The Conservation Potential of Lifestyle Changes

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As utilities and governments continue to explore the potential for conservation, their traditional focus has been on technology options. As part of a comprehensive study recently completed in British Columbia (BC), emphasis was shifted to look beyond technology and instead focus on the potential impacts associated with changes to customer and societal behavior. Given the uncertainties associated with BC's energy future and quantifying behavioral change, two distinct research approaches were applied. First, a conservation assessment based on quantifying energy impacts resulting from customer behavioral activities was completed. The results indicate appreciable energy savings ranging from 5,000 GWH to 15,000 GWH in BC by 2010. A second distinct approach focused on identifying impacts associated with a shift to a society grounded on the principles of sustainable development. Using the results of a recently completed Canadian assessment (Biggs, et al. 1992), energy consumption estimates specific to the province assuming a societal shift to a sustainable development future were developed. These results estimate a decrease in total energy use in BC from 925 petajoules in 1990 to 506 petajoules in 2030 as a result of the societal changes.

Introduction

As part of a collaborative planning effort between BC Hydro and various provincial interest groups, this paper presents the results from a detailed study (BC Hydro, 1994) designed to examine the conservation potential stemming from behavioral and societal changes. The primary objectives of the study include informing provincial decision makers of what is achievable through educating customers and businesses about conservation behavior and energy habits. This analysis is designed to better understand the magnitude of impacts resulting from a sustained proactive campaign to promote behavior and societal change as a tool for conservation and serves to give readers an idea of the types of alternatives available, beyond substantial technology investments, to pursue a path of energy efficiency in the province.

Research Approach

Given the uncertainties associated with projecting British Columbia's energy future and the difficulty in accurately accounting for energy impacts from changes in customer behavior, two distinct analysis approaches were developed. These approaches are described below.

Approach for the Customer Behavior Analysis

The initial analysis was designed to identify the potential for electricity conservation resulting solely from changes in customer behavior. This analysis reflected a year 2010 timeframe and consisted of a number of sequential steps. These are:

1. Identification of behavior responses - a comprehensive list of 154 possible behavior-based customer or business actions was developed. These were developed for each market sector (residential, commercial and industrial) and for all major end uses. The list included actions as simple as closing off vents to unused rooms to encouraging customers to purchase smaller refrigerators/freezers (and rely more on dry and canned goods). An illustrative list of customer actions reflecting space conditioning and water heater end uses is shown in Table 1.

2. Classification of responses - the identified responses were classified into three groups: those which result in minimal, moderate or significant lifestyle impacts. The use of these classifications acknowledges the

Table 1. Illustrative Listing of Residential Behavioral Changes

Sector: Residential

End-Use Response:	**Degree of Life Style Impact**
Space Conditioning	
Shutting off ventilation fans or individual fans when not in room or at home	Minimal
Closing down vents to unoccupied rooms	Minimal
Vacuuming register vents regularly	Minimal
Using hot water bottles in cold weather	Minimal
Dressing appropriately	Moderate
Clearing away obstructions from registers	Moderate
Opening draperies on south-facing windows in winter	Moderate
Using bath/kitchen exhaust fan sparingly in winter	Moderate
Loading room air conditioners on north side of home	Moderate
Closing doors to rooms that are kept cooler than the rest of the house (e.g., bedroom)	Moderate
Closing the fireplace damper when fireplace not in use	Moderate
Drawing window coverings at night to help keep the heat in	Moderate
Setting back temperature at night and when out of the house	Significant
Heating only those portions of the house which are in use	Significant
Moving to appropriately sized (smaller) housing as needs diminish (i.e., empty nesters)	Significant
Water Heating	
Repairing leaky (hot water) faucets immediately	Minimal
Turning off electric water heater when on vacation	Minimal
Not allowing water to run unnecessarily when shaving, washing hands, or brushing teeth	Minimal
Filling up basin to shave or wash hands	Minimal
Filling the sink when hand washing dishes	Minimal
Cleaning out sediment from water heater tank	Moderate
Using short cycles on dishwasher	Moderate
Disconnecting (shutting off if possible) the drying cycle on dishwasher and air dry	Moderate
Using cold water detergents for lightly soiled clothes	Moderate
Setting the water level in the washing machine to suit the size of the load	Moderate
Cutting back on the number of showers and baths	Moderate
Taking shorter and cooler showers	Moderate
Locating water heater near greatest point of use	Significant
Sharing bath and shower water	Significant

experience that customer adoption of these conservation habits vary in accordance with resulting impacts on lifestyle. Those habits which are easy to adopt and sustain over time will likely be more acceptable to customers than those activities which require constant application or greater customer hassle.

