BC hydro

reliable power,
at low cost,
for generations

To our customers and residents across British Columbia:

These reports are the outcome of an intensive research project to identify some of the electricity savings available to BC Hydro customers.

Marbek Resource Consultants and their consultant team have carried out comprehensive technical reviews to develop the Conservation Potential Review (CPR 2007). An External Review Panel and BC Hydro's project team have made significant contributions through their reviews, suggestions and information. I want to thank everyone for their contribution and hard work over the 16-month study period.

Although this review builds on the work of previous CPR studies, it goes much farther than previous studies in B.C. The researchers have adopted new techniques for energy modelling and used them for the first time to attempt to assess difficult topics including the potential for B.C. residents to reduce energy consumption through behavioural and lifestyle changes.

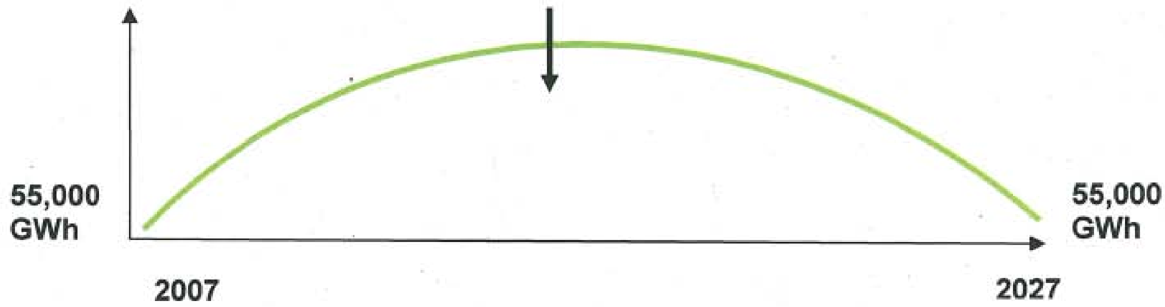
The CPR 2007 has identified almost 20,000 GWh/yr of energy savings that are economically viable by the year 2020. The study used a series of workshops to further estimate that approximately 50% of the economic energy savings or 10,400 GWh/yr could be achieved by the year 2020. While these findings support the target of 10,000 GWh/yr in 2020, as set out by the 2007 BC Energy Plan, they do not include additional savings within the study from lifestyle changes or additional savings opportunities outside of the scope of the study through supply-side efficiency improvements within BC Hydro and BCTC's systems, savings from emerging technologies beyond 2011 or step-changes in energy-efficient technologies.

The information in the CPR 2007 will be one of several inputs to developing BC Hydro's Demand-side Management (DSM) Plan - a plan to meet the 50% conservation target in the BC Energy Plan and to go further to lead British Columbia into a sustainable energy future for B.C.

Creating a conservation culture

Our goal is to develop and foster a conservation culture in BC that leads to customers choosing to make a dramatic and permanent reduction in electricity intensity: a visionary approach to energy use that will minimize the impact on the environment and ensure the province's electricity needs are met. Following this vision, we strongly believe that we can go beyond the 50% conservation target set out by the 2007 B.C. Energy Plan and lead a change such that in 2027 we would return to 2007 electricity consumption levels while allowing for growth and economic prosperity. In the short term, consumption will go up, but with concerted action we can bring it back down to the levels of 2007.

Electricity use is rising, but can fall again.



"Develop and foster a conservation culture in BC that leads to customers choosing to make a dramatic and permanent reduction in electricity intensity."

Making the right choices

In British Columbia, we have to understand that saving energy must be more than a technical solution. We must also address the issue of wasted electricity. We use more electricity per capita than almost anywhere else in the world. What would we save if everyone in B.C. lived in a green home and worked in a green building and all of our industries were among the most efficient in the world?

Such a future is possible. Some progressive European communities use 60% less electricity in their homes than comparable communities in B.C. without compromising quality of life. What seems like an amazing conservation feat is really quite possible – it's due to efficient lifestyle choices that are rooted within the culture. What kind of choices?

- Homes that are designed and sized to conserve resources, with technology such as smart meters to help us use energy more efficiently
- Communities and commercial buildings designed to use solar heat and light and to recover waste heat
- Buildings that generate their own energy, and feed excess energy to the utility grid

What these examples mean is that each household makes a choice to use significantly less energy. Efficient lifestyle and product choices can reduce electricity used in the home by

50% today and potentially even more with net zero energy homes. Commercial buildings can cut electricity use by at least 30% through efficient integrated design and operation – and more again is possible with distributed and self generation.

Living green at home and working green is really about smart, integrated, efficient building design and using resources with respect. A well insulated, draft-free space that controls solar gain is comfortable and efficient. Choosing appliances and lighting that meet our needs, while using less energy, shows our care for the environment.

Industry can play an important part, too. Current world leaders in industrial production are over 40% more efficient than most industries in B.C. With state-of-the-art technologies, processes, and operating practices, B.C. industries could reduce operating costs and strengthen our economy. If they do so, they can establish themselves as world leaders in energy efficient production.

Acting together for a solution

BC Hydro's traditional approach to demand-side management has succeeded in driving technological change. However, to accomplish our new vision for British Columbia we must go farther. We must engage British Columbians so that efficiency and conservation are a way of life and a way of doing business. It must become something we do as consumers, businesses and communities. It must become persistent and self-sustaining. Other countries live by a conservation culture, and we can do it, too.

But a utility cannot do this alone. We are in a unique position to act as a catalyst for change in B.C., but we need communities to show their leadership and develop comprehensive and integrated sustainability plans that adopt the policy changes needed to encourage the right choices. Together, we can launch concrete actions that not only drive resource savings but also build the foundation for sustainable cities.

We want British Columbians to move toward this new vision. The CPR 2007 reports show that there are huge savings available that make economic sense. What remains is action.

We are creating a new DSM plan that not only directly acts upon many of the technical opportunities identified within the CPR 2007 but that also supports appropriate policies, new technologies, community engagement, education and leadership at all levels. We invite all British Columbians to embrace the vision and to join us in dialogue, commitment and action.

British Columbia now has the opportunity to join the world leaders in conservation and sustainability. We all contribute to the environmental problems of the world and it's now time for us to be leaders in the solution.

Regards,

Bob Elton

Bob Elton

BC Hydro President and Chief Executive Officer

BC Hydro

2007 CONSERVATION POTENTIAL REVIEW

The Potential for Electricity Savings, 2006 – 2026

Residential, Commercial and Industrial Sectors in British Columbia

– Summary Report –

Submitted to:

BC Hydro

Submitted by:

Marbek Resource Consultants Ltd.

November 20, 2007

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ACKNOWLEDGEMENTS

Completion of the Conservation Potential Review 2007 on an accelerated timetable is due in no small part to the consistent input from many BC Hydro staff members, External Review Panel members, as well as the hard work of the Consultant Team engaged by BC Hydro. The heaviest work load fell on the Conservation Potential Review Core Group and the External Review Panel, which oversaw the management of the study.

BC HYDRO PROJECT TEAM

Murray Bond – Manager of Evaluation, Measurement and Verification, Power Smart
Christine Gustafson – Manager of Market Analysis and Information, Power Smart
Zechy Khoo – Quality Assurance, Power Smart
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Graham Henderson – Engineering, Power Smart
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David Ince – Manager of Portfolio Risk, Market Forecast
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Jim Nelson – Manager of Marketing, Power Smart
Cynthia Lee – Manager of Strategic Resource Planning, Power Smart
Ron Sanderson – British Columbia Transmission Corporation
Ken Tiedemann – Manager of Evaluation, Power Smart
Cindy Verschoor – Community Relations Manager, Stakeholder Engagement, Corporate Affairs

EXTERNAL REVIEW PANEL

A number of organizations in B.C. agreed to serve on an External Review Panel. They provided input on project scope and methodology, participated in workshops and reviewed and commented on draft reports. However, their participation on the Panel should not be construed as indicating full agreement with, or endorsement of, any of the CPR 2007 reports. The External Review Panel was facilitated by Nancy Cooley of Nancy J. Cooley and Associates, Victoria.

Members of the Panel include:

B.C. Sustainable Energy Association – Kevin Pegg*
Building Owners' and Managers' Association of B.C. – Len Horvath
Canadian Home Builders' Association of B. C. – Robert Barry
Commercial Energy Consumers of B.C. – David Craig
David Suzuki Foundation – Nicholas Heap
FortisBC – Keith Veerman
Independent Power Producers Association of BC – David Kiess* and Barbara Docherty*
Joint Industry Electricity Steering Committee – Dan Potts* and Ian May*
Kwantlen University College – Tom Knox
Malaspina University-College – Steven Earle
Ministry of Energy, Mines and Petroleum Resources – Andrew Pape-Salmon* (Ex Officio)
Nisga'a Lisms Government – Mansell Griffin
Sierra Club of Canada, B.C. Chapter – Tom Hackney
Terasen Gas – Sarah Smith
University of British Columbia – Colleen Brown*
West Fraser Mills – Dave Humber
David Isaac – Student
Casey Jarvis – Residential Customer
Don Scarlett – Residential Customer
BC Hydro – Steve Hobson (Ex Officio) and Murray Bond (Ex Officio)

* These individuals were involved for part of the CPR 2007 study period.

Guests of the Panel in attendance at one or more meetings include:

Catalyst – Paul Einarson and Frank Slater
Joint Industry Electricity Steering Committee – Pierre Lamarche
Mayor of Hudson's Hope – Lenore Harwood
Mayor of Dawson Creek – Calvin Kruk
Ministry of Energy, Mines and Petroleum Resources – Michael D'Antoni and Liz Kelly
Poyry Vancouver Inc. – Michael Jackson

OTHER BC HYDRO STAFF

In addition, there were many other BC Hydro staff who reviewed draft reports, participated in meetings, and/or provided support for the project. In particular we would like to thank the Stakeholder Engagement, Power Smart Evaluation, Market Forecast, Power Smart Marketing, Power Smart Engineering, Transmission Services, Resource Planning, Engineering, Aboriginal Relations, Generation Strategy and Investment, Power Smart Strategic Planning, and Digital Communications groups.

CONSULTANTS

The Conservation Potential Review 2007 was completed by a team of consultants lead by Paul Robillard of Marbek Resource Consultants Ltd. (Ottawa, Ontario). Consultants and sub-consultants were:

Residential sector: Dave Shipley and Katie Gent of Marbek Resource Consultants Ltd. and Joe Lopes of Applied Energy Group Inc. (New York, N.Y.), conducted the research, modelling and analysis of the Residential sector, with the assistance of Fred Schwartz of Intellergy Corporation (San Francisco, Cal.), Ken Cooper of SAR Engineering (Victoria, B.C.), and Doug Overholt of DL Overholt Management.

Commercial sector: Richard Patterson and Chris Pulfer of Marbek Resource Consultants Ltd. and Joe Lopes of Applied Energy Group Inc. conducted the research, modelling and analysis of the Commercial sector, with the assistance of Fred Schwartz of Intellergy Corporation, and Curt Hepting of Enersys Analytics Inc. (Coquitlam B.C.).

Industrial sector: Paul Willis and Anthea Jubb of Willis Energy Services Ltd. (Vancouver, B.C.), and Joe Lopes of Applied Energy Group Inc. conducted the research, modelling and analysis of the Industrial sector, with assistance of Marbek Resource Consultants Ltd.

Behaviour: Jay Kassirer of Cullbridge Marketing and Communications (Ottawa, Ont.), Jack Habart of Habart and Associates Consulting Inc. (North Vancouver, B.C.) conducted the research, modelling and analysis, with the assistance of Loren Lutzenhiser of Lutzenhiser Associates (Portland, Ore.), Mithra Moezzi of Ghoulem Research (San Rafael, Cal.), and Marbek Resource Consultants Ltd.

Fuel Switching: Dave Shipley and Richard Patterson of Marbek Resource Consultants Ltd. and Paul Willis and Anthea Jubb of Willis Energy Services Ltd. conducted the research, modelling and analysis, with the assistance of Curt Hepting of Enersys Analytics Inc., Joe Lopes of Applied Energy Group Inc., and Ken Cooper of SAR Engineering.

Customer-supplied Renewable Energies: Innes Hood of the Sheltair Group (Vancouver, B.C.) conducted the research, modelling and analysis, with the assistance of Fred Schwartz of Intellergy Corporation and Marbek Resource Consultants Ltd.

Lifestyle: Dave Biggs of Envision Sustainability Tools Inc. (Vancouver, B.C.) conducted the research, modelling and analysis, with the assistance of Mithra Moezzi of Ghoulem Research and Marbek Resource Consultants Ltd.

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LIST OF EXHIBITS

1. INTRODUCTION

1.1 BACKGROUND AND OBJECTIVES

In 1991 and again in 2002, BC Hydro conducted an in-depth technical end use analysis of where, how and at what cost electricity demand in British Columbia could be reduced. These analyses are contained in two separate documents, known as Conservation Potential Reviews (CPR).

Since completing the CPR 2002, new pressures in the electricity industry and on the environment have led to a renewed interest in conservation, load management and demand-side management (DSM). In addition, the performance efficiency of major energy-using technologies has continued to improve, technology prices have changed, new products have become available, and additional technologies, based largely on advances in information technology (IT) and materials science, are under development.

In June 2006, BC Hydro initiated a third Conservation Potential Review (CPR) study that was carried out in cooperation with an External Review Panel (ERP), a panel of representatives from community groups and sectors from across B.C. This study investigates new and different ways for B.C.'s industries, businesses and households to save energy as provincial electricity demand continues to grow.

The purpose of the CPR 2007 is to develop estimates of electricity conservation potential in BC Hydro's service area to the year 2026. This included analysing a broad range of energy-saving technologies, behaviour and lifestyle changes, small-scale renewable energies and fuel switching. This information will be used for:

- Providing input to the Demand-side Management (DSM) Plan for BC Hydro's Energy Conservation and Efficiency long-term goal
- Developing new conservation programs and modifying existing ones
- Providing estimates for future Integrated Electricity Plans
- Providing input for load forecasts
- Developing new capacity programs to meet the needs of the British Columbia Transmission Corporation (BCTC) and BC Hydro Distribution Planning

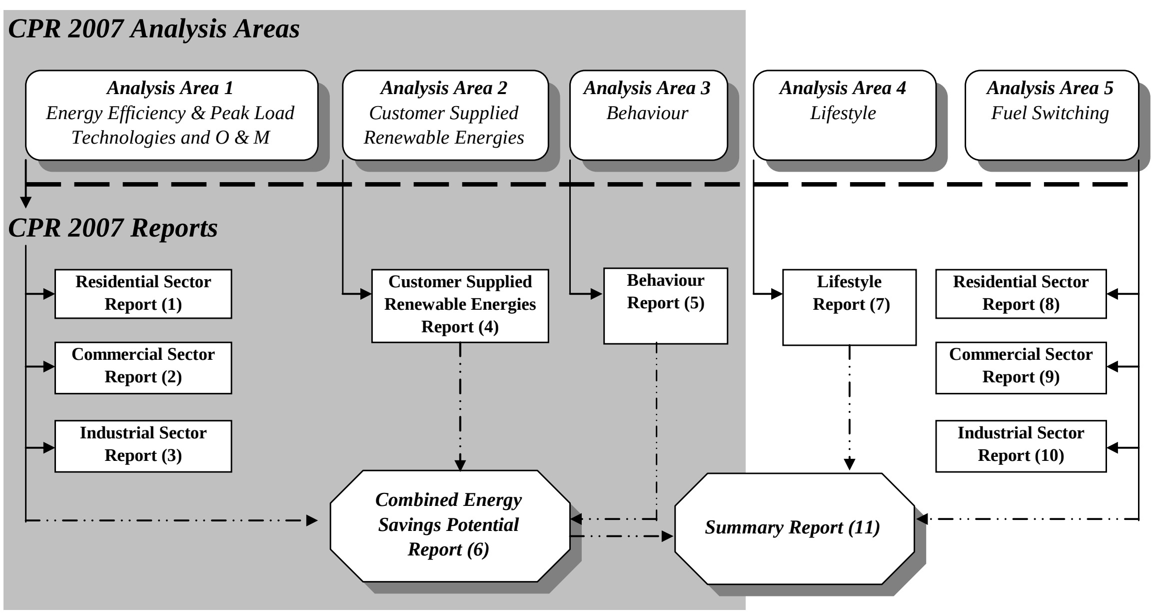
1.2 SCOPE AND ORGANIZATION

The scope of CPR 2007 is expanded from CPR 2002. It covers a 20-year study period, rather than the 15-year time frame used in the previous CPR. It expanded its sector coverage to include street lighting in addition to the three core sectors (Residential, Commercial and Industrial). The CPR 2007 encompasses current and emerging electrical efficiency technologies or measures that are expected to be commercially viable by the year 2011. It also considers behavioural and lifestyle changes, customer-supplied renewable energies in the Residential and Commercial sectors, and fuel switching to natural gas.

