Evaluation of Energy Efficiency Initiatives in BC

Final Report

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Executive Summary

In 2005, the Ministry of Energy, Mines, and Petroleum Resources (MEMPR) adopted the following six targets for improved energy efficiency in buildings in BC by 2010:

2010 Targets for Improved Energy Efficiency in Buildings in BC

Building Type	2010 Targets
Single Family Detached / Row Housing – Existing	Retrofit 12% of buildings with average savings of 17% per building
Single Family Detached / Row Housing – New	Achieve an EnerGuide for Houses rating of 80 for all new homes
Multi Unit Residential Buildings – Existing	Retrofit 16% of buildings with average savings of 9% per building
Multi Unit Residential Buildings – New	Achieve an average of 25% better than MNECB for all new buildings*
Commercial Buildings – Existing	Retrofit 20% of buildings with average savings of 14% per building*
Commercial Buildings – New	Achieve an average of 25% better than MNECB for all new buildings*

* Targeted savings for existing buildings are relative to a 2001 baseline.

The policies and programs intended to achieve the targets continue to unfold and will be delivered from a variety of agents (e.g. MEMPR, electric and natural gas utilities, municipalities, etc.). In order to assess the success of those diverse policies and programs, and understand overall progress towards the targets, it is critical to have a robust evaluation process in place.

This research follows two complementary evaluation approaches to estimate how much energy has been saved between 2001/2002 and 2005/2006.

- **Decomposition analysis** breaks down overall trends in energy consumption to discern the role that changes in energy intensity and other factors have in causing the overall trend. Because this approach is based on high-level trends, it is useful for understanding the overall direction and drivers of energy use in British Columbia, but does not attribute changes in provincial energy consumption to specific programs.
- **Summation analysis** compiles all of the savings estimates for individual program evaluations to produce an overall energy estimate of the energy savings generated by program activity. Because this approach is based on estimates of energy savings from specific programs, estimates can be made of program effectiveness, but the approach does not allow inferences to be made about overall trends in energy consumption in British Columbia.

Both approaches indicate that the overall targets for energy savings are being met, with the summation approach revealing a total of 5,810 terajoules (TJ) saved between 2001/2002 and 2005/2006 compared to a target of 4,290 TJ. Data from the decomposition approach reveal a similar magnitude in savings, but time lags in data availability prevent 2005/2006 results from being reported. When the individual targets are examined using the summation approach, the available data shows that the targets for existing buildings are being exceeded (5,257 TJ saved versus 2,712 TJ targeted), while the savings in new buildings are falling short of the targets (542 TJ saved versus 1,579 TJ targeted). The decomposition approach is not able to provide this level of resolution.

However, the quality of the data underlying both approaches introduces some significant uncertainty and potential bias that limit the confidence that can be placed in these results. Furthermore, several additional challenges introduce some ambiguities into the evaluation results and limit the transparency of those results. To address some of these concerns in ongoing evaluation efforts, we are recommending MEMPR consider the following improvements to the evaluation of energy efficiency in BC:

Improvements that will help reduce uncertainty and bias in evaluation results:

- Work with NRCan to resolve the irregularities in the commercial sector data.
- Develop and adopt a standard evaluation methodology that can be applied to all energy-efficiency programs by all delivery agents, and ideally be comparable with other jurisdictions.

Improvements that will make the evaluation process more transparent and better aligned with overall MEMPR objectives:

- Define the energy efficiency targets in terms of annual energy savings for partners and evaluators, and link the energy efficiency targets to other goals such as greenhouse gas emission reductions.
- Develop a plan to show how each of the programs are supporting the various targets and how those program by program impacts will combine to help achieve the targets.
- Consider adopting greenhouse gas emissions reduction targets for buildings in BC to complement the energy savings targets already in place.
- Improve the public availability of evaluation results so that interested parties are able to easily access an overall assessment of evaluation efforts in the province and then be linked to more in depth evaluation material if desired.

Improvements that will provide additional evaluation tools to augment the inherent limitations of existing approaches:

- Consider using sampling approaches to evaluation to further improve the ability to evaluate improvements in energy efficiency. These options have only been investigated at a preliminary level at this point, but at a minimum there would appear to be cost-effective opportunities to evaluate improvements in energy intensity for new buildings using a sampling approach.

In addition to these three types of improvements, this research has also provided several additional research questions aimed at helping MEMPR evaluate the targets' suitability and adequacy as support mechanisms for broader societal goals (e.g. greenhouse gas emissions reductions, reduced levels of energy poverty, etc.). The answers to these questions are beyond the scope of this research, but the questions themselves arose frequently enough that they merited introduction in the report.

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Acronyms

AEE....................Association of Energy Engineers
BREDEM……………………………....British Research Establishment Domestic Energy Model
CALMAC ....California Measurement Advisory Council
CBIP....................Commercial Building Incentive Program
CMVP ....Certified Measurement and Verification Professional
DSM....................Demand Side Management
GJ ....Gigajoules
MAESTRO .... Market Assessment and Evaluation State-wide Team of Research Organizations
MEMPR....................Ministry of Energy, Mines, and Petroleum Resources
MNEBC ....Model National Energy Building Code
MURB....................Multi Unit Residential Building
NRCan....................Natural Resources Canada
NYSERDA....................New York State's Energy Research and Development Authority
OFGEM……………………………Office of Gas and Electricity Markets
PJ....................Petajoules
RIM....................Ratepayer Impact Measure
SAP……………………………Standard Assessment Procedure
SFA ....Single Family Attached
SFD ....Single Family Detached
TJ....................Terajoules
TRC....................Total Resource Cost
UC ....Utility Cost

Tables and Figures

Tables

Figures

1 Introduction

In 2005, the Ministry of Energy, Mines, and Petroleum Resources (MEMPR) adopted the six targets for improved energy efficiency in buildings in BC (referred to as "the targets" in the remainder of the report) shown in Table 1.

Table 1 – 2010 Targets for Improved Energy Efficiency in Buildings in BC

Building Type	2010 Targets
Single Family Detached / Row Housing – Existing	Retrofit 12% of buildings with average savings of 17% per building
Single Family Detached / Row Housing – New	Achieve an EnerGuide for Houses rating of 80 for all new homes
Multi Unit Residential Buildings – Existing	Retrofit 16% of buildings with average savings of 9% per building
Multi Unit Residential Buildings – New	Achieve an average of 25% better than MNECB for all new buildings*
Commercial Buildings – Existing	Retrofit 20% of buildings with average savings of 14% per building*
Commercial Buildings – New	Achieve an average of 25% better than MNECB for all new buildings*

* Targeted savings for existing buildings are relative to a 2001 baseline.

The policies and programs intended to achieve the targets continue to unfold and will be delivered through a variety of agents (e.g. MEMPR, electric and natural gas utilities, municipalities, etc.). Seeking to develop a better understanding of progress toward meeting the targets, MEMPR contracted the Pembina Institute and MK Jaccard and Associates to evaluate the existing energy efficiency initiatives in the Province.

In order to assess the success of those diverse policies and programs, and understand overall progress towards the targets, it is critical to have a robust evaluation process in place. California's Evaluation Framework (2004) provides a comprehensive description of how to best evaluate initiatives designed to improve energy efficiency. According to this document,

> *"…the over-arching purpose of evaluation is to help ensure that good decisions are made regarding the investment of energy program resources by providing rigorous, independent evaluation studies and study results."*

Keeping this broad definition in mind, it is clear that a comprehensive evaluation system needs to cut across individual programs and have a presence across the life cycle of different programs. To accomplish this, California's Framework document lays out the main types of evaluation as shown in Table 2. The vertical axis (effects versus process evaluation) describes whether the evaluation is focused on the results of a program (effects) or the explanation of the results (process). The horizontal axis (program versus market evaluations) describes whether the evaluation is focused on an individual program or on a broader cross-section of the market (e.g. new housing or the commercial sector). An additional axis could also be added to show that evaluations should occur in program design (e.g. will this program be cost-effective, what amount of energy savings are expected), during and after program delivery (e.g. is this program generating cost-effective savings, were the expected energy savings achieved). These are typically referred to as ex-ante and ex-poste evaluation.

Table 2 – Four main types of evaluation

	Program Level Evaluations	Market Level Evaluations
Effects Evaluations	Understanding how much energy is being saved by a program and how much those savings are costing.	Understanding how much the market is changing (e.g. 5% reduction in per household energy consumption).
Process Evaluations	Understanding why a program is (or is not) achieving energy savings.	Understanding why the market is (or is not) changing and the ways in which that change is occurring.

Although all of the quadrants in Table 2 are relevant to evaluation efforts in BC, the primary focus of this project falls within the top row of the table (i.e. measuring actual energy savings and costs at a program level and across the market). Ideally, the activities within these quadrants would allow MEMPR to:

1. Understand whether the Province is moving towards the targets at an acceptable pace. For example, based on measurements of progress since the targets were developed, is this progress sufficient to expect that the targets will be met in 2010.
2. Understand how much of the progress towards the targets can be attributed to the various policies, partners and programs implemented throughout BC, and assess whether or not any adjustments are required to ensure that the targets are achieved.

Largely because of problems with the quality and quantity of information available for the 2005/2006, it was beyond the scope of this research to comprehensively answer these two questions. To help move MEMPR to a point where these questions can be answered comprehensively, this research seeks to accomplish the following:

1. Communicate the current trends in energy consumption in BC, the targets, and the programs in place to achieve the targets. (Section 2)
2. Describe the characteristics required in a system that effectively evaluates energy efficiency initiatives. (Section 3)
3. Demonstrate what forms of evaluation can be completed given the data that is currently available in BC, and then assess those options against the characteristics identified as being important for effective evaluations. (Section 4)
4. Present some ideas on how current approaches to evaluation could be improved or supplemented and describe what level of effort would be involved in pursuing each alternative approach. (Section 5)

In addition to helping understand how successful a series of initiatives have been, evaluation can also help inform future directions. Specifically, evaluation can help understand:

- If existing targets are sufficient to support other provincial objectives (e.g. greenhouse gas reduction targets, reduction in energy poverty goals, energy self-sufficiency goals, improved health, employment and housing goals, etc.)
- How knowledge of past policy and program experience can help inform progress towards achieving existing targets and with the setting of new targets.

To this end, this research also attempts to provide insights for future review and development of new targets. (Section 6)

2 Trends, Targets and Programs Being Evaluated

The purpose of this section is to provide readers with a clear understanding of:

- The current trends in energy consumption in BC in the commercial and residential sectors. (Section 2.1)
- The energy savings that are projected if the targets are met and (Section 2.2)
- The various policies and programs intended to help achieve the targets. (Section 2.3)

In combination, this information provides a 'snap-shot' picture of energy efficiency activities in BC and the scale of challenge faced if the targets set by the Province are to be achieved. This picture is limited to the residential and commercial sectors, and does not look at energy efficiency activities within transportation or industry for example.

2.1 Trends in Energy Consumption in BC

This section provides an overview of energy consumption trends in BC from 1990 to 2004, with the focus limited to residential and commercial buildings. Many explanatory factors underlie the trends presented in the following figures (e.g. changes in population, temperature and energy intensity). However, the discussion in this section has been limited to the overall trends. Section 4.3.1 provides a detailed discussion of these explanatory factors to help the reader understand overall energy consumption patterns. All data is sourced from Natural Resource Canada's (NRCan) Comprehensive End-use Database.[1] Information on greenhouse gas emissions was also collected, and is presented in Appendix A.

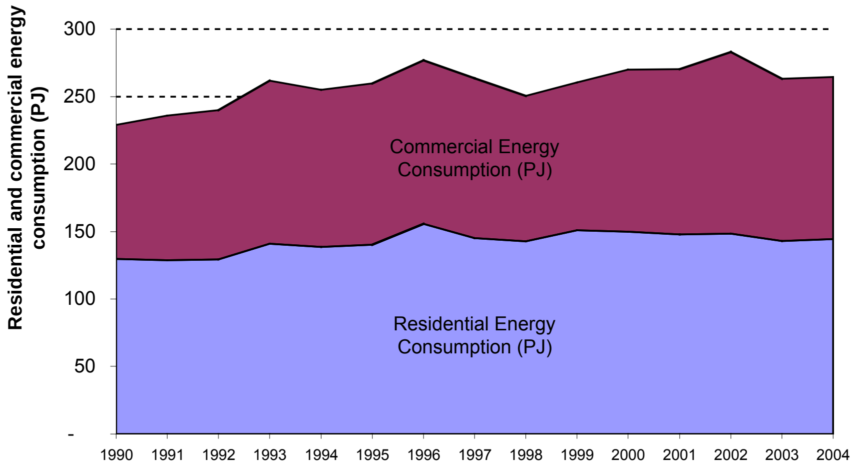
Between 1990 and 2004, the total secondary energy consumption in the BC buildings sector increased by about 16% from about 229 Petajoules (PJ) to 265 PJ.[2] Slightly over half of this energy is consumed in the residential sector, and slightly under half is consumed in the commercial sector.[3] As shown in Figure 1, the trends reveal an increase in secondary energy consumption in both sectors.

[1] Through the course of this research, several irregularities were observed in the NRCan data set for the commercial sector (see Section 4).

[2] Secondary energy is energy used directly in buildings, cars, and factories to heat buildings, provide lighting, and drive engines. This excludes energy required to generate and transport energy to the buildings, cars, and factories.

[3] The residential sector includes single-family attached and detached homes, and apartment buildings and mobile homes. The commercial sector includes office buildings (including government buildings), warehouses, hospitals, schools, universities, and other buildings. Data from Natural Resources Canada aggregates the British Columbia commercial sector with that of the Territories. We did not attempt to separate the two.

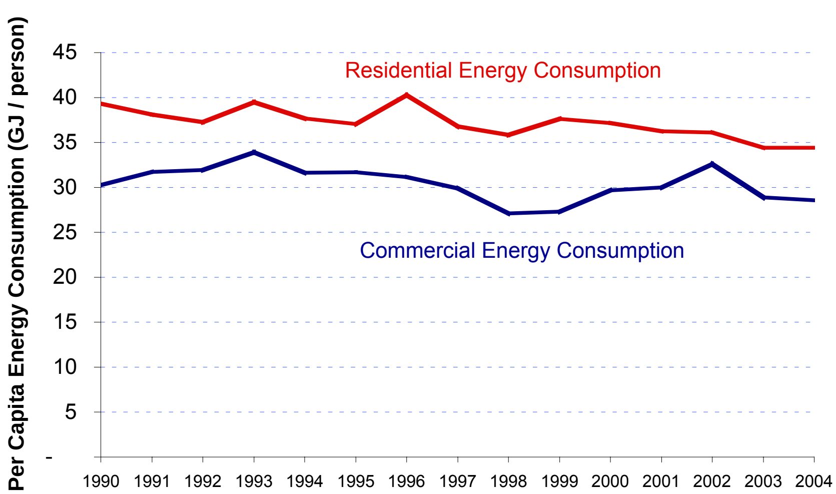
Figure 1: Energy consumption in commercial and residential buildings in BC, 1990-2004



Source: Natural Resources Canada, Comprehensive Energy Use Database.

However, it is worth noting that although overall energy consumption has been increasing, secondary energy consumption in residential and commercial buildings has been declining over the same period on a per capita basis. As shown in Figure 2, per capita residential energy consumption has reduced from 39.3 Gigajoules (GJ) per person to 34.4 GJ per person between 1990 and 2004 (a 13% decrease), while per capita commercial consumption has reduced from 30.3 GJ per person to 28.6 GJ per person over the same period (a 6% decrease). The influence of population change and other underlying factors that influence energy demand are explored in greater detail in Section 4.

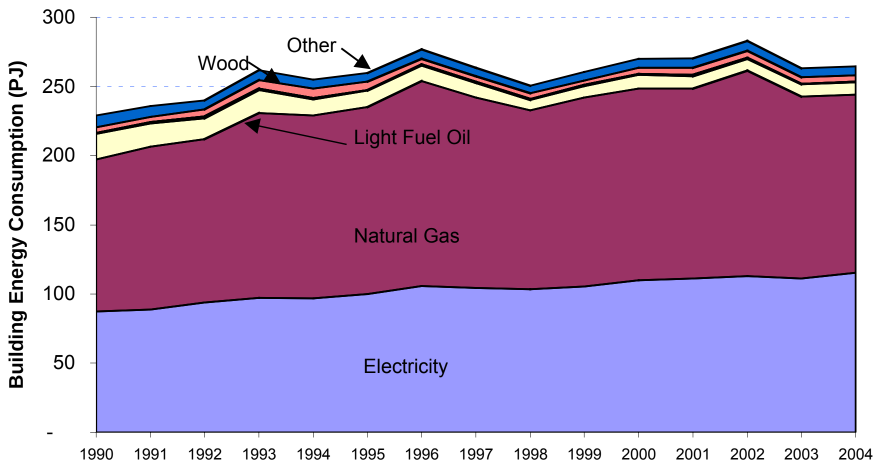
Figure 2: Per-Capita Energy consumption in commercial and residential buildings in BC, 1990-2004



Source: Natural Resources Canada, Comprehensive Energy Use Database.

Most energy used in the buildings sector in British Columbia is natural gas (rising slightly from 48% to 49% between 1990 and 2004), which is used as the primary space heating and water heating fuel in both the residential and commercial sectors. Electricity is also widely used in BC buildings (rising from 38% to 44% between 1990 and 2004), sometimes as a heating fuel, but mostly for lighting, space cooling, and to run appliances and office equipment. In addition to these fuels, light fuel oil, wood, and other fuels are used to a much smaller extent for space heating. General trends in energy consumption are shown in Figure 3.

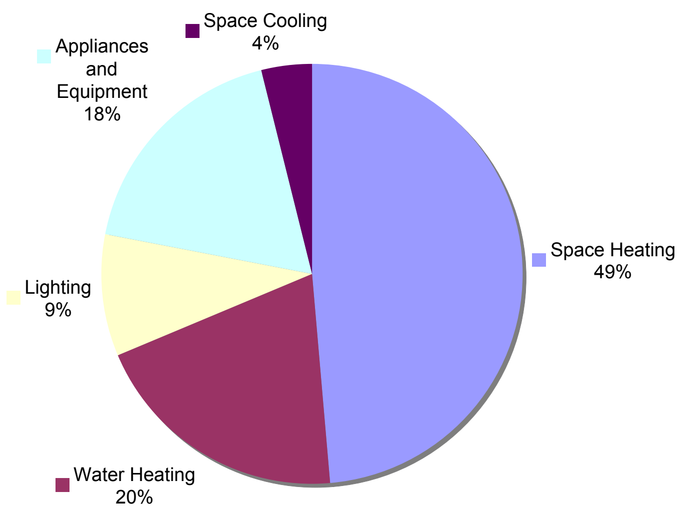
Figure 3: Energy consumption in BC buildings by fuel type, 1990-2004



Source: Natural Resources Canada, Comprehensive Energy Use Database.

About half (fluctuating between 48% and 56% over the period 1990 and 2004) of the energy consumed in buildings in British Columbia is used for space heating. Demand for space heating energy is strongly influenced by the weather in a particular year. Between 17% to 20% is used for water heating, and 17% to 19% is used for running appliances and office equipment, including motors in commercial buildings. About 8% to 10% of total energy is used for lighting, and 1% to 4% is used for space cooling. The percentage breakdowns for 2004 are shown in Figure 4.

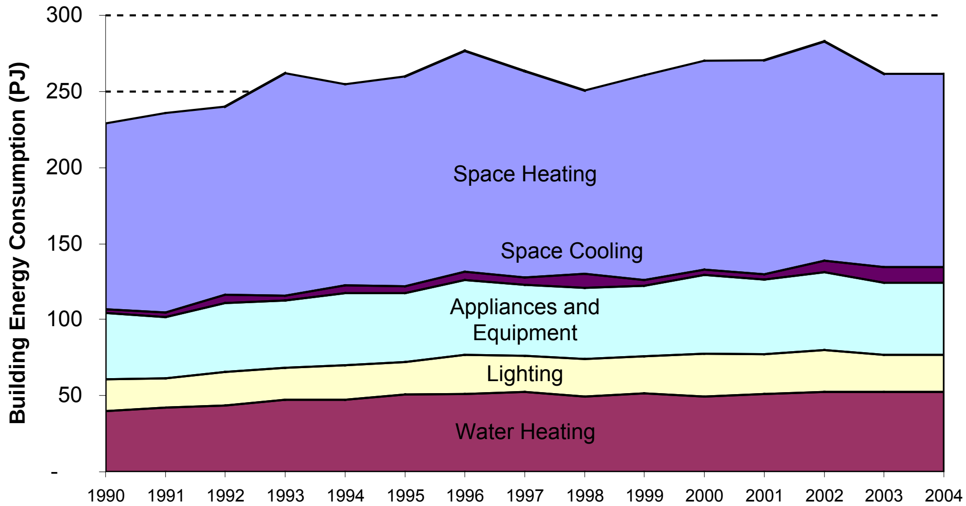
Figure 4: Energy consumption in British Columbia buildings by end-use, 2004



Source: Natural Resources Canada, Comprehensive Energy Use Database.

Each of the demand categories have increased since 1990, but the change in space heating is the only trend to demonstrate significant fluctuations from year to year. The amount of energy used for space cooling, although small, has increased since 1990 as more residential and commercial buildings have installed air conditioning units. Trends in energy consumption by end-use are shown in Figure 5.

Figure 5: Energy consumption in British Columbia buildings by end-use, 1990-2004



Source: Natural Resources Canada, Comprehensive Energy Use Database.

2.2 Targets

In order to evaluate progress towards the targets, it is important that all delivery agents, evaluators, and other stakeholders have a common understanding of the targets and a common methodology by which to measure performance against those targets. The savings from energy efficiency programs often occur over multiple years following the program activity – a house built today with an EnerGuide rating of 80 will provide significant energy savings compared to a house built to standard building practices until at least when the house undergoes its first major retrofits or renovations. When considering annual energy savings from programs, the timeframe of program activity that is being used to evaluate the savings must be clear. In addition, to evaluate progress toward a target in a future year, evaluators need to understand the relationship between the desired savings in a future year and the energy savings in the current year. To help provide additional clarity and understanding, we have presented the targets in terms of:

- *Cumulative and Incremental Targets:* Cumulative targets express the energy savings accumulated since the base year (e.g. "as a result of the initiatives to improve energy efficiency between 2001 and 2010, existing buildings will consume 50 PJ less energy in 2010"). Incremental targets express the energy saving generated in a given year (e.g. "of the 50 PJ of cumulative savings anticipated by 2010, 5 PJ of incremental savings were generated by program activity that occurred in 2005").
- *Final and Intermediate Targets:* Final targets express the energy savings that are expected in the target year (e.g. 2010 for MEMPR's current targets), while intermediate

targets express the energy savings that are expected in some year prior to the target year (e.g. 2007). Intermediate targets help to define the “path” that will be followed in achieving the final targets.

The two pairs of target types result in four possible types of targets, each of which provides useful information that is not communicated by the other types. In their current form (Table 1), the targets for existing buildings are cumulative targets for 2010, while the targets for new buildings are incremental targets for 2010. As such, three of the four types of targets are missing in each case, so the current targets are incomplete. Table 3 provides an example of what a comprehensive set of targets would look like for new SFD/Row housing. Selecting the appropriate years to have intermediate targets depends on the ability to evaluate intermediate progress and the length of time until the cumulative target will be measured.

Table 3 – Example of comprehensively described targets for new housing

	Cumulative Target	Incremental Target
Final Target	50% of homes built between 2001 and 2010 achieve E80*	100% of homes built in 2010 achieve E80
Intermediate Target	25% of homes built between 2001 and 2007 achieve E80*	50% of homes built in 2007 achieve E80

* The cumulative targets reference the 2001 base year.

Table 4 and Table 5 present the original targets (Table 1) after they have been converted to cumulative and incremental targets for 2010 and 2007. Appendix B describes how this conversion was accomplished, and Appendix C provides additional tables for the other intermediate years. With these changes, the targets are now presented in a more comprehensive manner that helps reduce the potential for inaccurate interpretations. The following statements help illustrate how the numbers in the tables should be interpreted:

- In Table 4, the cumulative target for new commercial buildings indicates that the average energy consumption of new commercial buildings built between 2001 and 2010 should be 11.6% less than the average energy consumption had those buildings been built with the same level of energy efficiency as the 2001 baseline.
- In Table 4, the incremental target for new commercial buildings indicates that the average energy consumption of new commercial buildings built in 2010 should be 20% less than the average energy consumption had those buildings been built with the same level of energy efficiency as the 2001 baseline.
- In Table 4, the cumulative target for existing commercial buildings indicates that the 2010 energy consumption of the commercial buildings that existed in 2001 should be 2.7% less than their average energy consumption in 2001.
- In Table 4, the incremental target for existing commercial buildings indicates that the 2010 energy consumption of the commercial buildings that existed in 2001 should be reduced by 0.3% compared to their average energy consumption in 2001.

As shown, new buildings are targeted for significantly greater percentage savings than existing building (16.4% versus 2.2% in 2010). These differences should not be interpreted as indicators of the relative aggressiveness of the different targets because the challenges associated with achieving savings in new and existing buildings are significantly different. That said, the targets for existing buildings are relatively small on a percentage basis (less than 0.5% improvement on an annual basis). The appropriateness of the target’s aggressiveness is discussed in greater detail in Section 6, and the small percentage improvement also introduce some statistical challenges when alternate evaluation models are considered in Section 5.

