CITY OF YELLOWKNIFE

ENERGY AND EMISSIONS BASELINE

(as revised)

Prepared for:

City of Yellowknife
Community Energy Planning Committee

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June 2006

Note to Reader

The original version of this report was published in September 2005. Due to the discovery of an inadvertent error, a revised report was published in June 2006 to correct a slight inaccuracy in the 2004 greenhouse gas emissions values contained in the original report.

Specifically, the following changes were made:

- Table 3.2 (p.10) – several of the 2004 greenhouse gas emissions figures for electricity and fuel oil and the associated relative percentage figures were changed.
- Page 11 – several of the observations were modified to reflect the new figures inserted in Table 3.2. These revisions did not result in changes in any of the conclusions contained in the report.
- Table 4.3 (p. 23) – was updated to reflect the changes made in Table 3.2.
- Executive Summary – was updated to reflect the changes made in Table 3.2.
- Appendix C – the 2004 greenhouse gas emissions chart was modified to reflect the new figures from Table 3.2.

We apologize for any inconvenience or confusion that this may have caused.

Acknowledgements

The project team would like to acknowledge the co-operation and support of the following organizations and individuals:

Arctic Energy Alliance – Andrew Robinson
Bassett Distributors – Peter Lane
City of Yellowknife – Greg Kehoe and Dennis Althouse
Commission Scolaire Francophone De Division – Gerard Lavigne
Department of Finance, GNWT – Aranka Raffai
Matonabee Petroleum – Brian Harrison
Midnight Petroleum – Sheena Jensen
Northland Utilities (Yellowknife) Ltd. – Jerome Babyn
NWT Power Corporation – Randy Patrick
Polar Fuels – Dermott O'Neill
Public Works & Services, GNWT – Kim Hawkins & Mike Oram
Public Works and Government Services – Marg Henderson
RTL Robinson Enterprises
Stanton Territorial Health Authority – Frank Fells
Superior Propane – Ken Yoder
Yellowknife Public District Education Authority – Mike Huvenaars
Yellowknife Education District No.1 – Vince McCormick
YK Motors – Trevor Turner

EXECUTIVE SUMMARY

The City of Yellowknife is leading a comprehensive community energy planning initiative to find ways to better manage energy supplies and energy consumption within the city municipal boundary.

As an early step in this process, the City engaged Terriplan Consultants and the Pembina Institute to develop a baseline (or inventory) of Yellowknife's past, present and future energy use and emissions of greenhouse gases.

The energy baseline provides information on Yellowknife's estimated energy supply and consumption, emissions and expenditures for three different years (2000, 2004, 2015) and four sectors of the City's economy (residential, commercial, institutional and transportation).

Currently, Yellowknife's energy supply is about 65% fuel oil, 10% electricity, 10% diesel, 7% gasoline and 7% propane. From 2000 to 2004, energy consumption in Yellowknife grew by almost 9% while emissions increased by 12%. From a cost perspective, annual energy expenditures rose from $98.9 million in 2000 to $113.9 million in 2004.

The residential sector is the largest consumer of energy (37%), followed by the commercial sector (31%), road transportation (17%) and the institutional sector (15%). Space heating of homes and buildings is the single largest use of energy, accounting for approximately 83% of energy use in the residential sector, about 71% in the commercial sector and 80% in the institutional sector.

Unless action is taken, by 2015, Yellowknife's energy consumption is forecast to increase by another 19% and emissions by 20%.

Through implementation of a Community Energy Plan (that achieves a 10% reduction in energy use from the business-as-usual forecast in 2015 and 10% of the energy supply from new, zero GHG emission renewable energy sources), it is estimated that Yellowknife's total energy consumption would only increase 6.7% between 2004 and 2015 and that GHG emissions would decrease 7% over the same time period.

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1.0 INTRODUCTION

Yellowknife, a modern city of some 19,000 people, is situated on the north shore of Great Slave Lake. As the capital of the Northwest Territories, Yellowknife is an important economic, transportation and government centre.

For environmental and economic reasons, the City of Yellowknife has decided to develop a comprehensive community energy plan to find ways to better manage its energy supplies and energy consumption.

As an early step in its community energy planning process, the City engaged Terriplan Consultants and the Pembina Institute to develop an energy and emissions baseline for Yellowknife. An energy and emissions baseline is essentially an inventory of the city's past, present and future energy use and emission of greenhouse gases.

This report provides the energy and emissions baseline for the City of Yellowknife. It includes:

- Energy supply, by type
- Energy consumption, by sector and energy type
- Greenhouse gas emissions
- Energy expenditures

The baseline provides actual energy consumption, emissions and expenditure information for the years 2000 and 2004 and two different forecasts for the year 2015.

The report is organized as follows:

Section 2 – provides background information on the Yellowknife Community Energy Plan, the purpose and structure of the baseline and explains the data sources and methodology used to develop the baseline.

Section 3 – presents the "business-as-usual" baseline results for the years 2000, 2004 and 2015. The results reported include annual energy supply and consumption patterns, annual greenhouse gas emissions and annual energy expenditures.

Section 4 – briefly describes the potential for developing local renewable energy sources and undertaking energy efficiency measures in Yellowknife and presents a “community energy planning” forecast of Yellowknife’s energy and emission baseline for the year 2015. This forecast assumes implementation of a comprehensive community energy plan which results in increased penetration of renewable energy sources and energy efficiency.

Section 5 – presents several important conclusions that can be drawn from the baseline results.

2.0 BACKGROUND

2.1 Yellowknife Community Energy Plan

A Community Energy Plan helps to answer the following energy questions:

1. What is our current energy situation?
2. What is our likely future energy situation?
3. What do we want our future energy situation to be?
4. How do we get there?

By providing information about where the community’s annual energy requirements come from and how this energy is being consumed, a Community Energy Plan helps decision-makers develop policies and programs to reduce energy use and expenditures and minimize impacts on the air, land and water.

The City of Yellowknife is using a multi-stakeholder committee to spearhead the development of the Yellowknife Community Energy Plan (YK CEP). Based on some early meetings and input from the Arctic Energy Alliance and the Pembina Institute, the committee has established the following vision and general goals for the YK CEP:

> ***Vision*** *– through an ongoing Community Energy Planning approach, and with due consideration of economic, social and environmental costs and benefits, our community will strive to meet or exceed the standards of climate protection excellence as set out by the FCM’s Partners for Climate Protection Program*

Goals:

- *Enlist the support of the community by providing information and encouraging participation in the community energy planning process;*
- *Create a CEP that will reduce greenhouse gas emissions through increased energy efficiency and use of renewable energy; and,*
- *Create an innovative CEP that evolves with the community and technology.*

The Committee is currently developing a list of potential actions and measures for further study and consideration. The results of the energy and emissions baseline will assist the Committee in evaluating the list of potential actions and measures and selecting specific actions or initiatives for inclusion in the Yellowknife Community Energy Plan.

2.2 Purpose and Structure of the Baseline

The Yellowknife energy and emissions baseline has been developed to provide information that will assist the Yellowknife CEP Committee in:

- understanding how energy within the City's municipal boundaries is currently supplied and used;
- setting specific targets with respect to energy, emissions and expenditure reductions;
- identifying specific actions and measures that could help achieve the stated goals and targets and therefore merit additional investigation and consideration; and,
- understanding what the future energy and emissions profile for Yellowknife may look like in 2015 depending on whether a community energy plan is or isn't implemented.

The Yellowknife energy and emissions baseline consists of four sectors within the Yellowknife city boundary:

- Residential
- Commercial / Industrial
- Institutional (including Municipal)

- Transportation

The residential sector consists of private and rental housing units. Four sub-categories of housing were identified: single detached, single attached (row housing, multiplexs etc), apartments and mobile homes. Major energy sources for this sector include oil, propane and wood for space heating, electricity and propane for water heating and electricity for lighting, appliances, water heating and other uses.

The commercial / industrial sector also consists of four sub-categories: retail & office, shops & garages, hospitality (bars, restaurants, hotels etc) and warehouses & hangers. Yellowknife has limited industrial activity within its municipal boundaries so commercial and industrial were combined. Major energy sources for this sector include oil for space heating and electricity for lighting, equipment and other machinery.

The institutional sector includes municipal, territorial and federal government assets. The municipal assets include all energy-consuming facilities and infrastructure operated by the City of Yellowknife. The territorial and federal assets were organized in three sub-categories: office buildings, education & health facilities and warehouses & garages & shops. The major energy sources for this sector are heating oil for space and water heating and electricity for lighting, office equipment and other machinery.

The transportation sector was limited to fuel used for all road transportation. Gasoline and diesel fuel consumption was estimated for light, medium and off-road vehicles. Fuel use related to aviation and marine transport activities was not included in the baseline.

2.3 Methodology / Data Sources

The methods used to calculate the historical, current and future baselines relied on actual data where available and on proxy information in instances where actual data did not exist or was not possible to obtain.

The results described in this report were developed using the following steps and information:

1. *2004 baseline* – the 2004 baseline figures represent the most accurate "snapshot" of the current energy and emissions situation in Yellowknife. This baseline was developed first, using actual energy supply information obtained from fuel suppliers, two electric utility companies as well as current (and reasonably accurate) information on key energy consumption drivers such as the population, the number and total square footage of commercial, industrial and institutional facilities, detailed information on the current housing market in Yellowknife, the total number and type of vehicles registered and various energy and emission intensity factors by sector.

2. *2000 baseline* – the 2000 baseline information was developed next as it represents a mix of actual data and information for 2000, and "backcasting" from the 2004 data sets in those instances where 2000 data was not available. Actual information for 2000 used in the model included population data, total number of residential housing units, municipal energy consumption figures, electricity sales figures and energy and emission intensity factors. Data sets for 2000 that were estimated based on the 2004 actual data included the breakdown of residential housing units by sub-category, annual fuel supplies by product and the total square footage of the commercial, industrial and institutional sectors.

3. *Projection factors* – in order to forecast the energy and emissions baseline for the year 2015, information was collected on key factors such as population forecasts and projected hydroelectricity supply.

4. *2015 baseline (business as usual)* – using the 2000 and 2004 baseline results and the projection factors, a "business-as-usual" forecast was developed to illustrate what the energy and emissions profile for Yellowknife might be in 2015 if little change occurs in the next decade regarding Yellowknife's energy supply mix and energy consumption patterns.

5. *Sustainable energy potential* – to assist the Committee compile its list of potential actions and illustrate how the implementation of a community energy plan could reduce energy use, expenditures and emissions,

research was conducted to assess the potential for alternative energy and energy efficiency measures in Yellowknife.

6. *2015 baseline (CEP version)* – the last step in the study was to use the potential for alternative energy and increased energy efficiency to modify the 2015 "BAU" baseline to create a "community energy plan" baseline. This 2015 CEP baseline demonstrates the positive impacts that implementation of a good community energy plan could yield in Yellowknife in terms of reduced energy use, expenditures and emissions.

