

Lean, Clean and Green: British Columbia's Approach to Energy Efficiency in Small and Medium Size Manufacturers

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ABSTRACT

The government of British Columbia (BC) has committed to aggressive energy conservation and efficiency targets and has established tangible goals for reducing energy demand for the industrial sector. In response, an Industrial Energy Efficiency (IEE) program is being developed to encourage industry driven investment in energy efficient technology and processes and to reduce funding barriers that discourage energy efficiency in the industrial sector.

While BC's manufacturing sector includes a significant number of very large energy-intensive industrial operations (such as mines, smelters, oil and gas operations and pulp and paper mills), the population of manufacturers in the province is dominated by the small and medium size manufacturer (SMM). BC's IEE program recognizes that the financial and operational dynamics around energy can be very different in an SMM than for larger industrial players by employing a Lean approach in transforming the SMM segment of the industrial sector.

Through key partnerships with the Business Development Bank of Canada (BDC) and utilities, the provincial government is implementing a strategy for SMMs which places primary emphasis on productivity improvements, with confidence that energy efficiency improvements will be a significant derivative result. Formal adoption of the provincial IEE program is planned for 2009.

This paper presents some of the analysis and considerations behind British Columbia's selection of a Lean initiative as an important element of the province's IEE program strategy, especially for SMMs, and highlights the unique value of a provincial partnership with the BDC.

Introduction

Small and medium size manufacturers are an important economic driver in British Columbia's economy and collectively contribute to significant energy consumption. On an individual basis however, any one company or operation may not use energy on a scale that warrants direct targeting by utility demand side management (DSM) programs. Also, because SMMs are numerous small energy users, it is challenging for utilities to maintain a communications channel to SMMs in a cost effective manner.

One tool that is ideally suited for pursuing energy efficiency improvements with SMMs is Lean. Since the 1970's Lean manufacturing techniques have proven successful worldwide, in both manufacturing as well as business process applications, in achieving productivity improvements. In recent years, Lean techniques have also been focused on environmental and energy improvements.

British Columbia is exploring the application of Lean methodologies to identify and capture otherwise hard to get energy efficiency savings while at the same time improving the competitiveness of BC's industry, especially SMMs. Bringing Lean ideas into the picture for

industry and ensuring a sustained effort and alignment with the Province's energy efficiency and climate goals is not without challenges but the potential rewards are very attractive.

By partnering with the BDC, the Province hopes to leverage the unique position and assets of the Bank to bring both awareness and expertise to SMMs in a way that will facilitate significant improvements in both productivity and energy efficiency, across BC's industries.

British Columbia's Industrial Energy Efficiency Program

IEE Program Mandate

The government of British Columbia has committed to aggressive energy conservation and climate action targets. The 2007 BC Energy Plan: A Vision for Clean Energy Leadership, the 2008 BC Efficient Building Strategy and the BC 2008 Climate Action Plan (BC 2007a, 2008a, 2008b) together contain tangible goals for reducing energy demand for buildings and for the industrial sector. The Province has set a target (BC 2007b) to reduce greenhouse gas (GHG) emissions to 33 percent below 2007 level by 2020 and to 80% below 2007 levels by 2050.

In response, an Industrial Energy Efficiency (IEE) program is being developed. In 2007 the BC Energy Plan (BC 2007a, 8) described the intentions for its industrial program as follows:

“Government will establish an Industrial Energy Efficiency Program for British Columbia to address challenges and issues faced by the B.C. industrial sector and support the Canada wide industrial energy efficiency initiatives. The program will:

- Encourage industry driven investment in energy efficient technologies and processes;
- Reduce emissions and greenhouse gases;
- Promote self generation of power; and
- Reduce funding barriers that discourage energy efficiency in the industrial sector.”