Table 4 – Incremental and Cumulative Percentage reductions in energy consumption in 2010 relative to 2001

	Incremental Targets			Cumulative Targets		
Building Type	**New Buildings**	**Existing Buildings**	**All Buildings**	**New Buildings**	**Existing Buildings**	**All Buildings**
SFD/Row	32.0%	0.2%	1.2%	18.3%	2.0%	5.3%
MURBs	37.0%	0.2%	1.2%	21.6%	1.5%	5.3%
Commercial	20.0%	0.3%	0.8%	11.6%	2.7%	4.4%
All	28.7%	0.2%	1.0%	16.4%	2.2%	4.9%

Table 5 – *Intermediate Targets,* Incremental and Cumulative Percentage reductions in energy consumption in 2007 relative to 2001

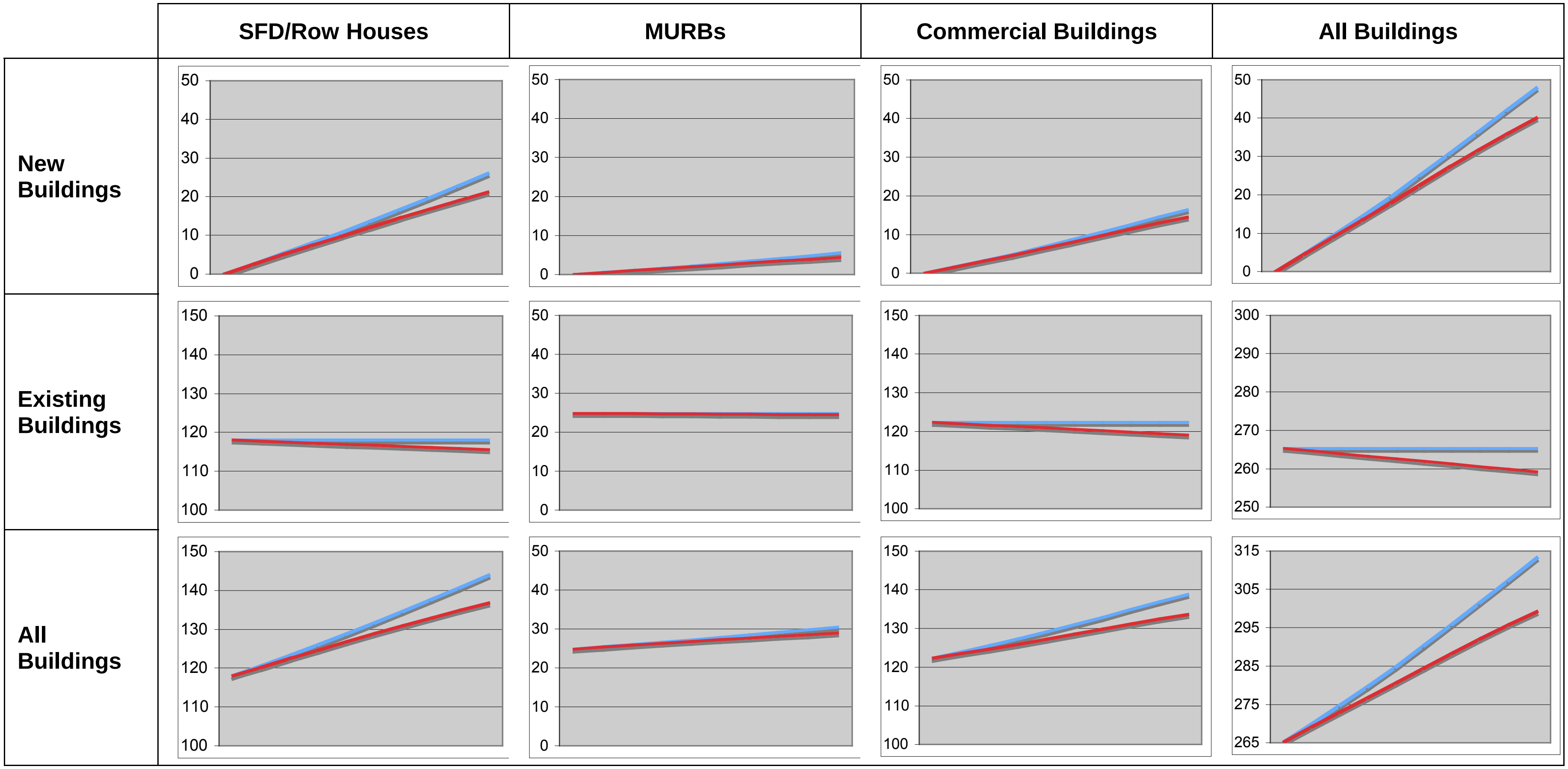
	Incremental Targets			Cumulative Targets		
Building Type	**New Buildings**	**Existing Buildings**	**All Buildings**	**New Buildings**	**Existing Buildings**	**All Buildings**
SFD/Row	21.3%	0.2%	0.8%	12.7%	1.4%	2.9%
MURBs	24.7%	0.2%	0.8%	14.9%	1.0%	2.8%
Commercial	13.3%	0.3%	0.7%	8.1%	1.8%	2.6%
All	18.9%	0.2%	0.8%	11.4%	1.5%	2.7%

The information in Table 4 and Table 5 is presented in terms of percentage reductions, but it is often desirable to convey energy efficiency targets in terms of absolute savings (e.g. 2,000 GWh). This conversion is straightforward for existing buildings because the targets are already formulated with respect to absolute energy savings. The same conversion for new buildings relies on forecasts about the number of new buildings because the original targets are based on building energy intensity (i.e. EnerGuide and MNECB). These growth rates are taken from the forecasts in BC Hydro's 2002 Conservation Potential Review (available at http://www.bchydro.com/info/reports/reports856.html).[4]

Figure 6 shows the results of these conversions by comparing the cumulative energy savings targets with a scenario in which no improvements were made. The values underlying the various graphs are available in Appendix D. When viewed in terms of absolute energy savings (as opposed to percentage energy savings), the energy savings expected from new and existing buildings is approximately equivalent. The figure also shows that the vast majority of savings are accounted for in the SFD/Row and Commercial buildings targets (as opposed to MURBs).

[4] If these assumptions prove to be accurate, then the intensity based and absolute energy reduction targets would be equivalent. However, if growth is faster than anticipated and the intensity based target is met, the targeted energy savings will exceeded because there is more building stock available to be improved. Conversely, if growth is slower than anticipated and the intensity-based target is met, the targeted energy savings will not be achieved.

Figure 6: Baseline and targeted energy consumption



Note 1: All horizontal axis cover from 2001 to 2010.

Note 2: All vertical axes cover a range of 50 PJ, but the start and finish points vary. As a result, the slopes of every line are directly comparable.

Note 3: The blue lines indicate energy consumption assuming that no changes are made to the existing building stock and all new buildings are built to the same standard as an average building in 2001.

Note 4: The red lines indicate energy consumption if the targets are achieved.

2.3 Programs

This research has identified a total of 46 energy efficiency programs active in BC between 2001/2002 and 2005/2006. Table 6 summarizes these programs according to the type of primary delivery agent. As can be seen, almost half of the programs are delivered by the electric utilities, with the gas utilities being the second most active delivery agent in terms of number of programs. The table also indicates how many programs are targeted at the residential and consumer sectors. Although many programs target both sectors, there is a considerably stronger focus on the residential sector (in terms of number of programs), with almost two times as many programs targeting residential buildings compared to commercial buildings.

The financing for these programs comes from a variety of sources that are not necessarily the same as the delivery agent. Of particular note are the Opportunities Envelope funds, which are administered by the Provincial Government to help all of the other delivery agents extend the scope of their programs. In total, the Opportunities Envelope invested $2.5 million in 2005/2006 to support 17 of the programs listed below. The details of this financing relationship are discussed in greater detail in Section 4.

Table 6 – Number of programs by delivery agent

	Number of Programs		
	Total	*Targetting Residential*	*Targetting Commercial*
Federal Government	6	6	3
Provincial Government	6	6	2
Municipal Government	1	1	1
Electric Utilities	19	15	8
Gas Utilities	10	8	4
Other	4	2	3
Total	46	38	21

Table 7 lists all of the programs considered within the scope of this research. Also included in the table are the delivery agents, the targets each program supports (either directly or indirectly), and whether or not the program is supported with Opportunities Envelope dollars. Although there is reasonable certainty regarding the target(s) that each program is supporting, there is often considerable uncertainty involved in attributing a program's savings and expenditures to different targets when multiple targets are supported. These uncertainties are reported in section 4. A description of each program is provided in Appendix E.

Table 7 – Energy Efficiency Initiatives in Brisith Columbia, 2001-2005

Program Name	Delivery Agent Name	Delivery Agent Category	Program Applies to… SFD / Row Exist.	SFD / Row New	MURB Exist.	MURB New	Comm. Exist.	Comm. New	Supported by Opportunities Envelope Funds
R-2000	NRCan	Federal		X					
EnerGuide for new houses	NRCan	Federal		X					X
EnerGuide for existing houses	NRCan	Federal	X						
Commercial Buildings Incentive Program	NRCan	Federal				X		X	
EnerGuide for existing buildings	NRCan	Federal			X		X		
Renewable Energy Deployment Initiative	NRCan	Federal			X	X	X	X	
Tax exemptions – Condensing furnaces	M. Finance	Provincial	X	X					
Tax exemptions - Air source heat pumps	M. Finance	Provincial	X	X					
Tax exemptions - Ground source heat pumps	M. Finance	Provincial	X	X					
Tax exemptions - Manufactured windows	M. Finance	Provincial	X	X					
Tax exemptions – Site assembled windows	M. Finance	Provincial			X	X	X	X	
Tax exemptions – Insulation	M. Finance	Provincial	X	X	X	X	X	X	
Community Action on Energy Efficiency	Various	Municipal	X	X	X	X	X	X	X
CFL Program	BC Hydro	Electric Util.	X	X	X	X			
Home Energy Upgrade - Renovation Rebate	BC Hydro	Electric Util.	X						X
New Home Program	BC Hydro	Electric Util.		X					X
Variable Speed Furnace Motor Program	BC Hydro	Electric Util.	X	X					X
Refrigerator Buyback Program	BC Hydro	Electric Util.	X		X				
Seasonal Light Emitting Diode Program	BC Hydro	Electric Util.	X	X	X	X			
Residential Electricity to Nat. Gas Conversions	BC Hydro	Electric Util.	X	X					
Schools, Univ., Colleges, and Hospitals Prog.	BC Hydro	Electric Util.					X		
Power Smart Partners	BC Hydro	Electric Util.					X		
Product Incentive	BC Hydro	Electric Util.			X		X		
Small Business CFL	BC Hydro	Electric Util.			X		X		
High Performance Buildings	BC Hydro	Electric Util.						X	X
BC Hydro additional costs (not program specific)	BC Hydro	Electric Util.	X	X	X	X	X	X	
Home Improvement Program / Watersavers	Fortis	Electric Util.	X		X				X
New Home Program	Fortis	Electric Util.		X		X			X
Heat Pumps Program	Fortis	Electric Util.	X	X	X	X			X
Lighting Program – Residential	Fortis	Electric Util.	X	X	X	X			
Building Improvement / New Facility Program	Fortis	Electric Util.					X	X	
Lighting Program – Commercial	Fortis	Electric Util.					X	X	
Smart Meters	Fortis	Electric Util.	X	X					X

Program Name	Delivery Agent Name	Delivery Agent Category	Program Applies to… SFD / Row Exist.	SFD / Row New	MURB Exist.	MURB New	Comm. Exist.	Comm. New	Supported by Opportunities Envelope Funds
High Efficiency Furnace/Boiler Upgrades	Terasen	Gas Utilities	X						X
New Construction Energy Star Heating	Terasen	Gas Utilities		X					X
Homeworks	Terasen	Gas Utilities	X						
Heating System Tuneup	Terasen	Gas Utilities	X						
Weatherproofing and Insulation	Terasen	Gas Utilities	X						
Fireplace Upgrade	Terasen	Gas Utilities	X						
Efficient Boiler Program	Terasen	Gas Utilities					X	X	X
Destination Conservation	Terasen	Gas Utilities					X		
Energy Assessments	Terasen	Gas Utilities					X		
Terasen Total Costs (all programs)	Terasen	Gas Utilities	X	X	X	X	X	X	
Energy* heating	PNG	Gas Utilities	X	X					X
Solar hot water heating program	BCSEA	Other	X	X					X
Energy Savings Plan	Various	Other	X	X	X	X	X	X	X
BOMA Go Green	BOMA	Other					X	X	X
Building and Environmental System Course	Douglas	Other					X	X	X
OE Spending (no savings)*	Mixed	Mixed	X	X	X	X	X	X	X

* The program entry labeled "OE Spending (no savings)" actually contains 18 individual programs that are entirely funded by the Opportunities Envelope funds. They have been amalgamated in this table and throughout the report, because although money was spent in 2005/2006, no savings have been attributed to any of the programs in 2005/2006. As savings are attributed to these individual 18 programs in subsequent years, it will make sense to disaggregate them.

3 Characteristics of a Successful Evaluation

Since the 1970s, governments and utilities (primarily electric) have implemented policies and programs designed to reduce energy demand, motivated by a number of goals including increasing energy security, reducing energy costs and reducing undesirable impacts associated with energy use. In North America, existing energy efficiency initiatives have generally taken one of three forms:

1. **Incentive programs**, which use financial incentives from government or from electric or natural gas utilities to encourage consumers and businesses to reduce energy consumption, generally through purchases of more energy efficient equipment.
2. **Regulations**, which set standards on the minimum efficiency of certain types of building characteristics, appliances, lighting, or equipment.
3. **Information programs**, which provide information and training to consumers and delivery agents about the benefits of reducing energy demand and the options available to them to do so.

As these policies and programs have evolved, there has been an increasing focus on the use of evaluation tools to measure success and to assist decision making on whether or not they merit further (or new) funds. The majority of evaluation efforts have focused on utility delivered incentive programs, because that is where much of the spending has occurred many utility regulators require evaluation to justify any program spending. More recently however, the evaluation of market transformation efforts (which often combine all three tools listed above) has gained greater focus as those types of programs have become more common.

Evaluation efforts have often suffered from significant flaws that have tended to over-estimate the energy savings and under-estimate the costs of achieving those savings. Through experience however, utilities, commissions, academics, and other stakeholders have learned a great deal about how to better structure and conduct evaluations so that the results are more representative of the expected or actual energy savings, and the total costs of achieving those savings.

This section is designed to introduce and explain the key characteristics that can help produce effective energy efficiency evaluations. These characteristics that can help foster successful evaluations are divided into: 1) the portfolio level, and 2) the program level. Section 4 offers some commentary on the varying levels of success experienced in BC at creating evaluation environments that possesses these characteristics.

3.1 Portfolio Level Characteristics

The portfolio level characteristics are those that cut across programs and delivery agents to define the framework within which evaluation occurs, the targets against which success is to be measured, and the measurement metrics. What follows are observations on the portfolio level characteristics present in California, Vermont, New York and the UK that are used to aid effective energy efficiency evaluation.

3.1.1 Clearly Defined Targets

In order to provide a context for any evaluation it is important to clearly define targets describing the energy efficiency improvements being sought. Ideally this should include broad jurisdiction- or sector-wide targets and more specific targets for individual programs. Without these, it is impossible to have metrics against which the overall success of an initiative or a supporting program can be evaluated. Although it is not a critical issue from the perspective of evaluating energy efficiency improvements, it is still important that any targets are chosen in a way that supports relevant provincial goals. For example, improving energy efficiency could be a goal unto itself, but it could also be a sub-goal designed to help reduce energy expenditures and greenhouse gas emissions. Section 2 provides a more detailed discussion on the specifics of MEMPRs current targets.

3.1.2 Appropriate Evaluation Metrics

Appropriate metrics can be assessed against the established targets and goals. The appropriate metrics for all evaluations will involve some measure of program costs and energy savings. These are used to produce traditional cost effectiveness tests such as Total Resource Cost (TRC) test[5], the Utility Cost (UC) test[6], and the Ratepayer Impact Measure (RIM) test[7]. Although utilities are the primary users of these evaluation tests, they can be applied to any energy efficiency program. In California for example, all program delivery agents that access public benefits funds are required to justify their cost effectiveness to the California Public Utilities Commission using similar tests.

If the goal of an energy efficiency initiative is broader than finding the most cost-effective way of reducing energy demand, the appropriate metrics will also be broader. In addition to the financial costs and benefits assessed by the TRC and UC tests, some utilities also evaluate their programs using non-financial benefits. New York State’s Energy Research and Development Authority (NYSERDA) provides an excellent example of this approach, where they also report the changes in employment, GHG emissions, and local air emissions that are expected to result from a program. These additional measures are always reported, but only used in the decision making process where the TRC and UC evaluation results are marginal. As an additional

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[5] The Total Resource Cost (TRC) evaluates a program from the perspective of society as a whole. It considers the costs incurred by program participants and the program costs incurred by the utility. The benefits accounted for are the avoided transmission, distribution, generation and capacity costs over the life of the measure. Costs and benefits are expressed in terms of net present value (NPV) and if the benefits exceed the costs the program is deemed beneficial to society. If costs calculated as a result of the TRC test are annualized over the life of the measure and divided by annual energy savings, the resulting levelized costs (cost per negawatt-hour) can be used to compare the DSM measure against energy supply options.

[6] The Utility Cost (UC) test measures the impact on utility revenues. The test only includes those costs and benefits that are borne by the utility, and is used to provide an indication of additional revenue requirements or savings due to implementation of a DSM program.

[7] The Ratepayer Impact Measure (RIM) test measures the impact on customer bills or rates as a result of a DSM program. The test measures changes in utility revenues and costs and translates these into an impact on the utility customer. Costs accounted for by the test include program costs and lost revenues incurred by the utility over the life of the measure. Benefits include avoided supply costs over the life of the measure.

example, California has adopted the Public Purpose Test (PPT), which includes estimates of spillover savings, non-energy cost/benefits, and positive/negative externalities.

3.1.3 Consistent Evaluation Methodologies

A concern in some jurisdictions is that there are no standards in place that ensure consistent evaluation methodologies across all delivery agents in the jurisdiction. When consistency is absent it is difficult or impossible to know how well a jurisdiction is progressing towards energy efficiency goals because too many of the initiatives are not being evaluated to a reasonable standard. This challenge is most relevant when energy efficiency initiatives include programs that overlap across multiple delivery agents and multiple energy types.

Consistent evaluation methodologies can help facilitate the cost-effective use of resources for evaluation, can allow the reports to be easily reviewed and compared with other evaluations and can facilitate ease of decision making at both the policy and program design and implementation levels. Although larger delivery agents (e.g. utilities) will often have the resources to ensure their evaluations are following best practices, this will not always be the case, and it can be even more challenging for smaller delivery agents. Standard protocols that delivery agents are responsible for following seem to be one of the best approaches to resolve this concern. Several jurisdictions have invested considerable effort to develop these types of protocols, and much of their pre-existing experience and knowledge can be adopted elsewhere. In these cases, it is important for any adopting jurisdiction to understand the protocols well prior to adopting them to ensure that they will provide the quality of data required and that they can be completed at an acceptable cost. These considerations should be communicated to a variety of stakeholders, including government, utilities commissions, utilities and other delivery agents, ENGOs, and academics.

In 2002, the International Performance Measurement and Verification Protocol Inc. developed the Certified Measurement & Verification Professional (CMVP) program, in conjunction with the Association of Energy Engineers (AEE). This program works to raise professional standards and improve the practice of those engaged in measurement and verification.[8] Similarly, California has developed a comprehensive set of guidelines for measuring energy efficiency programs. These were developed and continue to be modified by a collaborative group of state government staff, utilities, energy efficiency industry consultants, and other stakeholders. The guidelines provide approaches for estimating costs and savings prior to program implementation, which are often used to screen programs based on cost-effectiveness and other criteria. Other guidelines focus on evaluations during and after program implementation to verify expected savings, determine impacts beyond the program participants, and provide lessons for future programs.

All of California's guidelines are the responsibility of the California Measurement and Advisory Council (CALMAC). They are periodically reviewed and revised by a CALMAC committee called the Market Assessment and Evaluation State-wide Team of Research Organizations (MAESTRO). This committee consists of representatives from all aspects of the energy efficiency industry, and they are responsible for maintaining a database of the studies done on California's programs (www.calmac.org/maestro.asp), which is a valuable resource for developing programs in other regions. All program delivery agents in the State are responsible for conducting their evaluations according to these protocols.

[8] http://www.ipmvp.org/

An additional component of California's protocols offers some interesting approaches to help set the level of effort to be invested in evaluation. The protocols include providing several approved methods for each type of evaluation, each of which will provide a different level of accuracy. The exact approach a program delivery agent is required to follow is determined based on the uncertainty surrounding the costs and savings, the magnitude of the costs and savings, and the length of time since a similar type of program was evaluated.

Following a comparable model, the UK uses the British Research Establishment's Domestic Energy Model (BREDEM) as the standard method for estimating and evaluating energy use and energy efficiency of domestic dwellings. BREDEM is continually reviewed and revised to take account of such issues as changes in householder lifestyle, product innovation and ownership of energy using equipment. Reviews and revisions have included: heat loss through air leakage, lights and appliances energy use, heating systems, efficiencies, controls, occupancy, solar water heating, etc.

For all UK programs, Governement set the targets and the industry regulator, the Office of Gas and Electricity Markets (OFGEM) sets the evaluation metrics and the consistent methodologies. OFGEM has implemented the British Research Establishment Domestic Energy Model (BREDEM) as its standard protocol for measurement and verification of performance across all utility programs under the Energy Efficiency Commitment. On a program-by-program basis, all utility companies use the BREDEM model to carry out *ex ante* tests to establish average savings per measure, cost effectiveness, ability to reach energy savings targets, CO2 reductions and energy bill savings for consumers. Then *ex poste* tests establish if the programs were successful. Both assessment processes are submitted to the regulator OFGEM, who are in turn monitored by the National Audit Office.

The same model is also used by government funded energy efficiency programs, mainly in the low-income sector. Qualified auditors carry out Standard Assessment Process (SAP) assessments of each home and then a minimum of 5% of all homes are physically and independently inspected after work is completed. The SAP procedure draws upon the same BREDEM model that the utility companies utilities to evaluate energy efficiency programs. In order to ensure tight control over standards of completed work, only pre-qualified contractors are allowed to access these programs.

3.1.4 Publicly Accessible Evaluation Information

In addition to consistency, it is important that evaluations are conducted in a transparent manner that makes the data and results available to any interested parties. Having publicly accessible evaluations allows those results to be used in other processes where appropriate and also provides an additional safeguard to ensure that evaluations are presenting an accurate reflection of energy savings and expenditures. Requiring transparency and public accessibility can also facilitate the implementation of deadlines for the timely production of evaluation data.

3.1.5 Impartial Evaluations

Although many delivery agents do conduct meaningful evaluations of their own programs, there is a concern that they are not necessarily in the best position to conduct that evaluation because of their vested interest in seeing positive evaluations. Different jurisdictions have taken different approaches to deal with this concern. For example, California and the UK have prepared a series of protocols that all evaluations need to follow (see below), which are then independently audited. Following a similar model, Vermont allows Energy Efficiency Vermont to evaluate their own programs, but then commissions an independent verification audit of those evaluations.

One concern with any of the approaches that rely on private contractors to conduct the evaluations is that some consultants may be "rubber stamping" their evaluations in hopes of receiving future evaluation contracts.[9] A number of different approaches have been taken to measure and ensure the accuracy of the energy efficiency evaluation. Examples include:

- The United Kingdom provided additional verification of savings by using its National Audit Office to audit energy savings that are reported to the national gas and electric regulator OFGEM, who is responsible for administering a range of utility energy efficiency programs.
- California has enshrined the American Evaluation Association's guiding principles for evaluation in its evaluation protocols. These principles include: systematic enquiry, competency, integrity/honesty, respect for people, and responsibilities for general and public welfare.

Peer reviewed analyses by academics whose funding is not directly linked to the energy industry also provide important contributions that help ensure impartial evaluations.

3.1.6 Recognition of Overlapping Programs

Multiple programs will often independently target the same energy efficiency measure, and in these cases the potential exists for multiple programs to lay claim to the same energy savings (i.e. double counting energy savings). For example, efficiency improvements in existing commercial buildings in BC are supported by the provincial utilities, by NRCan's EnerGuide for Existing Buildings program, and by the BOMA Go Green program. Having more than one program target a specific energy efficiency opportunity is not problematic on its own from an evaluation perspective, but it is critical to ensure that energy savings are attributable to a specific program without any double counting. This potential flaw is further complicated by energy efficiency regulations that overlap with incentive programs. In the same way, when funding from multiple parties is integrated into the same program, there is a risk that the funding parties lay claim to the same energy savings and also lay claim to all the incremental energy savings associated with a particular measure, rather than counting the savings as a proportion of the amount contributed. The potential for double counting can be alleviated through the careful tracking energy efficiency activity, associated savings and funding partners.

3.2 Program Level Characteristics

Academics have often critiqued traditional utility cost-benefit tests and other types of evaluation efforts as over-estimating energy savings or under-estimating the costs of achieving those savings. Overall, these critiques generally imply that cost-effectiveness estimates of programs have been biased downwards, although the overall magnitude is ambiguous (especially as utilities have begun to better account for these critiques). The following sub-sections present some actions that program evaluations can undertake in response to the various critiques.

[9] K. Tiedeman, BC Hydro, personal communication, June 2006.

