Conservation Potential Review 2007: A Beacon for the Future

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ABSTRACT

The Conservation Potential Review (CPR) 2007 is the most comprehensive of any done so far. The results of this study will help to ensure that British Columbia's future energy needs will be met through cost effective and environmentally friendly conservation measures.

This paper presents methodologies and results from a 16 month study which was carried out for BC Hydro by a team of over 30 consultants to assess potential energy and peak demand savings over 20 years from existing technologies, emerging technologies, behavioral changes, lifestyle changes, fuel switching, and customer-supplied renewable energies. Some methodologies, especially around technologies, are well established while others, especially around behaviors and lifestyle are brand new. These results guide strategic planning, program design and the DSM portion of our integrated electricity plan. They will also be used by stakeholder organizations in promoting conservation. The paper also shows how customer groups, first nations, environmental organizations and other stakeholders were able to participate in and even direct parts of the study.

Each utility must make decisions around how much conservation to pursue. Too often this is done without thoroughly establishing how much is available and at what cost. The CPR 2007 estimates that there is enough economic savings potential in B.C. to flatten out our consumption while ensuring economic prosperity. The conservation measures outlined in the CPR 2007 are estimated to require roughly half of the utility investment when compared to the investment required for new supply.

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Introduction

Since the early 1990s, BC Hydro has been carrying out Conservation Potential Review (CPR) studies to determine how much electricity conservation is available in our service area, at what cost, when it will be available, where it will be available and in what sectors, end uses and technologies. BC Hydro continues to pursue conservation as the most cost effective resource option.

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 our Conservation Potential Review 2007(CPR 2007) study that was carried out in consultation with an External Review Panel (ERP), a panel of representatives from community groups, First Nations and customer sectors from across B.C. The study was carried out by a team of about 30 consultants with Marbek Resource Consultants Ltd. being the lead consultant. This study investigated 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 was 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 is 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

BC Hydro serves over 1.7 million people. BC Hydro's various facilities generate between 43,000 and 54,000 gigawatt hours of electricity annually, depending on prevailing water levels.[1] In fiscal 2006, revenue was $4.3 billion, which resulted in a return on equity of 9.26 per cent.[2] British Columbian's enjoy some of the lowest electricity rates in North America paying approximately 6.5 cents per kilowatt-hour due in large part to our hydroelectric heritage resources.

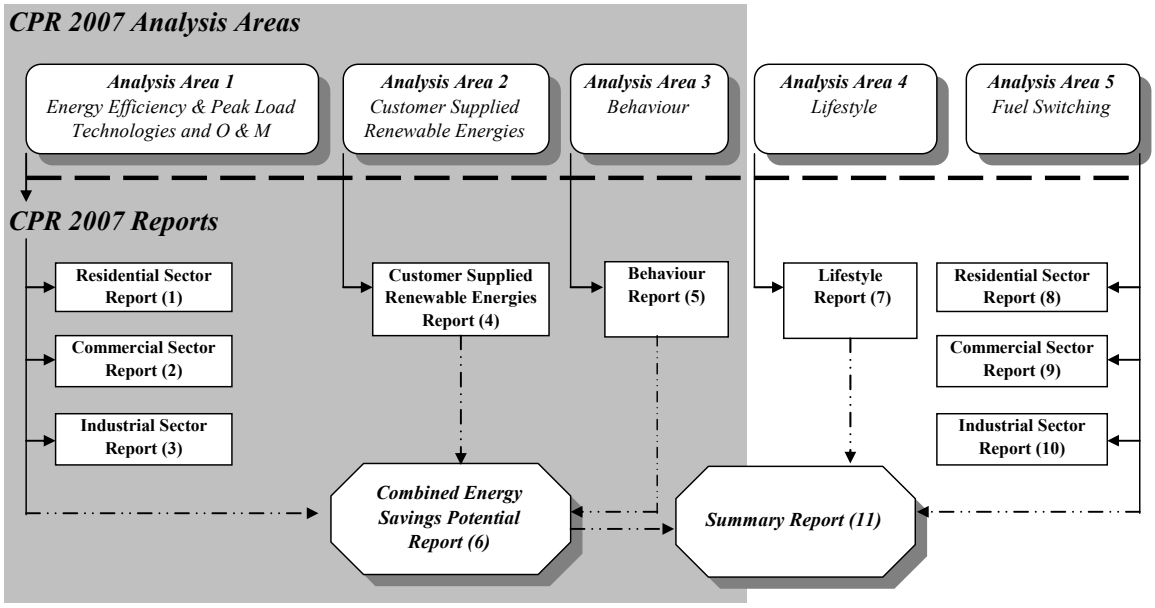
[1] BC Hydro, Quick Facts, http://www.bchydro.com/info/reports/reports921.html, accessed November 18, 2007.
[2] BC Hydro, Quick Facts, http://www.bchydro.com/info/reports/reports921.html, accessed November 18, 2007.

