 

Yukon Electricity Conservation and Demand Management Potential Review (CPR 2011)

Summary Report

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Submitted to:
Yukon Energy, Yukon Electrical Company,
Government of Yukon

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1 Introduction

1.1 Background and Objectives

Yukon residents rely on electricity not only to live meaningful, healthy lives but also to support and strengthen the economy. Given the concerns over the environmental implications, including climate change, and the limited generating capacity in the Yukon, there is growing interest not only in how electricity is generated, transmitted and distributed, but also in how efficiently it is used on the customer's end. In Yukon, as well as in a growing number of North American jurisdictions, how electricity is generated and used is being closely analyzed to find innovative ways of meeting individual and corporate energy service needs while minimizing pollution and the creation of greenhouse gases.

Experience throughout many North American jurisdictions has demonstrated that energy efficiency, conservation and customer-supplied alternative energy technologies all have a significant potential to reduce energy consumption, energy costs and emissions. The 2009 *Energy Strategy for the Yukon* also recognizes this potential and notes the following efficiency and conservation priorities:

- Avoid the cost and environmental impact of building new generation
- Increase energy efficiency in Yukon by 20% by 2020
- Reduce energy consumption in Yukon buildings
- Reduce energy consumption for transportation in Yukon
- Promote the use of energy-efficient products by providing incentives for products that meet energy performance standards
- Improve energy efficiency for Yukon government operations.

Efficient use of electricity through conservation, peak demand control and alternative energy sources can assist greatly in the path forward for the electrical supply industry. This study will provide a resource for Yukon Energy Corporation (YEC), Yukon Electrical Company Limited (YECL), and the Government of Yukon to develop a comprehensive vision of the territory's future electricity service needs.

More specifically, the objective for this study is to provide:

"…a necessary reference point to determine the potential for (electricity) demand-side management (DSM) in the Yukon."[1]

1.2 Scope of Study

The scope of this study is summarized below:

- **Sector Coverage:** This study addresses two sectors: residential households (Residential sector), and commercial and institutional buildings (Commercial sector). Yukon's on-grid Industrial sector consists primarily of a small number of operating mines, which are not

[1] Yukon Energy Corporation Request For Proposals #2010-045, "Consulting Services for Electricity Conservation and Demand Management Potential Study," 2011.

appropriate to be included in this type of study. Efficiency opportunities within these sites will be addressed outside of this study.

- **Geographical Coverage:** The study addresses all regions of Yukon that are served by either YEC or YECL. Customers served by both the hydroelectric grid and the stand-alone diesel grids are included. Note that the hydroelectric grid is remote, not connected to other grids, and dependent on trucked fuel to meet demand above the existing hydro / wind capacity, while the stand-alone diesel grids rely at all times on fuel that is trucked or flown in.
- **Study Period:** This study covers a 20-year period. The Base Year is the calendar year 2010, with milestone periods at five-year increments: 2015, 2020, 2025 and 2030. The Base Year of 2010 was selected to enable this study's results to be aligned with the most recent Yukon load forecast.[2]
- **Technologies:** This study addresses a comprehensive range of demand-side management (DSM) measures. This includes all electrical efficiency technologies or measures that are expected to be commercially viable by the year 2015, as well as peak load reduction technologies and customer-side renewable and alternative energies.

1.2.1 Data Caveat

As in any study of this type, the results presented in this report are based on a large number of important assumptions. Assumptions such as those related to the current penetration of energy-efficient technologies, the rate of future growth in the building stock and customer willingness to implement new energy-efficiency measures are particularly influential. Wherever possible, the assumptions used in this study are consistent with those used by YEC, YECL and the Government of Yukon and are based on best available information, which in many cases includes the professional judgment of the consultant team, client personnel and local experts. The reader should, therefore, use the results presented in this report as best available estimates; major assumptions, information sources and caveats are noted throughout the report.

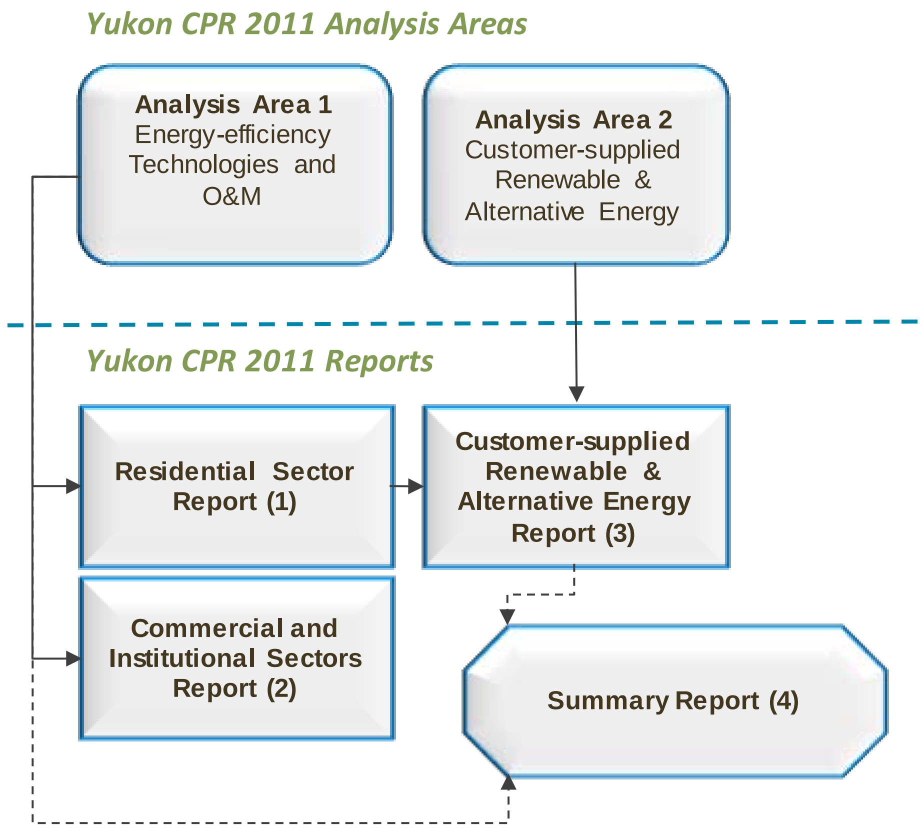
1.3 Study Organization

Exhibit 1 presents an overview of the study's organization; as illustrated, the study has been organized into two analysis areas and four individual reports.

A brief description of each analysis area and the report contents is provided below in Exhibit 1.

[2] Yukon Energy Corporation, *20-Year Resource Plan – 2011, First Draft*, April 2011.

Exhibit 1 Overview of CPR 2011 Organization – Analysis Areas and Reports



1.3.1 Analysis Area 1 – Energy-efficiency and Peak Load Technologies and O&M

This area of the CPR 2011 assesses electric energy and peak load reduction opportunities that could be provided by electrical efficiency and peak load reduction technologies that are expected to be commercially viable by the year 2015; operation and maintenance (O&M) practices are also addressed. The results of Analysis Area 1 are presented in two individual sector reports and summarized in the Summary Report.

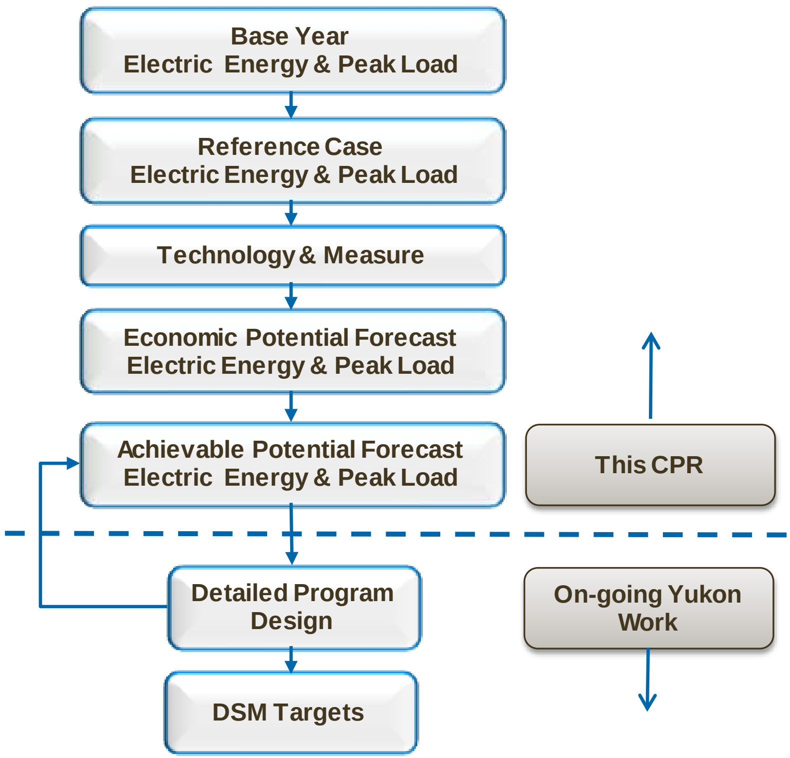
1.3.2 Analysis Area 2 – Customer-Supplied Renewable and Alternative Energies

This area of the CPR 2011 assesses electric energy reduction opportunities that could be provided by customer-supplied renewable and alternative energies. The results of Analysis Area 2 are presented in a single report and are also summarized in the Summary Report.

1.4 Major Analytic Steps

The study was conducted within an iterative process that involved a number of well-defined steps. A summary of the steps for Analysis Area 1 is presented below in Exhibit 2. (Major analytical steps for Analysis Area 2 are presented below in Section 5 of this report.)

Exhibit 2 Major Analytic Steps



A summary of the steps is presented below.

Step 1: Develop Base Year Electric Energy and Peak Load Calibration Using Actual Utility Billing Data

Build a model of electric energy and demand for the sector, disaggregated to all the building types and end uses, and calibrated to sales of electricity in Yukon. This includes the following sub-steps:

- Compile and analyze available data on Yukon's existing building stock.
- Develop detailed technical descriptions of the existing building stock.
- Undertake computer simulations of electricity use in each building type and compare these with actual building billing and audit data.
- Compile actual utility billing data.
- Create sector model inputs and generate results.
- Calibrate sector model results using actual utility billing data.
- Use end-use load shape data to convert electric energy use to electric demand in each selected peak period.

Step 2: Develop Reference Case Electric Energy Use and Peak Load Profile

Extend the base year model to the end of the study period, based on forecast building stock growth and expected natural changes in construction practices, equipment efficiency levels and/or practices. This includes the following sub-steps:

- Compile and analyze building design, equipment and operations data and develop detailed technical descriptions of the new building stock.
- Develop computer simulations of electricity use in each new building type.
- Compile data on forecast levels of building stock growth and "natural" changes in equipment efficiency levels and/or practices.
- Define sector model inputs and create forecasts of electricity use for each of the milestone years.
- Compare sector model results with the load forecasting data provided by YEC for the study period.
- Use end-use load shape data to convert electric energy use to electric demand in each selected peak period over the study period.