3.2.1 Evaluating Programs Using Pre- and Post-Program Data

Many evaluations are solely based on *ex ante* tests (i.e. administered prior to program implementation) so they are only predictions of program impacts. In these cases, the delivery agents will not know if the actual energy savings or costs of a program are different from those estimated in the *ex ante* test. Although any new program spending will need to rely on *ex ante* tests to justify program implementation, more robust evaluation schemes use the results of other *ex poste* evaluations (i.e. evaluations conducted after program implementation) to inform new program assessments and then conduct *ex poste* evaluations on those programs once implemented to verify and improve the *ex ante* tests. Many of the following points (e.g. not accounting for free ridership) are the types of factors that can be overlooked in cases where only *ex ante* tests are used.

3.2.2 Accounting for Free Riders

Energy efficiency programs often provide incentives for consumers or businesses to adopt more energy efficient equipment. One of the main challenges with estimating the cost effectiveness of such a program is estimating how much adoption of energy efficient technologies would have occurred without the program and how much is attributable to the program. When an incentive program is applied, it cannot normally distinguish between individuals who would have adopted the energy efficient technology anyway and those that required the subsidy to do so. As a result, at least some part of most incentive programs is paid to 'free riders', who did not require the subsidy to undertake the action specified by the program. Programs that target low-income households can be the exception to this statement because affordability is a critical barrier to participation so the potential for free riders is minimized.

Some evaluations attempt to account for free riders, typically by conducting follow up surveys of subsidy recipients asking, "Would you have adopted technology X if there was no subsidy?" Calculations from such surveys often show fairly low free rider levels (5-25%, averaging 11.4% for a large survey of electric utility programs in the US).[10] Such surveys suffer the normal biases of stated preference surveys, including respondent bias, recall problems, hypothetical bias, etc. Many other program delivery agents do not account for free riders at all.[11] Some program delivery agents conduct more sophisticated analyses comparing program participants with a control group of non-participants to estimate program free-riders.

Academics have used a variety of techniques to attempt to determine the number of free-riders on an incentive program. Gehring (2002) reports retrospective program-level analysis of programs throughout the US showing free-rider rates of 71% for refrigerator programs, 53% for air conditioner programs, and 41% for water heater programs.[12] Malm (1996) uses a statistical analysis and finds a free rider rate of 89% on heating system programs.[13] Train and Atherton (1995) use combined market and survey data to find free rider rates of 36% for refrigerator

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[10] Eto, J., Kito, S., Shown, L., and Sonnenblick, R., 1995, "Where did the money go? The cost and measured performance of the largest commercial sector DSM programs", Lawrence Berkeley National Laboratory Report, LBL-38201.

[11] Joskow, P. and Marron, D., 1992, "What does a negawatt really cost? Evidence from utility conservation programs", *The Energy Journal, 13*(4), 41-74.

[12] Gehring, K., 2002, "Can yesterday's demand side management lessons become tomorrow's market solutions", *The Electricity Journal, 15*(5), 63-69.

[13] Malm, E., 1996, "An actions-based estimate of the free-rider fraction in electric utility DSM programs", *The Energy Journal, 17*(3).

programs and 66% for air conditioner programs.[14] Loughran and Kulick (2004) use an econometric panel data analysis to show overall free-rider rates (an average of all utility programs in all sectors) on the order of 50-90%.[15] Blok et al. (2004) report studies showing free-rider rates of over 50% on a variety of programs for the business sector in the Netherlands.[16]

As can be seen, the free rider rates calculated by utilities and other program delivery agents (when it is included in calculations) are often significantly lower than that calculated by independent analysts. By implication, the energy savings attributed by utilities to specific programs will be higher than those calculated by the analysts listed above. Evaluations of programs that do not account for free-riders at all are likely to be biased.

3.2.3 Estimating Equipment Lifecycle Costs and Benefits Accurately

When considering an investment in new energy efficiency equipment it is important to quantify the expected benefits to be received over the lifetime of that equipment. To do this, it is important to understand the time value of energy savings; the value of a dollar saved today compared to the value of that dollar in the future taking into account inflation. Calculating the present value of expected energy savings generated by the initial investment in the energy efficiency equipment is one way to do this. The expected energy savings need to be discounted to reflect inflation and opportunity cost. If the cost of the energy efficiency equipment is less than the present value of the savings, then the net present value is positive which indicates that the investment is worth while.

Comparing investment costs with energy savings costs requires accurate estimates of the equipment's lifetime and usage. Many program evaluations have used engineering estimates of equipment lifetimes, which have been found to often overestimate actual lifetimes.[17] Overestimating equipment lifetime can result in poor investment decisions, because assuming that savings will be accrued for longer than the technology is actually likely to last will produce overestimates of energy savings. Sound evaluation practices are able to overcome this concern by collecting actual data on the usage and lifetime of equipment and updating energy savings calculations as needed.

3.2.4 Accounting for Spillover

Some evidence exists that suggests that the effects of energy efficiency programs in one jurisdiction can "spill over" into another jurisdiction.[18] For example, there is some evidence that the US EPA's Green Lights program to encourage firms to adopt electronic fluorescent lighting ballasts has helped to lower the costs of those ballasts. As a result, electronic ballasts have become more attractive to customers in other jurisdictions. Accounting for spillover is difficult, and not normally attempted in program evaluations. Not accounting for spillover can potentially lead to over or underestimating the savings attributed to an energy efficiency program.

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[14] Train, K. and Atherton, T., 1995, "Rebates, loans, and customers' choice of appliance efficiency levels: Combining stated and revealed preference data", *The Energy Journal, 16*(1).

[15] Loughran, David S. and Jonathan Kulick. 2004. "Demand-Side Management and Energy Efficiency in the United States." *The Energy Journal, 25*(1), p.19.

[16] Aalbers, R., de Groot, H., Ossokina, I., and Vollebergh, H., 2004, Chapter 3 in "The effectiveness of policy instruments for energy-efficiency improvement in firms: The Dutch experience", eds. Blok, K., de Groot, H., Luiten, E., Reitbergen, M., Dordrecht: Kluwer Academic.

[17] Joskow, P. and Marron, D., 1992, "What does a negawatt really cost? Evidence from utility conservation programs", *The Energy Journal, 13*(4), 41-74.

[18] Duke, R. and Kammen, D., 1999, "The economics of energy market transformation programs", *The Energy Journal*, *20*(4), 15-64.

3.2.5 Accounting for Market Transformation and Free Drivers

Energy efficiency programs are designed to encourage customers to choose more energy efficient equipment, typically in response to an incentive. It is possible that the programs could transform the market, resulting in consumers that choose energy efficient appliances in the future even in the absence of the programs. It is also possible that energy efficiency programs foster "free drivers": people who don't actively participate in the program (i.e., receive the subsidy) but who nonetheless shift their behaviour in response to it. The presence of either market transformation effects or free drivers would increase the savings attributable to utility conservation programs, and lead to underestimated energy savings if not accounted for in the evaluation. Free drivers are sometimes accounted for at a program level of evaluation (e.g. BC Hydro does account for free drivers[19]), while market transformation effects are accounted for at a state or provincial level (if they are accounted for at all). For example, Vermont and California both make estimates of the savings generated by market transformation as a result of all programs operating in their jurisdictions, but they do not attempt to attribute these savings to specific programs or account for them when justifying their expenses of public funds. The academic literature generally does not provide estimates of the effect of free drivers or market transformation.

3.2.6 Accounting for Rebound Effect

Equipment that is more energy efficient costs less to run because of lower energy costs. Economic theory implies that customers could therefore increase the amount that they use the equipment, while maintaining their energy costs at pre-installation levels. For example, a household may not use their heating system much due to high operating costs. Having installed an energy efficient heating system however, they may turn up the heat to achieve greater comfort levels for the same amount of money. This increase in demand caused by adoption of energy efficiency is known as the "rebound effect" or the "comfort effect" and would lower the energy savings due to the program. Unlike free riders, which result in less energy savings being attributable to an energy efficiency program, a rebound effect would result in less energy savings – regardless of attribution. Greening et al. (2000) survey about 50 empirical studies of the rebound effect and finds evidence that a substantial rebound effect does exist.[20] Although there is a wide variety in estimates, most studies report a rebound of 10-30% in the residential sector, and a smaller effect in the commercial and industrial sectors.

3.2.7 Accounting for All Delivery Agent Costs and Savings

Joskow and Marron (1992) report, from a survey of 10 major utilities in the US, that many utilities fail to account for all important utility costs, including measurement and evaluation of conservation savings as well as overhead. Not attributing these costs to the various programs they support will lead to an underestimate of the true program costs and will also fail to recognize that there may be more cost effective delivery mechanisms.

Energy efficiency can also bring about operational cost savings to other areas of the utility business in the form of reduced debt burden from un-paid fuel bills or reduced costs incurred through the debt recover and disconnection processes. Such benefits go straight to the bottom

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[19] BC Hydro, 2005, "BC Hydro 2005 Resource Expenditure and Acquisition Plan".

[20] Greening, L., Greene, D., and Difiglio, C., 2000, "Energy efficiency and consumption – the rebound effect – a survey", *Energy Policy, 28*, 389-401.

line financial performance of the company and can often be overlooked in decision making processes.

3.2.8 Accounting for All Consumer Costs

In the same survey, Joskow and Marron report that most utilities fail to fully account for consumer costs of participating in utility conservation programs. For example, evaluations of utility programs are typically conducted assuming that utilities target customers at a point in time when they are making investment choices between purchasing a standard equipment device and a more efficient device. In fact, utility programs often target customers before they have reached such a point and, but for the conservation incentive, would continue to use existing equipment for some period of time. As a result, any residual, or “scrap” value of the existing equipment should be included in the total resource cost test.

4 Evaluating Improvements in Energy Efficiency in BC

Section 3 introduced a series of evaluation characteristics that have been demonstrated in successful models elsewhere. The purpose of this section is to discuss the options for evaluation in BC that can be produced with available data, report on the strengths and weaknesses of these available approaches and present the evaluation results.

4.1 Available Evaluation Approaches

Working with data currently available in BC, this research uses two approaches to evaluate overall energy savings: 1) a decomposition analysis, and 2) a summation of individual program evaluations. The decomposition analysis is a top-down approach that isolates the effect of different factors (including energy intensity) on overall energy consumption in a sector. The summation analysis is a ground-up approach that combines all of the program-by-program estimates of energy savings to estimate the overall energy savings. Both approaches have their own strengths and weaknesses, and can complement each other in combination.

Decomposition analysis is a mathematical tool that breaks down a change in one indicator into two or more explanatory factors that cause changes in the indicator (e.g. population, floor space, building occupancy, weather, economic structure, energy intensity, and fuel mix).[21] Ultimately, this approach allows the change in energy intensity (see Appendix F for an explanation of why intensity is used instead of efficiency) to be viewed in isolation of other factors. Almost all data required for this analysis is collected by Natural Resources Canada and is publicly available as part of the *Comprehensive Energy Use Database*. The inherent weakness in this approach is that the results do not explain whether energy intensity is increasing or decreasing due to policies and programs, or due to the economy's natural evolution towards greater energy efficiency. Likely explanations include price pressures and demand side management programs, but a decomposition approach is unable to show how much change each factor is responsible for.

The summation approach simply adds the energy savings estimated for each of the 46 programs introduced in Section 2 (and described in Appendix E) to produce an estimate of the total amount of energy saved in a given time period. The advantages of this approach are that it allows savings to be linked directly with specific targets and it allows the savings to be linked with the associated expenditures to partially understand cost-effectiveness. Even if all of the program level evaluations are conducted perfectly, the summation approach is still limited in that it only

[21] Many different types of decomposition analysis can be used. Our analysis is based on the Log Mean Divisia I (LMD I) approach, which has recently been adopted by Natural Resources Canada.

includes savings that are attributable to programs and excludes savings (or increases) that are generated for other reasons (e.g. price).

The two approaches complement each other quite well in that the decomposition approach tracks overall energy consumption and the relative role that improvements in energy intensity are playing, while the summation approach provides a more detailed picture of how those improvements are being generated. It is important to stress that the energy savings measured by the two approaches are not directly comparable because the decomposition analysis estimates total energy savings, whereas the summation approach is only intended to estimate energy savings attributable to programs. Energy intensity could get better or worse independent of the role of programs, where this program-independent change would be the theoretical gap between the two approaches.

4.2 Challenges with Current Approaches

Although the inherent weaknesses of the decomposition and summation approach are largely addressed by using the two approaches in combination, there are unfortunately a number of other challenges that are introduced by the quality of data available in BC. These challenges are presented in Table 8, where they are organized by using the success factors introduced in Section 3 as a checklist. Also included in the table is an indication as to whether the challenge likely results in an over- or under-estimate for the energy savings estimated using the decomposition and summation approaches.

In combination, these challenges introduce a significant degree of uncertainty into the results from both approaches, and an additional bias towards over-estimating savings in the summation approach. Although each of the challenges in Table 8 presents an opportunity to improve MEMPR's ability to undertake a comprehensive and accurate evaluation, there are several key challenges that introduce the aforementioned uncertainty and bias.

Key Sources of Uncertainty in the Decomposition Approach

- The NRCan data for the commercial sector seems to have some underlying discrepancies, because year-to-year fluctuations in weather cannot be shown to have had a major impact on energy consumption and energy intensity appears to fluctuate unrealistically. Staff at NRCan confirmed that the commercial sector has underlying data deficiencies because it is used as a "catch-all" for otherwise unassigned energy.

Key Sources of Uncertainty and Bias in the Summation Approach

- There is no standard evaluation methodology that has been applied to all energy-efficiency programs by all delivery agents, so as a result it is difficult to confidently compare evaluations or have confidence that they are following a best practices approach to evaluation.[22]
- There is no system in place to identify and resolve when programs provided by different agents overlap and have the potential to double count savings.

[22] The Opportunities Envelope attempted to introduce a standard template to provide consistency across all partners in reporting energy savings. While partners generally used the template for the programs funded by OE dollars, it did not prescribe how the evaluations should be completed, and the majority of energy savings in BC have been recorded using self evaluations.

Table 8 – Challenges with current evaluation approaches in BC, and direction of potential bias introduced by the challenge.

	Success Factor	Observed Challenges	Impact on Energy Savings from Decomp.*	Impact on Energy Savings from Summation*
PORTFOLIO LEVEL CHARACTERISTICS	Clearly defined targets	Aggregate targets are in place, but are somewhat ambiguous and not straightforward to measure.	NI	NI
		Targets are not split into natural gas and electricity savings, making it difficult to assess the level of success at reducing GHGs.	NI	NI
		Although many individual programs have targets, they are not always clearly linked to one of the six MEMPR targets, and the sum of the program targets does not provide sufficient savings to achieve the overall targets.	NI	NI
	Appropriate evaluation metrics	Policies are not consistently evaluated using an appropriate measure of cost effectiveness, which accounts for social benefits (GHG abatement, employment gains) as well as costs (program delivery costs, private costs, employment losses).	NI	NI
	Consistent evaluation methodologies	Although some of the larger delivery agents are following many evaluation best practices (BC Hydro and Terasen use the California protocols to some extent), there are no standard protocols common across all delivery agents.	NI	↑ or ↓
	Publicly accessible and accurate evaluation information	When evaluations were conducted, they were available upon request, but they weren't usually easily accessible to the public.	NI	NI
		Understandably all of the data is only available following a time lag (typically several months). The NRCan data used for the decomposition data is of particular note however because the data has a release delay of approximately two years. This delay makes any direct comparisons with program evaluations difficult.	NI	NI
		The NRCan data for the commercial sector seems to have some underlying discrepancies. Based on the available data, year-to-year fluctuations in weather cannot be shown to have had a major impact on energy consumption. As a result, it appears that energy intensity unrealistically fluctuated from one year to the next. The errors and uncertainties present in Natural Resources Canada's occur in part because they have to scale up survey samples (e.g., Commercial and Institutional Building Energy Use Survey; Survey of Household Energy Use) to reflect broader populations, and because they need to use models to estimate energy consumption by fuel type and end-use.	↑ or ↓	NI
		The NRCan data includes the Territories with BC, and no attempt was made to separate this additional component.	↑	NI
	Impartial evaluations	Although the BCUC acts in a limited role to review some evaluations by electric and natural gas utilities, most evaluations are being conducted by the delivery agents or their consultants. This problem is compounded by the fact that there are no standard protocols for the delivery agents to follow in their evaluations. It should be noted that no evidence found that any evaluations were being conducted in a manner that would purposely benefit the delivery agent, where evaluations were being conducted. The lack of rigorous evaluations of many programs could make it appear that these programs are producing greater results than they actually do.	NI	NI
	Recognition of overlapping programs	In the cases where the double-counting of energy savings was a possibility, we could not find any procedures in place to avoid the outcome. We could not find any evidence that this was being accounted for in cases where it was possible to occur. It is worth noting that the programs with the greatest degree of potential overlap were the provincial tax incentives, and in these cases, no savings were attributed to the tax incentives.	NI	↑

	Success Factor	Observed Challenges	Impact on Energy Savings from Decomp.*	Impact on Energy Savings from Summation*
PROGRAM LEVEL CHARACTERISTICS	Evaluating programs using pre- and post-program data	This was primarily a challenge for the smaller delivery agents. In these cases post-program data was rarely used, and the reported savings were typically based on the anticipated savings. Often, anticipated savings did not appear to be calculated based on rigorous methods, but were subjective estimates. While larger delivery agents are analyzing post-program data, it is unclear how this information is used to adjust historic estimates of energy savings.	NI	↑ or ↓
	Accounting for free-riders & Accounting for Rebound Effect	Although some of the larger delivery agents used evaluation techniques to account for these factors, most of the evaluations did not seem to account for either.	NI	↑
	Accounting for spillover & Account for Market Transformation	Although some of the larger delivery agents used evaluation techniques to account for these factors, most of the evaluations did not seem to account for either.	NI	↓
	Accounting for All Delivery Agent and Consumer Costs and Savings	The lack of transparency of evaluation reporting made it difficult to assess which costs and savings were included in many cases, but there were certainly a number of cases where not all of the delivery agent costs were accounted for.	NI	NI**

* NI = Factor results in no impact on the estimated energy savings; ↑ or ↓ = Factor results in an unknown impact on estimated energy savings; ↑ = Factor results in over-estimated energy savings; and ↓ = Factor results in an under-estimated energy savings.

** Although these factors do not impact the energy savings, they do impact the program expenditures, and as a result, the estimated cost-effectiveness. The direction of the affect is ambiguous.

4.3 Evaluation Results

Recognizing the challenges introduced in the previous section, the following sub-sections present the evaluation results that are available given the data available.

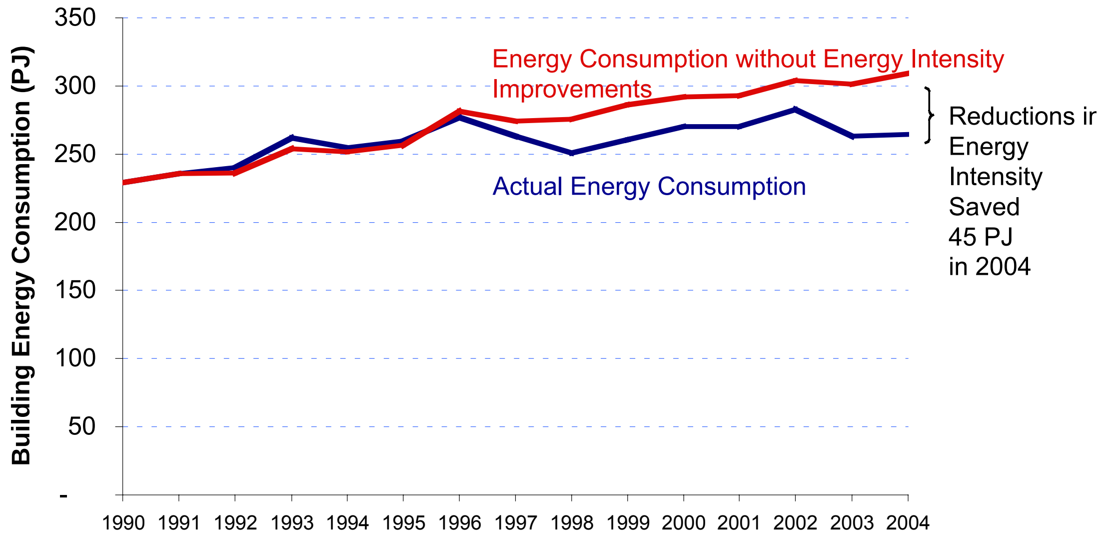
4.3.1 Decomposition Analysis

This section includes an overview of the key results from the decomposition results. A full set of results is available in Appendix G. The appendix also includes an electronic version of the analysis, which is easily updated from year to year as new data become available.

Overall Results

Figure 7 shows that actual energy consumption of buildings in British Columbia (the blue line) increased by 35.7 petajoules (PJ) between 1990 and 2004 (an increase of 16%).[23] Without improvements in energy intensity since 1990, buildings in British Columbia would have consumed about 45 petajoules more energy in 2004 than they did in reality (the red line), an increase of about 17%. This is roughly the amount of energy required for all energy requirements for a city of 150,000 people.

Figure 7: Energy consumption in buildings in BC, with and without energy intensity improvements, 1990-2004



Residential Sector Results

Figure 8 shows that actual energy consumption in residential buildings in British Columbia (the blue line) increased by 15.2 petajoules (PJ) between 1990 and 2004 (an increase of 11.7%). Without improvements in energy intensity since 1990, buildings in British Columbia would have consumed about 18.6 petajoules more energy in 2004 than they did in reality (the red line).

Despite the 18.6 improvement in energy intensity, overall energy consumption in the residential sector still increased. Some of the key reasons for this increase were:

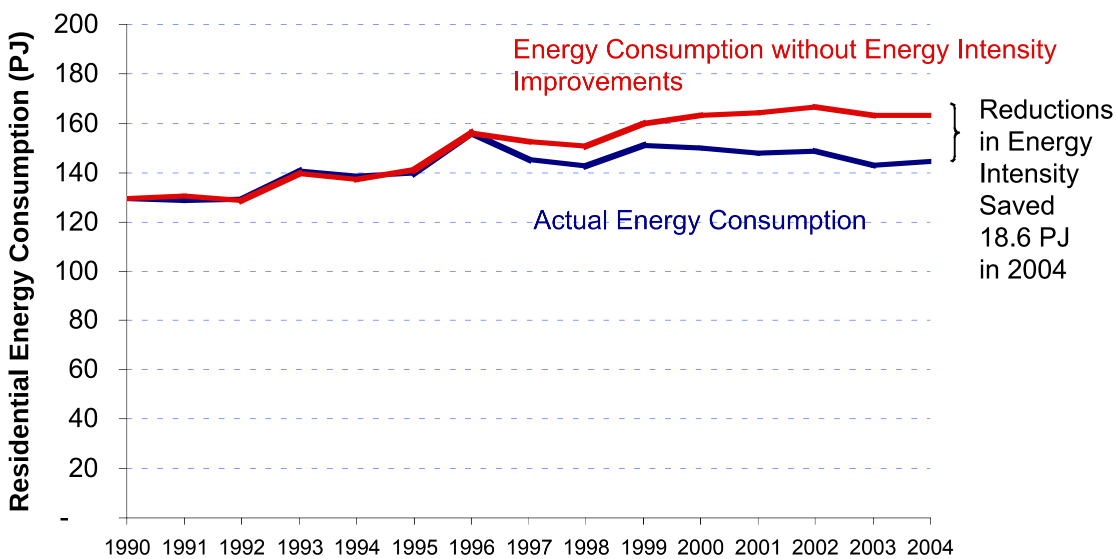
[23] Although the base year for MEMPR's evaluation is 2001/2002, the decomposition analysis results are presented with a base year of 1990 to provide a longer timeline and give a better sense of trends. Comparisons with the 2001/2002 baseline are discussed in Section 4.3.3.

- A 28% increase in population that caused a 34.3 PJ increase in energy consumption.
- An increase in the average floor space of dwellings that caused an 8.8 PJ increase in energy consumption.
- A 5% decrease in number of people per household that caused a 7.5 PJ increase in energy consumption.

Mitigating these upward trends, the following factors caused a decrease in overall energy consumption in addition to improvements in energy intensity:

- A warmer winter in 2004 compared to 1990 caused an 8.7 PJ decrease in energy consumption. Of all the factors introduced in this section, changes in weather are the only one not influenced by provincial government policy.
- A shift to more efficient heating fuels (e.g. wood and oil to gas and electricity) caused a 4.4 PJ decrease in energy consumption.
- A shift from single-family detached housing into apartment buildings and row housing has caused a 3.7 PJ decrease in energy consumption.

