Leveraging the Market: Strategies for Transforming End Use Energy Efficiency in the Industrial Sector

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ABSTRACT

The purpose of this paper is to report on the impacts of BC Hydro's Industrial Power Smart program on end use energy efficiency. Five main end use areas are examined: lighting systems; fan and blower systems; pump systems; compressor systems; and materials handling and industrial processes. The basic study approach involved a quasi-experiment with a treatment group of 59 program participant sites and a comparison group of 65 program non-participant sites. Data were collected through on-site engineering audits, end-use metering, and surveys, with sample sizes designed to provide precision at the ± 10% level, 19 times out of 20. Proven engineering techniques including engineering algorithms and computer simulations were used to determine gross energy and demand savings. Survey-based information was used to determine net energy and demand savings.

Introduction

Interest in industrial energy efficiency has steadily increased over the past decade for two reasons. First, the stalled movement towards market deregulation has led many state and provincial regulators and utilities to re-examine mechanisms to place demand side and supply side energy options on an equal footing. Second, increasing concern with the potential impacts of increased atmospheric concentrations of greenhouse gases has led governments to seriously explore options for reducing emissions including increasing energy efficiency and thereby reducing energy consumption. In British Columbia, the BC Hydro Power Smart Partner Industrial Program has been the centre piece of energy conservation activities. Through the Power Smart Partner Industrial Program, BC Hydro helped its largest customers to break down barriers to increased energy efficiency. BC Hydro partnered with these companies, and it contributed matching funding and other resources to help them overcome barriers to realizing energy savings opportunities. Requirements of the Power Smart Partners included: (1) commitment to improve overall electrical energy efficiency; (2) signing a Power Smart Partner (PSP) Program agreement outlining their commitment, energy-efficiency target and the Energy Champion who will be responsible for carrying out the plan; and (3) commitment to match dollars to identify and implement energy-saving opportunities. BC Hydro in turn provided: (1) energy savings opportunity identification; (2) matching funds for businesses to identify electrical energy savings opportunities which may be used towards an energy manager, electrical energy audit, and building re-commissioning; (3) education and training to help in developing the company's pool of energy management skills; (4) e.Points bonus, an ongoing recognition program that rewards customers for the attainment of 5% electrical efficiency targets with further financial incentives; (5) a Fixed Incentive Fund and a Large Project Fund.

The purpose of this paper is to report on the impact of the Power Smart Partners Industrial program. The next section outlines the data and method used for the evaluation. This is followed by a review of major energy savings technologies in the industrial sector. Subsequent sectors examine energy efficient lighting, fans and blowers, pumps, compressors, and industrial processes. The final section provides some lessons learned.

Data and Method

For the period covered by this study, some 151 facilities that participated in the Power Smart Partner Industrial Program, with 233 projects and total expected savings of 497.3 GWh. A survey was made of a sample of decision makers for facilities that participated in the PS Partner Industrial Program to gather information used to estimate free ridership and spillover impacts for projects in the PS Partner Industrial Program, with each participant interviewed using a common survey instrument. Free ridership refers to Partners who would have undertaken the measure even in the absence of the program and spillover refers to Partners who undertook additional measures outside of the program but were influenced to undertake the measures by the program. For those sites in the sample that received on-site visits, the interviews were conducted during the visits. For sites not visited, the interviews were conducted by telephone. For sampling purposes, projects were divided into three groups: (1) incentive projects, where BC Hydro provided financial incentives to finance hard-wired savings opportunities; (2) consultative projects, where BC Hydro provided technical assistance including energy studies, workshops, energy managers and other support; and (3) combined projects, where BC Hydro provided both incentive and consultative support.

The on-site data collection for the study was used to collect data not only with which to verify savings for installed measures but also with which to undertake the market assessment which focused on estimated saturations for energy efficiency technologies. Data on saturations of energy efficiency technologies were available for a sample of 59 participant facilities out of a population of 151 facilities. Baseline data for high efficiency technology implemented at a site, regardless if the technology were implemented under any program or were installed by the customer were collected at these 59 sites.