Step 3: Identify and Assess Energy-efficiency and Peak Load Reduction Measures

Compile information on upgrade measures that can save electric energy and/or reduce peak demand, and assess them for technical applicability and economic feasibility. This includes the following sub-steps:

- Develop list of energy-efficiency upgrade and peak load reduction measures.
- Compile detailed cost and performance data for each measure.
- For energy-efficiency measures, identify the baseline technologies employed in the Reference Case, develop energy-efficiency upgrade options and associated electricity savings for each option, and determine the cost of conserved energy (CCE) for each upgrade option.
- For each peak load reduction measure, identify the affected end use, the potential load reduction or off-peak shifting and determine the cost of electric peak reduction (CEPR).
- Based on the above results, prepare summary tables that show the amount of potential peak load reduction provided by each measure and at what cost ($/kW/yr.).
- Apply each peak load reduction measure to the affected end use, regardless of cost, and determine total peak reduction.
- Summarize the peak load reduction impacts in a supply curve.

Step 4: Estimate Economic Electric Energy Savings Potential

Develop an estimate of the electric energy savings potential that would result from implementing all of the economically feasible measures in all the buildings where they are applicable. This includes the following sub-steps:

- Compile utility economic data on the forecast cost of new electricity generation and set an economic threshold value; different economic threshold values were selected for each supply system (hydroelectric and diesel grids).
- Identify the combinations of energy-efficiency upgrade options and building types where the cost of saving one kilowatt of electricity is equal to, or less than, the cost of new electricity generation.
- Apply the economically attractive electrical efficiency measures from Step 3 within the energy-use simulation model developed previously for the Reference Case.
- Determine annual electricity consumption in each building type and end use when the economic efficiency measures are employed.
- Compare the electricity consumption levels when all economic efficiency measures are used with the Reference Case consumption levels and calculate the electricity savings.

Step 5: Estimate Achievable Potential Electricity Savings

Develop an estimated range for the portion of economic potential savings that would likely be achievable within realistic DSM programs. This includes the following sub-steps:

- Bundle the electric energy and peak load reduction opportunities identified in the Economic Potential Forecasts into a set of opportunities.
- For each of the identified opportunities, create an Opportunity Profile that provides a high-level implementation framework, including measure description, cost and savings profile, target sub sectors, potential delivery allies, barriers and possible synergies.
- Review historical achievable program results and prepare preliminary Assessment Worksheets.
- Conduct a full day workshop involving the client, the consultant team, trade allies and technical experts to reach general agreement on the upper and lower range of Achievable Potential.

Step 6: Estimate Peak Load Impacts of Electricity Savings

Develop an estimate for the peak load impacts associated with the measures that save electric energy. This includes the following sub-steps:

- The electricity (electric energy) savings (MWh) calculated in the preceding steps were converted to peak load (electric demand) savings (kW).[3]
- The conversion of electricity savings to hourly demand drew on a library of specific sub sector and end-use electricity load shapes. Using the load shape data, the following steps were applied:
  - Annual electricity savings for each combination of sub sector and end use were disaggregated by month
  - Monthly electricity savings were then further disaggregated by day type (weekday, weekend day and peak day)
  - Finally, each day type was disaggregated by hour.

1.5 Definition of Terms

This study uses numerous terms that are unique to analyses such as this one and consequently it is important to ensure that readers have a clear understanding of what each term means when applied to this study.

A brief description of some of the most important terms and their application within this study is included below.

Base Year Electricity Use	The Base Year is the starting point for the analysis. It provides a detailed description of where and how electrical energy is currently used in the existing building stock. Building electricity use simulations were undertaken for the major sub sector types and calibrated to actual utility customer billing data for the Base Year. As noted previously, the Base Year for this study is the calendar year 2010.
Base Year Electric Peak Load Profile	Electric peak load profiles refer to specific time periods throughout the year when Yukon's generation, transmission and distribution system experiences particularly high levels of electricity demand. These periods are of particular interest to system planners; improved management of electricity demand during these peak periods may enable deferral of costly system expansion. This study addresses three specific peak periods, as outlined in the main text.

[3] Peak load savings were modelled using the Cross-Sector Load Shape Library Model (LOADLIB).

Reference Case Electricity Use (includes “natural” conservation)

The Reference Case electricity use estimates the expected level of electrical energy consumption that would occur over the study period in the absence of new (post-2010) utility-based DSM initiatives. It provides the point of comparison for the subsequent calculation of Economic and Achievable electricity savings potentials. Creation of the Reference Case required the development of profiles for new buildings in each of the sub sectors, estimation of the expected growth in building stock, and finally an estimation of “natural” changes affecting electricity consumption over the study period. The Reference Case is calibrated to YEC’s most recent load forecast, minus the impacts of new, future DSM initiatives.

Reference Case Electric Peak Load Profile

The Reference Case peak load profile estimates the expected electric peak loads in each of the three defined peak periods over the study period in the absence of new utility DSM program initiatives. It provides the point of comparison for the subsequent calculation of Economic and Achievable Potentials for peak load reduction.

Demand-Side Management (DSM) Measures

DSM measures can include energy efficiency (use more efficiently), energy conservation (use less), demand management (use less during peak periods), fuel switching (use a different fuel to provide the energy service) and customer-side generation (displace load off of grid). Fuel switching is not included in this study.

The Cost of Conserved Energy (CCE)

The CCE is calculated for each energy-efficiency technology measure. The CCE is the annualized incremental capital and O&M cost of the upgrade measure divided by the annual energy savings achieved, excluding any administrative or program costs. The CCE represents the cost of conserving one kWh of electricity; it can be compared directly to the cost of supplying one new kWh of electricity.

The Cost of Electric Peak Reduction (CEPR)

The CEPR for a peak load reduction measure is defined as the annualized incremental capital and O&M cost of the measure divided by the annual peak reduction achieved, excluding any administrative or program costs. The CEPR represents the cost of reducing one kW of electricity during a peak period; it can be compared to the cost of supplying one new kW of electric capacity during the same period.

Levelized Cost of Generation/Conservation (LCG/LCC)	The LCG or LCC is calculated for each customer-side renewable and alternative technology measure. The LCG/LCC is the annualized incremental capital and O&M cost of the measure divided by the annual energy generated or conserved, excluding any administrative or program costs. The LCG/LCC represents the cost of generating one kWh of energy; it can be compared directly to the cost of supplying one new kWh of electricity. (The choice of LCG/LCC depends on the technology: solar PV systems generate electricity, and would therefore have an LCG; wood-pellet burning furnaces conserve electricity in an electrically-heated home and would therefore have an LCC.)
Electric Capacity-Only Peak Load Reduction Measures	Capacity-only measures are technologies or activities that result in the shifting of certain electrical loads from periods of peak system demand to periods of lower system demand.
Economic Potential Electricity Forecast	The Economic Potential Electricity Forecast is the level of electricity consumption that would occur if all equipment and building envelopes were upgraded to the level that is cost effective against the economic threshold value,[4] which has been set at different prices per kWh for the different supply system types. (One kWh from the hydroelectric grid is much less expensive than one kWh from the diesel grid in Old Crow.) All the energy-efficiency, renewable or alternative energy upgrades included in the technology assessment that had a CCE or LCG/LCC equal to, or less than, the economic threshold value for a given supply system were incorporated into the Economic Potential Forecast.
Economic Potential Electric Peak Load Forecast	The Economic Potential Electric Peak Load Forecast is the expected electric peak loads that would occur in each of the three defined peak periods if all peak load reduction measures that are cost effective against the future avoided cost of new capacity in Yukon were fully implemented.
Achievable Potential	The Achievable Potential is the proportion of the savings identified in the Economic Potential Forecasts that could realistically be achieved within the study period. The Achievable Potential recognizes that it is difficult to induce customers to purchase and install all the electrical efficiency technologies that meet the criteria defined by the Economic Potential Forecast. The results are presented as a range, defined as lower and upper.

1.6 Peak Period Definitions

Based on discussions with utilities personnel, the following three peak period definitions were selected for inclusion in this study:

[4] The economic threshold value is related to the cost of new avoided electrical supply. The values for each supply system were selected to provide the CPR study with a reasonably useful time horizon (life) to allow planners to examine options that may become more cost effective over time.

- **Annual Peak Hour** – This has traditionally been the hour ending at 6 pm on a day in December; it is highly correlated with the coldest day of the year when occurring in December, although it has sometimes occurred in January.

- **Evening Peak** – The 4-8 pm period on the coldest four days of the year when occurring in December or January (total 16 hours).

- **Morning Peak** – The 7-9 am period on the 10 coldest days of the year when occurring in December or January (total 20 hours).

1.7 Report Organization

This report is Report 4 in Exhibit 1, above, and is organized as follows:

- Section 2 presents the combined electric energy and peak load savings for the two sectors from technology adoption and O&M measures.
- Sections 3 and 4 present a summary of the electric energy and peak load savings from technology adoption for the Residential and Commercial sectors, respectively.
- Section 5 presents a summary of the electric energy savings from small-scale customer-supplied renewable and alternative energies in the Residential and Commercial sectors.

2 Summary of Findings

CPR 2011 confirms that significant cost-effective electric energy and peak load savings opportunities exist in both the Residential and Commercial sectors.

To determine the total electric energy and peak load savings potential, this study combined the results contained in each of the stand-alone sector reports included in Analysis Area 1, as depicted in Exhibit 1.

The combined results presented in this section are net of overlapping measures that, if simply summed, would result in double counting of results. In addition, all savings are reported at the customer meter and do not include line losses. Results from Analysis Areas 2 (Customer-side Renewable and Alternative Energy) are not included in the calculation of combined savings as these measures also fundamentally alter the load forecast.

Additional Achievable Potential electricity savings are likely available from electrical efficiency technologies and measures that become commercially viable beyond 2015, or step changes in energy-efficient technologies that are not reflected in the following results. Finally, supply-side efficiency improvements in Yukon utility supply systems could provide additional electricity savings, which are not included here.

2.1 Electric Energy Savings

Exhibit 3 and Exhibit 4 summarize the total combined Achievable Potential electric energy savings that have been identified in each of the stand-alone Commercial and Residential sector reports (Analysis Area 1). As illustrated:

- In the upper Achievable Potential scenario, electricity savings are about 16,000 MWh/yr. in 2015 and increase to about 97,000 MWh/yr. by 2030.
- In the lower Achievable Potential scenario, electricity savings are about 11,000 MWh/yr. in 2015 and increase to about 66,000 MWh/yr. by 2030.
- In the Reference Case, total electricity consumption increases from approximately 312,000 MWh/yr. in 2010 to about 515,000 MWh/yr. by 2030, an increase of about 65%.
- In the combined upper Achievable Potential scenario, the electricity savings of 97,000 MWh/yr. in 2030 means that the total electricity consumption would increase to about 418,000 MWh/yr., a decrease of about 18% relative to the Reference Case.
- In the combined lower Achievable Potential scenario, the electricity savings of 11,000 MWh/yr. in 2030 means that the total electricity consumption would increase to about 450,000 MWh/yr., a decrease of about 13% relative to the Reference Case.