Figure 8: Energy consumption in residential buildings in BC, with and without energy intensity improvements, 1990-2004

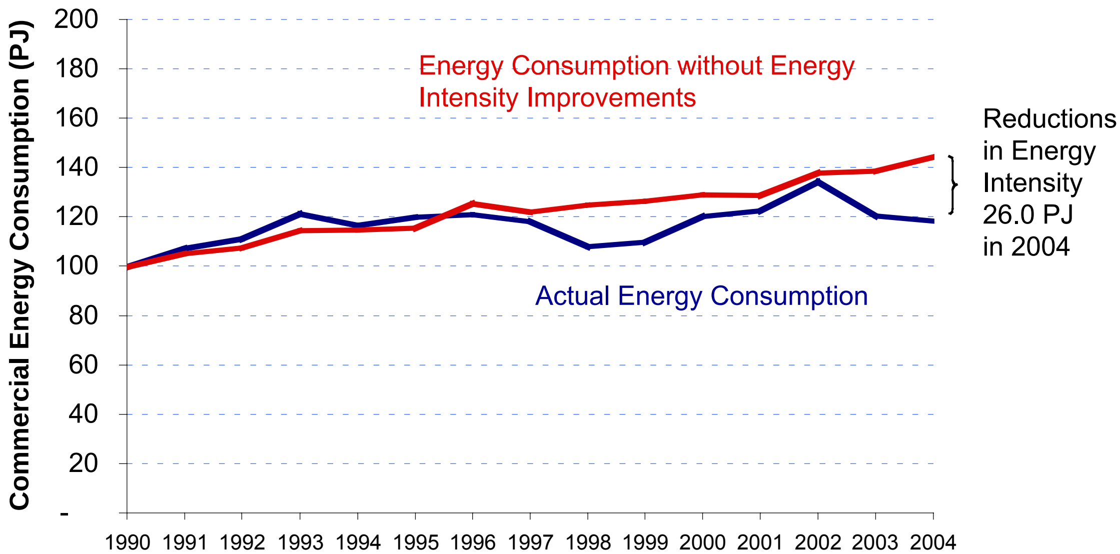


Commercial Sector Results

Figure 9 shows that actual energy consumption in commercial buildings in British Columbia (the blue line) increased by 19 petajoules (PJ) between 1990 and 2004. Without improvements in energy intensity since 1990, commercial buildings in British Columbia would have consumed about 26.0 petajoules more energy in 2004 than they did in reality (the red line).

As mentioned, there are some problems with the data underlying the decomposition analysis in the commercial sector. Based on the available data, structure, fuel switching, or weather changes cannot be shown to have had a major impact on energy consumption in the commercial sector, and energy intensity appears to cause unrealistic fluctuations. The negligible effect of structure and fuel switching does not seem unreasonable, but it is difficult to explain how climate did not have an impact, or that energy intensity has such an irregular impact. The other factor included in the commercial decomposition was floorspace, and an increase in this factor was found to be responsible for a 42 PJ increase in energy consumption.

Figure 9: Energy consumption in commercial buildings in BC, with and without energy intensity improvements, 1990-2004



4.3.2 Summation of Program Evaluations

Energy saving and expenditure estimates were obtained for all 46 programs included in this evaluation. The complete results of this evaluation are provided electronically (Appendix H). Appendix H also documents the links between the 46 programs and the Opportunities Envelope funding. This section highlights a number of key summaries that are derived from the complete results.

Energy Savings by Sector

Table 9 presents the cumulative energy savings by sector (i.e. the total savings accumulated between 2001/2002 and 2005/2006). The first row of this table only assigns the estimated savings to one of the six targets listed in Section 1 if they can be unambiguously linked to that target. For example, if the estimated savings from a program could not be split between two targets without having to make assumptions, they were included in the 'not designated' column. In the second row, the 'not designated' amount from the first row is attributed to what was deemed the most appropriate sector. Almost half of the total savings could not be attributed to a sector without making assumptions.

Both rows are then compared to the targeted savings derived in Section 2 (row three in the table). As can be seen, the total estimated savings and the savings for existing buildings exceed the targets, but the savings for new buildings fall well short of the targets. An identical pattern can be seen in Table 10, which presents the incremental energy savings (i.e. the savings generated by program activities in 2005/2006). These patterns could be occurring because the energy savings in new buildings are not as great as anticipated and/or it could be because the 'not designated' savings have not been attributed accurately to the different sectors. It should also be reiterated that the attributed savings are subject to the challenges introduced in Section 4.2, and could potentially be overestimating the actual savings.

Table 9 – Cumulative Energy Savings by Sector (2001/2002 to 2005/2006)

	Sector							
	SFD/Row Existing	*SFD/Row New*	*MURB Existing*	*MURB New*	*Commercial Existing*	*Commercial New*	*Not Designated*	*Total*
Attributed Savings - TJ (no assumptions)	1,152	95	0	17	1,463	234	2,849	5,810
Attributed Savings - TJ (with assumptions)	2,525	243	346	49	2,397	251	NA	5,810
Targeted Savings - TJ	1,073	972	164	229	1,475	378	NA	4,291

Yellow cells indicate that the attributed savings exceed the target
Green cells indicate that the attributed savings fall short of the target

Note: - The "no assumptions" row only assigns estimated savings to individual sectors if the savings can be attributed unambiguously.
- The "with assumptions" row assigns all estimated savings to most appropriate sector.

Table 10 – Incremental Energy Savings by Sector (2005/2006)

	Sector							
	SFD/Row Existing	*SFD/Row New*	*MURB Existing*	*MURB New*	*Commercial Existing*	*Commercial New*	*Not Designated*	*Total*
Attributed Savings - TJ (no assumptions)	381	29	0	0	270	67	571	1,317
Attributed Savings - TJ (with assumptions)	588	54	47	5	549	75	NA	1,317
Targeted Savings - TJ	268	397	41	93	369	163	NA	1,331

Yellow cells indicate that the attributed savings exceed the target
Green cells indicate that the attributed savings fall short of the target

Energy Savings and Expenditures by Delivery Agent

Most of the programs included in this evaluation focus on grants, rebates, or tax incentives, so the magnitude of the expenditures is obviously a metric of interest. Table 11 shows the energy savings and expenditures for the different programs, categorized by delivery agent. The expenditures include costs born by the delivery agents – primarily, financial incentives and administration costs. Costs born by the consumer, for example any incremental cost of more energy efficiency equipment and energy bill savings for the customer are excluded from Table 11.

As can be seen, the Provincial Government ($49 million on tax incentives) and the electric utilities ($30 million) dominate the spending. Interestingly, the gas utilities are spending a much smaller amount per program and the Provincial government has the highest per program spending (note that we treat foregone tax revenue as expenditure). Note however, that we have determined large uncertainty ranges for the estimates of tax incentives – the revenue that the government has foregone by providing provincial sales tax exemptions on certain energy efficient equipment. To estimate the lost revenue, we used a range of potential costs for equipment (for example, there is a wide range in cost per window) and potential purchases (for example, the number of windows purchased in a year was estimated based on data for number of new houses combined with estimates of windows per house). Our estimates for lost revenue from provincial sales tax exemptions range from a potential low of $24 million to possibly as high as $90 million.

The fact that the Provincial Government is not attributed any energy savings illustrates one of the challenges in overlapping programs. In this case, all of the government expenditures are on sales tax exemptions, which may very likely lead to energy savings, but none were attributed because other programs were already targeting the same technologies and claiming the savings. In addition, the provincial sales tax exemption on double-glazed windows, which accounts for nearly 80% of the estimated Provincial Government expenditures, does not lead to any energy savings since these windows are required by provincial regulation. Of the $33 million spent by utilities and other delivery agents, $2.5 million was provided by the Provincial government through the Opportunities Envelope Program. The savings attributable to this portion of the expenditures is discussed below.

Table 11 – Savings and Expenditures by Delivery Agent

	Delivery Agent						
	Federal Government	*Provincial Government*	*Municipal Government*	*Electric Utilities*	*Gas Utilities*	*Other*	*Total*
Cumulative Energy Savings - TJ	1,446	0	0	3,519	801	43	5,810
Incremental Energy Savings - TJ	499	0	0	614	161	43	1,317
2005/2006 Incremental Expenditures - $M	7	49	0	30	2	1	89

Note: Expenditures refer to costs born by the delivery agent

Estimated Life-cycle Implications

Table 12 presents some estimated life-cycle implications of the energy savings achieved in 2005/2006. These figures have been calculated with some simple assumptions about the lifespan of the energy savings (20 year lifespan and a 6% net present value discount rate), so they should not be viewed as rigorous or robust estimates. The $/GJ and $/tonne estimates only include the program spending, so they are not comparable to a total resource cost, which would also include consumer spending.

Table 12 – Estimated Life-cycle Implications

	Not Discounted	*Discounted*
2005/2006 Incremental Expenditures - $M	89	89
Estimated Lifecycle Savings - TJ	26,349	15,111
Estiated Lifecycle GHG reductions - MT	2	1
Program cost per energy savings - $/GJ	3	6
Program costs per GHG reductions - $/tonne	43	75

Estimated Opportunities Envelope Contribution to Savings and Expenditures

Table 13 summarizes the scale of Opportunities Envelope programs in relation to the full scope of energy efficiency programs. Based on the data available, the $2.5 million of Opportunities Envelope money spent in 2005/2006 represented 3% of total expenditures on energy efficiency programs. Although the 195 TJ of savings attributed to opportunities envelope expenditures (representing 15% of the total savings) would appear to indicate that the Opportunities Envelope investments produced more cost-effective savings, there is enough uncertainty in the data to prevent us from making this conclusion. The saving estimates used to produce the 195 TJ estimate were provided through a separate reporting process, and for the reasons discussed in Section 4.2, the different sources are difficult to compare and introduce uncertainties and potential biases. Appendix H provides some additional detail on the opportunities envelope funds and the estimated savings.

Table 13 – Estimated Opportunities Envelope Contribution to Savings and Expenditures

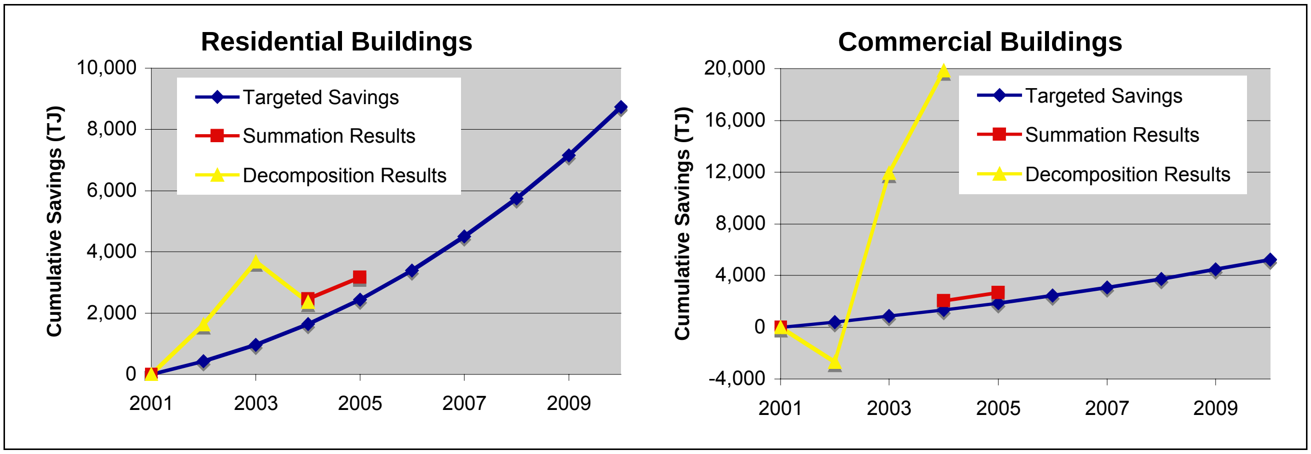
	OE	*Other programs*	*Total*	*OE fraction*
2005/2006 Incremental Energy Savings - TJ	195	1,122	1,317	15%
2005/2006 Incremental Expenditures - $M	2.5	86.2	88.7	3%

4.3.3 Comparing the Approaches

Figure 10 compares the targets and the results of the two evaluation approaches to help understand how similar the evaluation approaches are and how the estimated savings compare to the targets. This comparison is somewhat limited because the decomposition approach cannot be disaggregated into new and existing buildings, and the evaluations are not available for the same time periods (2002 to 2004 for decomposition and 2004-2005 for summation). Additionally, the comparison should not be treated as a validation (or invalidation) of either approach because as mentioned, they are not measuring exactly the same thing. The decomposition results are the total change in energy consumption, whereas the summation results are only the energy savings that are attributable to a program.

Nonetheless, the comparison provides some interesting insights. In both the commercial and residential sector, the summation approach produces estimated savings that are slightly greater than those targeted. The decomposition results for the residential sector also seem to be reasonable, but for reasons that have already been discussed, the commercial results exhibit a degree of variability that we were unable to explain. Once a few more annual evaluations have been completed, this analysis will become more powerful because there will be a greater degree of overlap in the two approaches.

Figure 10: Comparing evaluation approaches with targets



5 Possible Improvements to Evaluation in BC

In previous sections, we have described two evaluation methods that were conducted using data currently available in British Columbia to estimate progress towards MEMPR energy efficiency targets: decomposition and summation. The decomposition approach is useful because it allows us to understand key trends underlying changes in energy consumption over time – changes that may be outside of the direct influence of the individual energy efficiency programs. The summation approach is useful because it allows for an assessment of programs that are designed to improve energy efficiency in the Province, including comparisons of program achievements. In combination, these two approaches have the potential to complement each other to provide an effective overall evaluation.

As discussed in Section 4 however, there are a number of challenges with each approach that prevent them from reaching their full potential and significantly reduce the confidence that can be placed in the evaluation results. The purpose of this section is to explore some opportunities to address these challenges. Section 5.1 offers some suggestions for improvements that focus on reducing uncertainty and bias, which will increase the accuracy of the current approaches to evaluation. Section 5.2 offers some additional improvements to the existing approaches that will further increase the value of the evaluation results. Section 5.3 closes by offering some additional approaches for evaluation based on sampling that could further complement the existing approaches. Although all of the suggestions in this section offer opportunities to improve evaluation efforts in BC, Sections 5.1 and 5.2 should be considered priorities, because the value of additional sampling approaches will only be fully realized if the current approaches are first improved.

5.1 Options to Increase Accuracy of Evaluation Results

As noted in Section 4.2, the evaluation data that is currently available in BC has a number of sources of uncertainty and potential bias. Based on these challenges, the following two recommendations would help reduce these to increase the accuracy of results from the decomposition and summation approaches.

1. Work with NRCan to resolve the irregularities in the commercial sector data. Unfortunately the exact source of the irregularities that led to counterintuitive and unexplained trends in the commercial sector was never determined (staff at NRCan suggested several possible problems), so it is not clear how much additional effort would be required to find and then alleviate the concern(s). That said, if MEMPR is interested in continuing to use a decomposition approach for evaluation, this option should be a fairly high priority given the lack of confidence that can placed in the commercial sector results currently.
2. Develop and adopt a standard evaluation methodology that can be applied to all energy-efficiency programs by all delivery agents. This methodology can be more detailed for

larger programs, but should generally account for free-riders, rebound effect, spillover, market transformation, double-counting with other programs, and all costs and savings incurred by the delivery agent as well as other parties. The methodology should stipulate a common reporting format, and when independent third-party evaluation is appropriate. Although developing such a methodology could be a significant undertaking, the benefits would also be significant, and the costs could be significantly reduced by basing it on existing methodologies developed by other jurisdictions, notably California and the UK. In addition, by drawing on other jurisdictions' experiences, the methodology will be capable of producing results that can be compared with those jurisdictions. Interestingly, there was very little resistance from any of the OE partners to the use of a standard reporting template, which indicates that there is a willingness to accept a province wide evaluation protocol.

5.2 Options to Further Increase Value of Evaluation Results

In addition to the recommendations in 5.1 that are intended to improve the accuracy of results, our research has also revealed several other opportunities for improvement in evaluation practice.

1. Define the energy efficiency targets in terms of annual energy savings for partners and evaluators, and link the energy efficiency targets to other goals such as greenhouse gas emission reductions. This task has been accomplished in part by the work presented in Section 2.2, but in the future, this understanding should be built into the targets from the beginning. The need for clear linkages between the overall targets and individual program targets, and the overall targets and other goals (e.g. GHG emissions reductions) remains.
2. Develop a plan to show how each of the programs are supporting the various targets and how those program by program impacts will combine to help achieve the targets. This type of plan is in place to some degree with the programs currently supported by the Opportunities Envelope funds, but they miss many significant efforts and do not clearly map out how a program's efforts will be shared between targets when more than one is covered.
3. Consider adopting greenhouse gas emissions reduction targets for buildings in BC to complement the energy savings targets already in place. Given the rapidly evolving nature of climate change policy BC, which now has a medium-term emissions reduction target, having greenhouse gas targets for buildings as part of the same evaluation framework could help maximize the cost-effectiveness of the evaluation and ensure that programs are contributing to any broader climate objectives.
4. Improve the public availability of evaluation results so that interested parties are able to easily access an overall assessment of evaluation efforts in the province and then be linked to more in depth evaluation material if desired. This should not be a significant challenge, as MEMPR has already taken the first steps in producing an overall evaluation and the program level evaluation are available if people know who to ask or where to look.

5.3 Possible Sampling Approaches to Evaluation

To assess annual progress toward the Targets, it would be possible to measure the energy efficiency of a sample of households and buildings in British Columbia on an annual basis. The intent behind this type of approach would be to provide market level data that could be directly linked to MEMPR's targets. It would not be capable of replacing the program level summation approach, but it could either complement or replace the decomposition approach. It should be stressed that the discussion of sampling approaches is preliminary at this point, and a more extensive analysis would need to be conducted prior to proceeding. That said, the preliminary analysis does show that sampling could be a relatively cost-effective way of supporting evaluation efforts in BC (particularly for new buildings).

In general, sampling approaches could generate reliable measures of the average energy intensity of the new and existing BC building stock in each year (disaggregated into single family housing, multi-unit housing, and commercial buildings). The energy efficiency of this sample could then be compared to the energy consumption of the baseline building stock in 2001 to understand progress towards targets. The sampling data could either rely on home and building audits or on billing data[24].

The number of samples required will depend on the variability of the data (more variability necessitates more samples) and the magnitude of improvement being targeted (smaller percentage improvements necessitate more samples).[25] If the number of samples is too small, two types of incorrect conclusions are possible: 1) concluding that the energy intensity of the building stock has improved when it really has not improved, and 2) concluding that the energy intensity of the building stock has not improved when it really has improved. Allowing a 10% probability of each type of error, Table 14 shows the number of samples required in both 2007 and 2010 for each building category. As can be seen far fewer samples are required to test the new building targets because the magnitude of improvement is significantly bigger. Likewise, fewer samples are required to test the final 2010 targets as opposed to the intermediate targets because the average savings are intended to be larger by 2010. The estimates in Table 14 should be considered preliminary in nature, and they are dependant on assumptions about the variability in building energy consumption that should be further investigated. The estimated sampling requirements in Table 14 were produced using an a-priori t-test in the G* Power 3 software. The standard deviations in building stock were obtained from Natural Resource Canada's EnerGuide database.

[24] A sampling approach is the focus of this discussion, because it is likely logistically impossible to measure the energy intensity of every home and building in BC and the cost of such an endeavor would almost certainly be prohibitive.

[25] This discussion on sampling is based on a frequentist approach to statistics. Although not explored in this analysis, MEMPR could also consider a Bayesian statistical approach if they choose to explore sampling approaches in more detail. Whereas the frequentist approach is based on testing hypothesis (e.g. has the target for new commercial buildings been met), a bayesian approach is based on probabilities (e.g. with what probability do we believe the target for new commercial buildings has been met).

Table 14: Number of samples required to measure progress towards Targets

	Final Target in 2010	Intermediate Target in 2007	Standard Deviation	Required Samples in 2007	Required Samples in 2010
Existing Houses	2.0%	1.3%	33%	5,162	2,529
Existing MURB	1.5%	1.0%	24%	5,572	2,730
Existing Commercial	2.7%	1.8%	40%	3,870	1,896
New Houses	32.0%	21.3%	17%	20	10
New MURB	37.0%	24.7%	12%	8	4
New Commercial	20.0%	13.3%	20%	76	37

Sampling the energy efficiency of buildings and households could be conducted using energy efficiency audits or billing data from utilities. Each possibility is described in the following sections.

5.3.1 Sampling Based on Energy Efficiency Audits

Energy efficiency audits directly reveal the energy efficiency of a building using a blower door test and an inspection of heating, cooling, and water heating equipment (typical audits do not measure electrical appliance efficiency). Efficiency Vermont uses an energy audit approach to track the efficiency of new housing in the State. Audits are relatively expensive, and so are most effective for small sample sizes.[26] Because they require contact with building owners however, their value can be enhanced beyond simple data collection. For example, by including a questionnaire designed to foster understanding of reasons for changes in energy efficiency (policies, prices, etc.) delivery agents could gain better understanding of program effectiveness, and building owners could gain a better understanding of energy efficiency objectives.

Recognizing that these are preliminary estimates, sampling costs for an auditing approach can be estimated using the sample requirements in Table 14 and audit costs of $200 per audit for houses and MURB units, and $500 per audit for commercial buildings. For existing buildings, a sampling plan would require expenditures totaling about $4 million in 2007 and $2 million in 2010. For new buildings, the sampling plan would require expenditure totaling about $44 thousand in 2007 and $21 thousand in 2010. Sampling costs for new buildings are much lower because the magnitude of the improvement expected is much greater than for existing buildings. A total expenditure of about $50,000 may be a reasonable expenditure for MEMPR in identifying whether Targets for new buildings are being met. Based on the cost for existing buildings (in the range of $5 million), a sampling approach of this scale would seem unreasonable given only $90 million is spent on energy efficiency programs. It should be stressed that these are preliminary estimates, and are not reflective of a comprehensive statistical design.

Although a considerable amount of energy audit data is already available through existing programs (e.g. EnerGuide for existing and new homes, BOMA GoGreen, CBIP, etc.), these sources are not well suited to sampling approach. The primary problem with all of these sources

[26] A typical household audit costs $100-250, depending on the information provided. An energy efficiency audit of a commercial building can vary widely in cost, depending on the level of detail. Natural Resources Canada (1994) reports that building audits vary in cost from about $250 for a “Yardstick” audit to over $50,000 for a detailed “Engineering” audit.

is that they do not represent a random sample, and therefore are unlikely to represent the overall building stock. For example, the participants in the EnerGuide for existing homes program are skewed towards older homes that have not undergone any recent energy related improvements, so they are unlikely to adequately account for newer homes or homes that have recently been retrofitted. The EnerGuide for new homes program does keep data on new homes, but this is skewed towards more efficient homes and would not be representative of all new homes. If a random sampling approach proves to be cost prohibitive, it would be possible to develop an approach that relied on these types of program data, but that option has not been investigated as part of this analysis.

5.3.2 Sampling Based on Billing Data

Billing data from electricity and natural gas utilities combined with data on floor space of those buildings from BC Assessments could provide an alternate approach to measure changes in building energy efficiency. Given that this data is already collected by all of BC's utilities, obtaining the raw data should be cheaper than an auditing approach (especially when larger samples are required). The specific costs to the utilities and BC Assessments have not been explored in detail, but once collected and assembled, the billing data could be used in the same way that audit results would allow the progress towards the targets to be evaluated.

Although they have not been explored in detail, the following challenges would all need to be addressed prior to proceeding with a sampling approach based on billing data. These challenges are not present in an audit-based approach. These challenges would likely result in a greater variation in the energy consumption data, which would necessitate more samples to have reasonable confidence in the results.

- Energy consumption is strongly influenced by annual changes in climate (e.g. warmer winters lead to reduced heating demands), so billing data would need to be weather normalized to allow for meaningful comparisons. Without this normalization, changes in heating degree days cause changes in energy consumption of upwards of 15%, which overwhelms the targeted annual improvements in energy efficiency.
- Utility billing data is only available for electricity and natural gas consumption, which omits other fuels such as wood and oil. These other fuels are approximately 5-10% of total provincial energy consumption in the residential and commercial sectors, so any billing data approach would have to account for this missing data.
- Currently, electricity and gas utilities in BC have independent billing systems that would need to be matched together to produce a comprehensive picture of energy use based on billing data. A similar challenge would need to be resolved with the BC Assessments data.
- To help evaluate progress towards the targets, all billing data would need to be available in categories that correlate with the targets (i.e. SFD/row housing, MURBs, commercial buildings). Based on discussions with BC Hydro and Terasen, there systems may have some different conventions for the splits between MURBs and commercial buildings, which would need to be resolved.

BC Hydro and Terasen both currently complete conservation potential reviews on a three to five year cycle. Although these are not currently integrated, they both make use of billing data, and could potentially serve as a starting point for a billing data approach.

6 Next Steps

Despite some of the concerns with data quality that have been discussed, it is important for BC to continue on a path of conducting province wide evaluation efforts that coordinate across energy types and delivery agents. Without this coordinated approach, it will be difficult or impossible to understand the combined effect of the numerous individual programs. The following two sub-sections summarize the key opportunities to improve province wide evaluations.

6.1 Make improvements to existing evaluation processes

Improvements that will help reduce uncertainty and bias in evaluation results (Section 5.1):

- Work with NRCan to resolve the irregularities in the commercial sector data.
- Develop and adopt a standard evaluation methodology that can be applied to all energy-efficiency programs by all delivery agents, and ideally be comparable with other jurisdictions.

Improvements that will make the evaluation process more transparent and better aligned with overall MEMPR objectives (Section 5.2):

- Define the energy efficiency targets in terms of annual energy savings for partners and evaluators, and link the energy efficiency targets to other goals such as greenhouse gas emission reductions.
- Develop a plan to show how each of the programs are supporting the various targets and how those program by program impacts will combine to help achieve the targets.
- Consider adopting greenhouse gas emissions reduction targets for buildings in BC to complement the energy savings targets already in place.
- Improve the public availability of evaluation results so that interested parties are able to easily access an overall assessment of evaluation efforts in the province and then be linked to more in depth evaluation material if desired.

Improvements that will provide additional evaluation tools to augment the inherent limitations of existing approaches (Section 5.3):

- Consider using sampling approaches to evaluation to further improve the ability to evaluate improvements in energy efficiency. These options have only been investigated at a preliminary level at this point, but at a minimum there would appear to be cost-effective opportunities to evaluate improvements in energy intensity for new buildings using a sampling approach.