While the scope of the CPR is expanded, as with any study there are limitations to the scope. For example, the study did not include supply-side efficiency improvements within BC Hydro and BCTC's systems and savings from emerging technologies beyond 2011 or step-changes in energy-efficient technologies. In addition, electricity savings from lifestyle changes were not included in the combined Upper Achievable Potential but could contribute substantially to meeting the BC Energy Plan target.

The CPR 2007 has been organized into five Analysis Areas. The results are presented in 11 individual reports. Exhibit 1.1 provides an overview of each Analysis Area.

Exhibit 1.1: Overview of CPR 2007 Organization – Analysis Areas and Reports



❑ Analysis Area 1 – Energy Efficiency and Peak Load Technologies and O&M

This area of the CPR 2007 assesses electricity 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 2011; this area also addresses operation and maintenance (O&M) practices. The Analysis Area also includes an assessment of the potential impacts of emerging technologies in the latter portion of the study period. The results of this Analysis Area are presented in three individual sector reports. In addition, as shown in Exhibit 1.1, the Analysis

Area 1 results are included in a set of combined results that also include their potential impacts when combined with the results of Analysis Areas 2 and 3.

- **Analysis Area 2 – Customer-supplied Renewable Energies**

This area of the CPR 2007 assesses electric energy savings that could be provided by small-scale customer-supplied renewable energies in the Residential and Commercial sectors. The results of this Analysis Area are presented in a single report. In addition, as shown in Exhibit 1.1, the Analysis Area 2 results are included in a set of combined results that also include their potential impacts when combined with the results of Analysis Areas 1 and 3.

- **Analysis Area 3 – Behaviour**

This area of the CPR 2007 assesses electricity and peak load reduction opportunities that could be provided by the actions of Residential and Commercial customers who habitually save energy within their daily routines. In addition, as shown in Exhibit 1.1, the Analysis Area 3 results are included in a set of combined results that also include their potential impacts when combined with the results of Analysis Areas 1 and 2.

- **Analysis Area 4 – Lifestyle**

This area of the CPR 2007 assesses electricity and peak load reduction opportunities that could be provided by customer choices related to the energy-consuming systems that they purchase or use; e.g., purchasing a refrigerator that is not only efficient but also smaller in size. As shown in Exhibit 1.1, the Analysis Area 4 results are contained in a separate, stand-alone report.

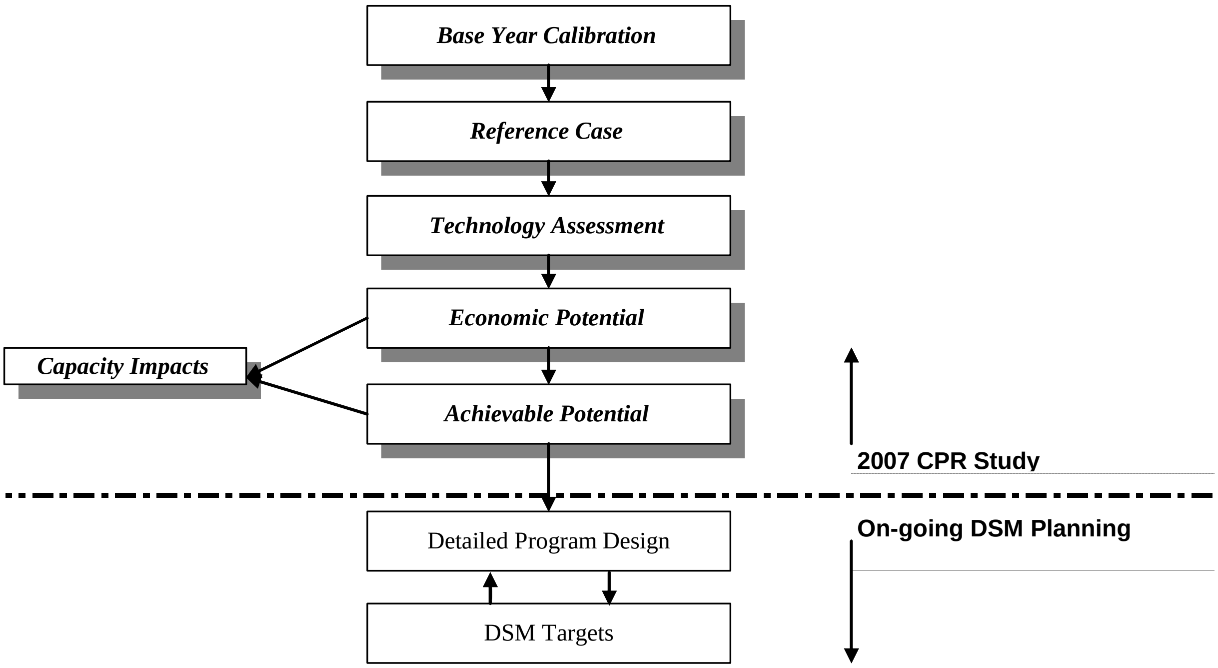
- **Analysis Area 5 – Fuel Switching**

This area of the CPR 2007 assesses electricity and peak load reduction opportunities that could be provided by switching selected end uses, such as space or water heating, from electricity to natural gas. As shown in Exhibit 1.1, the Analysis Area 5 results are contained in three individual sector reports.

1.3 APPROACH

Exhibit 1.2 summarizes the major steps involved in the analysis. They are defined and discussed in the following paragraphs. As illustrated, the results of CPR 2007, and in particular the estimation of Achievable Potential, support on-going DSM planning and management. However, the estimates of Achievable Potential are not DSM targets. Rather, they inform the selection and design of DSM initiatives, along with other inputs.

Exhibit 1.2: Study Approach – Major Analytical Steps



1.4 MAJOR ANALYTIC STEPS AND DEFINITIONS

The analysis conducted within each of the five Analysis Areas noted above followed a similar set of steps, as outlined below.

Step 1: Develop Base Year Calibration Using Actual BC Hydro Sales Data

The Base Year (F2006) is the starting point for the analysis. This step provides a detailed description of "where" and "how" electricity is currently used, based on actual electricity sales. Consistent with the expanded scope of CPR 2007, the Base Year calibration applied to both electric energy and electric peak loads.[1] The consultants reviewed BC Hydro's daily and seasonal system demand patterns and, in consultation with BC Hydro personnel, CPR 2007 defined four specific peak periods (detailed in Chapter 3 of each of the sector reports, *Base Year Electric Peak Load Profile*):

- **Peak Period 1: Annual System Peak Hour** – For BC Hydro, this has traditionally been the hour ending at 6 pm on a day in December or January; highly correlated with the coldest day of the year.
- **Peak Period 2: System Critical Peak Days** – The 4 to 9 pm period on the four highest System Peak Days; totals 20 hours.
- **Peak Period 3**: **Typical Winter Peak Day** – This adds the morning peak 8 am to 1 pm to the System Critical Peak Days definition; totals 40 hours per year.

[1] These are periods throughout the year when BC Hydro's generation, transmission and distribution system experiences particularly high levels of electricity demand. These periods are of particular interest to BC Hydro system planners; improved management of electricity demand during these peak periods may allow costly system expansion to be deferred.

- **Peak Period 4: Winter Peak Energy** – This uses the Typical Winter Peak Day hour definition (8 am to 1 pm and 4 to 9 pm) for all winter weekdays when minimum daily temperature is below 0ºC. Typically, this consists of 45 days or 450 hours per year.

The study consultants used macro models to estimate electric energy use and peak loads; they then compared the results to actual BC Hydro billing and system load data to verify their accuracy.

Step 2: Develop Reference Case

The Reference Case is the result of macro modelling that estimates the expected level of electricity consumption and peak loads that would occur over the study period with no new (post F2006) DSM initiatives. The Reference Case includes projected increases in electricity consumption based on expected rates of population and economic growth, using the growth rates included in BC Hydro's 2006 load forecast.[2] The Reference Case also makes an estimate for some "natural" conservation, that is, conservation that occurs without utility programs like Power Smart. The Reference Case provides the point of comparison for the calculation of Economic and Achievable electric energy and peak load savings potentials.

Step 3: Develop and Assess Energy Efficiency Upgrade and Peak Load Savings Options

The consultants researched existing and emerging technologies and practices that can enable BC Hydro customers to use electricity more efficiently, as well as those that enable them to shift[3] their electricity use away from periods of high demand to periods of lower electricity demand. In each case, the consultants assessed how much electricity the technology could save or shift together with the expected cost, including purchase (capital), operating and maintenance costs.

In the case of energy-efficiency upgrades, the consultants then used a formula to produce a value for cost per year per kilowatt-hour of saved electric energy, referred to as the Cost of Conserved Energy (CCE). CCE is calculated as the annualized incremental cost (including operating and maintenance) of the measure divided by the annual kilowatt-hour savings achieved, excluding any administrative or program costs to achieve full use of the measure. Applying this formula allowed the consultants to compare a standardized cost for new technologies with the cost of new electricity supply, or other electricity-conserving technologies, and to determine whether or not to include the technology in the Economic Potential forecast.

In the case of capacity-only peak load measures, the consultants used a formula to produce the cost per year to save a kilowatt, referred to as the Cost of Electric Peak Reduction (CEPR). The CEPR for a peak load reduction measure is defined as the annualized incremental cost of the measure divided by the annual peak reduction achieved, excluding any administrative or program costs required to achieve full use of the technology or measure. The CEPR provide a basis for the subsequent selection of measures to be included in the Economic Potential forecast.

[2] *Electric Load Forecast 2006*, BC Hydro Market Forecast, December 2006; and *CPR 2007 Industrial Load Forecast – Study Decision*, BC Hydro, March 2007.

[3] CPR 2007 assessed two sources of peak load savings and their effect on each of the four peak periods: peak load savings from electric energy savings and peak load savings from capacity-only measures.

Step 4: Estimate Economic Electric Energy and Peak Load Savings Potential

To forecast the potential electric energy savings that are defined as economic, the consultants used macro models to calculate the level of electricity consumption that would occur if B.C. residents installed all "cost-effective" technologies. "Cost effective" for the purposes of this study means that the CCE is less than or equal to 13 cents per kilowatt-hour.

BC Hydro has determined that its energy reference price is $88/MWh, or $0.088/kWh, based on an average of the results of the 2006 call for new energy supply. It represents the average real levelized cost to deliver firm energy to the load centre in the Lower Mainland. It includes infrastructure costs and losses in getting energy to the Lower Mainland at the bulk transmission level. Further infrastructure costs are driven mainly by capacity needs, rather than energy needs, and are best accounted for in the capacity screen. The energy reference price also includes a greenhouse gas adder to value GHG emissions which are expected to be regulated.

The energy economic screen is calculated by adding 50% to the energy reference price to capture potential future opportunities above current costs. The resulting energy economic screen used in this analysis is, therefore, $0.13/kWh ($0.088/kWh*1.50). This allows for uncertainties in the energy reference price over time and ensures that the study results are not rendered obsolete in the short term due to a new energy reference price that exceeds the study's economic screen. The electric energy Economic Potential forecast incorporates all the electric energy-efficient upgrades that the technology assessment found with a CCE equal to or less than $0.13/kWh.

Selection of the electric peak load measures to be included in the peak load forecast followed a similar approach as for electric energy. In this case, a reference price for capacity is required. Since BC Hydro has not finalized its capacity reference price, it was agreed that CPR 2007 would use the most recent draft. The capacity reference price is dependent on region, so CPR 2007 uses the Vancouver Island region because it has the highest costs.

The capacity economic screen is calculated by adding 50% to the capacity reference price to capture potential future opportunities above the current avoided cost and rounding to the nearest $10. Capacity Economic Screen: $115/kW/yr*1.5 = $170/kW/yr (rounded). The electric peak load Economic Potential forecast incorporates all the measures with a CEPR equal to or less than $170/kW/yr.

Step 5: Estimate Achievable Electric Energy and Peak Load Savings Potential

The Achievable Potential is the proportion of the savings identified in the Economic Potential forecast that could realistically be achieved within the study period. 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, therefore, presented as a range, defined as "Upper" and "Lower."

The Lower Achievable Potential assumes market conditions, program efforts, and incentive levels remain at a similar level when compared to existing levels. The Upper Achievable Potential assumes that market conditions and government policy are supportive and that energy savings are aggressively pursued. For full definitions of these terms please refer to any of the main reports.

Estimates provided were developed in collaboration with Power Smart personnel, External Review Panel members and industry experts. They are based on a combination of empirical results from earlier DSM initiatives, results in other jurisdictions and a qualitative assessment of current market and customer receptivity to electrical efficiency investments. The range of estimates also recognizes that, in addition to factors within BC Hydro's control (e.g., program design), factors external to the utility (e.g., state of the economy, climate change implications, etc.) could significantly influence the Achievable Potential.

It is important to note that the Upper and Lower Achievable numbers are intended to bracket savings which could reasonably be expected to be attainable given the assumptions and scope of the study. The Upper Achievable Potential is not the maximum possible because, for example, it does not include future unknown technologies beyond 2011. The Lower Achievable Potential is not the minimum possible because, for example, it assumes that BC Hydro's DSM programs continue at or near their current level of effort.

Definitions

Some of the terms used in the reports have specific definitions, which are listed in the Glossary in each of the main reports.

1.5 THIS REPORT

This report presents the results of Report 11 in Exhibit 1.1, above and is organized as follows:

- Section 2 presents the combined electric energy and peak load savings for the three sectors from the combination of technology, behavioural and customer-supplied renewable energy measures.
- Sections 3, 4 and 5 present a summary of the electric energy and peak load savings from technology adoption for, respectively, the Residential, Commercial and Industrial sectors.
- Section 6 presents a summary of the electric energy savings from small-scale customer-supplied renewable energies in the Residential and Commercial sectors.
- Section 7 presents a summary of the electric energy and peak load savings from changes in customer behaviours in the Residential and Commercial sectors.
- Section 8 presents a summary of the electric energy and peak load savings from changes in customer lifestyle choices.
- Section 9 presents a summary of the electric energy and peak load savings from switching selected electric end uses to natural gas in the Residential, Commercial and Industrial sectors.
- Section 10 provides recommendations for BC Hydro's consideration.