Exhibit 3 Combined Annual Electricity Consumption—Energy-efficiency Economic and Achievable Potential Relative to Reference Case Forecast, (MWh/yr.)

	Annual Consumption, Combined				Potential Annual Savings, Combined					
			Achievable Potential				Achievable Potential			
	Reference Case	Economic Potential	Upper	Lower	Economic Potential		Upper		Lower	
	MWh/yr.	MWh/yr.	MWh/yr.	MWh/yr.	MWh/yr.	%	MWh/yr.	%	MWh/yr.	%
Milestone Year	(A)	(B)	(C)	(D)	(A-B)		(A-C)		(A-D)	
2010	312,117									
2015	345,540	243,694	329,304	334,560	101,846	29%	16,236	5%	10,980	3%
2020	387,814	266,823	350,883	362,814	120,991	31%	36,931	10%	25,000	6%
2025	443,564	300,607	381,949	401,819	142,957	32%	61,615	14%	41,745	9%
2030	515,412	347,760	418,496	449,556	167,652	33%	96,916	19%	65,856	13%

Exhibit 4 Annual Electricity Consumption—Energy-efficiency Achievable Potential Relative to Reference Case and Economic Potential Forecast, (MWh/yr.)

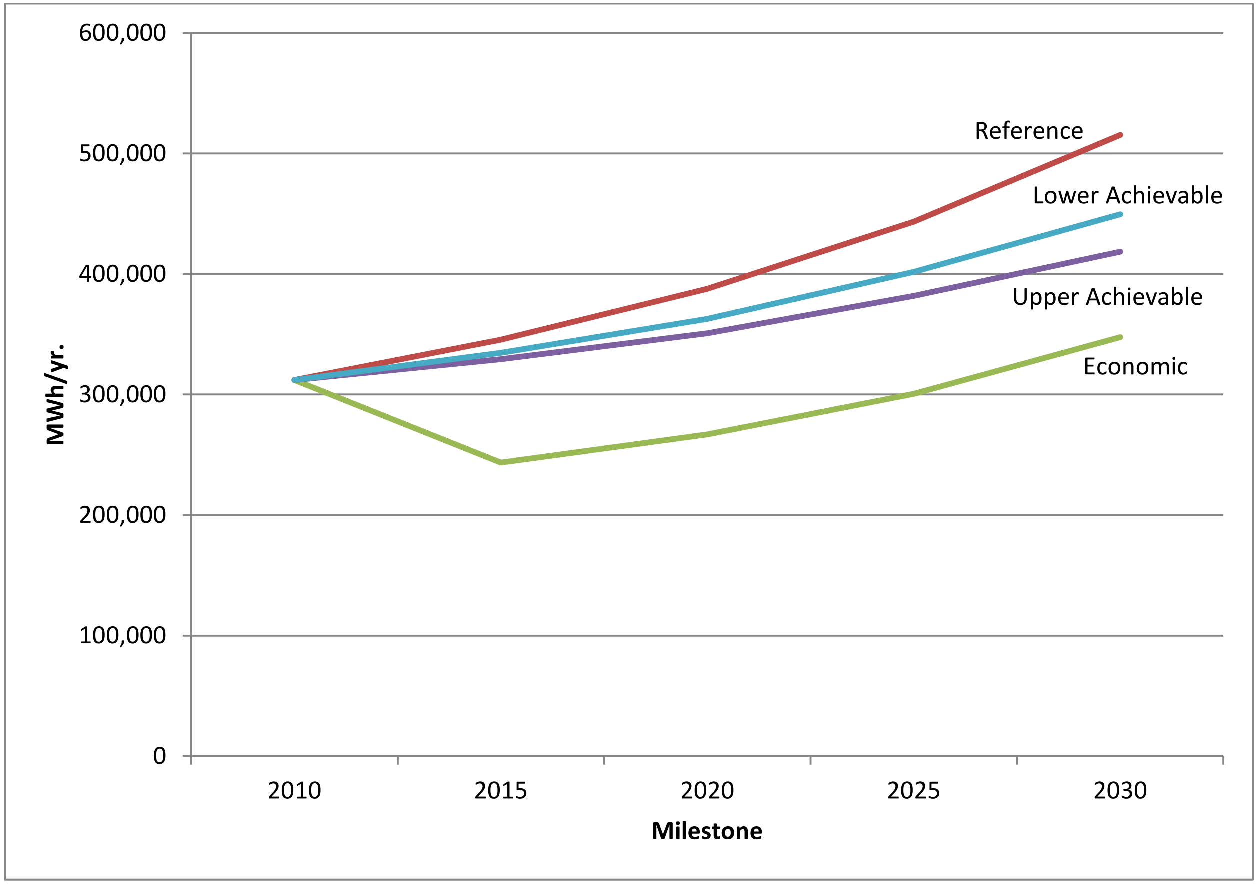
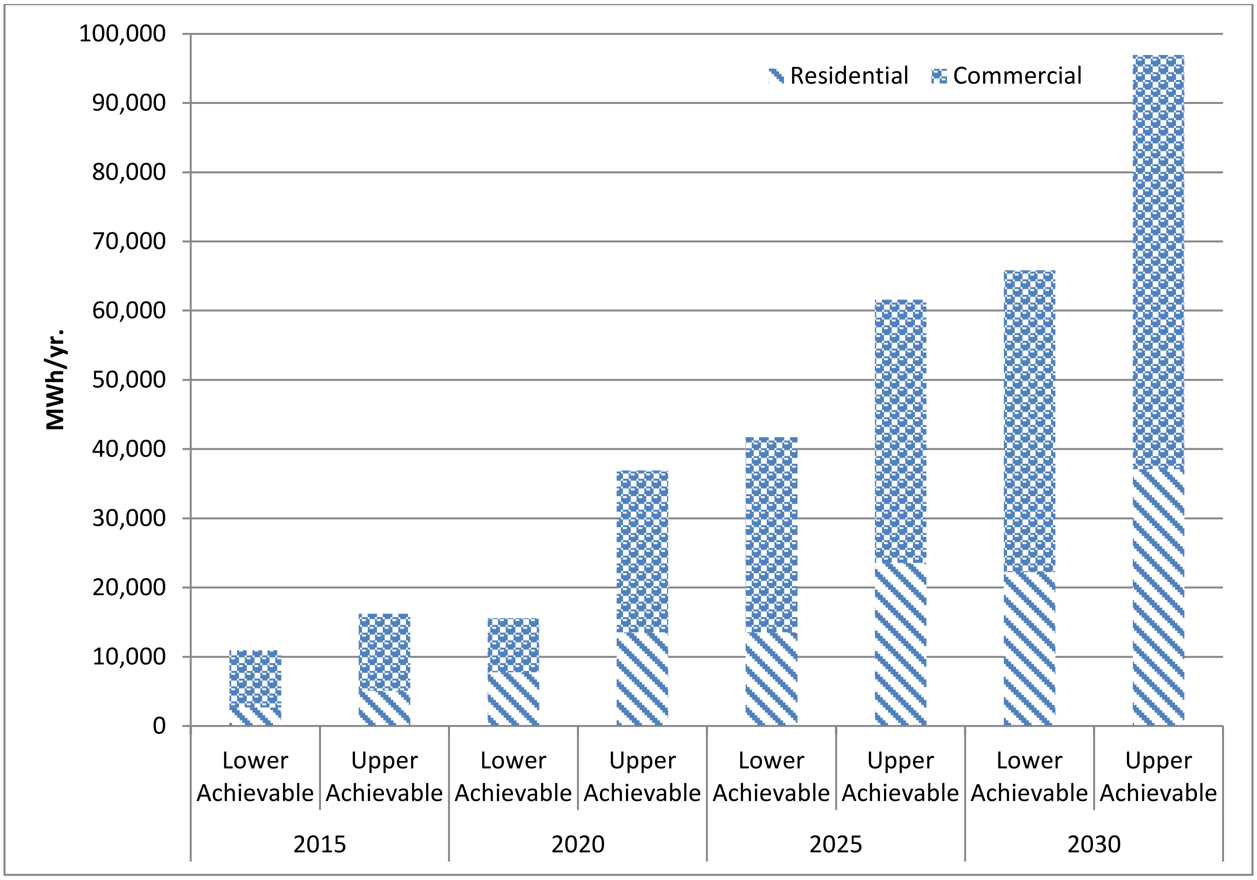


Exhibit 5 indicates how the upper and lower Achievable savings are distributed by sector. The potential savings in the Commercial sector are slightly larger than those in the Residential sector.

Exhibit 5 Upper and Lower Achievable Electricity Consumption Savings by Sector (MWh/yr.)



2.2 Electric Peak Load Savings

This study also confirmed that significant cost-effective opportunities exist for peak load savings during each of the three peak periods. The peak load savings considered in this study are those that result from electric energy savings measures.

For the purposes of this report, the results for the Annual Peak Hour are presented in Exhibit 6; details for the other two peak periods are provided in each of the stand-alone reports listed at the end of this section

As illustrated in Exhibit 6:

- In the Base Year 2010, the peak load was approximately 64 MW for the Annual Peak Hour.
- In the absence of new DSM initiatives, the study estimates that the total peak load in the Annual Peak Hour will grow to about 107 MW by 2030, an increase of about 67%.

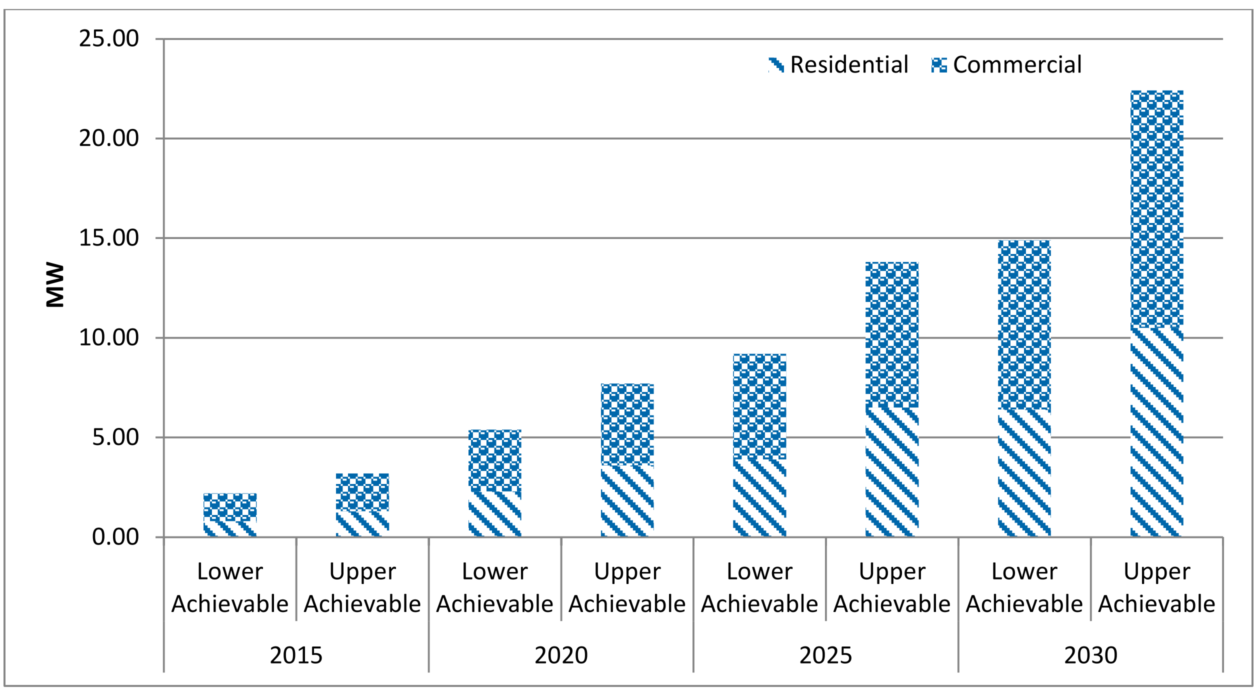
- Electric energy savings would provide peak load savings of approximately 22 MW (21%) and 15 MW (14%) during the Annual Peak Hour by 2030 in, respectively, the upper and lower Achievable Potential scenarios.