6.2 Continue to assess the adequacy of the targets

Improved energy efficiency of buildings is often pursued by public agencies as a means for gaining wider societal goals (e.g. greenhouse gas emissions reductions, cleaner air, land and water, and decreased energy costs for citizens). While this report is focused on evaluating whether energy efficiency activities are sufficient to meet the energy savings targets, questions regarding the adequacy of the targets have arisen frequently enough that they merit some discussion. In particular, it is important to consider the broader societal goals that the targets are intended to support and whether or not the targets could be providing greater support to those goals. This first question is a constant challenge for all public agencies and usually broached through surveys, stakeholder discussions, public consultations, and elections. The answers tend to involve tradeoffs by each member of society between competing financial, environmental and lifestyle values.

The second question is more relevant to this research because evaluation can help point to opportunities for stronger targets. The building targets will ideally push the market beyond what would have been achieved in the absence of policies and program while still being achievable. The answer to "what is achievable" will shift with time, so it is important to periodically revisit the question. This can be accomplished through ongoing examination of the conservation potential reviews by BC utilities and the targets proposed and implemented elsewhere (e.g. Ontario and Nova Scotia residential building codes, Washington and California Green Building policies, 2030 Challenge recently adopted by the American Institute of Architects and US Conference of Mayors).[27] The fact that the targets for existing buildings are already being exceeded and that the targets do not consider strategies that would reduce the footprint of buildings or neighborhoods illustrate why they could possibly be stronger, while still be achievable.

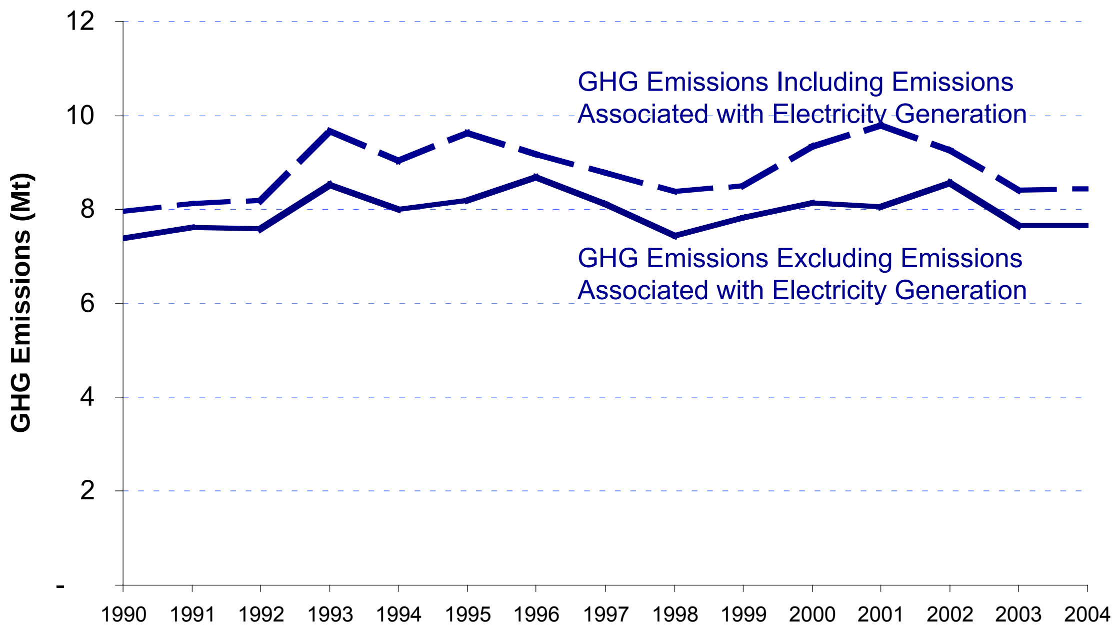
[27] California Executive Order S-20-04 sets a goal of reducing energy use in state-owned buildings by 20 percent by 2015 (from a 2003 baseline) and encourages the private commercial sector to set the same goal.

Architecture 2030 sets a 2030 challenge of Net Zero energy for new homes by 2030, and existing buildings (equal in area to the building area of new buildings each year) be renovated annually to emit 50% of the GHG emissions currently being produced.

Appendix A: Greenhouse Gas Emissions Trends

Consumption of fossil fuel based energy produces greenhouse gas emissions. Buildings in British Columbia produced about 7.7 megatonnes (Mt) of greenhouse gas emissions in 2003 as a result of fossil fuel consumption, an increase of about 4% since 1990. Consumption of electricity also produces indirect GHG emissions, depending on how electricity is generated.[28] When indirect emissions are included, buildings in British Columbia produced about 8.4 Mt of GHG in 2003. Trends in emissions are shown in Figure 11, both including and excluding indirect emissions.

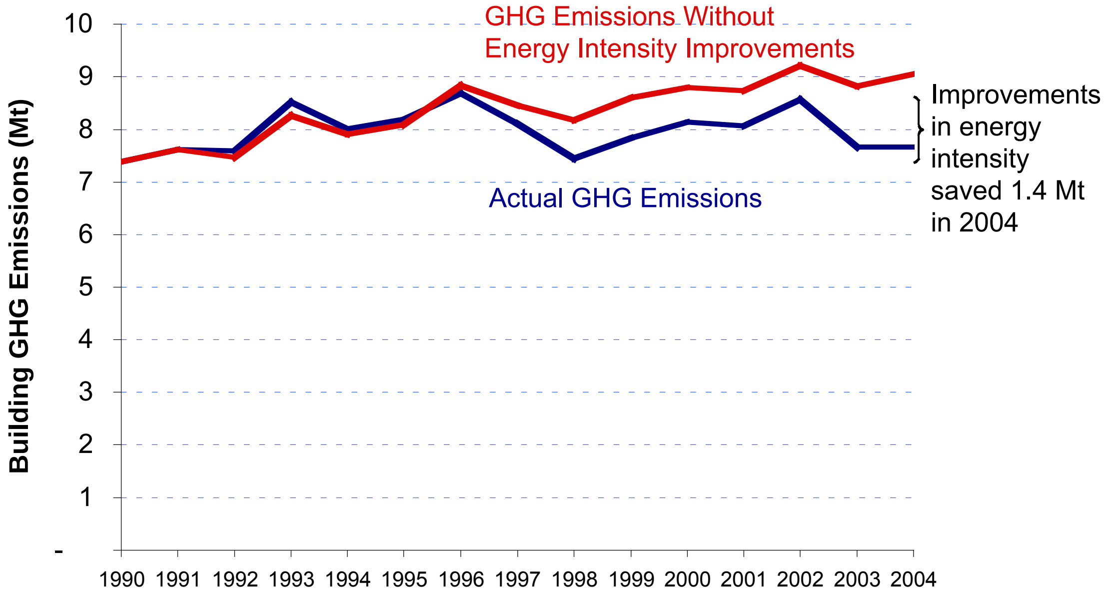
Figure 11: Greenhouse gas emissions from buildings in British Columbia, 1990-2004



Based on the decomposition analysis, direct greenhouse gas emissions would have been about 1.2 Mt higher if energy intensity had not improved since 1990, as shown in Figure 12. Greenhouse gas emissions in British Columbia buildings have also fallen because of fuel-switching away from fuels like heating oil and wood into natural gas and electricity.

[28] Indirect emissions are calculated using an average electricity generation emissions intensity from Natural Resources Canada's Comprehensive Energy Use Database. The average electricity generation emissions intensity in 2003 was 6.7 tonnes of CO_2 per TJ of electricity generated. The intensity fluctuates from year-on-year due to changes in the mix between fossil fuels and hydro power for electricity generation.

Figure 12: Greenhouse gas emissions from buildings in British Columbia, excluding indirect emissions from electricity, 1990-2004



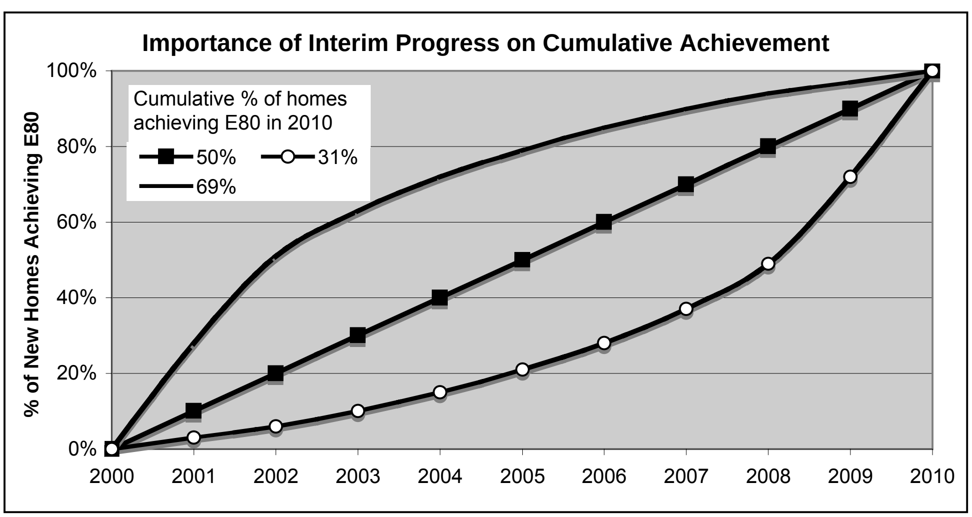
Appendix B: Developing Cumulative and Incremental Targets

To convert the targets from their original form (Table 1) to the point where they convey the information described in Section 2.2, two steps need to be taken:

Convert energy rating improvements to reduction in energy consumption: The new building targets are expressed in terms of percentage of buildings achieving a certain energy rating (e.g. 100% of new homes achieving E80). These have been converted to reductions in energy consumption to allow comparisons with the existing buildings targets and clearly indicate the degree of energy savings anticipated. An ancillary benefit of this conversion is that the majority of available evaluations report results in terms of energy savings. The energy rating targets can also be problematic because measuring partial progress can be misleading. For example, in a scenario where 100% of homes had achieved an EnerGuide rating of 79 by 2010, none of those houses would have met the E80 target, but significant progress would have actually been made.

Assume rates of progress towards targets: None of the targets detail how quickly progress will be made in the years leading up to the target. This omission is particularly important for new buildings because the assumed rate of progress dictates the cumulative energy savings (which aren't defined by the current targets). To illustrate this issue, Figure 13 shows three hypothetical progress curves towards achieving 100% E80 certification in 2010 (assuming an equal number of homes constructed per year). The numbers in the top left corner indicate the percentage of cumulative new homes that would have achieved E80 in 2010. This research has assumed a steady rate of progress between the baseline (2001) and the target year (2010) for all six sectors, and growth rates are based on BC Hydro's Conservation potential review (2002).

Figure 13 – Importance of Interim Progress on Cumulative Energy Savings



Appendix C: Percentage Energy Savings Targets

Table 15 – Incremental and Cumulative Percentage reductions in energy consumption in 2010 relative to 2001

	Incremental Targets			Cumulative Targets		
Building Type	**New Buildings**	**Existing Buildings**	**All Buildings**	**New Buildings**	**Existing Buildings**	**All Buildings**
SFD/Row	32.0%	0.2%	1.2%	18.3%	2.0%	5.3%
MURBs	37.0%	0.2%	1.2%	21.6%	1.5%	5.3%
Commercial	20.0%	0.3%	0.8%	11.6%	2.7%	4.4%
All	28.7%	0.2%	1.0%	16.4%	2.2%	5.0%

Table 16 – Incremental and Cumulative Percentage reductions in energy consumption in 2009 relative to 2001

	Incremental Targets			Cumulative Targets		
Building Type	**New Buildings**	**Existing Buildings**	**All Buildings**	**New Buildings**	**Existing Buildings**	**All Buildings**
SFD/Row	28.4%	0.2%	1.0%	16.4%	1.8%	4.4%
MURBs	32.9%	0.2%	1.1%	19.3%	1.3%	4.4%
Commercial	17.8%	0.3%	0.8%	10.5%	2.4%	3.8%
All	25.2%	0.2%	1.0%	14.7%	2.0%	4.2%

Table 17 – Incremental and Cumulative Percentage reductions in energy consumption in 2008 relative to 2001

	Incremental Targets			Cumulative Targets		
Building Type	**New Buildings**	**Existing Buildings**	**All Buildings**	**New Buildings**	**Existing Buildings**	**All Buildings**
SFD/Row	24.9%	0.2%	0.9%	14.6%	1.6%	3.6%
MURBs	28.8%	0.2%	0.9%	17.1%	1.2%	3.5%
Commercial	15.6%	0.3%	0.7%	9.3%	2.1%	3.2%
All	22.1%	0.2%	0.9%	13.0%	1.7%	3.5%

Table 18 – Incremental and Cumulative Percentage reductions in energy consumption in 2007 relative to 2001

	Incremental Targets			Cumulative Targets		
Building Type	**New Buildings**	**Existing Buildings**	**All Buildings**	**New Buildings**	**Existing Buildings**	**All Buildings**
SFD/Row	21.3%	0.2%	0.8%	12.7%	1.4%	2.9%
MURBs	24.7%	0.2%	0.8%	14.9%	1.0%	2.8%
Commercial	13.3%	0.3%	0.7%	8.1%	1.8%	2.6%
All	18.9%	0.2%	0.8%	11.4%	1.5%	2.8%

Table 19 – Incremental and Cumulative Percentage reductions in energy consumption in 2006 relative to 2001

	Incremental Targets			Cumulative Targets		
Building Type	New Buildings	Existing Buildings	All Buildings	New Buildings	Existing Buildings	All Buildings
SFD/Row	17.8%	0.2%	0.7%	10.8%	1.1%	2.3%
MURBs	20.6%	0.2%	0.7%	12.7%	0.8%	2.1%
Commercial	11.1%	0.3%	0.6%	6.9%	1.5%	2.1%
All	15.8%	0.2%	0.7%	9.7%	1.2%	2.2%

Table 20 – Incremental and Cumulative Percentage reductions in energy consumption in 2005 relative to 2001

	Incremental Targets			Cumulative Targets		
Building Type	New Buildings	Existing Buildings	All Buildings	New Buildings	Existing Buildings	All Buildings
SFD/Row	14.2%	0.2%	0.6%	9.0%	0.9%	1.7%
MURBs	16.4%	0.2%	0.5%	10.4%	0.7%	1.5%
Commercial	8.9%	0.3%	0.5%	5.7%	1.2%	1.6%
All	12.6%	0.2%	0.6%	8.0%	1.0%	1.6%

Table 21 – Incremental and Cumulative Percentage reductions in energy consumption in 2004 relative to 2001

	Incremental Targets			Cumulative Targets		
Building Type	New Buildings	Existing Buildings	All Buildings	New Buildings	Existing Buildings	All Buildings
SFD/Row	10.7%	0.2%	0.5%	7.2%	0.7%	1.1%
MURBs	12.3%	0.2%	0.4%	8.3%	0.5%	1.0%
Commercial	6.7%	0.3%	0.4%	4.5%	0.9%	1.1%
All	9.5%	0.2%	0.5%	6.4%	0.7%	1.1%

Table 22 – Incremental and Cumulative Percentage reductions in energy consumption in 2003 relative to 2001

	Incremental Targets			Cumulative Targets		
Building Type	New Buildings	Existing Buildings	All Buildings	New Buildings	Existing Buildings	All Buildings
SFD/Row	7.1%	0.2%	0.4%	5.4%	0.5%	0.7%
MURBs	8.2%	0.2%	0.3%	6.2%	0.3%	0.6%
Commercial	4.4%	0.3%	0.4%	3.3%	0.6%	0.7%
All	6.4%	0.2%	0.4%	4.8%	0.5%	0.7%

Table 23 – Incremental and Cumulative Percentage reductions in energy consumption in 2002 relative to 2001

	Incremental Targets			Cumulative Targets		
Building Type	New Buildings	Existing Buildings	All Buildings	New Buildings	Existing Buildings	All Buildings
SFD/Row	3.6%	0.2%	0.3%	3.6%	0.2%	0.3%
MURBs	4.1%	0.2%	0.3%	4.1%	0.2%	0.3%
Commercial	2.2%	0.3%	0.3%	2.2%	0.3%	0.3%
All	3.2%	0.2%	0.3%	3.2%	0.2%	0.3%

Appendix D: Baseline and Targeted Energy Consumption

Figure 14 – Baseline cumulative energy consumption by year and sector

			01/02	02/03	03/04	04/05	05/06	06/07	07/08	08/09	09/10	10/11
Baseline Cumulative Energy Consumption (PJ)	New	SFD / Row	0	3	5	8	11	14	17	20	23	26
		MURB	0	1	1	2	2	3	4	4	5	6
		Commercial	0	2	3	5	7	9	10	12	14	16
		Total	0	5	10	14	20	25	31	36	42	48
	Existing	SFD / Row	118	118	118	118	118	118	118	118	118	118
		MURB	25	25	25	25	25	25	25	25	25	25
		Commercial	122	122	122	122	122	122	122	122	122	122
		Total	265	265	265	265	265	265	265	265	265	265
	Total	SFD / Row	118	121	123	126	129	132	135	138	141	144
		MURB	25	25	26	27	27	28	28	29	30	30
		Commercial	122	124	126	127	129	131	133	135	137	139
		Total	265	270	275	280	285	290	296	302	307	313

Note 3: The baseline cumulative energy consumption is based on the assumption that no changes are made to the existing building stock and all new buildings are built to the same standard as an average building in 2001. These figures correspond with the blue lines in Figure 6.

Figure 15 – Targeted cumulative energy consumption by year and sector

			01/02	02/03	03/04	04/05	05/06	06/07	07/08	08/09	09/10	10/11
Targeted Cumulative Energy Consumption (PJ)	New	SFD / Row	0	3	5	7	10	12	15	17	19	21
		MURB	0	1	1	2	2	2	3	3	4	4
		Commercial	0	2	3	5	6	8	10	11	13	14
		Total	0	5	9	14	18	23	27	32	36	40
	Existing	SFD / Row	118	118	117	117	117	117	116	116	116	116
		MURB	25	25	25	25	25	25	25	25	25	25
		Commercial	122	122	122	121	121	121	120	120	119	119
		Total	265	265	264	263	263	262	261	261	260	259
	Total	SFD / Row	118	120	122	125	127	129	131	133	135	137
		MURB	25	25	26	26	27	27	28	28	28	29
		Commercial	122	124	125	126	127	128	130	131	132	134
		Total	265	269	273	277	281	285	288	292	296	299

Note: The targeted cumulative energy consumption matches with the red lines in Figure 6.

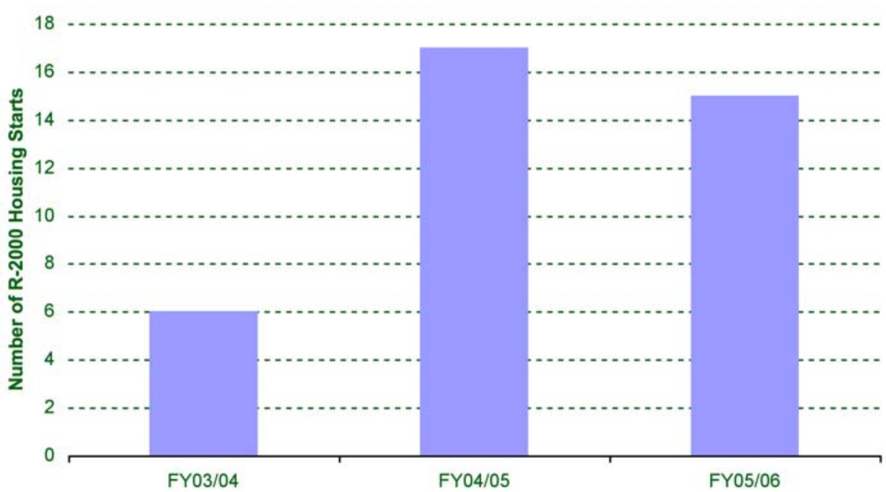
Appendix E: Description of Current Programs

R-2000 Program and the EnerGuide for New Houses Program

The R-2000 program is a voluntary program administered by Natural Resources Canada. It is designed to encourage Canadian builders to build, and Canadian consumers to purchase, homes that are more energy efficient than required by current Canadian building codes. NRCan trains and licences R-2000 homebuilders and provides third-party quality assurance by testing and certifying R-2000 homes.

Since 1982/83, almost 700 houses have been certified R-2000 in British Columbia (less than 0.1% of the total single family detached housing stock). Figure 16 shows the uptake of R-2000 houses in British Columbia since 2003. Assuming an average savings of about 25 GJ per year per R-2000 house, total energy savings due to the R-2000 program are crudely estimated at about 17.5 TJ in 2005.

Figure 16: Number of R-2000 Housing Starts in British Columbia, FY2003/04-FY2005/06



Source: Natural Resources Canada.

The EnerGuide for New Houses program is a voluntary energy performance rating and labelling scheme designed to encourage Canadian builders to build, and Canadian consumers to purchase, more energy efficient homes. Ratings are calculated by professional EnerGuide for New Houses advisors who analyze building plans, provide upgrade recommendations to improve energy efficiency, and complete a test to confirm the air tightness of the home once it has been built. The EnerGuide for new houses program is targeted at large-volume, mass-market builders.

The results of the EnerGuide for New Houses program in British Columbia are shown in Table 24. British Columbia represents only 1% of the total EnerGuide for New Houses evaluations in

Canada since 2004, well below average. Assuming average new home construction has an EnerGuide rating of 70, the total energy savings attributable to the EGNH program is about 300 GJ in 2005.

Table 24 - Results of EnerGuide for New Houses Program in British Columbia, 2004-2006

	Average Rating	# of Evaluations
2004	N/A	0
2005	78	14
2006	78	25

Source: Natural Resources Canada.

Both the EnerGuide for New Houses program and the R-2000 program are administered by the Canadian Home Builders' Association of British Columbia. The CHBA-BC receives core funding of about $50,000 annually from Natural Resources Canada to deliver these programs. Since 2005-06, the CHBA-BC has also received funding from MEMPR through the Opportunities Envelope funding to advance these programs. Funding is spent roughly equally on administration (25%), file management and quality assurance (25%), technical support and training (25%), and marketing (25%).

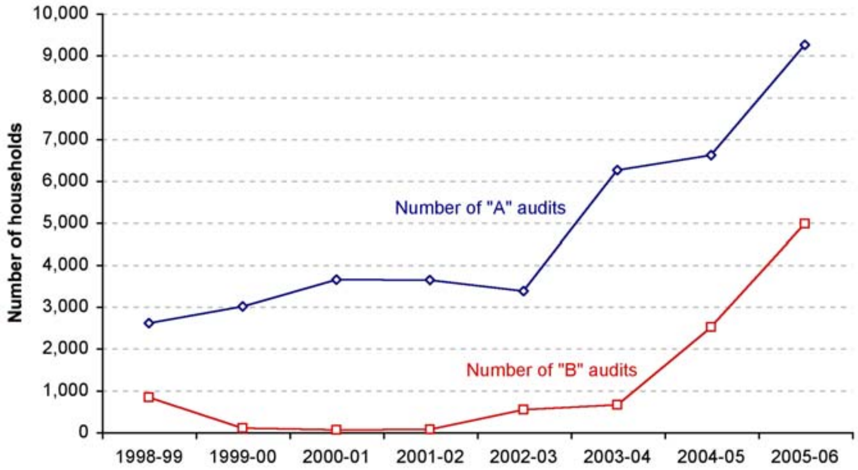
EnerGuide for Houses Program

The EnerGuide for Houses (EGH) program was initiated in 1998 and provides personalized expert advice to Canadian homeowners on how to best improve the energy performance of their houses. Under EGH, a retrofit incentive was officially launched in 2003, which allows homeowners to qualify for a grant when they improve the energy efficiency of their homes through retrofits. The size of the grant is based on the improvement in the home's energy efficiency rating resulting from the retrofit, and is calculated by comparing the pre-retrofit EGH evaluation (called an "A" audit) with another evaluation conducted after the retrofit (called a "B" audit). In May 2006, the federal government terminated financial support for any housing assessments not already completed, and although the rating system is still being supported, the long-term future of the program is unclear.

From program inception until the end of FY 2005-06, about 38,000 EGH "A" audits were conducted in the province, and almost 10,000 EGH "B" audits were conducted (a "B" audit is only performed if some of the measures recommended following the "A" audit are adopted). Following the provision of the EGH grant by the federal government in late 2003, the number of houses undertaking energy efficiency retrofits following "A" audits increased substantially. The number of "A" and "B" audits conducted every year since 1998 is shown in Figure 17.[29]

Figure 17: Number of EnerGuide "A" and "B" audits conducted in British Columbia from FY 1998-99 to FY 2005-06

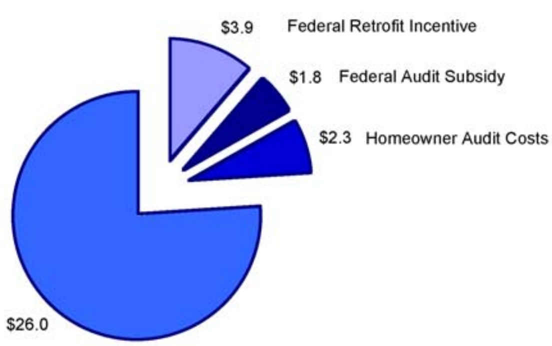
[29] Jeff Murdoch, Vice President of Building Insight Technologies, claims that between 70-80% of households receiving "A" audits from HomePerformance in 2004 and 2005 undertook retrofits and received "B" audits.



Source: Natural Resources Canada EnerGuide for Houses database.