2. SUMMARY OF FINDINGS

CPR 2007 confirms that significant cost-effective electric energy and peak load savings opportunities exist in every sector in BC Hydro's service area. All savings are at the customer meter and do not include line losses.

To determine the total electric energy and peak load savings potential, CPR 2007 combined the results contained in each of the stand-alone reports included in Analysis Areas 1, 2 and 3. These include:

- The potential electric energy and peak load savings from technology adoption, operation and maintenance
- Behavioural changes and
- Small-scale customer-supplied renewable energies.

The combined results presented in this section are net of overlapping measures that, if simply summed, would result in double counting of results.

It should also be noted that there are additional Achievable Potential electricity savings that could be provided through Analysis Area 4, Lifestyle. These measures, summarized in Section 8, challenge customers to take action beyond technology and eliminating waste, and to change their consumption choices. The Lifestyle changes would fundamentally change the BC Hydro load forecast and have not been included in the combined total presented in this report as they are not directly additive and there is currently no existing methodology to combine them. Similarly, it was also agreed at the outset of CPR 2007 that Analysis Area 5, Fuel Switching, would not be included in the calculation of combined savings as these measures also fundamentally alter the load forecast.

In addition, additional Achievable Potential electricity savings are likely available from electrical efficiency technologies and measures that become commercially viable beyond 2011, or step-changes in energy-efficient technologies, and that are not reflected in the following results.

Finally, supply-side efficiency improvements in BC Hydro and BCTC's systems could provide additional electricity savings.

2.1 ELECTRIC ENERGY SAVINGS

Exhibits 2.1 and 2.2 summarize the total combined Achievable Potential electric energy savings that have been identified in each of the stand-alone reports included in Analysis Areas 1, 2 and 3. As illustrated:

- In the Upper Achievable Potential scenario, electricity savings are about 3,470 GWh/yr in F2011 and increase to about 15,070 GWh/yr by F2026.

- In the Lower Achievable Potential scenario, electricity savings are about 1,600 GWh/yr in F2011 and increase to about 8,660 GWh/yr by F2026.

- In the Reference Case, total electricity consumption increases from approximately 51,000 GWh/yr in F2006 to about 68,700 GWh/yr by F2026, an increase of about 35%.

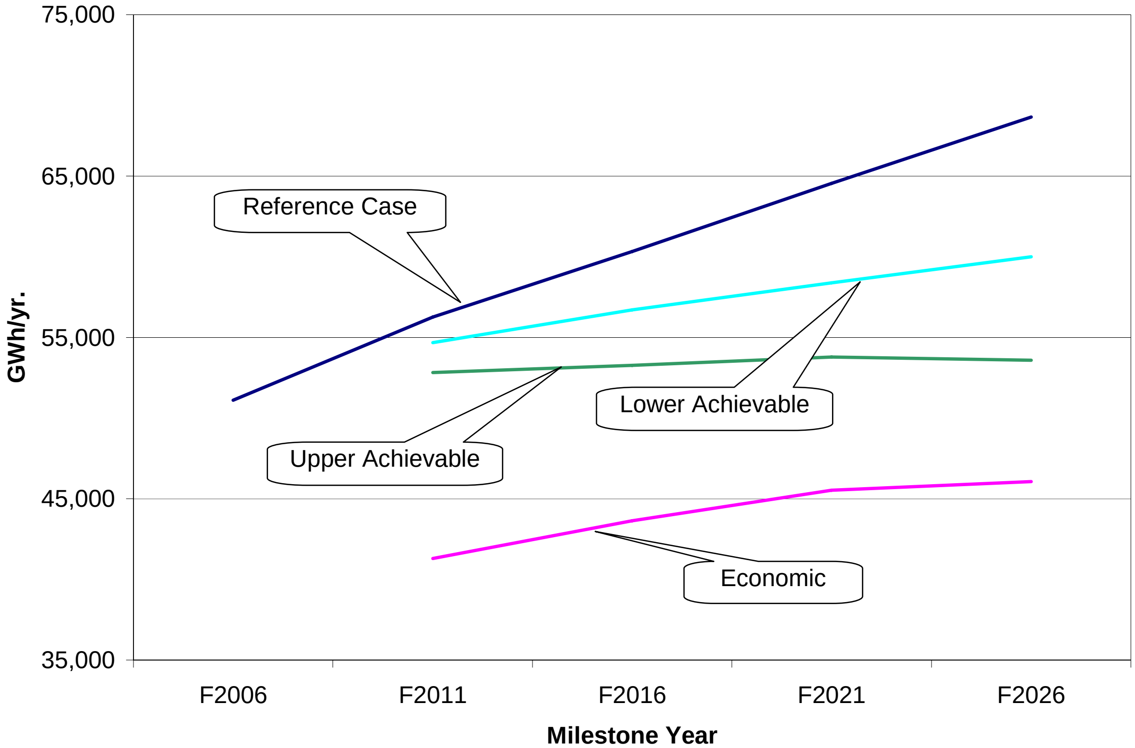
- In the combined Upper Achievable Potential scenario, the electricity savings of 15,070 GWh/yr in F2026 means that total electricity consumption would increase to about 53,600 GWh/yr, a decrease of about 28% relative to the Reference Case.

- In the Lower Achievable Potential scenario, total electricity consumption would increase to about 60,000 GWh/yr, a decrease of about 14% relative to the Reference Case.

Exhibit 2.1: Combined Upper and Lower Achievable Electric Energy Savings for the Total BC Hydro Service Area

Annual Consumption (GWh/yr.)						Potential Annual Savingss (GWh/yr.)		
Milestone Year	Base Year	Reference Case	Economic Combined	Achievable Combined		Economic Combined	Achievable Combined	
				Upper	Lower		Upper	Lower
F2006	51,016	51,016						
F2011		56,263	41,297	52,794	54,656	14,966	3,469	1,607
F2016		60,323	43,638	53,266	56,711	16,685	7,057	3,612
F2021		64,548	45,531	53,779	58,381	19,017	10,769	6,167
F2026		68,665	46,058	53,593	60,006	22,607	15,072	8,659

Exhibit 2.2: Combined Upper and Lower Achievable Electricity Consumption Relative to the Reference Case for the Total BC Hydro Service Area F2006-F2026



Note: The Reference Case models electricity consumption for the BC Hydro Service Area using the "Total Domestic Sales" outlined in BC Hydro's load forecast. BC Hydro's system needs ("Total Gross Requirement" in the load forecast) includes system losses and sales to Fortis and New Westminster, which are not included in the Reference Case.

2.2 ELECTRIC PEAK LOAD SAVINGS

CPR 2007 also confirmed that significant cost-effective opportunities exist for peak load savings during each of the four peak periods. CPR 2007 assessed two sources of peak load savings and their effect on each of the four peak periods:

- Peak load savings from electric energy savings
- Peak load savings from capacity-only measures

For the purposes of this report, the results of Peak Period 1 are presented in Exhibit 2.3; details for the other three peak periods are provided in each of the stand-alone reports that are listed at the end of this section.

As illustrated in Exhibit 2.3:

- In the Base Year F2006, the peak load for BC Hydro's total service area was approximately 9,650 MW for Peak Period 1.

- In the absence of new DSM initiatives, the study estimates that the total peak load in Peak Period 1 will grow to about 13,180 MW by F2026, an increase of about 37%.

- Electric energy savings would provide peak load savings of approximately 2,280 and 1,415 MW during BC Hydro's Annual System Peak Hour by F2026 in, respectively, the Upper and Lower Achievable Potential scenarios.

- Capacity-only measures would provide peak load savings of approximately 1,080 and 670 MW by F2026 in, respectively, the Upper and Lower Achievable Potential scenarios. The capacity-only results shown in Exhibit 2.3 do not include industry as the one-hour timeframe defined by Peak Period 1 is not a practical match with the industrial measures.[4]

Exhibit 2.3: Peak Load Savings in Peak Period 1 from Electric Energy Savings and Capacity-Only Measures – Reference Case vs. Achievable Potential for the Total BC Hydro Service Area

Average Peak Load (MW)			Peak Load Savings from Electric Energy Savings (MW)		Peak Load Savings from Capacity-Only Measures (MW)	
Milestone Year	**Base Year**	**Reference Case**	**Upper Achievable**	**Lower Achievable**	**Upper Achievable**	**Lower Achievable**
F2006	9,653	9,653				
F2011		10,556	621	276	320	165
F2016		11,613	1,168	592	659	399
F2021		11,992	1,729	1,066	922	563
F2026		13,183	2,278	1,415	1,084	673

Notes: Industrial peak load savings from capacity-only measures are not practical for Peak Period 1 and are not included in the results shown (Refer to Exhibit 5.4).

Electric peak load reductions from electric energy savings and from capacity-only measures presented in Exhibit 2.3 are not directly additive. For example, if the electric peak load reductions due to electric energy-efficiency measures applied to domestic hot water use provide a 5% saving, the capacity-only measure for electric peak reductions should be discounted by that same 5% to reflect the new lower consumption level. Further detail is provided in the main body of the core sector reports.

Additional details on the specific technologies and practices that provide the savings shown above are contained in the detailed reports, which are listed at the end of this section.

[4] However, the timeframe defined by Peak Period 2 is a good match with the industrial measures; Industrial capacity-only peak load savings for Peak Period 2 are estimated to be 579 MW and 374 MW by F2026 in, respectively, the Upper and Lower Achievable Potential scenarios (Refer to Exhibit 5.4).

2.3 GREENHOUSE GAS EMISSION IMPACTS

For the CPR 2007 study period of F2006 to F2016, inclusive, the greenhouse gas (GHG) emission intensity factor for electricity generation was assumed to be 550 tonnes $CO_{2\ equiv}$ per GWh. This is a proxy electricity emissions factor based on actual values for imported electricity in F2006.

For the CPR 2007 study period of post F2016 to F2026, the GHG emission factor for electricity generation is zero. The selection of a zero emissions factor for the post F2016 study period is based on two factors:

- This study assumes that imports decline linearly to zero by F2016, in keeping with the self-sufficiency goal in the BC Energy Plan.
- BC Hydro will adhere to the B.C. Energy Plan, which requires net zero GHG emissions from new electricity generation projects as well as all existing thermal generation by 2016.

Based on the GHG emission intensity factors noted above, Exhibit 2. 4 summarizes the potential annual reduction in GHG emissions that would occur as a result of the combined electric energy savings shown previously in Exhibit 2.1. The results are presented for each Milestone Year and for both the Upper and Lower Achievable Potential scenarios. In each case, the results shown are for the year shown (i.e., they are not cumulative).

Exhibit 2.4: Annual GHG Emission Reduction from Combined Electric Energy Savings for the Total BC Hydro Service Area, by Milestone Year

Milestone Year	Electric Energy Savings GWh/yr		GHG Emission Reduction Tonnes $CO_{2\ equiv}$/yr	
	Upper Achievable	Lower Achievable	Upper Achievable	Lower Achievable
F2006				
F2011	3,469	1,607	1,907,950	883,850
F2016	7,057	3,612	3,881,350	1,986,600
F2021	10,769	6,167	0	0
F2026	15,072	8,659	0	0

Exhibit 2.5 shows the value of the GHG reduction shown in the preceding Exhibit 2.4. The values shown are based on a current 2007 price of $15[5] per tonne of $CO_{2\ equiv}$ and are discounted back to 2006 using a discount rate of 6%. In the absence of any specific data, the values shown in Exhibit 2.5 do not adjust for future increases in the price of carbon.

[5] It is impossible to know the future price of CO_2 at this time; however, the value of $15 per tonne is currently being used in federal government discussions and was agreed to at a meeting of the External Review Panel in August 2007.

Exhibit 2.5: Value of GHG Emission Reduction from Combined Electric Energy Savings for the Total BC Hydro Service Area, by Milestone Year

Milestone Year	GHG Emission Reduction Tonnes $CO_{2\ equiv}$/yr		Value of GHG Savings in Forecast Year (thousands $2007)	
	Upper Achievable	Lower Achievable	Upper Achievable	Lower Achievable
F2006				
F2011	1,907,950	883,850	$22,666	$10,520
F2016	3,881,350	1,986,600	$34,460	$17,638
F2021	0	0	0	0
F2026	0	0	0	0

2.4 ENERGY EFFICIENCY INVESTMENT F2026

CPR 2007 calculated the approximate value of the energy efficiency investment required to achieve the annual electric energy savings in F2026 (i.e. a one-year snapshot), as shown in Exhibit 2.6. The energy efficiency investment value for F2026 was calculated by multiplying each kilowatt-hour of electric energy savings in F2026 by its annualized cost, which in this study is referred to as the cost of conserved electricity (CCE). As illustrated in Exhibit 2.6, the energy efficiency investment required to achieve the electric energy savings in F2026 would be approximately $619 million in the case of the Upper Achievable Potential scenario and $354 million in the case of the Lower Achievable Potential scenario. This does not differentiate between potential utility DSM strategies, does not include any utility program costs and does not give an indication of the level of financial incentive that may be provided by BC Hydro.

The energy efficiency investment costs for F2026 provide an illustrative comparison with the cost of providing the same amount of electric energy using new electricity generating supply at a cost of $88/MWh, which is the reference price that is used throughout CPR 2007. As illustrated in Exhibit 2.6, if new electricity generation was used to meet the same incremental electricity requirements in F2026, then the cost would be approximately $1.3 billion in the case of the Upper Achievable Potential scenario and $760 million in the case of the Lower Achievable Potential scenario.

The annual cost savings for the F2026 electric energy savings provided by the energy efficiency investment are, therefore, in the range of $708 million for the Upper Achievable Potential scenario and $408 million in the case of the Lower Achievable Potential scenario.

Exhibit 2.6: Investment Requirement for DSM vs. New Supply, Combined Electric Energy Savings for the Total BC Hydro Service Area for F2026

Electric Energy Savings F2026 (GWh/yr.)		Required Investment Efficiency F2026 (000, $2007)		Required Investment New Supply F2026 (000, $2007)		Investment Savings Efficiency vs New Supply F2026 (000, $2007)	
Upper Achievable	Lower Achievable	Upper Achievable	Lower Achievable	Upper Achievable	Lower Achievable	Upper Achievable	Lower Achievable
15,072	8,659	$618,691	$353,792	$1,326,336	$761,992	$707,645	$408,200

2.5 ADDITIONAL INFORMATION

The combined potential electricity savings results presented in this section are based on the detailed data and analysis contained in the CPR 2007 reports listed below. The reader is referred to these reports for additional information:

- *The Potential for Electricity Savings through Technology Adoption, Behavioural Changes and Customer-supplied Renewable Energies, 2006-2026 – Residential, Commercial and Industrial Sectors in British Columbia*
- *The Potential for Electricity Savings through Technology Adoption, 2006-2026 – Residential Sector in British Columbia*
- *The Potential for Electricity Savings through Technology Adoption, 2006-2026 – Commercial Sector in British Columbia*
- *The Potential for Electricity Savings through Technology Adoption, 2006-2026 – Industrial Sector in British Columbia*
- *The Potential for Electricity Savings through Behavioural Changes, 2006-2026 – Residential and Commercial Sectors in British Columbia*
- *The Potential for Electricity Savings through Customer-supplied Renewable Energies, 2006-2026 – Residential and Commercial Sectors in British Columbia*

2.6 CAVEATS

The CPR's scope was limited to the five Analysis Areas outlined in Section 1.2. 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 three of the five Analysis Areas. 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 2011 or through step-changes in energy-efficient technologies. They could also come from lifestyle changes estimated in the CPR but not included in the combined Achievable Potential savings. And they could come from supply-side efficiency improvements within BC Hydro and BCTC's 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 BC Hydro Load Forecast, Discount Rates, and Reference 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. THE RESIDENTIAL SECTOR

The Residential sector includes single-family homes, duplexes, row homes, high-rise and low-rise apartment buildings and mobile homes.