To complement the data collected from participants in the Industrial PS Partner Program, data pertaining to saturations of energy efficiency technologies were also collected at a sample of 65 non-participant sites. The non-participant facilities were selected from among the following industrial categories: pulp and paper (NAICS 322); wood products (NAICS 321); chemical manufacturing (NAICS 325); metal mining (NAICS 2122); coal mining (NAICS 2121); and other, miscellaneous industrial facilities.

Using the data collected, estimates of saturations for energy efficiency technologies have been developed for several types of general technologies used in industrial facilities, including lighting, motors, pumps, fans, and compressors/compressed air systems. The saturations are reported in terms of percentage of facilities that are using the energy efficient technology. Saturations are reported separately for participant and non-participant facilities in order to better define the market potential. T-tests were used identify statistically different saturation rates between participants and non-participants.

Although data on project savings showed a high degree of variability in savings across the projects, a relatively small number of projects accounted for a high percentage of the estimated savings. Expected saving for the sample facilities were verified by: (a) reviewing the documentation for the projects at a facility and (b) visiting the facilities to verify that the energy efficiency measures had been installed and the conditions under which the measures were operating. Project documentation was collected and reviewed for each facility that was selected for the evaluation sample.

For each facility, the savings calculations from the program documentation were reviewed to determine (1) whether the methodology used for the calculation was appropriate, (2) whether assumptions used were reasonable and appropriate, and (3) whether savings calculations were done correctly. The review of the calculations of energy savings and peak demand reductions associated with lighting, motor, and other direct, pre-calculated savings measures focused on the main factors that determine energy use. For example, operating hours and usage patterns are important factors in determining energy use for major end-use equipment.

The accuracy of the savings estimates developed through engineering calculations depends on the extent to which the analysis is based on correct assumptions regarding these factors. Metered data were used to verify operating conditions, in those cases where it was appropriate. For some facilities, data on operating hours was available through the BC Hydro Monitoring and Verification data. For other sample facilities, additional monitoring was conducted. On-site inspections of the sample facilities were made to verify the installation of the energy efficiency improvements and to collect information on the operating characteristics of the facilities. Several types of data were collected during the on-site visits:

- Data were first collected through interviews with the staff of the site. Interviews with a facility engineer or other knowledgeable personnel provided information on occupancy schedules, lighting schedules, ventilation schedules, equipment schedules, and operational and maintenance practices.
- Documents or records at the site were reviewed. This included reviewing basic building plans and architectural drawings. Other data reviewed included information on process equipment, HVAC systems and equipment, on lighting and on hot water systems from mechanical, electrical and plumbing plans.
- Visual inspections were undertaken. These included control settings, lighting levels, inventory of end use equipment, ventilation rates, building population, occupancy level, and other parameters.

Verification that energy conservation measures had been installed and that the installation has been done correctly was examined as follows:

- Process measures. For process improvement measures, including refrigeration equipment and boilers, the installation of any energy efficient process equipment, any removal of process equipment, reduction in building or equipment energy use due to reduced production, or any other process measurement measures as indicated by the program documentation for the facility were checked and verified.
- Lighting measures. For lighting measures, the installation of lamps, ballasts, reflectors, and controls was checked and verified.
- Motor systems. For motors, pumps, and fans, information pertaining to efficiency was obtained from name plates. Motors with adjustable speed drives (e.g., as used in variable air volume distribution systems, distribution pumps, or industrial processes) are connected to a controller box, which varies the speed according to the load requirements. Changes in speed

cause changes in the noise level, which can be heard, or a clamp-on voltage meter can be used to measure the variation in the voltage provided by the controller box to the motor.

