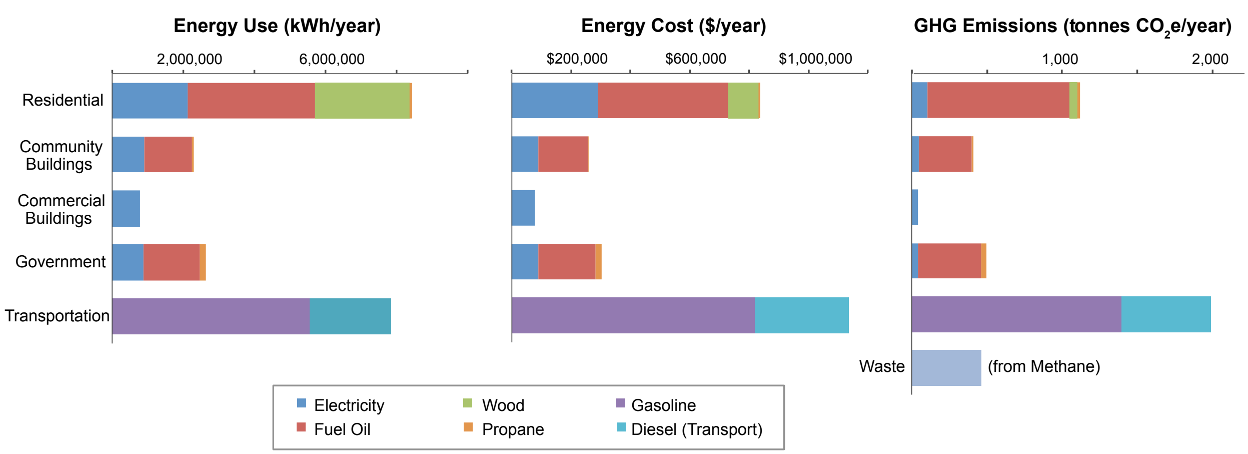

Figure 1 Annual energy use, energy cost, and emissions by source and sector

In 2012, the community as a whole spent $2.6 million to purchase energy. On average, a Faro household spends about $5,750 per year on vehicle fuel and $4,500 to heat and power their home, for a community-wide total of $1.9 million. Powering and heating the municipality’s buildings and fleet costs over $350,000 per year. The municipal buildings with highest energy use are the recreation centre and the arena (costing ~$78,000 and $48,000 per year respectively). The four pump houses are also significant energy users, costing over $100,000 per year — about half of which is spent to pump water throughout town, while the other half is spent on heating the pump houses themselves. Fueling the municipal fleet cost $66,000 in 2012. Total energy cost for the six territorial buildings, which includes the school, nursing station and liquor store, is about $320,000 per year. The Del van Gorder/Yukon College building accounts for about half of that energy use.

The combustion of fossil fuel to power vehicles, heat buildings, and produce electricity results in the emissions of greenhouses gases (GHGs), which contribute to global warming. The total GHG emissions in the community of Faro in 2012 are estimated at 4,506 tonnes of carbon dioxide equivalents (CO_2e). Almost half of these emissions come from transportation (42% from residents, 2% from municipal fleet), a quarter comes from residential buildings, and the last quarter is roughly equally divided between territorial building, municipal buildings, and landfill emissions (eleven, nine and ten percent of total emissions, respectively). Furnace oil, used for heating buildings, accounts for 38% of all emissions, while gasoline and transportation diesel account for a further 31% and 13% of emissions respectively. Wood, while providing 11% of the total energy use for the community, contributes only 1% to the total GHG emissions. Similarly, since most of the electricity generated in the Yukon comes from hydroelectric dams, the GHG footprint of electricity is low: in Faro, electricity accounts for 20% of energy use and 5% of emissions. Faro households, on average, are directly responsible for 10 tonnes CO_2e per year for transportation, and 6 tonnes CO_2e per year for home heating and appliances.

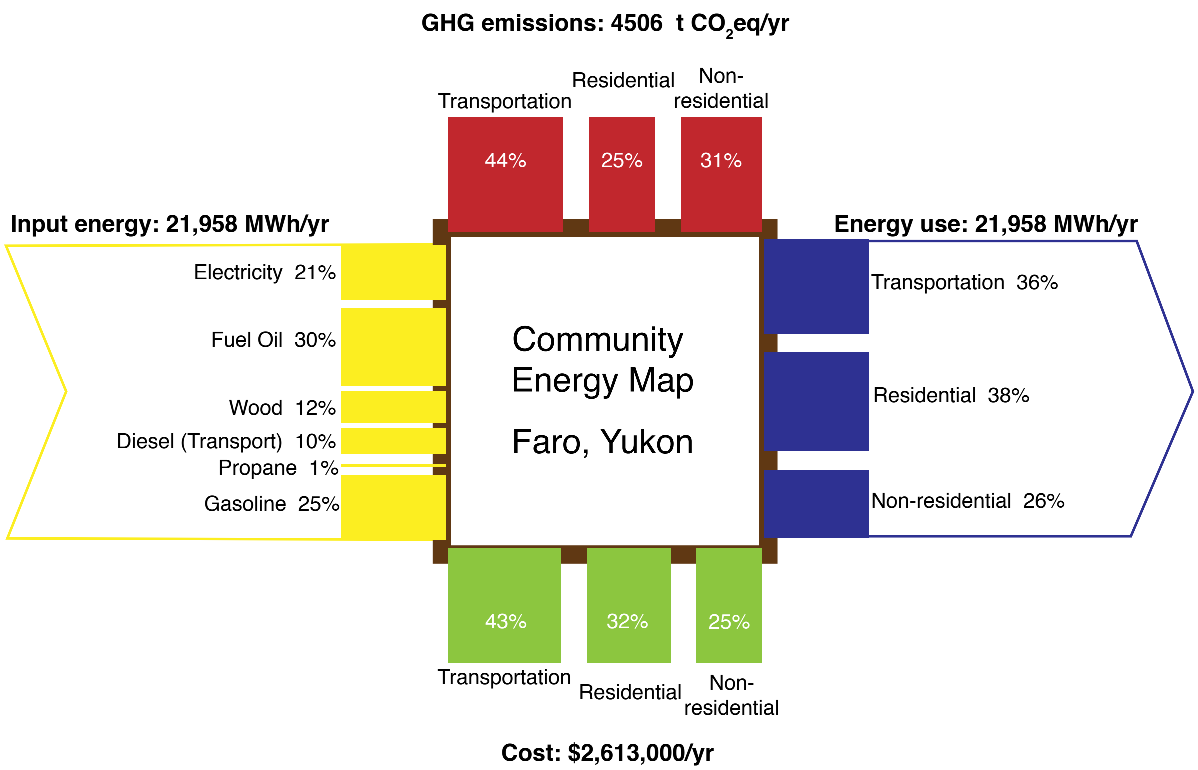

Figure 2 Faro community energy map, 2012

There are several opportunities in Faro to reduce energy demand, use energy more effectively, and switch to cleaner fuels, both in the community and in municipal operations. These opportunities were discussed in the community energy workshop, and several suggestions have been made in this report. The three main recommendations at the community level are:

1. **Promote the use of wood as heating fuel.** Promote rebate programs available for the purchase of high-efficiency wood stoves, and facilitate a community conversation on how to ensure local supply of wood, including the possible creation of a wood co-op.
2. **Convene a community dialogue on transportation.** Energy used to travel to Whitehorse and for in-town commuting could be reduced through car pooling, shared shopping list, shuttles, active transportation, vehicle sharing, or a focus on strengthening local suppliers through a farmers' market and other means.
3. **Partner with Energy Solutions Centre and the territories utilities to roll out demand side management programs and promote energy conservation in the community.** This could include providing information to citizens, volunteering to run pilot programs, partnering with local businesses, and promoting behavior changes that save on energy bills while costing very little.

Key recommendations to lead by example and reduce energy use in municipal and territorial buildings include**:**

Conduct a weather-stripping walkthrough of all major buildings to capture opportunities for low-cost actions that yield high energy saving returns.

Conduct energy audits with site visits on the top four or five most energy-intensive municipal buildings, which are the recreation centre, the arena, the pump houses, the administration building and the firehall.

Conduct an energy audit on the Del van Gorder School. This territorial government building accounts for almost 8% of the total energy use in the community. Involving the Faro school and the Yukon College students in the process could provide a unique opportunity for community engagement on energy issues.

Conduct an energy audit on the Faro nursing station. The nursing station is the second largest energy user of the territorial buildings in the town. As the primary health center in the community, it also offers opportunities to educate the population about environmental health, and the health risks of poorly performing buildings.

In addition to these measures, it is paramount that the Town of Faro, as well as the territorial government, continue to measure and monitor energy use by public assets, as well as in the community at large. To this end, we recommend that the Town of Faro staff:

Provide a yearly report to council on energy use by building and fleet, and continue to build on its current effort in tracking building and vehicle energy use.

Reconvene the Energy Champion group three to four times a year to monitor progress and discuss ways to engage with the community on these matters.

We encourage the territorial government to:

Continue to develop and maintain the Public Building Energy Tracker database (PBET), which is a useful tool to track public assets across the territory. They should also incorporate the municipal assets of the Town into the tracker and incorporate the assets of other Yukon municipalities and First Nations where possible. Yukon government should consider providing training and capacity building support for its adoption.

Develop a protocol to update the energy and emissions survey every two or three years, so that the evolution of community energy use can be monitored over time. This will allow municipal and territorial government to measure the effectiveness of programs and continuously adapt to a changing energy reality.

Advancing these recommendations will require the support of the territorial government and its agencies, the electricity utilities, and municipal staff. The federal gas tax is one source of funding which can be accessed to finance some of these recommendations. Faro's overall allocation to December 31, 2014 is $1,424,820, based on a yearly allocation of $219,198. With $519,005 in approved projects as of Spring 2013, Faro has a balance of $905,815 available for further projects.

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- The Government of Yukon Energy Solutions Centre
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  - Tom Lie, Town of Faro CAO (steering committee)
  - Ryan Hennessey, Energy Solutions Centre (steering committee)
  - Inge Kvemo, Resident, Town of Faro
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1. Introduction

1.1 Local context

The Town of Faro (62° 13' 59"N, 133° 19' 59" W) is located in south central Yukon, Canada, along the Pelly River, 365 km northeast of Whitehorse on the Campbell Highway. It is home to 372 year-round inhabitants[1] (as of 2012) and a number of seasonal residents. Surrounded by pristine wilderness in the heart of the Pelly Mountains, Faro offers residents and visitors a variety of activities including camping, canoeing, cross country skiing, bird and wildlife viewing, fishing, gold panning, golfing, hiking, rock hounding, nature walks, photography, sledding, swimming, snowboarding, snowshoeing and snowmobiling.

The town was home to the largest open pit lead–zinc mine in the world until the closure of the mine in 1998. The town population decreased significantly as a result, going from 1,261 in the 1996 census to 313 at the 2001 census.[2] There are 185 occupied dwellings in the community, and 179 vacant units owned by Faro Real Estate.[3] The mine is currently abandoned and being reclaimed at public expense; while the reclamation process employs a few residents, it is not a significant contributor to the local economy.

The community is currently updating its Official Community Plan, as well as its Integrated Community Sustainability Plan (ICSP). As part of this process, community workshops were led to create a shared vision of the future of the town, including some goals regarding its infrastructure and energy systems:

> ***Goal: Faro's infrastructure systems meet the needs of the community, contribute to quality of life and the economy, and are convenient, safe, affordable, reliable and renewable.***
>
> ***Description of success: Faro's energy system is transitioning to a more local and renewable energy system that supplies reliable power to the town, and in the event of outages, power is quickly restored.***

This Community Energy Plan was commissioned to support these objectives and inform the ICSP.

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[1] Yukon Bureau of Statistics, Population Report June 2012 (updated) Information sheet no. 58.41 - Nov 2012. http://www.eco.gov.yk.ca/stats/pdf/populationJun(r)_2012.pdf

[2] Statistics Canada, Profile of Census Divisions and Subdivisions, 1996 Census http://www12.statcan.ca/english/census96/data/profiles/Rp-eng.cfm?TABID=1&LANG=E&APATH=3&DETAIL=0&DIM=0&FL=A&FREE=0&GC=00&GID=205307&GK=1&GRP=1&PID=35782&PRID=0&PTYPE=3&S=0&SHOWALL=0&SUB=0&Temporal=1996&THEME=34&VID=0&VNAMEE=&VNAMEF=&D1=0&D2=0&D3=0&D4=0&D5=0&D6=0 ; Statistics Canada, Profile of Census Divisions and Subdivisions, 2006 Census http://www12.statcan.gc.ca/census-recensement/2006/dp-pd/prof/92-591/details/Page.cfm?Lang=E&Geo1=CSD&Code1=6001004&Geo2=PR&Code2=60&Data=Count&SearchText=faro&SearchType=Begins&SearchPR=01&B1=All&Custom=

[3] Town of Faro tax roll data, 2012

1.2 What is energy planning?

Community energy planning is a process that accounts for the impact of energy supply and demand on the community, including the cost of the energy and the greenhouse gas pollution resulting from its use. The initial phase of a community energy plan generally includes an energy and emissions baseline report examining the current and future energy consumption patterns for the community and/or for municipal operations.

The goal of a community energy plan is to help a community identify ways that it can reduce its dependence on fossil fuel by using less energy and investing in cleaner sources of energy.

1.3 Why is it important?

There are many benefits to taking action to reduce non-renewable energy use and GHG emissions, as well as costs to not taking action.

Economic benefits

- Lowering energy costs to businesses and residents for transportation/mobility, infrastructure, heating, lighting and cooling.
- Creating new revenue streams from local energy production and supporting local jobs while keeping money in the community by focusing on local energy efficiency projects.
- Improving fiscal sustainability of municipal infrastructure so that revenue streams can be used for more valuable activities.
- Creating opportunities to support the community's economic development programs.

Social benefits

- Improving outdoor and indoor air quality and reducing health costs and impacts.
- Creating more comfortable and affordable homes that are resistant to temperature variations and external noise.
- Improving physical health through promoting active travel like walking and biking.
- Creating more complete neighbourhoods, facilitating social interaction and greater well being.
- Creating an age-friendly community.

Costs of inaction

There are opportunity costs and risks associated with keeping energy demand at current levels. These include:

- Risk of increases in energy costs, putting more financial stress on the community
- Risk of disruption in supply, either due to local disruption (damaged roads, grids outages) or global shortages
- Risks to local air, water, and soil due to fuel spills and emissions of air pollutants

In addition to the risks associated to the disruption or increase cost of energy supply, governments around the world are working on reducing GHG emissions because the impacts of human-made climate change are likely to be severe if we do not take action. Globally, the impacts of climate change in the future if GHG emissions continue to grow include[4]:

- water shortages for over one billion people;
- food shortages for hundreds of millions of people;
- hundreds of millions of people permanently displaced;
- the extinction of up to 40% of species;
- more expensive and extreme weather events; and
- a permanent loss of quality of life of up to 20% of GDP worldwide.

In Canada, northern communities have been and will continue to be most severely impacted by climate change. Direct impacts for the Yukon include higher temperatures year round, melting of permafrost, increased winter precipitations, and more extreme weather events such as severe storms, floods, and droughts.[5] Local ecosystems will change faster than ever before and there will be a significant loss of endemic species.

Indirectly, the Yukon could also face the consequences of international economic and social disruptions due to major changes to the global agricultural industry and other disruption to international trade and security, caused by changes in the hydrological cycle, heat waves, increase in storms, droughts and unusual weather.[6]

1.4 Structure of this report

This Community Energy Plan is divided in four chapters and four Appendices:

- Chapter 1 provides local context and background on energy planning.
- Chapter 2 presents the results of the inventory, including energy use, cost, and resulting GHG emissions.
- Chapter 3 discusses actions at the community, municipal, and territorial level to reduce energy demand and emissions.
- Chapter 4 summarizes key recommendations for action.
- Appendix A discusses in further detail the methodology used for the inventory.
- Appendix B provides more information on the method used to estimate of energy use by Faro households.
- Appendix C shows the community energy survey.

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[4] Jesse Row, et. al. *Edmonton's Energy Transition Discussion Paper – Appendix A* (Pembina Institute, 2012)

[5] Environment Yukon, "Impacts of Climate Change." http://www.env.gov.yk.ca/air-water-waste/physicalimpacts.php

[6] N. Stern, *Stern Review Report on the Economics of Climate Change*, 2006.

2. Community energy and emissions inventory (2012)

2.1 Summary of scope and methodology

The development of community energy and emission inventories follows principles akin to those of the finance sector to ensure accurate accounting and reporting. These six principles were used to guide the development of a methodology for the Faro inventory:[7]

- Consistency: develop a methodology that is consistent in order to allow comparison over several years.
- Transparency: disclose relevant assumptions, data sources, and calculation methods to provide a clear trail for anyone aiming to replicate the calculations.
- Accuracy: the quantification of greenhouse gas emissions and energy use should not systematically over- or underestimate the actual values.
- Relevance: the inventory should be organized to reflect the areas in which local government and communities exert control, in such a way to facilitate decision-making and action.
- Completeness: attempt to account for all greenhouse gases sources within the chosen scope, and explicitly disclose any exclusion.

This inventory aims to covers most energy uses and greenhouse gas (GHG) emissions generated within the city limits of the Town of Faro. The inventory methodology used for evaluation energy consumption and GHG emitted by the community of Faro is provided in Appendix A and Appendix B. Emissions from fuel use at stationary sources (e.g., buildings and infrastructures) include residential, commercial, and governmental/institutional users. The energy use associated with the reclamation of the mine was left out of scope since the mine is outside town boundary and does not significantly contribute to the local economy. When considering stationary sources, we include emissions generated on site by the combustion of fuels (wood, heating oil, propane) as well as emissions resulting from electricity generation. We do not include, however, the emission and energy used in delivering combustible fuels to Faro.

From the transportation sector, we include both on- and off-road vehicles for residential use. Due to a lack of data, we have not included commercial transportation in this inventory. We also have not included emissions from air transportation. This is in part due to the difficulty of accessing data on fuel use by air traffic to Faro (or number and distance of trips), and in part due to the lack of local capacity to reduce the demand for air travel. While energy use and emissions from planes can be significant, the steering group considered that the opportunities to reduce in that sector were mostly out of the jurisdiction of the Town of Faro, and deemed that it would be

[7] These principles are based on the International Local Government GHG Emissions Analysis Protocol (ICLEI 2009). http://archive.iclei.org/index.php?id=ghgprotocol

preferable to focus the inventory on areas where residents and municipality can most realistically facilitate reductions.

Three direct sources of data were used to compile this inventory: electricity sales data, as compiled by Yukon Energy Corporation (YEC); energy purchases by the Town of Faro, as compiled by its finance department; and energy purchases by territorial buildings, as compiled in the Yukon government's Public Building Energy Tracker (PBET) database.

In addition to these sources, we sent out a community energy survey (see Appendix C). The survey was mailed to all households in the community twice over a period of three weeks, and an online version was made available on the city website, Facebook page, and in the community newsletter. Twenty-seven residents filled the survey online, and 11 filled out the paper survey, representing a return rate of 38 households out of 185, or 21% of the community. Data was also gathered through conversation with Faro CAO and with the Energy Champions, community members who provided local knowledge to guide the energy planning process. Table 1 summarizes the source of information for the different sectors and energy end uses.