Marbek Resource Consultants conducted the research, modelling and analysis of the Residential sector with the assistance of SAR Engineering, the Applied Energy Group and Intellergy.

3.1 APPROACH

The detailed end-use analysis of electric energy in the Residential sector employed two linked modelling platforms: **HOT-2000,** a commercially supported, residential building energy-use simulation software, and **RSEEM** (Residential Sector Energy End-use Model), a Marbek in-house spreadsheet-based macro model. Peak load savings were modelled using Applied Energy Group's Cross-Sector Load Shape Library Model (LOADLIB).

The major steps in the general approach to the study are outlined in Section 1.4 above (*Major Analytic Steps and Definitions*). Specific procedures for the Residential sector were as follows:

Modelling of Base Year – The consultants used BC Hydro customer data to break down the Residential sector by four factors:

- Type of dwelling (single detached, row house, low-rise apartment (four or fewer stories), high-rise apartment (five or more storeys), etc.)
- Heating category (electric or non-electric heat)
- The age of the building
- BC Hydro service region

To estimate the electric energy used for space heating, the consultants factored in building characteristics such as insulation and air-tightness using a Canadian "Energuide for Houses" database as well as climate data. They also used BC Hydro survey data on supplemental heaters, hot water use and appliances to calculate an average total electricity use per dwelling unit. The consultants' models produced a very close match with actual BC Hydro sales data.

To estimate the peak loads in each of the four 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 four 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 BC Hydro's own December 2006 forecast of future electricity requirements.

Assessment of electric energy savings options technologies –To estimate the Economic and Achievable electric energy savings potentials, the options assessed included technologies such as:

- Improved lighting systems
- Reduced standby losses in computers and electronic equipment
- Improved designs for new buildings
- Upgrades to the walls, roofs and windows 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 estimate the Economic and Achievable peak load reduction potentials, the options assessed included technologies such as thermostat or switch-based control of space- and water-heating equipment, electric thermal storage and switch-based control of swimming pool and spa pumps.

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 CPR 2007 is presented in Exhibits 3.1 and 3.2, by Milestone Year. The results shown in Exhibits 3.1 and 3.2, net of any double counting of results, are included in the combined savings levels presented previously in Section 2. Further discussion is provided in the paragraphs below.

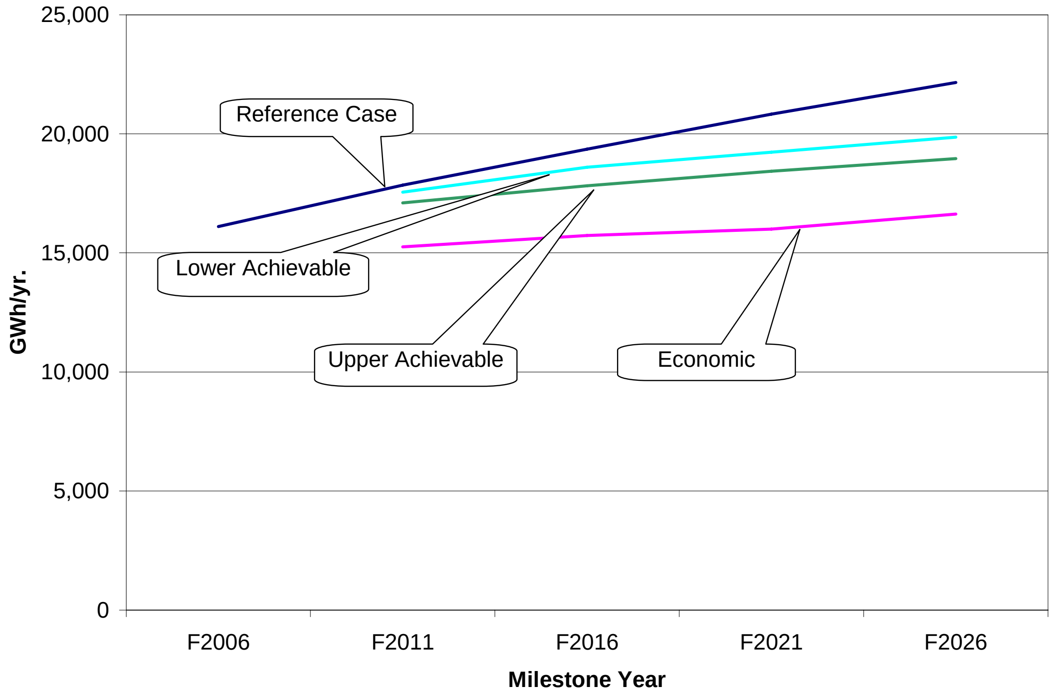
Electric energy savings from electrical efficiency improvements would provide between 3,173 and 2,295 GWh/yr of electricity savings by F2026 in, respectively, the Upper and Lower Achievable Potential scenarios, or about 14% and 10%, respectively, relative to the Reference Case. The most significant Achievable savings opportunities were in the actions that addressed lighting, space heating and household electronics (e.g., computers and peripherals, televisions and television peripherals).

Exhibit 3.1: Summary of Forecast Results – Annual Electric Energy Consumption, Residential Sector (GWh/yr)

Annual Consumption (GWh/yr.) Residential Sector						Potential Annual Savings (GWh/yr.)		
Milestone Year	Base Year	Reference Case	Economic	Achievable		Economic	Achievable	
				Upper	Lower		Upper	Lower
F2006	16,106	16,106						
F2011		17,843	15,248	17,102	17,547	2,595	740	296
F2016		19,359	15,730	17,821	18,596	3,628	1,537	762
F2021		20,821	16,001	18,430	19,228	4,820	2,391	1,593
F2026		22,156	16,635	18,963	19,861	5,521	3,193	2,295

Note: Results are measured at the customer's point of use and do not include line losses.

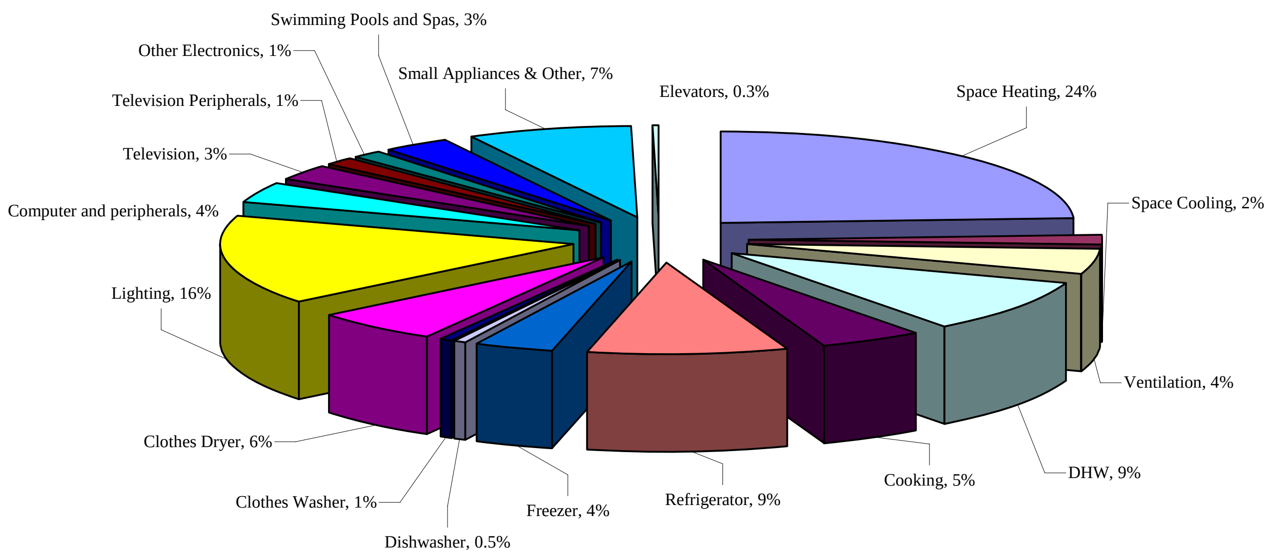
Exhibit 3.2: Graphic of Forecast Results – Annual Electric Energy Consumption Residential Sector (GWh/yr)



Base Year Electricity Use

In the Base Year of F2006, BC Hydro's Residential sector consumed about 16,100 GWh. Exhibit 3.3 shows that space heating accounts for about 24% of total Residential electricity use.[6] Kitchen appliances (i.e., refrigeration, freezers, cooking, microwave ovens and dishwashers) account for approximately 19% of the total electricity use, followed by lighting (16%). Household electronics (i.e., computers and peripherals, televisions and television peripherals) and domestic hot water (DHW) each account for about 9% of the total electricity use.

Exhibit 3.3: Residential Sector Base Year Electricity Use by End Use



[6] Values are for all residential dwellings. Space heating share is much higher in electrically heated homes.

In the Base Year, single-family detached (SFD)/duplex dwellings account for the largest share (67%) of Residential Base Year electricity use, followed by high-rise apartments (10%), row houses (8%) and low-rise apartments (7%). Mobile homes account for the remainder.

Reference Case – Electric Energy

In the absence of new DSM initiatives, CPR 2007 estimates that electricity consumption in the Residential sector will grow from 16,100 GWh/yr in F2006 to about 22,100 GWh/yr by F2026. This represents an overall growth of about 38% in the period and compares very closely with BC Hydro's December 2006 forecast, which also included consideration of the impacts of "natural conservation."

Economic Potential Forecast – Electric Energy

Under the conditions of the Economic Potential forecast,[7] the study estimated that electricity consumption in the Residential sector would grow to about 16,600 GWh/yr by F2026. Annual savings relative to the Reference Case are 5,500 GWh/yr or about 25%. The Economic Potential annual savings in the intermediate Milestone Years are 2,600 GWh/yr in F2011, 3,600 GWh/yr in F2016, and 4,800 GWh/yr in F2021.

Achievable Potential – Electric Energy

The Achievable Potential is the proportion of the economic electric energy savings (as noted above) that could realistically be achieved within the study period. In the Residential sector, the Achievable Potential for electric energy savings through technology adoption was estimated to be 3,173 GWh/yr and 2,295 GWh/yr by F2026 in, respectively, the Upper and Lower scenarios.

Consistent with the results in the Economic Potential forecast, the most significant Achievable Savings opportunities were in the actions that addressed lighting, space heating and household electronics (e.g., computers and peripherals, televisions and television peripherals).

3.3 SUMMARY OF PEAK LOAD SAVINGS

CPR 2007 assessed two sources of electric peak load reductions and their effect on each of the four peak periods:

- Peak load reductions from electric energy savings
- Peak load reductions from capacity-only measures

Exhibit 3.4 provides a summary of the peak load savings potential from each source. For the purpose of this summary, the results of Peak Period 1 are highlighted below; details for the other three 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.

[7] The level of electricity consumption that would occur if all equipment and building envelopes were upgraded to the level that is cost effective against future avoided electricity costs.

Exhibit 3.4: Residential Peak Load Savings from Electric Energy Savings and Capacity-Only Measures – Reference Case vs. Achievable Potential for the Total BC Hydro Service Area

Average Peak Load (MW) Residential Sector			Peak Load Savings from Electric Energy Savings (MW)		Peak Load Savings from Capacity-only Measures (MW)	
Milestone Year	**Base Year**	**Reference Case**	**Upper Achievable**	**Lower Achievable**	**Upper Achievable**	**Lower Achievable**
F2006	4,812	4,812				
F2011		5,244	220	89	273	138
F2016		5,632	417	209	559	333
F2021		6,007	608	409	778	468
F2026		6,335	805	582	908	557

Note: Electric peak load reductions from electric energy savings and from capacity-only measures are not directly additive. For example, if the electric peak load reductions due to electric energy efficiency measures applied to domestic hot water use provide a 5% savings, the capacity-only measure for electric peak reductions should be discounted by that same 5% to reflect the new lower consumption level. Further detail is provided in the main body of the Residential sector report.

Highlights of the peak load savings shown in Exhibit 3.4 are presented below:

- In the Base Year F2006, the peak load for BC Hydro's total Residential sector was approximately 4,810 MW for Peak Period 1.
- In the absence of new DSM initiatives, the study estimates that the Residential sector peak load in Peak Period 1 will grow to about 6,340 MW by F2026, an increase of about 31%.
- Electric energy savings would provide peak load savings of approximately 805 to 582 MW during BC Hydro's Annual System Peak Hour by F2026 in, respectively, the Upper and Lower Achievable Potential scenarios.
- Capacity-only measures would provide peak load savings of approximately 908 to 557 MW by F2026 in, respectively, the Upper and Lower Achievable Potential scenarios. The most significant Achievable Savings opportunities were from one-way, switch-based utility control of space heating, lighting and plug loads.

3.4 ADDITIONAL INFORMATION

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

- *The Potential for Electricity Savings through Technology Adoption, 2006-2026 – Residential Sector in British Columbia*

4. THE 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 hospitals and nursing homes, schools and universities. 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 telephone exchange buildings, but they were not modelled in this study.

Marbek Resource Consultants conducted the research, modelling and analysis of the Commercial sector, with the assistance of EnerSys Analytics Inc., The Applied Energy Group and Intellergy.

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 Applied Energy Group's Cross-Sector Load Shape Library Model (LOADLIB).

The major steps in the general approach to the study are outlined in Section 1.4 above (*Major Analytic Steps and Definitions*). Specific procedures for the Commercial sector were as follows:

Modelling of Base Year – Marbek first established data describing the Base Year, F2006, including "where" and "how" electricity is currently used in existing Commercial buildings. They created building energy-use simulations for each of 15 large and medium types of building and calibrated the models to reflect actual BC Hydro customer sales data. They derived estimated savings for the Small Commercial and the Other categories from the results of the modelled segments. They did not directly model those categories because they are extremely diverse and the electricity use of individual categories is relatively small.

Reference Case calculations – For the Commercial sector, Marbek developed detailed profiles of new buildings in each of the building segments, estimated the growth in building stock, and estimated "natural" changes affecting electricity consumption over the study period. As with the Base Year calibration, the consultants' projection closely matches BC Hydro's own December 2006 forecast of future electricity requirements.

Assessment of electric energy savings options – To estimate the Economic and Achievable electric energy savings potentials, the options assessed included:

- Technology options such as more efficient lighting and office equipment, improved construction in new buildings, and upgraded heating, ventilating and cooling systems
- O&M measures such as reducing equipment operating times, optimizing the procedures for controlling security lighting and lighting used by cleaning staff
- Combined technology and O&M measures

Assessment of capacity-only peak load reduction options – To estimate the Economic and Achievable Potentials, the options assessed included technologies such as thermostat or switch-based control of space conditioning and water heating equipment, electric thermal storage and control of non-essential lighting.