Additional details on calculations, data sets and assumptions used in the study are provided in Appendix A.

2.4 Informational Limitations

Before reviewing the results of the study, it is important to note the following points concerning the limitations of this study:

- The results derived from the model are highly dependent on the quality and quantity of the data and information available for input into the model. Within the budget established for the study, all reasonable efforts were made to obtain actual data or where such information was not available, to use the best proxy information possible;
- From a modeling perspective, the community and sector-wide results were derived using energy supply data provided by local suppliers, whereas the breakdowns of energy uses into sub-sectors were derived using sector statistics for the number and types of buildings and vehicles and generic energy intensity factors; and,
- The conclusions presented in the study are derived from the modeling results and represent the best understanding possible of Yellowknife's energy and emissions picture based on the available data.

3.0 BASELINE RESULTS – 2000, 2004 and 2015

The results of the baseline models for the years 2000, 2004 and 2015 are shown below. A tabular format has been used to summarize the numerical and percentage figures. Key observations are provided after each table.

Charts depicting the annual energy consumption, emissions and energy expenditures for the years 2000, 2004 and 2015 are provided in Appendices B, C and D respectively.

3.1 Energy Supply and Consumption

The following table outlines the annual supply and consumption of energy in Yellowknife by energy type and sector:

Table 3.1 – Annual Energy Supply and Consumption

	2000	2004	2015	2000	2004	2015
	GJ	GJ	GJ	% of total	% of total	% of total
Residential						
Electricity	182,377	208,754	247,594	9.5%	10.0%	10.1%
Fuel Oil	1,596,452	1,722,419	2,042,886	83.8%	83.2%	83.2%
Propane	106,450	116,474	138,145	5.6%	5.7%	5.6%
Wood	21,276	23,280	27,611	1.1%	1.1%	1.1%
Sub-Total	1,905,555	2,070,927	2,456,235	100.0%	100.0%	100.0%
Commercial						
Electricity	213,722	238,077	288,505	12.9%	13.8%	13.7%
Fuel Oil	1,203,042	1,223,209	1,512,774	72.8%	71.1%	71.7%
Propane	237,359	259,712	308,033	14.3%	15.1%	14.6%
Sub-Total	1,654,124	1,720,997	2,109,312	100.0%	100.0%	100.00
Institutional						
Electricity	138,877	157,525	180,701	20.0%	18.9%	19.6%
Fuel Oil	556,842	675,538	739,246	80.0%	81.1%	80.4%
Sub-Total	695,719	833,063	919,947	100.0%	100.0%	100.0%
Transportation						
Gasoline	369,122	403,883	479,028	42.2%	42.2%	42.2%
Diesel	505,911	553,554	656,546	57.8%	57.8%	57.8%
Sub-Total	875,034	957,437	1,135,574	100.0%	100.00	100.0%
Totals						
Electricity	534,976	604,356	716,800	10.4%	10.8%	10.8%
Fuel Oil	3,356,336	3,621,165	4,294,905	65.5%	65.0%	65.0%
Propane	343,809	376,186	446,178	6.7%	6.7%	6.7%
Wood	21,276	23,280	27,611	0.4%	0.4%	0.4%
Gasoline	369,122	403,883	479,028	7.2%	7.2%	7.2%
Diesel	505,911	553,554	656,546	9.8%	9.9%	9.9%
Total	**5,131,431**	**5,582,424**	**6,621,068**	100.0%	100.0%	100.0%
% increase		8.7%	18.6%			
Annual Growth Rate		1.7%	1.9%			

The following observations can be made regarding energy supply and consumption in Yellowknife:

- Fuel oil (65%) and electricity (10%) accounts for much of the City's total annual energy supply. Other important fuels include propane (6.7%), gasoline (7.2%) and diesel (9.9%).
- Energy consumption has grown about 8.7% (1.7% annually) from 2000 to 2004 and is projected to grow another 18.6% (1.9% annually) by 2015.
- The residential sector is the largest consumer of energy (37%), followed by the commercial sector (31%), road transportation (17%) and the institutional sector (15%).
- The City's facilities consume approximately 71,000 GJ of energy per year (1% of the total energy use in Yellowknife).
- Space heating of homes and buildings is the single largest use of energy, accounting for approximately 83% of energy use in the residential sector, about 71% in the commercial sector and 80% in the institutional sector.
- Diesel (57%) and gasoline (42%) are both significant fuels for road transportation.

3.2 Greenhouse Gas Emissions

The following table outlines the greenhouse gas emissions in Yellowknife for the years 2000, 2004 and 2015. Combustion of wood is assumed to be carbon neutral (i.e. the wood is harvested in a sustainable manner) however, emissions of methane and nitrous oxide from wood combustion are accounted for in the calculations.

For simplicity, the global warming potential of the various greenhouse gases is presented in their carbon dioxide equivalents. Factors of 21 and 310[1] were used to convert the 100-year global warming potential of methane and nitrous oxide to carbon dioxide.

[1] Environment Canada. 2004. Canada's Greenhouse Gas Inventory, 1990-2002. Ottawa, ON. ISBN 0-660-18894-5.

Table 3.2 – Annual Greenhouse Gas Emissions

	2000	2004	2015	2000	2004	2015
	Tonnes C0²e	Tonnes C0²e	Tonnes C0²e	% of total	% of total	% of total
Residential						
Electricity	2,100	6,744	2,820	1.6%	4.8%	1.8%
Fuel Oil	116,949	126,177	149,653	93.1%	90.8%	92.9%
Propane	6,505	7,118	8,442	5.2%	5.1%	5.2%
Wood	124	135	161	0.1%	0.1%	0.1%
Sub-Total	125,588	140,174	161,076	100.0%	100.0%	100.0%
Commercial						
Electricity	2,356	7,858	3,286	2.3%	6.7%	2.5%
Fuel Oil	88,130	93,435	110,819	83.9%	79.8%	83.4%
Propane	14,505	15,871	18,824	13.8%	13.5%	14.2%
Sub-Total	104,991	117,164	132,929	100.0%	100.0%	100.00
Institutional						
Electricity	1,531	4,921	2,058	3.6%	9.7%	3.7%
Fuel Oil	40,792	45,659	54,154	96.4%	90.3%	96.3%
Sub-Total	42,323	50,580	56,212	100.0%	100.0%	100.0%
Transportation						
Gasoline	26,042	28,494	33,796	41.8%	41.8%	41.8%
Diesel	36,196	39,604	46,973	58.2%	58.2%	58.2%
Sub-Total	62,238	68,099	80,769	100.0%	100.00	100.0%
Totals						
Electricity	5,897	19,523	8,164	1.8%	5.2%	1.9%
Fuel Oil	245,870	265,271	314,626	73.4%	70.6%	73.1%
Propane	21,011	22,989	27,266	6.3%	6.1%	6.3%
Wood	124	135	161	-	-	-
Gasoline	26,042	28,494	33,796	7.7%	7.6%	7.8%
Diesel	36,196	39,604	46,973	10.8%	10.5%	10.9%
Total	**335,140**	**376,017**	**430,986**	100.0%	100.0%	100.0%
% increase		12.2%	14.6%			
Annual Growth Rate		3.0%	1.3%			

The following observations can be made regarding greenhouse gas emissions in Yellowknife:

- GHG emissions have grown by 12.2% from 2000 to 2004 (about 3% per year) and are forecast to grow by approximately 15% between 2004 and 2015 (about 1.3% per year).
- In the context of the NWT emissions profile, Yellowknife's 2004 total of about 376 kilo-tonnes represents about 21% of the NWT total.[2]
- Between 2002 and 2004, the rate of growth in greenhouse gas emissions was slightly higher than the growth in energy demand. To a large extent, this resulted from a higher than normal use of diesel fuel for electricity generation in 2004, to compensate for a lower than normal hydro-electric generation due to low water conditions on the Snare River.
- About 70% of GHG emissions are from heating oil consumption for space heating purposes. Other significant sources of emissions include gasoline and diesel fuel used for road transportation (18.1% total) and propane used for heating and commercial purposes.
- On a sectoral basis, residential and commercial emissions account for 37% and 31% respectively of Yellowknife's annual GHG emissions. Transportation and the institutional sector comprise the balance at 18% and 13% respectively.
- The City's facilities are responsible for approximately 4,100 t CO_2e emissions per year (1% of Yellowknife's total annual GHG emissions).
- The emissions from the residential sector average about seven (7) tonnes per person per year which is well above the Canadian average of five (5) tonnes per person per year.

3.3 Energy Expenditures

The following table outlines the energy expenditures for Yellowknife for the years 2000, 2004 and 2015. The calculations for 2000 are based on a combination of actual and estimated 2000 prices. The calculations for 2015 are based on 2004 prices.

[2] See GNWT's 2001 NWT Greenhouse Gas Inventory.

Table 3.3 – Annual Energy Expenditures

	2000	2004	2015	2000	2004	2015
Residential						
Electricity	$7,685,122	$10,170,920		22.3%	25.7%	
Fuel Oil	$24,751,127	$26,704,094		71.8%	67.5%	
Propane	$1,768,774	$2,439,434		5.1%	6.2%	
Wood	$256,016	$280,125		0.1%	0.1%	
Sub-Total	$34,461,039	$39,594,573	$46,961,387	100.0%	100.0%	100.0%
Commercial						
Electricity	$8,162,987	$10,594,384		27.2%	30.8%	
Fuel Oil	$18,651,763	$18,964,421		62.1%	55.1%	
Propane	$3,241,161	$4,872,685		10.8%	14.2%	
Sub-Total	$30,055,911	$34,431,489	$42,071,516	100.0%	100.0%	100.00
Institutional						
Electricity	$5,304,312	$7,009,843		38.1%	40.1%	
Fuel Oil	$8,633,185	$10,473,424		61.9%	59.9%	
Sub-Total	$13,937,497	$17,483,267	$19,502,301	100.0%	100.0%	100.0%
Transportation						
Gasoline	$9,848,774	$10,776,250		48.2%	48.2%	
Diesel	$10,598,675	$11,596,770		51.8%	51.8%	
Sub-Total	$20,447,449	$22,373,020	$26,535,658	100.0%	100.0%	100.0%
Totals						
Electricity	$21,152,421	$27,775,147	$32,942,884	21.4%	24.4%	24.4%
Fuel Oil	$52,036,075	$56,141,939	$66,587,492	52.6%	49.3%	49.3%
Propane	$5,009,935	$7,312,119	$8,672,584	5.1%	6.4%	6.4%
Wood	$256,016	$280,125	$332,244	0.3%	0.2%	0.2%
Gasoline	$9,848,774	$10,776,250	$12,598,966	10.0%	9.5%	9.5%
Diesel	$10,598,675	$11,596,770	$13,754,420	10.7%	10.2%	10.2%
Total	**$98,901,896**	**$113,882,350**	**$135,070,862**	100.0%	100.0%	100.0%
% increase		15.1%	18.6%			
Annual Growth Rate		3.8%	1.9%			

The following observations can be made regarding energy expenditures in Yellowknife:

- Total energy expenditures in Yellowknife in 2004 were $113.8 million which is an increase of about 15% from 2000 (about 3.8% per year). The higher rate of increase in energy expenditures (compared to the rate of growth in energy consumption) is attributable to significant increases in the prices for electricity and fuel between 2000 and 2004.