3. Development of reduction estimates - energy reduction estimates were developed for each of the behavior changes. Specific reductions were developed from a number of sources including: review of behavioral literature, discussions with key energy experts and engineering estimates. Effort was placed on

accounting for end-use market share and eligibility requirements to address issues of overstating potential and interactive effects.

This approach provided rough estimates of conservation potential by market sector, end use and classification levels. These estimates were subsequently aggregated to provide a comprehensive set of impacts for use in the analysis.

Approach for the Sustainable Society Analysis

The sustainable society analysis was designed to be more comprehensive and examines the conservation potential associated with a societal shift to a path of sustainable development. The societal model used in this analysis was grounded on the principles of human activity in compliance with ecological and socio-political limits and constraints (Robinson, et al. 1990). It was decided that the approach should incorporate the work that has already been completed as part of Canada's Sustainable Society Project (Biggs, et al. 1990). This work included research based on modeling a full range of variables over a planning horizon of 1990 to 2030, including changes to technologies, customer behavior and infrastructure. These variables included activity indicators such as: production levels, employment levels, economic considerations and energy consumption.

A key consideration in applying the results from the Sustainable Society Project was the need to disaggregate the study's Canada-wide impacts to the BC provincial level. This disaggregation approach was based on developing proxies to identify the relative contributions of BC impacts to Canadian national total. For example, the total automobile energy consumption estimated for Canada is disaggregated through the use of current vehicle registration data in BC as a percentage of total Canadian vehicle registration. Specific proxies were established for each major sector. Once all the fractions are applied, an identification of total consumption both in Canada and BC was prepared.

Results

The impacts from both analyses point to the potential for significant reductions in energy consumption. A discussion detailing the results from these two approaches follows:

The Conservation Potential from Customer Behavior

The maximum conservation potential resulting from sustained modifications to customer behavior and energy habits can be significant. Figure 1 illustrates the results of the analysis and presents the energy impacts by sector and lifestyle impact. These results indicate potential savings ranging from 5,700 GWH if all the minimal impact behavioral activities were adopted and increases to approximately 15,440 GWH if all of the measures with significant lifestyle impacts were adopted. Using BC Hydro's 2010 electricity forecast as a reference, the potential savings could provide significant contributions to future utility resource needs.

The data also points to the significant contributions from modifying residential and commercial behavior while the potential in the industrial sector remains limited. In large

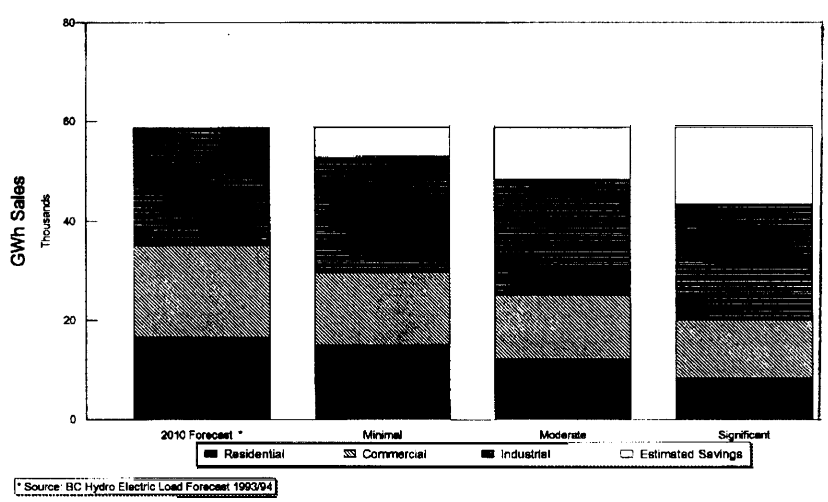

Figure 1. Estimates of Conservation Impacts

part, this reflects the numerous behavioral activities available to the residential and commercial sectors and the barriers associated with identifying conservation habits which do not affect industrial processes.