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Table 1 Data sources for the energy and emissions inventory, by end use and sector

End use	Sector	Data type	Data source
Buildings	Residential	Number of buildings and building types	Sewage and water billing data, Town of Faro
		Electricity consumption	Billing data, Yukon Energy
		Fuel oil, wood, propane use	Community survey (estimate)
		Energy end uses	Estimates from archetype models 2010
	Commercial	Electricity consumption	Billing data, Yukon Energy
		Fuel oil, wood, propane consumption	No data available
	Municipal	Building by building electricity, fuel oil, and propane consumption	Town of Faro finance department
	Territorial	Building by building electricity, fuel oil, and propane consumption	PBET database (some data missing)
Transportation	Residential	Fuel use	Community survey (estimate)
	Commercial	Fuel use or purchase	No data available
	Municipal	Fuel purchase	Town of Faro finance department
	Territorial	Fuel use or purchase	No data available
Municipal waste	Community-wide	Total tonnage	Estimate for 2002 and 2012,Town of Faro

2.2 Energy costs

The cost of heating fuels in the Yukon has seen a steady increase in the last fifteen years (Figure 3). The cost of electricity, on the other hand, has been regulated, and kept stable, through electrical rebates offered by Yukon government, since 1999. This is now changing as Yukon Energy got approval from the Yukon Utilities Board for a rate increase of 11.01% over two years.[8] Compared to the YEC electricity rates before July 2012 (before the rate increases began), Yukoners are paying 15.6% more for their electricity as of July 1st, 2013. Without the interim electrical rebate this would be 36.1% more. [9]

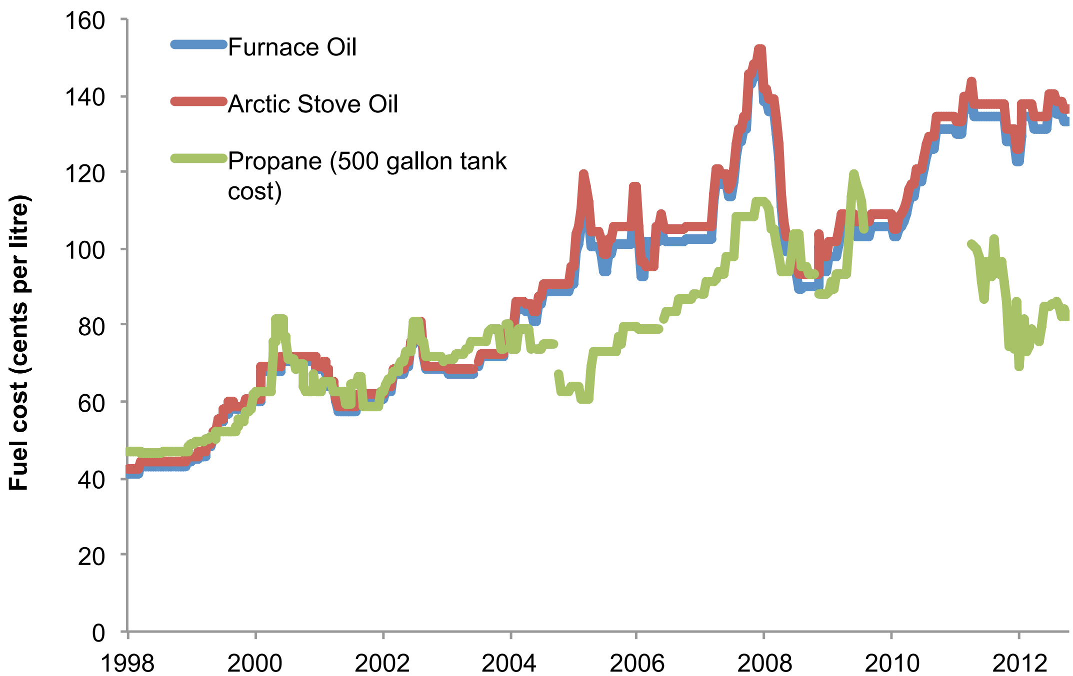

Figure 3 Heating fuel prices for the Town of Faro, 1998–2013

Data source: Yukon Department of Energy, Mines and Resources

Table 2 presents the 2012 annual average prices for residential and transportation fuels in Faro. Unless cost data is explicitly available (e.g. for municipal and territorial buildings), these are the values that were used to estimate total energy costs.

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[8] An increase of 6.4% was effective July 1, 2012, and the full 11.01% increase will come into effect July 1, 2013. Yukon Energy Blog, "The latest utilities board decision and what it means for you", Monday June 24 2013. http://blog.yukonenergy.ca/blog/the_latest_utilities_board_decision_and_what_it_means_for_you/

[9] *ibid*. Based on an average consumption of 1,000 kWh per month, the cost before July of 2012 would have been $118.26 (including the Interim Electrical Rebate, a credit of $26.60). As of July 1st 2013, the cost of 1,000 kWh of electricity is $136.76 (a 15.6% increased compared to before July 2012). If the Interim Electrical Rebate was removed (adding another ~$26.60) the increase would be 36.1%.

Table 2 Average energy prices, 2012

Fuel	Average price	
Fuel oil	$1.320 /L	
Propane	$0.849 /L	
Gasoline	$1.435 / L	
Diesel	$1.484 / L	
Wood – purchased	$275 / cord plus $50-$100 splitting fee	
Wood – average cost[10]	$196.75 / cord	
Electricity, residential rate, monthly flat fee	$14.65 / month	
Electricity, residential rate, energy charge	1–1,000 kWh	12.14 ¢/kWh
	1,001–2,500 kWh	12.82 ¢/kWh
	>2,501 kWh	13.99 ¢/kWh

Data sources: Yukon Ministry of Energy, Mines and Resources; Yukon Energy; Faro community[11]

Comparing the cost per kWh and GHG intensity of the various fuels yields interesting insights into possible shifts in energy profile of the community. For example, looking at **Error! Reference source not found.**, we can see that electricity and wood have much lower GHG intensities than the other fossil fuels. This is because the Yukon energy grid is mostly hydro power, which has a low carbon footprint. Wood is considered to have a low GHG footprint as long as new trees grow where the wood has been harvested, thus over time re-capturing the carbon emitted when the wood was burned. Wood has also the lowest cost per energy output.

It is also noteworthy that due to the increase in the price of oil in recent years, the cost of electricity and that of oil are now comparable on a per unit of energy basis. Given that generally electric heating systems are much more efficient than oil systems (95-100% vs. 60-85% efficiency), customers looking to replace their furnace might be tempted to replace it by an electric furnace. Because electric furnaces do not require exhaust systems, switching to an electric system might even improve the air tightness of a home. Note, however, that it is not considered good practice to heat a home with electricity, as electricity is a high quality energy that can be used for many end uses; while many fuels can provide heat, electricity is unique in its capacity to power computers and appliances, provide on-demand lighting, power entertainment systems, etc. A combination of wood heating with electrical backup would be a preferable

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[10] The cost of a cord of wood depends on whether it is purchased or self-supplied. From the survey, we do have estimates of annual costs spent on wood; since the survey also asked respondents to estimate how many cords they use per year, we can estimate an average cost for a cord of wood. Interestingly, the corresponding estimated price per cord varies greatly amongst households: from $25 to $336 per cord, with an average price just below $200 per cord.

[11] Fuel oil, propane, gasoline, diesel: Yukon residential fuel prices for Faro, as compiled by Yukon Department of Energy, Mines and Resources, 2013 (spreadsheet provided by Energy Solutions Centre).
Electricity: Yukon Energy price schedule, 2012 (spreadsheet provided by Yukon Energy).
Wood: Comment from Energy Champion group, energy workshop 2013, and community energy survey, 2013.

alternative to electrical furnaces. Furthermore, given that the YEC grid relies on diesel generation to meet peak demand, a significant increase in electrical heating across the territory will almost certainly require the diesel generators to be fired more regularly, thus losing some of the greenhouse gases benefits of electricity, and potentially contributing to further rate increases.

Table 3 Fuel summary

Fuel	Uses	Providers	Cost per unit of energy (¢/kWh)	GHG intensity (kg CO_2e/kWh)	% of total energy (all sectors)	% of total GHG emissions
Wood	Heating	Keith Carreau, or self supplied	3.8	0.02	11%	1%
Electricity	Appliances, lighting, heating	Yukon Energy Corporation	12.1	0.05	20%	5%
Fuel oil	Heating	Tu-Lidlini or North of 60	12.3	0.26	34%	47%
Propane	Heating, lighting, cooking	Superior propane	12.1	0.22	0.4%	0.5%
Gasoline	Transportation	Pacesetters	147.6	0.25	21%	28%
Diesel	Transportation	Pacesetters	138.2	0.26	14%	18%
Coal	Heating	Gathered in Ross River	N/A	0.33-0.47	Minimal	Minimal
Sun	Heating (particularly Feb-May), lighting		Free	0	N/A	N/A

2.3 Energy use in buildings

2.3.1 Residential buildings

Energy use in residential buildings is a significant portion of community energy use and also, given the number of buildings involved, represents one of the most complex sectors of the community to provide an estimate for. See Appendix A and Appendix B for a more detailed discussion of the method used to estimate energy use from the residential sector.

Table 4 summarizes average energy demand and costs for the different residential building archetypes in Faro, based on survey results.

Table 5 presents the average energy demand for appliances and domestic hot water on one hand, and heating on the other. Appliances and domestic hot water are mostly electrical in Faro, and this demand was estimated from the 2010 Conservation Potential Review CPR study results. The CPR was commissioned by Yukon Energy, the Yukon Electrical Company Ltd. (YECL) and the Government of Yukon to research and collect information about how people use electricity in the territory and to provide recommendations on where the greatest gains might be in terms of reducing energy consumption. This study provided a basis of modeling and data to estimate typical energy use in Faro households when no local data was available. The energy demand for heating, and the fuel mix used, is estimated from the community energy survey. We assume that any electricity demand beyond the CPR averages for appliances and domestic hot water is used for heating.

Table 4 Survey results: Average annual energy costs ($) and use

Building Archetype	#*	Average annual** …	Oil	Wood	Propane	Electricity
1980 & newer non-electrically heated single detached homes	15	Cost	$2,311	$1,769	$475	$1,392
		Quantity	1,750 L	4.3 cords	560 L	8,683 kWh
Non-electrically heated mobile/other	4	Cost	$1,750	$1,075	$80	$1,330
		Quantity	1,326	4.0 cords	94.2	9,507 kWh
Pre-1980 electrically heated attached/row housing	1	Cost	-	-	-	$3,000
		Quantity	-	-	-	23,264 kWh
Pre-1980 non-electrically heated attached/row housing	3	Cost	$1,800	$1,125	-	$3,160
		Quantity	1,364	3.0 cords	-	24,582 kWh
Pre-1980 non-electrically heated single detached homes	14	Cost	$2,248	$1,385	$125	$1,282
		Quantity	1,703	5.6 cords	147	7,808 kWh
Average	**37**	**Cost**	**$2,177**	**$1,459**	**$256**	**$1,554**
		Quantity	**1,649 L**	**4.5 cords**	**302 L**	**10,124 kWh**

* Number of survey respondents in that category.

** Averages are calculated using billing data only for houses that use that fuel, i.e. if a house does not use a certain kind of fuel, its contribution not set as zero, but rather it was not included in the calculation of the average.

Table 5 Average electricity use for appliances & domestic hot water (DHW) and average heating load and heating fuel mix

Building Archetype	#*	Appliances + DHW[12]	Heating					
		Energy use (kWh/yr)	Energy use (kWh/yr)	Source				
				Oil	Wood	Bottled Propane	Electri -city
1980 & newer non-electrically heated single detached homes	15	9,317	38,797	49%	47%	2%	2%
Non-electrically heated mobile/other	4	7,458	37,243	52%	41%	1%	5%
Pre-1980 electrically heated attached/row housing	1	8,786	14,478	0%	0%	0%	100%
Pre-1980 non-electrically heated attached/row housing	3	9,477	40,460	39%	29%	0%	32%
Pre-1980 non-electrically heated single detached homes	14	8,866	45,828	43%	55%	0%	2%
Average		**8,944**	**40,767**	**45%**	**47%**	**1%**	**7%**

* Number of survey respondents in that category

Based on survey, the total wood usage in the community in 2012 is estimated at 514 cords (2670 MWh). Of this, a little less than half (220 cords) was provided commercially by Keith Carreau, at a cost of $275 per cord (plus $50-$100 for splitting). This is the only commercial wood supplier in town. We assume the rest of the supply to be sourced locally by residents. The Energy Champion group suggested that the community would use more wood for heating if more wood was available for purchase. The municipality estimates that the yearly demand for commercially provided cut wood could be at least 350 cords per year.[13] See Section 3.2.3 for a more detailed discussion on opportunities to increase the use of wood as heating fuel in the community.

Figure 4 shows a histogram of annual electrical uses for residential customers. Interestingly, the total number of accounts is greater than the number of occupied dwellings in Faro, as compiled in water and sewer billing data. According to YEC's billing data, there are 250 different product trackers (indicating different billing locations), while there are 185 dwellings paying for water and sewer service. Of these, 77 consume less than 5,000 kWh per year. It has been suggested that some of that discrepancy might be due to some of the unoccupied homes having basic electrical heating to prevent severe mold and moisture damage to the house, or that some garages or annexes might have distinct electrical connections.

[12] We estimate total electricity use for each survey respondent based on their estimate of monthly electricity cost. To determine the fraction of that electricity used for heating, we use the 2010 Conservation Potential Review estimates for electricity use for appliance and domestic hot water. If the total electricity demand from a survey participant is smaller than the average DHW+appliances demand estimate in CPR, we assume all of that electricity is used for appliances and domestic hot water. If the total is greater, we assume the excess electricity was used for heating.

[13] Comment from Energy Champion group, energy workshop 2013

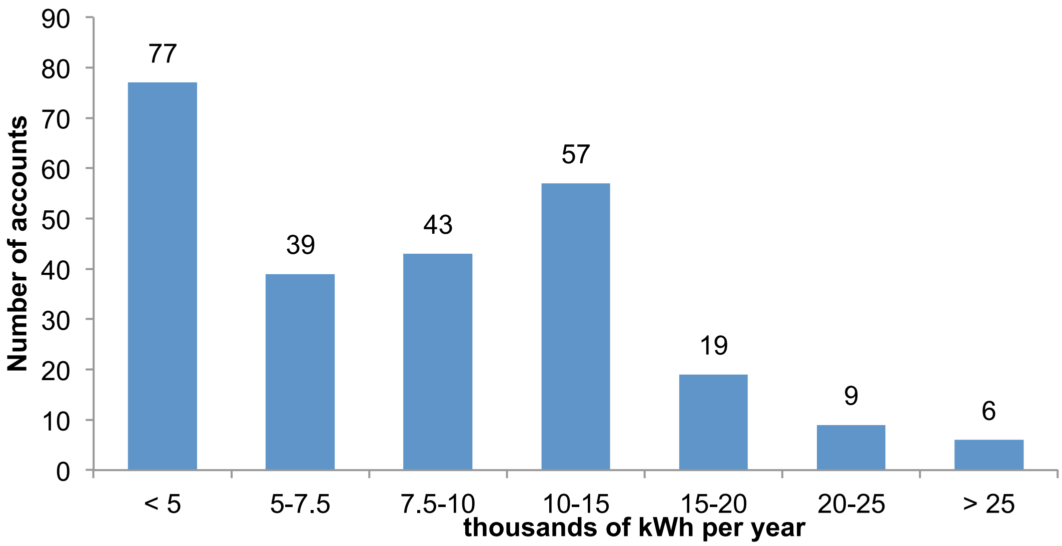

Figure 4 Spread of yearly electricity consumption for residential customers (2012)

The community energy survey data does not allow us to fully break down the total stationary energy demand by end use; however, the 2010 CPR does give some estimates of the relative size of energy end uses in Yukon household (see Figure 5).

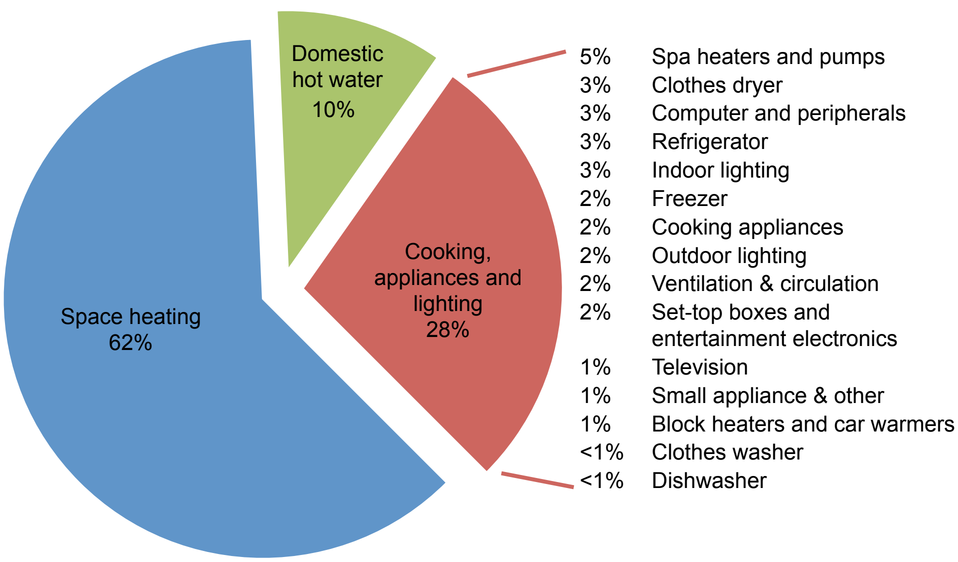

Figure 5 Relative breakdown of energy use for a 1980 and newer non-electrically heated detached single family home.

Note: Totals may not be exact due to rounding.

Source: 2010 Conservation Potential Review.

It is important to note that these are averages, and the actual range might vary significantly. Figure 4, for example, shows that the annual electricity demand for residential customers ranges from less than 5,000 kWh per year to more than 35,000 kWh per year (a seven-fold difference), with the bulk of the annual demand ranging in the 10,000 to 15,000 kWh per year. It is likely that the homes at the higher end of that spectrum rely more on electricity for heating than other homes do.

2.3.2 Commercial buildings

Conversations with Faro's CAO and the Energy Champion group identified the following commercial buildings in operation in 2012:

- Discovery Store & Faro Hardware
- Faro Real Estate
- M. Hampton's Shop
- J. McLachlan Bus Shop
- North of 60
- Faro Shell Service Station
- Klondike Dreams
- Faro Studio Hotel
- Hotel kitchen (leased out)

The only data we have for commercial buildings is their electricity consumption. We do not have estimates for their other fuel uses, and this is a gap in the inventory.

Figure 6 gives the range of annual electricity use for commercial accounts. It is interesting to note that there are 29 commercial accounts registered in Faro in the YEC billing database. It is not clear what the commercial operations are beyond the nine listed above; however, they probably are not major power users: sixteen of the 29 accounts have annual consumption below 5,000 kWh per year, and another four are in the 5,000 to 15,000 kWh per year range. In 2012, two commercial users were responsible for 62% of commercial electricity use, the following seven accounting for 30%, while the other 20 accounts were responsible for less than 10% of total use. There might be benefit in working with the main two commercial consumers to look for opportunities for savings, particularly if their furnace oil usage is on par with their electricity use.

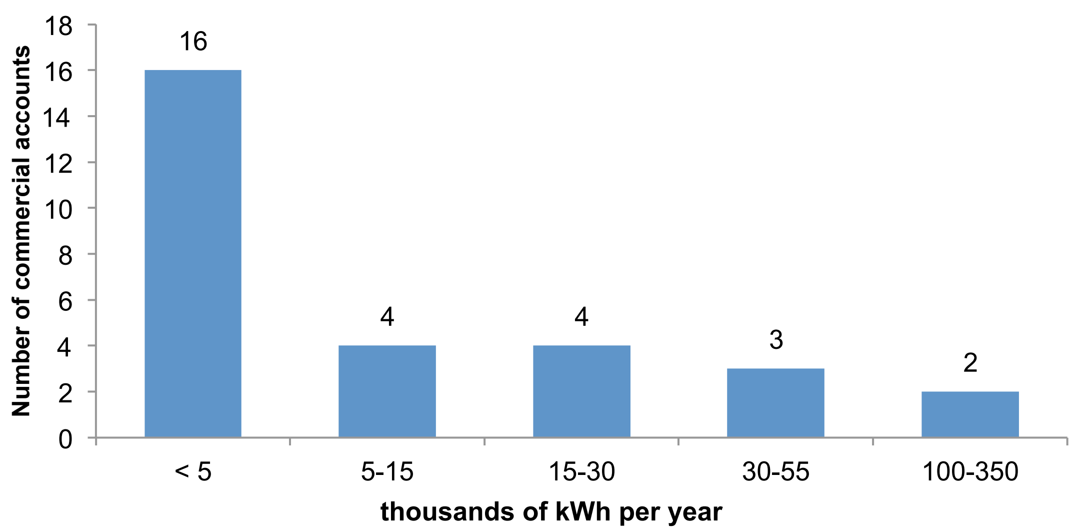

Figure 6 Annual electricity use for commercial accounts in Faro area

2.3.3 Municipal buildings

Table 6 summarizes the fuel and electricity use from municipal buildings, as provided by the Town's finance department.