- By 2015, total energy expenditures are expected to grow to about $135 million (in constant 2004 dollars), an increase of about 18% or almost 2% per year. This is based on projected population growth only, and assumes that energy prices increase at the same rate as inflation.
- The residential and commercial sectors account for 35% and 30% respectively of Yellowknife's 2004 energy expenditures. Transportation and the institutional sector account for the balance at 20% and 15% respectively.
- The City's annual energy expenditures for its own facilities is estimated to currently be $1.9 million per year (2% of Yellowknife's annual total).
- Electricity, which represents about 10% of Yellowknife's current (2004) energy mix and only about 2% of Yellowknife's annual GHG emissions total, represents about 24% of annual expenditures on energy.
- Fuel oil, which represents 65% of Yellowknife's energy mix and 73% of Yellowknife's annual GHG emissions, accounts for only 49% of annual energy expenditures.

4.0 COMMUNITY ENERGY PLANNING SCENARIO

To illustrate the extent to which a community energy plan might reduce future energy use, environmental emissions and expenditures in Yellowknife, research was conducted to assess the potential for alternative energy and energy efficiency measures in the city.

Due to time and budget constraints, research efforts were limited to the collection and evaluation of publicly available information. Section 4.1 addresses the renewable energy supply potential and section 4.2 addresses the energy efficiency potential. Section 4.3 summarizes Yellowknife's forecast energy consumption, GHG emissions and energy expenditures in 2015 assuming the successful implementation of a community energy plan starting in 2005.

4.1 Renewable Energy Supply Potential

Yellowknife's current annual energy supply mix is approximately 89% imported fossil fuels, 10.5% hydro-electricity and 0.5% wood. As described in section 3.1, fossil fuels are used mainly for space heating, electricity generation and road transportation. One option for reducing environmental emissions in Yellowknife would be to increase the use of locally available renewable energy sources for electricity generation and space heating, rather than combusting imported fuels.

Some of the specific renewable energy technologies that may be feasible for use in Yellowknife are described below.

4.1.1 Electricity Generation

In 2004, the electricity supplied to Yellowknife by the NWT Power Corporation was approximately 85% hydro-electric (142 GWH) and 15% diesel-generated (25.8 GWH). As noted earlier, this was higher than normal due to low water conditions. For 2005 and 2006, NTPC is forecasting lower diesel-electric requirements, likely in the range of 1%-5% of the total supply mix[3]. This trend appears stable as much of the reduction in diesel generation requirements is the result of lower electricity demand (due to the closure of the gold mines) and increased hydro capacity and output.

For the purposes of this study, it will be assumed that the diesel generation requirements for Yellowknife for the next 10 years will remain at 5% of the annual supply mix or approximately 8.5 GWH per year. Using NTPC's current fuel efficiency at Jackfish of 3.7 kWh/litre of fuel, this would mean annual diesel fuel consumption at Jackfish of about 2.3 million litres. Assuming no significant changes in diesel fuel prices, NTPC's current cost to generate diesel-electric power at Jackfish averages about $0.15/kWh[4] (depending on diesel fuel prices).

Proven renewable energy technologies for generating electricity include wind turbines, photovoltaic panels and hydroelectricity. Each is discussed below.

<u>Wind Turbines</u>

From a technical and environmental perspective, there is little doubt that wind turbines are a feasible and proven technology. Statistics provided on the website

[3] Based on personal correspondence with Randy Patrick, Director, North Slave Region, NWT Power Corporation.
[4] Ibid.

of the Canadian Wind Energy Association indicate that Canada currently has 327 MW of installed wind energy capacity, another 28,000 MW of developable potential (with current technology) and may have up to 100,000 MW of wind energy potential including offshore areas. Worldwide, the installed wind energy capacity was over 31,000 MW in 2003 and growing rapidly.

In the Canadian north, there have been wind energy demonstration projects in Whitehorse, Sachs Harbour, Cambridge Bay, Kugluktuk and Rankin Inlet. NTPC, which was involved in the NWT and Nunavut projects, experienced significant technical difficulties and project cost overruns, some of which were attributable to construction and maintenance limitations in remote communities[5].

From a cost perspective, the Canadian Wind Energy Association indicates that the cost of generating wind energy in southern Canada ranges between $0.06/kWh to $0.12/kWh in good wind areas. Based on NTPC's experiences with wind energy in small communities, typical wind energy generation costs in the North may be in the range of $0.20/kWh to $0.70/kWh.

The only known source of information on the feasibility of wind energy in Yellowknife is an unpublished study prepared by the Arctic Energy Alliance in 2002. In summary, the study used NRCan's RETScreen pre-feasibility software and the Yellowknife airport's known wind speed of 4.1 metres/second to evaluate several options for installing wind turbines on Jackfish Hill (close to the Yellowknife landfill). The estimated cost per kWh of wind energy ranged from a low of $0.195/kWh to a high of $0.657/kWh, depending on the type of turbine installed and site location.

Based on the above analysis, it appears wind power could become cost-competitive with diesel-generated electricity in Yellowknife, particularly if diesel fuel prices rise over time. Additional analysis, including the collection of actual wind resource data for Yellowknife, is required to determine if wind energy is a cost-competitive electricity supply option for Yellowknife.

Photovoltaic Panels

[5] See Arctic Energy Alliance's "Review of Wind Energy" study.

Photovoltaic, or PV, panels, convert direct solar energy from the sun to electrical energy. The panels consist of solar cells that trap energy from flowing electrons to produce electricity. An inverter converts the direct current (DC) energy from the cells to alternating (AC) energy, which can be used for immediate electrical needs or stored in battery banks.

PV panels have been used in numerous northern applications such as remote camps, seasonal hunting and fishing lodges and for off-grid housing. The technology is robust and works extremely well in summer conditions due to the very long days and abundance of solar radiation. Information provided on the CANMET Energy Technology Centre web site indicates that PV panels work in cold, dry winter conditions but that the expected output from a PV system during winter will be lower due to decreased module and inverter efficiencies at low light and power levels.

From a cost perspective, PV panels are not yet competitive with hydro or diesel-electric generation costs on local utility grids. A recent 2 kW grid-interconnected PV demonstration project undertaken at Sir John Franklin High School was installed for $75,000 and is expected to produce about 1,400 kWh per year[6]. Even if the system costs are amortized over the full 25 years and assuming no other capital or operating expenses, the cost per kWh from the system will average $2.15/kWh, which is much more expensive than electricity generated from diesel, hydro or wind.

As a grid-connected demonstration project, the installation at Sir John Franklin should not be used to automatically conclude that PV systems are not cost-competitive in Yellowknife. It can be expected that wider deployment of the technology in Yellowknife would help reduce costs (by achieving better economies of scale on purchasing and installation) however, additional analysis is required to predict if and when PV systems may potentially become cost-competitive with diesel-generated electricity.

Hydro

[6] Based on personal correspondence with Jim Sparling, Energy Programs Coordinator, Environmental Protection Service, ENR.

As noted above, the energy baseline developed for 2015 assumed that the diesel generation requirements for Yellowknife for the next 10 years will average 5% of the annual supply mix (i.e. approximately 8.5 GWH per year) which means annual diesel fuel consumption at Jackfish of about 2.3 million litres.

Notionally, the development of additional hydroelectric generating capacity to serve Yellowknife would appear to be an obvious alternative to using the Jackfish diesel-electric plant and possibly allow for electric space heating, which would reduce heating oil consumption.

From a supply perspective, there are no known small hydroelectric sites close enough to Yellowknife to be developed on an economic basis. In terms of large hydro, at least 33 MW (or about 229 GWH annually)[7] of undeveloped hydro-electric potential exists on the Snare River system north of Yellowknife. However, actual development of this potential at some point in the future may necessitate development of additional transmission system capacity and would certainly require installation of additional diesel-electric generating capacity at Jackfish to satisfy NTPC's 105% minimum diesel requirement (in case of a sustained outage on the transmission system)[8].

Additional analysis is required to determine whether there is a reasonable prospect of developing cost-effective additional hydro-electric capacity for Yellowknife to displace diesel-generated electricity and/or permit electric space heating.

4.1.2 Space Heating

The 2004 energy baseline indicates that approximately 109 million liters of heating fuel and propane are consumed annually in Yellowknife for space heating across the residential, municipal, commercial/industrial and institutional sectors. Potential renewable energy supply options for reducing the consumption of fossil fuels for space heating include passive and active (air and

[7] Based on personal correspondence with Randy Patrick, Director, North Slave Region, NWT Power Corporation and Darren Huculak, Financial and Business Analyst, NWT Energy Corporation.

[8] For reliability purposes, the combined capacities of diesel generation at Jackfish and Bluefish hydro generation must equal 105% of Yellowknife's peak load (excluding mine loads). See NWT Public Utilities Board Decision 14-2004, p. 21-25.

water) solar heating, heat pumps and wood heating. Several options are addressed below.

Passive Solar Heating

Passive solar heating of buildings occurs when sunlight passes through a window, hits an object, is absorbed and converted to heat. The term "passive" refers to the fact that no mechanical equipment is involved.

The most efficient window orientation for heat gain is due south, although any orientation within 30 degrees of due south is acceptable. A ratio of about 8% window to floor area is suggested for south-facing walls. Once the heat is inside the building, a well-insulated and air tight building envelope helps prevent heat loss[9].

Passive solar heating, in conjunction with energy efficiency features, can reduce space heating loads in homes and buildings by as much as 25%[10]. To take advantage of this potential, it is suggested that the establishment of minimum passive solar requirements for new construction be investigated as a potential measure for inclusion in the Yellowknife community energy plan.

Active Solar Heating

Active solar heating systems consist of collectors that collect and absorb the heat of the sun and electric fans or pumps that transfer and distribute the heat (in a liquid or air). The local climate, the type and efficiency of the collector and the area (size) of the collector determine how much heat an active solar heating system can provide.

An example of an active solar heating system evaluated and tested in Yellowknife is the Solarwall system. Solarwall is an active air heating system, installed on the exterior of a building, which pre-heats the air being drawn into a building's ventilation system, thereby reducing the need to heat the air using a conventional oil-fired boiler or furnace system. Numerous RETScreen analyses of potential Solarwall projects in Yellowknife showed that Solarwall was not

[9] See www.newenergy.org/sesci/publications/pampphlets/passive.html
[10] Ibid.

typically cost-effective if installed on a retrofit basis[11]. With recent increases in oil prices, there may be merit in re-examining this conclusion, particularly in instances where Solarwall is included in the initial design and construction.