The Conservation Potential from a Sustainable Development Society

The energy impacts resulting from a societal shift to a sustainable development future can be significant, particularly for certain market sectors. The aggregate results which present total energy consumption by fuel type in both Canada and BC are shown in Table 2. A companion set of results which focuses solely on electricity impacts both in Canada and in BC is also provided. A qualitative depiction of the types of changes and the flavor of personal and business life in the province are described below.

Residential Sector Description. The residential sector will be affected greatly by a movement to halt suburban sprawl and re-focus settlement patterns on "densifying" existing urban areas. As a result, typical homes will be smaller with a greater sense of neighborhood and community. A key activity will be a retrofit upgrade of existing homes to meet higher efficiency levels. Significant changes are also assumed in household appliance choices over the scenario period. This includes increased family sharing of freezers, washers and dryers reflecting the densification strategy, the shift to a shared style of living and an individual desire to maximize usage of appliances.

The results of the data point to significant energy and electricity reductions in BC's residential sector by 2030. Total energy consumption is estimated to decrease from 144 petajoules in 1990 to 56 petajoules in BC in 2030. Similarly, electricity consumption in this sustainable society is estimated to decrease from 49 petajoules in 1990 to 13 petajoules in 2030.

Commercial Sector Description. Commercial life in 2030 under this sustainable scenario will be affected by a number of considerations. It is assumed that absolute labor force levels will remain relatively unchanged. Employees will operate in a shorter work week, leaving time to pursue other education and community interests. Additionally, there will be opportunities to practice telecomrnuting and increase work outside of the office. In general, traditional commercial trade operations are assumed to address a community-based level with smaller stores using less total energy, smaller land needs and reduced parking requirements. Office buildings will also be more energy-efficient despite the continued growth in electric technologies for data processing and communications.

Table 2. Summary of Sector Energy Impacts

Total Energy (Petajoules)

	1990		2010		2030	
	Canada	**BC**	**Canada**	**BC**	**Canada**	**BC**
Residential	1403	144	879	112	437	56
Commercial	1114	114	1022	113	911	102
Industrial	2699	417	2391	300	2065	253
Transportation	1598	250	1046	145	704	95
TOTALS	6814	925	5338	670	4117	506

Total Electricity (Petajoules)

	1990		2010		2030	
	Canada	**BC**	**Canada**	**BC**	**Canada**	**BC**
Residential	461	49	249	29	115	13
Commercial	397	44	360	39	335	36
Industrial	709	99	604	80	478	66
Transportation	3	1	50	6	73	9
TOTALS	1570	193	1263	154	1001	124

The commercial sector results highlight the energy reductions from efficiency improvements in facilities countered with slight energy increases for education and health care services. Additionally, electricity impacts due to increases in computers, data processing and communications technologies all add to consumption. Total commercial sector energy in BC is expected to decrease from 114 petajoules in 1990 to 102 petajoules in 2030. Commercial sector electricity impacts are expected to decrease from 44 petajoules in 1990 to 36 petajoules in 2030.

Industrial Sector Description. The year 2030 sustainable development scenario reflects a continued shift to a more service-oriented society with industries becoming more efficient in the use of materials and labor. Within BC, the fishing, forestry, and mining remain the largest concerns. Within the fishing industry, the sustainable ethic is translated to the regeneration of stocks in the initial years of the scenario period. By year 2010, the fishing industry shifts away from large off-shore fleets to more close-to-shore community fleets. By year 2030, ocean fisheries production is assumed to be restored to 90% of the estimated 1990 capacity. In the forestry industry, the sustainable development orientation points to forest rehabilitation and selective cutting rather than current practices of clear-cutting. The harvesting levels are significantly reduced. The basic mining processes are not assumed to drastically change between 1990 and 2030. Activity levels for base metals (copper, nickel, aluminum) remain fairly constant.