Scope

The scope of CPR 2007 covers a 20-year study period from 2006 to 2026 and includes sector coverage (Residential, Commercial and Industrial) for technology, and operations and maintenance. 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.

The CPR 2007 has been organized into five Analysis Areas. The results are presented in 11 individual reports. Exhibit 1 provides an overview of each Analysis Area.

Exhibit 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. As shown in Exhibit 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. As shown in Exhibit 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. As shown in Exhibit 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.

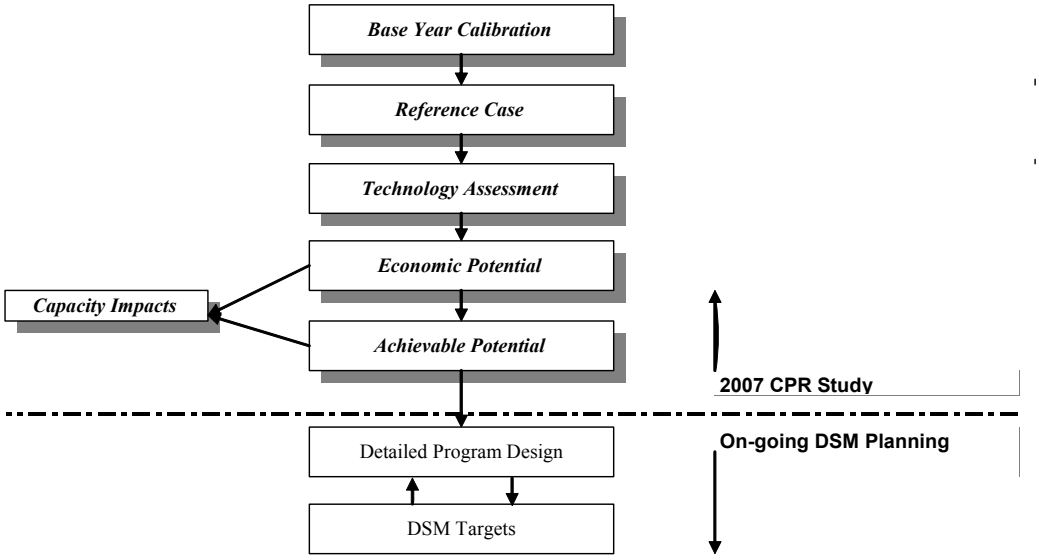
Analysis Area 4 – Lifestyle. This area of the CPR 2007 assesses electricity and peak load reduction opportunities that could be provided by customer choices related to the energy-consuming systems that they purchase or use; e.g., purchasing a refrigerator that is not only efficient but also smaller in size, or purchasing a smaller home.

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.

Methodology

Exhibit 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 2: Study Approach – Major Analytical Steps



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.[3] 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 to be studied.

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 provides the following:

- 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[4]
- An estimate for some "natural" conservation, that is, conservation that occurs without utility programs like Power Smart
- The point of comparison for the calculation of Economic and Achievable electric energy and peak load savings potentials
- The point of comparison for DSM Planning and results

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[5] 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.

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[3] 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.

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

[5] 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. This was calculated from BC Hydro's average real levelized cost to deliver firm energy, using a 50% allowance over current costs to capture future opportunities above the current avoided cost.

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. The capacity economic screen is calculated by adding 50% to the capacity reference price to capture potential future opportunities above the current avoided cost. The capacity economic screen was $170/kW/yr. The electric peak load Economic Potential forecast incorporates all the measures with a CEPR equal to or less than the capacity economic screen.