Wood Heating

The 2004 baseline results indicated that about 1,245 cords of wood are burned in Yellowknife per year, which equals only 0.4% of the total annual energy mix. Given that residential space heating in Yellowknife requires the consumption of about 50 million liters of heating oil and propane each year, an increase in the use of wood heating would directly displace the consumption of imported fossil fuels and provide local employment opportunities.

One cord of wood can typically displace about 450 litres of heating oil. Reducing residential heating oil consumption by 10% (i.e. 5 million liters) would require annual wood harvesting of about 11,100 cords of wood, an increase of some 10,000 cords from current levels of harvesting. Alternatively, wood pellets can be sourced from several companies in Alberta and BC. It is recommended that additional study be undertaken to determine:

- What the sustainable annual wood harvesting capacity in the Yellowknife area may be;
- The potential for introducing a wood stove rebate program (or similar incentive program) to stimulate a conversion to wood heating in residential homes, or the replacement of old wood stoves with more efficient models; and,
- The potential for wood pellet stoves, using wood pellets from southern Canada, to be used to cost effectively reduce fuel oil requirements.

4.1.3 Summary

The information presented above suggests that hydro-electricity, passive and active solar heating and wood heating are energy supply options that should be investigated further for potential inclusion in the Yellowknife community energy plan. Some analysis has occurred into wind power showing that it could

[11] RETScreen evaluations of Solarwall completed by staff at the Arctic Energy Alliance typically indicated simple paybacks in the range of 5 to 15 years for most Solarwall installations.

potentially cost more per kWh than the cost to run the Jackfish diesel plant. At present, photovoltaic systems are considered to be the most expensive renewable energy alternative. It should be noted that renewable energy technology costs have declined over time and are expected to continue to decline; therefore it may be worthwhile to revisit certain technologies in the future.

For the purposes of preparing the 2015 “Community Energy Planning” baseline forecast, it was assumed that 10% of Yellowknife’s energy supply could come from various local renewable energy sources.

4.2 Energy Efficiency Potential

Irrespective of how a community’s annual energy requirements are supplied, it is important to prevent or eliminate wasteful or unproductive energy consumption. Improving energy efficiency in Yellowknife will involve making changes in people’s behaviours and attitudes, providing support for energy efficiency upgrades in existing homes and buildings, ensuring reasonable energy performance standards for new construction, and encouraging efficient transportation. Some specific suggestions are presented below by sector.

4.2.1 Residential

The residential sector accounts for about 37% of total energy use in Yellowknife, most of which is heating fuel consumption for space heating and electricity use for lighting and appliances. Through the Arctic Energy Alliance, homeowners already have access to the EnerGuide for Homes program, which can provide an independent assessment of the relative energy performance of a house and how it can be improved.

To augment the EnerGuide program and provide a more comprehensive suite of programs to Yellowknife homeowners and renters, it is suggested that the following programs be investigated for potential inclusion in the Yellowknife community energy plan:

- Green mortgage program – to provide an additional financial incentive to homeowners to improve the energy efficiency of their home;

- Home energy efficiency retrofit loan (or grant) program – to provide financial support to homeowners to undertake energy efficiency improvements;
- Free advisory services – to provide technical advice and implementation assistance to homeowners interested in proceeding with energy efficiency improvements;
- Appliance rebate program – to provide an incentive to homeowners to replace inefficient appliances with energy efficient appliances; and,
- Appropriate use of instruments, such as an energy code, bylaws, zoning or permitting processes, to ensure a minimum energy efficiency standard in the construction of new residential housing.

4.2.2. Commercial / Industrial / Institutional

In total, commercial, industrial and institutional facilities (including municipal infrastructure) account for about 46% of annual energy use in Yellowknife. Heating fuel and propane consumption for space and water heating is the largest end-use activity, followed by electricity consumption for lights and equipment.

It is suggested that the following ideas be evaluated for potential inclusion in the Yellowknife community energy plan:

- Free (or subsidized) energy audit service – to provide accurate, independent advice to businesses and government departments on how to reduce energy use and improve the energy performance in their facilities;
- Commercial energy efficiency retrofit loan (or grant) program – to provide financial support to commercial and industrial operations to undertake energy efficiency improvements;
- Appropriate use of instruments, such as an energy code, bylaws, taxation, zoning or permitting processes, to ensure a minimum energy efficiency standard in the construction of new commercial or institutional facilities.

4.2.3 Transportation

Fuel use for road transportation accounts for 17% of Yellowknife's annual energy use. About 82% of this consumption occurs in "light" vehicles, such as cars, SUVs and trucks, which are typically used for work and personal activities.

It is suggested that the following ideas for reducing fuel use by light vehicles be evaluated for potential inclusion in the Yellowknife community energy plan:

- Increase use of public transit – Yellowknife has a year-round transit system however it may be possible to adopt measures to increase the level of riders on the system, thereby reducing the number of light vehicles on the roads;
- Anti-idling campaigns – Previous and current anti-idling efforts by the Arctic Energy Alliance and Ecology North should be continued and supported through inclusion in the Yellowknife Community Energy Plan. Convincing Yellowknife residents to cut unnecessary idling of vehicles would reduce fuel use, lower emissions and save on fuel expenditures;
- Ethanol and biodiesel – Even if no changes are made in the use of vehicles in Yellowknife, one way to reduce GHG emissions is to reduce the volume of gasoline and diesel consumed by switching to gasoline-ethanol and biodiesel blends. Further investigation should be made to determine if an ethanol blend of gasoline or a biodiesel blend could be supplied in Yellowknife and what potential impact this may make in reducing local emissions.
- Improved vehicle efficiencies – promotion of high efficiency vehicles and efficient driving habits has the potential to reduce energy use within personal vehicles.

4.2.4 Summary

The information presented above suggests that several different energy efficiency measures and programs, targeted specifically for different sectors, should be investigated further for potential inclusion in the Yellowknife community energy plan.

For the purposes of preparing the 2015 "Community Energy Planning" baseline forecast, it was assumed that a 10% reduction in Yellowknife's energy consumption could be achieved by 2015.

4.3 2015 Community Energy Plan Results

To illustrate the difference that a community energy plan could make on Yellowknife's future energy situation, an alternate 2015 baseline was developed. This baseline assumes a 10% reduction in energy use from the business-as-usual forecast in 2015 and 10% of the total energy in 2015 will come from new, zero GHG emission renewable energy sources.

The following table shows Yellowknife's 2004 energy situation as compared with the 2015 Business-As-Usual forecast and the 2015 Community Energy Plan forecast. Charts are provided in Appendix E.

Table 4.3 – 2015 BAU Forecast vs 2015 CEP Forecast

	2004	**2015 BAU**	**2015 CEP**	**CEP Results**
Energy Supply & Consumption (GJ)				
Electricity	604,356	716,800	580,608	<136,192>
Fuel Oil	3,621,165	4,294,905	3,478,873	<816,032>
Propane	376,186	446,178	361,404	<84,774>
Wood	23,280	27,611	22,365	<5,246>
Gasoline	403,883	479,028	388,013	<91,015>
Diesel	553,554	656,546	531,802	<124,744>
New Renewables	-	-	595,896	595,896
Total	**5,582,424**	**6,621,068**	**5,958,962**	
% increase		18.6%	6.7%	
GHG Emissions (tonnes)				
Electricity	19,523	8,164	6,612	<1,552>
Fuel Oil	265,271	314,626	254,848	<59,778>
Propane	22,989	27,266	22,086	<5,180>
Wood	135	161	130	<31>
Gasoline	28,494	33,796	27,375	<6,421>
Diesel	39,604	46,973	38,048	<8,925>
New Renewables	**-**	**-**	**-**	**-**
Total	**376,017**	**430,986**	**349,099**	**<81,887>**
% increase		14.6%	- 7.2%	

The following observations can be made regarding the potential benefits of implementing a community energy plan in Yellowknife during the period 2005 to 2015:

- Total energy consumption increases by 6.7% between 2004 and 2015. compared with a 19% increase under the 2015 BAU forecast;
- Total emissions would be 7% lower (as compared to the 2004 level) by 2015, rather than almost 15% higher as forecast under the 2015 BAU scenario;
- It was not possible to estimate total energy expenditures for the CEP forecast as it was beyond the scope of this study to estimate the cost of the assumed renewable energy and energy efficiency actions.

5.0 CONCLUSIONS

Several important conclusions can be drawn from the baseline results presented in this report:

- Yellowknife is heavily dependent on imported fossil fuels. If no specific actions are taken, this dependence will continue for the foreseeable future;
- Over the next 10 years, Yellowknife's use of energy is forecast to increase by almost 19%. If this occurs, similar levels of growth will occur with respect to the associated annual emissions and energy expenditures;
- Successful development and implementation of a Yellowknife Community Energy Plan has the potential to significantly reduce the forecast level of growth in energy use and emissions;
- The residential, commercial, institutional and transportation sectors of the Yellowknife economy are all significant contributors to energy use and emissions;
- The analysis and selection of measures to include in the Yellowknife Community Energy Plan should be tailored to specific sectors to the extent possible to address the different fuel types and activities inherent in each sector.