A review of the data results indicates a decrease in energy consumption in BC from 417 petajoules in 1990 to 253 petajoules in 2030. Electricity impacts are shown to decrease from 99 petajoules in 1990 to 66 petajoules in 2030.

Transportation Sector Description. The sustainable development scenario as it addresses the transportation sector possesses the greatest energy- and lifestyle-related changes. The transportation sector, by 2030, is designed to consist of integrated urban-rural communities connected by walking/bicycle paths, light rail lines, waterways and roads. The scenario includes a major shift away from standard combustion engine-driven vehicles to a number of alternative-fueled vehicles such as electric, compressed natural gas, hydrogen- and methanol-fueled cars. The shift away from suburban sprawl and the growth of community-based industries result in minimizing the extent of travel needs. Urban travel is handled by public transit (rail and bus). Bus efficiencies were assumed to increase by 50% and the current diesel bus fleet will gradually shift to methanol- and hydrogen-fueled vehicles.

A review of the data indicates that overall energy dedicated to transportation is expected to decrease significantly. Within the province, total energy is shown to decrease from 250 petajoules in 1990 to 95 petajoules in 2030. Consumption increases are noted for electricity use in the transportation sector in BC reflecting the increase in electric cars and buses.

Implications and Conclusions

This study was designed to be exploratory in nature with a goal of providing a forum to provoke thought and discussion on the appropriate responses and direction needed to better understand the relationship between energy consumption and changes to behavior. It is acknowledged that despite the differences in the two types of research approaches used in this study, the results provide some comparable findings that help address the goal. Most significantly, the results indicate that there is significant potential available through customer and societal behavioral changes and that a conservation focus should look beyond technology options.

In looking at the traditional technological perspective, utility DSM programs have been successful in motivating customers. For example, BC Hydro has programs in place which are forecast to achieve 4400 GWH by 2010 (BC Hydro, 1992). The utility has already acquired 1300 GWH of DSM since the utility's Power Smart program was launched in 1989. More specifically, with high-efficiency motors, BC Hydro achieved a market share of some 70% and has begun to transform the motors market. In the residential sector, the refrigerator program has, in concert with other Canadian utilities and agencies, influenced an improvement in the average specific consumption of refrigerators from less than 4.5 cu. ft./kWh in 1988 to 9.4 cu. ft./kWh in 1994 with just under 11 cu. ft./kWh forecast by 1996 (Sampson, 1993). These successes reflect the utility's ability to promote efficient technologies.

BC Hydro also operates a variety of promotional campaigns intended to motivate customers to modify energy behavior. In Canada these utility campaigns have been complemented by a variety of similar government campaigns which have been run since the 1970s. To date, BC Hydro has not enjoyed the same success with these promotional campaigns as they have with technology-based programs.

As evidence, recent customer segmentation research completed by BC Hydro (Chow, 1993) indicates that, despite current utility efforts to focus on modifying customer behavior as a means of encouraging conservation, there are distinct customer groups who have not changed their behavior or actions. BC Hydro does recognize that information campaigns do assist in the successful delivery of other programs. Still, BC Hydro realizes it may need to look beyond informational efforts to induce and sustain significant levels of resource-conserving behavior. Given that a utility wishes to tap a significant portion of the lifestyle-related conservation resource, there are a number of issues which will need to be resolved, including:

1. What motivates (drivers) and inhibits (barriers) the electricity-consuming behavior of customers?

2. How can utilities design initiatives which can successfully reduce the barriers and enhance the drivers?

3. How do we demonstrate that a behavior change has been motivated by our initiative and how do we measure that change?

Even a casual interpretation of the results indicates that the potential energy impacts resulting from behavioral changes can be significant. The results of this study suggest that there are planning uncertainties regarding the magnitude and reliability of behavioral-based energy impacts. Despite these uncertainties, the magnitude of impacts indicates the importance of including customer behavior as a component of a comprehensive conservation strategy.

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