Exhibit 6 Combined Peak Load Reductions for the Annual Peak Hour, from Electric Energy Savings Measures, Reference Case, Economic and Achievable Scenarios (MW)

Milestone Year	Average Peak Load (MW)	Peak Load Savings (MW, %)					
	Reference Case	Economic Case		Upper Achievable		Lower Achievable	
2010	64.4						
2015	71.9	22.8	32%	3.2	4%	2.2	3%
2020	81.1	26.9	33%	7.7	9%	5.4	7%
2025	92.7	31.7	34%	13.8	15%	9.2	10%
2030	107.4	37.1	35%	22.4	21%	14.9	14%

Exhibit 7 shows how the Annual Peak Hour potential savings are distributed between the Residential and Commercial sectors. Consistent with the energy savings, the Commercial sector peak savings are slightly larger than those for the Residential Sector

Exhibit 7 Upper and Lower Achievable Annual Peak Hour Reductions by Sector (MW)



2.3 Additional Information

The combined potential electricity savings results presented in this section are based on the detailed data and analysis contained in the reports listed below. The reader is referred to these reports for additional information:

- *Yukon Electricity Conservation and Demand Management Potential Review (CPR 2011): Residential Sector*
- *Yukon Electricity Conservation and Demand Management Potential Review (CPR 2011): Commercial Sector*
- *Yukon Electricity Conservation and Demand Management Potential Review (CPR 2011): Customer-side Renewable and Alternative Energy*

2.4 Caveats

The CPR 2011's scope was limited to the two analysis areas outlined in Section 1.3. Within each analysis area, analysis was limited to known or expected technologies and measures for which sufficient information was available. Estimates of combined Achievable Potential savings were limited to Analysis Area 1. As a result, additional electricity savings beyond those identified in the combined Achievable Potential are likely feasible. These additional savings could come from electrical efficiency technologies and measures not reflected in the CPR, including those that become commercially viable beyond 2015 or through step changes in energy-efficient technologies. They could also come from behaviour changes, customer-supplied renewable or alternative energy use, or fuel switching. Finally, they could come from supply-side efficiency improvements within Yukon's electrical systems.

As in any study of this type, the results presented in this report are based on a number of important assumptions. Assumptions such as those related to the current penetration of efficient technologies and the rate of future growth in the economy and the stock of buildings are particularly influential. Wherever possible, the assumptions used in this study are consistent with the Yukon load forecast, discount rates and economic threshold price.

This summary describes the key assumptions underlying the report. However, the full text of the individual sector reports contain a number of specific definitions and cautions that could influence the interpretation of the results. Readers should review the full texts before drawing any conclusions based on this summary.

3 Residential Sector

The Residential sector includes single-family detached homes, attached and row homes, apartment and condo buildings and mobile homes. Seasonal homes and separately-metered garages are also included as distinct sub sectors.

3.1 Approach

The detailed end-use analysis of electric energy in the Residential sector employed two linked modelling platforms: HOT2000, a Natural Resources Canada supported residential building energy-use simulation software, and RSEEM (Residential Sector Energy End-use Model), an ICF Marbek in-house spreadsheet-based macro model. Peak load savings were modelled using Lopes Consulting Services' Cross-Sector Load Shape Library Model (LOADLIB).

The major steps in the general approach to the study are outlined in Section 1.4. Specific procedures for the Residential sector were as follows:

Modelling of Base Year

Utility customer billing data, and, to a lesser extent, housing data from the Yukon Housing Corporation and the results of Yukon's Residential Electrical End-Use Survey (REEUS), were used to break down the Residential sector by three factors:

- Type of dwelling (single detached, attached or row house, apartment, etc.)
- Heating category (electric or non-electric heat)
- Vintage (age of the building).

To estimate the electric energy used for space heating, the consultants factored in building characteristics such as insulation and air-tightness using the EnerGuide for Houses database as well as climate data. They also used Yukon survey data on hot water heaters, appliances, lights, etc. to estimate electricity consumption for these end uses. The resulting average total electricity use per dwelling was then calibrated to actual Yukon utility data by adjusting assumptions about the individual electric end uses to produce the correct totals. HOT2000 models were developed to match the calibrated average consumption per dwelling; these later served as baselines to estimate the savings from building shell improvement measures.

To estimate the peak loads in each of the three peak periods, the consultants developed a series of factors, based on measured load data for the major dwelling types and end uses, which provide the basis for converting annual energy to any hourly demand specified, including the grouping of hours used in the three peak periods defined in this study.

Reference Case Calculations

For the Residential sector, the consultants developed detailed profiles of new buildings for each type of dwelling. They estimated the growth in building stock and estimated the amount of electricity used by both the existing building stock and the projected new buildings and appliances. In doing so, they incorporated the energy savings that would be expected to occur naturally due to improvements to thermal characteristics of existing homes and appliances over the study period. As with the Base Year calibration, the consultants' projection closely matches Yukon utility forecasts of future electricity requirements.

Assessment of Electric Energy Savings Options Technologies

To estimate the Economic and Achievable electric energy and peak savings potentials, the consultants assessed technologies such as:

- Improved lighting systems
- Reduced standby losses in computers and electronic equipment
- Improved designs for new buildings
- Upgrades to the basement walls, windows and air leakage sealing of existing buildings
- Improved space heating and cooling equipment
- Improved ventilation fans and furnace blowers
- Improved water heaters and devices to reduce hot water use
- More efficient household appliances and other plug-in equipment.

Assessment of Capacity-Only Peak Load Reduction Options

To evaluate the additional peak load reduction potentials resulting from capacity-only measures, the options assessed included utility control of water heating equipment, engine block heating, non-essential lighting, overridable utility control of non-essential plug loads, and electric thermal storage.

3.2 Summary of Electric Energy Savings

A summary of the levels of annual electricity consumption contained in each of the Residential sector forecasts addressed by this study is presented in Exhibit 8 and Exhibit 9 by milestone year. These results, net of any double counting, are included in the combined savings levels presented previously in Section 2. Highlights of this analysis include:

- Electric energy savings from electrical efficiency improvements would provide between 22,000 and 37,000 MWh/yr. of electricity savings by 2030 in, respectively, the lower and upper Achievable scenarios. The most significant Achievable savings opportunities were in the actions that addressed space heating. Significant savings were also found in domestic hot water (DHW) systems, clothes dryers,[5] standby load in household electronics (e.g., computers and their peripherals, televisions, and other home entertainment electronics), and 13 other end uses.
- The electric energy savings noted above would provide peak load savings of approximately 6.4 to 10.5 MW during Yukon's annual system peak hour by 2030 in, respectively, the lower and upper Achievable scenarios.[6]

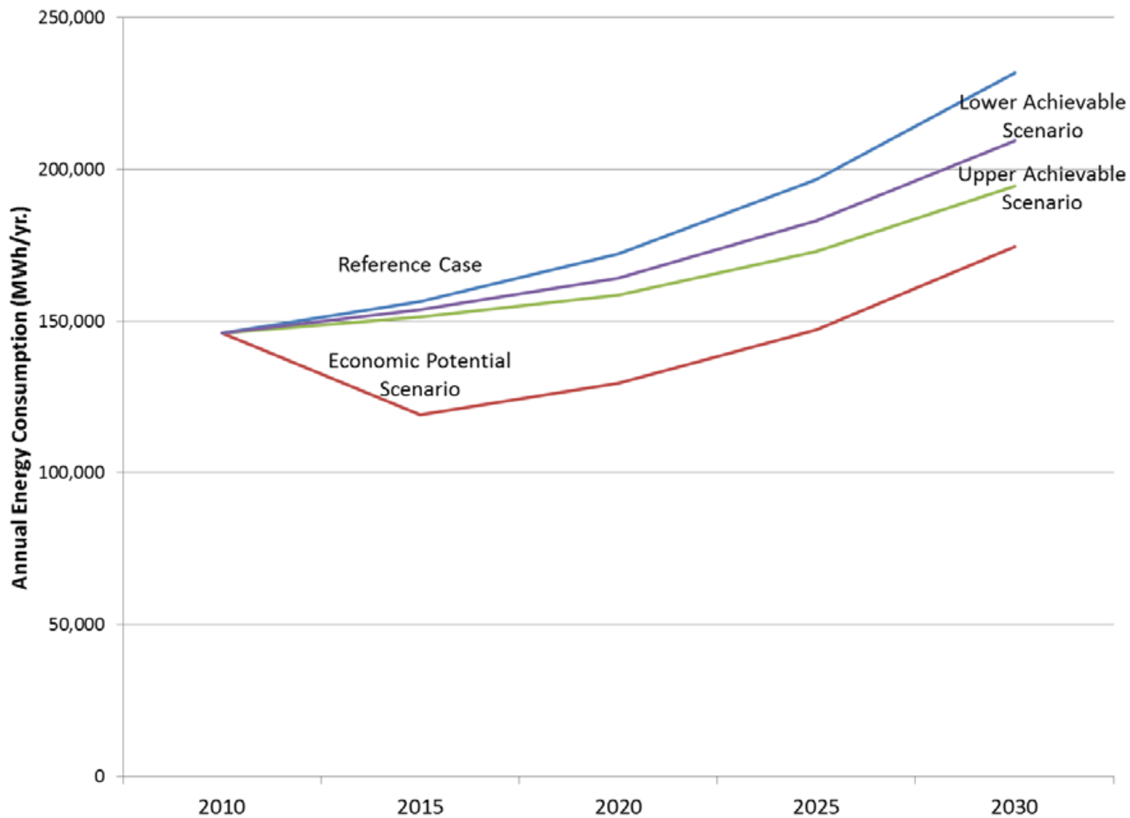
[5] Savings in the clothes dryers result from the faster spin cycle in energy-efficient clothes washers. Spinning the clothes more thoroughly in the washer reduces the runtime of the clothes dryer.