The two largest energy users are the recreation centre and the arena; energy bills for these two buildings totaled $77,635 and $47,872 respectively in 2012. The pump houses are also significant energy users, with nearly 250,000 kWh of electricity and 240,000 kWh of fuel oil and costing over $100,000 per year. Most of the electricity is used to run the water system of the town, as large electric pumps are used to move water from the Pelly River to the treatment facility and storage reservoirs and ultimately to the sewage ponds. Some of the electricity is also used to heat pump house #1, for which an electric furnace was installed in November 2012, and pump house #2, which has baseboard heat. Pump house #2A also has an electric wall board, though most of the heat is from a fuel oil furnace, which was also changed at the end of 2012. Pump houses 3 and 4 have furnaces and use fuel oil. The heating load for these buildings is quite large; pump house 3, for example, uses as much fuel oil as the firehall. Improvements in insulation of these buildings and the installation of more efficient furnaces, as initiated at the end of 2012, could yield significant savings.

Table 6 Municipal building energy use and cost

Building Name	Electricity (kWh/yr)	Fuel oil (kWh/yr)	Total energy cost ($)	Intensity (kWh/m^2)	
				Actual	NRCan benchmark[14]
Town of Faro Recreation Centre	127,560	348,988 + 42,119 propane for pool	$77,635	427	461 (Recreation)
Father Pierre Rigaud Arena (inc. concession and ice plant)	100,644	256,316	$47,872	157	461 (Recreation)
Pump house 1 & 2	276,320	45,291	$49,905	5,966	N/A
Pump house 3	195,000	141,852	$47,042	3,839	N/A
Pump house 4	26,840	52,138	$10,436	1,770	N/A
Shop tank 2 (Building)	48,474	125,337	$23,338	0	N/A
Town of Faro Municipal Office	46,190	106,137	$22,199	329	578 (Office)
Firehall	41,200	111,838	$18,632	412	383 (Non-food Service)
Greenhouse/ Woodshop	4,165	49,657	$7,786	905	367 (Warehouse)
Campbell Region Interpretive Centre	5,557	42,271	$6,651	348	383 (Non-food Service)

[14] Benchmarking data from NRCan, *Survey 2000: Commercial and Institutional Building Energy Use,* Summary Report (2003). http://oee.nrcan.gc.ca/corporate/statistics/neud/dpa/data_e/Cibeus2/CIBEUS2_ENG.pdf

78 Ogilvie	8,054	38,100	$4,577	N/A	N/A
Animal shelter	3,558	19,449	$2,659	645	383 (Non-food Service)
John Connelly municipal campground and RV park	13,259	0	$2,948	396	383 (Non-food Service)
PRV chamber	10,150	0	$1,537	1,706	447 (Administration)
Street lighting	N/A	0	$33,707	N/A	N/A
TOTAL	**906,971**	**1,379,492**	**$356,924**	**-**	**-**

Data source: Town of Faro finance department.

There are 183 streetlights in operation in Faro: 175 with 100 W lamps, six with 150 W, and three with 400 W. Their electricity consumption is not metered and Faro gets charged a flat fee for their use ($33,707 in 2012).

2.3.4 Territorial buildings

Table 7 presents the heating and electricity energy demand and cost for buildings owned or managed by the territorial government. Since government buildings get charged a different rate for electricity, Yukon Energy billing data can give us the total of electricity sold to government buildings in Faro (about 880 MWh). The heating fuel use is estimated based on the data compiled in the Public Building Energy Tracker (PBET) database. Heating demands for these buildings amounts to about 1,740 MWh per year, similar to the fuel demand from municipal buildings. The building hosting the Del van Gorder School and Yukon College Faro Campus accounts for about half of that energy use.

Table 7 Territorial buildings energy use, 2012

Building	Electricity use (kWh/yr)	Other fuels (kWh/yr)	Cost ($)
Del van Gorder School + Yukon College[15]	436,640	1,338,400	$224,258
Faro Nursing station	110,720	151,731	$29,978
Faro airport	64,200	81,197	$21,622
Faro liquor store	N/A	120,124	$12,738
Faro North 60	N/A	48,716	$5,338
Faro shopping centre	21,302	N/A	$4,027
RCMP Office	N/A	N/A	N/A
Balance[16]	249,002		~$34,400
TOTAL	**881,864**	**1,740,167**	**$332,361**

[15] Electricity consumption data was not available for 2012; we used 2011 values as a proxy.

[16] Difference between the total of electricity bills for building above and the total electricity sold at fee schedule #2180 (government buildings) in 2012 according to YEC billing data. To estimate the associated cost, we assume this electricity was charged at the lowest step of the schedule for territorial government service (13.81 ¢/kWh).

Source: PBET database

2.4 Energy use for transportation

The total transportation fuel uses for the community, as extrapolated from the energy survey, are presented in Table 8.

On average, Faro households spend $6,289 per year each on vehicle fuel, for a total of over one million dollar per year community-wide. Fuel use by the municipal fleet cost about $66,000 in 2012. It should be noted that we do not have estimates for commercial vehicles or vehicles used by the territorial government agencies in Faro.

Table 8 Estimated community-wide fuel use per vehicle type

Vehicle type	Per household average		Community total	
	Annual fuel use (L/yr)	Annual cost ($)	Annual fuel use (L/yr)	Annual cost ($)
Car	757	$1,086	140,066	$200,994
Truck (gasoline)	1484	$2,130	274,573	$394,012
Truck (diesel)	1061	$1,574	196,267	$291,260
Snowmobile	229	$329	42,448	$60,913
ATV	202	$290	37,389	$53,654
Boat	236	$338	43,584	$62,543
Motorcycle	344	$494	63,686	$91,390
RV	30	$44	5,635	$8,086
Municipal diesel vehicles	-	-	17,081	$23,199
Municipal gasoline vehicles	-	-	34,690	$42,829
TOTAL	**4,344**	**$6,286**	**855,419**	**$1,129,937**

2.5 Total energy use

The total energy use in Faro in 2012 is estimated at 21,959 MWh. Of this, 36% is used in transportation, 38% in residential buildings, 12% in buildings of the territorial government, 10% in municipal buildings, and 4% in commercial buildings (though it should be noted that for commercial buildings, only the electricity use is accounted for).

Of this energy, 30% was supplied by furnace oil, 22% by electricity, 12% by wood, 25% by gasoline, 10% by diesel, and 1% by propane.

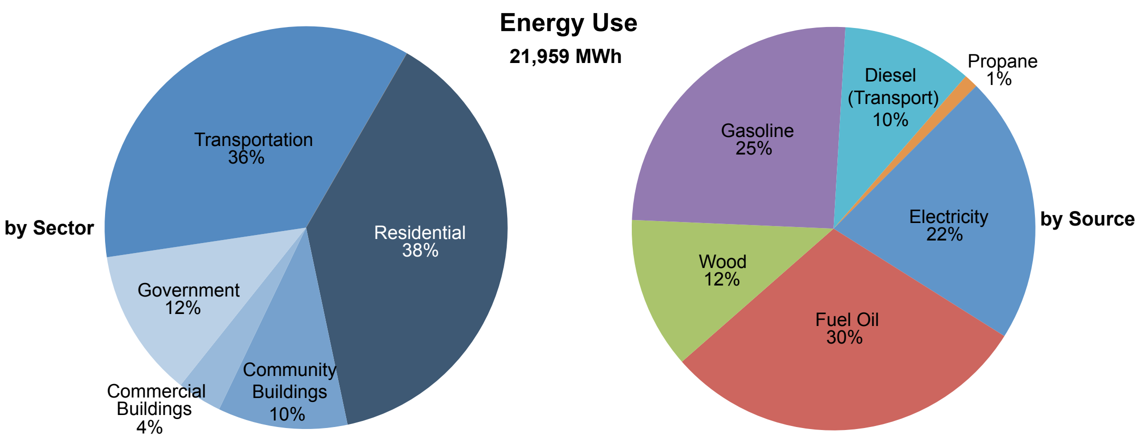

Figure 7 Energy use, per sector and by fuel source (2012)

2.6 Greenhouse gases emissions

Total GHG emissions in the community of Faro in 2012 are estimated to be 4,476 tonnes of CO_2e. Of this, almost half comes from transportation (42% from residents, 2% from municipal fleet;[17]), a quarter from residential buildings, and the last quarter is roughly equally divided between territorial buildings, municipal buildings, and landfill emissions (eleven, nine and ten percent of total, respectively). The commercial building sector accounts for only 1% of emissions in the inventory, but this sector certainly accounts for a greater portion of emissions in reality; the difference resulting from a lack of data on commercial heating fuel use and transportation. In terms of greenhouse gases emissions, community transportation amounts to an average of 10 tonnes CO_2e per household, plus another 132 tonnes CO_2e for the municipal fleet.

Furnace oil, which is used for heating buildings, accounts for 38% of all community emissions. Wood, while providing 11% of the total energy use for the community, contributes only 2% to the total GHG emissions; similarly, electricity accounts for 20% of energy use and 5% of emissions. Of the 45% of emissions attributed to transportation, 13% is due to diesel and 31% to gasoline.

[17]Note that we have no estimate of commercial transportation fuel use, nor of transportation fuel use from territorial agencies operating in Faro.

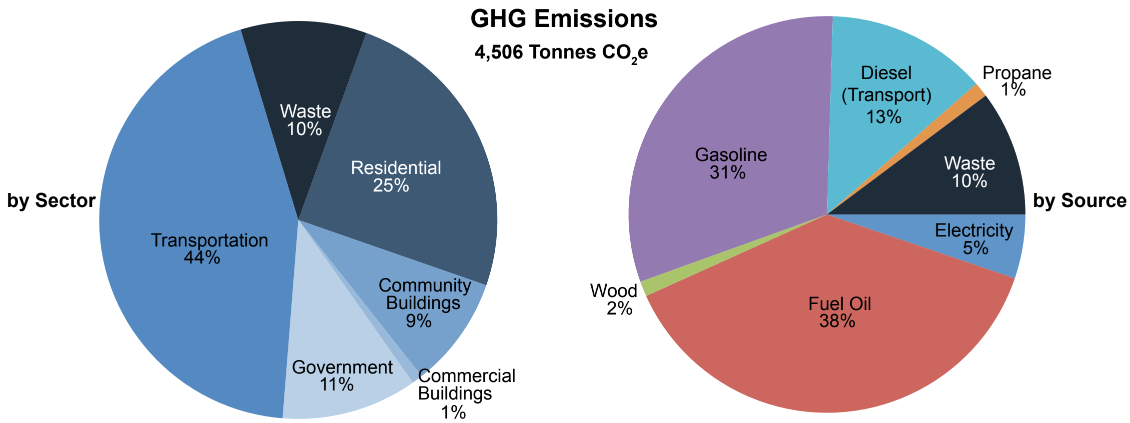

Figure 8 Greenhouse gas emissions, per sector and fuel source (2012)

Faro's per capita emissions are estimated at 12 tonnes CO_2e per person per year – this includes all emissions in the community. Looking only at direct household emissions, Faro households, on average emit 10 tonnes CO_2e per year for transportation and 6 tonnes CO_2e per year for home heating and appliances. For context, Table 9 compares the Faro per capita emissions to those of other northern towns. While the energy context of these towns are different due to varying degree of isolation, road access, reliance on diesel generators, and economic activity, they provide a range of variability within a northern context.

To provide an even broader context, Table 10 presents the per capita emissions for a few large cities around the world. These should not be directly compared to Faro, as the urban energy context is quite different from that of rural town; however, it is worthy to note the wide range of per capita emissions between these cities. This is indicative that some choices in urban planning and energy sources can yield to very different outcomes when it comes to greenhouses gas intensity. It would be interesting to similarly compare the use of energy is rural northern European town to that of rural north American town and see if the results are as different as they are for cities — and more importantly, see what leads to these differences. Unfortunately, we do not have access to this information at this point.

Table 9 Per capita emissions for various northern towns[18]

Town / City (year of inventory)	**Region and characteristics**	**Pop.**	**Tonnes CO_2e / year / person**
Faro (2012)	**Yukon Territory**	**372**	**12**
Tulita (2007-2008)	NWT, off grid, fly in	542	12
Fort Liard (2007-2008)	NWT, off grid, ~200km form Fort Nelson	596	8
Alert Bay Village, B.C. (2010)	Coastal B.C.	486	8.5
Fraser Lake Village, B.C. (2010)	Central B.C.	1,161	11.6
Granisle Village, B.C. (2010)	Central B.C.	396	8.0

Table 10 Per capita emissions for major cities[19]

Town / City (year of inventory)	Region and characteristics	Pop.	Tonnes CO_2e / year / person
Calgary (2003)	Alberta	1.0M	17.7
New York City (2005)	U.S.	8.2M	10.5
Toronto (2004)	Ontario	2.6M	8.2
Paris (2005)	France	2.2M	5.2
Tokyo (2006)	Japan	13.2M	4.9
Vancouver (2010)	B.C.	642,843	3.6
Oslo (2005)	Norway	1.4 M	3.5
2050 target to stabilize climate	B.C./Global		~ 1

[18] All B.C. data from B.C. 2010 CEEI inventories http://www.env.gov.bc.ca/cas/mitigation/ceei/ ; NWT data from Arctic Energy Alliance inventories: http://aea.nt.ca/communities

[19] International data and global target from "Cities and greenhouse gas emissions: moving forward," Daniel Hoornweg, Lorraine Sugar and Claudia Lorena Trejos Gómez, *Environment and Urbanization* 23(2011) 207 originally published online 10 January 2011: http://eau.sagepub.com/content/23/1/207

2.7 Summary

Figure 9 presents a summary of the use, cost, and resulting emissions in each sector for each fuel used in Faro.

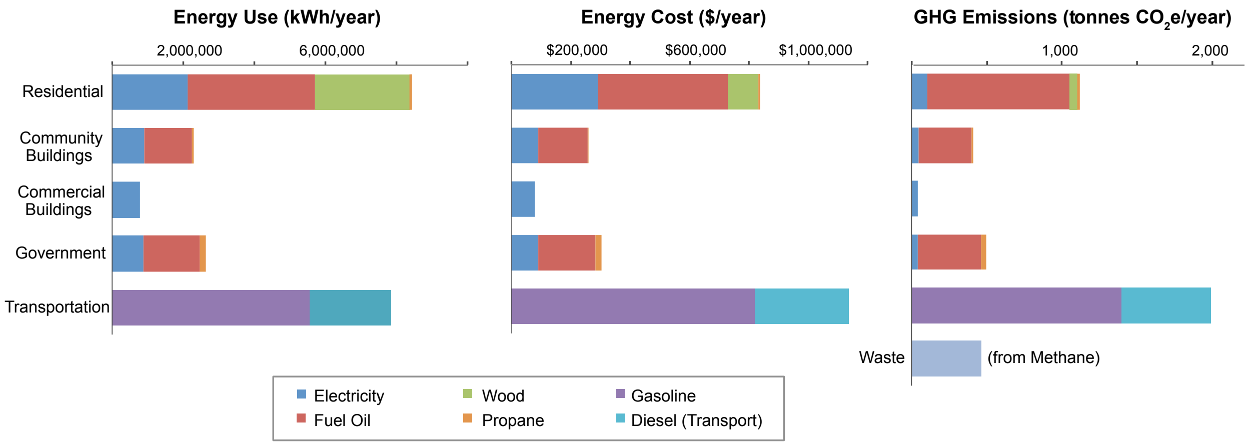

Figure 9 Annual energy use, energy cost, and emissions by source and sector

An overall view of the energy inputs and uses, plus costs and emissions, is shown schematically in Figure 10.

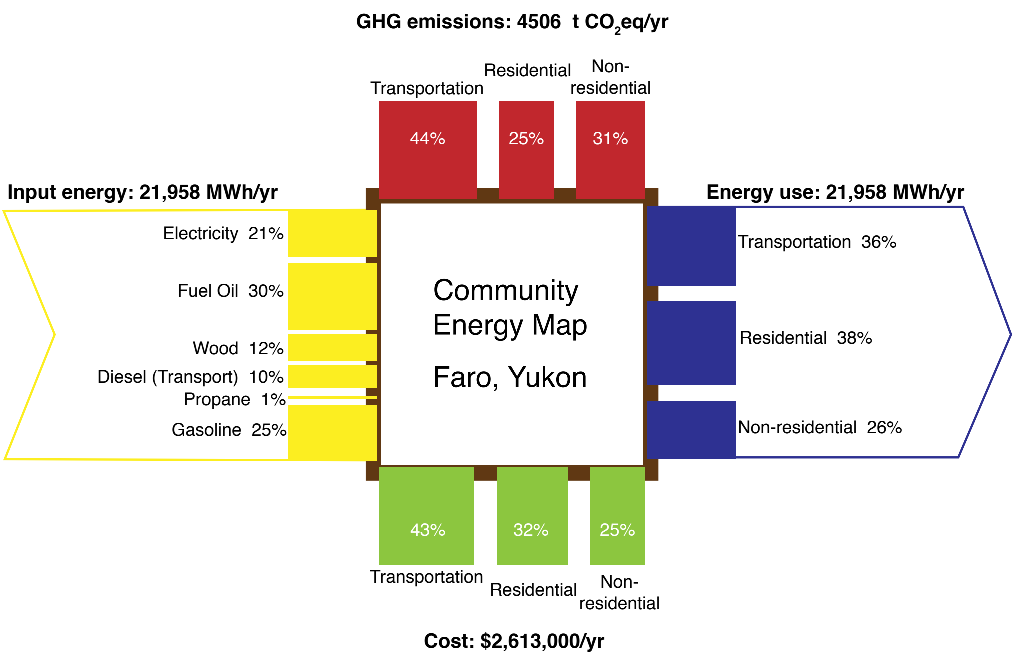

Figure 10 Faro community energy map, 2012

The average cost of energy for a typical Faro household is about $10,250 per year: a little more than half goes to transportation fuels (~$5,750), and the rest (~$4,500) goes to heating, domestic hot water, appliances, and lighting. This results in per-household emissions of about 10 tonnes CO_2e per year for transportation, and 6 tonnes CO_2e per year for home heating and appliances.

3. Actions on energy use and emissions

Working with the Energy Champion group and the Town of Faro, Pembina identified actions that have already been taken in the community to cut down on energy use, switch to cleaner fuels, and reduce greenhouse gas pollution. The community energy survey also provided insight into actions taken by Faro residents. These actions are outlined in Section 3.1.

During the energy workshop, participants brainstormed opportunities for further action in the community and in municipal operations. From these conversations, the results of the community survey and based on experience drawn from other municipalities, this report provides possible suggestions for further community-wide and municipal action, outlined in Sections 3.2 and 3.3.

3.1 Current activities to reduce energy use and GHG emissions

3.1.1 Municipal and community actions

Workshop participants noted that several actions to reduce energy use and save energy costs are underway in the community and municipal operations, including:

- A handful of home energy retrofits are completed every year; these include window upgrading, new siding over upgraded insulation, and house-wrapping/air sealing.
- Wood is widely used as a heating fuel, which is cheaper and cleaner than furnace oil.
- Town of Faro has invested $75,000 to upgrade seven furnaces to higher efficiency.[20]
- Town of Faro has started tracking municipal fleet vehicle fuel use.
- Some LED lighting has been adopted in homes and municipal buildings.

The household energy survey provides additional details on actions that community members are taking. It also suggests areas for improvement for future actions. Thirty-eight households completed the survey, representing over 20% of the community. It is likely that this survey over-represents current energy actions, as people who think about energy already are more likely to fill in the survey.