IEE Program Strategy Development

In January 2008, BC's Ministry of Energy, Mines and Petroleum Resources (MEMPR) established an Industrial Energy Efficiency Working Group with representation from the federal government, several ministries of British Columbia's provincial government, provincial utilities, British Columbia's major industrial sectors and the Canadian Industrial Energy End-Use Data and Analysis Centre at Simon Fraser University. Collaboration among this group throughout 2008 has resulted in a strategy (BC 2008c) for BC's IEE program which includes the following key elements:

1. Adopting a voluntary “Certified Plant” program for key sectors as a means of ensuring integrated energy management across industry and as the platform for the provincial IEE program.
2. Developing an Industrial Energy Efficiency Financing Consortium to simplify access to capital and incentives and to leverage an energy service company approach to encourage investment in, and implementation of, significant IEE projects.
3. Investigating various market stimuli such as pricing and DSM programs so as to utilize the market as a tool to enhance and promote energy efficiency.

4. Coordinating between energy efficiency and climate action objectives by establishing individual agreements with industrial sectors that include commitments from all parties, and, wherever possible, harmonizing industry reporting requirements.
5. **Promoting a continuous improvement culture and facilitating the adoption of Lean manufacturing methodologies across industry, especially to small and medium size manufacturers.**
6. Promoting and adopting codes and standards for equipment (e.g. NEMA Premium[®] efficiency electric motors) to ensure full market transformation, where industry investment in cost-effective, high efficiency energy devices keeps pace with technological advances.
7. Recognizing the achievements of industry in helping to establish and maintain British Columbia as leader in energy conservation and efficiency.

The SMM Gap

BC's IEE program strategy recognizes that the financial and operational dynamics around energy can be very different in SMMs, from those typical of larger industrial players. Element five of the IEE program strategy was specifically developed to capture small and medium size manufacturers. For British Columbia, the value of small businesses to the provincial economy cannot be overstated; as explained by the following statistics (BC Stats 2008, 2; NRCan 2009a):

- There were approximately 379,700 small businesses operating in British Columbia in 2007. These operations accounted for 98 per cent of all businesses in the province.
- Approximately 1,048,000 people were employed by small businesses in British Columbia in 2007 (almost a quarter of the total provincial population of ~4.5 million). These jobs accounted for 56 per cent of private sector employment in the province, the highest rate in the country.
- British Columbia's small businesses generated approximately 33 per cent of provincial gross domestic product and shipped 37 percent of the total value of goods exported from the province.
- In 2006, small-to-medium manufacturing in British Columbia consumed 72.6 petajoules of energy, more than 70 percent of that energy was in the form of natural gas.

While small and medium manufacturers constitute just a small portion of the small businesses in the province, their energy and GHG emissions savings opportunities, whether they are process related for natural gas or associated with electrical equipment, are not captured by most of the existing residential/commercial demand side management (DSM) programs offered by government and utilities.

Additionally, the characteristics of these manufacturers tend to leave them underserved. British Columbia's SMMs are numerous and spread out, mostly across the lower third of the province, and energy costs at any one business may not be large, or even a large fraction of operating costs. Because any one client is a relatively small energy consumer, they typically don't meet the thresholds set by utilities (see Table 1) for DSM programs and services and therefore have no designated account manager or point of contact, at the utility, that the SMM can direct their inquiries to.

Table 1. Qualification Threshold Values for Industrial Energy Efficiency Program

Utility/Organization	Program	Threshold Value
BC Hydro	Power Smart – Medium Industry Programs	>\$50,000 annual electricity bill
FortisBC	PowerSense – Small Business and Commercial	No threshold
Terasen Gas	Energy Assessment Program	>\$20,000 annual natural gas spend
Natural Resources Canada	ecoEnergy Retrofit Incentive for Industry	No threshold

Sources: BC Hydro 2009; FortisBC 2009; TGI 2009; NRCan 2009b

Just recently, BC Hydro has partnered with Canadian Manufacturers and Exporters (CME) in an agreement (CME 2009a) which effectively allows BC Hydro to lower its threshold slightly by using CME as an agent to pursue electrical savings in the larger clients that reside just below the current program qualification threshold.