[6] These reduction estimates do not include the change in load shape that results when timers are used on block heaters. In fact, if timers are used, close to 90% of the peak load caused by block heaters would be eliminated because the block heater load at most homes with timers would not begin until the early hours of the morning. At the same time, the figures include an overestimate of peak impact from space heating measures because the heat pump measures do not offer demand reductions. These effects almost cancel out: the range of peak savings is between 6.6 MW and 9.9 MW if they are included.

Exhibit 8 Annual Electricity Consumption—Energy-efficiency Economic and Achievable Potential Relative to Reference Case Forecast for the Residential Sector, (MWh/yr.)

Milestone Year	Annual Consumption, Residential				Potential Annual Savings, Residential					
			Achievable Potential				Achievable Potential			
	Reference Case	Economic Potential	Upper	Lower	Economic Potential		Upper		Lower	
	MWh/yr.	MWh/yr.	MWh/yr.	MWh/yr.	MWh/yr.	%	MWh/yr.	%	MWh/yr.	%
	(A)	(B)	(C)	(D)	(A-B)		(A-C)		(A-D)	
2010	145,984									
2015	156,505	119,271	151,391	153,794	37,234	24%	5,114	3%	2,711	2%
2020	172,039	129,467	158,485	164,247	42,572	25%	13,554	8%	7,792	5%
2025	196,519	147,104	172,921	182,980	49,415	25%	23,598	12%	13,539	7%
2030	231,739	174,493	194,642	209,500	57,246	25%	37,097	16%	22,239	10%

Exhibit 9 Annual Electricity Consumption—Energy-efficiency Achievable Potential Relative to Reference Case and Economic Potential Forecast for the Residential Sector, (MWh/yr.)



Base Year Electricity Use

In the Base Year of 2010, Yukon's Residential sector consumed about 146,000 MWh. Exhibit 10, below, shows that DHW and space heating each account for about 19% of total residential electricity use. These are followed by spa heaters and pumps with about 9%, indoor lighting with 8%, and computers (with their peripherals) and clothes dryers with about 7% each. Refrigerators account for 6%, followed by cooking, ventilation/circulation, and freezers with 4% each. Other end uses account for 3% or less of the total.

Exhibit 11, also below, shows the distribution of Base Year electricity consumption by dwelling type. As illustrated, single detached housing dwellings account for the largest share (72%) of Residential sector Base Year electricity use.

Reference Case

In the absence of new DSM initiatives, CPR 2011 estimates that electricity consumption in the Residential sector will grow from 146,000 MWh/yr. in 2010 to about 232,000 MWh/yr. by 2030. Exhibit 10 and Exhibit 11 below show the year 2030 Reference Case consumption breakdown by end use and dwelling type. The overall growth is about 59% in the period and is higher than the forecast set out in YEC's 20-Year Resource Plan – 2011. This is largely because projections of construction of electrically heated residential dwellings have been revised since the publication of that forecast.

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Exhibit 10 Base Year and 2030 Reference Case Year Electricity Use by End Use, Residential Sector

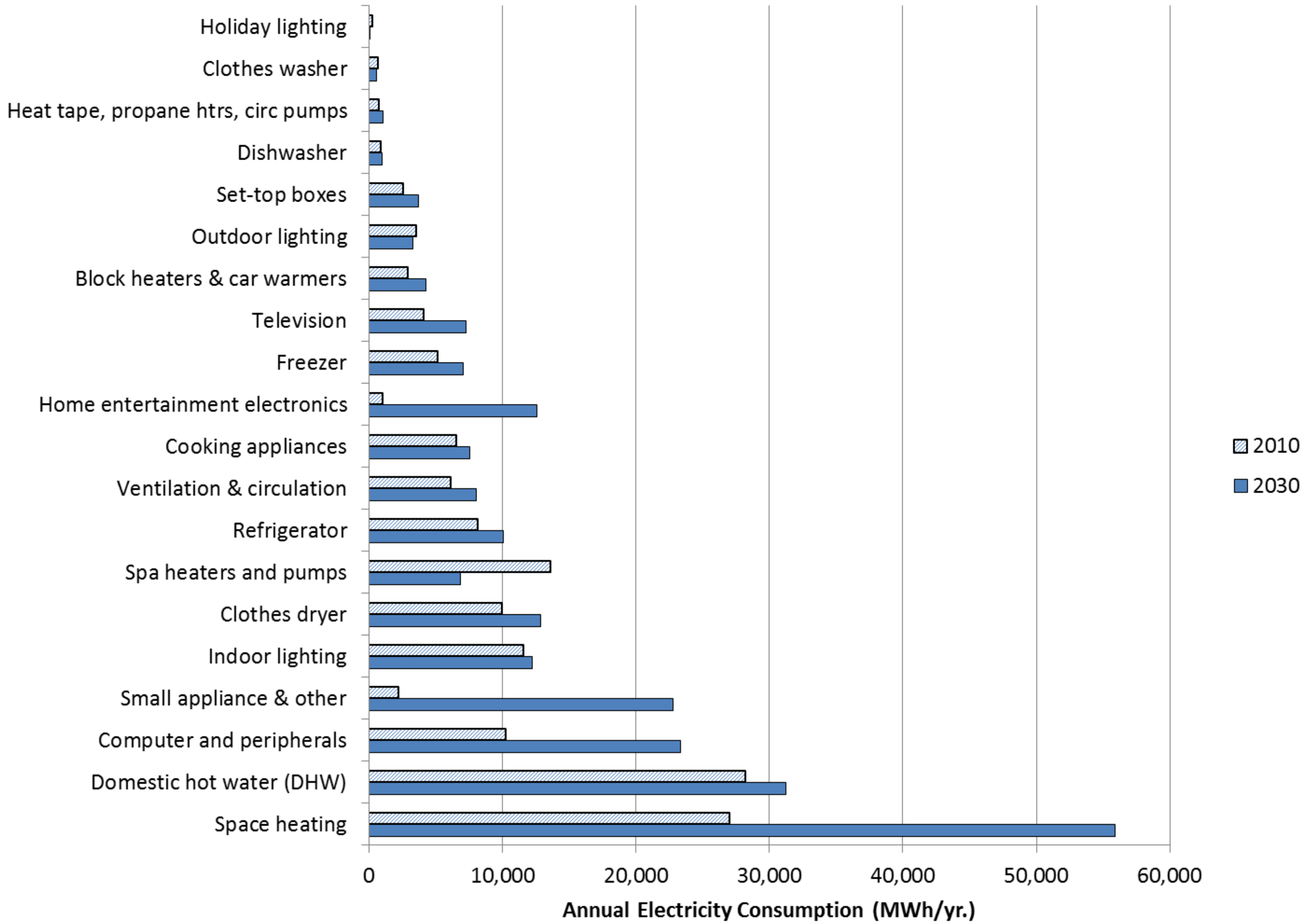
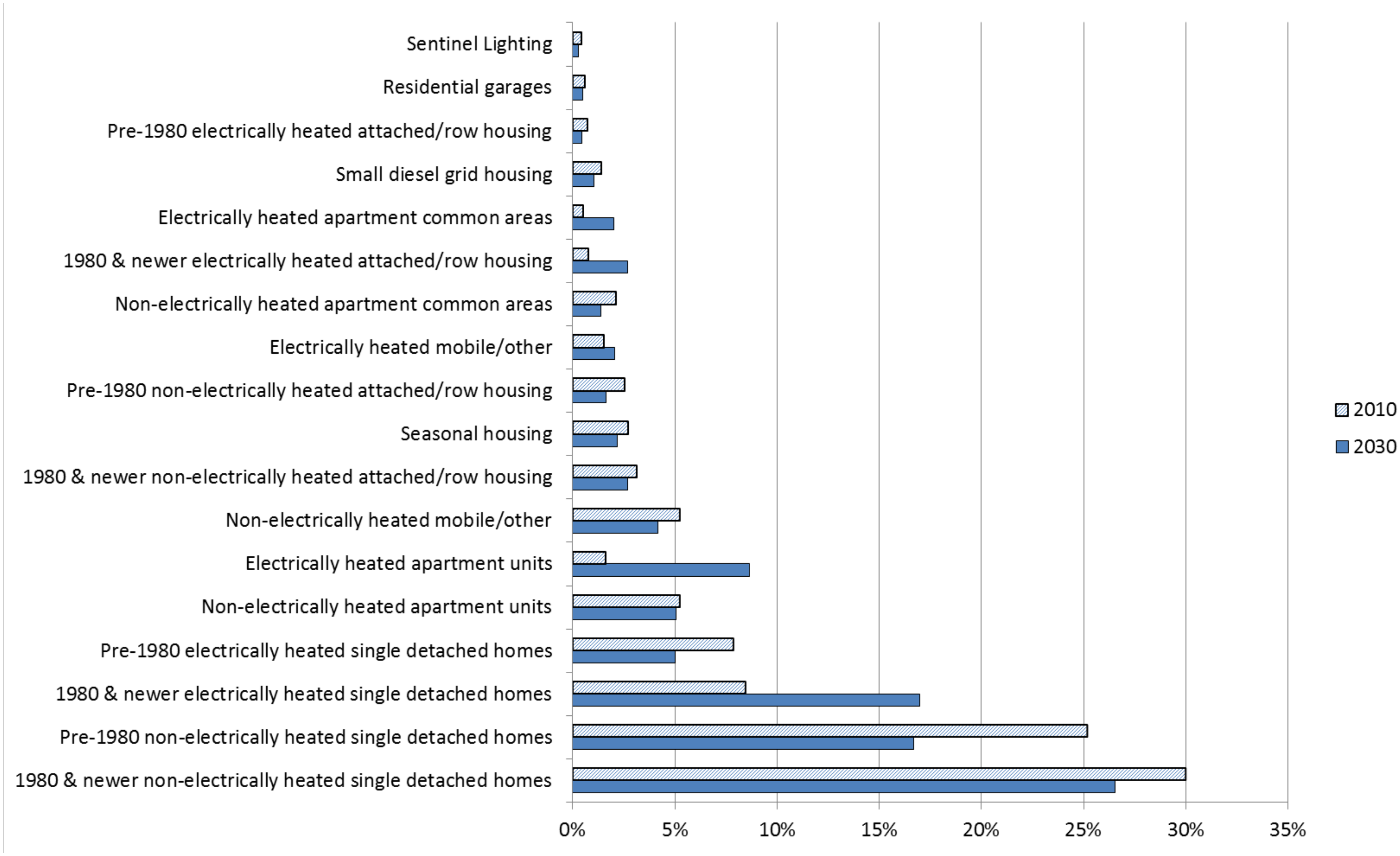


Exhibit 11 Base Year and 2030 Reference Case Year Electricity Use by Dwelling Type, Residential Sector



Economic Potential Forecast

Under the conditions of the Economic Potential Forecast, the study estimated that electricity consumption in the Residential sector would grow to about 174,000 MWh/yr. by 2030. Annual savings relative to the Reference Case are 57,000 MWh/yr. or about 25%. The Economic Potential annual savings in the intermediate milestone years are 37,000 MWh/yr. in 2015, 43,000 MWh/yr. in 2020, and 49,000 MWh/yr. in 2025.