3.1.2 Residential buildings, current actions

As shown in Table 11, in the last three years 25-50% of survey participants have engaged in energy efficiency upgrades to their homes; this included action such as upgrading furnaces, improving insulation, upgrading windows and doors, and reducing drafts. More than 50% have

[20] These were installed in pump house 1 (new electric furnace); pump house 2A (new fuel oil furnace); the arena (one new fuel oil furnace); the firehall (two new fuel oil furnaces); the Public Works building (one new fuel oil furnace); the CAO residence (one new fuel oil furnace).

installed energy efficient light bulbs and upgraded at least one appliance. Fewer than 25% have installed a programmable thermostat in the last three years.

In terms of behavioural change, fewer than 50% have turned down the temperature or unplugged electronic devices when not in use. Almost 50% of respondent's compost organic waste, with the highest adoption rate shown in recycling behaviour: over 80% of survey participants recycle some household waste.

Table 11 Survey Questions 11 and 15: Home energy and waste

To reduce the amount of energy you use at home, in the last THREE years, have you...	% of respondents
Upgraded your furnace to a more efficient model?	24%
Improved the insulation of your roof, your walls, or your basement?	29%
Installed new energy-efficient windows or doors?	37%
Reduced cold drafts by using caulking around windows and doors?	50%
Installed a programmable thermostat?	16%
Reduced the average temperature of your home, and/or turned the temperature down at night?	42%
Installed energy efficient light bulbs?	63%
Upgraded one or more of your appliances to a more efficient (or energy STAR) model?	61%
Unplugged electronic devices (like your TV, your radio or your cell phone charger) when not in use?	34%
Composted your organic waste?	47%
Recycled any of your household waste (such as paper, cardboard, glass, aluminum or plastic)?	84%

3.1.3 Personal transportation, current actions

Table 12 and Table 13 provide insight into Faro residents' transportation behaviour. 50% of survey respondents walk, bike or ski at least once a week instead of taking a car, while 30% carpool at least once a week. Over 50% combine errands or activities to reduce the number of car trips they take. Well over 50% maintain their vehicles and engage in "Smarter Driver" behaviour such as anti-idling and slow acceleration.

Some residents have also down-sized their vehicles or purchased more fuel efficient models. No survey participants have purchased alternate fuel vehicles like hybrids, and only 11% of respondents said that they had reduced their overall number of vehicles.

Table 12 Survey Question 12: Commuting choices

To reduce fuel usage, in the last year how many times a week have you...		% of respondents
Carpooled to work, school or to leisure activities?	1 or 2 times / week	11%
	3 or 4 times / week	13%
	5 or more	5%
	Total	29%
Worked from home?	1 or 2 times / week	8%
	3 or 4 times / week	0%
	5 or more	5%
	Total	16%
Walked, biked or skied for transportation instead of taking a car?	1 or 2 times / week	24%
	3 or 4 times / week	13%
	5 or more	13%
	Total	50%
Combined errands or car trips to avoid extra trips?	1 or 2 times / week	18%
	3 or 4 times / week	13%
	5 or more	21%
	Total	56%

Table 13 Survey Questions 13 and 14: Vehicle purchasing and operation choices

In the last three years, have you…	% of respondents
Reduced the total number of vehicles in your household?	11%
Downsized your vehicle? Smaller vehicles typically use less fuel than larger, heavier vehicles.	18%
Upgraded your vehicle to a fuel efficient model? By choosing a vehicle with best-in-class efficiency, you can save both money and fuel.	16%
Upgraded your vehicle to a model that uses cleaner fuel (like a hybrid vehicle)?	0%
Measured your tire pressure regularly (i.e., at least once a month)?	68%
Used high quality fuels and lubricants in your vehicle?	61%
Avoided excess idling of your vehicle?	61%
Avoided high speeds and abrupt changes in vehicle speed (i.e., sudden braking or acceleration)?	76%

3.2 Opportunities for further action in the community

The energy inventory, community energy champion workshop, and household survey together provide insight into further actions that can be taken in the community to reduce energy use and greenhouse gas pollution. Reducing energy use also reduces energy costs and some of the actions have good payback periods on the upfront investments. These are noted as a general guide where possible.

Conservation and energy efficiency—or demand side management—offer the most cost effective options to reduce energy costs in both residential and non-residential sectors. Reducing demand before changing fuels or heating systems saves costs now and into the future.

Once demand has been reduced, improving the efficiency of the heating system or switching to a cleaner fuel are the next options to reduce costs and greenhouse gas pollution. Fuel switching is more feasible in buildings (for heating and hot water) than in transportation. When considering fuel switching reliability of supply, opportunities for local economic development, local air quality, affordability and greenhouse gas pollution should all be considered.

Responsibility for action lies with members of the Faro community, the municipality and other levels of government, and the energy providers. Community-wide emissions reductions require action from many residents, while several of the municipal actions focus on a few specific buildings and fleet management. Some municipal energy reductions will also require resident engagement and action, such as reducing water use to reduce water pumping requirements. Several actions can be supported by rebate and other programs from the Yukon government's Energy Solutions Centre, the utilities (YEC and YECL), and other agencies.

3.2.1 Input from community Energy Champions

The Energy Champions brainstormed several ideas to improve the energy resilience of the community and decrease emissions. To indicate which ideas had the most traction amongst them, members of the group were given three dots to place beside the ideas that they thought had the most potential. Table 14 presents the ideas with at least two votes.

These actions have been incorporated into the list of actions to consider, covered in the remainder of this section.[21]

Table 14 Reduction action ideas discussed at the April 2013 energy workshop

Idea for energy action	Votes
Air seal houses	4
Start a wood co-op	4
Use Ross River coal as heat source	4

[21] Note that the votes were gathered in the workshop as a way of assessing where the participants saw the most opportunities; this was not conducted as a decision-making process in any way. These suggestions were considered when making the recommendations in this report, but the prioritization of recommendations is dependent on these votes.

Solar thermal for hot water	3
Automate/optimize temp controls	3
Local shopping	3
Lead by example (start with municipal building and operations)	3
Reduce home temperature	2
More recycling	2
Community transportation alternatives	2
Have energy audits / incentivize energy audits	2

The following sections provide a range of ideas and approaches to reduce energy use, emissions, and costs in the residential, commercial, municipal, and territorial sector. We do not suggest that the Town of Faro or governmental agencies pursue all of them; they are discussed here to provide options for action and inform decision making. Our top recommendations are provided in Section 4.

3.2.2 Residential energy conservation and efficiency actions

Reduce electricity used for lighting and appliances

Light-emitting diode (LED) lights can replace many forms of incandescent or compact fluorescent (CFL) bulbs. They use approximately 75%–90% less energy than incandescent bulbs. They turn on immediately when switched on and perform well in the cold. They are considerably more expensive than standard and CFL bulbs. However, with an estimated lifespan of over 20 years, they will pay themselves back in electrical savings. A Yukon rebate program to help offset the upfront costs of LED light purchase is being set up by YEC and YECL.[22]

Compact Fluorescent Light bulbs (CFLs). Conventional southern energy efficiency programs promote CFLs to replace standard incandescent bulbs. CFLs reduce electricity consumption by approximately 75% and last 7–9 times longer than incandescent bulbs. Energy Star labeled CFLs cost approximately $3-7 more than traditional incandescent light bulbs.[23] However, CFLs illuminate slowly, do not perform well in the cold and need to be disposed of properly (recycling rather than landfill). The Yukon does not currently have any CFL waste handling facilities. Therefore, moving directly from incandescent lights to LEDs may be a preferred option. As well, LEDs are included in the utilities rebate program.

EnergyStar computers and other appliances such as front-loading washing machines help to reduce household electrical use. Energy Star rated appliances often cost as little as 5% more than standard appliances, yet they typically use 10% to 20% less energy throughout the year. The small amount of extra cost up front will be returned to the user through annual energy savings.

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[22] Yukon Energy and Yukon Electrical, *Backgrounder: Yukon-wide electricity conservation plan* (2013). http://www.yukonenergy.ca/downloads/db/1255_Summary_Electricity_Conservation_Plan_May2013.pdf

[23] Weiss, T. and Cobb, P. *Aboriginal Energy Alternatives* (2008) Pembina Institute, pg 12; http://www.bchydro.com/powersmart/business/small_medium_business/green_your_business/lighting_guide/Replace_Incandescent_Bulbs_With_CFLs.html

The international Energy Star symbol is a simple way for consumers to identify products that are among the most energy-efficient on the market. the Yukon government's Energy Solutions Centre currently offers a rebate on a wide range of Energy Star home appliances through their Good Energy Rebate program[24]. Yukon's utilities, through their *inCharge* brand, are currently planning to offer an incentive that covers EnergyStar rated computers for the commercial sector.

Reduce home heating demand by improving the building envelope and heating system

Programmable thermostats. Only 27% of Faro energy survey respondents said they had one or more programmable thermostat in their house; more than half of those have been installed in the past three years. Programmable thermostats reduce the reliance on individual behavior, and by ensuring that the temperature is turned down at night or during times when the space is regularly unoccupied, can save up to 10% on home heating costs.[25]

Air sealing to improve the air-tightness of homes. This action was high on the Energy Champion list. It includes weather-stripping and reducing leaks in the building envelope to improve building envelope performance and reduce heating demand. The sum of gaps, cracks and holes in a poorly sealed home can lead to losing as much energy as leaving a door open year round. Savings from draft-proofing a home can lead to energy savings of 5–10%;[26] given that the average heating cost in Faro is about $3000 per year, this can amount to hundreds of dollars of savings per year. Through their Home Repair Program, Yukon Housing Corporation offers a low-interest loan of up to $35,000 to retrofit homes, including renovations that improve energy efficiency[27].

Upgrading the building envelope through better home insulation and other components such as exterior doors and energy-efficient windows, alongside air sealing, ensures high energy performance. This also includes insulating basement walls, basement floors and headers along with the usual suspects of attic and wall insulation. Insulating the attic can reduce energy use by 20–60%.[28] . Renovations of this nature also qualify under the Home Repair Program.

A community-wide retrofitting program could be undertaken that combines air sealing with better insulation, making it easier for homeowners to take action. However, several challenges to such a program were noted by the Energy Champions. Many residents are retirees, making the longer payback periods of retrofitting homes less enticing. Significant retrofits, such as blowing

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[24] Yukon Government, 'Good Energy Rebate Program' http://www.energy.gov.yk.ca/good_energy.html

[25] Energy Solutions Centre, *Easy$ tips sheet: Thermostats for efficiency and comfort*, http://www.energy.gov.yk.ca/pdf/em10_thermostats.pdf
See also BC Hydro *Thermostats for efficiency and comfort,* fact sheet.

[26] BC Hydro *Draftproof your home to keep the energy in and the cold out*, fact sheet. http://www.bchydro.com/content/dam/hydro/medialib/internet/documents/Power_Smart_FACT_sheets/FACTS_Draftproofing.pdf; for Yukon specific information see also Energy Solutions Centre, Easy$ tips sheet: Draft proofing your home, http://www.energy.gov.yk.ca/pdf/em7_draftproofing.pdf

[27] http://www.housing.yk.ca/hrp.html

[28] BC Hydro *Insulate your home to keep the heat in and the energy bills* fact sheet. http://www.bchydro.com/content/dam/hydro/medialib/internet/documents/Power_Smart_FACT_sheets/FACTS_Insulating_for_Energy_Efficiency.pdf ; for more information see also Energy Solutions Centre, *Insulating for energy Efficiency* http://www.energy.gov.yk.ca/em_insulating.html

in insulation or changing out windows, can be relatively expensive at the front end. Therefore, the Energy Champions suggested that the municipal and/or territorial governments could "lead by example" by retrofitting government buildings first, using this as a way to foster community dialogue on energy retrofits.

Use thermal imaging as an education tool. Thermal imaging is a tool successfully used by local groups to encourage homeowners to seal and insulate their homes.[29] Using an infrared camera, one can take a picture of a home showing its most important energy leaks, which is an impactful way to 'make the invisible visible'. 'Before and after' pictures can also be a striking way to show the impact of home energy retrofits. The Yukon government's Energy Solutions Centre has the appropriate equipment to do thermal imaging; a winter trip to conduct imaging could be coordinated as part of a community-wide retrofitting program. thermal imaging would be most effective if combined with retrofit incentives or financing options.

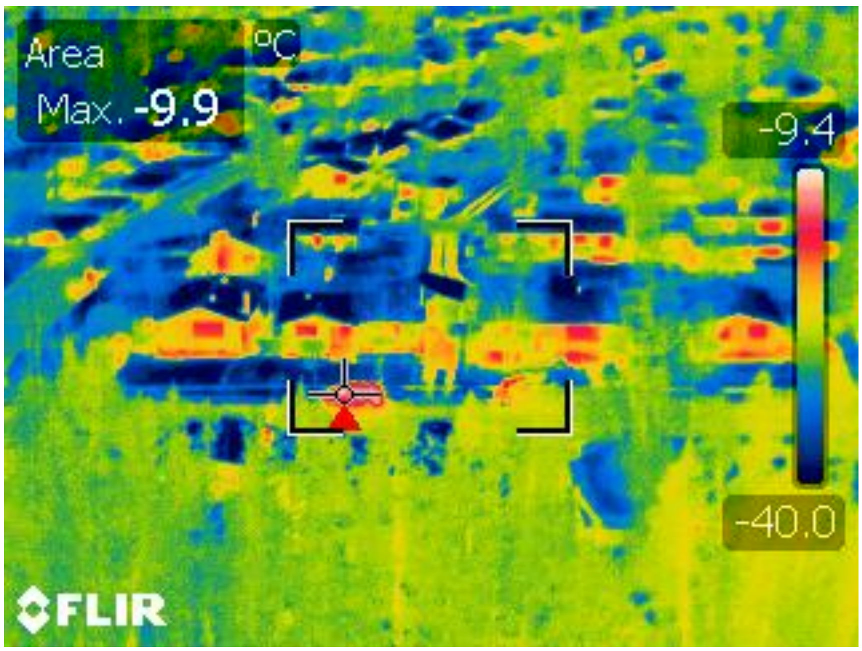

Figure 11 A Thermal image taken of the Riverdale subdivision, Whitehorse, Yukon.
The picture was taken in the winter when outside temperatures had reached -40°C. Notice the car in the cross-hair (pink area), which is losing significant heat because it is not insulated. Most house attics (light and dark blue areas) in the photo seem well insulated, yet significant heat is loss is still occurring through the windows (red areas) and building facades (yellow areas).

Photo credits: Yukon government's Energy Solutions Centre

Reduce wastewater and hot water demand

Hot water tank insulating blanket: A simple way to reduce water-heating costs is to insulate the water tank with a low-cost insulating blanket that wraps around the tank. Insulating blankets work best on older heaters that have less insulation. ***Note that gas-fired tanks need to be***

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[29] See for example the 'Cool Neighborhood' program lead by Cool North Shore, a community organization engaging residents on the North Shore of Vancouver on conservation issues: http://www.coolnorthshore.ca/action/cool-neighbourhoods and http://wwww.coolneighbourhoods.org/

wrapped by a heating professional.[30] Additionally, insulating hot water pipes also reduces heat loss.

Reduce water pumping and hot water use. Residential action to reduce water use and the amount of sewage that requires pumping can save energy use at pumping stations and energy costs for the municipality. Reducing hot water use also saves residential energy. Residential water use can be reduced by:

- **Low-flow showerheads:** Showering is usually the largest single use of hot water in a home. Old style showerheads use 3 or even 4 gallons per minute (gpm). Newer models typically use 2.5 or 2.2 gpm, and super low-flow showerheads use only 1.75 gpm.[31]
- **Front-loading clothes washers**: Front-loading washing machines have been used for decades in Europe and are rapidly being adopted in Canada. They use approximately half the amount of water of a top-loading washer. With higher spinning speeds, they also extract more moisture from clothing, reducing drying time. An additional benefit is that front-loading (or horizontal axis) tumbling action is much gentler on clothing fabric. New front-loading washers use one-third to one-quarter as much energy as new top-loading models.[32]
- **Faucet aerators and toilet dams**: Faucet aerators can be placed on all sinks in the home; they operate on the same principle as the low-flow shower heads to reduce water use. Toilet displacement devices cost approximately $5 and save 3-5 litres per flush. A brick or even a rock in the toilet tank will have the same effect.[33]

Behavioural change for energy conservation

The Town of Faro could work with Yukon Energy on a behaviour change campaign with local residents. Behaviour-based programs have better results when they involve peer groups reporting to each other, rather than individuals. In addition to encouraging the efficiency changes noted above, the Faro conservation program could promote shifts around the followings: [34]

- Set water heaters to 55°C and no lower than 54°C [35]
- Turn off lights when leaving a room and unplug electronics to reduce “phantom loads”
- Reduce home temperatures at night and while residents are away: set thermostats to 21°C (70°F) in winter when at home and down to 16°C (61°F) at bedtime or while away — programmable thermostats do most of this automatically once set
- Use energy-saving settings on washing machines, clothes dryers, dishwashers, and refrigerators
- Use water thoughtfully, hot or cold, inside or outside your home

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[30] Energy Solutions Centre, *Residential Water Heating,* fact sheet. http://www.energy.gov.yk.ca/pdf/em13_reswaterheating.pdf

[31] *ibid.*

[32] *ibid.*

[33] *ibid.*

[34] *ibid.*

[35] A range of temperatures is recommended in the literature that considers both energy savings and health concerns. This report uses the current Energy Solutions Centre and BC Hydro recommendation.

- Clean your refrigerator's condenser coils once a year
- Air-dry clothes/use a clothesline — especially easy in the summer
- Close heating vents in unused rooms
- Repair leaky faucets and toilets (5% of water "use" is leakage)
- Regularly maintain your vehicles and make sure that your tires are properly inflated

Leverage energy programs

Several of the conservation and efficiency actions will be supported by rebate or pilot programs. The Yukon government's Energy Solutions Centre currently has rebates of 15% of pre-tax purchase costs (in hydro communities like Faro) for **EnergyStar refrigerators, freezers, clothes washers and dishwashers,** in addition to rebates on various heating appliances, water heaters, and water efficient toilets.[36]

Yukon Energy and Yukon Electrical also offer some rebates[37] For example, once their *inCharge* program has been implemented, **automotive block heater timer rebates** will be available for consumers in the Yukon who purchase a timer for a block heater, car warmer and/or battery blanket

3.2.3 Residential home heating actions, fuel switching

Once demand has been reduced through conservation, fuel switching is one way to further reduce energy costs and greenhouse gas pollution. In some cases fuel switching can also increase local resilience by providing local energy supplies. For example, wood has a much lower GHG footprint than coal or oil and could be provided through a renewable regional supply.

Increase use of wood as heating fuel

Wood heating. The Faro community could consider a program to encourage more residents to replace existing older stoves or switch to wood heating with high efficiency EPA-certified wood or pellet stoves. The Yukon government's Energy Solutions Centre currently has rebates of up to $300 on woodstoves, $600 on pellet stoves and $800 on wood furnaces/boilers.[38]

The Energy Champion group suggested that the community would use more wood for heating if more wood for purchase was available. Based on the energy use survey, estimated total wood usage is 514 cords (2670 MWh). Of this, almost half (220 cords) were commercially provided by Keith Carreau, at a cost of $275 per cord (plus $50-$100 for splitting). Keith Carreau is the only commercial wood supplier in town. We assume the rest of the supply to be sourced locally by residents. The Energy Champion group estimates that the yearly demand for cut wood could be at least 350 cords per year if a supplier could be found.[39]

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[36] See Yukon Energy, Mines and Resources, "2013/14 Good Energy Eligibility Criteria." For a full list of eligible items. http:// http://www.energy.gov.yk.ca/pdf/eligibility_criteria__2013-14.pdf

[37] *Backgrounder: Yukon-wide Electricity Conservation Plan*.

[38] "Good Energy Rebate Program."

[39] Comment from Energy Champion group, energy workshop 2013.

Factors limiting supply include the cost and effort of shipping the wood from Haines Junction, the lack of a Forest Resources Management Plan to establish local annual allowable cut, and the limits of local suppliers.

Currently, commercial wood is gathered from the beetle kill stands in Haines Junction and trucked to Faro. This adds to the price of the operation. It also has a GHG impact, more than doubling the estimated CO_2e per cord of wood emitted compared to when the wood is harvested and burned locally.[40]

Note that energy required to transport fuels is NOT considered in scope for the community energy and emission inventory, and therefore these emissions were not included in the 2012 baseline. Nevertheless, these emissions could be reduced by using a more local source of wood. A local wood supply would also increase community resilience and could support some local economic development.