These procedures were used to calculate gross realization rates for the incentive, consultative and both (incentive and consultative) savings groups. Gross savings were then calculated as follows:

(1) ***Gross Program Savings = Realization Rate* Program Estimated Savings by Group:*** A major objective of this evaluation of a program was to determine those energy savings and gains in efficiency, which were solely attributable to the program or the program's net savings impact. The net savings impact of a program is determined as follows:

(2) ***Net Program Savings = Gross Program Savings – Free Ridership Impacts + Spill Over Impacts:*** Free ridership refers to the extent to which participants in a program would have adopted energy-efficiency measures and achieved the observed energy changes even in the absence of the program. The energy savings associated with free ridership can be taken to represent naturally occurring conservation, which is calculated as a free ridership rate weighted by energy savings. Spillover refers to savings that are due to the program for which no incentive was received, in particular, where participants may take additional actions as a direct result of the program, but beyond those taken through the program.

Literature Review

We conducted a brief review of the literature on industrial DSM, with a focus on those industries which are important in British Columbia including pulp and paper, sawmilling, coal mining, metal mining and industrial chemicals (please see references). Some key findings of this review included the following:

- Industry uses perhaps 40% of the non-transportation energy produced in North America, and in many industries cost-effective technologies exist to reduce consumption by 10% or more. The presence of apparently cost-effective investment opportunities which are not undertaken suggest the presence of significant market barriers.
- Existing capital typically has a long remaining life, and in the absence of an external intervention such as a utility DSM program or electric rates which encourage conservation, equipment may not be upgraded for many years. When equipment fails, shelf ready replacements are needed quickly to restore production.
- Plant experience varies with respect to the availability of on-site energy expertise. At some plants, there may not be an engineer or energy manager directly responsible for energy efficiency; and decision-makers may be located far from regional plant sites. At other plants, there are on-site energy managers who know their facilities well.
- Modifications to industrial manufacturing processes are complex, can affect product quality, may require extended shutdowns, and may affect output and productivity, at least in the short term. With the high cost and potentially high risk of process modifications, uncertain energy cost savings alone may not be sufficient to meet a firm's payback requirements.
- In some cases, energy efficiency expenditures have a lower risk-adjusted rate of return than product improvement expenditures. For companies where electricity is a small part of overall

costs, energy cost savings may be dismissed as not significant enough to warrant the attention of busy management and technical staff.

- Customer access to accurate and dispassionate technical information, particularly for new and emerging technologies, is sometimes difficult. Some companies consider their production processes proprietary, and they need assurances that their operations will be kept confidential before they will participate in a DSM project.

Overview of Energy Efficient Industrial Technologies

An initial issue was to understand the relative efficiency of base and energy efficient technologies. This was done by estimating gross energy savings ratios. These ratios are estimates of the share of energy for that end use that will be saved on average through the installation of the efficient as opposed to the standard version of the technology. Using a wide variety of sources, the gross measure savings ratio was estimated for each measure using the following equation:

$$\textbf{(3) Savings ratio}_i = (1 - \text{efficiency}_{st}/\text{efficiency}_{ef}).$$

Here, the savings ratio is the ratio applied to the end use consumption for a given measure and efficiency_{st} and efficiency_{ef} are the percentage efficiency levels of the standard and the efficient technologies for the relevant end use, as shown in Table 1.

Table 1. Relative Efficiency for Selected End Use Technologies

Measure	End Use	Standard efficiency	Energy efficient	Savings Ratio
Drive/Controls	Fans/Blowers	Vane 75%	ASD 95%	0.211
Fan Motor 1-5 HP	Fans/Blowers	Std efficiency 83.3%	Hi efficiency 87.5%	0.048
Drive/Controls	Pumps	Control valve 80%	ASD 95%	0.158
Pump Motor 6-25 HP	Pumps	Std efficiency 86.3%	Hi efficiency 90.1%	0.042
Drive/Controls	Compressed Air	Control throttle 83%	ASD 95%	0.126
Compressor Motor 1-5 HP	Compressed Air	Std efficiency 83.3%	Hi efficiency 87.5%	0.048
Reduce Air Leaks	Compressed Air	Average leaks 75%	Reduced leaks 85%	0.118
Coupling/Drive	Conveyance	Worm gear/v belt/helical 85%	ASD 95%	0.105
Convey Motor 6-25 HP	Conveyance	Std. efficiency 86.3%	Hi efficiency 90.1%	0.042
Coupling/Drive	Other Process	Worm gear/v belt/helical 85%	ASD 95%	0.105
Process Motor 6-25 HP	Other Process	Std. efficiency 86.3%	Hi efficiency 90.1%	0.042
CFL	Lighting	Type A 6%	CFL 24%	0.750
T8 Lamps	Lighting	T12 24%	T8 25.5%	0.059
HID Lamps	Lighting	Mercury vapor 15%	HID 30%	0.500