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 level similar to existing levels. The Upper Achievable Potential assumes that market conditions and government policy are very supportive and that energy savings are aggressively pursued.

Estimates provided were developed in collaboration with BC Hydro 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.

Results

The CPR 2007 estimates that there is enough economic savings potential in B.C. to flatten out our consumption while ensuring economic prosperity. The economic savings amount to 23,000 GWh/yr by 2026, which is more than the incremental load in our load forecast based on a robust economy.

Industry is a particularly significant contributor accounting for almost 45% of the total savings potential. The most significant opportunities are in mechanical pulp refiner projects, pump system upgrades, compressed air system upgrades, fans & blowers system upgrades, and lighting system upgrades. Over half of the savings potential are low cost (Cost of Conserved Energy < $0.04/kWh).

Approximately 34% of the total residential potential was found to be in detached dwellings in the Lower Mainland. The most significant savings came from actions in lighting, space heating, and household electronics and included installing compact fluorescent lamps, reducing standby losses for electronics, and insulating, leak sealing, and installing programmable thermostats.

In the commercial sector, the Lower Mainland represents approximately 67% of total commercial achievable potential. The Office and Retail sub-sector account for approximately 59% of total commercial achievable potential. The vast majority of the savings come from actions in lighting and HVAC.

Results for the combined potential are presented below. The combined potential includes energy savings from technologies, operations and maintenance, behavioural changes, and customer-supplied renewable energies in all three sectors. Not included in the total are energy savings from Lifestyle choices or fuel switching measures as these choices fundamentally alter the Reference Case.

Electric Energy Savings

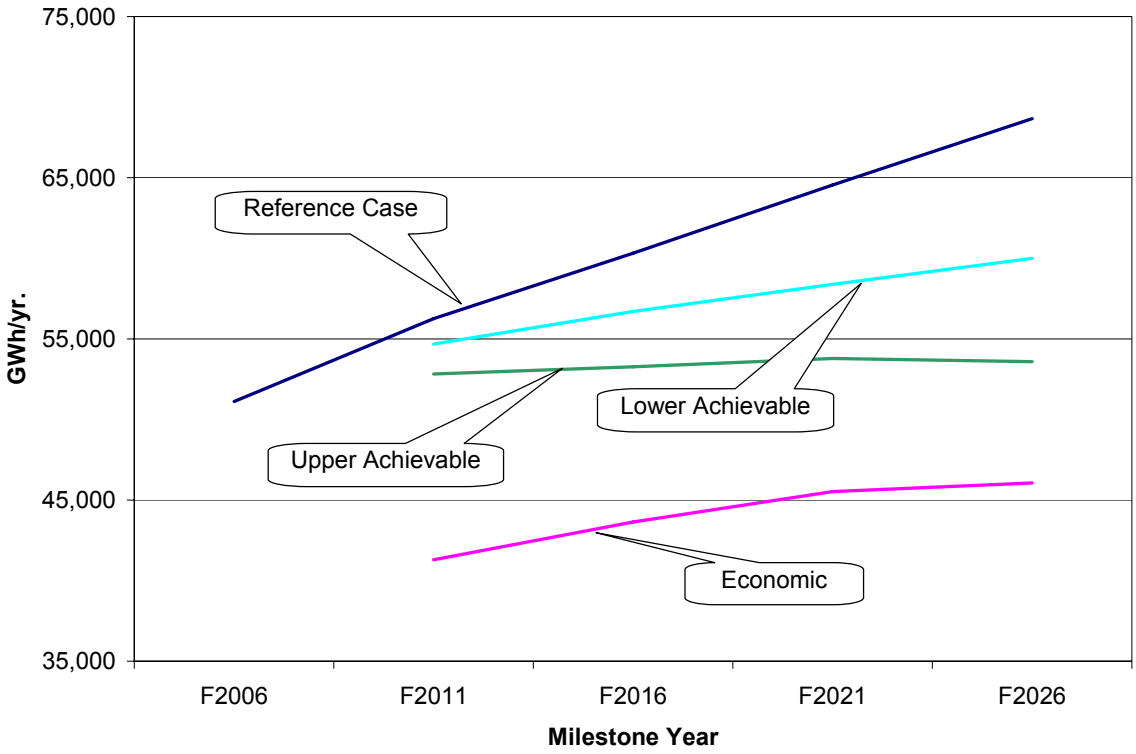
In the Reference Case, total electricity consumption increases from approximately 51,000 GWh/yr in F2006 to about 68,700 GWh/yr by F2026, an increase of about 35%.