Even with the shipping from Haines Junction, wood has still a much lower GHG footprint than alternative fuels such as oil and coal, as indicated in

Table 15. Note that the emission factors for oil and coal in this table do NOT include those associated with the shipping of these fuels. Even when factoring energy required for shipping the wood, energy from wood still has a GHG footprint about a third that of oil or coal.

Table 15 Greenhouse gas emission per unit of energy for wood shipped from Haines Junction compared to that of oil and coal

Greenhouse gas emission ($kgCO_2e$)	Wood			Oil[41]	Coal[42]
	Burning[43]	Transportation[44]	Total		
Per cord	109	280	389	-	-
Per kWh of energy	0.021	0.054	0.075	0.26	0.33-0.47

[40] Note that while greenhouse gases are emitted when the wood is burned, these emissions are currently calculated to have a net GHG impact of zero under current inventory methods as the wood stands are assumed to re-grow and re-absorb the carbon.

[41] NRCan, *Guide to Residential Wood Heating,* 54

[42] Coal was mined at Whiskey Lake from 1986 to ca 1992 and used to dry concentrate at the Curragh Resources mill at Faro. Coal rank ranges from low volatile bituminous to semi-anthracite, with caloric content between 13 280 and 26 300 MJ/tonnes (~3700-7300 kWh/tonnes). Emission factor from combustion for Canadian bituminous ranges from 1725 kg CO_2e / tonnes for sub-bituminous coal (western) and 2387 kg CO_2e / tonnes for anthracite coal (Environment Canada, *National Inventory Report 1990-2010: Greenhouse Gas Sources and Sinks in Canada.* Part 2, table A8-7, 197. http://www.ec.gc.ca/ges-ghg/default.asp?lang=En&n=83A34A7A-1). Taking the two extremes we calculate an emission intensity ranging from 0.33 to 0.47 kg CO_2e / kWh.

[43] Note that we count here only emissions due to methane and nitrous oxide release when the wood is combusted. The CO_2 released is assumed to be re-absorbed as new trees grown to replace the cut trees. Total emission, counting biogenic CO_2, are 0.33 kg CO_2 / kWh, or 1,714 kg CO_2 per cord. Energy intensity of softwood is 18700 MJ/cord, (5194 kWh/cord,) *Guide to Residential Wood Heating,* 54.

[44] Assuming a 53' trailer, 3780 cuFt, ~25 cord / trip. Dry pine: ~30 lb./ cu ft, ~ 1.74 tonnes per cord. GHG emission, per trip = 0.324 kg/ton/km (NREL LCI Database) x 500 km x 25 cords/trip x 1.74 tonnes per cord = 7.1 tonnes CO_2e per trip, or 0.28 tonnes per cord. Energy density of softwood: 5194 kWh/cord (*Guide to Residential Wood Heating,* 54), so emissions 0.054 kg CO_2e / kWh.

There are no commercial cut block leases within Faro's vicinity. The community is waiting for the completion of a local Forest Resources Management Plan to determine where commercial wood cutting leases could be established.

Keith Carreau has been the sole provider of commercial cut wood in Faro for the last few years, a side-business that he has maintained possibly more as a way to support the community than as a money-making venture. Given the significant amount of work involved and small profit margins, it is unclear how much longer this service will be available.

Local wood co-op. The Energy Champion group suggested that one possible approach to ensure steady supply of wood would be the creation of a wood co-op. This would allow several wood providers to coordinate their application for wood cutting permits in the area. The completion of the Forest Resource Management Plan is a pre-requisite to the allocation of these permits. The creation of a wood co-op could be a valuable economic development and community service opportunity, enabling the community to reduce GHG emissions, reduce reliance on outside energy sources and keep money in the community by shifting heating demand from imported oil to local wood.

A local wood co-op, in conjunction with a Forest Resource Management Plan, could also ensure that the wood used for home heating is replaced through well-managed forest re-planting. This is critical to realizing the greenhouse gas gains from wood as a fuel.

Furnace upgrades

The Town of Faro, working in conjunction with the Yukon government's Energy Solutions Centre, should provide information about incentives to upgrade to more efficient furnaces. To achieve the full energy efficiency gains, furnace upgrades need to be installed by a trained technician, the furnace must well maintained, and the filters changed regularly. The Energy Solutions Centre currently offers rebates of up to $600 on an oil furnace/boiler that has an EnergyStar rated efficiency of 92% or better.[45]

Some residents might be inclined to convert to electric furnaces as the cost of energy (electricity to oil) is now similar. While electric furnaces are cleaner, the increase in electricity at peak demand (cold days) will require more use of the diesel generator in Faro that backs up the hydro-grid power. Use of the diesel generator to provide some of the electricity reduces the gains in local air quality and greenhouse gas reductions.

Additionally, there is an increased risk to homeowners during power outages. In 2011, Faro lost power approximately six times.[46] The local diesel plant is now staffed five days per week to allow rapid start-up, which should help reduce interruptions.

Further study is required to consider price forecasts, long-term cost, local air pollutants and greenhouse gas emissions for electric vs. oil furnaces. In general, however, electricity is considered a high quality energy that should be reserved for needs that cannot be met otherwise (e.g. running computers and medical equipment).

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[45] "Good Energy Rebate Program."

[46] Based on discussion with the Energy Champion group.

Coal

The Energy Champions discussed the merits and challenges in fuel-switching to coal. Coal can be accessed at ground level in Ross River, making it a locally available fuel that is cheap and compact (one truckload providing a few month's worth of heating).

However, coal has many drawbacks, including:

- Access is on First Nations land and should be negotiated.
- Coal has serious impacts on local air quality and can impact residents' health. Local air pollutants from burning coal include sulphur dioxide (SO_2), nitrogen oxides (NO_x), fine particulate matter ($PM_{2.5}$), and mercury (Hg).[47] Nitrogen oxides, in addition to being acid rain precursors, react in the atmosphere to form ground-level ozone, which is linked to the exacerbation of asthma, as is exposure to sulphur dioxide. Exposure to fine particulate matter — either from direct emissions or formed as a result of sulphur dioxide emissions — is known to affect lung development in children. Short-term exposure to fine particulate matter has also been associated with increased incidence of cardiac disease. Mercury and lead are pollutants emitted by coal plants that can affect neurological development when exposure to sufficient quantities occurs during the early stages of life.[48] These health impacts ultimately depend on exposure to the chemical compounds, which depends on the quantity of emissions as well as the characteristics of the local airshed. The risk is small if there are only a few users in a well ventilated area, but would increase if there was a significant uptake of coal in the community. This may be particularly an issue because there are no quality controls on the coal picked up from Ross River.
- Not all wood-burning stoves can accommodate coal, and switching from wood to coal would significantly increase GHG emissions.
- Coal has a high carbon intensity and is considered a high-GHG fuel source.

Therefore, while coal would meet local supply and resilience criteria for community energy, its impact as a greenhouse gas pollutant is high. The impact on local air quality is unknown but must be seriously considered as it could be significant. Pembina recommends against increasing the use of coal.

Ground source and cold climate heat pumps

Heat pumps transfer energy from warmer or cooler sources, such as the ground, to provide heating or cooling. In the north, they are used only to supply heating.[49] They are considered

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[47] Asthma Society of Canada, Canadian Association of Physicians for the Environment, The Lung Association and the Pembina Institute, *A Costly Diagnosis: subsidizing coal power with Albertans' health* (2013). http://www.pembina.org/pub/2424

[48] *A Costly Diagnosis.*

[49] Alaska Center for Energy and Power, Cold Climate Housing Research Centre, *Ground Source Heat Pumps in Cold Climates: The current state of the Alaska industry, a review of the literature, a preliminary economic assessment, and recommendations for research,* A report for the Denali Comission (2011). http://www.uaf.edu/files/acep/Ground-Source-Heat-Pumps-in-Cold-Climates.pdf ; see also Alaska Center for Energy and Power, Cold Climate Housing Research Centre, *Air source heat pumps in Southeast Alaska: a review of*

partially renewable because they use heat from the ground or air, which is then supplemented by electricity. Heat pumps offer significant efficiency gains over conventional heating systems because their efficiencies are well over 100% (generally 250% or more). Studies conducted in Alaska concluded that that heat pumps are cost effective in some communities, depending on the prices of conventional fuels such as fuel oil and electricity[50] and the Yukon government's Energy Solutions Centre completed a similar report for Yukon in 2010[51].

YEC is piloting cold climate heat pumps and might consider additional incentives to those already offered through the Good Energy Rebate: "the utilities will pilot these systems to ensure their application in our northern environment. If the pilots are successful the utilities will look at incentives for this technology."[52] Given the rapid rise of uptake of air source heat pump by Yukoners, with varying results, it would be judicious to extend the pilot study to include a review of private installations, and following this review, consider the need for incentives.

Depending on the results of the Yukon pilots, Faro residents may want to consider heat pumps as an alternative to conventional furnace upgrades, particularly if the utilities provide incentives for their purchase and installation. Heat pumps may increase electrical use, so building envelope upgrades to reduce overall energy demand are recommended prior to sizing systems. The Yukon government's Energy Solutions Centre currently offers a $600 rebate on an air source heat pump that is Energy Star 7.0 HSPF or better.[53]

3.2.4 Residential hot water actions

Fuel switching – consider solar hot water

This action was a high priority for the Energy Champions, though its applicability in northern climate was debated. Solar hot water systems are a proven technology used for several decades in Canada and across the Yukon. There are experienced contractors living in Dawson and Whitehorse and demonstration projects in Dawson, Whitehorse and Mayo. The principle is simple: solar collectors absorb energy from solar radiation and transfer the heat into a storage tank, either directly in cases where the water is unlikely to freeze, or through the use of an anti-freeze and heat exchanger in colder climates. Solar water heating supplements conventional hot water and reduces the amount of conventional energy needed to heat the water.

Solar hot water systems are designed to be mounted on the roofs of houses and in Canada are ideally built facing south. The ideal slope of the collector is typically the latitude of the location less 15 degrees (0 degrees would be laying horizontal, and 90 degree would be vertically

the literature, a market assessment, and preliminary modeling on residential air source heat pumps in Southeast Alaska (2013). http://cchrc.org/docs/reports/ASHP_final.pdf

[50] Ibid.

[51] Caneta Research, *Heat pump characterization study*, prepared for Energy Solutions Centre, 2010 http://www.energy.gov.yk.ca/pdf/yukon_airsource_heatpump_mar_2010.pdf

[52] *Backgrounder: Yukon-wide electricity conservation plan.* See also Yukon government's Energy Solution Centre, *An evaluation of air source heat pump technology in Yukon* (2013) http://www.energy.gov.yk.ca/pdf/air_source_heat_pumps_final_may2013_v04.pdf

[53] "Good Energy Rebate Program."

mounted). If the roof is not at the ideal angle, framing can be used to mount the system as shown in Figure 12.

One generalized study estimates that solar hot water systems in Whitehorse could meet 31% of annual hot water demand.[54] The payback period on solar hot water systems in Faro is not known, but could be investigated.

Solar hot water systems may be combined with wood stove water heating systems to displace conventional water heating altogether. In this case, the solar system heats the water in the summer while the wood stove heats the water in the winter.

The Yukon government's Energy Solutions Centre has rebates of 15% on solar hot water systems, to a maximum of $1200.[55] They also have rebates on efficient water heaters.

[54] NRCan, *Solar hot water heating systems: A buyer's guide*, (2004) . Note that the numbers in this study are low compared to studies on the potential in other communities and are dependent on system sizing. For additional information on sizing, sloping, and possible hot water production see http://www.energy.gov.yk.ca/pdf/sola_dhw_sizing.pdf.

[55]. See "Certified Solar Domestic Hot Water Systems" for a complete list of eligible solar hot water systems. http://www.energy.gov.yk.ca/pdf/certified_sdhwh.pdf

(a)

(b)

(c)

Figure 12 Solar hot water systems installation in northern regions. (a) Hatton Residence, Whitehorse, YT (b) Gold Rush Inn, Whitehorse, YT, (c) Wha Ti, NWT[1]

3.2.5 Community transportation actions

As presented in Table 12 and Table 13, there are various ways in which the community is already trying to reduce transportation fuel cost and emissions, including car pooling, active transportation, and telecommuting (working from home). The Town of Faro can continue to build on these efforts to reduce energy use for transportation. Following are a few strategies to do so.

Reduce number of trips to Whitehorse

Residents regularly drive to Whitehorse (a distance of approximately 350 km) for shopping and access to healthcare, the airport, government offices, etc. The Energy Champions suggested two main approaches to reduce commuting to Whitehorse: shopping locally and coordinating travel by multiple households to reduce number of trips.

- Although shopping locally would reduce the trips to Whitehorse, residents currently make the trip to purchase items that aren't available in the community.
  - Some farmers have produce in summer that they cannot sell; summer farmer's markets could bring people together and create a better market for local products. This would provide a synergy between community economic development and energy conservation[56]
  - However, as people would still have to go to Whitehorse for other business, the reduction in driving might not be as great as hoped.
- Trips to Whitehorse could be better coordinated. Suggestions included car pool, share shopping list, create a shuttle, etc. A mini-bus that runs to Whitehorse might be difficult because of coordination — people want to go to many different locations once in Whitehorse.

Purchase fuel efficient vehicles, down-size and right-size vehicles

When trips cannot be reduced, the size and efficiency of vehicles plays a big role in fuel use and GHG emissions. Vehicle fuel economy is now regulated by the federal government.[57] In 2010, the federal government announced new regulations and is gradually improving efficiency for light-duty vehicles (passenger cars and pickup trucks, SUVs and vans) for 2011-2016, particularly with respect to greenhouse gas emissions. They intend to bring in more stringent regulations as of 2017.[58]

These regulatory changes provide an opportunity for individuals and communities to reduce the fuel used by passenger cars and light-duty trucks. In some cases, replacing an older vehicle with

[56] The Silver Hills Farmers Market in Mayo may provide a good precedent for this.

[57] The first regulatory framework was only set as of 2007, with the regulations coming into effect in 2011; prior to that, fuel consumption standards were set by voluntary agreements with automobile manufacturers. http://www.tc.gc.ca/eng/programs/environment-fcp-history-630.htm

[58] Office of the Auditor General, *2012 Spring Report of the Commissioner of the Environment and Sustainable Development*, Chapter 2—Meeting Canada's 2020 Climate Change Commitments, Exhibit 2.3—GHG regulations are in place in the transportation sector and proposed for the electricity sector, http://www.oag-bvg.gc.ca/internet/English/parl_cesd_201205_02_e_36774.html#ex3

a new, fuel-efficient one can result in savings of up to 40%. Over time, these fuel-efficient vehicles will become available as used models as well.

In addition to including fuel economy in vehicle purchase decisions, Faro residents can also think about "down-sizing" and "right-sizing" their vehicles. This means considering whether a smaller vehicle might be able to meet their vehicle needs, and making sure that they are buying the right vehicle for its intended use.

Convene a community dialogue on transportation

The challenges in reducing trips to Whitehorse and down-sizing or right-sizing vehicles suggest that Faro residents may want to convene a dialogue on transportation options to reduce their vehicle fuel consumption, save money and build community.

The preliminary set of ideas noted above could be a starting point. Other ideas might include: developing a local food co-op that places food orders in Whitehorse and has the full community order brought in to the community regularly; using online tools to connect residents for ride-sharing to Whitehorse; sharing special purpose work trucks (as noted in the resident survey, many households have several vehicles, including specialized work trucks).

Active transportation, supported by community design

Quality public spaces in the community, including trails, sidewalks and gathering spaces, can support residents who choose active transportation over driving a vehicle. Active transportation includes walking, cycling and skiing as well as skateboarding and mobility scooters/wheelchairs.

There are many benefits in having more people actively moving around the community: stronger social networks; healthier kids, parents, and seniors; and support for the local economy and businesses, including tourism. The following suggestions to support active transportation also make for a more livable, attractive community:

- Make walking more enticing with benches, trails, and good quality sidewalks; make sure there are safe crossings around the schools.
- Support cycling with trails, space on roads/shoulders, bike racks, signage; make sure there are safe cycling routes to the schools.
- Support skiing in the winter by maintaining a network of ski tracks and trails.

Anti-idling

Idling can account for a significant proportion of fuel use and increase local air pollution and greenhouse gas emissions. Idling also increases wear and tear on vehicles. There is a range of actions the community could take on idling including:

- Bring in an anti-idling bylaw, limiting non-purposeful idling to three minutes.[59] Anti-idling bylaws are becoming common in Canadian municipalities that want to reduce local air pollution as well as greenhouse gas pollution. Anti-idling saves money on fuel costs for residents and municipal fleet vehicles.
- Declare the community idle-free.

[59] Some idling is necessary, such as when trucks need to idle to run safety lights.

- Have a community-wide anti-idling education campaign, led by a municipal anti-idling program, with signs in commercial parking areas, schools, at municipal buildings and in municipal fleet vehicles.

3.3 Opportunities for further action by the commercial sector

YEC and YECL will be bringing in several demand side management (DSM) programs for commercial buildings.[60] As some of the commercial buildings in Faro have high energy use (see Figure 6), these programs could provide energy reduction and cost saving benefits. The programs will include:

A lighting redesign and equipment incentive to design the best lighting system for the building's need, with additional incentives for building owners to retrofit their lighting systems. Owners should look for rebates on high efficiency lighting, including LEDs and high performance T8 and high output T5 fluorescent lights.

Rebates on refrigeration system upgrades, helping pay for the cost of retrofitting the refrigeration systems.

Rebates for EnergyStar computers, to support the cost of buying more energy efficient computers and peripherals.

In addition to these programs, commercial building owners may also want to undertake **energy audits** (discussed below under municipal buildings), and/or **building envelope upgrades** such as air sealing and improved insulation (discussed under residential building actions) to reduce the energy used for building heating.

3.4 Opportunities for further action in municipal operations

3.4.1 Municipal buildings

Energy Efficiency

The highest energy use building is the Faro Recreation Centre, followed by the arena. the water pumping stations also have high energy use, and the highest combined electrical use of all the buildings. Other buildings at the high end of energy use include the mechanical shop, the fire hall and the administration building.

Energy Audits of key buildings

Faro could consider conducting detailed, on-site energy audits for the high energy use buildings (arena, shop, fire hall and administration building) as well as their recreation centre, using gas

[60] *Backgrounder: Yukon-wide electricity conservation plan.*

tax funding. The energy audits would include performance evaluation and specific recommendations.

These detailed audits should build on to the high-level energy audit based on building energy consumption data that has been conducted for the Faro Recreation Centre.[61] The recommendations below draw on the generalized recommendations contained in the recreation centre energy audit report.

Building envelope upgrades

Air sealing. Weatherstripping doors and windows and sealing vents and dampers are very important, as air leakage is often the single largest source of heat loss in a building.[62] Tightly sealed vents, doors or windows allow less cold air to enter the building; fresh air will enter the building only through controlled means such as an air handling system. In winter, poorly sealed dampers, doors and windows greatly affect heating. By maintaining and replacing worn weatherstripping, heating savings as large as 25% can be realized.[63]

Air sealing is recommended as a priority for the Faro Recreation Centre in the StartPoint report.[64] Walk-through site assessments and repairs could be carried out for the four other high energy use buildings in Faro at the same time as the recreation centre. Replacing weatherstripping and caulking is a low-cost, high benefit action.

Insulation upgrades. On-site energy audits would be required to assess potential insulation upgrades to Faro's municipal buildings. Insulation upgrades have the potential to significantly reduce heating demand; however, retrofits can be complex and must be done well.[65] Faro could consider a gas tax funded program to conduct detailed energy audits as well as insulation upgrades and other recommendations.

LEDs, efficient fluorescent lights and occupancy sensors in offices can reduce the electrical load in municipal buildings. The Faro Recreation Centre report notes that "many older buildings have T12 fluorescent lamps and magnetic ballasts that use up to100 watts for a 2-lamp fixture. Replacing these with T8 lamps and electronic ballasts will reduce the power consumed by up to 30% while providing equal or better illumination." [66] Exit lights run 24 hours a day; LED exit lights can reduce their electrical consumption by up to 90%.[67]

Faro's municipal government could pursue lighting system redesigns, potentially partially funded by YEC/YECL under their new DSM program[68], or funded by gas tax monies (see 3.4.5).