4.2 SUMMARY OF ELECTRIC ENERGY SAVINGS

A summary of the levels of annual electricity consumption contained in each of the forecasts addressed by CPR 2007 is presented in Exhibits 4.1 and 4.2. The results shown in Exhibits 4.1 and 4.2, net of any double counting of results, are included in the combined savings levels presented previously in Section 2. Further discussion is provided in the paragraphs below.

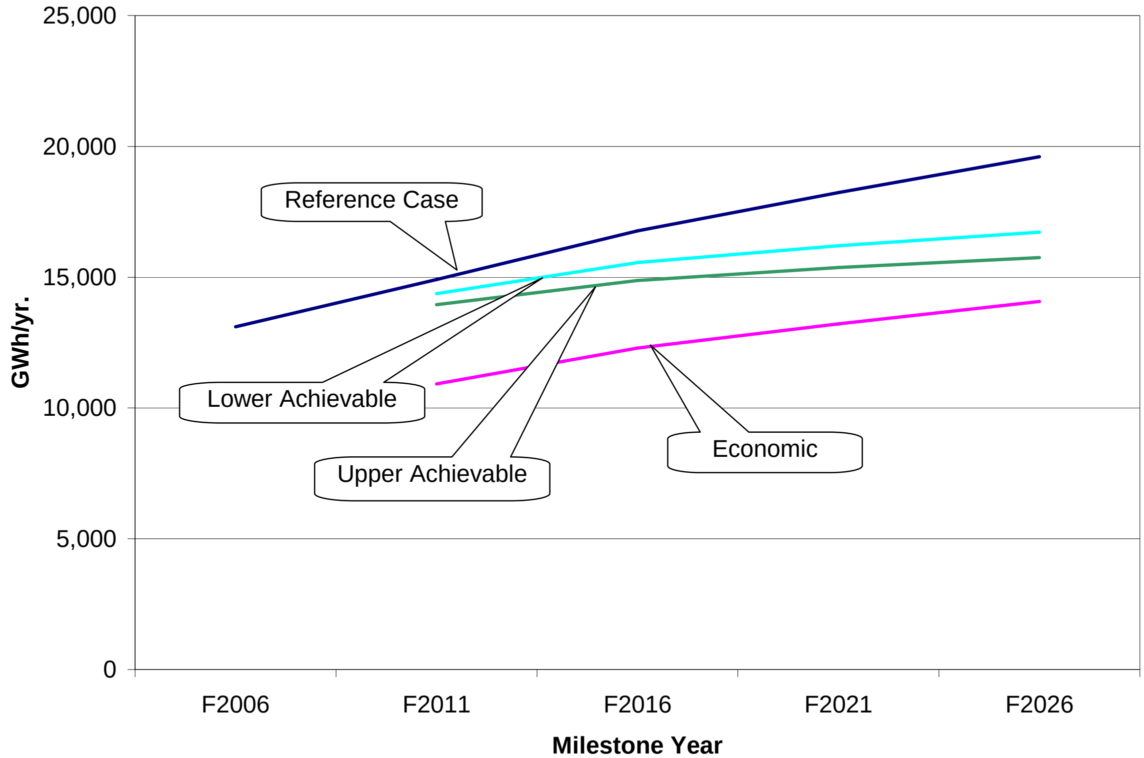
Electric energy savings from the combined technology and O&M efficiency improvements would provide between 3,855 and 2,876 GWh/yr of electricity savings by F2026 in, respectively, the Upper and Lower Achievable Potential scenarios, or about 20% and 15%, respectively, relative to the Reference Case. The most significant Achievable Savings opportunities were in the actions that addressed lighting, computer equipment and HVAC equipment.

Exhibit 4.1: Summary of Forecast Results – Annual Electric Energy Consumption, Commercial Sector (GWh/yr)

Annual Consumption (GWh/yr) Commercial Sector						**Potential Annual Savings (GWh/yr)**		
Milestone Year	Base Year	Reference Case	Economic	Achievable Combined Technology and O&M		Economic	Achievable Combined Technology and O&M	
				Upper	Lower		Upper	Lower
F2006		13,100						
F2011		14,909	10,917	13,951	14,374	3,992	958	535
F2016		16,775	12,294	14,870	15,560	4,481	1,905	1,215
F2021		18,230	13,211	15,364	16,205	5,019	2,866	2,025
F2026		19,601	14,073	15,746	16,725	5,528	3,855	2,876

Note: Results are measured at the customer's point of use and do not include line losses.

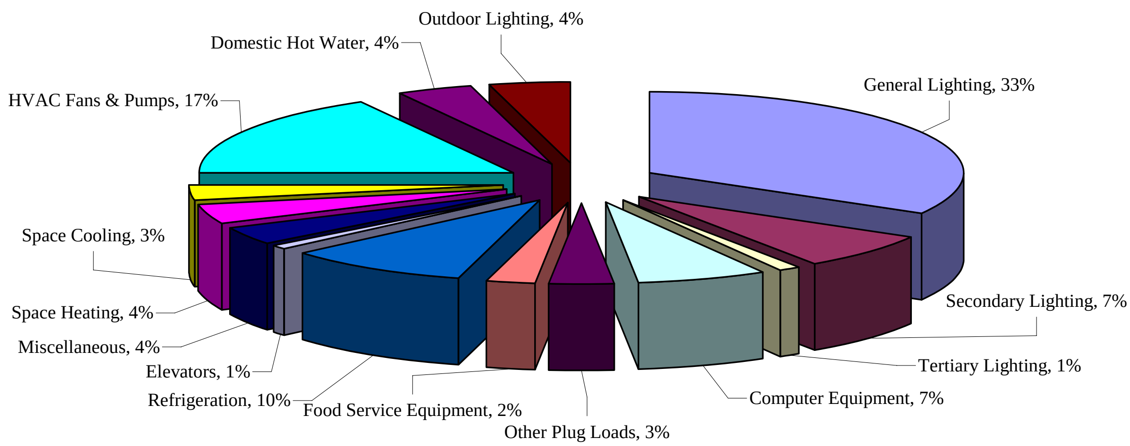
Exhibit 4.2: Graphic of Forecast Results – Annual Electric Energy Consumption, Commercial Sector (GWh/yr)



Base Year Electricity Use

In the Base Year of F2006, BC Hydro's Commercial sector consumed about 13,100 GWh. Exhibit 4.3 below shows the distribution of annual electricity consumption in the Base Year by end use for the Commercial sector. Indoor and outdoor lighting (general, secondary, tertiary and outdoor lighting) accounts for 45% of the total electricity use, followed by HVAC fans and pumps at 17%.

Exhibit 4.3: Distribution of Commercial Sector Electricity Consumption for the Total BC Hydro Service Area, by End Use in the Base Year (F2006)



Reference Case – Electric Energy

In the absence of new DSM initiatives, CPR 2007 estimates that electricity consumption in the Commercial sector will grow from 13,100 GWh/yr in F2006 to about 19,600 GWh/yr in F2026. This represents an overall growth of about 50% in the period and compares very closely with BC Hydro's December 2006 forecast, which also included consideration of the impacts of "natural conservation."

Economic Potential Forecast – Electric Energy

Under the conditions of the Economic Potential forecast,[8] the study estimated that electricity consumption in the Commercial sector would grow to about 14,073 GWh/yr by F2026. Annual savings relative to the Reference Case are 5,528 GWh/yr or about 28%. The Economic Potential annual savings in Milestone Year F2011 are 3,992 GWh/yr, 4,481 GWh/yr in F2016 and 5,019 GWh/yr in F2021.

Achievable Potential – Electric Energy

The Achievable Potential is the proportion of the Economic electric energy savings (as noted above) that could realistically be achieved within the study period. In the Commercial sector, the Achievable Potential for electric energy savings through technology adoption was estimated to

[8] The level of electricity consumption that would occur if all equipment and building envelopes were upgraded to the level that is cost effective against future avoided electricity costs.

be approximately 3,855 GWh/yr and 2,876 GWh/yr by F2026 in, respectively, the Upper and Lower scenarios.

Consistent with the results in the Economic Potential forecast, the most significant Achievable Savings opportunities were in the actions that addressed lighting, computer equipment and HVAC equipment.

4.3 SUMMARY OF ELECTRIC PEAK LOAD SAVINGS

CPR 2007 assessed two sources of electric peak load reductions and their effect on each of the four peak periods:

- Peak load reductions from electric energy savings
- Peak load reductions from capacity-only measures

Exhibit 4.4 provides a summary of the peak load savings potential from each source. For the purpose of this summary, the results of Peak Period 1 are highlighted below; details for the other three 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 4.4: Commercial Peak Load Savings from Electric Energy Savings and Capacity-Only Measures – Reference Case vs. Achievable Potential for the Total BC Hydro Service Area

Average Peak Load (MW) Commercial Sector			Peak Load Savings from Electric Energy Savings (MW)		Peak Load Savings from Capacity-Only Measures (MW)	
Milestone Year	**Base Year**	**Reference Case**	**Upper Achievable**	**Lower Achievable**	**Upper Achievable**	**Lower Achievable**
F2006		1,781				
F2011		2,023	158	86	47	27
F2016		2,265	265	168	100	66
F2021		2,482	360	256	144	95
F2026		2,687	443	323	176	116

Note: Electric peak load reductions from electric energy savings and from capacity-only measures are not directly additive. That is, if the electric peak reductions due to energy efficiency reductions for 2011 represent a 5% reduction, for example, the capacity-only measure electric peak reductions should be discounted by that same 5% to reflect a lower Base Case, assuming the energy-efficiency measures are indeed adopted. Further detail is provided in the main body of the Commercial sector report.

Highlights of the peak load savings shown are presented below:

- In the Base Year F2006, the peak load for BC Hydro's total Commercial sector was approximately 1,781 MW for Peak Period 1.

- In the absence of new DSM initiatives, the study estimates that the Commercial sector peak load in Peak Period 1 will grow to about 2,687 MW by F2026, an increase of about 51%.

- Electric energy savings would provide peak load savings of approximately 443 to 323 MW during BC Hydro's Annual System Peak Hour by F2026 in, respectively, the Upper and Lower Achievable Potential scenarios.

- Capacity-only measures would provide peak load savings of approximately 176 to 116 MW by F2026 in, respectively, the Upper and Lower Achievable Potential scenarios. The most significant Achievable Savings opportunities were from one-way switch-based utility control of space heating, HVAC and pumps and refrigeration measures.

4.4 ADDITIONAL INFORMATION

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

- *The Potential for Electricity Savings through Technology Adoption, 2006-2026 – Commercial Sector in British Columbia*

5 THE INDUSTRIAL SECTOR

B.C.'s Industrial sector is a complex mix of facilities, including:

- Resource companies, such as forestry and mining extractors
- Primary and secondary manufacturers, such as wood, metal and chemical producers
- A wide variety of other companies, such as food and beverage producers, clothing and textile makers, construction, electronic and other manufacturers

For the purposes of this study, the Industrial sector is defined to also include agriculture, fisheries, pipeline transmission and transportation. These operations use electricity in a way that is closer to that of other industrial users, since they use electricity primarily for motors and moving products and supplies.

Willis Energy Services Ltd. conducted the research, modelling and analysis of the Industrial sector with the assistance of the Applied Energy Group. Marbek Resource Consultants provided analytic design and ensured that research methods and reporting in the Industrial sector were consistent with those in other sectors.

5.1 APPROACH

Electric energy savings were modeled using the Willis Industrial Model. The major output of this model is the electric energy-use intensity (EUI) of each sub sector, by Milestone Year. The Willis Industrial Model splits the electricity sold to Industrial customers into a number of sub sectors such as Kraft Pulp, Mechanical Pulp, Metal Mines, Coal Mines, Food and Beverages, etc. Some Industrial customers generate a portion of their own electricity, which contributes to their overall electricity consumption. For each sub sector, the electricity consumption is divided into end uses such as pumps, fans and blowers, compressed air, material handling, etc. For each of these end uses, the electricity consumed and useful work output is calculated and from that, the sub sector electric EUI is derived. The electric EUI varies with the efficiency of processes and equipment used. Using this approach, the electricity consumption can be derived for a range of scenarios, such as improving the process control, upgrading all the motors to the premium-efficiency level, etc.

Peak load reductions were modelled using Applied Energy Group's Cross-Sector Load Shape Library Model (LOADLIB).

The major steps in the general approach to the study are outlined in Section 1.4 above (*Major Analytic Steps and Definitions*). Specific procedures for the Industrial sector were as follows:

Modelling of Base Year – The consultants compiled data on B.C.'s Industrial sector from BC Stats, BC Hydro's Load Forecasting Department, company websites and annual reports and various consultant reports. To account for the fact that some large energy users, especially pulp and paper producers, generate a portion of their own electricity, Willis estimated the amount of self-generated electricity and offset it from the consumption data. Using these information sources, Willis modelled the electricity use for the Base Year, F2006, and compared it with BC Hydro's actual billing data. The macro models produced a close match with actual BC Hydro sales data.

Reference case calculations – Willis developed detailed profiles of the expected production levels in each sub sector, for each of the Milestone Years in the study period. This step recognizes that changes in overall production activity levels (e.g., tonnes of paper produced) as well as changes to sub-product mix (e.g., type of coated paper produced) will result in changes in electricity use. Willis also identified changes that are expected to occur “naturally,” such as changes in production processes or equipment efficiency that will affect the amount of electricity required to produce each unit of output (i.e., electric EUI). The resulting electricity consumption was then estimated and compared with the BC Hydro Industrial load forecast.

Assessment of electric energy savings options – To estimate the Economic and Achievable electric energy savings potentials, the options assessed included:

- Technology options such as more efficient systems for pumps, air displacement (fans), compressed air, material conveyance (such as conveyor belts and chains) and industrial refrigeration, as well as more efficient industrial lighting, electric motors etc.
- O&M measures such as improved maintenance and control system tuning for pumps, fans and blowers, compressed air systems, etc.
- Combined technology and O&M measures

Assessment of capacity-only peak load reduction options – To estimate the Economic and Achievable Potentials, the options assessed included technologies such as direct control of lighting, refrigeration or cooling loads, as well as the deferring or interrupting industrial loads during specified times and under pre-arranged conditions.

5.2 SUMMARY OF ELECTRIC ENERGY SAVINGS

A summary of the levels of annual electricity purchases contained in each of the forecasts addressed by CPR 2007 is presented in Exhibits 5.1 and 5.2. The results shown in Exhibits 5.1 and 5.2, net of any double counting of results, 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 6,737 and 2,895 GWh/yr of electricity savings by F2026 in, respectively, the Upper and Lower Achievable Potential scenarios, or about 25% and 11%, respectively, relative to the Reference Case[9]. The most significant Achievable Savings opportunities were in the actions that addressed the process end use in the Mechanical Pulp sub sector, as well as the pumps, compressed air, fans and blowers, and lighting end uses in all sub sectors.[10]

[9] Industry constraints related to factors such as facility layout, business uncertainty, production impacts and changes to product mixes may affect the Potential savings estimates and are beyond the influence of BC Hydro.