The total value of EGH grants paid to homeowners in British Columbia in FY 2005-06 was about $3.9M, for an average grant value of about $800 per household.[30] It is estimated that this grant represents only about 10 to 20 percent of total household spending on retrofits. In addition, households in BC spent about $160 per household on "A" and "B" audits, for a total of about $2.3M.[31] The federal government supplemented the amount spent on "A" audits by homeowners by subsidizing auditing firms a total of about $1.8M.[32] In total, spending on retrofits that were part of the EGH program is estimated at $34.0M in FY 2005-06, with about 17% of costs covered by the federal government.

Figure 18: Estimated spending on EnerGuide for Houses Program in British Columbia, FY 2005-06 (millions of dollars)



Source: Federal retrofit incentive calculated from Natural Resources Canada EnerGuide for Houses database; Federal audit subsidy estimated assuming an average of $125/audit; Homeowner audit costs estimated assuming an average of $160/audit; Homeowner retrofit costs estimated assuming that federal retrofit grant covers 15% of total retrofit costs.

[30] Personal communication with Suzanne Deschenes, Manager of the Existing Houses Program, Natural Resources Canada. Jeff Murdoch, Vice President of Building Insight Technologies, provided evidence that the size of the retrofit incentive provided to BC homeowners has grown significantly over time and continues to grow.

[31] Based on national estimates of total spending in "EnerGuide for Houses Program: Analytical Report", STATPLUS, March 31, 2005.

[32] Based on a federal subsidy of $125 per audit as estimated by HomePerformance (personal communication with Jeff Murdock, May 31, 2006).

Natural Resources Canada estimates that because of the retrofits performed in FY 2005-06 in British Columbia, home energy consumption was reduced by about 342 TJ annually, or about 69 GJ per participating household, which corresponds to an average saving of about 33%. As a result of the energy savings, Natural Resources Canada calculates that homeowners will save about $3.5M per year in energy costs, or about $700 per household annually. Assuming a 20-year equipment lifetime, and discounted at 8%, this represents energy savings of about $37M over the life of the retrofits. There is some evidence that estimates of energy savings provided by Natural Resources Canada are overly optimistic, since they are based on “average households”, which may not reflect actual occupancy or use, and do not factor in rebound effects.[33] The cost effectiveness of the EGH program is not clear, since it is difficult to estimate the incremental effect of the program (i.e., distinguish between those consumers that would have conducted the retrofits even without the grant from those that required the grant to conduct the retrofits).

Commercial Building Incentive Program (CBIP) for New Buildings

The **Commercial Building Incentive Program (CBIP),** offered by Natural Resources Canada's Office of Energy Efficiency (OEE), encourages the design and construction of new, energy-efficient commercial, institutional and multi-unit residential buildings and facilities. CBIP provides design assistance and funding of up to $60,000, with funding amount based on building energy savings.

New or extensively renovated industrial, commercial or institutional buildings that are heated and/or cooled, intended for occupancy, and constructed to CBIP criteria are eligible. For this evaluation, all savings are assumed to meet criteria for new building targets, rather than for existing buidings. Further refinement of this work should consider differentiating savings into new and existing buildings.

The building design must demonstrate a reduction in energy use by at least 25 percent when compared with the requirements of the Model National Energy Code for Buildings (MNECB). CBIP helps offset the extra cost of designing energy-efficient buildings by providing financial incentives, calculated as a one-time amount equal to twice the difference between the estimated annual energy costs if the building were constructed to the MNECB standard, to a maximum of $60,000 or the total design costs, whichever is less. The program runs from April 1, 1998, to March 31, 2007.

The table on the following page presents the energy savings in GJ and as a fraction of MNECB energy consumption, for buildings in BC that received CBIP funding. This information was provided by OEE staff. The estimates of CBIP incentives are the authors’ calculations calculated as the minimum of $60,000 or twice the annual $ saved, as provided by NRCan. This value might over-estimate the CBIP incentive since the calculation does not account for design costs, which might be lower than the calculated incentive amount

The buildings that received incentives in BC could also be eligible for incentives from BC Hydro, Terasen Gas and/or Fortis BC. The energy savings reported below are by building rather than by specific program. Some double-counting may occur between these numbers and the energy

[33] Based on comments from HomePerformance (personal communication with Jeff Murdock, May 31, 2006).

savings reported by utility, if the same building also received incentives from one or more of the utilities.

Table 25 - Results of Commercial Building Incentive Program in British Columbia, 2002-2006, commercial and mixed use (commercial and residential) buildings

Building Type		2002	2003	2004	2005	2006	Cumulative Savings
Airport Terminal	Energy Savings (GJ)	13,413					13,413
	CBIP incentive	$60,000					
Hotels/Motels	Energy Savings (GJ)				4,566		4,566
	CBIP incentive				$60,000		
Institution	Energy Savings (GJ)					4,608	,608
	CBIP incentive					$60,000	
Library / Police Station	Energy Savings (GJ)		1,515			1,005	2,520
	CBIP incentive		$31,146			$34,354	
Office	Energy Savings (GJ)	22,913	12,701	5,552	3,136		44,302
	CBIP incentive	$512,996	$184,540	$78,792	$72,905		
Office Retail MURB	Energy Savings (GJ)			7,012	3,149		10,161
	CBIP incentive			$60,000	$55,670		
Recreation	Energy Savings (GJ)	4,030					4,030
	CBIP incentive	$60,000					
Retail	Energy Savings (GJ)	5,867					5,867
	CBIP incentive	$60,000					
Supermarket	Energy Savings (GJ)					1,845	1,845
	CBIP incentive					$14,306	
Warehouse	Energy Savings (GJ)					435	435
	CBIP incentive					$16,262	
Education / Lab / Church	Energy Savings (GJ)	1,790	8,589	11,609	22,372	22,835	67,195
	CBIP incentive	$60,000	$130,563	$156,901	$210,285	$256,617	
Health Care / Hospital	Energy Savings (GJ)	2,347				35,753	38,100
	CBIP incentive	$51,689				$201,894	
TOTAL Energy Savings (GJ)		50,360	22,804	24,173	33,223	66,482	197,042
TOTAL CBIP incentive		$804,685	$346,249	$295,693	$398,860	$583,433	

Notes: Energy savings are the estimated annual savings for the buildings receiving incentives in that year, based on the building design information. CBIP incentive is the authors' estimate, calculated as the minimum of $60,000 or twice the annual $ saved, as provided by OEE. This value is reported in nominal dollars.

Table 26 - Results of Commercial Building Incentive Program in British Columbia, 2002-2006, multi-unit residential buildings

Building Type		2002	2003	2004	2005	2006	Cumulative Savings
MURB	Energy Savings (GJ)		13,623	2,276			
	CBIP incentive		$240,702	$48,641			

Notes: Energy savings are the estimated annual savings for the buildings receiving incentives in that year, based on the building design information. CBIP incentive is the authors' estimate, calculated as the minimum of $60,000 or twice the annual $ saved, as provided by OEE. This value is reported in nominal dollars.

EnerGuide for Existing Buildings

EnerGuide for Existing Buildings (EEB), formerly known as the Energy Innovators Initiative, works with a network of partners and service providers across Canada to provide financial assistance, publications, training and tools for commercial business, public institutions and other eligible organizations (such as some industrial offices and crown corporations). OEE provides financial incentives for

> *Planning*: Organizations undertaking energy management plans, audits, feasibility studies and other retrofit planning activities can receive up to 50 percent of eligible costs or up to $1 per gigajoule of annual energy consumption in the affected buildings – whichever amount is less – to a maximum of $25,000. All projects must be completed by March 31, 2007.
>
> *Implementation*: This incentive can be used to help pay for costs related to management, materials, labour, monitoring and tracking, staff training, awareness and for other retrofit implementation projects. Measures for efficient lighting, the building envelope, motors, controls, heating, ventilating, air conditioning and other energy-saving projects may be eligible. Organizations can receive up to $7.50 per gigajoule of annual energy savings or up to 25 percent of eligible costs – whichever amount is less – to a maximum of $250,000.

OEE provided the following estimates of annual energy savings, by year that the funding was provided, OEE incentives and customer capital costs.

iscal Year	1999/2000	2000/2001	2001/2002	2002/2003	2003/2004	2004/2005	2005/2006
IRCan ncentive	$590,436	$0	$750,000	$908,210	$564,774	$1,394,316	$722,040
lient nvestment	$9,055,804	$0	$9,636,832	$12,370,863	$9,591,804	$20,580,846	$9,296,353
nergy aved (GJ)	45,170	0	105,489	135,757	84,957	202,712	101,088

The buildings that received incentives in BC could also be eligible for incentives from BC Hydro, Terasen Gas and/or Fortis BC. The energy savings reported below are by building rather than by specific program. Some double-counting may occur between these numbers and the energy savings reported by utility, if the same building also received incentives from one or more of the utilities.

British Columbia Provincial Sales Tax Exemptions

The Social Service Tax Act provides an exemption from provincial sales tax (PST) for:

- Prescribed energy conservation materials and equipment that prevent heat loss from a building such as insulation and windows.
- Prescribed residential energy efficient furnaces, boilers and heat pumps.
- Prescribed alternative energy sources.

Exemptions for energy efficient equipment began in 1981 and have been amended several times since then.

Where possible, data on shipments and prices of exempt equipment have been used to estimate total foregone revenue from provincial tax exemptions. In some cases, such data was not available, so estimates of foregone taxation revenue are based on estimates of shipments developed from other data. As such, there is significant uncertainty surrounding the estimates of foregone revenue.

As shown in the table, we estimate total foregone revenue of $48.9 million in FY 2005-06 as a result of exemptions to the provincial sales tax for energy efficient equipment. Because of lack of reliable data, there is uncertainty in this estimate. We estimate that the true total foregone revenue lies between $24.1 million and $90.0 million.

No attempt has been made to estimate savings in energy resulting from the tax exemptions, since no data is available on the degree to which tax exemptions affect behaviour. However, it is important to note that the tax exemption for both site-assembled and manufactured windows causes no incremental improvement in energy efficiency, since these products are also regulated under the British Columbia Building Code. It is also important to note that the tax exemptions described here overlap with other energy efficiency measures in the province. For example, incentives for condensing furnaces are provided by Terasen Gas and by the federal government (as part of the EnerGuide for Houses retrofit incentive) as well as through provincial sales tax exemptions.

Equipment	Foregone Revenue, FY 2005/06
Condensing Furnaces	$1.8 M
Air-source Heat Pump	$0.3 M
Ground-source Heat Pump	$0.2 M
Manufactured Windows	$19.7 M
Site-assembled Windows	$21.1 M
Insulation	$5.9 M
Total	**$48.9 M**

BC Hydro PowerSmart Programs

BC Hydro's current DSM program was started in 2001 and consists of two elements - Energy Efficiency 2 (EE 2) and Load Displacement 2 (LD 2). The following make up the EE 2 programs:

(1) Industrial – Power Smart Partners and High Performance Buildings

(2) Commercial – Power Smart Partners, Schools, Universities and Hospitals (SUCH), Product Incentive, High Performance Buildings, Small Business Compact Fluorescent Lighting (program terminated) and Traffic Light (program terminated); and

(3) Residential – Compact Fluorescent Lighting, Refrigerator Buy Back, Seasonal Light Emitting Diode, New Home, Renovation Rebate, Fuel Substitution and Variable Speed Motors.

Industrial programs and the Commercial Traffic Light Program are excluded from this review since they are beyond the scope (focus on commercial and residential buildings). The LD 2 programs are also for large industrial customers are excluded. The following subsections describe the remaining programs. BC Hydro also ran its PowerSmart Legacy programs from 88/89 through 01/02. Cumulative savings have been substantial but are not included in this report because the focus is on energy efficiency programs that have started since 2001.

The BC Hydro program evaluation of energy savings and costs was compiled on a program basis. Since the programs often include actions that apply to more than one of the BC Building targets, we provided rough estimates of the savings by target in Appendix H. Conversation with BC Hydro staff helped determine which targets were covered by each program. For each program that covered multiple targets, energy savings were estimated by target by using the fraction of electricity consumption in 2005 of each target types (new residential buildings, existing residential buildings, new commercial buildings, existing commercial buildings, new residential MURBs, existing MURBs).

CFL Program

This program had dual motivations of increasing the number of CFLs used by residential customers and helping transform the market so that energy efficiency lighting becomes the standard lighting option. The program used variety of levers including distribution of vouchers, incentive coupons, educational material, and in-store give-away events. In the last few years, the in-store give-away events have comprised the largest amount of staff resources and program expenditures. As it moves into its second phase, the program is expected to shift away from in-store give-away events to focusing more on discount coupons and advertising.

Year	f2002/03	f2003/04	f2004/05	f2005/06
Annual Savings - GWh	39	134	137	30
- TJ	140	482	493	106
Program and Admin. Costs (thousand $ nominal)	7,528	13,316	4,047	2,023
Customer Costs (thousand $ nominal)	5,060	14,330	7,341	4,359

Relevant Targets – SFD – existing and new, MURB – existing and new

Home Energy Upgrade (Renovation Rebate program)

This program, using a combination of education, information, incentives and collaboration with retailers and manufacturers, aims to stimulate the investment in energy efficient windows and insulation during home renovations. The program provides information through print advertising, bill inserts, web-site and in-store, point of purchase materials. Customers with electric heating that conduct specific window and insulation upgrades will qualify for incentives.

From BC Hydro's Revenue Requirement Application 2004/05 and 2005/06, Volume 2, Appendix N "BC Hydro's participation in the renovation market ensures its voice is heard in regards to the adoption of higher efficiency standards, much like how another program, the original Power New Home Program, positively influenced insulation standards for the last version of the BC Building Code."

Year	f2002/03	f2003/04	f2004/05	f2005/06
Annual Savings - GWh	3	0	1	1
- TJ	11	0	4	3
Program and Admin. Costs (thousand $ nominal)	267	448	354	306
Customer Costs (thousand $ nominal)	135	31	214	80

Relevant Targets – SFD – existing

New Home Program

This program is directed at builders and developers of new homes. BC Hydro provides incentives and marketing material (signs for display at developments) to builders who install Power Smart packages of energy efficient products. The program staff work with developers to gain their support. Advertising is used to help educate new home purchasers to provide market pull through demand for energy efficient products. BC Hydro notes that a critical feature of the program is that it helps maintain provincial standards (BC Building Code) and influence the adoption on energy efficiency requirements in future Building Code revisions. BC Hydro's New Homes program that ran from 1994 through 2002 was credited (by BC Hydro) with having a positive influence on insulation standards in latest version of the BC Building Code.

Year	f2002/03	f2003/04	f2004/05	f2005/06
Annual Savings – GWh	10	4	4	6
- TJ	36	14	14	21
Program and Admin. Costs (thousand $ nominal)	377	309	405	254
Customer Costs (thousand $ nominal)	950	736	968	1,290

Relevant Targets – SFD – existing and new, MURB – existing and new

Variable Speed Furnace Motor Program

This program works with Terasen Gas program promoting for high efficiency gas furnaces. BC Hydro, in partnership with NRCan, provides $150 rebate coupons toward qualifying VSFMs. Terasen's program takes on the majority of the program marketing so BC Hydro is able to offer the VSFM program at much lower cost. Estimates of energy savings from this program are provided to BC Hydro from Terasen Gas based on their analysis of the program. This co-ordination between utilities helps develop consistency in measurement of energy savings.

Year	f2002/03	f2003/04	f2004/05	F2005/06
Annual Savings – GWh	0	2	0	1
- TJ	0	7	0	3
Program and Admin. Costs (thousand $ nominal)	0	112	16	120
Customer Costs (thousand $ nominal)	0	468	0	184

Relevant Targets – SFD – existing and new

Refrigerator Buy Back Program

This program provides $30 rebate and free pick up of second operating fridge. The program was designed to run for 3 years in market, 4 years out of market, and then return for a final 3 years. Fiscal 2004/05 was designed as the final year of the first phase. This approach has been proven to be the most cost-effective approach based on the learning for the original program that ran in the 1990s. By coming in and out of the market, BC Hydro avoids spending fixed costs in years when activity slows down. When the program is relaunched in its second phase the pent-up demand fuels larger pick-up volumes. However, customers continued to request fridge pick up in f2005/06. The large number of these requests led BC Hydro to continue the program.

Year	f2002/03	f2003/04	f2004/05	f2005/06
Annual Savings - GWh	5	19	35	27
- TJ	18	68	126	96
Program and Admin. Costs (thousand $ nominal)	1,164	3,316	4,897	3,627
Customer Costs (thousand $ nominal)	159	220	331	-696

Relevant Targets – SFD – existing and MURB – existing

Seasonal Light Emitting Diode Program

Program uses incentives, mass advertising and product donations to educate and encourage residential customers to adopt seasonal LEDs for lighting displays.

Year	f2002/03	f2003/04	f2004/05	f2005/06
Annual Savings - GWh	0	9	12	2
- TJ	0	32	43	8
Program and Admin. Costs (thousand $ nominal)	556	710	807	1,090
Customer Costs (thousand $ nominal)	0	1,149	286	-152

Relevant Targets – SFD – existing and new, MURB – existing and new

Residential Electricity to Natural Gas Conversions

This section includes three programs (water heaters, dryers, and ranges), each of which offer incentives to home-owners on Vancouver Island and parts of the Sunshine Coast to purchase high-efficiency natural gas equipment. As with the *Vancouver Island New Home Furnace Program*, BC Hydro, NRCan and Terasen gas are partnering to deliver the programs. All three organizations contribute to incentives that are offered to homeowners that purchase and install high efficiency gas water heaters, dryers or ranges. Some appliance manufacturers also provide incentives. BC Hydro and Terasen Gas work with suppliers and installers to ensure adequate training, resources and awareness of the program.

At the 2006 BC Hydro hearing at the British Colombia Utilities Commission, BC Hydro provided the following response to an information request on the split.

> For the space heating portion of the program, BC Hydro and Terasen Gas each contribute $250 towards a customer incentive and $25,000 annually for marketing and promotions. For F2006, Natural Resources Canada (NRCan) and the Ministry of Energy Mines and Resources (MEMPR) contributed to the same level as the other partners.
> For the water heating portion of the program BC Hydro and Terasen Gas each contribute $200 towards a customer incentive and $40,000 annually towards marketing and promotion.
> In addition to the contributions described above, BC Hydro and Terasen Gas each incur additional labour and administrative costs related to the Fuel Substitution Program.[34]

Year	f2002/03	f2003/04	f2004/05	F2005/06
Annual Savings - GWh	0	0	2	2
- TJ	0	0	7	8
Program and Admin. Costs (thousand $ nominal)	0	86	229	140
Customer Costs (thousand $ nominal)	0	145	655	475

Relevant Targets – SFD – existing and new

[34] http://www.bcuc.com/Documents/Proceedings/2006/DOC_12197_B-11-13_SCCBCC-IR1-Resp.pdf

Schools, Universities, Colleges, and Hospitals Program

This is a modified version of the Power Smart Partners program – focused on schools, universities, colleges, and hospitals (SUCH). For this program, BC Hydro provides energy savings opportunities studies to interested institutions. The studies are fully funded by BC Hydro for SUCH participants compared to partial funding for non-SUCH participants.

Year	F2002/03	f2003/04	f2004/05	F2005/06
Annual Savings - GWh	51	2	30	18
- TJ	184	7	108	65
Program and Admin. Costs (thousand $ nominal)	4,098	2,410	3,951	6,039
Customer Costs (thousand $ nominal)	19,773	613	9,938	2,030

Relevant Targets – Commercial – existing

Power Smart Commercial (Smart Use)

The Power Smart Partners commercial and government program's objective is to encourage large customers (those with sales exceeding $50,000) to integrate energy efficiency into on-going business decisions. It comprises several elements – funds to help identify and implement energy savings, education and information (demonstration projects, case studies, skills training, employee awareness, energy manager training, and targeted seminars).

Year	f2002/03	f2003/04	f2004/05	f2005/06
Annual Savings - GWh	114	57	48	48
- TJ	410	205	173	173
Program and Admin. Costs (thousand $ nominal)	8,872	10,570	7,861	6,517
Customer Costs (thousand $ nominal)	42,964	19,751	15,920	11,085

Relevant Targets – Commercial – existing

Product Incentive Program

This program encourages industrial, commercial and government customers to complete simple energy efficiency retrofits – those that involved simple equipment changes but do not require a system redesign. BC Hydro has developed a list of specific products that qualify for each of Phase I (mostly lighting) and Phase II (examples include rooftop HVAC, occupancy sensors, controls, pumps and motors). Customers need to identify retrofit opportunities and apply for incentives on-line prior to purchasing the more efficient products, BC Hydro must approve the application to proceed with a pre-approved installation contractor or in-house staff, and the customer then send receipts to BC Hydro for incentive. BC Hydro will conduct random pre- and post-inspections.

Year	f2002/03	f2003/04	f2004/05	F2005/06
Annual Savings - GWh	0	2	8	15
- TJ	0	7	29	53
Program and Admin. Costs (thousand $ nominal)	15	587	1,276	1,260
Customer Costs (thousand $ nominal)	0	331	1,442	6,369

Relevant Targets – MURB – existing, Commercial – existing

Small Business Compact Fluorescent Lighting

This program is being cancelled. The low cost of CFLs currently means that BC Hydro's actions would lead to limited additional energy savings.[35]

Year	f2002/03	f2003/04	f2004/05	F2005/06
Annual Savings - GWh	0	5	3	0
- TJ	0	18	11	0
Program and Admin. Costs (thousand $ nominal)	0	169	521	9
Customer Costs (thousand $ nominal)	0	0	0	0

Relevant Targets – MURB – existing, Commercial – existing

High Performance Buildings

This program aims to increase adoption of energy efficiency into design objectives and of whole building integrated design. Owners, developers, engineers, architects, energy consultants and contractors will be targeted with focused education, tools and incentives. The program will establish a target energy efficiency level (a certain percent above baseline design) and provide financial incentives to incremental costs for meeting this target level. The program provides different incentives and tools for large and small customers.

[35] Derek Henriques. Personal Communication. November 2006.

Year	f2002/03	f2003/04	f2004/05	f2005/06
Annual Savings - GWh	0	3	2	0
- TJ	0	11	7	0
Program and Admin. Costs (thousand $ nominal)	0	74	400	288
Customer Costs (thousand $ nominal)	0	554	421	-6

Relevant Targets – Commercial – new

Additional Costs (not program specific)

In its Energy efficiency evaluation and planning, BC Hydro estimates costs that are not attributed to specific programs. The following table summarizes these costs for f2002/3 through f2005/6.

Year	f2002/03	f2003/04	f2004/05	f2005/06
Industrial Enabling Activities	1522	551	295	474
Commercial Enabling Activities	1454	512	964	1,216
Residential Enabling Activities	2300	393	164	287
Public Awareness and Communications	6582	6546	4118	4,607
Indirect and Portfolio Enabling Activities	11039	7421	6881	6,036

Fortis Residential Programs

The Fortis program evaluation of energy savings and costs was compiled on a program basis. Since the programs often include actions that apply to more than one of the BC Building targets, we provided rough estimates of the savings by target in Appendix H. For each program that covered multiple targets, energy savings were estimated by target by using the fraction of electricity consumption in 2005 of each target types (new residential buildings, existing residential buildings, new commercial buildings, existing commercial buildings, new residential MURBs, existing MURBs). The only exception was estimates for the heatpump program – since heatpumps uptake is occurring in more new homes than in existing, the energy savings for this program are split into targets based on the estimated energy saving targets (which include greater savings for new buildings).

Home Improvement Program / Watersavers

The HIP / Watersavers encourages energy and hot water savings through energy audits and hot water kits. Customers using all electric heat in their homes are eligible for a free Energy Audit of their home or a $50 contribution toward an Energy Audit and a free hot water kit. The Energy Audit identifies opportunities to save energy. Fortis provides grants (PowerSense rebates) to homeowners that install identified energy saving improvements; the grants cover 5 cents/kWh of electricity saved. Additionally, Fortis provides rebates of $1.50 per square foot of window for customers who purchase and install ENERGY STAR® approved windows, between September 15, 2005 and February 28, 2007. Funds for the windows are limited and available on a first-come first served basis.

Reported savings and costs:

Year	2002	2003	2004	2005
Annual Savings (GWh)	0.3	0.1	0.4	0.1
- TJ	1	0	1	0
Program and Admin. Costs (thousand $)	78	26	45	42
Customer Costs (thousand $)	40	41	84	32

New Home Program

This program provides high E window upgrade rebates of up to $2.50 per square foot of window for developers ($1.50 per square foot for home-owners) and a free CFL demonstration package of 10 lights valued at $100.

Reported savings and costs:

Year	2002	2003	2004	2005
Annual Savings (GWh)	0.5	0.8	1.7	1.2
- TJ	2	3	6	4
Program and Admin. Costs (thousand $)	87	146	370	318
Customer Costs (thousand $)	43	63	26	25

Heat Pumps Program

Fortis customers installing heat pumps (air and ground) are eligible for rebates based on 5 cents/kWh saved. The financial incentives are available as either cash grants (5 cents/kWh saved) or a loan for $5000 at 4.9% interest for a tern of 10 years.

Reported savings and costs:

Year	2002	2003	2004	2005
Annual Savings (GWh)	2.9	4.3	5.3	6.1
- TJ	10	15	19	22
Program and Admin. Costs (thousand $)	325	383	490	673
Customer Costs (thousand $)	346	532	760	840

Lighting Program

Fortis offers product rebates of $5 or 50% of the cost of compact fluorescent lights (CFL) or a grant of 5 cents/kWh saved with a 2 year minimum payback period.