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[61] Energy Solutions Centre, *StartPoint Energy Audit, Faro Recreation Centre* (2012).

[62] Ibid, 27.

[63] *Aboriginal Energy Alternatives,* 14.

[64] *StartPoint Energy Audit, Faro Recreation Centre,* 27.

[65] See the StartPoint Recreation Centre report for specific recommendations on insulation jobs.

[66] *StartPoint Energy Audit, Faro Recreation Centre,* 27.

[67] Ibid, 28.

[68] It is unknown to us at this point whether this program will be offered only to commercial customers, or to both commercial and institutional costumers.

Building renewables

Solar air heating is a proven technology, developed in Canada, for heating or pre-heating building air. The Solarwall™ uses metal building cladding on institutional and commercial to pre-heat ventilation air. It also recaptures some of the building wall heat loss.[69] Solar air heating can be financially attractive where heating costs are high, such as in northern buildings. The recreation building in Fort Smith has a solar air heating system.[70] The gas tax money may be applicable to retrofitting Faro buildings with solar air heating.

Solar hot water could also be considered for buildings with high hot water demand; this includes the Faro Recreation Centre, and possibly the nursing station and school buildings.

Reducing water pumping station energy use

As noted in the Residential section, reducing water demand could reduce energy use in the pumping stations. Thus, engaging the community in water reduction measure can help the Town of Faro reduce its corporate energy use. The municipality could consider an active water reduction program for residents, encouraging the uptake of low-flow showerheads, faucet aerators, low-flow toilets and front-loading washing machines. The utilities may make some of these (e.g. low-flow showerheads) available to customers at low or no cost.[71] Low flow showerheads are also on offer from Yukon governments' Energy Solutions Centre.

3.4.2 Municipal fleet

Maintenance and management

On-going sound data management is key to reducing energy use, fleet costs and greenhouse gas emissions from municipal vehicle fleet. Specifically, tracking annual vehicle kilometers travelled in addition to vehicle fuel use, and calculating vehicle fuel economy, are a critical component of active data use for efficient fleet operations. Actions include:

Track odometer readings with each fuel-up or at the first fuel-up of every year and at every service check. This provides annual mileage and, along with the annual vehicle fuel use, the fuel economy for each vehicle. This data enables the municipality to identify under-utilized vehicles that could be down-sized or better used, and identify under-performing vehicles that need servicing.

Systematic maintenance is critical to fleet performance and optimizing vehicle fuel economy. This includes a regular tire pressure check program.

Route optimization ensures that the shortest routes are driven to perform services.

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[69] Canmet Energy Technology, *Clean Energy Project Analysis, RETSCreen Engineering and Case Studies Textbook: Solar air heating project analysis chapter.* RETSCreen International Clean Energy Decision Support Centre, Natural Resources Canada. www.retscreen.net

[70] Arctic Energy Alliance website. http://aea.nt.ca/saving-energy/heating-and-cooling

[71] *Backgrounder: Yukon-wide electricity conservation plan.*

Adopt green vehicle policy

A Green Fleet policy could include policy to purchase "best-in-class" vehicles from a fuel efficiency standpoint, include fuel economy conditions for vehicle replacement and in requests for proposals, replace larger vehicles with smaller ones that can perform the same tasks, and purchase alternate fuel vehicles if applicable (e.g. hybrids).

Some Green Fleet vehicles are more economical in both capital and fuel costs: compact, best-in-class passenger cars generally have lower upfront capital costs as well as lower fuel costs over time as compared to larger passenger cars. A business case study is recommended to ensure that alternate vehicles fit the job required and that price differentials are paid back through fuel savings.

The overall impact of a Green Fleet policy will depend on the type of vehicles in Faro's municipal fleet.

Anti-idling

The municipal government could bring in an anti-idling program for fleet vehicles, with signage in municipal vehicles and at parking areas including the town office and recreation centre. This action would be strengthened if combined with community-wide anti-idling initiatives discussed under community-wide actions.

3.4.3 Streetlights

YEC and YECL, along with the Yukon government, have piloted LED streetlight projects in Dawson City and Whitehorse. In Dawson City, replacing six conventional high-pressure sodium fixtures with LED fixtures resulted in a 64% savings in energy use over a 10-month period. The lights performed as well as the high-pressure sodium lights, with no weather-related problems. 89% of residents who responded to a survey about the lights supported switching to the LED lights.[72] YEC is now conducting an additional test of a newer brand of LED lights.[73]

The municipality of Faro could work with the utilities and the Yukon government on a streetlight bulb replacement program, once final results from the pilots have been compiled. Replacing the current streetlights with LED's could save Faro money on energy costs; even though streetlights service are currently charged at a flat rate, independent of their actual demand, it might be possible once the light fixture are replaced to renegotiate the rate to account for the reduced demand.

Replacing the streetlights with LED fixtures also presents an opportunity to highlight the benefits of LED bulbs to homeowners and local businesses.

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[72] Roske, K. et al. (2012) *Dawson LED Streetlight Project – Final Report.* Yukon Energy. http://yukonenergy.ca/downloads/db/1121_Dawson%20LED%20Streetlight%20Pilot%202011%20Report.pdf

[73] Yukon Energy, "How's our lighting, Part 2" blog, January 11, 2013. http://blog.yukonenergy.ca/blog/hows_our_lighting_part_2/

3.4.4 Solid waste

Emissions from Faro's landfill account for about 10% of total greenhouse gas pollution in the community. There are two main ways to reduce emissions from the landfill: either the emissions are captured at the site before they reach the atmosphere and are flared or otherwise treated, or the quantity of organics in the landfill is reduced through waste diversion. Methane capture at the landfill would be costly and, from a municipal perspective, investing in energy efficiency in buildings and fleet would offer better returns in energy savings and greenhouse gas reduction.

Encouraging waste diversion and composting can be done at much lower cost. The residents of Faro are reportedly already engaged in composting and recycling to a limited degree[74]. The Town could work with these individuals and the Yukon government, which has a current commitment to waste diversion through its Solid Waste Management Strategy and Solid Waste Working Group, to enhance the waste diversion capacity of Faro. While the impact of waste diversion is not immediate, as the organics currently in place in the landfill will continue to emit methane until fully decomposed, it remains a valuable strategy to reduce future landfill emissions. Reducing solid waste by recycling and composting have other benefits including reduced landfill maintenance costs and reduced demand for raw materials. Social marketing programs to encourage reducing material consumption and increasing recycling and composting are generally helpful in reducing energy use community-wide as they foster an overall culture of conservation.

3.4.5 Funding sources - Municipal Gas Tax

The federal gas tax can be accessed to fund some of the municipal projects suggested above. Faro's overall allocation to December 31, 2014 is $1,424,820. With $519,005 in approved projects to date, Faro has a balance of $905,815 available, based on a yearly allocation of $219,198.[75]

Eligible activities include active transportation infrastructure (local roads, bike lanes, etc. that improve sustainability outcomes), and building system improvements that promote significant energy efficiency improvements and/or utility as well as public transit, water and wastewater facilities, solid waste, community energy systems, cogeneration and district heat.[76]

Gas tax funding can also cover up to $25,000 of general management, planning, oversight, coordination, evaluation, and reporting on eligible category activities, and thus can help pay for the administrative cost for the maintenance or creation of programs.

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[74] Town of Faro, Solid waste management plan, 2003.

[75] http://www.infrastructure.gov.yk.ca/gastaxtoolkit.html

[76] Canadian government and Yukon Government, *Agreement on the transfer of federal gas tax revenues under the new deal for cities and communities 2005-2015*, Schedule A, 25. http://www.infrastructure.gov.yk.ca/pdf/Canada-Yukon_agreement_-_FINAL.pdf

3.5 Opportunities for further action in territorial government buildings

Actions for territorial government buildings include the same suite of actions as proposed for municipal buildings: energy audits, envelope upgrades, and system improvements including solar air heating, particularly for the largest energy users: the Del van Gorder School/Yukon College Faro campus and the Nursing Station. The school building alone accounts for almost eight percent of the total energy use in the community, costing over $200,000 per year. Retrofitting this building could yield valuable savings.

3.6 Community energy systems

Community energy systems include district heating systems (biomass, natural gas or other plants that supply heat and hot water to several buildings in close proximity), waste heat capture (e.g. from the diesel generator), or local renewables such as wind and solar. District energy systems in particular are common in northern European communities. Biomass district energy systems can provide very significant reductions in community greenhouse gas emissions.[77]

Pre-feasibility of community energy systems is beyond the scope of this project. However, a preliminary analysis suggests that such projects could be challenging in Faro. For example, the largest heating load buildings (Yukon College, schools, nursing station) that could take advantage of waste heat from the diesel generating plant are up to one kilometre away and across a river, suggesting that a waste heat capture system might not be viable from a financial or technical perspective. Nevertheless, there might be other opportunities for renewable energy development in the area.

[77] See for example the studies conducted by Compass Resources Management consulting for the BC Clear project on biomass district energy in Vancouver: Compass Consulting, BC Clear Backgrounder: Climate, 2011.

4. Recommendations

This section summarizes Pembina's recommendations for the Town of Faro for next steps in terms of actions at the community level and in municipal operations. We also include recommendations regarding buildings managed by the territorial government and suggestions to facilitate future data gathering and monitoring, which can be led by the municipality or by territorial agencies.

Recommendations to advance community actions

1. **Promote the use of wood as heating fuel.** Wood is a low-cost, low-GHG, locally sourced renewable resource that could play a greater role in the Faro energy mix. We suggest that this could be facilitating by coordinating with the territorial government to ensure prompt completion of the Forest Resources Management Plan, promoting rebate programs available for the purchase of high efficiency wood and pellet stoves, and facilitating a community conversation on how to ensure local supply of wood, including the possible creation of a wood co-op.
2. **Convene a community dialogue on transportation.** Several of the options discussed in Section 3.2.5 to reduce time and money spent on travel, particularly to Whitehorse, require community leadership. These options include car pooling, shared shopping lists, shuttles, active transportation, vehicle sharing, or a focus on strengthening local suppliers through a farmers' market and other means. The dialogue could also be a platform to discuss the possibility of becoming an idle-free community. The community dialogue should focus on practical yet innovative solutions and community building.
3. **Partner with the Yukon government's Energy Solutions Centre and the utilities to roll out demand side management (DSM) programs and promote energy conservation in the community.** Local government can be a strong ally to ensure the success of DSM plans; approaching the utility company to signify interest in facilitating the rollout could yield mutual benefits:
   - The Town can promote the programs through its newsletter, Facebook page and website.
   - Faro can also offer YEC/YECL a willing test ground for pilot projects, which can often yield substantial benefits to participants, such as access to reduced-cost or free energy efficient suppliers and services.
   - The Town of Faro could find an Energy Champion amongst its staff who would serve as the 'go to' person for information regarding the various rebate programs.
   - YEC/YECL will be looking for "community energy efficiency ambassadors" to assist with public engagement on DSM. The energy champions or Town of Faro representatives could volunteer for this program.

- Outreach to the local businesses could increase uptake of the DSM offerings provided by the utilities for commercial customers, improving the efficiency of commercial buildings and keeping money in the community. Cooperation with local retailers could also help ensure that energy efficient products with rebates are available locally, reducing the need for trips to Whitehorse and returning more benefits to local businesses.
- The Town could create a display area by the reception desk to showcase energy conservation fact sheets[78] and other educational materials.
- If programs are made available to address building envelope and insulation, the Town of Faro could collaborate with the Energy Solutions Centre to advance a thermal imaging campaign in the community, providing homeowners with a way to see their energy losses and to access incentive programs to improve building performance.
- A collaborative behavior change campaign could promote cost-free energy savings in the community.

The Town of Faro will need resources to advance these outreach strategies, just as local residents will need some resources to act on them. Partnering with the utilities, who could benefit from local partners to roll out its DSM programs, might be a way to facilitate this process. Also, up to $25,000 of tax gas money could be used to finance the administration of programs.

Recommendations to advance actions at municipal operations

4. **Conduct a weather-stripping walkthrough of buildings.** As a first step to capture low-hanging fruit, maintenance staff could conduct a visit of all major buildings, focused on opportunities to improve air sealing of the building envelopes by replacing worn weather-stripping and caulking gaps and cracks. These are low-cost actions that yield high energy saving returns.
5. **Conduct energy audits with site visits of the top four or five most energy-intensive buildings,** which are the recreation centre, the arena, the pump houses, the administration building and the firehall. These energy audits could be financed through the gas tax fund, and would lead to a list of suggested improvements for each building. These building-specific actions should be prioritized, with key actions as the basis for gas tax funding applications over the following years.

Recommendations to advance actions in buildings operated by the territorial government

6. **Conduct an energy audit on the Del van Gorder School and engage students in the process.** This building alone accounts for almost 8% of the total energy use in the

[78] The Energy Solutions Centre as well as BC Hydro's powersmart program have created very useful educational fact sheets on various aspects of energy conservation. Generally, the BC Hydro materials have a simpler communication style and talk more explicitly about the potential benefits to the customers; the Energy Solutions Centre materials on the other hand build on the BC Hydro examples and go into more detail about the technical aspects of each measure in a local context. We consider these two series to be a great complement to each other, the BC Hydro material being most suited as quick read to convince readers to take action, and the Energy Solutions Centre fact sheet providing a more in-depth analysis when the consumer has decided to take action and looks for the best path to do so. Powersmart fact sheets: http://www.bchydro.com/powersmart/residential/guides_tips/green-your-home/heating_guide.html ; Energy Solutions Centre: http://www.energy.gov.yk.ca/energy_efficiency.html

community, costing over $200,000 per year; retrofitting this building could yield valuable savings. Furthermore, this could be a unique opportunity to engage students at both the Faro school and the Yukon College on energy issues.

7. **Conduct an energy audit on the nursing station, and engage staff and population on a conversation around health and building performance.** The nursing station is the second largest energy user of the territorial buildings in town. As the primary health center in the community, it is also a great platform to educate the population about environmental health, and the health risks of poorly performing buildings.

Recommendations for data gathering and monitoring

For the Town of Faro:

8. **Provide a yearly report to council on energy use by buildings and the vehicle fleet**. The Town of Faro already does a good job of tracking energy use for buildings and acting on this information. It has also now started tracking fuel use per fleet vehicle as well. Tracking distance travelled with each fuel-up, or at least annually, is another key aspect of data gathering for fleet. In addition to compiling this data on buildings and fleet, it is important to review the data periodically and draw conclusions from that analysis on the state and performance of these assets. Instigating a yearly presentation to council on energy use would be an effective way to spur the conversation and ensure that the data collected is put to good use.
9. **Reconvene the Energy Champion group three to four times a year to monitor progress.** Members of the Energy Champion group have expressed their willingness to continue to support this process through their feedback and connections in the community. Local leadership plays a key role in ensuring the community is aware of and on board with local plans, monitoring progress, and spurring innovation on the ground. Convening a group of citizens engaged on energy issues on a regular basis will support ongoing implementation of the energy plan by residents.

For Town of Faro and/or territorial agencies:

10. **Continue dialogue with energy suppliers to obtain sales data.** Energy inventories are much simpler and more accurate when information on the total amount of energy supplied to the community is available. One advantage that small communities have is that generally there are only a few suppliers to gather information from, making a 'top-down' inventory possible. The Town of Faro, or staff from the territorial government, should continue the conversation with the local suppliers to see if their concerns with sharing this data can be addressed. Alternately, it should be investigated whether the equivalent information can be drawn from fuel tax records kept by the territorial government.

For territorial agencies:

11. **Continue investment in the development and maintenance of the PBET database.** The Public Building Energy Tracker Database is a useful tool to track public assets across the territory. The maintenance of this tool, or other asset management platforms, is key to track and diagnose energy performance of public buildings. The territorial government should continue to invest resources in establishing PBET as a tool for Yukon

municipalities to use. Yukon government should consider providing training and capacity building support for its adoption.

12. **Develop a protocol to update the energy and emissions survey every two or three years.** The main value of an inventory comes from its capacity to monitor energy use over time. Trend data can show what actions are effective, and also enable Faro to adapt to a changing energy reality. This inventory was conducted as a pilot project — key learnings should be leveraged and a methodology should be developed to facilitate the creation of replicable inventories. This methodology could then also be used in other Yukon communities and across the Yukon as a whole. The resulting local inventory results would then provide the basic information necessary to help local and territorial governments and the electricity utilities to improve energy resilience, keep dollars in the community by saving on energy bills, and reduce greenhouse gas pollution and local air contaminants.

Appendix A. Energy and emissions inventory: scope and methodology

A.1 Scope

The scope of this inventory follows the general guidance of ICLEI's International Local Government GHG Emissions Analysis Protocol (ICLEI 2009)[79], with a few exceptions. The inventory aims to include all energy uses and greenhouse gas (GHG) emissions generated within the city limits of the Town of Faro. Emissions from fuel use at stationary sources (e.g., buildings and infrastructures) include residential, commercial, and governmental/institutional users. The only industry in the area, the mine, was left out of scope since it is outside the boundary of the town.[80] When considering stationary sources, we include emissions generated on site by the combustion of fuels (wood, heating oil, propane) as well as emissions resulting from electricity generation. We do not include, however, the emission and energy used in delivering combustible fuels to Faro. From the transportation sector, we include both on- and off-road vehicles for residential use. For lack of data, we have not included commercial transportation in this inventory. Similarly to the B.C. CEEI protocol, the Faro inventory does not include energy and emissions from air transportation. This is in part due to the difficulty of accessing data on jet fuel use (or number and distance of trips), and in part due to the lack of local capacity to reduce the demand for air travel. While energy use and emissions from planes can be significant, the steering group considered that the opportunities to reduce in that sector were mostly out of the jurisdiction of the Town of Faro, and that it would be preferable to focus the inventory on areas where residents and municipality can most realistically facilitate reductions.

In terms of emissions, while ICLEI would consider the six greenhouses gases covered under the Kyoto Protocol (carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), perfluorocarbons (PFCs), hydrofluorocarbons (HFCs), and sulfur hexafluoride (SF_6)), we concentrate here on the three main ones: carbon dioxide, methane, and nitrous oxide. We will provide an estimate of methane emissions from the Faro landfill, but do not attempt to quantify emissions related to land use, forestry or agriculture — which are, in any case, relatively limited within the town limits.

[79] ICLEI, *International Local Government GHG Emissions Analysis Protocol (IEAP)*, (2009). http://www.iclei.org/fileadmin/user_upload/documents/Global/Progams/CCP/Standards/IEAP_October2010_color.pdf

[80] It should be noted furthermore that the mine is no longer in operation and thus does not significantly contribute to the local economy. The mine is currently being reclaimed, and this process does demand a significant use of energy. While it would be worthwhile to consider how this energy use could be reduced, this is outside the boundary and the jurisdiction of the Town of Faro, and therefore has been excluded from this inventory.

A.2 Methodology

There are two main approaches to compiling an inventory of energy use and greenhouse gas emissions in a community: one can evaluate total use by summing the various fuel supplies to the community, or one can estimate and sum the various energy end uses. These two approaches are sometimes referred to respectively as top-down and bottom-up. Which approach should be used depends on the data available.

The **top-down** approach estimates total energy use by compiling sales data for the different fuels used in the community. Based on actual consumption data, it gives the most accurate measure of *how much* of each energy sources is used. This is a very accurate way to build an energy inventory for a community. However, since only the aggregated data collected at point of sale is reported, this approach does not provide information on the end use of the energy, i.e., *what* the energy is used for, and by *whom*. Information on end use is important because it can provide useful insights to guide actions to reduce energy use and emissions. For example, one could get total gas sales in a community, but would not be able to tell how much was used by residential and commercial customers. One can know the total amount of electricity used by a customer class, but not how much is used for heating, for lighting, for appliances, etc. Information on end use is also necessary to calculate GHG emissions, since the composition of the emissions depend not only on the fuel used, but also on the quality of the combustion. For example, the emissions from burning one litre of diesel or gasoline vary depending on the type of vehicle used (see Table 17). While a top-down approach is the most accurate way to characterize a community's energy use and track its evolution over time, some information on the end uses of energy is helpful to complete the picture and get a more accurate inventory of emissions.