In general however, SMMs are not only missing a clear link to existing DSM programs, and to the prime source for energy efficiency information in the province, but by their very nature, they are not well equipped to pursue energy efficiency opportunities. These businesses generally have few employees and rarely have in-house expertise, or even in-depth understanding of energy issues. Unlike large industrial players, where utilities support the establishment of dedicated energy managers and the adoption of formal energy management systems, small manufacturers cannot practically or economically support these types of measures. Additionally, SMMs simply lack the economies of scale to warrant pursuing and engaging outside expertise for the sake of energy opportunities alone.

Finally, and perhaps most important, SMMs are driven by cash flow. Equipment purchases decisions are generally based upon process performance requirements and the lowest purchase price. So, not only are energy efficiency options frequently left unexplored, higher efficiency equipment, which generally commands a premium in the purchase price, is normally not even considered due to the higher up-front cost, regardless of the payback period.

It quickly became evident to the Ministry, from consultations within the IEE Working Group, that a new approach to energy efficiency, one tailored to the requirements of SMMs, was needed. Rationalizing energy efficiency based upon energy costs savings was not a tenable approach for SMMs.

The Lean Approach

Finding the Right Tool

A key element of BC's IEE program strategy is the development of a program specifically enabled for SMMs that focuses on productivity but also addresses and captures energy savings and GHG emissions reductions. In 2008, the CME surveyed (CME 2009b, 24) their membership with regards to perceived determinants of future growth and profitability. At least seven of the top 20 responses (see Table 2) were items that could be directly addressed through one common tool – Lean manufacturing techniques.

Table 2. Key Determinants of Future Business Growth & Profitability

Rank	Determinant	% of Companies
4.	Reducing Operating Costs	53%
7.	Managing Energy Costs	42%
11.	Improving Labor Productivity	41%
12.	Introducing new/improved processes	36%
16.	Improving existing products/services	36%
18.	Shortening lead times	30%
20.	Enhancing flexibility	22%
	Expanding production capacity inside Canada	

Source: CME 2009b

Note: Companies were asked to identify the three most important determinants of future business growth.

The term “Lean” was first coined by John Krafcik in a Fall 1988 article, *Triumph of the Lean Production System*, published in the Sloan Management Review and based on his master's thesis at the MIT Sloan School of Management. Krafcik's research was carried forward and eventually led to the international best-seller book called *The Machine That Changed the World* (1990). The fundamental concepts from which Lean has developed predate Krafcik by roughly 100 years. In Japan those concepts coalesced over time, due in great part to the efforts of Taiichi Ohno, into the now famous Toyota Production System. (Wikipedia 2009)

In the world of manufacturing, Lean is a proven performer in the delivery of productivity improvements and bottom line results. That makes Lean a powerful motivator for action and a tool that SMMs can derive immediate financial benefit from. At the core of Lean is the systematic reduction, and ultimately the elimination, of non-value-added activities; better known as waste. Using Lean methods, waste is often segmented into seven or eight primary categories which include: transportation, inventory, defects, excess motion, over production, waiting and underutilized employees.

Nearly every category of waste has strong, clear energy use linkages, for example:

- Improving product quality, and reducing defects, means energy consuming process equipment is not being operated to produce unsalable products and energy-intensive processed raw materials are not being wasted. Improved product quality may also mean fewer customer returns – potentially eliminating roundtrip transportation costs and related GHG emissions.
- A reduction in inventory and work-in-process means less warehouse space is required. It is not uncommon to be able to dramatically reduce warehousing requirements. That means less energy is expended heating and lighting those same warehouses.

Clearly there are derivative energy and GHG reduction benefits realizable through improved productivity. Additionally, Lean is an excellent platform for instilling a conservation culture within the workforce. The people of British Columbia have always been environmentally conscious. Lean, with its focus on the elimination of waste, expands that awareness to the workplace and to areas such as energy, water and climate action. The Lean approach is biased toward action and it demands participation across the organization and at all levels. For an SMM, Lean activities build teamwork, develop clarity of mission, establish a more sustainable workplace and deliver bottom line results.