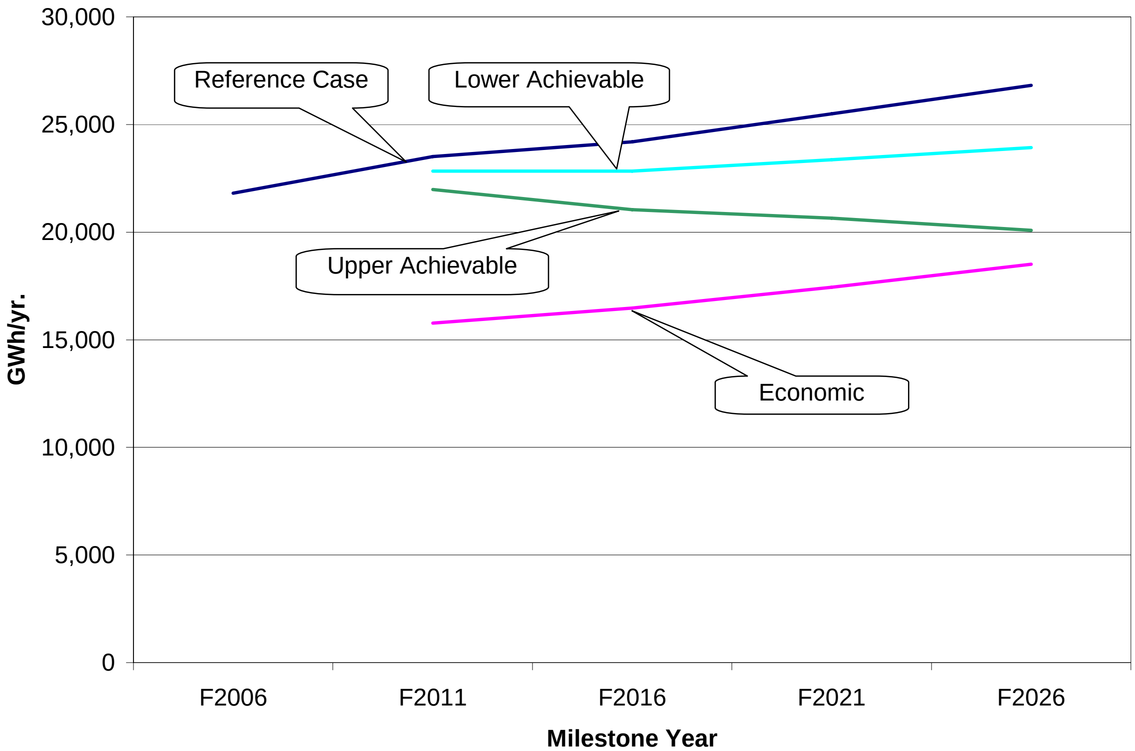
[10] Opportunities related to increasing self-generation through the consumption of additional fuel were not considered.

Exhibit 5.1: Summary of Forecast Results – Annual Electric Energy Purchases, Industrial Sector (GWh/yr)

Industrial Sector Annual Purchases (GWh/yr.)						Potential Annual Savings (GWh/yr.)		
Milestone Year	Base Year	Reference Case	Economic	Achievable		Economic	Achievable	
				Upper	Lower		Upper	Lower
F2006	21,810	21,810						
F2011		23,511	15,771	21,980	22,837	7,741	1,531	675
F2016		24,189	16,474	21,041	22,837	7,715	3,147	1,352
F2021		25,497	17,434	20,648	23,360	8,064	4,849	2,137
F2026		26,818	18,510	20,081	23,923	8,308	6,737	2,895

Note: Results are measured at the customer's point of use and do not include line losses.

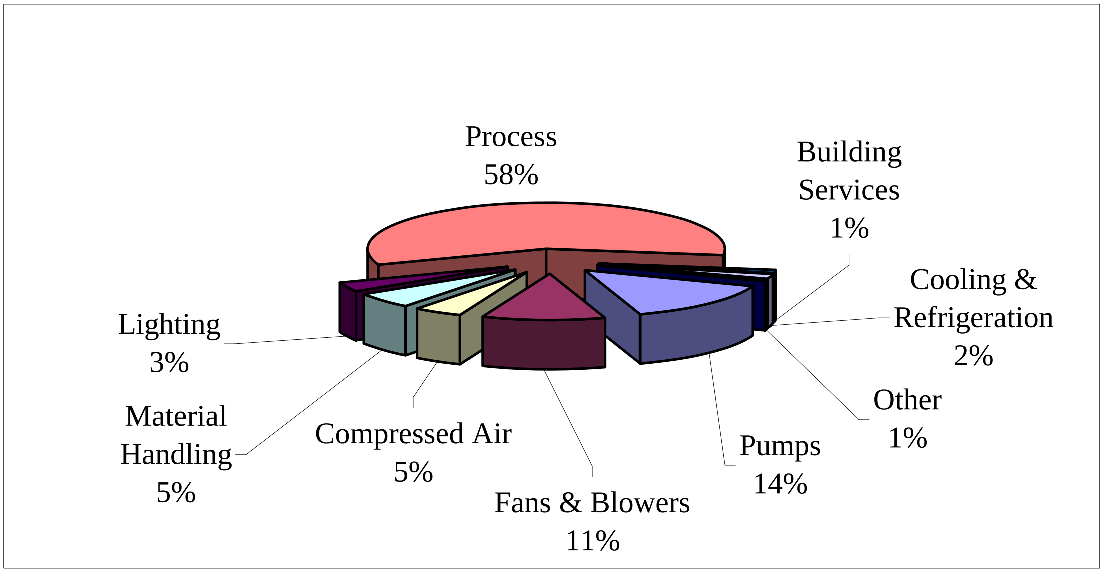
Exhibit 5.2: Graphic of Forecast Results – Annual Electric Energy Purchases, Industrial Sector (GWh/yr)



Base Year Electricity Consumption

In the Base Year of F2006, BC Hydro's Industrial sector consumed about 25,367 GWh/yr, which consisted of about 21,810 GWh/yr of purchased electricity and about 3,557 GWH/yr that was self-generated. As shown in Exhibit 5.3, the process end use accounts for about 58% of total Industrial electricity use. Pumps and fans and blowers consumed 14% and 11% respectively. Compressed air, material handling and lighting consumed 5%, 5%, and 3%, respectively. Cooling and refrigeration, building services, and other end uses consumed the remaining 4%.

Exhibit 5.3: Industrial Sector Base Year Electricity Consumption by End Use



In the Base Year, the Paper, Mechanical Pulp and Kraft Pulp sub sectors combined account for the largest portion of electricity consumption (55%), followed by Wood (12%), Metal and Coal Mining (12%), Chemical (9%) and Petroleum Refining (2%). Light and Heavy Manufacturing combined with Food and Beverage facilities account for the remaining Base Year Industrial electricity consumption.

Reference Case – Electric Energy

In the absence of new DSM initiatives, CPR 2007 estimates that electricity purchases in BC Hydro's Industrial sector will grow from 21,810 GWh/yr in F2006 to about 26,818 GWh/yr by F2026. This represents an overall growth of about 23% in the period and is based on BC Hydro's *CPR 2007 Industrial Load Forecast – Study Decision 2007-03-16*, referenced in the main Industrial sector report, which also included consideration of the impacts of "natural conservation."

Economic Potential Forecast – Electric Energy

Under the conditions of the Economic Potential forecast,[11] the study estimates that electricity purchases in the Industrial sector will decrease to about 18,510 GWh/yr by F2026. Annual savings relative to the Reference Case are 8,308 GWh/yr or about 31%. The Economic Potential annual savings in the Milestone Year of F2011 are 7,741 GWh/yr, 7,715 GWh/yr in F2016 and 8,064 GWh/yr in F2021.

[11] The level of electricity consumption that would occur if all equipment and systems were upgraded to the level that is cost effective against future avoided electricity costs.

Achievable Potential – Electric Energy

The Achievable Potential is the proportion of the economic electric energy savings (as noted above) that could realistically be achieved within the study period. In the Industrial sector, the Achievable Potential was estimated to be 6,580 GWh/yr and 2,895 GWh/yr by F2026 in, respectively, the Upper and Lower scenarios.

Consistent with the results in the Economic Potential forecast, the most significant Achievable Savings opportunities were in the actions that addressed the process end use in the Mechanical Pulp sub sector, as well as the pumps, compressed air, fans and blowers, and lighting end uses in all sub sectors.[12]

5.3 SUMMARY OF ELECTRIC PEAK LOAD REDUCTIONS

CPR 2007 assessed two sources of electric peak load reductions and their effect on each of the four peak periods:

- Peak load reductions from electric energy savings
- Peak load reductions from capacity-only measures

Exhibit 5.4 provides a summary of the electric peak load reduction potential from each source. For the purpose of this summary, the results of Peak Period 2 (System Critical Peak Days - 20 hours across 4 days) are highlighted below; details for the other three peak periods are provided in the main body of the Industrial sector report. Peak Period 2 is considered the most relevant for the Industrial sector, since one-hour peak load reductions, while a primary objective, would not be practical because any one-hour load shifting activities could simply shift the system peak to the prior or following hour. Peak Period 3 (Typical Winter Peak Day with a morning and evening peak) would also not be practical for industrial process applications because of the difficulties associated with restoring production for only the three-hour “off-peak” period between the morning and evening peak periods. The morning portion (7 am to 1 pm) of Peak Period 3 could be substituted for the evening peak in areas where morning peaks are critical (e.g., Vancouver Island). Exhibit 5.4 shows the reductions as average value over the peak period, defined relative to the Reference Case.

[12] Opportunities related to increasing self-generation through the consumption of additional fuel were not considered.

Exhibit 5.4: Industrial Peak Load Reduction (Peak Period 2) from Electric Energy Savings and Capacity-Only Measures – Reference Case vs. Achievable Potential for the Total BC Hydro Service Area

Industrial Sector Average Load (MW)			Peak Load Reduction from Electric Energy Savings (MW/Yr.)		Peak Load Reduction from "Capacity Only" Measures (MW/Yr.)	
Milestone Year	**Base Year**	**Reference Case**	**"Upper" Achievable**	**"Lower" Achievable**	**"Upper" Achievable**	**"Lower" Achievable**
F2006	3,022	3,022				
F2011		3,243	184	81	332	201
F2016		3,323	377	162	457	290
F2021		3,479	580	254	528	339
F2026		3,637	784	345	579	374

Note: Electric peak load reductions from electric energy savings and from capacity-only measures are not directly additive. For example, if the electric peak load reductions due to electric energy efficiency measures applied to industrial process applications provide a 5% savings, the capacity-only measure for electric peak reductions should be discounted by that same 5% to reflect the new lower consumption level. Further detail is provided in the main body of the Industrial sector report.

Highlights of the Peak Load Reductions shown in Exhibit 5.4 are presented below:

- In the Base Year F2006, the peak load for BC Hydro's total Industrial sector was approximately 3,022 MW for Peak Period 2.

- In the absence of new DSM initiatives, the study estimates that the Industrial sector peak load in Peak Period 2 will grow to about 3,637 MW by F2026, an increase of about 20%.

- Electric energy savings would provide peak load savings of approximately 784 to 345 MW during Peak Period 2 by F2026 in, respectively, the Upper and Lower Achievable Potential scenarios.

- Capacity-only measures would provide peak load reductions of approximately 579 to 374 MW by F2026 in, respectively, the Upper and Lower Achievable Potential scenarios. The most significant Achievable Savings opportunities were from storable / deferrable production measures or those that involved load curtailment over specified time periods.

5.4 ADDITIONAL INFORMATION

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

- *The Potential for Electricity Savings through Technology Adoption, 2006-2026 – Industrial Sector in British Columbia*

6. CUSTOMER-SUPPLIED RENEWABLE ENERGIES

This component of CPR 2007 addressed a selected number of small-scale customer-supplied renewable energies (CSRE) that were identified in consultation with BC Hydro and External Review Panel members. They include: solar photovoltaic (PV), wind electric, micro-hydro, solar hot water and space heating and biomass space heating systems.

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 BC Hydro grid. Specific system size assumptions are defined in the main CSRE report, which is identified at the end of this section.

The Sheltair Group Inc. conducted the research, modelling and analysis of the CSRE technologies, with the assistance of Marbek Resource Consultants and Intellergy.

6.1 APPROACH

The CSRE 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 CSRE 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 above (*Major Analytic Steps and Definitions*). Specific procedures for the CSRE options were as follows:

- Step 1: Select candidate CSRE technologies.
- Step 2: Define “typical” small-scale applications.
- Step 3: Estimate B.C. resource potential for each CSRE.
- Step 4: Model the potential energy production for each CSRE.
- Step 5: Establish the current cost and performance data for each CSRE.
- Step 6: Calculate the levelized cost of energy production for each CSRE technology.
- Step 7: Estimate Technical and Economic Potential for each CSRE technology.
- Step 8: Estimate Achievable Potential for the CSRE technologies.

6.2 SUMMARY OF ELECTRIC ENERGY SAVINGS

A summary of the potential levels of savings in purchased electric energy provided by the CSRE technologies is presented in Exhibit 6.1. The results shown in Exhibit 6.1, net of any double counting of results, are included in the combined savings levels presented previously in Section 2.

As illustrated in Exhibit 6.1, by F2026, potential reductions in purchased electricity from the use of CSRE technologies were estimated to be approximately 410 GWh/yr for the Upper Achievable Potential scenario and about 100 GWh/yr for the Lower Achievable Potential scenario. These savings were roughly equally divided between the Residential and Commercial sectors.

In the Residential sector, small-scale CSRE technologies would provide between 203 GWh/yr and 50 GWh/yr of electricity by F2026 in, respectively, the Upper and Lower Achievable Potential scenarios. In the Commercial sector, small-scale CSRE technologies would provide between 206 GWh/yr and 52 GWh/yr of electricity by F2026 in, respectively, the Upper and Lower Achievable Potential scenarios.

Exhibit 6.1: Summary of Annual Electric Energy Savings from Customer-supplied Renewable Energies (GWh/yr)

CSRE Technology	Milestone Year							
	F2011		F2016		F2021		F2026	
	Upper Achievable	Lower Achievable	Upper Achievable	Lower Achievable	Upper Achievable	Lower Achievable	Upper Achievable	Lower Achievable
Photovoltaic	*	*	*	*	*	*	375	86
Wind	*	*	*	*	*	*	*	*
Micro-hydro	*	*	*	*	*	*	*	*
Solar Thermal/ DHW	1	0.5	2	1	2.5	1.5	4	2
Biomass	7.5	3.75	15	7.5	22.5	11.25	30	15
Total	8.5	4.25	17	8.5	25	12.75	409	102

* Denotes a small but non-zero value

Selected highlights are presented below:

- The study concluded that solar PV electric represents the most significant opportunity for small-scale CSRE. At the time of this study, none of the solar PV electric technologies passed the economic screen. However, PV technology improvements and cost reductions are expected over the 20-year study period. Consequently, for the purposes of this study, it was assumed that PV systems would become economic in the last quarter of the study period. The study did not attempt to predict any large step-type advancements in technology or changes in price.

- Solar space heat and hot water systems are both estimated to have small potential over the study period; however, only solar thermal systems with collector areas greater than 100 m^2 currently meet the study's economic criteria. In contrast to solar PV electric, these technologies are relatively mature and, therefore, only modest performance and cost improvements were assumed over the study period.

- Biomass space heating systems are estimated to have the potential to save 30 GWh/yr over the study period and are economic today.

6.3 SUMMARY OF ELECTRIC PEAK LOAD SAVINGS

The CSRE 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 energies are included in the combined peak load savings.