End Use Energy Consumption

We examined energy consumption by end use for the principal industrial sectors for F2006, as shown in Table 2. The metal mining sector is dominated by copper and gold mining, but includes a number of other metals usually produced as bi-products. The metal mining industry was in significant decline for a number of years, but it has undergone a major recovery in recent years due to a five-fold increase in the world price of copper. The medium term outlook for metal mining in British Columbia continues to be positive, given strong and growing demand in China and India, and constraints on increased supply, with few world class deposits discovered in recent years. Capacity utilization in metal mining in 2005 was above 90% and additional mines are ramping up. About 87% of the electricity used in the metal mining sector is used by process activities such as grinding and ore separation. Opportunities for energy reduction include appropriate motor sizing, energy efficient conveyance, energy efficient pumping and flotation cell technologies.

Table 2. Energy Consumption by End Use (GWh in F2006)

	Metal mining	Wood products	Pulp and paper	Chemicals	Coal mining
Pumps	134	5	2,677	66	101
Fans/blowers	14	260	1,259	20	51
Compressors	7	127	343	5	10
Materials handling	21	131	628	1	76
Lighting	118	65	257	5	10
Process	2,016	46	7,291	1,617	254
Building services	<1	25	69	3	<1
Cooling/refrigeration	,1	3	2	27	,1
Other	2	28	3	<1	5
Total	2,312	1,110	12,527	1.744	507

The wood products sector operates both in the interior and coastal regions. The interior woods industry has been performing reasonably well, but the coastal wood products industry has faced challenges and is earning low rates of return. The interior industry has relatively high efficiency levels and an abundant supply of low cost, beetle killed timber. The coastal industry has relatively high harvesting and mill labour costs. Table 2 shows that about 42% of the electricity used in the wood products sector is used by process activities including sawing, cutting and trimming. Opportunities for cost effective energy reduction include appropriate motor sizing, energy efficient conveyance, energy efficient fans, blowers and compressors.

The pulp and paper sector produces and exports a wide variety of products including newsprint, softwood kraft pulp, hardwood kraft pulp, softwood thermo-mechanical pulp and hardwood thermo-mechanical pulp. Although pulp capacity has fallen by about 10% since 2002, the medium term outlook for the industry appears to be fairly positive as the Asian demand for pulp and paper products remains strong and fibre costs in the interior remain low, due to the availability of beetle killed timber. Table 5.9 shows that about 58% of the electricity used in the pulp and paper sector is used by process activities including pulping and drying. Opportunities for cost effective energy reduction include appropriate motor sizing, energy efficient conveyance, energy efficient pumps, fans and blowers. Note that total energy consumption is higher than the reported purchased energy consumption listed above by the amount of self-generation.

The chemicals sector includes one chlor-alkali plant, three sodium chloride plant and one hydrogen peroxide plants, which receive electricity at transmission voltage. Electricity typically accounts for 40% to 60% of the costs of these facilities. Table 2 shows that about 93% of the electricity used in the metal mining sector is used by process activities including grinding and ore separation. Opportunities for cost effective energy reduction include change in appropriate motor sizing, energy efficient pumps, fans and blowers and electro-chemical technologies.