When data on fuel sales is not available, a **bottom-up** approach must be used. Not knowing how much energy was sold, we can still try to estimate how much was used. This can be done by asking residents about their energy uses through community surveys or by modeling. For example, we can divide the building stock into a limited number of archetypes (e.g., single family homes, row homes, low-rise apartment buildings) and make assumptions about average energy use (per m2) for each of these archetypes. The bottom-up approach requires more data to be gathered from multiple end users, rather than a few energy providers. Because there is generally only a subset of data available, some assumptions must be made to generalize from that sample to get a picture of the entire community. These assumptions can make it more difficult to track energy use over time, and to compare with other municipalities. Still, by painting a more detailed picture of energy end use, the bottom-up approach can provide insights into strategies to reduce energy demand.

For this inventory, we were not able to obtain sales data from the three fossil fuel providers in community. The only complete information we have on the supply side is from the electricity company, Yukon Energy Corporation (YEC). Missing several of the fuels suppliers, we could not use a top-down approach, but rather had to use a bottom-up approach to characterize energy use for transportation and buildings from the residential sector. Billing data from public buildings is compiled and was available for the municipal, and territorial sectors. GHG emissions from municipal waste are also included in the emissions inventory. Table 1 summarizes the key source of data for each of these sectors.

The following sections describe in more detail the methodology used for each end use and sector.

A.3 Buildings

A.3.1 Residential buildings

Energy use in residential building is a significant portion of community energy use and also, given the number of buildings involved, one of the most complex to estimate. Four sources of information were used to estimate residential use of wood, furnace oil, propane, and electricity:

- The Town of Faro's sewage and water billing information provided the number of units occupied and the type of building.
- The 2010 Conservation potential review provided typical electrical use for lighting and appliances, as well as heat load estimates for building archetypes.
- The community survey provided information about home heating systems and average fuel costs.
- Yukon Energy provided electricity utility data, giving us total electricity use for residential customers, as well as a sense of the spread of electricity demand amongst these users.

There are six steps to estimate and validate residential building energy use. We give an overview of the process here, while detailed calculations and assumptions are detailed in Appendix A.

Step 1: Inventory the residential building stock: Water and sewer billing data provides accurate data on the fabric of the residential building stock, including number and type of occupied units.

Step 2: Divide building stock amongst 16 building archetypes defined in the 2010 Conservation Potential Review (CPR): data provided on the age of the building (pre/post 1980), its main heating fuel (electric/other), and the building type (detached, row, mobile) allows us to classify each survey entry into one of the 16 building archetypes defined in the 2010 CPR.

Step 3: Use community energy survey to estimate fuel use for each archetype: Having estimates of prices and household annual energy costs, we can assess how much fuel they use, and calculate averages for the five building archetypes represented in the survey. Total energy cost per building archetype is presented in Table 4.

Step 4: Use CPR and survey data to evaluate energy demand by end use: The survey provides total fuel use, the CPR provides estimates for lighting and appliances; the difference between the two tells us how much must be used for heating. The results of this analysis are presented in

Table 5.

Step 5: Validate estimates: compare to CPR results and to aggregated electricity billing data. We can compare heat loads for different archetypes as inferred from survey results (based on fuel consumption and performance of heating system) to those provided in the CPR. Yukon Energy data is used to calibrate the electricity estimates generated from the community energy survey. Ultimately, we use Yukon Energy data rather than the survey estimates to get total electricity use per sector, since it is a more accurate source for overall electrical use.

Step 6: Calculate GHG emissions from energy use: Emission factors tell us how much CO_2 equivalent is emitted by the combustion of different fuels, as well as for the generation of electricity. These factors represent the sum of carbon dioxide, methane, and nitrous oxides emitted when a combustible is burned. Each of these gases has a different global warming potential, which is expressed relative to that of carbon dioxide. This allows us to synthesize the overall greenhouse gas impact of these gases in units of CO_2 equivalent, or CO_2e. The GHG intensity of the different fuels is presented in Table 29.

A.3.2 Commercial buildings

The only data we have for commercial buildings is their electricity consumption. We do not have estimates for their other fuel uses, and this is a gap in the inventory.

A.3.3 Municipal buildings

Data on fuel and electricity use from municipal building was provided by the Town's finance department, and is summarized in Table 6.

A.3.4 Territorial buildings

Information on territorial buildings energy use was provided by the Yukon government's Energy Solutions Centre, based on data compiled in the Public Buildings Energy Tracker (PBET) database; the available data is presented in Table 7.

A.4 Transportation

Fuel use and GHG emission estimates for transportation are based on the data provided in the community survey. We were not able to obtain data on fuel sales from the local diesel and gasoline provider, and therefore had to create a community energy survey to compile that information. The first survey question asked respondents to estimate their household weekly fuel cost for each vehicle they owned (car, truck, snowmobile, motorcycle, ATV, boat, RVs), as well as the number of months per year they are used and the average weekly distance travelled (if available). Knowing the type of vehicles (diesel/gasoline) and the average fuel costs for each survey respondents, we can estimate an average annual fuel use per household. Extrapolating this average to the 185 households in Faro, we get a rough estimate of the diesel and gasoline use by residential customers. To this we add the fuel used by the Town of Faro, to get overall diesel and gasoline consumption.

We can validate the survey results by comparing them to vehicle registration data. This data does not provide any information on fuel use, but it does give an indication of the number of vehicles in operation in the city. Extrapolating the average number of cars, trucks, and other vehicles in each household based on the community survey to the entire community, we get another estimate of the number of vehicles in use in Faro. Comparing the two, we can get a sense of how representative our sample is (see Table 16).

Table 16 Estimated number of vehicles per household, and community-wide

<table>
<tr><th>Vehicle type</th><th>Number in each household (average based on survey)</th><th>Total in community (based on survey)</th><th>Total in community (based on registration data)</th><th>Difference (survey estimate relative to registration data)</th></tr>
<tr><td>Car</td><td>0.79</td><td>146</td><td>121</td><td>+ 20%</td></tr>
<tr><td>Truck (gasoline)</td><td>0.68</td><td>127</td><td rowspan="2">479</td><td rowspan="2">- 57%</td></tr>
<tr><td>Truck (diesel)</td><td>0.42</td><td>78</td></tr>
<tr><td>Snowmobile</td><td>0.32</td><td>58</td><td rowspan="2">91</td><td rowspan="2">+ 100%</td></tr>
<tr><td>ATV</td><td>0.39</td><td>73</td></tr>
<tr><td>Boat</td><td>0.37</td><td>68</td><td>N/A</td><td>N/A</td></tr>
<tr><td>Motorcycle</td><td>0.13</td><td>24</td><td>21</td><td>+ 16%</td></tr>
<tr><td>RVs</td><td>0.08</td><td>15</td><td>N/A</td><td>N/A</td></tr>
</table>

The match is reasonably good for cars and motorcycle (within 20%); however the survey significantly underestimated the number of trucks, and overestimated the number of off-road vehicles. Note that there are 479 trucks registered in Faro, for a population of 372 inhabitants. Based on conversation at the energy workshop, we know it is not atypical for a household to have several trucks, each serving different uses. The survey only gave respondents two lines for trucks, thus capping the number of trucks per household that could be declared. While this might have led to underestimating the total number of trucks, we do not expect it to have a great impact on the total fuel consumption estimates, since from what we have heard the third or fourth trucks generally do not get driven as much. The discrepancy in the number of ATVs and snowmobiles is more difficult to explain; either the survey respondents are atypical in their off-road vehicle ownership, or several off-road vehicles are registered outside of Faro or not registered at all. Either way, we do not expect this to greatly affect total fuel use estimates as, given that even if we have overestimated their use, off-road vehicles account for less than 10% of total fuel use.

Both the type of vehicle or equipment used and the fuel type are important to consider when calculating greenhouse gas emissions. Different vehicle types (technically referred to as vehicle modes) have different regulatory requirements for fuel efficiency, and emit more or fewer greenhouses gases per litre of fuel combusted. The emission factor for combustion of gasoline and diesel depends on the type of vehicle used, as outlined in Table 17. Note that we do not have the breakdown of consumption per vehicle for the Town’s fleet, only total diesel and gasoline use. For these, we used emission factors for light duty trucks. We also do not have data on the commercial vehicle use in town, but assume it is small compared to the other sources.

Table 17 Greenhouse gas emission factors for vehicle type and fuels.

Vehicle Type	g CO_2/km	g CH_4/km	g N_2O/km	kg CO_2e	km/L
Light Duty Gas Vehicle	239	0.03	0.05	0.253	9.7
Light Duty Gas Truck Under 6000 lbs.	335	0.05	0.09	0.364	6.7
Light Duty Gas Truck Under 8500 lbs.	335	0.05	0.09	0.364	6.7
Heavy Duty Gas Truck Over 8500 lbs.	724	0.09	0.09	0.751	3.3
Motorcycle	112	0.09	0.00	0.113	21.7
Light Duty Diesel Vehicle	297	0.01	0.02	0.304	8.9
Light Duty Diesel Truck	383	0.01	0.03	0.392	6.9
Heavy Duty Diesel Truck	823	0.04	0.02	0.830	3.3
Two-Stroke Vehicles	2350	0.14	0.23	2.421	N/A
Four-Stroke Off-Road	2360	0.00	0.06	2.379	N/A
Other Off-Road Engine/Vehicle	112	0.09	0.00	0.113	21.7

Data source: Greater Vancouver Regional District[81]

As well as the type of vehicle and fuel, driver behaviour, vehicle loads and vehicle maintenance all impact fuel use and GHG emissions. “Smarter Driver” techniques including smooth driving, regular vehicle maintenance, lighter loads, minimal use of air conditioning, and reduced idling may reduce fuel use by 5 to 33%.[82]

A.5 Solid waste

The decomposition of organic material in landfills can lead to the creation of methane, a greenhouse gas 21 times more potent than carbon dioxide (on a 100-year horizon). This section of the greenhouse gas inventory estimates emissions from the landfill; it does not account for emissions resulting from the collection and compression of the waste, which are included in the total municipal transportation fuel use.

To estimate the GHG emissions from the landfill, we use a method known as ‘waste in place’, following the approach recommended by the IPCC for the accounting of waste emissions in national inventories. This method estimates the annual emissions from a landfill based on the decomposition of all municipal solid waste (MSW) previously disposed at the site. This requires information on historical MSW disposal, as well estimates of the decay rate and methane generation potential of the MSW. Unfortunately, the Town of Faro, like most small municipalities, does not keep a record of the amount and composition of the waste trucked to the landfill. The disposal rates have therefore to be estimated.

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[81] Greater Vancouver Regional District, study of vehicle emissions (GVRD Mobile 6) 2000.

[82] Alison Bailie, Katie Laufenberg, Cherise Burda, Graham Haines, *Behind the Wheel: Opportunities for Canadians to drive less, reduce pollution and save money* (Pembina Institute, 2012). http://www.pembina.org/pub/2379

We use population as a proxy for waste disposal, assuming a constant per capita waste production. Data on per capita waste disposal is available from the 2003 Solid Waste Management Plan; a rough estimate based on the experience of staff operating the garbage trucks was also be made for 2012. The Solid Waste Management Plan estimated the 2002 total municipal waste to be 152 metric tonnes from residential homes, and 31 tonnes from commercial use.[83] Given a population of about 313 people (2001 census) this is equivalent to a per capita waste disposal of 0.58 tonnes per person. Staff operating the garbage collection estimated that in 2012 there was on average five truckloads of about a tonne delivered to the landfill per week. This is equivalent to a per capita disposal rate of about 0.65 tonnes per person per year: in the same ball park as the 2002 estimates. We use an average of 0.6 tonnes per capita, and multiply by population estimates from census data to estimate historical waste disposal (assuming a linear progression from one census year to the next). Other parameters required to model methane production from landfill are described in Table 19; lacking regional estimates for these parameters, we default to average values recommended by the IPCC for dry temperate climates.

Table 18 Population of Faro, census data

Year	Population
1991	1221
1996	1261
2001	313
2006	341
2011	344
2012	372

Table 19 Assumptions for the calculation of landfill methane generation[84]

Parameter	Value used	Rationale
Per capita SMW (tonnes/year)	0.60	Average of 2003 Solid Waste Management Plan estimates and rough estimate for 2012 disposal rate
Wet fraction of decomposable organics in waste (fraction)	0.19	Midway of typical range according to IPCC: 0.12-0.28.
Methane generation rate constant (year-1)	0.05	Default value for dry temperate climate, as suggested by IPCC
Fraction of methane in developed gas (fraction)	0.5	IPCC default value.
Fraction of methane recovered	0	No landfill gas capture at Faro landfill.

The method outline here allows us to get a sense of the magnitude of emissions coming from the Faro landfill, even if only a rough estimate. However, since the fraction of decomposable

[83] Town of Faro, Solid waste management plan, 2003.

[84] IPCC Guidelines for national greenhouse gas inventories, Volume 5 Chapter 3, 2006. Associated spreadsheet http://www.ipcc.ch/meetings/session25/doc4a4b/ipcc-waste-model.xls

materials is assumed to be constant, it would not allow us to detect the impact of possible waste management strategies such as organic waste diversion. Diversion of organics, either through backyard composting and/or centralized municipal composting, is an effective strategy to reduce landfill methane emission and generate compost which can be used to fertilize local gardens. For the inventory to detect these changes, it would be necessary to better estimate, and track over time, the fraction of decomposable organics in municipal waste.

Appendix B. Residential energy use – details of calculations

This appendix provides the details of how the fuel uses were estimated for residential customers.

Step 1: Inventory the residential building stock

Municipal tax roll, water and sewer accounts, and the federal census all provide information about the total number of buildings in the community. We use the data from the water and sewer accounts as it is most up to date, counts only occupied units, and provides information about building form. This data is given in Table 20 for 2011 and 2012.

Table 20 Number of building by type and number of occupied units, 2011 and 2012

Building type	Number of buildings 2011	Number of buildings 2012	Number of occupied units 2012
Single	115	108	108
Single Seasonal	11	13	13
Mobile House	10	11	11
Mobile House Seasonal	4	3	3
2-Plex	15	22	24
2-Plex Seasonal	4	3	3
3-Plex	3	3	5
4-Plex	5	7	10
5-Plex	3	3	8
Total	170	173	185

Source: Water and sewer billing, Town of Faro, 2012. In addition to these occupied units, there are 179 unoccupied units owned by Faro Real Estate (Town of Faro tax roll data, 2012)

Step 2: Divide building stock amongst 16 building archetypes defined in the 2010 Conservation Potential Review

The 2010 Conservation Potential Review considers 16 building archetypes, based on the form of the building (single detached, row, apartment, and mobile homes), its age (pre-1980, 1980 and newer), and whether it is electrically heated or not. This classification in archetype helps assess typical energy consumption, which to a great extent dependent on these design characteristics. The size of the home and number of occupants are also key factors in how much energy it uses, but since that information is not readily available, it was not incorporated in the definition of these archetypes.

Since neither tax roll data, census data, or water and sewer data includes the age of the building or its main heating fuel, we use local knowledge to estimate the number in each category. The result, and rationale for the estimate, is presented in Table 21.

Table 21 Faro residential units archetypes

Archetype	# of units 2012	Rationale for estimate
Total occupied dwellings	185	From sewers and water billing
1980 & newer non-electrically heated single detached homes	77	From sewers and water billing we know there are 108 single family homes occupied in Faro (Table 20). Based on local knowledge, 85 of these were built since 1980; leaving 23 from before 1980. We estimate that about eight of them now have electrical furnaces (85 -8 = 77).[85]
Pre-1980 non-electrically heated single detached homes	16	Of the 23 pre-1980 we estimate ~ 7 to be electrically heated, leaving 16 non-electrically heated (23 – 7 = 16)
1980 & newer electrically heated single detached homes	8	~ half of an estimated 15 homes with electrical furnaces
Pre-1980 electrically heated single detached homes	7	~ half of an estimated 15 homes with electrical furnaces
1980 & newer non-electrically heated attached/row housing	0	
Pre-1980 non-electrically heated attached/row housing	46	47 multiplexes units are occupied: eight occupied units in three 5-plexes, 10 occupied units in seven 4-plexes, five occupied units in three triplexes, and 24 occupied units in 22 duplexes (see Table 21). From the survey, we know at least one to be electrically heated – we assume the rest have oil/wood heating.
1980 & newer electrically heated attached/row housing	0	
Pre-1980 electrically heated attached/row housing	1	Community energy survey
Non-electrically heated apartment units	0	
Non-electrically heated apartment common areas	0	

[85] According to CAO, 85 new homes were built since 1980, all of them single-family detached. Eighty-three were built in 1980, 1981, 1982. A new RCMP house was built in 2010 and the new house for the Catholic priest was built in 2011. At the energy workshop, Al Young reported having installed 10 electrical furnaces in the last year, and estimated at about 15 the number of single family homes with electrical heating in the community. Not having information about the age of these 15 homes, we will assume them equally distributed between pre- and post-1980. This leaves an estimate of 85 – 8 = 77 non-electrically heated single family homes built after 1980. There are 108 single-family detached homes occupied year-round according to water and sewer billings; 85 of these are 1980 and older and the balance, 23, must be pre-1980; seven of which we assume to be electrically heated.

Electrically heated apartment units	0	
Electrically heated apartment common areas	0	
Non-electrically heated mobile/other	11	All mobile homes are assumed to be non-electrically heated
Electrically heated mobile/other	0	
Seasonal housing	19	3 mobile, 2 duplexes, and 14 single-family dwellings are seasonally occupied (see Table 21)
Residential garages	0	Data not available

Step 3: Use community energy survey to estimate fuel use for each archetype

The community energy survey asked participants to estimate how much they spend on different fuels per year, or in a typical winter or summer month. From this data, and information gathered about building type, age, and main heating source, we can estimate cost averages for each archetype. Knowing the fuel prices, we can use this annual cost information to infer annual fuel consumption.[86]

Wood, however, is an exception, since the cost of a cord of wood depends on whether it is purchased or self-supplied; we therefore asked survey respondents to directly estimate their annual wood use (See Section 2.2 for a more complete discussion on wood costs). Of the 39 survey respondents, 22 used wood for heating, at an average rate of 7.3 cords per year. This is in line with estimates provided by the Energy Champion group. If this is typical of the total population, we expect the total yearly consumption to be ~ 760 cords. Keith Carreau, the sole provider of cut wood, estimates having delivered 220 cords in 2012, supplying about 29% of that demand; the rest is assumed to be self-supplied. Supply of wood is the main constraint on its use; anecdotal evidence suggested that the demand for cut wood could easily be increased to 350 cords per year if the supply was available.[87]

Table 22 Survey results: Average annual energy costs ($)

Building Archetype	#*	Oil	Wood	Bottled Propane	Electricity
1980 & newer non-electrically heated single detached homes	15	$2,311	$1,769	$475	$1,392
Non-electrically heated mobile/other	4	$1,750	$1,075	$80	$1,330
Pre-1980 electrically heated attached/row housing	1	-	-	-	$3,000
Pre-1980 non-electrically heated attached/row housing	3	$1,800	$1,125	-	$3,160
Pre-1980 non-electrically heated	14	$2,248	$1,385	$125	$1,282

[86] When annual data was provided, we used that by default. If monthly summer and winter data was provided, we estimated annual use assuming eight months of winter and four months of summer.

[87] Comment from Energy Champion group, energy workshop 2013.

single detached homes					
Total/Average	37	$2,177	$1,459	$256	$1,554

*Number of survey respondents in that category. Note that the averages are average costs for houses that use the given fuel (i.e., not averaged over the entire category).

Table 23 Survey results: Average annual energy use

Building Archetype	#*	Oil (L/yr)	Wood (cords/yr)	Propane (L/yr)	Electricity (kWh/yr)
1980 & newer non-electrically heated single detached homes	15	1,750	4.3	560	8,683
Non-electrically heated mobile/other	4	1,326	4.0	94	9,507
Pre-1980 electrically heated attached/row housing	1	-	-	-	23,264
Pre-1980 non-electrically heated attached/row housing	3	1,364	3.0	-	24,582
Pre-1980 non-electrically heated single detached homes	14	1,703	5.6	147	7,808
Average		1,649	4.5	302	10,124

*Number of survey respondents in that category. Note that the averages are average costs for houses that use the given fuel (i.e., not averaged over the entire category).