6.4 ADDITIONAL INFORMATION

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

- *The Potential for Electricity Savings through Customer-supplied Renewable Energies, 2006-2026 – Residential and Commercial Sectors in British Columbia*

7. BEHAVIOUR

This component of CPR 2007 addressed the major behaviours that can affect electric energy use and peak loads in B.C.'s Residential and Commercial sectors.[13] These measures represent energy savings realized through the actions (behaviours) of individuals to habitually save energy within their daily routine, without reducing the level of energy service provided (e.g., light levels, space heat temperature, size of home, etc.).

For the Residential sector, these focus on the actions that all household members can take to reduce electricity consumption without affecting their quality of life. For the Commercial sector, they focus on the activities that employees can take in their daily routines that will reduce electricity consumption but not productivity.

There are a wide range of possible behaviours that residents and employees can undertake to reduce the usage of electricity in buildings. The project started with a long list of possible behaviours, which were narrowed down through consultation with BC Hydro (including both the CPR team and the residential and commercial marketing managers) and with the External Review Panel (ERP) members. CPR 2007 considers 25 behaviours that affect the major end uses in the Residential sector and 15 in the Commercial sector.

Cullbridge Marketing and Communications conducted the research and analysis with the assistance of Habart and Associates Consulting Inc., Lutzenhiser Associates, Ghoulem Research and Marbek Research Consultants.

7.1 APPROACH

The behaviour measures were modeled using a custom Excel-based model that was developed specifically for CPR 2007. The potential contribution of behaviour 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.

Peak load reductions were modeled using Applied Energy Group's Cross-Sector Load Shape Library Model (LOADLIB).

The major steps in the general approach to the study are outlined in Section 1.4 above (*Major Analytic Steps and Definitions*). Specific procedures for the Behaviour options were as follows:

- Step 1: Select candidate behaviour measures.
- Step 2: Develop baseline of participants for selected behaviours.
- Step 3: Develop estimates for waste energy services.
- Step 4: Develop unbundled/Economic Potential for energy.
- Step 5: Develop unbundled/Economic Potential for capacity.
- Step 6: Develop Achievable Potential.

[13] CPR 2007 did not consider the Industrial sector as it was agreed that changes in the usage of equipment in this sector would be under management control and hence would be considered as operation and maintenance (O&M).

7.2 ELECTRIC ENERGY SAVINGS

A summary of the levels of annual electricity consumption contained in each of the Residential and Commercial sector forecasts addressed by CPR 2007 is presented in Exhibits 7.1 and 7.2. The results shown in Exhibits 7.1 and 7.2, net of any double counting of results, are included in the combined savings levels presented previously in Section 2. Further discussion is provided in the paragraphs below.

In the Residential sector, the Upper and Lower Achievable Potential for electrical efficiency behaviours would provide between 1,377 GWh/yr and 720 GWh/yr of electricity savings by F2026. Behaviours related to computers, domestic hot water use, lighting and space heating showed the greatest potential for electricity savings.

In the Commercial sector, the Upper and Lower Achievable Potential for electrical efficiency behaviours would provide between 548 GWh/yr and 410 GWh/yr of electricity savings by F2026. Behaviours related to lighting and plug loads showed the greatest potential for electricity savings.

Exhibit 7.1: Summary of Forecast Results for Behaviour Measures – Annual Electric Energy Consumption, Residential Sector

Annual Consumption (GWh/yr.)					Potential Annual Savingss (GWh/yr.)	
Milestone Year	Base Year	Reference Case	Achievable Behaviour Upper	Achievable Behaviour Lower	Achievable Behaviour Upper	Achievable Behaviour Lower
F2006	16,106	16,106				
F2011		17,843	17,541	17,717	302	126
F2016		19,359	18,709	18,996	650	363
F2021		20,821	19,813	20,257	1,008	564
F2026		22,156	20,779	21,436	1,377	720

Exhibit 7.2: Summary of Forecast Results for Behaviour Measures – Annual Electric Energy Consumption, Commercial Sector

Annual Consumption (GWh/yr.)					Potential Annual Savingss (GWh/yr.)	
Milestone Year	Base Year	Reference Case	Achievable Behaviour Upper	Achievable Behaviour Lower	Achievable Behaviour Upper	Achievable Behaviour Lower
F2006	13,100	13,100				
F2011		14,909	14,809	14,871	100	38
F2016		16,775	16,610	16,692	165	83
F2021		18,230	17,923	18,028	307	202
F2026		19,691	19,143	19,281	548	410

7.3 SUMMARY OF PEAK LOAD SAVINGS

Exhibits 7.3 and 7.4 provide a summary of the peak load savings impacts that would result from the electric energy savings provided by each of the behaviours in the Residential and Commercial sectors.[14] For the purpose of this summary, the results of Peak Period 1 are highlighted below; details for the other three peak periods are provided in the main body of the Behaviour report. In each case, the reductions are an average value over the peak period and are defined relative to the Reference Case.

Exhibit 7.3: Electric Peak Load Reductions (MW), Peak Period 1 Upper and Lower Achievable Scenarios – Residential Sector

Service Region	Milestone Year	Potential Peak Load Savings from Electric Energy Savings (MW)	
		Upper Achievable	Lower Achievable
Total BC Hydro	F2011	68	28
	F2016	145	81
	F2021	225	126
	F2026	308	161

Exhibit 7.4: Electric Peak Load Reductions (MW), Peak Period 1 Upper and Lower Achievable Scenarios – Commercial Sector

Service Region	Milestone Year	Potential Peak Load Savings from Electric Energy Savings (MW)	
		Upper Achievable	Lower Achievable
Total BC Hydro	F2011	25	10
	F2016	41	21
	F2021	77	51
	F2026	138	103

As illustrated in the preceding exhibits:

- In the Residential sector, customer behaviours that result in electric energy savings would provide peak load savings of approximately 308 to 161 MW during BC Hydro's Annual System Peak Hour by F2026 in, respectively, the Upper and Lower Achievable Potential scenarios.

- In the Commercial sector, customer behaviours that result in electric energy savings would provide peak load savings of approximately 138 to 103 MW during BC Hydro's Annual System Peak Hour by F2026 in, respectively, the Upper and Lower Achievable Potential scenarios.

[14] Capacity-only peak load reduction measures (as opposed to energy savings) for the Residential and Commercial Sectors are assessed in two 2007 Conservation Potential Review reports: *The Potential for Electricity Savings through Technology Adoption, 2006-2026; Residential Sector in British Columbia* and *The Potential for Electricity Savings through Technology Adoption, 2006-2026; Commercial Sector in British Columbia.*

7.4 ADDITIONAL INFORMATION

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

- *The Potential for Electricity Savings through Technology Adoption, Behavioural Changes and Customer-supplied Renewable Energies, 2006-2026 – Residential, Commercial and Industrial Sectors in British Columbia*

- *The Potential for Electricity Savings through Technology Adoption, 2006-2026 – Residential Sector in British Columbia*

- *The Potential for Electricity Savings through Technology Adoption, 2006-2026 – Commercial Sector in British Columbia*

8. LIFESTYLE

This component of CPR 2007 addresses the potential for lifestyle changes that could result in reductions in electricity consumption. In contrast to the behaviour changes presented in the preceding section, the lifestyle component includes changes that affect the amount of energy service provided (e.g., the amount of lighting used or the size of home).

CPR 2007 focused on electricity use in the Residential sector as this is where the majority of decisions about the lifestyle of B.C. residents take place. The analysis was divided into two components:

- **Neighbourhood Design and Housing**, including where people live (dwelling types, neighbourhood patterns and designs), where they work (job location and building types) and how they get around (transportation options)

- **Energy Choices in the Home,** including the types of appliances, electronics and leisure products people have and how they use them and how they manage the heating and cooling of their homes

Envision Sustainability Tools Inc. conducted the research and analysis with the assistance of Ghoulem Research and Marbek Research Consultants.

8.1 APPROACH

The lifestyle analysis was modelled using two linked models: MetroQuest and RSEEM (Residential Sector End Use Model), which is the same model used to analyze the impacts of technology changes in the Residential sector (presented in Section 3 of this report). MetroQuest, jointly developed by the University of British Columbia and Envison Sustainability Tools Inc., is an integrated GIS modelling framework that allows communities to simulate long-range scenarios for land use, transportation, housing, environmental management and economic development.

Peak load reductions were modeled using Applied Energy Group’s Cross-Sector Load Shape Library Model (LOADLIB).

The major steps in the general approach to the study are outlined in Section 1.4 above (*Major Analytic Steps and Definitions*). Specific procedures for the lifestyle options included the preparation of three potential future scenarios. They are:

The Housing Scenario – This scenario presents a vision for the next 20 years in which B.C. makes changes towards smart growth and sustainable community design. In terms of electricity use, the scenario focuses on wide-scale changes to the types of housing that are developed to meet the demand of a growing and changing population. A sampling of community plans from communities throughout B.C. moving towards sustainability was used as guidance to estimate the magnitude of changes that might be possible to 2026. Note that these communities are amid the early transitioning stages. Progress lags considerably when compared to established sustainable communities in Europe.

The Lifestyle Scenario – This scenario focuses on changes that B.C. residents could make to their lifestyles in the home. The scenario focuses on end uses and measures that were evaluated to have the greatest potential for changes in lifestyle that could reduce electricity use most significantly. This scenario considers 21 lifestyle measures in the following six categories: space heating and cooling, domestic hot water (DHW), major appliances, household electronics, lighting and hot tubs. This alternative assumes no changes in the housing stock relative to the Reference Case to allow for the independent evaluation of the impacts of these lifestyle changes. Where available, data from B.C. and other jurisdictions were used to estimate the magnitude of lifestyle changes that might be realizable by F2026. Where reliable information was not available, conservative estimates were used.

The Housing and Lifestyles Scenario – This scenario combines the changes proposed to the housing stock associated with the Housing Scenario with the changes in end-use activity in homes associated with the Lifestyles Scenario. This scenario is presented to summarize the total savings that may be achieved if these lifestyle changes occurred.

8.2 SUMMARY OF ELECTRIC ENERGY SAVINGS

A summary of the levels of annual Residential sector electricity consumption contained in each of the three Lifestyle scenarios noted above is presented in Exhibits 8.1 and 8.2.

- Exhibit 8.1 shows the forecast electricity consumption for the Reference Case and the three scenarios by milestone year

- Exhibit 8.2 presents electricity savings by major end use category for the three scenarios relative to the Reference Case.

It should be noted that the results shown are not included in the combined savings levels presented previously in Section 2. As noted previously, the Lifestyle changes would fundamentally change the BC Hydro load forecast and have not been included in the combined total presented in this report as they are not directly additive and there is currently no existing methodology to combine them. In addition, it is recognized that BC Hydro's experience in this area and potential role relative to these savings is considerably different than in the Analysis Areas included. Further discussion is provided in the paragraphs below.

Exhibit 8.1: Forecast Electricity Consumption for the Reference Case and the Three Lifestyle Scenarios by Milestone Year

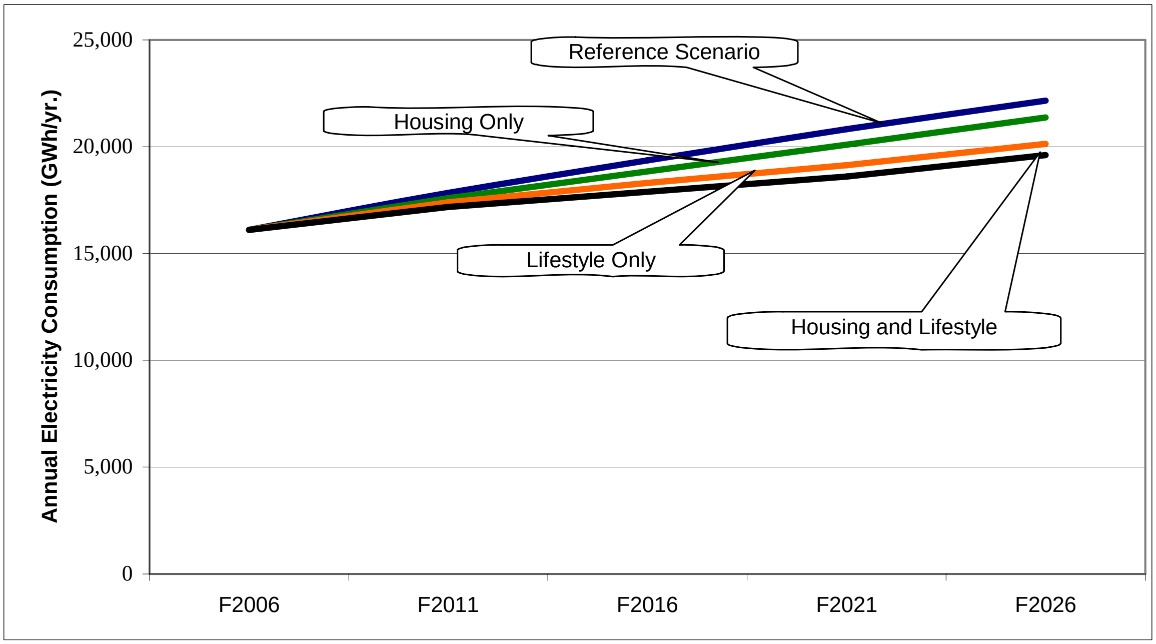
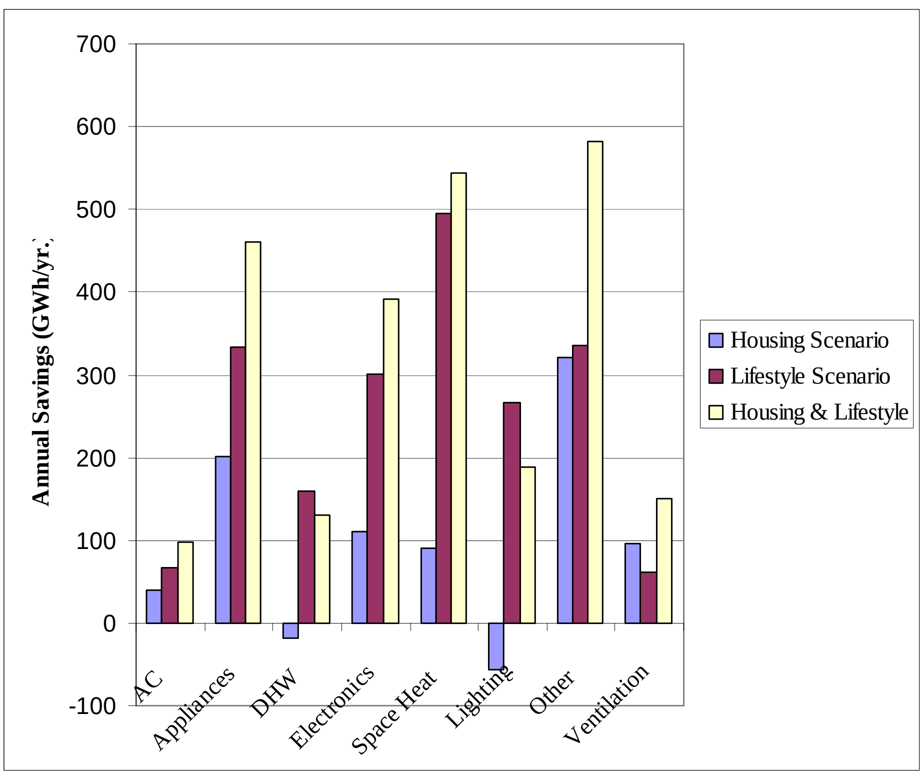


Exhibit 8.2: Estimated Electricity Savings in F2026 for the Three Lifestyle Scenarios Relative to Reference Case by End-Use Category



Selected highlights are provided below:

- The three scenarios each result in total electricity savings in each Milestone Year relative to the Reference Case. The Housing Scenario resulted in the most modest savings, totalling 786 GWh/yr by F2026. The Lifestyle Scenario resulted in significantly more savings, totalling 2,017 GWh/yr. The combined Housing and Lifestyle Scenario resulted in the most savings totalling 2,545 GWh/yr by F2026.