Achievable Potential

In the Residential sector, the Achievable Potential for electric energy savings through technology adoption was estimated to be 22,000 MWh/yr. and 37,000 MWh/yr. by 2030 in, respectively, the lower and upper scenarios.

Consistent with the results in the Economic Potential Forecast, the most significant Achievable savings opportunities were in the actions that addressed space heating. Significant savings can also be found in DHW, clothes dryers, standby load in household electronics (e.g., computers and their peripherals, televisions and other home entertainment electronics), and 13 other end uses.

3.3 Summary of Peak Load Savings

This study assessed the electric peak load reduction for each of the three peak periods resulting from electric energy savings measures.

Exhibit 12 provides a summary of the peak load savings from the electric energy savings, for the Annual Peak Hour. Details for the other two peak periods are provided in the main body of the Residential sector report. In each case, the reductions are an average value over the peak period and are defined relative to the Reference Case.

Exhibit 12 Residential Peak Load Reductions for the Annual Peak Hour, from Electric Energy-savings Measures, Reference Case, Economic and Achievable Scenarios (MW)

Milestone Year	Average Peak Load (MW)	Peak Load Savings (MW, %)					
	Reference Case	Economic Case		Upper Achievable		Lower Achievable	
2010	34.5						
2015	37.3	10.0	27%	1.3	3%	0.8	2%
2020	41.2	11.3	27%	3.6	9%	2.3	6%
2025	46.6	13.0	28%	6.5	14%	3.9	8%
2030	54	14.9	28%	10.5	19%	6.4	12%

Highlights of the peak load savings are:

- In the Base Year 2010, the peak load for Yukon's total Residential sector was approximately 34.5 MW for the Annual Peak Hour.

- The study estimates that the Residential sector peak load in the Annual Peak Hour will grow to 54 MW by 2030, an increase of about 57%

- Electric energy savings would provide peak load savings of approximately 6.4 to 10.5 MW during Yukon's annual system peak hour by 2030 in, respectively, the lower and upper Achievable scenarios.

3.4 Additional Information

Additional information on the summary results presented above is available in the main Residential sector report and accompanying appendices entitled:

- *Yukon Electricity Conservation and Demand Management Potential Review (CPR 2011): Residential Sector*

4 Commercial Sector

The Commercial sector includes office and retail buildings, hotels and motels, restaurants, warehouses and a wide variety of small buildings. In this study, it also includes buildings that are often classified as "institutional," such as health and educational buildings. Throughout this report, use of the word "commercial" includes both commercial and institutional buildings unless otherwise noted. The Commercial sector also includes some non-building electricity uses such as microwave repeater stations and telephone exchange buildings. Buildings or plants where energy use is primarily process driven (e.g., mines) are outside the scope of this study.

4.1 Approach

The detailed end-use analysis of electric energy use in the Commercial sector employed two linked modelling platforms: CEEAM (Commercial Electricity and Emissions Analysis Model), an in-house simulation model developed in conjunction with Natural Resources Canada for modelling electricity use in commercial and industrial buildings, and CSEEM (Commercial Sector Electricity End-use Model), an in-house spreadsheet-based macro model. Peak load savings were modelled using Lopes Consulting Services' Cross-Sector Load Shape Library Model (LOADLIB).

The major steps in the general approach to the study are outlined in Section 1.4. Specific procedures for the Commercial sector were as follows:

Modelling of Base Year

The consultants created building energy-use simulations for nine of the building types. These models were then calibrated to reflect actual Yukon customer sales data. Estimated savings for the Other General Service Buildings[7] and non-buildings categories were derived from the results of the modelled segments. These building categories were not modelled because they are extremely diverse and the electricity use of individual categories is relatively small.

Reference Case Calculations

Detailed profiles of new buildings in each of the building segments were then created, and building stock changes and "natural" changes affecting electricity consumption over the study period were estimated. These estimates were then adjusted to generate electricity totals that match the Yukon future electricity requirement forecast.

Assessment of Electric Energy-savings Options

To estimate the Economic and Achievable electric energy and peak savings potentials, the consultants assessed technologies such as:

- More efficient lighting and office equipment
- Improved construction in new buildings and building shell upgrades to existing buildings
- Upgraded domestic hot water, refrigeration, and heating, ventilating and cooling systems

[7] Other General Service Buildings sub sector represents buildings that do not fit into specific sub sectors, such as churches, theatres, service stations and transportation buildings, as well as buildings with a significant "process" load such as placer mines, manufacturing facilities and light industrial facilities.

- Whole building recommissioning
- Measures specific to recreation centres such as low-emissivity ceilings and refrigeration plant controls.

Assessment of Capacity-only Peak Load Reduction Options

To evaluate the additional peak load reduction potentials resulting from capacity-only measures, the consultants assessed options including utility control of water heating equipment, engine block heating, non-essential lighting, overridable utility control of non-essential plug loads, electric thermal storage, and occupancy-controlled heating system circuits.

4.2 Summary of Electric Energy Savings

A summary of the levels of annual electricity consumption contained in each of the forecasts addressed by this study is presented in Exhibit 13 and Exhibit 14. These results, net of any double counting, are included in the combined savings levels presented previously in Section 2. Further discussion is provided in the paragraphs below.

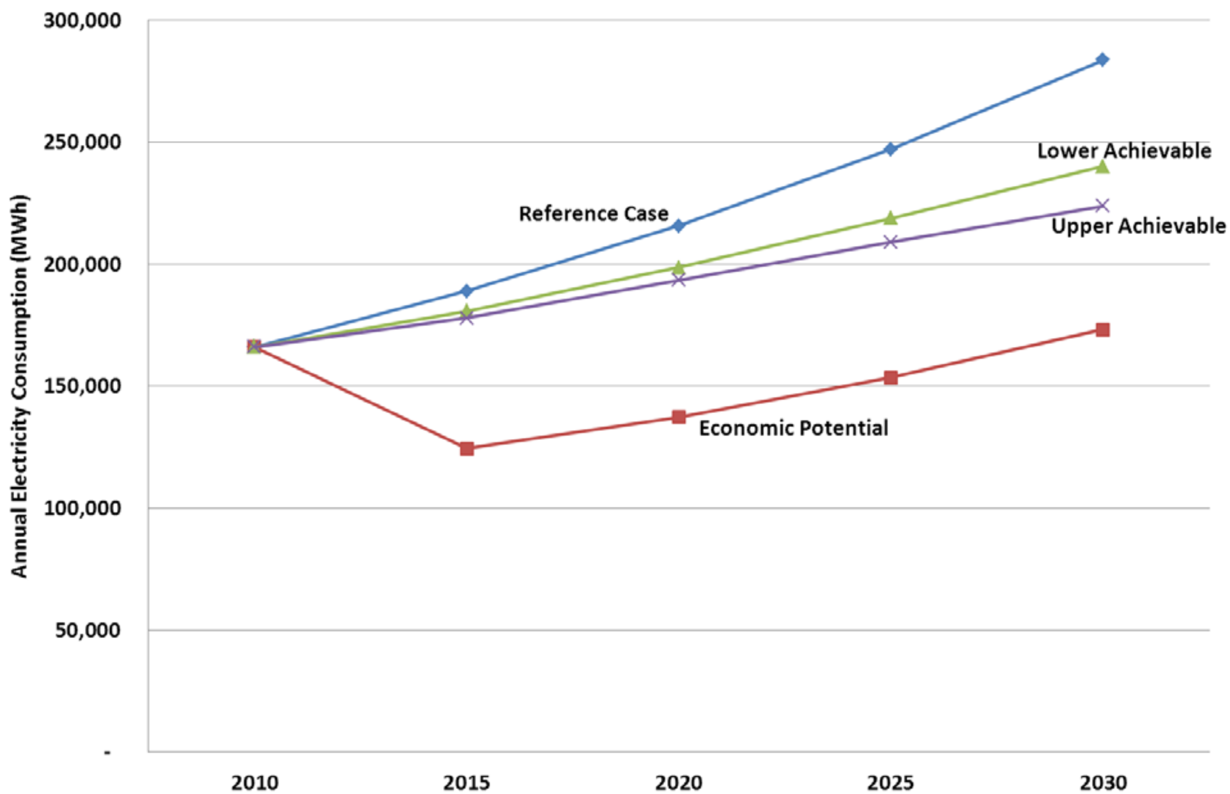
Electric energy savings from electrical efficiency improvements would provide between 44,000 and 60,000 MWh/yr. of electricity savings by 2030 in, respectively, the lower and upper Achievable scenarios. The most significant Achievable savings opportunities addressed indoor lighting and space heating. Significant savings were also found in refrigeration equipment, computer equipment and HVAC fan & pumps.

The electric energy savings noted above would provide peak load savings of approximately 8.5 to 11.9 MW during Yukon's annual system peak hour by 2030 in, respectively, the lower and upper Achievable scenarios.

Exhibit 13 Annual Electricity Consumption—Energy-efficiency Achievable Potential Relative to Reference Case and Economic Potential Forecast for the Commercial Sector (MWh/yr.)

Milestone Year	Annual Consumption, Commercial				Potential Annual Savings, Commercial					
			Achievable Potential				Achievable Potential			
	Reference Case	Economic Potential	Upper	Lower	Economic Potential		Upper		Lower	
	MWh/yr.	MWh/yr.	MWh/yr.	MWh/yr.	MWh/yr.	%	MWh/yr.	%	MWh/yr.	%
	(A)	(B)	(C)	(D)	(A-B)		(A-C)		(A-D)	
2010	166,133									
2015	189,035	124,423	177,913	180,766	64,612	34%	11,122	6%	8,269	4%
2020	215,775	137,356	192,398	198,567	78,419	36%	23,377	11%	17,208	8%
2025	247,045	153,503	209,028	218,839	93,542	38%	38,017	15%	28,206	11%
2030	283,673	173,267	223,854	240,056	110,406	39%	59,819	21%	43,617	15%

Exhibit 14 Annual Electricity Consumption—Energy-efficiency Achievable Potential Relative to Reference Case and Economic Potential Forecast for the Commercial Sector (MWh/yr.)



Base Year Electricity Use

In the Base Year of 2010, Yukon's Commercial sector consumed about 166,000 MWh. Exhibit 15, below, shows that lighting is the largest Commercial sector end use, accounting for approximately 37% of total Commercial sector electricity use. Indoor lighting, which consists of general, architectural and high-bay lighting, accounts for approximately 34%, while outdoor lighting accounts for the remaining 3% of lighting use. HVAC end uses (space heating, space cooling and HVAC fans & pumps) account for 22% of Base Year electricity use. Cooking equipment, domestic water heating and a number of smaller end uses account for the remaining Commercial sector electricity use. Non-building loads are treated as both an end use and sub sector in this analysis. These loads account for 13% of Commercial sector end-use electricity consumption.