- Fuel oil for heating buildings is the single largest type of energy used in Yellowknife, resulting in the most energy related GHG emissions and expenditures.
- There are a number of opportunities for introducing renewable energy and energy efficiency measures within Yellowknife. These include:
    - Hydroelectricity
    - Passive and active solar heating
    - Wood heating
    - Wind power
    - Photovoltaics
    - Building retrofits
    - Efficient building construction
    - High efficiency equipment and vehicles
    - Transit
    - Efficient vehicle operation
    - Ethanol and biodiesel

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APPENDIX A: METHODOLOGY, DATA SOURCES AND ASSUMPTIONS

The methods, data sources and assumptions used in the calculations of the 2000, 2004 and 2015 baselines are summarized below:

General Statistics

Population: (source = NWT Bureau of Statistics)

- 2000 = 17,415
- 2004 = 19,056
- 2014 = 22,278 (forecast)
- 2019 = 22,996 (forecast)

Energy Supply

Electricity:

Generation: (source = NWT Power Corporation)

2000: total sales to Northland = 148,604,000 kWh
- hydro-electric = 141,471,000 kWh
- diesel-electric = 7,132,992 kWh
- diesel fuel consumed = 2,110,352 litres (at 3.38 kWh/litre)

2004: total sales to Northland = 167,877,000
- hydro-electric = 142,023,000 kWh
- diesel-electric = 25,853,058 kWh
- diesel fuel consumed = 6,987,312 litres (at 3.7 kWh/litre)

Consumption: (source = Northland Utilities)

2000: 148,604,000 kWh purchased from NTPC
- distribution system losses = 8,731,000 kWh
- residential = 50,660,000 kWh, ave. price = $0.1517/kWh
- commercial = 87,641,000 kWh, ave. price = $0.1375/kWh
- streetlight = 1,510,000 kWh, ave. price = $0.3814/kWh
- sentinel = 62,000 kWh, ave. price = $0.1788/kWh

2004: 167,877,000 kWh purchased from NTPC
- line losses = 6,965,000 kWh
- residential = 57,987,000 kWh, ave. price = $0.1754/kWh
- commercial = 101,332,000 kWh, ave. price = $0.1602/kWh

streetlight = 1,513,000 kWh, ave. price = $0.4474/kWh
sentinel = 80,000 kWh, ave. price = $0.2222/kWh

Fuels (source = various Yellowknife fuel distributors and retails)

2000: extrapolated from 2004 figures based on the 2000 population figures

2004: Heating oil = 94,894,000 liters
Diesel = 14,317,000 liters
Gasoline = 11,650,000 liters
Propane = 14,868,517 liters
Total = 135,729,517 liters

Wood: (source = ENR North Slave Office)

2000: extrapolated from 2004 figure based on 2000 population figure

2004: 826 cords (free permits) and 417 cords (commercial permits). Total annual supply = 1,243 cords

Standard Fuel Emission Factors

(Source: Canada's GHG Inventory, 1990-2002 and electricity supply data above)

Electricity: 0.0397 kg CO_2e / kWh (2000)
0.116 kg CO_2e / kWh (2004)
Fuel Oil: 0.264 kg CO_2e / kWh
Wood: 0.021 kg CO_2e / kWh
Gasoline: 0.255 kg CO_2e / kWh
Diesel: 0.260 kg CO_2e / kWh

Energy Consumption

Residential Sector:

Methodology: overall energy use in the residential sector was calculated based on energy supply data. Information on the number and type of residential units was also collected and may be useful for further analysis of the community's energy profile. The key data collected includes:

- Energy supply to the sector
- Standard fuel emission factors
- # of units
- Estimated average floor space

Data Sources:

- 2004 = 6,257 households
    - Single detached: 2,714 units (source: 2004 NWT Community Survey) and average floor space of 1,500 sq. ft (estimate)
    - Single attached: 552 units (source: CMHC Rental Market Survey) and average floor space of 1,250 sq. ft (estimate)
    - Apartments: 1,791 units (source: CMHC Rental Market Survey) and average floor space of 900 sq. ft (estimate)
    - Mobile homes – 1,200 units (source: Coldwell Bankers) and average floor space of 1,200 sq. ft (estimate)

- 2000 = 5,952 households (source: 2000 NWT Housing Needs Survey)
    - Single detached: 2,582 (estimate based on 2000 population figures) and average floor space of 1,500 sq. ft (estimate)
    - Single attached: 525 units (estimate based on 2000 population figures) and average floor space of 1,250 sq. ft (estimate)
    - Apartments: 1,704 units (estimate based on 2000 population figures and average floor space of 900 sq. ft (estimate)
    - Mobile homes – 1,142 units (estimate based on 2000 population figures) and average floor space of 1,200 sq. ft (estimate)

Commercial / Industrial Sector:

Methodology: the commercial and industrial facilities in Yellowknife were combined due to data limitations. Total annual energy use and emissions in this sector was calculated based on energy supply data, whereas the breakdown of energy between the commercial / industrial sector and the institutional sector, and by business type was accomplished by applying energy intensity factors to the estimated actual floor space in several categories: Office, Retail, Hospitality (restaurants, hotels, bars), Warehouse (including Shops, Garages and Hangars).

The key variables used in the calculations include:

- Energy supply to the sector
- Standard fuel emission factors
- Estimated total actual floor space by sub-category
- Energy intensity (expressed as GJ/m^2/year) by sub-category

Data Sources:

- Actual floor space 2004 (source = City Hall permit & inspection files)
    - Office: 100,107 m^2
    - Retail: 40,593 m^2
    - Hospitality: 39,735 m^2
    - Warehouse: 69,939 m^2
- 2000 total square meters – scaled by population
- Energy intensity figures (GJ/ m^2) (source: OEE Database, Commercial/Institutional sector – BC & Territories):
    - Office – 2000=1.11, 2004=1.33 (Table 13)
    - Retail – 2000=1.58, 2004=1.79 (Table 15)
    - Hospitality – 2000=2.13, 2004=1.76 (Table 17)
    - Warehouses etc – 2000=1.84, 2004=2.12 (Table 21)

Municipal Sector:

Methodology / Data Sources: the energy use data used in the model for the City of Yellowknife's facilities was obtained from actual electricity and heating oil consumption records kept by the City on a facility-specific basis.

Institutional Sector:

Methodology: the institutional sector included facilities in Yellowknife owned or operated by the GNWT and Government of Canada. Total annual energy use and emissions in this sector was calculated based on energy supply data, whereas the breakdown of energy between the institutional sector and the commercial / industrial sector, and by institution was accomplished by applying energy intensity factors to the estimated actual floor space in several categories: Office/Building, Schools, Healthcare, Warehouse (including shops and garages).

The key variables used in the calculations include:

- Energy supply to the sector
- Standard fuel emission factors
- Estimated total actual floor space by sub-category
- Energy intensity (expressed as GJ/m^2/year) by sub-category

Data Sources:

- 2004 total square meters – source = City Hall records + direct inquiries
    - Office/Buildings – 73,122 m^2

    - Schools – 31,104 m^2
    - Health – 5,087 m^2
    - Warehouses/Garages – 7,008 m^2
- 2000 total square meters – scaled by population
- Energy intensity figures(GJ/ m^2) (source: OEE Database, Commercial/Institutional sector – BC & Territories):
    - Office/Buildings – 2000=1.11, 2004=1.33 (Table 13)
    - Schools – 2000=1.32, 2004=1.22 (Table 5)
    - Health – 2000=2.44, 2004=2.8 (Table 7)
    - Warehouses/Garages – 2000=1.84, 2004=2.12 (Table 21)

Transportation Sector:

Methodology: Total energy use related to road transportation was calculated based on energy supply data, whereas the breakdown by vehicle category was based on the number of reported vehicles for each category and estimates of use and fuel efficiency. The vehicle categories are: light duty (cars and pick-up trucks), medium duty (delivery vehicles, vans, buses) and off-road (ATVs, snow machines, motorcycles). The key variables used in the calculations include:

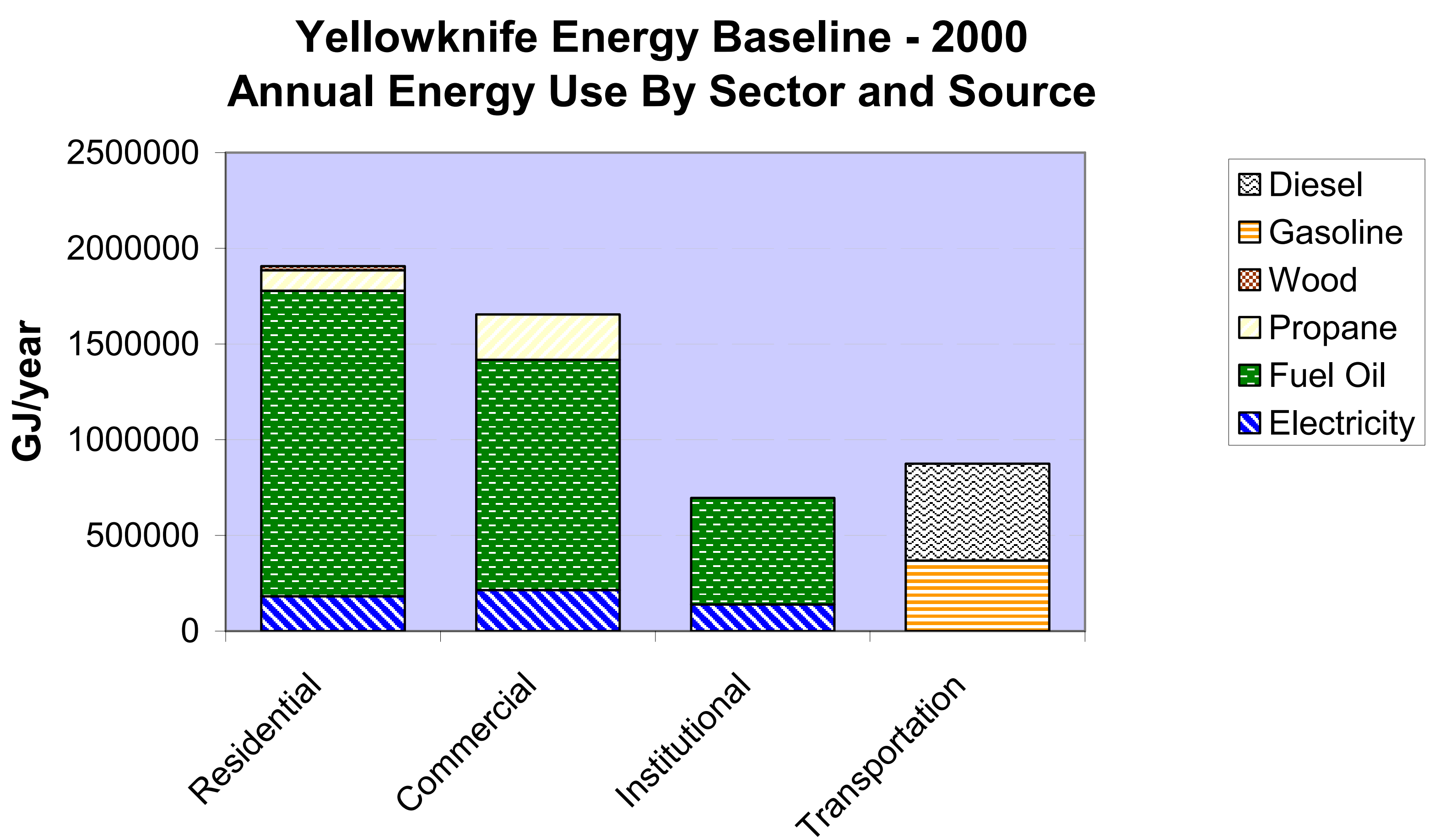
- Energy supply to the sector
- Standard fuel emission factors
- # of vehicles
- Estimated annual km of travel (within YK)
- Estimated fuel efficiency