- The savings in space heating were significant as a result of the measures taken in the Lifestyle Scenario. These changes also applied to the combined Housing and Lifestyle scenario. It was anticipated that the movement toward more compact housing associated with the Housing Scenario would result in significant reductions in space heating. While there were significant savings as a result of less floor areas required to be heated and more housing with shared walls (apartments, duplexes, row housing), these were offset by shifts towards more housing using electricity as a primary source for heating. These shifts occurred due to the large share of apartments that use electricity as a primary source for heating compared to single-family houses, which more heavily favour gas as a source.

- The domestic hot water (DHW) and lighting end uses both showed increased electricity use in the Housing Scenario relative to the Reference Case. DHW was found to increase as a result of an increase in the share of homes using electricity as a source for DHW. This shift follows from the changes to space heating described above since dwellings using electricity as a primary source for heating are more likely to use electricity for water heating. The shift towards compact housing, therefore, resulted in more water being heated using electricity and negative savings in this area. The negative savings in lighting for the Housing Scenario were due to a shift towards more apartment housing and the high use of lighting in apartment common areas. Apartments typically use lighting 24 hours per day in hallways, stairwells, lobbies and parking areas. The result is, on average, more electricity use for lighting for apartment units compared to single family houses on a per unit basis. The shift towards more compact housing, therefore, led to modest increases in total lighting electricity use.

8.3 SUMMARY OF ELECTRIC PEAK LOAD SAVINGS

Exhibit 8.3 provides a summary of the peak load savings impacts that would result from the electric energy savings provided by each of the Lifestyle scenarios.[15] For the purpose of this summary, the results of Peak Period 1 are highlighted below; details for the other three peak periods are provided in the main body of the Lifestyle report, as listed at the end of this section. In each case, the reductions are an average value over the peak period and are defined relative to the Reference Case.

[15] Capacity-only peak load reduction measures (as opposed to energy savings) for the Residential and Commercial Sectors are assessed in the 2007 CPR report: *The Potential for Electricity Savings through Technology Adoption, 2006-2026; Residential Sector in British Columbia*.

Exhibit 8.3: Electric Peak Load Reductions (MW) for Peak Period 1 Housing Scenario, Lifestyle Scenario, and Housing and Lifestyle Scenario

Service Region	Milestone Year	Scenario		
		Housing Scenario	Lifestyle Scenario	Housing and Lifestyle Scenario
Total BC Hydro	F2011	63	117	174
	F2016	134	294	404
	F2021	188	489	629
	F2026	195	587	717

8.4 ADDITIONAL STUDY FINDINGS

The study also evaluated the Housing Scenario using the MetroQuest simulation model. The results are presented in Appendix E of the main Lifestyles report. The study found that shifts towards sustainable communities and smart growth lead to electricity savings as well as a wide variety of other community and sustainability benefits including:

- Reduced urban sprawl, leading to lower infrastructure costs and a reduction in costs to the tax payer
- More efficient transportation systems in general, leading to reduced traffic congestion, greenhouse gas emissions and local air pollution
- Conservation of open space and agricultural land
- Reduced ecological footprint

Finally, this study concludes with an evaluation of the most appropriate roles for BC Hydro in influencing lifestyle changes to conserve electricity. The study concludes that while the conservation potential from lifestyle change is significant, many of the decision-making and influencing factors in the most promising areas will require BC Hydro to adopt a different role, recognizing that partnerships or synergies with other organizations may be the most effective strategy. The study outlines some initial thoughts on what form this may take; however, additional investigation into this area is warranted.

8.5 ADDITIONAL INFORMATION

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

- *The Potential for Electricity Savings through Lifestyle Changes, 2006-2026 – Residential Sector in British Columbia*

- *The Potential for Electricity Savings through Technology Adoption, 2006-2026 – Residential Sector in British Columbia*

9. FUEL SWITCHING

The fuel-switching component of CPR 2007 analyzed all commercially available natural gas technologies that can be substituted for electrical models in the Residential, Commercial and Industrial sectors.

The analysis of fuel-switching options was organized and reported separately for each of the three sectors. In each case, the research, modelling and analysis was undertaken by the same consultant teams that completed the electric energy and peak load savings assessment. Marbek Resource Consultants served as the lead consultant for the Residential and Commercial sectors; Willis Energy Services Ltd. led the Industrial sector analysis.

9.1 APPROACH

The detailed end-use analysis of fuel-switching options was conducted using the same sector models, the same definitions of sub sectors and end uses and the similar major analytic steps as were used in the electric energy and peak load savings analysis, which are reported in Sections 3, 4 and 5 of this report.

The main difference from the electric energy and peak load savings analysis is that this component of CPR 2007 assessed fuel-switching measures. Another key difference is that the 50% adder has not been added to the energy reference price. This is because the methodology for the analysis is different. In the analysis of core technologies, the Economic Screen is used to screen technologies and capture future opportunities above the current avoided cost of electricity. When analysing the Fuel Switching potential, the avoided cost of electricity is used to determine any applicable changes in operating costs from the perspective of both society and the customer.

In the Residential and Commercial sectors the analysis included measures such as switching space and water heating as well as selected appliances from electricity to natural gas. The Industrial sector analysis assessed measures such as the replacement of electric motors with natural gas engines in the cooling and refrigeration, pumps and compressed air end uses, and more.

The study conducted an economic analysis of fuel-switching measures using both Current and High natural gas supply cost forecasts.

9.2 SUMMARY OF ELECTRIC ENERGY SAVINGS

A summary of the levels of annual electricity consumption contained in each of the forecasts addressed by CPR 2007 is presented in Exhibits 9.1 and 9.2, by Milestone Year for, respectively, the Current and High natural gas supply cost forecasts and discussed briefly in the paragraphs below. The results are presented for the three sectors combined.

Exhibit 9.1: Current Natural Gas Supply Cost Forecast

Annual Consumption (GWh/yr.)						Potential Annual Savingss (GWh/yr.)		
Milestone Year	Base Year	Reference Case	Economic	Achievable		Economic	Achievable	
				Upper	Lower		Upper	Lower
F2006	F2016	51,016						
F2011		56,263	52,099	56,263	56,263	4,164	0	0
F2016		60,323	55,126	60,323	60,323	5,197	0	0
F2021		64,548	58,446	64,548	64,548	6,102	0	0
F2026		68,665	61,991	68,665	68,665	6,674	0	0

Exhibit 9.2: High Natural Gas Supply Cost Forecast

Annual Consumption (GWh/yr.)						Potential Annual Savingss (GWh/yr.)		
Milestone Year	Base Year	Reference Case	Economic	Achievable		Economic	Achievable	
				Upper	Lower		Upper	Lower
F2006	F2016	51,016						
F2011		56,263	54,845	56,263	56,263	1,418	0	0
F2016		60,323	58,067	60,323	60,323	2,256	0	0
F2021		64,548	61,623	64,548	64,548	2,925	0	0
F2026		68,665	65,372	68,665	68,665	3,293	0	0

Highlights of the information presented in Exhibits 9.1 and 9.2 are presented below.

Total electric energy savings from fuel-switching measures that passed the Economic screen would be between 6,670 GWh/yr and 3,293 GWh/yr in F2026, respectively, under the Current and High natural gas supply cost forecasts. At the level of individual sector,

- The Residential sector would provide between 2,390 GWh/yr and 2,090 GWh/yr in F2026, respectively, under the Current and High natural gas supply cost forecasts.
- The Commercial sector would provide between 991 GWh/yr and 979 GWh/yr in F2026, respectively, under the Current and High natural gas supply cost forecasts.
- The Industrial sector would provide between 3,290 GWh/yr and 222 GWh/yr in F2026, respectively, under the Current and High natural gas supply cost forecasts. The large difference in Industrial sector results for the two supply cost forecasts is because, under the High supply cost forecast, only one measure (natural gas process heat for the Heavy Manufacturing sub sector) passed the measure economic screen test and only at the time of equipment replacement.

Study team members, including those from the consultant team, BC Hydro and the External Review Panel, reviewed the results of the fuel-switching Economic Potential forecasts. Based on the results of that review, there was consensus that none of the fuel-switching measures included in either of the two Economic Potential forecasts provided a practical opportunity for BC Hydro to pursue as part of its DSM initiatives. Hence, there was no Achievable Potential for fuel switching under either of the supply cost forecasts.

This somewhat contradictory result (i.e., measure passes the economic screen but has excessively long payback period)[16] is explained by the large discrepancy between the wholesale and retail prices for natural gas and electricity. Exhibit 9.3 illustrates the gap between the retail price and wholesale prices. As illustrated in Exhibit 9.3, the currently forecast wholesale price of natural gas is 25% of that for electricity. This large cost difference is sufficient to bridge the typical end-use efficiency gap between electric and natural gas measures. However, the retail price of natural gas is about 76% of the retail price of electricity, which when combined with changes in efficiency, equipment capital and operating costs is not sufficient to close the price gap.

Exhibit 9.3: Sample Comparison of Retail and Wholesale Energy Price Forecast, Commercial Sector

Fuel	Commercial Sector	
	Retail Price ($/kWh)	Supply Cost ($/kWh)
Electricity	$0.0561	$0.0880
Natural Gas - Current Cost Forecast	$0.0427	$0.0220
Natural Gas: Electricity Ratio	76%	25%

The results noted above have important implications for the Achievable Potential portion of this study. More specifically, the results mean that for BC Hydro to promote fuel-switching measures to their customers, there would need first to be a mechanism (e.g., a rate change) that permanently closed the retail price gap between natural gas and electricity.

The study team did recognize that some customers may still choose to invest in the fuel-switching measure for non-financial reasons (i.e., non-energy benefits). Two frequently cited examples of these non-energy benefits include the faster heat recovery times for natural gas water heaters than for electric models and the premium cooking characteristics of natural gas ranges. However, the inclusion of non-energy benefits is outside the current study scope.

The sector-specific Fuel Switching reports provide additional details on the assessment of the fuel-switching measures and the reasons that the long measure payback periods exist despite the fact that several fuel-switching measures pass the economic screen.

9.3 SUMMARY OF ELECTRIC PEAK LOAD SAVINGS

None of the fuel-switching options provided Achievable electric energy savings and therefore, have no associated electric peak load savings. Fuel switching was not assessed as a capacity-only peak load reduction option.

[16] As is outlined in the full reports, retail prices are used to calculate simple payback (i.e., the customer's perspective) and the supply costs are used to calculate the economic screen.

9.4 ADDITIONAL INFORMATION

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

- *The Potential for Electricity Savings through Fuel Switching, 2006-2026 – Residential Sector in British Columbia*

- *The Potential for Electricity Savings through Fuel Switching, 2006-2026 – Commercial Sector in British Columbia*

- *The Potential for Electricity Savings through Fuel Switching, 2006-2026 – Industrial Sector in British Columbia*

10. RECOMMENDATIONS

Throughout the conduct of CPR 2007 a number of suggestions emerged from those involved with the study that could improve the next CPR. A summary is listed below.

- The Behavioural and Lifestyle components of CPR 2007 represented a scope expansion from the previous CPR 2002. Over the course of the study, particularly as the combined results were being prepared, it became evident that these components could have a critical contribution to achieving greater levels of energy savings. Given this recognition, the following related recommendations are provided to BC Hydro for consideration.

  Recommendation 1: BC Hydro should investigate a multi-stakeholder sustainability partnership with a range of B.C. groups. The proposed partnership would have a broad sustainability mandate that would include electricity, but not be limited to it alone. The group could work to further refine the definition of "Lifestyle" and ensure that there is sufficient research and data in place to better inform the next CPR.

  Recommendation 2: BC Hydro should conduct community visioning exercises focussed on energy-related choices in 10, or more, regions throughout B.C. The data from this community engagement process would be designed to fit directly into both the Lifestyle and the Behaviour components of the next CPR.

  Recommendation 3: Consideration should be given to integrating the Lifestyle component into the combined results for the next CPR.

- CPR 2007 also included a more detailed examination of capacity effects and measures than in previous CPRs. Given this additional emphasis, the following related recommendations are provided to BC Hydro for consideration.

  Recommendation 4: BC Hydro should begin studies to develop baseline end use and process load profiles via load modeling, simulations and/or end use data collection. Segmentation by key factors, including sector, building types, weather and region should be included.

  Recommendation 5: Pilot studies on programs should be designed to both collect baseline load profiles and DSM measure load profiles (where different) on targeted end uses, as well as program-related issues (costs, benefits, customer acceptance, technical barriers, etc.). These would provide both energy and capacity/peak reduction (full load profile) effects.

  Recommendation 6: Additional research on demand response measures and peak reduction technologies should be assembled to better inform BC Hydro and provide input into the next CPR.

- As in the previous CPRs the largest contribution to the identified savings potential contained in CPR 2007 continues to come from technology-related measures in the Residential, Commercial and Industrial sectors. Given this recognition, the following related recommendations are provided to BC Hydro for consideration.

    Recommendation 7: In the Residential sector, consideration should be given to addressing First Nations housing separately. This would require that data collection be undertaken in advance of the next CPR.

    Recommendation 8: In the Residential and Commercial sectors, BC Hydro should initiate studies or building surveys that would provide additional data confidence related to operating practices and the penetration of efficient technologies within existing facilities, by sub sector as defined in the next CPR. These data would provide additional confidence in the estimates of remaining energy-saving potential in these facilities.

    Recommendation 9: BC Hydro should consider undertaking more study to understand the viability of higher-cost conservation measures, especially for the Industrial sector. For example, little technical information exists on industrial conservation measures with a cost of conserved energy greater than 7 cents/kWh. Because of the historical low cost of power in B.C., industry and its associated trade allies have not considered higher cost measures to be worth investigating.

    Recommendation 10: BC Hydro should consider undertaking more study to examine the conservation implications of implementing measures on a full-cost basis. As shown in the CPR, energy conservation appears to be achieved more quickly when measures are implemented on a full-cost basis. However, it is not clear that this benefit outweighs the increased level of waste resulting from replacing equipment long before the end of its useful life.

- To further enhance the comprehensiveness and quality of the study, the following recommendations are provided to BC Hydro for consideration.

    Recommendation 11: Consideration should be given to analysis based on multiple reference cases as a result of different lifestyle scenarios. This would allow for a more comprehensive analysis of the conservation potential.

    Recommendation 12: Consider expanding the modelling capacity to include calculations of the total utility investment required to achieve the electricity savings potential outlined over the entire duration of the study period.

    Recommendation 13: Consideration should be given to including the cost of GHG emissions more explicitly throughout the study.

    Recommendation 14: Allow four months to plan the study and an additional 16 months to conduct the study.