The coal mining sector produces mainly metallurgical coal for export to Japan and China, so the industry is heavily influenced by industrial output trends in these two countries. Demand ahs recently been strong. Table 2 shows that about 50% of the electricity used in the coal mining sector is used by process activities including ore separation. Opportunities include appropriate motor sizing, energy efficient conveyance, energy efficient pumps, fans and blowers.

Lighting Systems

Lighting systems typically include lighting fixtures, lamps, ballasts and controls. Most lighting systems have efficiencies of twenty-five percent or less, with the electrical energy which is not converted to lighting converted instead to waste heat. Key methods of reducing lighting consumption include using more efficient lighting sources and installing appropriate lighting controls to reduce annual hours of use for a given light source. Table 3 shows the penetration rates for program participants and program non-participants for six energy efficient lighting technologies: dimming controls, EMS, T8 fluorescent lamps; compact fluorescent lamps; high pressure sodium lamps; metal halide lamps; LED lamps; and electronic ballasts. Differences between penetration rates for participants and non-participants and associated t-tests are also shown, with a t-value of 1.96 or greater being significant at the 95% level and a t-value of 1.67 or greater being significant at the 90% level. The differences are significant at the 95% level for T8 lamps, CFLs, LEDs and electronic ballasts and at the 10% level for EMS.

Table 3. Lighting Systems Penetration Rates

Component	Participant	Non-participant	Difference	t-test
Dimming controls	8.6	3.0	5.6	1.32
EMS	12.1	1.5	10.6	1.82
T8 lamps	65.5	30.8	34.7	4.12
CFLs	32.8	12.3	20.5	2.79
HPS	72.4	61.5	10.9	1.30
Metal halide	72.4	72.3	1.2	0.01
LEDs	29.3	10.8	18.5	2.62
Electronic ballasts	70.7	43.1	27.6	3.23

Table 4 summarizes energy and peak savings for lighting systems. Expected savings or program reported savings were 21.4 GWh per year for energy and 2.9 MW for demand. Gross evaluated savings based on the engineering analysis were 22.1 GWh per year for energy and 3.0 MW for demand. Net evaluated savings based on the free rider and spillover analysis were 20.2 GWh per year and 2.8 MW.

Table 4. Lighting Systems Savings

	Expected savings	Gross evaluated savings	Net evaluated savings
Energy (GWh per year)	21.4	22.1	20.2
Peak (MW)	2.9	3.0	2.8

Fan and Blower Systems

Fans and blowers provide the motive force to move air or another gas against the resistance of the air conveyance system. These systems typically include a motor, a fan or blower, a speed control, a control vane or damper and a duct system. Up to one-half of the potential energy savings in a fan or blower system can be captured though the appropriate sizing of motors, reducing unnecessary loads and minimizing motor idling. A number of energy efficient fan and blower technologies were examined. Table 5 shows the penetration rates for program participants and program non-participants for four energy efficient fan and blower technologies: adjustable speed drives; cog belts; appropriate motor sizing; and high efficiency motors. The differences between participants and non-participants are significant at the 95% level for adjustable speed drives, cog belts and high efficiency motors and at the 90% level for appropriate motor sizing.

Table 5. Fan and Blower Systems Penetration Rates

Component	Participant	Non-participant	Difference	t-test
ASD	27.1	6.2	20.9	3.21
Cog belts	35.6	6.2	29.4	4.25
Motor sizing	8.5	1.5	7.0	1.78
HEM	67.8	40.0	27.8	3.23

Table 6 summarizes energy and peak savings for fan and blower systems. Expected savings or program reported savings were 50.7 GWh per year for energy and 6.9 MW for demand. Gross evaluated savings based on the engineering analysis were 52.4 GWh per year for energy and 7.2 MW for demand. Net evaluated savings based on the free rider and spillover analysis were 47.9 GWh per year and 6.6 MW.