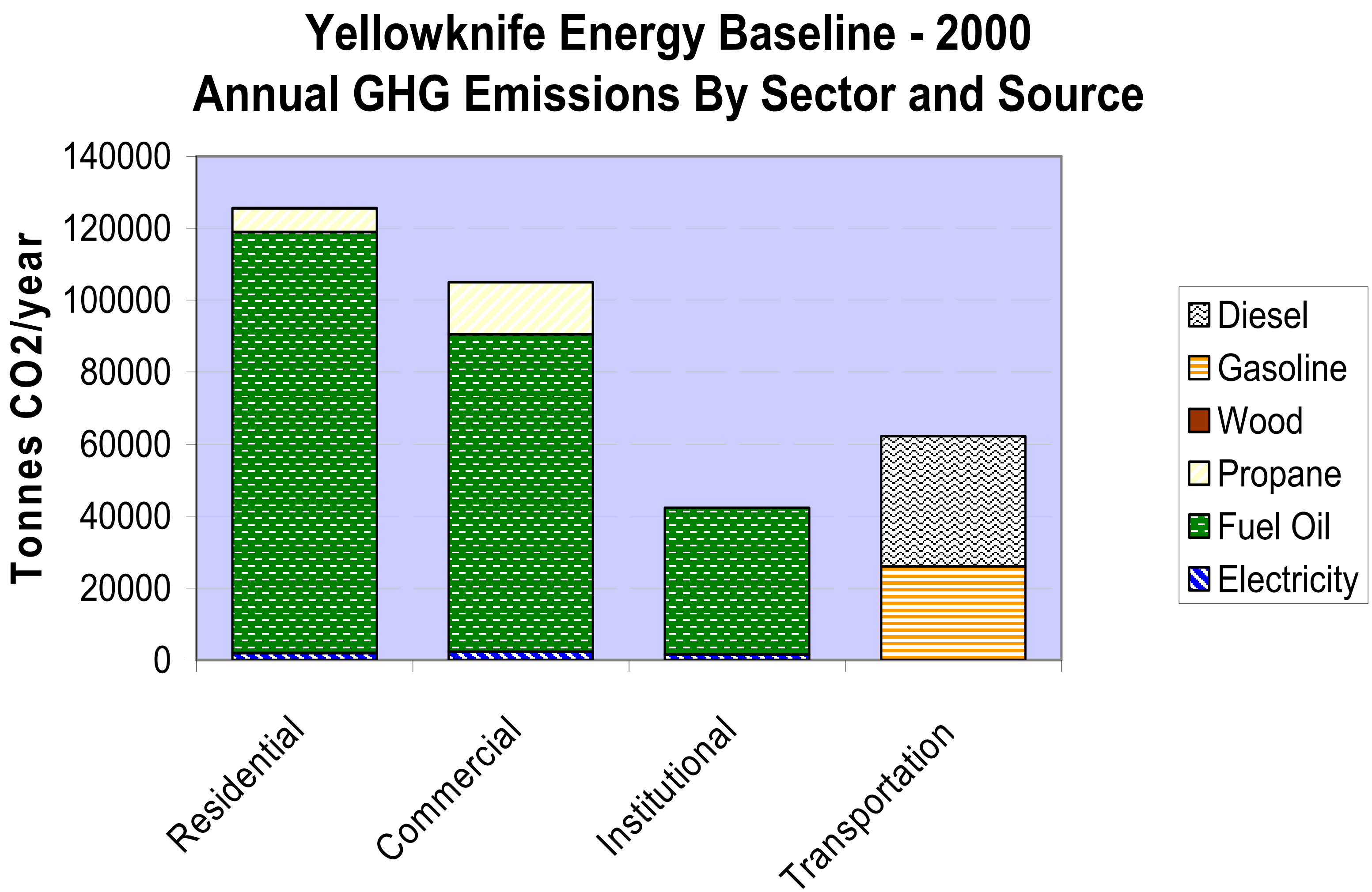
Data Sources:

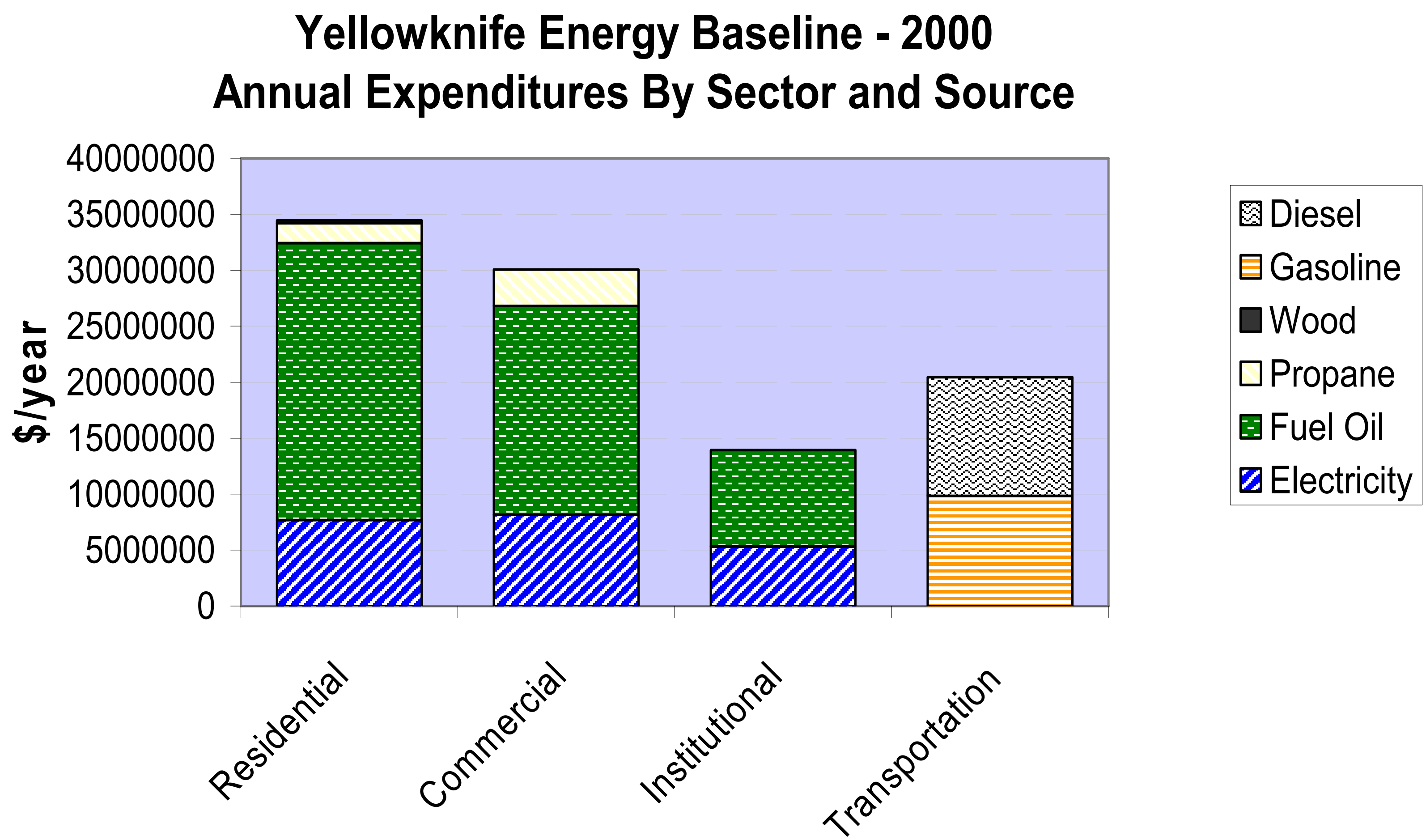
- # of vehicles: (source = vehicle registration data provided by GNWT Dep't of Transportation)
    - Light duty – 13,422
    - Medium Duty – 623
    - Off-road – 467
- Estimated annual km of travel (source: Table 3, 2000 Canadian Vehicle Survey - NWT figures)
    - Light duty – 12,500 km year
    - Medium duty – 8,700 km year
    - Off-road – 1,200 km year (source = 2001 NWT GHG Inventory, p. 17)
- Estimated fuel efficiency (source: Table 7, 2000 Canadian Vehicle Survey – Canadian averages)
    - Light vehicles – 11.3 L/100 km
    - Medium duty – 25.8 L/100 km

  - Off-road – 9.3 L/100 km (source = 2001 NWT GHG Inventory, p.17)

APPENDIX B: BASELINE CHARTS – 2000




Yellowknife Energy Baseline - 2000
Annual GHG Emissions By Sector and Source
Tonnes CO2/year
140000
120000
100000
80000
60000
40000
20000
0
Residential
Commercial
Institutional
Transportation
Diesel
Gasoline
Wood
Propane
Fuel Oil
Electricity