Reported savings and costs:

Year	2002	2003	2004	2005
Annual Savings (GWh)	0.8	1.2	2.4	2
- TJ	3	4	9	7
Program and Admin. Costs (thousand $)	53	113	189	132
Customer Costs (thousand $)	53	113	189	132

Fortis Commercial Programs

Lighting Program

As with the residential program, Fortis offers product rebates of $5 or 50% of the cost of compact fluorescent lights (CFL) or a grant of 5 cents/kWh saved with a 2 year minimum payback period.

Reported savings and costs:

Year	2002	2003	2004	2005
Annual Savings (GWh)	1.9	4.2	4	3.3
- TJ	7	15	14	12
Program and Admin. Costs (thousand $)	193	318	276	282
Customer Costs (thousand $)	117	227	279	170

Building Improvements and New Facility Program

These programs consist of energy efficiency measures for building envelopes, heating, ventilation and air conditioning (HVAC), lighting, municipal water and sewer process, and pump load management. The measures include:

1. Covering 100% of the cost of walk-through energy audit or 50% of the cost of a comprehensive energy efficiency study, to a maximum of $5000 subject to funding availability.
2. Providing financial incentives for energy efficiency measures, which are based on the lesser of:

- 50% of the cost of improvements for existing facilities or 100% for incremental cost of new facilities
- 5 cents per kWh saved
- rebates for the amount required for a 2 year payback

3. Loans for energy efficiency improvements are available at cost of funds + 2%
4. Fortis provides optional energy efficiency services for all general service customers. These services include a review of design and product specifications; project management; short term project financing and performance guarantees.

Measures undertaken through these two programs have contributed to over 50% of Fortis' reported energy savings for residential and commercial customers in the last 6 years.

Reported savings and costs:

Year	2002	2003	2004	2005
Annual Savings (GWh)	8.7	5.9	6.4	9.1
- TJ	31	21	23	33
Program and Admin. Costs (thousand $)	695	579	525	742
Customer Costs (thousand $)	721	713	909	876

Terasen Gas DSM Residential Programs

The Terasen Gas program evaluation of energy savings and costs was compiled on a program basis. Most of Terasen's programs apply to only one of the BC Building targets so it was not necessary for us to do additional calculations to allocate energy savings by target. The only exception was estimates for the boiler efficiency program, which needed to have energy savings split by new and existing commercial building targets. This calculation was based on energy consumption of the relevant target sector in 2005.

High Efficiency Furnace/Boiler Upgrades

A $150 utility bill credit is paid to residential customers who upgrade their existing natural gas furnace or boiler to an Energy Star model. An additional $150 utility bill credit (for a combined total of $300 per customer participant) was provided by Natural Resources Canada under a contribution agreement entered into between NRCan and BC Gas in mid-2002. This program was originally part of the *Winter Bill Saver* program prior to 2002. An additional incentive ranging from $150 to $1000 in value toward the purchase of 22 different brands of residential high efficiency furnaces and boilers offered by 14 different suppliers was organized and promoted by BC Gas as part of this program.

Reported Savings:

Year	2002	2003	2004	2005
Participants	2,850	4,000	3,000	3,500
Savings (GJ)	85,500	120,000	41,400	48,300
Savings (m3)	2,215,049	3,108,840	1,072,550	1,251,308

New Construction Energy Star Heating Systems

This two year program ending December 31, 2006 provides a $500 incentive to builders for installation of a natural gas DHW heater and Energy Star qualified space heating equipment. Market share of high efficiency furnaces in the retrofit market increased from 38% in 2001, to 57% in 2003 (2004 DSM Annual Review).

Reported Savings:

Year	2005
Participants	600
Savings (GJ)	7,614
Savings (m3)	197,256

Heating System Tune-up

First offered by BC Gas in the summer of 2001 as a furnace tune-up, the heating system tune-up was re-launched in mid 2002 to include both furnaces and boilers. The program encourages customers to engage a registered contractor to perform a series of furnace maintenance operations, performance checks and appliance adjustments. The offer was made in the summer period, traditionally a slow time for furnace contractors, and included a $25 utility bill credit for participants. The cost of the service prior to application of the bill credit was in the range of $80 to $150 typically. Contractors were encouraged by BC Gas to provide additional advice to customers at the time of the tune-up concerning the use of setback thermostats and the importance of changing air filters on a regular basis. The cost of the service prior to application of the bill credit averaged $88.

Reported Savings:

Year	2002
Participants	45,000
Savings (GJ)	135,000
Savings (m3)	3,497,445

Weatherproofing and Insulation

Winter Bill Saver campaign launched in 2002 included an offer of a $25 utility bill credit per customer toward the purchase of a minimum $75 of draft proofing and/or ceiling insulation products.

Reported Savings:

Year	2002
Participants	5,000
Savings (GJ)	15,000
Savings (m3)	388,605

Fireplace upgrade

This program was designed to encourage the purchase and installation of heating-style gas fireplace inserts and free-standing appliances showing the new EnerGuide label. This fireplace upgrade program included supplier and NRCan participation allowing a $200 bill credit and a $100 manufacturer rebate for the purchase and installation of eligible fireplaces. For homes in which electricity is the primary heating fuel, BC Hydro contributes the $100 utility rebate while Terasen provides the rebate for homes with natural gas as their primary heating fuel.

Reported Savings:

Year	2004
Participants	425
Savings (GJ)	6,162
Savings (M3)	159,639

Terasen Gas DSM Commercial Programs

Efficient Boiler

Similar in nature to the company's Efficient Boiler Program offered between 1994 and 2000, this initiative provides formula-based incentives to purchasers of high efficiency natural gas condensing and "near-condensing" boilers and is available to both the new construction and retrofit markets. NRCan has been a key partner in the program and has heralded the program to other utilities. Since the launch of the program, NRCan has included the program criteria in CBIP (Commercial Building Incentive Program) and allowed access to the program across Canada.

Reported Savings:

Year	2005
Participants	45
Savings (GJ)	70,605
Savings (M3)	1,829,164

Destination Conservation

Destination Conservation (DC) is a K-12 school program involving students, teachers and school facilities management staff. The program is organized by the Pacific Resource Conservation Society, a BC based not-for-profit group, and offered to school districts. It features energy conservation curricula and support materials for participating teachers and technical assistance to school facilities management staff. The DC program includes an energy monitoring component which allows school districts to monitor, analyze and report energy usage information. Utilizing software programs such as 'Utility Manager 4.0 Pro' coupled with operator training, schools are able to report weather-normalized energy savings resulting from implementation of energy efficiency measures.

Reported Savings:

Year	2002	2003	2004	2005
Participants	6	46	21	16
Savings (GJ)	1,200	9,000	4,300	3,200
Savings (m3)	31,088	233,163	111,400	82,902

Energy Assessments (Commercial Energy Utilization Advisory)

This program is being offered to larger (Rate 3/23 and Rate 5/25) customers by the Terasen Gas Commercial Energy Services group. The offer includes an initial benchmarking consultation and an onsite assessment of natural gas conservation and efficiency opportunities along with recommendations and estimated savings impact.

Reported Savings:

Year	2002	2003	2004	2005
Participants	12	45	45	84
Savings (GJ)	19,200	29,000	26,750	29,400
Savings (m3)	497,414	751,303	693,012	761,666

Terasen Gas DSM Costs

Terasen Gas did not provide information on costs for each program. Information on total costs for all DSM programs was derived from charts in Terasen Gas report, *2006 Annual Review 2004 – 2007 Multi-year Performance Based Rate Plan.*

Federal Energy Efficiency Regulations

Canada's Energy Efficiency Act was passed by Parliament in 1992 and provides for the making and enforcement of regulations concerning minimum energy performance levels for energy-using products, as well as the labeling of energy-using products and the collection of data on energy use. The first Energy Efficiency Regulations came into effect in February 1995, following extensive consultations with the provincial governments, affected industries, utilities, environmental groups and others. These Regulations establish energy efficiency standards for a wide range of energy-using products, with the objective of eliminating the least energy-efficient products from the Canadian market. They apply to regulated energy-using products imported into Canada or manufactured in Canada and shipped from one province to another.

Currently, the Energy Efficiency Act specifies minimum energy performance standards for major household appliances, water heaters, heating and air-conditioning equipment, and other energy-using equipment such as fluorescent light ballasts, electric motors, and exit signs. Amendments to the minimum performance standards are continuously being made for regulated products, and new products are added to the list of regulated products on a regular basis. As of May 2006, the Energy Efficiency Regulations had been updated 9 times.

Estimating the reduction in energy consumption attributable to the energy efficiency regulations is difficult because it is not clear what would have been the energy consumption of products in the absence of regulations. Natural Resources Canada has used a simple method to calculate the savings in energy attributable to energy efficiency improvements for major appliances in its report *Energy Consumption of Major Household Appliances Shipped in Canada – Trends for 1990-2003*. This analysis does not attempt to distinguish between improvements in energy efficiency due to the regulations and other improvements, and only covers major appliances. Based on the report, we calculated that 0.48 PJ of energy were saved in British Columbia in 2003 due to energy efficiency regulations and manufacturer improvements in major appliances. Regulations governing energy efficiency of other products are not included in this calculation.

Appliance	Energy Savings (PJ)
Refrigerators	0.18
Freezers	0.01
Dishwashers	0.10
Electric Ranges	0.02
Clothes Washers	0.15
Clothes Dryers	0.02
Total	**0.48**

Source: Calculated from *Energy Consumption of Major Household Appliances Shipped in Canada – Trends for 1990-2003*, Natural Resources Canada, 2003.

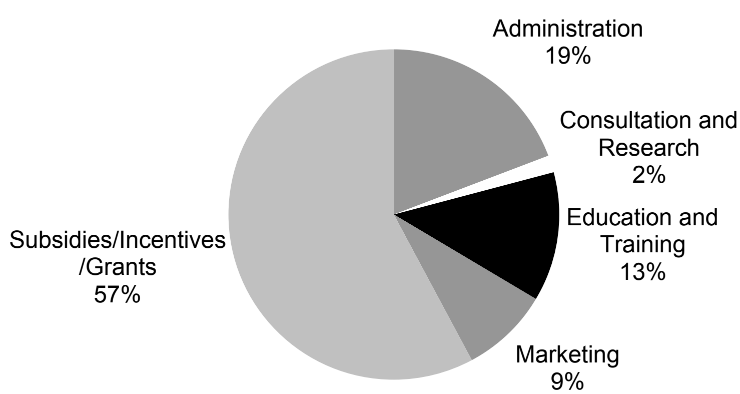
Opportunities Envelope Program

In August 2003, the federal government announced the $160M Opportunities Envelope (OE) program designed to support action on climate change by the provinces and territories.[36] British Columbia successfully applied for Opportunities Envelope support of $11M, and started receiving funds in FY 2005-06 to support achievement of six energy efficiency targets for buildings.

Total OE spending in FY 2005-06 was about $2.5M. This was matched by substantial leveraged spending by partners. Spending and reported energy savings by OE partners is discussed in sections of this report addressing partner programs.

Figure 19 shows that just over half of the total OE spending was directed at providing incentives to businesses and consumers to encourage adoption of energy efficient practices. About one fifth was administrative spending, and education, training, and marketing spending made up most of the rest of total spending.

Figure 19: Allocation of Opportunities Envelope Spending



[36] The OE program was terminated after two years, and only part of the $160M was actually spent.

Appendix F: Energy Efficiency and Energy Intensity

Energy efficiency is calculated based on the amount of energy required to provide a given service output. For example, a more efficient refrigerator will consume less electricity to cool a cubic foot of space to a set temperature than a less efficient refrigerator. Even if the more efficient refrigerator is much bigger than the less efficient refrigerator (and consumes more total energy), it is still considered more efficient. It is possible to calculate the energy efficiency of different technologies that provide the same service.

However, it is less easy to calculate the average energy efficiency of the entire economy because data is not available on the total service output (for example, there is no data on the total volume of refrigerators in British Columbia). Instead, we calculate the *energy intensity* of the economy throughout this report. We measure energy intensity as the amount of energy required per unit of floor space for different end-uses in the commercial and residential sectors. In order to understand trends in energy intensity over time, we use decomposition analysis to eliminate the effects of changes in population, weather, economic structure, and other variables.

To continue the example above, our analysis does not distinguish between more efficient refrigerators and less efficient refrigerators – just the total amount of energy consumed by refrigerators in British Columbia. If a homeowner that originally has a small refrigerator with poor efficiency (consuming 500 kWh per year to cool 10 cubic feet) trades it in for a new, much larger refrigerator with good efficiency (consuming 600 kWh per year to cool 20 cubic feet), our analysis would conclude that energy intensity has worsened, even though energy efficiency has improved. Understanding this distinction helps understand how changes in energy intensity can sometimes lead to an increase in overall energy consumption (e.g. as shown in Figure 7, an increase in energy intensity in 1993 caused an increase in overall energy consumption).

Appendix G: Complete Decomposition Results

Residential Sector Results

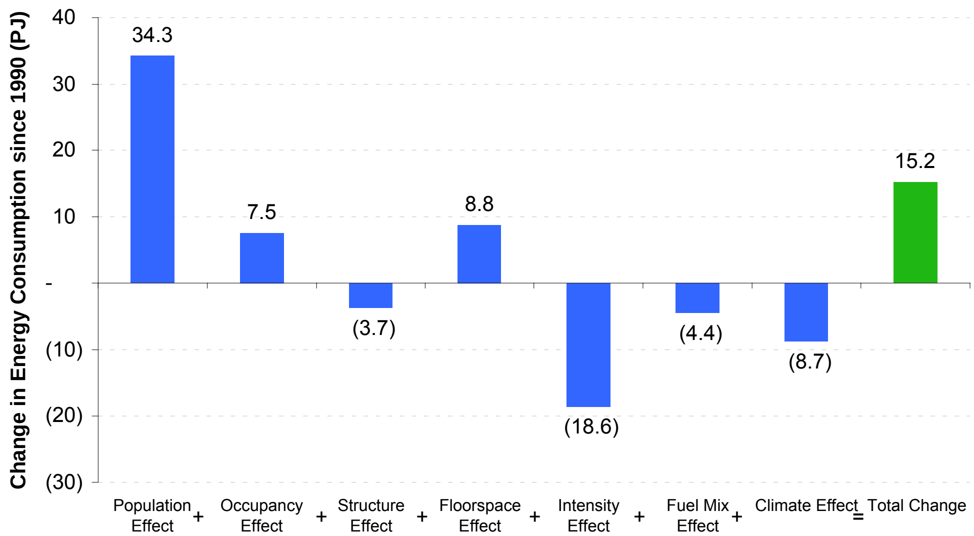
Between 1990 and 2004, energy consumption in the residential sector increased by 11.7% from 129.4 PJ to 144.6 PJ. Several confounding trends contributed to this 15.2 PJ increase in energy consumption:

- ***Population growth.*** British Columbia's population has increased from about 3.3 million people in 1990 to about 4.2 million people in 2004. This 28% increase in population has caused a corresponding increase in energy consumption. If population had remained at 1990 levels, energy consumption would have been 34.3 PJ lower in 2004 than it actually was.
- ***Decline in occupancy rates.*** In 1990, British Columbia had one residential dwelling for every 2.69 people. By 2004, British Columbia had one residential dwelling for every 2.56 people. This 5% decrease in house occupancy rates means that more houses are required per person. If occupancy rates had remained at 1990 levels, energy consumption would have been 7.5 PJ lower in 2003 than it actually was.
- ***Change in structure.*** Since 1990, many British Columbians have moved from detached single-family houses into apartment buildings and attached single-family houses. These attached dwellings are generally smaller and share walls with adjacent units, reducing heat loss compared to detached houses. This structural shift has had the effect of reducing energy consumption. If the BC residential sector had the same structure as in 1990, energy consumption would have been 3.7 PJ higher in 2004 than it actually was.
- ***Increase in average floor space.*** The average size of all types of residential dwellings in British Columbia has increased since 1990. Detached houses and mobile homes have increased in size by about 7% since 1990, while apartments and attached homes have increased in size by about 1%. This increase in the size of dwellings has caused an increase in energy consumption. If dwellings in British Columbia had remained the same size as in 1990, energy consumption in 2004 would have been 8.8 PJ lower than it actually was.
- ***Improvement in energy intensity.*** The amount of energy used per unit of floor space has decreased by 20% since 1990. Because of this improvement in energy intensity, energy consumption was 18.6 PJ lower in 2004 than it would have been in the absence of energy intensity improvements.
- ***Changes in weather.*** During warm winters, less energy is required for space heating, and vice versa for cold winters (the opposite applies for space cooling in warm or cold summers). Compared to 1990, 2004 had a warm winter, which reduced the amount of energy required. If 2004 had the same weather as 1990, buildings in British Columbia would have consumed 8.7 PJ more energy than they actually did. Weather has fluctuated significantly since 1990, with about two thirds of the years being warmer than the reference year.

- ***Changes in fuel mix.*** Since 1990, British Columbia residences have gradually been using relatively more natural gas and electricity and relatively less wood and heating oil for heating. Because heating with electricity and natural gas requires less energy than heating with wood or oil, this trend has reduced energy consumption. Without fuel switching, energy consumption in 2004 would have been 4.4 PJ higher than is actually was.

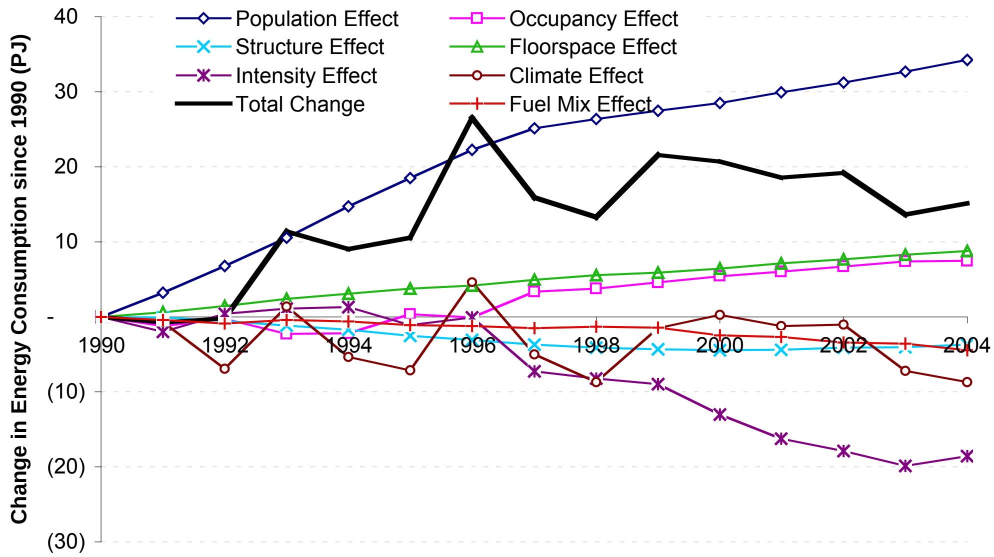
These trends are illustrated in Figure 20, which shows the total change in energy consumption in the residential sector between 1990 and 2004 as the green bar on the right of the diagram. The components of that total change are illustrated in each of the blue bars on the left of the diagram, which shows that population growth and energy intensity improvements have had the largest effect on energy consumption in British Columbia homes between 1990 and 2004.

Figure 20: Change in residential energy consumption between 1990 and 2004



The trends described above are also illustrated in Figure 21, which shows the annual changes in energy consumption compared to the 1990 reference level. The thick black line shows the change in overall energy consumption in the residential sector relative to 1990. Each of the coloured lines shows the factors that make up the total change since 1990. For example, in 2004, the population was 28% larger than in 1990, which caused a 34.3 PJ increase in energy consumption in the residential sector.

Figure 21: Change in energy consumption in the residential sector in BC, 1990-2004



Commercial Sector Results

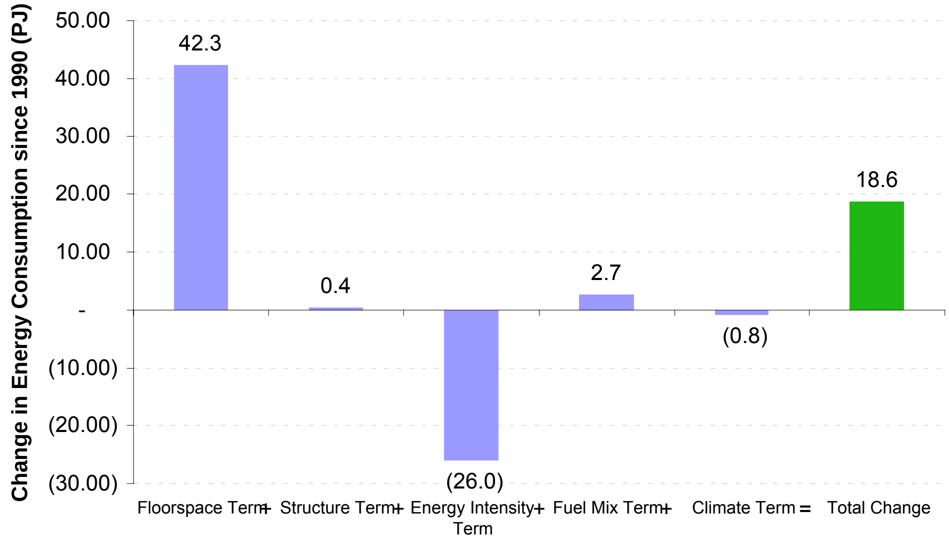
As discussed in the preceding section, there appears to be some problems with the data underlying the decomposition analysis in the commercial sector. Based on the available data, structure, fuel switching, or weather changes cannot be shown to have had a major impact on energy consumption in the commercial sector and energy intensity appears to cause unrealistic fluctuations. The negligible effect of structure and fuel switching does not seem unreasonable, but it is difficult to explain how climate did not have an impact, or that energy intensity has such an irregular impact.

Between 1990 and 2004, energy consumption in the commercial sector increased by 18.7% from 99.6 PJ to 118.2 PJ. Recognizing the challenges described above, the available data showed several confounding trends contributing to this 18.6 PJ increase in energy consumption:

- ***Increase in floor space.*** This is the main reason behind the increase in energy consumption. If floor space had remained at 1990 levels, total energy consumption would have been about 42 PJ lower in 2004 than it actually was.
- ***Improvement in energy intensity.*** The energy intensity of the commercial sector has exhibited an overall improvement since 1990, although the term fluctuates significantly and unrealistically over time (reasons are described above). All else equal, if energy intensity had remained the same as in 1990, total energy consumption in the commercial sector would have been about 26 PJ higher in 2004 than actual levels.
- ***GDP.*** We had hoped to include GDP as a factor in the decomposition analysis for the commercial sector, but data on commercial GDP was not available in a continuous time-series since 1990 at the appropriate level of disaggregation for this analysis.

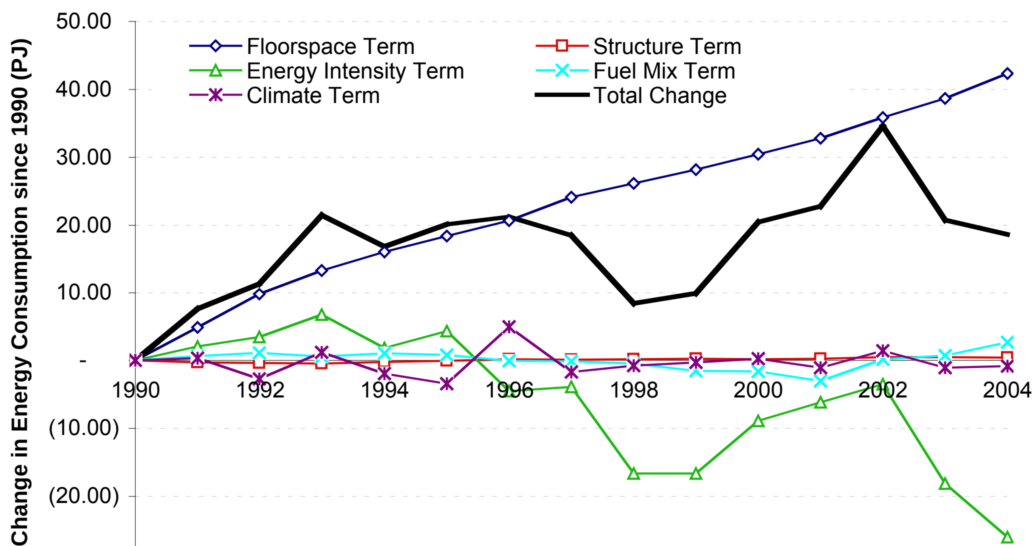
These trends are illustrated in Figure 22, which shows the total change in energy consumption in the commercial sector between 1990 and 2004 as the green bar on the right of the diagram. The components of that total change are illustrated in each of the blue bars on the left of the diagram, which shows that floor space growth and energy intensity improvements have had the largest effect on energy consumption in British Columbia commercial buildings since 1990.

Figure 22: Change in commercial building energy consumption between 1990 and 2004



The trends described above are also illustrated inFigure 23, which shows the changes in energy consumption compared to the 1990 reference level every year since 1990. The thick black line shows overall energy consumption in the commercial sector since 1990. Each of the coloured lines shows the factors that make up the total change since 1990. For example, in 2004, commercial floor space was much larger than in 1990, and caused a 42.3 PJ increase in energy consumption in the commercial sector.

Figure 23: Change in energy consumption in the commercial sector in BC, 1990-2004



Appendix H: Summation Approach Results

The complete summation approach results are available only in electronic format.