Exhibit 16, also below, shows the distribution of Base Year electricity consumption by sub sector. As illustrated, Other General Service Buildings account for the largest share of electricity use within the building sub sectors (18%), followed by Office (14%), and Education, Warehouse/Wholesale and Non-food Retail at 9% each. Non-buildings account for 13% of Base Year Commercial sector electricity use.

Reference Case

In the absence of new DSM initiatives, CPR 2011 estimates that electricity consumption in the Commercial sector will grow from 166,000 MWh/yr. in 2010 to about 284,000 MWh/yr. by 2030 Electricity use breakdown by end use and sub sector are shown in Exhibit 15 and Exhibit 16. This represents an overall growth of about 71% in the period and is higher than the forecast set out in YEC's 20-Year Resource Plan – 2011. This is largely because projections of construction of electrically heated commercial buildings have been revised since the publication of that forecast.

Exhibit 15 Base Year and 2030 Reference Year Electricity Use by End Use, Commercial Sector

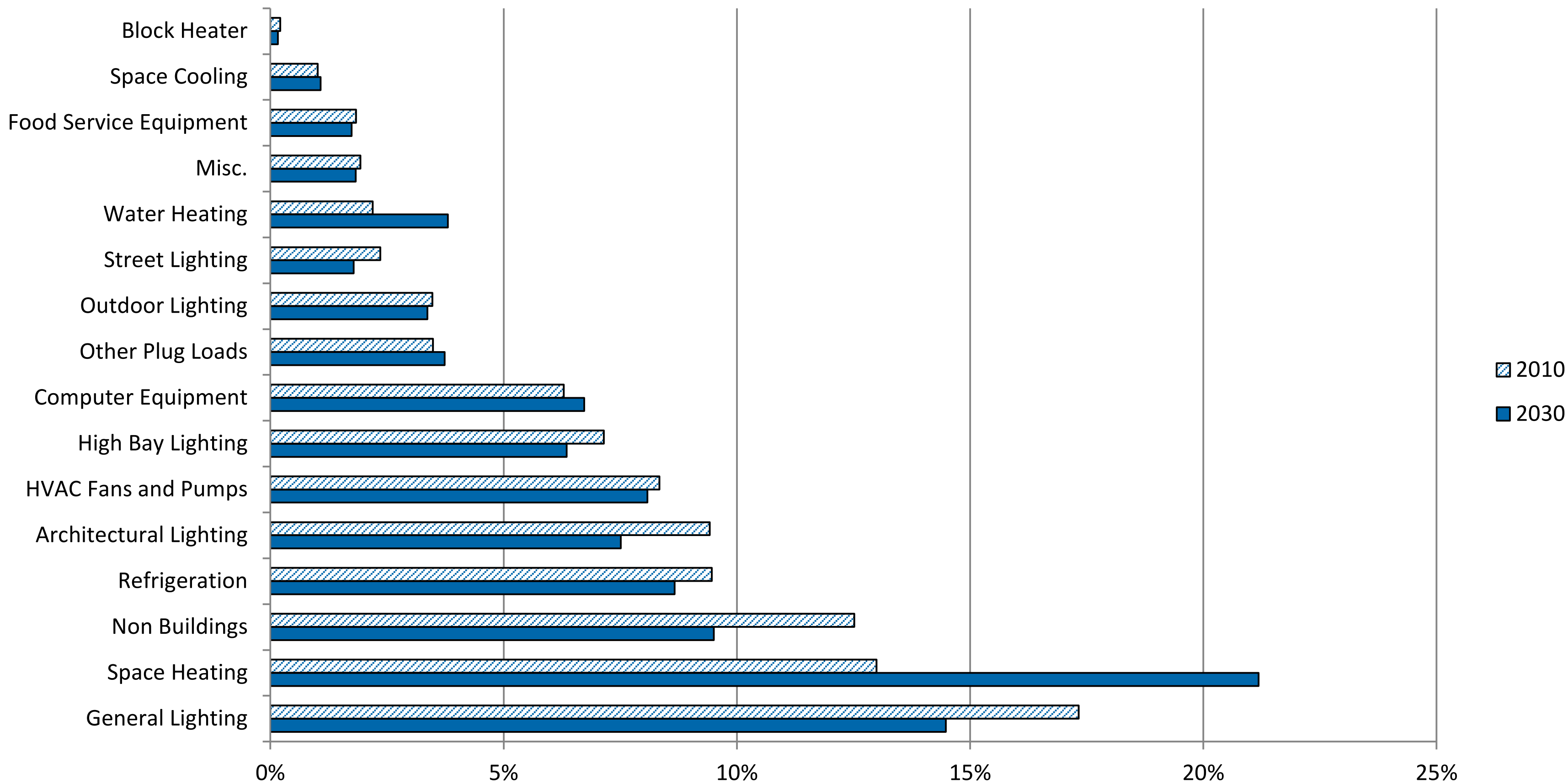
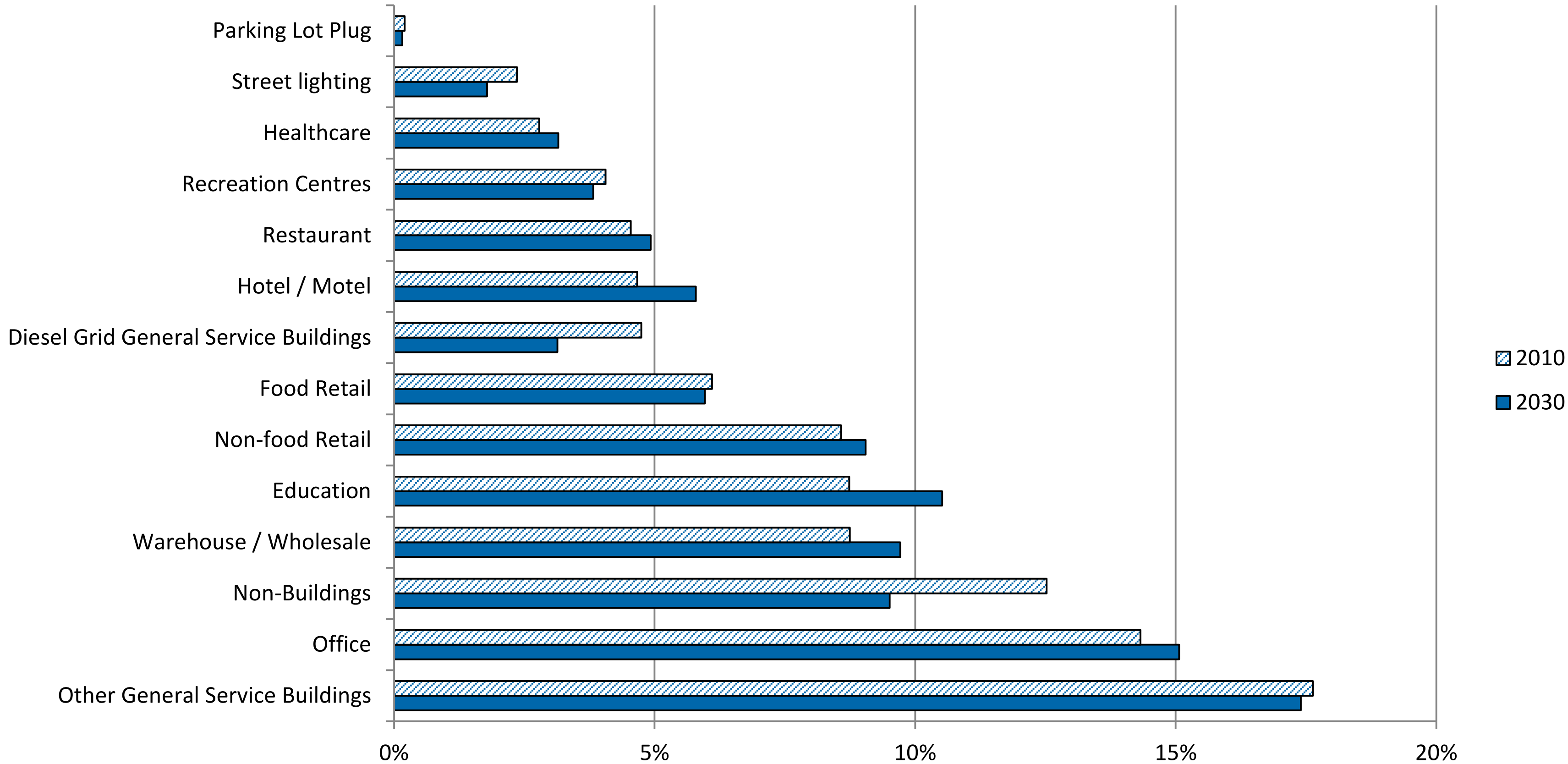


Exhibit 16 Base Year and 2030 Reference Year Electricity Use by Sub Sector, Commercial Sector



Economic Potential Forecast

Under the conditions of the Economic Potential Forecast, the study estimated that electricity consumption in the Commercial sector would grow to about 173,000 MWh/yr. by 2030. Annual savings relative to the Reference Case are 110,000 MWh/yr., or about 39%. The Economic Potential annual savings in the intermediate milestone years are 65,000 MWh/yr. in 2015, 78,000 MWh/yr. in 2020, and 94,000 MWh/yr. in 2025.

Achievable Potential

In the Commercial sector, the Achievable Potential for electric energy savings through technology adoption was estimated to be 44,000 MWh/yr. and 60,000 MWh/yr. by 2030 in, respectively, the lower and upper scenarios.

Consistent with the results in the Economic Potential Forecast, the most significant Achievable savings opportunities were in the actions that addressed indoor lighting and space heating.

4.3 Summary of Peak Load Savings

This study assessed the electric peak load reduction on each of the three peak periods resulting from electric energy savings measures. Exhibit 17 provides a summary of the peak load savings from the electric energy savings for the Annual Peak Hour. Details for the other two peak periods are provided in the main body of the Commercial sector report. In each case, the reductions are an average value over the peak period and are defined relative to the Reference Case.

Exhibit 17 Commercial Peak Load Reductions for the Annual Peak Hour, from Electric Energy-savings Measures, Reference Case, Economic and Achievable Scenarios (MW)

Milestone Year	Average Peak Load (MW)	Peak Load Savings (MW,%)					
	Reference Case	Economic Case		Upper Achievable		Lower Achievable	
2010	29.9						
2015	34.6	12.8	37%	1.9	5%	1.4	4%
2020	39.9	15.6	39%	4.1	10%	3.1	8%
2025	46.1	18.7	41%	7.3	16%	5.3	11%
2030	53.4	22.2	42%	11.9	22%	8.5	16%

Highlights of the peak load savings shown are presented below:

- In the Base Year 2010, the peak load for Yukon's total Residential sector was approximately 29.9 MW for the Annual Peak Hour
- The study estimates that the Commercial sector peak load in the Annual Peak Hour will grow to 53 MW by 2030, an increase of about 78%

- Electric energy savings would provide peak load savings of approximately 8.5 to 11.9 MW during Yukon's annual system peak hour by 2030 in, respectively, the lower and upper Achievable scenarios.