Yellowknife Energy Baseline - 2000
Annual Expenditures By Sector and Source
$/year
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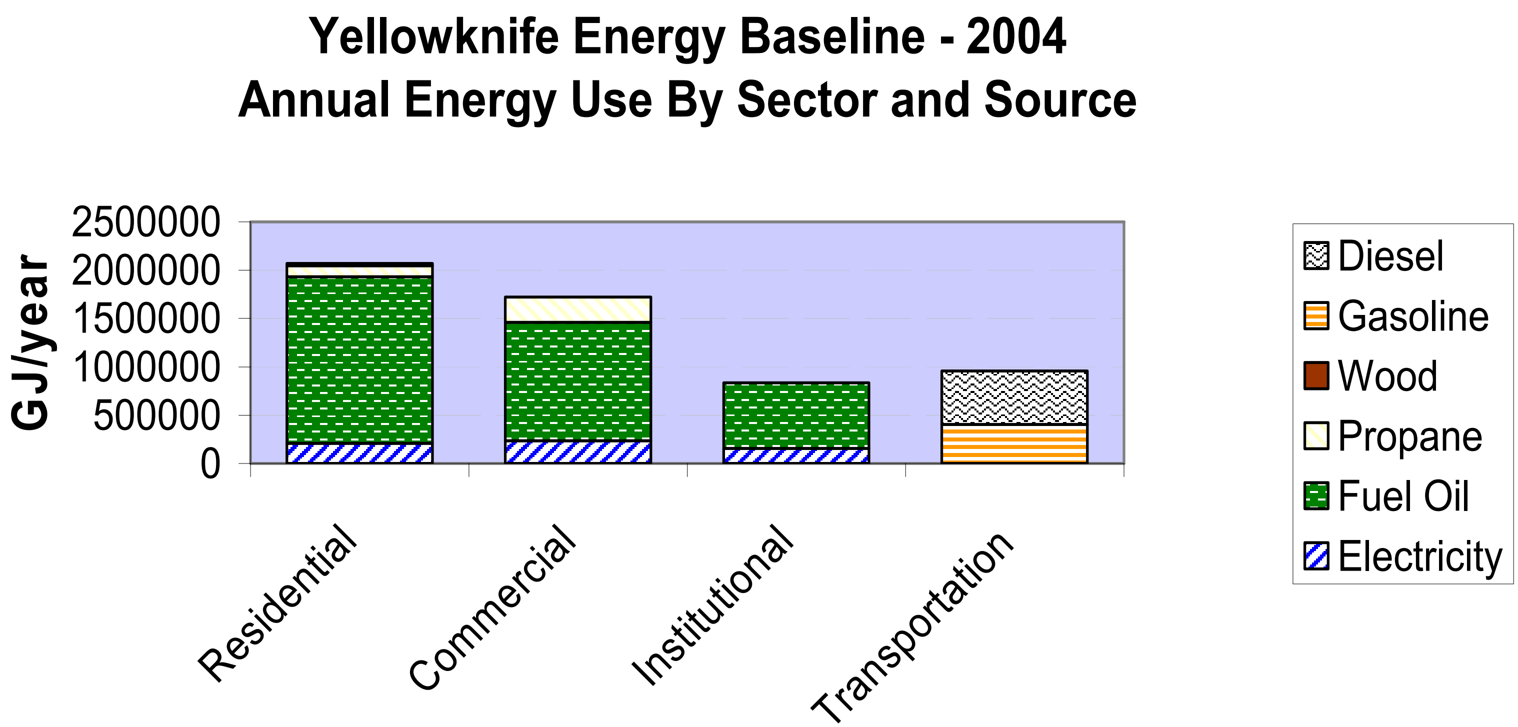
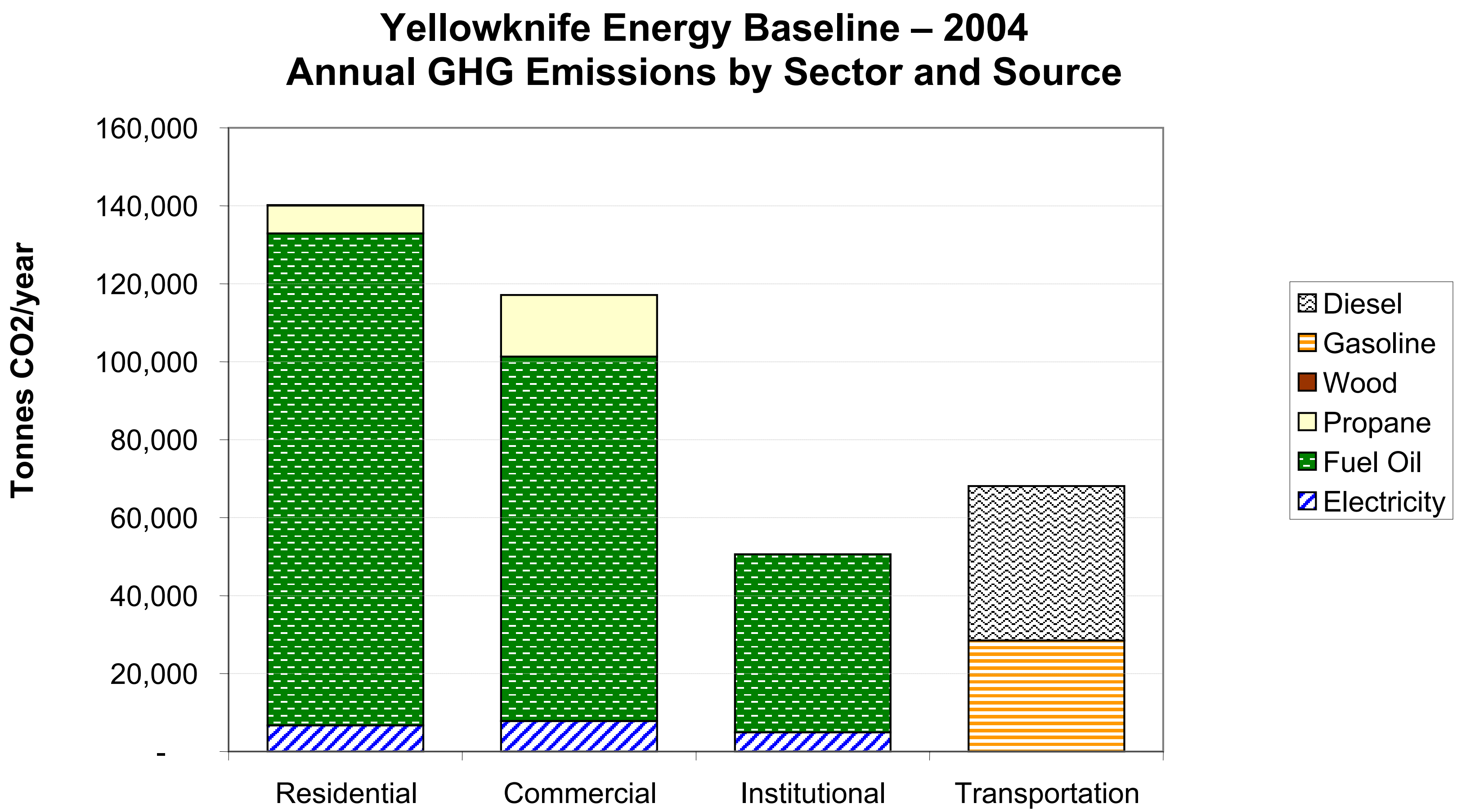
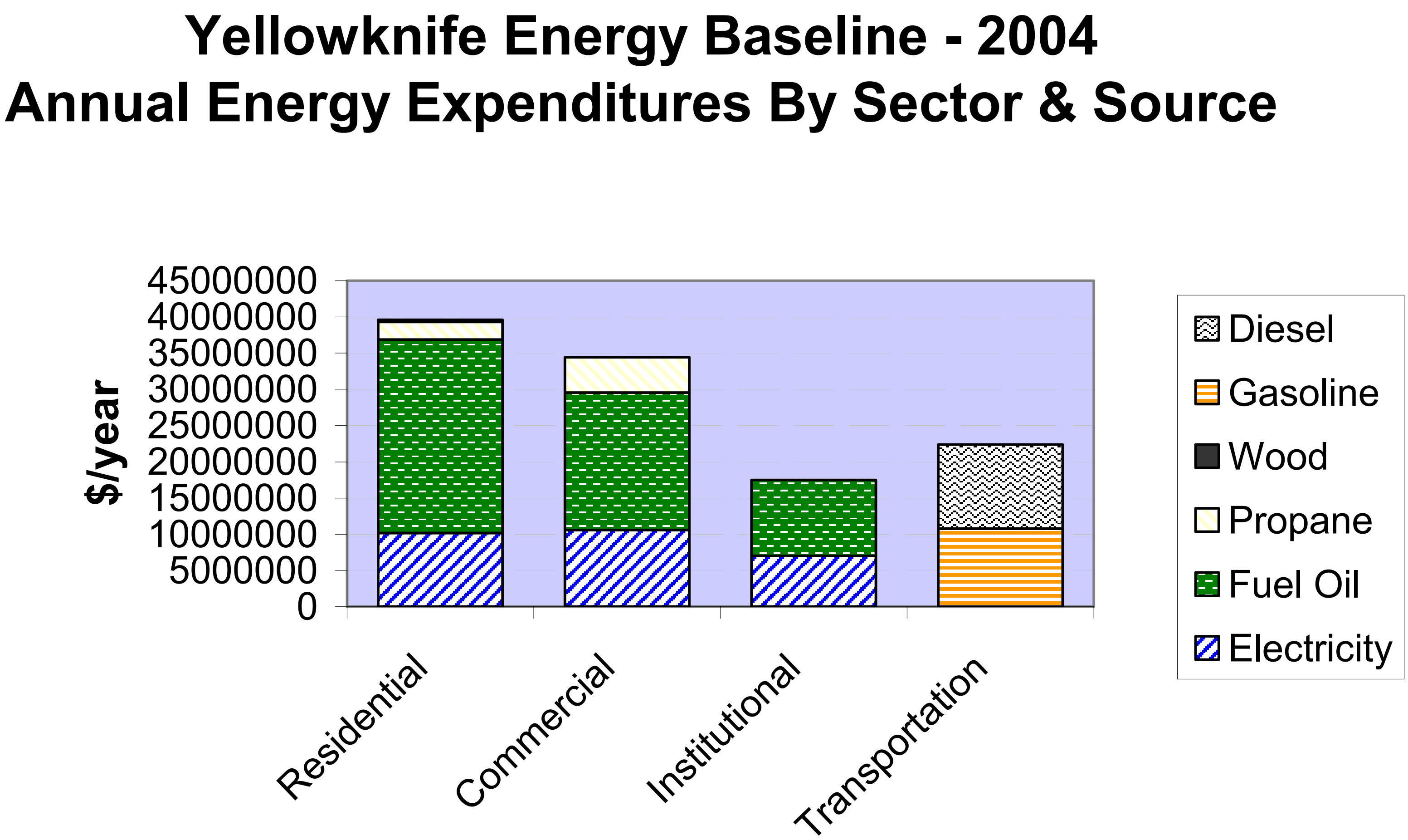
35000000
30000000
25000000
20000000
15000000
10000000
5000000
0
Residential
Commercial
Institutional
Transportation
Diesel
Gasoline
Wood
Propane
Fuel Oil
Electricity

APPENDIX C BASELINE CHARTS – 2004




Yellowknife Energy Baseline – 2004
Annual GHG Emissions by Sector and Source
Tonnes CO2/year
160,000
140,000
120,000
100,000
80,000
60,000
40,000
20,000
-
Residential
Commercial
Institutional
Transportation
Diesel
Gasoline
Wood
Propane
Fuel Oil
Electricity