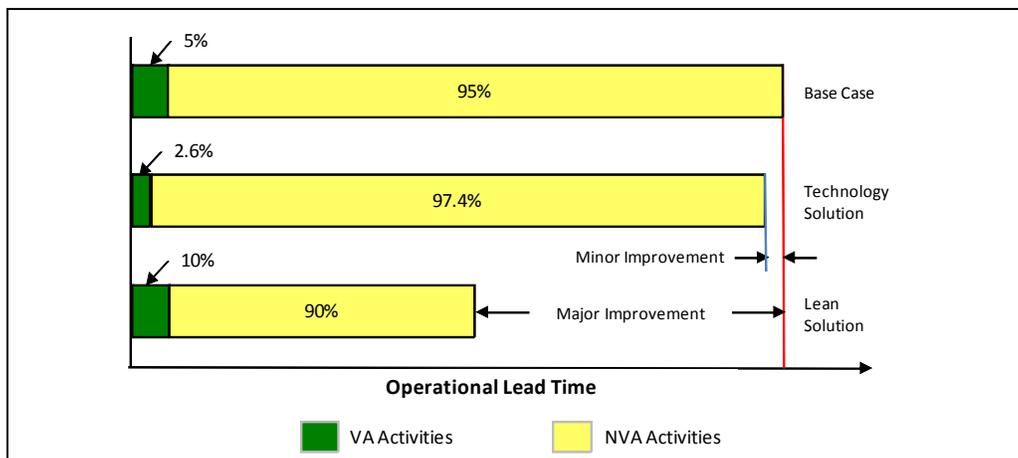
The applicability of Lean is not limited to SMMs and certainly is not limited to manufacturing or the shop floor. An integral component of MEMPR's Lean initiative is the

performance of pilot programs in five separate industrial sub-sectors, with general manufacturing being one sub-sector. Since the value of Lean has been repeatedly demonstrated and proven, in multiple environments around the world, the value of the pilots is to build awareness and understanding within BC’s industry. MEMPR is looking to start with SMMs both to address the existing service gap mentioned above and to act as a starting point for future expansion, both up-scale to larger manufacturers as well as laterally to small and medium sized businesses operating outside of the manufacturing arena.

Targeting the Biggest Opportunities

In Lean, value is looked at from the perspective of the customer and the term “value added” (VA) is applied to activities which convert materials and resources to finished products and services which the customer is willing to pay for. All other activities are considered non-value added (NVA). It is very common in the manufacturing world for process mapping activities, performed on companies that have not previously applied Lean methods, to show that only between 1 to 5 percent of the activities, based on time, associated with raw materials-to-finished good production cycle are actually VA. Yet it is very common for companies to expend the greatest amount of their resources focusing on the activities which are already value-added, often spending considerable capital dollars on the latest technology (e.g.: a faster lathe, a bigger oven, etc.) without considering the rest of the process. The simplified diagram in Figure 1 highlights the shortcomings of the technology approach.

Figure 1. Value Analysis of Process Lead Time with Improvement Options



Source: Adapted from TBM 1999

Building Upon the Success of Lean

MEMPR is not the first group to use Lean as a means of achieving energy efficiency improvements. Quite a number of Lean consultants offer a “Lean Energy” option. The most notable proponent is the United State Environmental Protection Agency (EPA). For nearly a decade now (EPA 2003, 6), EPA has been exploring and utilizing Lean techniques as a means of working with industry to reduce environmental waste. More recently, EPA has expanded those efforts to include a focus on energy. In addition to linkages to Lean providers and to the Green Supplier Network, EPA also offers comprehensive toolkits (guides) (EPA 2009), free of charge,

to industry as educational tools for understanding and applying Lean for energy, environment and government administration.

In early studies (EPA 2003, 31-32), EPA recognized the opportunities and potential benefits of supplementing Lean productivity activities with a focused look at environmental (or energy) factors. The EPA's approach has been to gear its efforts towards Lean implementers and to generate awareness of environment/energy opportunities within the companies that are already Lean adopters. Numerous case studies document the success of EPA efforts in this area. MEMPR's efforts are similar in that we are also engaging through experienced Lean providers (first with BDC) but in addition the Ministry is hoping to leverage the unique resources of the Bank and is also looking for opportunities even with first-time Lean participants.