GreenLearning

2006 Progress Report

The 2006 GreenLearning Progress Report provides an overview of all activities conducted during the period of January 1, 2006 to December 31, 2006, and includes:

- the planning and evaluation work completed in the earlier part of 2006,
- the development of new materials such as the e-Cards and EnerAction learning modules,
- partnerships with other NGOs and school boards,
- evolution of GreenLearning as the project moves forward,
- an update on funding status,
- a financial summary (to follow).

GreenLearning is a project of the Pembina Foundation for Environmental Research and Education; the Foundation was established to:

- Promote public education and information that increases understanding about environmental and global issues and enhances the public's ability to protect, and conserve the environment.
- Research, develop, and produce educational materials and programs that assist formal and informal educators involved in school, adult, and community education to implement or conduct education programs that increase understanding about environmental issues and methods of protecting and conserving the environment.

GreenLearning is developed and delivered by the education team of the Pembina Institute, a non-profit environment and energy research organization focused on "sustainable energy solutions." With extensive technical and policy expertise, a commitment to research, a national reputation for excellence in creative multi-stakeholder collaborations, and a decade of experience in providing comprehensive environmental education, the organization is well-positioned to develop and deliver effective educational resources. For more information, please visit our websites, starting with www.pembina.org

For more information, please contact:

Gordon Harrison, Director of GreenLearning
Pembina Foundation
HOME OFFICE:
s.22
Email: gordonh@pembina.org

1 Evaluation, Research and Design

During 2006, Pembina Foundation invested in evaluating GreenLearning Alberta to identify lessons learned to guide future development, and in researching and designing GreenLearning as a national program with an immediate focus on Ontario and BC. Key activities undertaken in this phase were:

- Assessing GreenLearning Alberta to articulate lessons learned;
- Conducting a participative design process for developing a detailed project plan based on assessing needs of current and future users;
- Assessing e-learning pedagogy to identify current best practices and principles;
- Reviewing BC and ON curricula to identify prime opportunities for the delivery of GreenLearning;
- Upgrading the GreenLearning home page to include some of the learnings and to provide access to updates and current development for BC and ON.

1.1 Assessment and Design Process

In Alberta, Pembina collected feedback from teachers regarding the specific materials they used, how they heard about GreenLearning, how they would rate the web site, what they liked etc. J. LeCavalier & Associates were hired to conduct phone interviews with Alberta teachers and to conduct an initial focus group with future users. Seventh Floor Media was also hired to conduct a detailed usability analysis of GreenLearning. Their joint recommendations included:

- Eliminate the distinction between the “teacher and student” and “public” parts of the site.
- Make most of the content on GreenLearning accessible to the “public” by removing password protection from all but those components (such as answer keys) that need to be kept secure.
- Build GreenLearning with the understanding that teachers new to the site will abandon the site very quickly if they do not find relevant information fast. Build the site more for your target audience.
- Build GreenLearning with the understanding that technology resources remain limited in many schools. Continue to build “offline” and “online” options.
- Integrate more Pembina “non-GreenLearning” content into GreenLearning. Teachers recognize the high quality of Pembina content, yet cannot easily access much of it. Teachers would like GreenLearning to be their “one-stop” shop for Pembina materials for education purposes.

Communicopia was hired to assist with strategy and project planning for developing the web site platform for continued growth for the program. They assisted in organizing the assessment/evaluation work and in providing recommendations for web site development and branding.

Communicopia recommendations included:

- The original plan of completely customizing content for each province based on local curriculum is highly resource intensive and an expensive proposition. The recommendation is to develop content that is curriculum aligned but not exclusively for one province's curriculum.
- Build a site that has strong "Web 2.0" style tagging, interlinking and searching capabilities that utilizes a content management system to provide a consistent look and feel, easier updating, sharing content and searchability – a key feature for teachers (e.g. Moodle, Droople, etc.).
- Build capacity within Pembina for web site page publishing etc.
- Define the target audiences in more detail and prioritize. We are focused on teachers and students but this is a very broad audience with many sub-groups.
- Further develop GreenLearning Branding and Positioning

The Communicopia work has allowed us to develop a plan for moving the project forward and to make some key decisions as to future development (see Section 4 – future directions).

1.2 e-Pedagogy – Current Practices

GreenLearning is providing resources to teachers and students through the online environment. Although some activities are done using "traditional" teaching methods some are using more of the e-learning methods. E-learning is a relatively new learning method and so work was done to articulate sound e-learning pedagogy. Stephen MacKinnon, author of Hurley Island and award winning IT teacher, was hired to develop a guideline for effective, cutting edge e-learning. This work will continue to evolve as we move through the project. J. LeCavalier & Associates were also hired to benchmark exemplary online learning programs in the environment/education arena.

The recommendations from Stephen MacKinnon, Pembina staff and J. LeCavalier & Associates include utilizing a "student centered" approach for e-learning activities as it is the most effective in achieving meaningful learning. Student centered approaches include: active learning, constructive learning, intentional learning, authentic learning and cooperative learning. Recommendations such as age-appropriate, meeting needs of students with different learning styles and achievement levels, including a role for the teacher, helping teachers with their real problems, and meeting learning outcomes are to be key design features. Other design features to include are: allowing student access to resources, providing flexibility, providing interaction, ensuring two-way communication, problem-solving, ensuring student creativity, visually engaging and moving students beyond the classroom. These recommendations are put together in a package that guide writers with development of the learning modules and conservation activities.

J. LeCavalier & Associates also completed benchmarking of some existing web sites to highlight design features and methodologies used to make learning meaningful. The web sites that were reviewed are: Canadian Environmental Literacy Project, Edutopia – The George Lucas Educational Foundation, Journey North, National Wildlife Federation, and University of Illinois Extension. Others that were considered include: Alaska Native Knowledge Network, Audubon Education, CPAWS Education Program, Ducks Unlimited – Project Webfoot, Population Connection, Project Learning Tree, Canadian Wildlife Federation – Project Wild and Wild Education, Project WET, and World Wildlife Fund (WWF).

1.3 BC and ON Curricula Opportunities

Curricula review was completed for both BC and ON. Consultants and Pembina staff completed the reviews and identified key grades and courses with opportunities for developing learning modules for GreenLearning.ca.

In Ontario, Professor Dick Holland of the Ontario Institute of Studies in Education conducted a thorough review of the recently-revised Ontario Social Studies curriculum. The work also included consultations with teachers and teacher consultants and made the following recommendations:

- There is great potential for the GreenLearning project in Ontario
- The Social Science courses provide fertile ground for this initiative
- The courses with the most potential are Grade 7 Geography, Grade 9 Geography and Grade 10 Civics.

The Ontario Science curriculum is being revised. Once the new science curriculum has been released, a review will be completed to determine the potential for GreenLearning learning modules. Grade 7 Geography has been the course that has been selected for development for Ontario with cross-over opportunities for both BC and potentially Alberta.

A review of BC Science and Social Studies/Geography curricula was also completed. The areas with the best potential were tested with BC teachers in initial focus groups and workshops. The areas with the most potential are:

- Sciences – grade 4, 5, 6, 7, 8, 10
- Earth Sciences – grade 11
- Physics – grade 12
- Geography – grade 12
- Social Studies – grade 5

Grade 5 and 6 Science has been selected as the course for BC with cross-over potential for ON and utilizing some of the existing content from Alberta.

1.4 Upgrading the GreenLearning Web Site

Through the planning process and the usability review of the existing GreenLearning web site, changes were made to the existing web site to ensure easier, faster access to materials. It was agreed that these changes should be done right away as the development of the new "Web 2.0" platform will take some time. Some of the changes that were made include:

- Easier, faster access to the curriculum learning units and ability to see the materials before having to log-in
- More content available up-front before having to log-in
- Focus the web site on the areas of importance and to allow users to know that it is for teachers and students
- Improve the navigation system and to use a more standard system
- Introduce the expansion for BC and ON

With the changes, the web statistics are showing that teachers and students are finding more of the curriculum materials. Usage of the PowerPoints, radio shows, climate change materials has increased.

2 Learning Modules/Projects

The most substantial and significant parts of the GreenLearning program are our learning modules and conservation programs. Information gathered from the evaluation/assessment work and teacher focus groups were used to discuss development options for new learning modules for GreenLearning.

Once the curricula opportunities were identified and e-pedagogy guidelines were developed, planning workshops were completed with BC and ON teachers and consultants. The goal of the planning workshops was to develop outlines for two learning modules for GreenLearning. One for Grade 7 Geography (eCards) in ON and a conservation module (EnerAction) for grade 5 and 6 in BC.

2.1 eCards

This is the first learning module for ON with a focus on Grade 7 Geography. Using eCards, students investigate where their energy comes from, and examine various forms of non-renewable and renewable energy sources. Based on their research, students create an eCard and email it to family, friends and others. The eCard learning module is student-directed, teacher-moderated learning based on the e-pedagogy guidelines that were developed. The eCards meets a real need for quality geography education and meets the curriculum expectations of Geography 7 and also is cross-curricular with language arts and other courses as well.

The process for development includes Alpha and Beta testing with Ontario teachers and school board consultants. The Alpha testing has already been completed with over 200 Ontario students. The teachers really like the approach and students found the project much more meaningful than their standard work.

Beta testing will be completed by the end of April, 2007 with a full-launch planned for September, 2007.

2.2 EnerActions

EnerAction is an energy conservation action-oriented learning module. One thing that was learned was that the conservation action activities still must still strongly support curriculum to get better teacher usage. This EnerAction learning module will have strong curricular connections. Students will examine energy use in their lives – at school, at home and with transportation. Implementing their action plan, they monitor the results in energy, dollars and emission reductions. Students will receive immediate feedback on the results allowing them to celebrate their achievements.

EnerAction consists of:

- An online tool for students to examine energy use in their lives
- Activities for teaching and learning – core curriculum activities in science, mathematics and language, that introduce the unit and support student activities, building higher level learning of analysis, synthesis and problem solving
- Topic resources information for students on energy conservation and efficiency and clean air
- Opportunities for students to showcase their work and their projects.

Design focus groups were held in BC and Ontario in October and November respectively. We are working closely with teachers and curriculum consultants, and Passion for Action is assisting in the development of this learning module.

3 Partnerships

Much work was done in the initial planning phase to also develop strategic partnerships for the development and especially the delivery of GreenLearning in BC and ON. The partnerships continue to evolve and new partners have been identified. The partnerships vary from a working relationship to an in-depth partnership in developing the materials or developing delivery partnerships.

The partners that we have worked with in 2006 and will continue to work with in the future are:

- Learning for a Sustainable Future (LSF)
- Ontario EcoSchools
- Wild BC
- Pollution Probe
- Canadian Network for Environmental Education and Communication (EECOM)
- Dearness Environmental Society (Ontario)
- Reduce the Juice (Ontario)
- Nature Works Learning
- Destination Conservation (BC and AB)
- Inside Education (AB)
- Edmonton Natural Learning Communities
- ScienceWorld (BC)
- Royal BC Museum

4 Future Directions

In 2006, much of the work was planning, assessing and fundraising. The work we have done with consultants, teachers and our funders has initiated some changes in the future direction of GreenLearning. This evolution will provide a more robust, responsive program. GreenLearning will be a suite of projects and undertakings designed to achieve broad goals of energy and sustainability literacy that is tied to core-curriculum requirements. All projects and undertakings will be under the GreenLearning brand and will be initiated and delivered by the Pembina Institute and its partners.

GreenLearning will be a national program with some offerings that may be more provincially specific but teachers from other regions may also use any of the materials. The materials will still be designed from the curriculum-first perspective in that they will meet core-curriculum requirements for teachers (some may be province-specific and some may be able to meet requirements from various regions).

The main audience for GreenLearning is teachers. The direction is to create a premier learning resource for innovative teachers interested in trends affecting student's future well being. It will be inspired by teachers and designed for teachers. Teachers will be the key delivery agent for using the materials with their students. The goal is to help students participate in their own learning while gaining a more holistic and hopeful understanding of the complex energy and environmental challenges of today's world. GreenLearning's leading edge technology, easy to find curriculum materials, and action oriented student activities will save teachers time and help them be more effective classroom teachers.

Staffing has also changed to reflect the future direction. There is one program leader in each province with Gordon Harrison as the GreenLearning.ca Program Director. Kathy Worobec is the Alberta program leader and Johan Stroman is the BC program leader with Diane Simpson providing support. To complete specific project work consultants and partners will complete specific contract work for development and delivery.

We are confident that the work in 2006 provides a long-term, sustainable future for GreenLearning in being a leading edge, national, energy and environmental education program that will be recognized as the education program of the Pembina Foundation.

5 Funders/Financial Report

We have been successful in securing $405,833 funds in 2006 with $238,333 secured for 2007. In working with funders in the past year, we have moved to more of a project-based approach.

In 2006, funding was secured from the following sponsors.

- Ontario Platinum sponsors: TransCanada, Ontario Power Authority, Ontario Ministry of the Environment, Scotia Bank
- Ontario Gold sponsors: Petro-Canada, Hydro One, Bullfrog Power Inc., Laidlaw
- British Columbia Platinum sponsors: BC Hydro, Enbridge, BC Ministry of Energy, Mines & Petroleum Resources, BC Ministry of the Environment

5.1 Sponsors: Funds Contributed in 2006

TCPL ($100,000 committed for Ontario)	$50,000
Petro-Canada	$50,000
Hydro One	$50,000
Ontario Power Authority ($75,000 committed)	$20,000
Ontario Ministry of Environment	$30,000
Bullfrog	$12,500
Scotia Bank	$25,000
Enbridge ($100,000 committed for BC)	$33,333
BC Hydro ($100,000 committed)	$35,000
BC Ministry of Energy	$50,000
BC Ministry of Environment	$50,000
Total to date:	$405,833

5.2 Sponsors: Funds Committed for 2007

TCPL (Ontario)	$50,000
Ontario Power Authority	$55,000
Scotia Bank	$25,000
Laidlaw	$40,000
Enbridge (British Columbia)	$33,333
BC Hydro	$35,000
Total to date:	$238,330

EnerAction

An Integrated Grade 4 to 6 GreenLearning™ Energy and Environment Program

Are you an intermediate elementary school teacher?

Are you interested in an innovative approach to Energy Education?

GreenLearning is hosting six ***EnerAction*** teacher workshops in

Kamloops (Mon, April 2)

Nelson (Wed, April 4)

Fulford Harb., Saltspr.Isl. (Wed, April 11)

Victoria (Thu, April 12)

Burnaby (Mon, April 16)

Vancouver (Tue, April 17)

Most workshops are from 5 - 7:30 pm or 5:30 - 8 pm ***You are invited!***

EnerAction is an innovative and integrated energy conservation and action program developed by GreenLearning. Grounded in sound pedagogical approaches of direct experience, critical thinking skills, and place-based education, ***EnerAction*** provides students with the opportunity to apply their knowledge and understanding of energy, and be inspired and empowered to take action on energy issues in their lives, schools, and communities. This energy environment program is designed using B.C.'s key learning outcomes in core subject areas including **Science**, **Social Studies**, and **Math**.

You are invited to help test and refine the ***EnerAction*** program by participating in a workshop.

Workshops will be:

- √ a fun and interactive session with other teachers interested in energy and environment
- √ fully catered with local and organic food and drinks
- √ about 2½ hours in the afternoon/evening in each host community

Participants will:

- √ have an opportunity to provide feedback on a province-wide program (launching fall 2007)
- √ receive an honorarium for participation
- √ leave with a resource package, access to online web-tools for their students, and support in profiling their class and school projects online

To **register** and for further ***EnerAction*** information contact:
nadiner@pembina.org

Visit www.greenlearning.ca for details on workshop host communities.

Space is limited in each workshop; please sign-up early to avoid disappointment.

Funders Update –BC ***EnerAction*** program

February 2007

GreenLearning is currently developing lesson content, a prototype webtool and BC Teacher Workshops for ***EnerAction*** an integrated Energy and Environment education program that supports teachers engaging students in BC Ministry of Education Prescribed Learning Outcomes (PLOs) in the core Intermediate (Grade 4 through 6) elementary areas: Science, Social Studies, Math and English. Developed around six enduring understandings, the program is designed to support student awareness, understanding and action on energy and environment. ***EnerAction*** uses engaging place-based, direct experience and reflective classroom approaches for multiple learning styles centered on a framework of Spark, Personalize, Explore, Understand, Act and Reflect. The ***EnerAction*** program will include several lesson threads allowing teachers to choose learning methods best suited to their student preferences and interests. A first set of 12 lesson activities will accompany and support the unit design.

A brief overview of particular program aspects related to webtool design, teacher focus groups, BC teacher workshops and ongoing Outreach and Communications efforts are highlighted below:

Webtool Development: Currently, the GreenLearning team in BC, Alberta and Ontario are working with a web development and educational team at Passion-for-Action on a webtool that will support teachers and students understanding of energy and environment savings and their importance. FLASH and HTML programming language used supports the broadest range of users and ensures easy use of the ***EnerAction*** webtool by teachers and students. The ***EnerAction*** webtool enables teachers and students to input electricity use and savings and determine their savings. It will allow students and teachers to compare and graph their savings with the results from other schools. The website will feature class project profiles from various schools who engage the program. Currently, we are refining webtool user functionality which includes a Carbon Coin Webtool Calculator and combines original comic character graphic illustration characters *Electra*, *Sparky* and the *Carbon Critters* who help narrate the unit's thematic storyline, highlight story elements and support student learning of the enduring understandings throughout the lesson activities. The basic storyline has our sidekick *Sparky* introduce the exhausted super-hero, Electra who has been foiled in her efforts to reduce global energy waste by the witless and careless actions of the *Carbon Critters*. Students are urged to assist *Electra* in her mission and in so doing, realize that the power to save energy and redirect the *Carbon Critters* lies at their finger tips.

Teaching resources are being developed and refined including support documents for use of the webtool; lesson plans and criterion based assessment tools; and curriculum tables that show the fit of each of these activities with existing PLOs. Each of these pieces will be available to teachers from the EnerAction website link for teachers to access. March 2007 will see the further refinement and merging of the EnerAction webtool through a link to our GreenLearning website (www.greenlearning.ca).

Teacher Focus Groups and Online Feedback: The GreenLearning Team has met with teachers in three BC focus groups in January and February. These meetings provided key input in supporting web tool functionality suitable for teachers and students to use. It also permitted 17 teachers and educators opportunities to help craft content which they felt is needed to support more effective Energy and Environment education programming in BC. In addition students in two grade 5 classrooms provided specific written feedback on graphic elements to support the most visually compelling design possible. In combination with a focus group held in Ontario in January the teacher meetings have supported curriculum development that is student centered, age appropriate and honours the input of working professionals in the classroom. From the BC focus groups a dozen teachers have volunteered to join us in continuing to provide feedback on the ***EnerAction*** webtool and specific lesson plans through an online teacher's forum hosted by Pembina. Teacher feedback from these focus groups was very positive: "*Well presented, thoughtfully planned and well paced*", "*Nice building of activity themes by the whole group*", and "*I liked the structure and the opportunity to break out of the grid to identify areas of interest*". Teacher input will continue assisting GreenLearning in providing a desirable and high quality educational resource.

BC Teacher Workshops: To ensure quality design and help refine the ***EnerAction*** program further, teacher input on the ***EnerAction*** program and our initial face-to-face promotion of the ***EnerAction*** program resource will take the form of 6 teacher workshops in early April 2007 in the following communities: Vancouver, Burnaby, Kamloops, Nelson, Fulford Harbour (Saltspring Island) and Victoria (see attached PDF for details). Teacher evaluations and workshop feedback will be summarized in late April to assist with the final stages of resource development. Teacher registrations have already begun on several workshops already including: Nelson, Vancouver, Burnaby, Victoria, and Saltspring Island. Workshop specifics are being arranged by a community designate (most often a teacher in each community) in early March. Communications with several CAEE representatives and several communities reveal interest in the program and the workshops.

Outreach and communications: Via the BC Working Group for Sustainability Education BCWGSE (www.walkingthetalk.ca), Environmental Education Provincial Specialist Association (EEPSA), the Intermediate Teachers Association, and Sea-to-Sky Outdoor school ***EnerAction*** teacher workshop promotions are reaching educators across BC. GreenLearning anticipates that 1,000 educators and sustainability education professionals will be reached via these networks combining online notices, email list-serve notices and printed brochures on the program.

On February 15th, BC GreenLearning Director, Johan Stroman, attended Science World's Spring teachers' evening to promote ***EnerAction***. Several hundred teachers in attendance showed great interest in the display and brief presentation with over 200 one-page colour flyers given out, 30 teachers in the Greater Vancouver area signed up for Vancouver and Burnaby workshops and several teachers requesting workshops in their areas.

GreenLearning's pilot unit launch in early April will combine teacher learning resources and the online webtool into an intensive 2 ½ hour workshop that will send teachers home with a printed copy of the resource, online access information and a set of tools for approaching student action projects in their own schools.

Using teacher feedback from our workshops and pre and post surveys from participating teachers and classes, GreenLearning will begin assessing unit strengths and challenges to further refine the EnerAction program for a full scale launch this fall. Given teacher feedback to date, support and interest for the program is high and we anticipate the potential for further workshops after we gather information and teachers input at the six BC community workshops in early April.

Greenlearning.ca BC

Progress Report

Submitted to the
Ministry of Energy, Mines and Petroleum Resources

Submitted by the
Pembina Institute

August 18, 2006

Introduction

Greenlearning BC is based on an internet-based educational resource and teacher-training program to examine energy and environmental issues. Students will have the opportunity to learn about sustainable energy, climate change, air quality, energy efficiency and renewable energy. In 2005 most of the work has been focused on securing funding for the first year of development. The BC Ministry of Energy, Mines and Petroleum Resources provided $50,000 in funding to begin development. Much of the work in the winter and spring of 2005/06 has been spent on planning for the roll-out of this three year project in BC. Much work has been done in planning with potential partners and meeting with BC teachers. This report outlines the Progress to Date for the planning pieces and the first stages of development. It also provides an outline of the workplan to complete the deliverables for the work outlined in the agreement with the BC Ministry of Energy, Mines and Petroleum Resources.

Progress to date

In 2005, the Pembina Institute began initial work to develop Greenlearning.ca BC. Activities from the fall of 2005 to August 15, 2006 have focused on:

- designing the Greenlearning.ca BC project to build on lessons learned in the Alberta project, to reflect BC education realities, needs and opportunities, and to address BC energy-environment issues and solutions;
- building strategic partnerships that will ensure the widespread uptake and use of Greenlearning.ca over the long-term;
- continuing to secure funding;
- reviewing and assessing the BC curriculum to determine grades, subjects and specific learning outcomes that best fit topics of energy education.
- reviewing the BC curriculum assessment to determine the first learning module development with a key focus on meeting the deliverables and needs of the Ministry of Energy and Mines;
- initiating exploratory work on the development of a *Framework for Energy in Education for BC;*
- conducting BC curriculum expert and teacher meetings to develop module/unit structure and best practices for an innovative educational energy program that delivers energy conservation and energy efficiency materials;

- developing best methods, activities and programs for an energy efficiency for buildings component for GLO in BC that focuses on existing residential homes, multi-unit residential, and school institutional buildings;

- developing website architecture, wire frames and design and best navigation practices and testing those with teachers;

- continuing work on *Lights Off* and determining ways to focus on existing residential homes, multi-unit residential, and school institutional buildings with teacher groups – will pilot in the fall in the classroom;

- continuing on strategic planning with BC teachers on how best to support them on-the-ground and with workshops in the 10 communities requested by Ministry of Energy;

Workplan

Activity	Timeline
Development of First Energy/Sustainability module with a focus on Grade 5 science and social studies, with a fit to Grade 4, 6 and 7 science. Includes the development of energy efficiency for buildings component, focusing on existing residential homes, multi-unit residential, and school institutional buildings. Includes the development of energy conservation and energy efficiency materials (lesson plans, on-line activities and backgrounders) for students to do at school and at home.	In process now and will be conducted from Sept – February. Teachers development sessions and piloting will begin in Sept, 2006 and will continue to Feb 2007. Completed Feb, 2007
Support teachers/school districts to facilitate the delivery of the GLO curriculum to at least 10 communities tied to the CAEE pilot program.	Workshop development and working with districts and community contacts to facilitate delivery of the GLO Energy/Sustainability curriculum and Lights Off Program will occur in Jan – March, 2007 Completed March, 2007

A survey of teachers and select students will be conducted on the uptake of energy efficiency learning at home and at school.	The survey will be developed in February and conducted in March 2007. Completed in March 2007
Initial work to design and pilot test *Lights Off* has begun. We have identified teachers to work with us on Lights off and now selecting schools to pilot test and improve and tailor the program. Continued development, classroom testing and tailoring the project for the web and web development.	Research, teacher input and surveys have been completed. Continued development and testing to be done in Sept – Dec, 2006. Completed early January, 2007
Conservation Resource Centre - begin development this fall that will include the lesson plans (adapting the EnerGuide activity done for Victoria), backgrounders, action plans for home and school, online home component (build a house type activity). This is a component that will be available nationally as well so the components specific to the BC Ministry of Energy, Mines and Petroleum Resources will be completed in February, 2007.	Development will begin in the fall of 2006. The BC materials will be completed by February, 2007 with the remainder of the national components completed by June, 2007.
Work continues to identify the skills, knowledge and attitudes/values young people need with regards to energy-sustainability issues and solutions, particularly energy conservation and efficiency, renewable energy technologies, climate change, and air quality. For this work, The Pembina Institute will draw on the energy and climate change benchmark work of Learning for a Sustainable Future, on the expertise of The Pembina Institute's other partners as well as on its own broad and deep in-house expertise.	On-going