4.4 Additional Information

Additional information on the summary results presented above is available in the main report and accompanying appendices entitled:

- *Yukon Electricity Conservation and Demand Management Potential Review (CPR 2011): Commercial Sector*

5 Customer-side Renewable and Alternative Energy Technologies

This component of the study addressed a selected number of small-scale customer-side renewable or alternative energy (CSRAE) technologies that were identified in consultation with YEC, YECL and the Government of Yukon. They include solar photovoltaic (PV), solar domestic hot water heating, wood-pellet burning furnaces in the Residential sector and wood-pellet burning boilers in the Commercial sector.

For the purposes of this study, small-scale was defined as suitable for application at the level of an individual residential dwelling or commercial facility that is connected to the power grid. Specific system size assumptions are defined in the main CSRAE report, which is identified at the end of this section.

5.1 Approach

The CSRAE measures were modeled using the RETScreen model at the level of individual application. RETScreen is a modelling tool developed and maintained by Natural Resources Canada specifically for analyzing renewable energy systems such as those addressed by this study.

The potential contribution of CSRAE measures to electricity savings in the Residential and Commercial sectors used the same definitions of building types and end uses as used in the other study analysis areas and aggregated in the RSEEM (Residential Sector Energy End-use Model) and CSEEM (Commercial Sector Electricity End-use Model) models.

The major steps in the general approach to the study are outlined in Section 1.4. Specific procedures for the CSRAE options were as follows:

- Step 1: Select candidate CSRAE technologies
- Step 2: Define “typical” small-scale applications
- Step 3: Estimate Yukon resource potential for each CSRAE technology
- Step 4: Model the potential energy production for each CSRAE technology
- Step 5: Establish the current cost and performance data for each CSRAE technology
- Step 6: Calculate the levelized cost of energy production or conservation for each CSRAE technology
- Step 7: Estimate the “unbundled” Technical, Economic and Achievable Potentials for each CSRAE technology.

5.2 Summary of Electric Energy Savings

A summary of the potential levels of savings in purchased electric energy provided by the CSRAE technologies is presented in Exhibit 18. By 2030, the potential reduction in purchased electricity from the use of CSRAE technologies was estimated to be approximately18,030 MWh/yr. for the upper Achievable Potential scenario and about 5,860 MWh/yr. for the lower Achievable Potential scenario.

Exhibit 18 CSRAE Achievable Potential (MWh/yr.)

Technology	Milestone Year							
	2015		2020		2025		2030	
	Upper Achievable	Lower Achievable	Upper Achievable	Lower Achievable	Upper Achievable	Lower Achievable	Upper Achievable	Lower Achievable
Solar PV	-	-	-	-	1,125	729	5,177	3,351
Solar Thermal	74	40	350	186	923	489	1,911	1,012
Pellet-Burning Appliance	220	32	1,284	166	1,284	467	10,945	1,498
Sub Total	295	72	1,634	352	3,332	1,685	18,033	5,861

As shown in Exhibit 19, in the Residential sector, small-scale CSRAE technologies would provide between 6,500 MWh/yr. and 2,830 MWh/yr. of electricity by 2030 in, respectively, the upper and lower Achievable Potential scenarios. In the Commercial sector, small-scale CSRAE technologies would provide between 11,540 MWh/yr. and 3,030 MWh/yr. of electricity by 2030 in, respectively, the upper and lower Achievable Potential scenarios.

Exhibit 19 CSRAE Achievable Potential by Sector (MWh/yr.)

	Technology	Scenario	Achievable Potential (MWh/yr.)			
			2015	2020	2025	2030
Residential	Solar PV	Upper	0	0	423	1873
		Lower	0	0	282	1249
	Solar Thermal	Upper	62	283	724	1462
		Lower	33	152	390	787
	Pellet-Burning Appliance	Upper	78	312	700	3162
		Lower	20	78	175	791
	Sub Total	Upper	140	595	1,846	6,497
		Lower	53	230	846	2,827
Commercial	Solar PV	Upper	0	0	702	3304
		Lower	0	0	447	2102
	Solar Thermal	Upper	12	68	199	449
		Lower	6	34	100	224
	Pellet-Burning Appliance	Upper	142	972	3214	7783
		Lower	13	88	292	708
	Sub Total	Upper	155	1,040	4,116	11,535
		Lower	19	122	839	3,034

Selected highlights are presented below:

- The range of potential results varies very widely between the upper and lower Achievable scenarios. This reflects the large number of unknown factors
- Under the upper scenario, the Commercial sector has a significantly higher potential than the Residential sector. However, under the lower scenario, the potentials in the Commercial and Residential sectors are comparable
- The largest potential may be with pellet-burning appliances, assuming an aggressive approach
- Even under the upper scenario, the absolute amount of savings possible from solar hot water is the smallest for the technologies examined
- Solar PV could provide considerable generation under the upper scenario, even though the penetration of this technology is expected to start later than for the others.

5.3 Summary of Peak Load Savings

The CSRAE report does not estimate peak load savings. This is because the electricity contributions of these systems are intermittent and cannot be reliably assigned to any of the selected peak periods. Therefore, no electric peak load savings for customer-supplied renewable or alternative energy technologies are included.

5.4 Additional Information

Additional information on the summary results presented above is available in the main report and accompanying appendices entitled:

- *Yukon Electricity Conservation and Demand Management Potential Review (CPR 2011): Customer-side Renewable and Alternative Energy*

6 Conclusions and Recommendations

The study findings confirm the existence of significant potential for cost-effective electrical efficiency improvements in the Yukon.

In the Lower and Upper Achievable potential scenarios[8], electrical efficiency improvements would provide between 44,000 and 60,000 MWh/yr. of savings in commercial buildings in 2030 and between 22,000 and 37,000 MWh/yr. of savings in residential dwellings in 2030. Combined, these potential savings represent approximately 32% to 48% of the forecast growth in electricity demand by 2030.

Substantial electric peak demand reductions would also occur as a result of the above efficiency improvements. The study estimates that in 2030 the associated electric peak demand reductions would be approximately 8.5 to 11.9 MW in commercial buildings and 6.4 to 10.5 MW in residential dwellings.

The most significant electrical efficiency opportunities in the residential sector are associated with electric space heating measures. The biggest single measure would encourage new homes to be constructed with an energy performance rating of EGH 85. This would reduce space heating consumption in new electrically-heated houses by approximately half, relative to the current building code in Whitehorse. Heat pumps, including both central units and ductless mini-split systems, offer the next largest space heating potential. Other space heating measures, such as deep insulation retrofits and improved control systems, also offer considerable potential. There is also considerable potential for saving electricity used for DHW, clothes dryers, computers and their peripherals, and 13 other end uses in the home.

The most significant electrical efficiency opportunities in the commercial sector are in space heating and indoor lighting. At the beginning of the study period, indoor lighting accounts for the largest fraction of savings potential. By 2030, however, many of the lighting measures are expected to be adopted naturally as a result of continued improvements to national lighting equipment performance standards, gradually eroding the lighting potential. In contrast, the potential for space heating savings is expected to increase substantially over the study period, eventually overtaking and surpassing the lighting savings. This is because of the expected large share of electric heating in new commercial construction.

The potential savings found in this CPR are generally larger than typically found in other jurisdictions, for a number of reasons:

- The Yukon climate is more severe, making space heating measures of all kinds more economically attractive.
- The cost of new marginal electricity generation options in Yukon is relatively high. Even on the hydro grid, new demand at the margins is assumed to be supplied by diesel generators.
- The past success of conservation programs suggests that the receptiveness of Yukon customers to efficiency measures is greater than is typical of other jurisdictions.

[8] It should be noted that these potential savings estimates are not yet constrained by the availability of program funding. These considerations will be addressed during the program design phase, which will build on the results of this CPR.

Other highlights of the study are as follows:

- Electricity consumption and peak demand over the study period are expected to grow by approximately 65%, because of both the rate of new construction and the proportion of new buildings that are expected to be electrically heated. It is currently less expensive to heat with electricity than with oil in Yukon, due to the relative prices of electricity and fuel oil.
- Because of the cost of new electricity supply from diesel generation, energy efficiency measures are comparatively attractive. Retail rates reflect more of an average cost of supply because they include the legacy hydro supply. Rates tied more closely to marginal supply costs would substantially change the economics of heating with electricity.
- There are large uncertainties in the rate of growth of electrical demand. The overall rate of new construction is heavily dependent on growth in the mining sector, which is difficult to forecast. The penetration of electric heat is also uncertain: rates that reflect the cost of diesel generation would reduce electric heating.
- There are also uncertainties about specific technologies that offer savings potential. Some technologies have not been subjected to rigorous testing and demonstration in the Yukon climate. They may require adaptation or may prove unsuitable.
- The Yukon utilities have good client data and their staff have a great deal of detailed customer knowledge. The availability of information at this level of detail was key to the success of the project. Nonetheless, there is scope for improvement. Specifically, the scope and timing of the future electrical end use surveys should take into account the needs of subsequent CPR studies.

The study also concluded that customer-side renewable and alternative energy (CSRAE) technologies could provide between 5,000 and 15,000 MWh/yr. of savings in residential and commercial buildings in 2030. A substantial portion of these savings overlap with the efficiency measures noted above and, therefore, are not directly additive.

The most significant opportunities in CSRAE are from wood pellet-burning appliances. These may include either pellet furnaces or pellet boilers, both of which can have hopper feeding systems for unattended operation. Pellet-burning stoves were not considered in this study because it is harder to quantify the fraction of the space heated by a stove, however stoves have the potential to provide additional savings. The success of wood pellet initiatives will be dependent on measures to ensure that customers consistently use the pellet appliances and avoid using electric heat backup systems. Solar hot water systems also meet the economic threshold in many but not all potential applications in Yukon. Photovoltaic generation is not cost-effective at the beginning of the study period, but costs are expected to drop so that it becomes cost-effective before 2030.

6.1 Recommendations

Throughout the conduct of CPR 2011, a number of suggestions emerged from those involved with the study that could improve the next CPR. A summary is listed below:

- The Yukon should proceed to develop electricity DSM programs addressing both the commercial and residential sectors.
- The technologies selected for program development should be subjected to more rigorous study than was possible with the large number of technologies examined in this CPR. This may include testing and demonstration in the Yukon climate in addition to an examination of the market barriers in the Yukon context.

- DSM program efforts should be leveraged as much as possible through collaboration with existing and planned programs by other entities.
- As mentioned above, the scope and timing of electrical end use surveys undertaken in the future should be informed by the needs of subsequent CPR studies. Ideally, the final results of a recent REEUS should be in hand before the next CPR begins. Questions should be included in the survey to provide the level of detail needed so that the CPR can cover the building types, end uses, and technologies the clients will require. Undertaking a commercial end use survey would improve the commercial component of the next CPR in the same way.