BDC Partnership

BDC History

MEMPR's primary partner in our SMM efforts is the Business Development Bank of Canada. Initially formed by the Canadian Parliament in 1944, the Bank was created as an arm of the Bank of Canada with a focus on "industrial enterprises" engaged, for the most part, in manufacturing (BDC 2009). Over time, both the name and the mandate have evolved to meet the needs of Canadian businesses and entrepreneurs. In 1975 the bank became a separate crown corporation owned and directly operated by the federal government. On July 13, 1995, the new *Business Development Bank of Canada Act* was adopted (CAN 1995) with a mandate to "... support Canadian entrepreneurship by providing financial and management services ..." and "... give particular consideration to the needs of small and medium-sized enterprises [SME]."

At the start of 2008, BDC employed 1,700 people in 94 locations across Canada serving more than 27,000 SMEs, with a loan portfolio worth more than \$9 billion (BDC 2008). A critical strength of BDC for supporting SMMs on energy efficiency and climate action is its expertise and experience with productivity improvement. Early on in its history BDC "... realized that the challenges facing small business owners were not related exclusively to financing. Many entrepreneurs needed ongoing advice about how to effectively manage their businesses. [The Bank] addressed this need by becoming the first national organization to provide management services such as counseling, training and planning for small business owners." (BDC 2009)

Today, BDC Consulting provides clients not only with financial planning support but with a wide range of services and expertise in the areas of business planning, purchasing, market development, operational efficiency and quality standards.

Lean Initiative with BDC

The concept behind our energy efficiency partnership with BDC is simple – introduce an energy efficiency component into the existing core operations of the BDC to create new channels for both promoting a culture of conservation and efficiency and for generating awareness of existing government and utility energy efficiency programs. At the same time, the program will leverage the BDC's intimate knowledge of SME operations, its consulting expertise and its unique latitudes in financing in order to identify and implement projects within the sector that

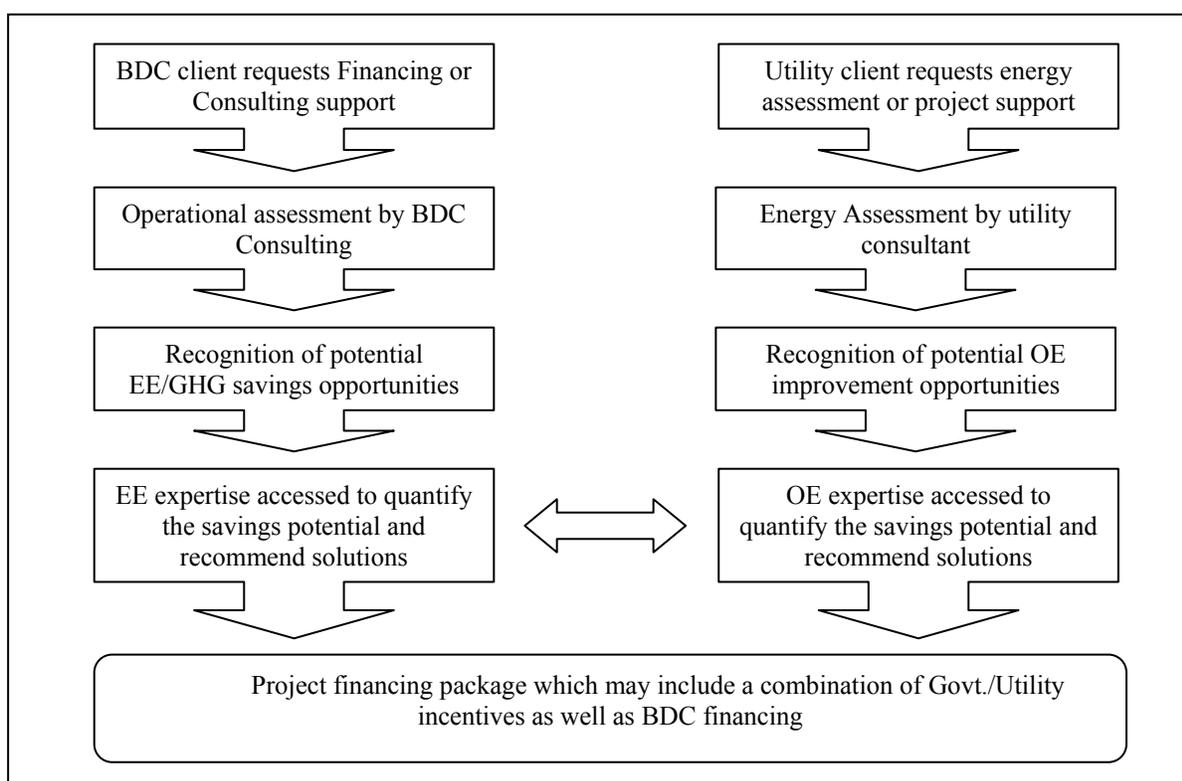
deliver energy and GHG emissions savings while focusing primarily on improving productivity and competitiveness.