Yellowknife Energy Baseline - 2004
Annual Energy Expenditures By Sector & Source
$/year
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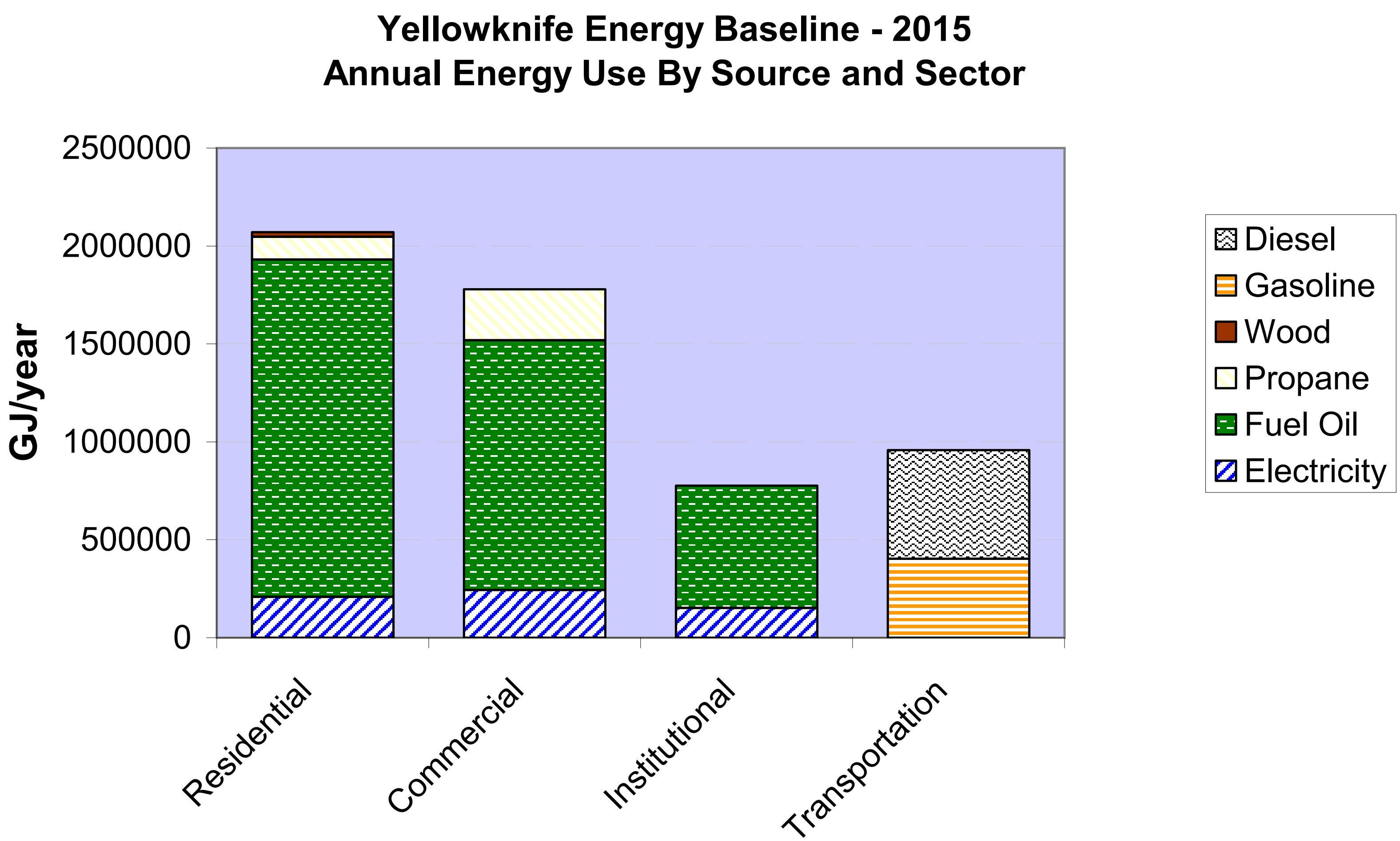
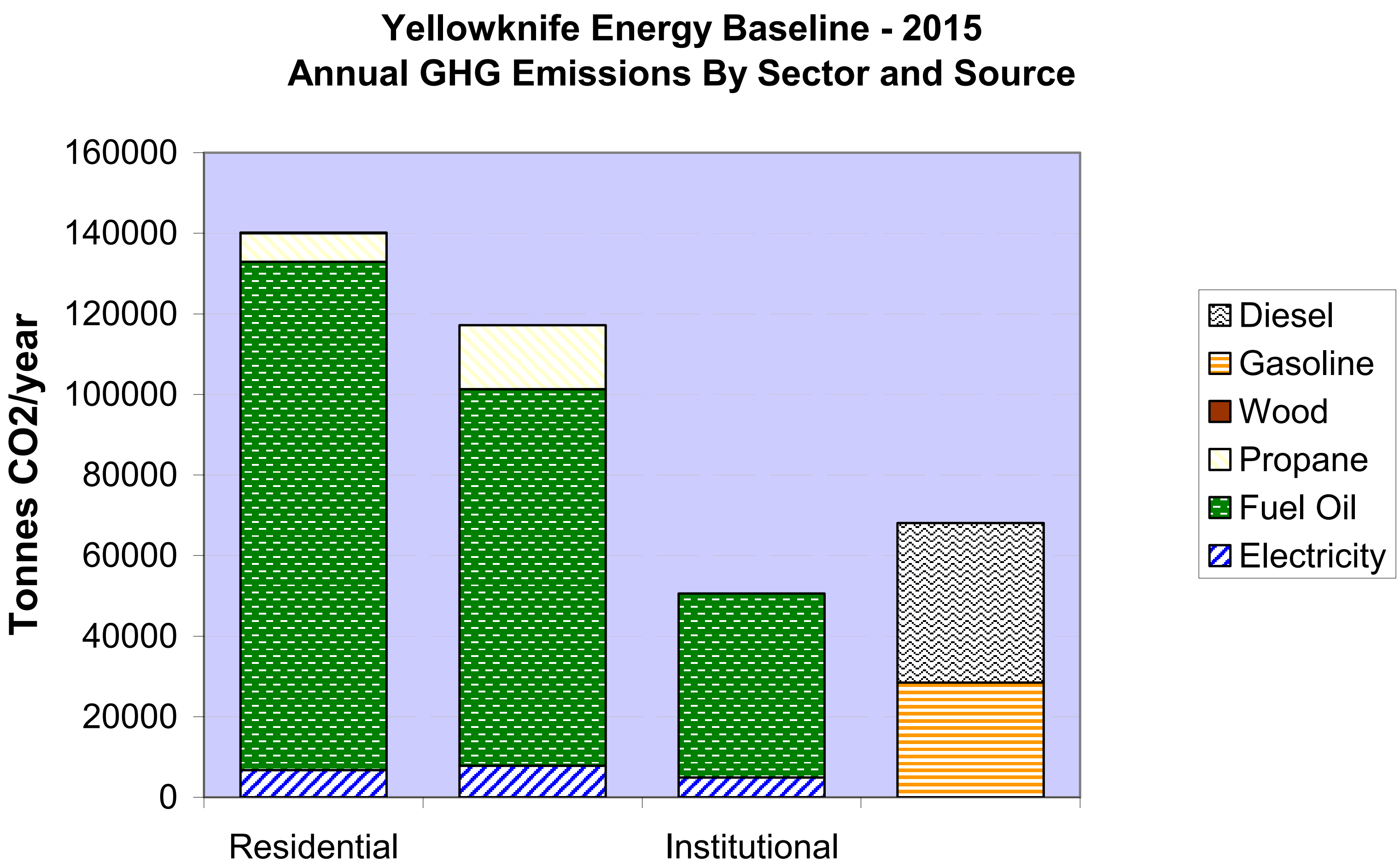
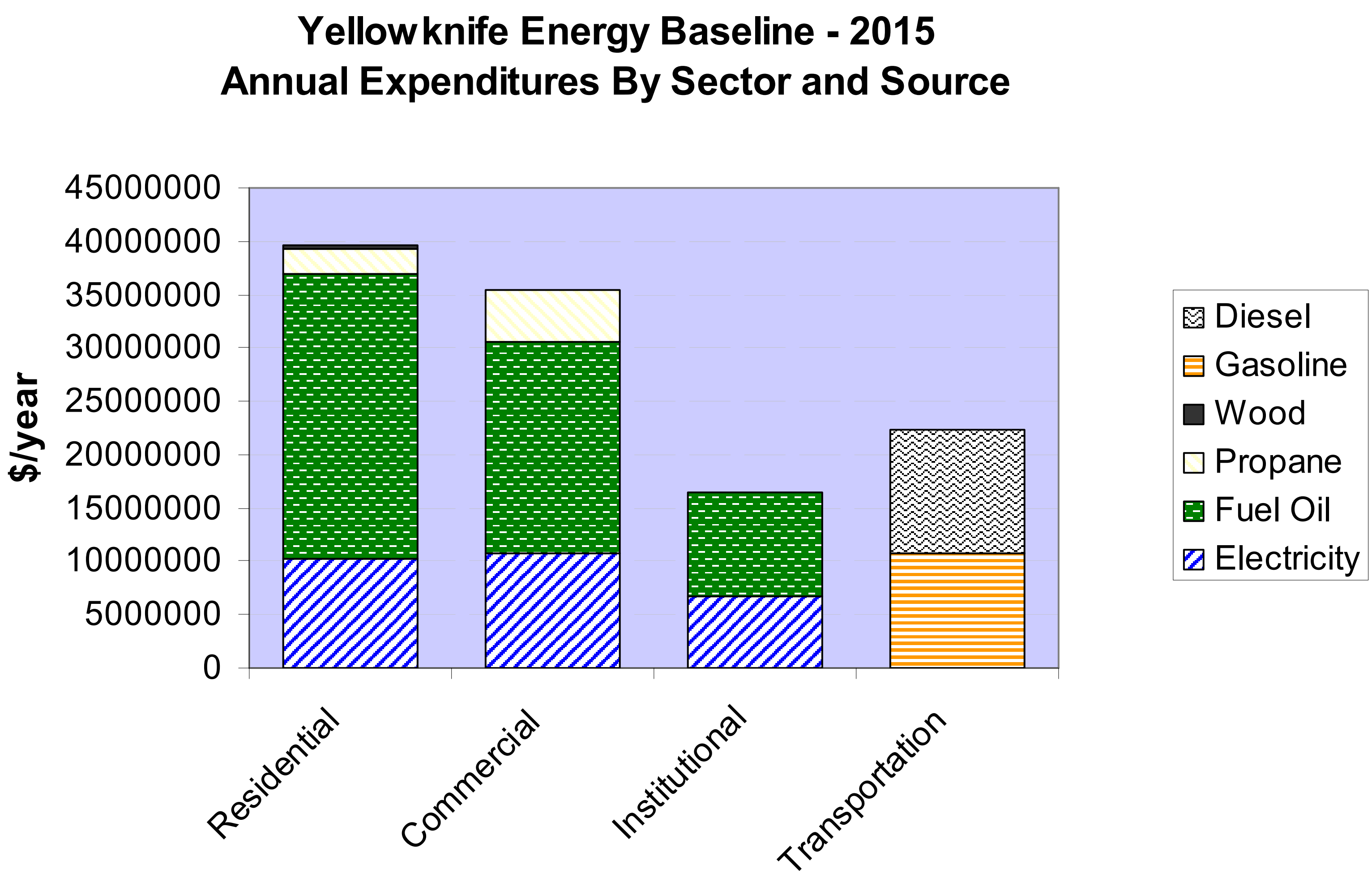
40000000
35000000
30000000
25000000
20000000
15000000
10000000
5000000
0
Residential
Commercial
Institutional
Transportation
Diesel
Gasoline
Wood
Propane
Fuel Oil
Electricity

APPENDIX D BASELINE CHARTS – 2015




Yellowknife Energy Baseline - 2015
Annual GHG Emissions By Sector and Source
Tonnes CO2/year
160000
140000
120000
100000
80000
60000
40000
20000
0
Residential
Institutional
Diesel
Gasoline
Wood
Propane
Fuel Oil
Electricity


Yellowknife Energy Baseline - 2015
Annual Expenditures By Sector and Source
$/year
45000000
40000000
35000000
30000000
25000000
20000000
15000000
10000000
5000000
0
Residential
Commercial
Institutional
Transportation
Diesel
Gasoline
Wood
Propane
Fuel Oil
Electricity

APPENDIX E CEP CHART – 2015