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 22% relative to the Reference Case.

Exhibit 3: 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	Reference Case	Economic Combined	Achievable Combined		Economic Combined	Achievable Combined	
			Upper	Lower		Upper	Lower
F2006	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
% of Reference Case					33%	22%	13%

Exhibit 4 Combined Upper and Lower Achievable Electricity Consumption Relative to the Economic Potential and Reference Case for the Total BC Hydro Service Area F2006-F2026



Electric Peak Load Savings

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 900 and 670 MW by F2026 in, respectively, the Upper and Lower Achievable Potential scenarios. The capacity-only results shown in Exhibit 5 do not include industry as the one-hour timeframe defined by Peak Period 1 is not a practical match with the industrial measures.[6]

Exhibit 5: 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) 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	9,653	9,653				
F2011		10,556	621	276	288	165
F2016		11,613	1,168	592	579	399
F2021		11,992	1,729	1,066	790	563
F2026		13,183	2,278	1,415	898	673

Stakeholder Engagement

In the CPR 2007, BC Hydro chose to involve many of the stakeholders who have an interest in the electricity supply for British Columbia. These included representatives of:

- Residential customers
- Industrial customers and their organizations
- Commercial customer groups
- Environmental organizations
- First Nations
- Universities and colleges (both academics and operations)
- Other electric and gas utilities
- Our provincial Ministry of Energy Mines and Petroleum Resources

We had 19 members of the External Review Panel (ERP) who were chosen to represent a broad diversity of views throughout our province. This panel was consultative in nature in that it brought information, ideas, and suggestions to the project. BC Hydro's position was that it would use the input from the panel where possible and appropriate and would explain why when suggestions were not incorporated into the study. Individual panel members determined their own level of involvement according to their

[6] 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.

interest and time available. In most cases there was a high level of interaction at quite a detailed level. Panel members reviewed and commented on all project documents from the initial Request for Proposals on to the final drafts of the 11 project reports. They participated in 6 Workshops and 8 panel meetings over 16 months.

This process proved somewhat onerous to the panel members, BC Hydro Staff and the consultant team. It necessitated the tracking of hundreds of comments and questions from their initiation through to their resolution. It was made especially difficult given the tight timeframe of the study – only 14 months from hiring the consultant to completed reports. While the panel generally made decisions through consensus, given the diversity of interests, this was not always possible.

Although this stakeholder engagement process was onerous, it was also very valuable. It expanded the project scope, brought forth very useful information which wouldn't otherwise been available, led BC Hydro to change its Load Forecast, and provided valuable discussions encompassing a broad cross section of views.

We are now more aware of the concerns of these stakeholder groups and will be better able to address them in our plans. Not the least of the ERP's benefits is that BC Hydro now has a much better informed group of stakeholder and potential interveners in our regulatory processes.

Conclusions and Recommendations

A CPR is an essential step in energy planning. Preparing a plan without doing so makes it impossible to address the question of how much DSM should be included in the energy plan. While such a study may initially appear to be expensive, its cost is a very small fraction of the value gained through being able to optimize an energy plan by including all cost effective DSM.

This study confirmed that the electricity conservation target set out in the BC government's energy plan is achievable. The CPR's results along with other inputs will provide a sound basis for BC Hydro's DSM Plan which, in turn, will feed into the Integrated Electricity Plan (IEP). It is expected that the additional cost- effective conservation found in this study will reduce the cost of the next IEP by hundreds of millions of dollars.

An external stakeholder team, while significantly increasing resource requirements, can be extremely valuable in providing information and diverse views, and in the case of the CPR 2007 demonstrably increasing the quality and value of the study.

Before embarking on a CPR, an internal team of users of the information needs to be formed to ensure it meets all the needs of the corporation. For example, the Marketing department needs detailed information regarding the availability of energy savings in order to design programs, Transmission and Distribution Planning staff need to know what peak reduction is potentially cost effective and available in order to optimize their plans.