Table 6. Fan and Blower Systems Savings

	Expected savings	Gross evaluated savings	Net evaluated savings
Energy (GWh per year)	50.7	52.4	47.9
Peak (MW)	6.9	7.2	6.6

Pump Systems

Pumps move liquids against the resistance of a piping system and uphill against gravity. Pumping systems typically include a motor, a pump or impellor, a speed control device, throttle or valve, and piping. Up to one-half the potential energy savings in a pumping system can be captured though appropriate sizing of the motor and its load, reducing unnecessary loads, and minimizing motor idling. A number of energy efficient pump technologies were examined. Table 7 shows the penetration rates for program participants and program non-participants for six energy efficient pump technologies: high efficiency pumps; appropriate pump sizing; correct pipe sizing; adjustable speed drives; appropriate motor sizing; and high efficiency motors. The differences between participants and non-participants are significant at the 95% level for high efficiency pumps; appropriate pump sizing; correct pipe sizing; adjustable speed drives; and high efficiency motors and at the 90% level for appropriate motor sizing.

Table 7. Pump Systems Penetration Rates

Component	Participant	Non-participant	Difference	t-test
Efficient pumps	55.9	27.7	28.2	3.31
Pump sizing	69.5	38.5	31.0	3.64
Pipe sizing	69.5	40.0	29.5	3.46
ASD	32.2	13.9	18.4	2.47
Motor sizing	8.5	1.5	7.0	1.78
HEM	67.8	40.0	27.8	3.23

Table 8 summarizes energy and peak savings for pump systems. Expected savings or program reported savings were 61.2 GWh per year for energy and 8.4 MW for demand. Gross evaluated savings based on the engineering analysis were 63.1 GWh per year for energy and 8.6 MW for demand. Net evaluated savings based on the free rider and spillover analysis were 57.7 GWh per year and 7.9 MW.

Table 8. Pump Systems Savings

	Expected savings	Gross evaluated savings	Net evaluated savings
Energy (GWh per year)	61.2	63.1	57.7
Peak (MW)	8.4	8.6	7.9

Compressor Systems

Compressors increase the pressure of a gas to the point where it can do useful work, typically by increasing the pressure from 15 pounds per square inch (or atmospheric pressure) to 100 pounds per square inch. Compressed air systems typically include a motor, a speed control device, compressor, dryer/filter unit, throttle or vane or damper, and a piping system. BC Hydro studies have estimated that Key methods of saving energy in compressor systems include using as little compression as possible, minimizing air leaks, and maintaining compressor efficiency through periodic maintenance. Table 9 shows the penetration rates for program participants and program non-participants for six energy efficient compressor system technologies: reduce air inlet temperatures; compressor system controls; heat recovery for hot water; adjustable speed drives; appropriate motor sizing; and high efficiency motors. The differences are significant at the 95% level for compressor system controls; adjustable speed drives; appropriate motor sizing; and high efficiency motors and at the 90% level for appropriate motor sizing.

Table 9. Compressor Systems Penetration Rates

Component	Participant	Non-participant	Difference	t-test
Air inlet temperature	11.9	4.6	7.3	1.47
System controls	64.2	27.9	36.3	4.34
Heat recovery	10.2	3.1	7.1	1.58
ASD	27.1	6.2	20.9	3.21
Motor sizing	8.5	1.5	7.0	1.78
HEM	67.8	40.0	27.8	3.23

Table 10 summarizes energy and peak savings for compressor systems. Expected savings or program reported savings were 104.4 GWh per year for energy and 14.3 MW for demand. Gross evaluated savings based on the engineering analysis were 107.8 GWh per year for energy and 14.8 MW for demand. Net evaluated savings based on the free rider and spillover analysis were 98.6 GWh per year and 13.5 MW.

Table 10. Compressor Systems Savings

	Expected savings	Gross evaluated savings	Net evaluated savings
Energy (GWh per year)	104.4	107.8	98.6
Peak (MW)	14.3	14.8	13.5

Material Handling and Process Systems

Process systems include conveyance systems, hydraulic systems, cutting, grinding and milling equipment, material shaping equipment, electro-chemical equipment and a wide variety of other specialized equipment. Many process systems include a motor, a controller, a drive and relevant end use equipment. Main opportunities for energy efficiency include proper equipment sizing, use of high efficiency motors, and sue of adjustable speed drives. Table 11 shows the penetration rates for program participants and program non-participants for four process system technologies: appropriate motor sizing; high efficiency motors; power factor correction; and adjustable speed drives. The differences are significant at the 95% level for high efficiency motors and power factor correction and at the 90% level for appropriate motor sizing.