Step 4: Use CPR and survey data to evaluate energy demand by end use

The 2010 Conservation Potential Review provides estimate of energy demand per dwelling unit for space heating, domestic hot water and various appliances. For each of these, it also estimates the fraction of the demand met by electricity. These results are presented in Table 24. However, since it is primarily concerned with electricity demand, the CPR does not attempt to quantify how much of the non-electrical energy is provided by oil, wood, propane, or other. We rely on the community energy survey to determine this.

Table 24 CPR Estimates for energy load per dwelling unit and fraction of the load provided by electricity

Building Archetype	Space heating (heat load)		Appliances and lighting		Domestic hot water		Cooking	
	(kWh/yr)	E.F.*	(kWh/yr)	E.F.*	(kWh/yr)	E.F.*	kWh/yr)	E.F.*
1980 & newer non-electrically heated single detached homes	20,540	5%	8,502	99%	3,471	79%	715	91%
Pre-1980 non-electrically heated single detached homes	28,760	5%	7,958	99%	3,471	79%	715	91%
1980 & newer electrically heated single detached homes	13,567	89%	7,575	100%	3,453	100%	716	100%
Pre-1980 electrically heated single detached homes	16,692	89%	7,059	100%	3,453	100%	716	100%
1980 & newer non-electrically heated attached/row housing	13,120	5%	6,863	99%	2,739	79%	477	91%

Pre-1980 non-electrically heated attached/row housing	17,980	5%	6,261	99%	2,739	79%	477	91%
1980 & newer electrically heated attached/row housing	7,418	89%	6,156	100%	2,724	100%	478	100%
Pre-1980 electrically heated attached/row housing	10,163	89%	5,584	100%	2,724	100%	478	100%
Non-electrically heated apartment units	10,380	5%	3,497	100%	1,186	100%	411	91%
Non-electrically heated apartment common areas	25,300	5%	19,798	99%	0	0%	0	100%
Electrically heated apartment units	6,020	95%	3,189	100%	1,483	100%	411	100%
Electrically heated apartment common areas	14,668	95%	16,213	100%	0	100%	0	100%
Non-electrically heated mobile/other	17,020	5%	5,155	99%	2,739	79%	479	92%
Electrically heated mobile/other	10,500	89%	4,822	100%	2,724	100%	478	100%
Seasonal housing	700	5%	844	99%	290	83%	61	92%
Residential garages	10,000	5%	2,649	100%	0	100%	0	100%

* E.F.: Electrical Fraction: share of the total load that is met by electricity. The rest of the energy comes form wood, fuel oil, or bottled propane. The CPR, primarily concerned with electricity use, does not estimate the relative importance of each of these other energy sources. We rely on the community survey to estimate the fuel mix.

Source: ICF Marbek[88]

We divide energy end use into four categories: space heating, appliances and lighting, domestic hot water, and cooking. Aside from the possible few propane gas stoves, we expect most appliances, lighting, and cooking in Faro to be electric. There could be some oil, propane, or even wood-burning domestic hot water heaters, but all survey respondents declared having electrical water heaters, so we therefore also assume domestic water heating to be electric. Space heating, on the other hand, is a mix of wood, oil, propane, and electricity. To determine the fraction of electricity used for heating, we subtract for each household the CPR estimates for appliances, lighting, and domestic hot water electrical demand from the total electricity usage reported in the community survey. This allows us to calculate the share of electricity contributing to heat load, which added to wood, oil, and propane use gives us the total energy used for heat for each survey entry. Averages over the different archetypes are presented in Table 25.

[88] ICF Marbek, *Yukon Electricity Conservation and Demand Management Potential Review* (CPR 2011) - Residential Sector Appendices, 2012. Derived from Exhibit A1 & A14, which give estimated electricity use for different end uses, divided by values in Exhibits A13, giving the electrical portion of the total demand

Table 25 Survey results: average electricity use for appliances & domestic hot water (DHW), average heating load, and heating fuel mix

Building Archetype	#*	Applian-ces + DHW (kWh/yr)	Heating (kWh/yr)	Heating fuel mix…			
				Oil	Wood	Bottled Propane	Electri-city
1980 & newer non-electrically heated single detached homes	15	9,317	38,797	49%	47%	2%	2%
Non-electrically heated mobile/other	4	7,458	37,243	52%	41%	1%	5%
Pre-1980 electrically heated attached/row housing	1	8,786	14,478	0%	0%	0%	100%
Pre-1980 non-electrically heated attached/row housing	3	9,477	40,460	39%	29%	0%	32%
Pre-1980 non-electrically heated single detached homes	14	8,866	45,828	43%	55%	0%	2%
Average		8,944	40,767	45%	47%	1%	7%

*Number of survey respondents in that category

Step 5: Validate estimates: compare to CPR results and to aggregated electricity billing data

There are two ways we can test the results obtained from the community energy survey: (1) we can compare average heat loads inferred from the survey to the CPR estimates; and (2) we can compare the total residential electricity use inferred from survey to electricity sales data compiled by the electric utility.

Comparing our survey results to the CPR data is useful because these two results have been obtained independently using two very different approaches. The CPR estimates average heat load for the 16 archetypes by assuming for each a ‘typical’ architecture and build, and estimating heat loss and gain using building energy modeling software. Our community energy survey collected information on energy costs, from which we inferred fuel use, and which we averaged over the ensemble of survey entries within each archetype. However, the total heating bill does not only depend on the building heat load (i.e., how much heat is necessary to keep the home warm) but also on the efficiency of the delivery system, whether it be a forced air furnace, boiler, woodstove, or other. The average fuel consumption values presented in Table 25 include not only the heating load, but also the energy loss due to the inefficiency of the heating system.

To get heating loads estimates for each survey entry, we must therefore estimate the efficiency of its heating system. We do this based on the information survey respondents provided regarding the type of furnace and wood stove they have (see Table 27 for typical fuel efficiency of different systems, and their prevalence in survey responses). The heat load estimates are calculated by dividing the total consumption for each fuel by the efficiency of the heat delivery system, making the sum of the heat load provided by each fuel to get total house heat load, and then averaging for each archetype. The resulting average heat load, standard deviation, and number of respondent in each archetype group are provided in Table 28, alongside the 2010 CPR estimates.

Table 24 above provides the CPR estimates for space heating load, while Table 26 summarizes the heating loads used in this inventory (most being inferred from the community energy survey). The fraction of space heating provided by each fuel, averaged over the values in each archetype represented in the survey, is given in Table 25. Typical fuel efficiency of different heating systems, as well as the average value used based on survey responses, is given in Table 27.

From the heat loads, we calculated heating fuel consumption using this equation:

> Fuel consumption = total space heating load x fraction of heat load met by that fuel x efficiency of heating system

Table 26 Heat loads estimates for each archetype used for the inventory

Archetype	# in community	Estimated heat load	Source of estimate
1980 & newer non-electrically heated single detached homes	77	27,248	survey
Pre-1980 non-electrically heated single detached homes	16	31,838	survey
1980 & newer electrically heated single detached homes	8	27,248	Assumed same as non-electrically heated
Pre-1980 electrically heated single detached homes	7	31,838	Assumed same as non-electrically heated
1980 & newer non-electrically heated attached/row housing	0	13,120	
Pre-1980 non-electrically heated attached/row housing	46	31,876	survey
1980 & newer electrically heated attached/row housing	0	7,418	
Pre-1980 electrically heated attached/row housing	1	14,478	survey
Non-electrically heated apartment units	0	10,380	
Non-electrically heated apartment common areas	0	25,300	
Electrically heated apartment units	0	6,020	
Electrically heated apartment common areas	0	14,668	
Non-electrically heated mobile/other	11	26,404	survey
Electrically heated mobile/other	0	10,500	
Seasonal housing	19	700	CPR
Residential garages	0	10,000	

Note that heat loads depend on building design, and are independent of heating technology. The efficiency of different heating technology and fuels must be considered to calculate actual fuel consumption.

Table 27 Average efficiency of different heating technologies

Fuel	Technology	Typical efficiency range*	% of survey respondents	Average value used in calculations
Fuel Oil	Conventional	60	54.1%[89]	66%
	Advanced Efficiency	83-89	16.2%	
	Unknown	60-89	2.7%	
Electric	Baseboard or Central	95-100	8.1%	100%
Propane	Conventional	55-65	13.5%[90]	60%
	Powered Exhaust	76-83		
	Condensing	85-93		
Wood	Central Furnace	55-65	8.1%	76%
	Conventional Stove	75-82	45.9%	
	"High Tech Stove"	70-80	8.1%	

*Source: NRCan[91]

Table 28 Heat load estimated from survey compared to heat load estimates from 2010 CPR

	#*	Heat load estimates (survey)		Heat load estimates (2010 CPR)	Diff.
		Average	Std		
1980 & newer non-electrically heated single detached homes	15	27,248	11,562	20,540	+33%
Non-electrically heated mobile/other	4	26,404	10,793	17,020	+55%
Pre-1980 electrically heated attached/row housing	1	14,478	-	10,163	+42%
Pre-1980 non-electrically heated attached/row housing	3	31,876	22,195	17,980	+77%
Pre-1980 non-electrically heated single detached homes	14	31,838	18,264	28,760	+11%

*Number of survey respondents in that category.

Overall, the two methods compare reasonably well when the survey sample sizes are sufficient. For single-family homes, the archetype with the most respondents, the heat loads estimates based on survey are 11-33% higher than those of the CPR, a reasonably close match given the coarseness of the methods. The difference between the CPR and survey results for the other archetypes is greater, but the sample sizes are too low to say whether this divergence reflects a

[89] 73% of survey respondents have an oil furnace; 24.3% of which is 5 years old or younger,5.4% 5-10 years old, 13.5% 10-20 years old, 18.9% 20 years or older, and 11% age unknown.

[90] One propane fireplace, other propane equipment unknown.

[91] *Guide To Residential Wood Heating.*

significant difference between Faro houses and the average Yukon building stock, or simply is an artifact of a small sample size, reflecting natural variation between houses.

Comparing total electricity use by the residential sector to the survey estimates is another way to test these results. The electricity billing data does not allow us to distinguish between building types, so we will only compare the total residential use. Figure 4 presents the range of yearly electricity use by residential customer. The total electricity demand for all residential customers in 2012 was 4,708 MWh. In comparison, total electricity inferred from survey by summing averages over the five archetypes present in Faro comes to 5,442 MWh. The estimates extrapolated from the survey results are 16% greater than the actual electricity demand, a reasonably close match. Since the billing data is ultimately the most accurate representation, we scale our estimates so that the total would match the actual sales data; thus we preserve the relative size of demand between each archetype, while ensuring the total matches the billing data.

Step 6: Calculate GHG emissions from energy use

Once we have total fuel use, we estimate resulting greenhouses gases by using documented emission factors for each fuel. These factors represent the sum of carbon dioxide, methane, and nitrous oxides emitted when a combustible is burned, expressing them as a CO_2 equivalent value based on their respective global warming potential (CO_2: 1, CH_4: 21, N_2O: 310, based on a 100-year horizon). Table 29 gives the energy density and GHG intensity (i.e., quantity of GHGs emitted for each unit of energy generated) for each fuel.

Table 29 Energy density and GHG intensity of various fuels

Energy source	Energy density	GHG intensity (kg CO_2e/kWh)
Electricity	1 kWh/kWh	0.05
Bottled Propane	7.028 kWh/L	0.22
Diesel Fuel	10.74 kWh/L	0.26
Soft wood[92]	5194 kWh/cord	0.021
Fuel Oil	10.75 kWh/L	0.26
Coal[93]	3.7-7.3 kWh/kg	0.33-0.47

Source: Environment Canada,[94] unless otherwise noted

[92] *Guide to Residential Wood Heating,* 54. Note that we count here only emissions due to methane and nitrous oxide released when the wood is combusted. The CO_2 released is assumed to be re-absorbed as new trees grown to replace the cut trees. Total emission, counting biogenic CO_2, are 0.33 kg CO_2 / kWh, or 1,714 kgCO_2 per cord.

[93] Coal at Whiskey Lake ranges from low volatile bituminous to semi-anthracite, with caloric content between 13,280 and 26,300 MJ/tonne (~3.700-7300 kWh/tonne) (source: http://ygsftp.gov.yk.ca/publications/minfile/text_files/105F/105F048.pdf). Emission factor from combustion for Canadian bituminous ranges from 1725 kg CO_2e / tonne for sub-bituminous coal (western) and 2387 kg CO_2e / tonne for anthracite coal (*National Inventory Report 1990-2010* Part 2, table A8-7). Taking the two extreme values, we calculate emission intensities ranging from 0.33 to 0.47 kg CO_2e / kWh.

[94] *National Inventory Report 1990-2010,* Annex 13 Emission Factors, Table A13-12.

Appendix C. Community energy survey

Save money, energy and reduce pollution.

We are working on a community energy plan to identify energy use in Faro.

Please help us. Fill in the following survey by **April 7** and return it to Town of Faro.

This survey is also availble online: www.surveymonkey.com/s/faroenergy

All information collected will be treated anonymously and used solely for planning purposes.

Questions? Contact Tom Lie at Town of Faro, 994-2728.

Enter to WIN

Midnight Sun Coffee Roasters gift basket valued at $100.

Submit completed survey with your contact information by **April 7, 2013**.

Name: ______________________________

Address: ____________________________

Phone number: _______________________

Email: ______________________________

You are invited

April 3, 7pm, Sportsman Lounge

Join us to see preliminary results of this survey and provide input on how we can reduce energy consumption and global warming pollution in the community.

TOWN OF FARO

PEMBINA institute

Section 1: Energy use

Help us calculate Faro's energy use by filling out this survey as completely as possible.

Energy use on the road

1. Please provide information about all motor vehicles in your household in the table below.

a. How many months per year are they in use?
b. When used, how much do you spend on fuel per week?
c. If you do not know how much fuel you buy, can you estimate the distance you travel on a typical week?

Vehicle	Fuel type *Circle the one that applies.*	Yearly usage (months/year)	Fuel cost ($ per week)	Distance traveled (km per week)
Car #1	gasoline diesel			
Car #2	gasoline diesel			
Truck #1	gasoline diesel			
Truck #2	gasoline diesel			
Snowmobile	gasoline diesel			
ATV	gasoline diesel			
Boat	gasoline diesel			
Other? ______	gasoline diesel			
Other? ______	gasoline diesel			

Energy use at home

2. What type of home do you live in? *Circle the one that applies.*

Single detached Duplex Apt/Condo Mobile home Row-townhouse

3. When was your home built? *Circle the one that applies.*

Before 1980 After 1980 Don't know

4. Which is the MAIN source of heat for your house? *Circle the one that applies.*

Electricity Oil Bottled propane Wood Other: ________________________

TOWN OF FARO

PEMBINA institute

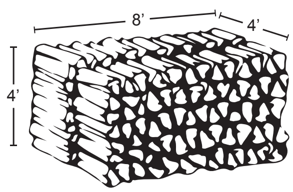
5. Indicate your average home energy costs.

How much do you pay for each of these fuels in a typical winter and summer month?
If you only know yearly totals, indicate those.

	winter month	summer month	OR yearly
Electricity:	$__________	$__________	$________
Oil:	$__________	$__________	$________
Bottled propane:	$__________	$__________	$________
Wood:	$__________	$__________	$________

If you use wood, how many cords of wood do you use per year? ________________

One Chord of wood is 128 cubic feet.



6. Indicate the systems used to heat your home.

Check all that apply. Circle and add any additional options that apply.

☐ Oil-fired furnace	normal high efficiency	age of unit ____(yrs)
☐ Oil-fired boiler	normal high efficiency	age of unit ____(yrs)
☐ Propane-fired furnace	normal high efficiency	age of unit ____(yrs)
☐ Propane-fired boiler	normal high efficiency	age of unit ____(yrs)
☐ Wood-fired furnace	normal high efficiency	age of unit ____(yrs)
☐ Wood-fired boiler	normal high efficiency	age of unit ____(yrs)
☐ Electric furnace	normal high efficiency	age of unit ____(yrs)
☐ Electric boiler	normal high efficiency	age of unit ____(yrs)
☐ Electric baseboard		
☐ Wood stove	conventional advanced tech. catalytic control	
☐ Wood pellet stove		
☐ Heat pump	air source ground source	
☐ Portable electric heater		
☐ Oil monitor		
☐ Wood fireplace		
☐ Propane fireplace		
☐ Electric fireplace		
☐ Other (specify)____		

7. Indicate the number of heating controls in your home.

a. Total number of manual thermostats (not programmable): _____

b. Total number of programmable thermostats: _____

8. Estimate the temperature your home is usually at in Celsius (ºC) or Fahrenheit (ºF) for each period listed below. *Circle the one that applies.*

a. Winter days, someone home 19ºC/66ºF 20ºC/68ºF 21ºC/70ºF 22ºC/72ºF
other: _____

b. Winter days, no one home 19ºC/66ºF 20ºC/68ºF 21ºC/70ºF 22ºC/72ºF
other: _____

c. Winter nights, while asleep 19ºC/66ºF 20ºC/68ºF 21ºC/70ºF 22ºC/72ºF
other: _____

9. What is the MAIN power source used to heat the hot water tank in your home?

Electricity Propane Oil Solar

No hot water tank (on demand system) Don't know

10. How old is your water tank? *Circle the one that applies.*

Less than 5 years More than 5 years Don't know

a. What was the temperature set at? ________

b. Does the system have an insulating blanket? Yes No

Section 2: Energy conservation

Please fill out the information about energy conservation at home and on the road as completely as possible.

Energy conservation at home

11. To reduce the amount of energy you use at home, in the last THREE years, have you:

Check all that apply.

- ☐ Upgraded your furnace to more efficient model?
- ☐ Improved the insulation of your roof, your walls, or your basement?
- ☐ Installed new energy-efficient windows or doors?
- ☐ Reduced cold drafts by using caulking around windows and doors?
- ☐ Installed a programmable thermostat?
- ☐ Reduced the average temperature of your home, and/or turned the temperature down at night?
- ☐ Installed energy efficient light bulbs?
- ☐ Upgraded one or more of your appliances to a more efficient (or energy STAR) model?
- ☐ Unplugged electronic devices (like your TV, your radio or your cell phone charger) when not in use?

Energy conservation on the road

12. To reduce fuel usage, in the last year how often have you:

Check all that apply.

- ☐ Carpooled to work, school or to leisure activities? ___ times per week
- ☐ Worked from home? ___ times per week
- ☐ Walked, biked or skied for transportation instead of taking a car? ___ times per week
- ☐ Combined errands or car trips to avoid extra trips? ____ times per week

13. In the last THREE years, have you: *Check all that apply.*

- ☐ Moved to live closer to work?
- ☐ Reduced the total number of vehicles in your household?
- ☐ Downsized your vehicle? Smaller vehicles typically use less fuel than a larger, heavier vehicles.
- ☐ Upgraded your vehicle to a fuel efficient model? By choosing a vehicle with best-in-class efficiency, you can save both money and fuel.
- ☐ Upgraded your vehicle to a model that uses cleaner fuel (like a hybrid vehicle)?

14. With regards to driving habits and vehicle maintenance, in the last year, have you:

Check all that apply.

- ☐ Serviced your vehicle regularly?
- ☐ Measured your tire pressure regularly (i.e., at least once a month)?
- ☐ Used high quality fuels and lubricants in your vehicle?
- ☐ Avoided excess idling of your vehicle?
- ☐ Avoided high speeds and abrupt changes in vehicle speed (i.e., sudden braking or acceleration)

Household waste

15. To reduce your household waste, in the last year have you:

Check all that apply.

- ☐ Composted your organic waste?
- ☐ Recycled any of your household waste (such as paper, cardboard, glass, aluminum or plastic)?

16. Is there any thing else your household has done in the last THREE years to reduce energy use at home and on the road or to reduce your household waste?

____

____

____

Thank you for participating in this survey.