Table 11. Materials Handling and Process Systems

Component	Participant	Non-participant	Difference	t-test
Motor sizing	8.5	1.5	7.0	1.78
HEM	84.8	61.5	27.8	3.23
Power factor	57.6	20.0	37.6	4.63
ASD	67.8	56.0	10.9	1.26

Table 12 summarizes energy and peak savings for process systems. Expected savings or program reported savings were 259.6 GWh per year for energy and 35.5 MW for demand. Gross evaluated savings based on the engineering analysis were 268.0 GWh per year for energy and 36.7 MW for demand. Net evaluated savings based on the free rider and spillover analysis were 245.0 GWh per year and 33.7 MW.

Table 12. Process Systems Savings

	Expected savings	Gross evaluated savings	Net evaluated savings
Energy (GWh per year)	259.6	268.0	245.0
Peak (MW)	35.5	36.7	33.7

Total Program Savings

Table 13 summarizes energy and peak savings for all technologies installed under the Power Smart Partners Industrial program. Expected savings or program reported savings were 469.7 GWh per year for energy and 68.1 MW for demand. Gross evaluated savings based on the engineering analysis were 513.4 GWh per year for energy and 70.3 MW for demand. Net evaluated savings based on the free rider and spillover analysis were 469.3 GWh per year and 64.5 MW.

Table 13. Program Savings

	Expected savings	**Gross evaluated savings**	**Net evaluated savings**
Energy (GWh per year)	497.3	513.4	469.3
Peak (MW)	68.1	70.3	64.5

Lessons Learned

1. **Organization and Management.** Clearly define project management roles and responsibilities, and ensure that trade allies clearly understand who is responsible for what. Adjust the program to reflect new opportunities and challenges in the market, but ensure that the revised program definition and strategy is clearly communicated to program staff and stakeholders. Ensure that requirements for Requests for Proposals, contracting and contact supervision are clearly defined, appropriately monitored and adequately enforced.
2. **Program Planning.** Conduct adequate market research to understand market barriers and drivers, identify and build contacts with key market players and align the goals and interests of market players and the program. Develop a program plan with a clearly articulated program logic that clearly states the program objectives, operational outputs and resources required, and ensure that program schedules are clear and realistic and that suitable allowance is made for possible slippage in program implementation. Ensure that program objectives are clear, well defined, measurable and achievable and base line data should be collected to the extent feasible and practical to allow for cogent analysis of the extent to which a program is meeting its objectives and achieving efficiency and effectiveness in delivery.
3. **Program Delivery.** Leverage scarce marketing dollars through Key Account Managers relationships with customers and through partnerships and cooperation with other market players. Develop of open and respectful relationships with consultants and contractors, and leverage relationships with partners in one area to build support for additional areas. Ensure that incentives are an appropriate instrument in the context of the specific market being addressed, and if incentives are viewed as appropriate, ensure that incentive levels are appropriate to buy down first costs to the point where the efficient product is competitive on a life cycle cost basis. Keep program procedures, including applications, modeling and verification, as simple and transparent as possible to maximize participation and energy savings.
4. **Program Monitoring and Evaluation.** Conduct baseline research on product awareness, product attitudes, and product installation behaviour before a program is in the field, and replicate this research as required to understand and document changes in the market as well as market effects that can be ascribed to the program. Establish systems to track sales levels and market shares (and possibly other metrics) as well as their changes. Report program

progress against program objectives, and make suitable corrections if key objectives are not being met. Establish appropriate algorithms to estimate energy and demand savings and collect suitable data through surveys, site visits and metering to ensure that the algorithms can be applied.

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