In 2007 alone, BDC executed 5,145 loan authorizations (BDC 2008) with SMEs for business expansions; and business expansion accounts for two thirds of all loan authorizations. That represents more than 5,000 opportunities (14 per day on average) to influence the adoption of energy efficient buildings, equipment and processes in the SME sector.

Proposed Program Design

Figure 2 outlines the process flow for customers entering into the MEMPR/BDC program from either BDC’s organizational activities or from those of a utility partner and highlights the complimentary aspects of Lean operational efficiency (OE) and energy efficiency (EE), as well as the common endpoint – project execution with an optimal mix for funding resources.

Figure 2. Proposed Program Design for BDC Energy Efficiency Partnership



Source: Ciccateri 2009

Anticipated Barriers and Obstacles

While Lean has proven effective for decades it is still far from universally adopted, even in the manufacturing world. There are a number of challenges in bringing Lean and energy efficiency together for SMMs, a few of which are discussed below.

First, there is still a knowledge gap around Lean. This was a primary consideration in selecting the BDC as a partner. BDC’s experience in bringing operational efficiency to SMMs provides a solid base upon which an energy efficiency element can be added.

Second, bringing energy expertise into play at the appropriate time is important. BDC’s consulting expertise lies with operational efficiency and not energy efficiency. Also, existing DSM programs and incentives reside mainly with utilities. Gaining the support of utilities in providing access to energy expertise and linkages to DSM programs is critical.

Third, in British Columbia, our provincial utilities are single fuel utilities and are structured around their single commodity. For BC Hydro, which has by far the most extensive industrial energy efficiency program in the province, there is little precedence for DSM activities that are not directly aimed at achieving greater electricity conservation and efficiency. This is expected since the utility’s mandate is all about electricity and it must justify its DSM expenditures to the British Columbia Utility Commission. So, by design, the productivity and competitiveness of industry falls outside the purview of BC Hydro and pursuing a program which only indirectly captures electricity savings is a much harder sell for the utility.

Fourth, similar to barrier number three, utilities typically take a technology or project approach and leave the process concerns to the manufacturer. So, from the utility perspective, an equipment replacement with a higher efficiency unit may be an attractive project, with quantifiable savings. From a Lean perspective however, there may be an opportunity to eliminate the machine altogether; or, conversely, a new process which may use more energy might be the appropriate response. Trying to get Lean efforts as the first step, followed by energy optimization will be new for utilities.

Finally, establishing performance metrics that can be used broadly in conjunction with Lean and energy efficiency which will lead to sound policy direction is a serious challenge. It is hoped that our pilot programs will provide insight with respect to the sequencing of Lean and energy efficiency efforts as well as provide guidance for when and how to best bring energy expertise into play for SMMs.

Program Goals

MEMPR sees value to all participants from this approach (see Table 3) and believes that encouraging Lean thinking is consistent, compatible and complimentary to the Province’s overall efforts on energy conservation and environmental stewardship.

Table 3. Benefits to Partner Organizations in the BDC Lean Initiative

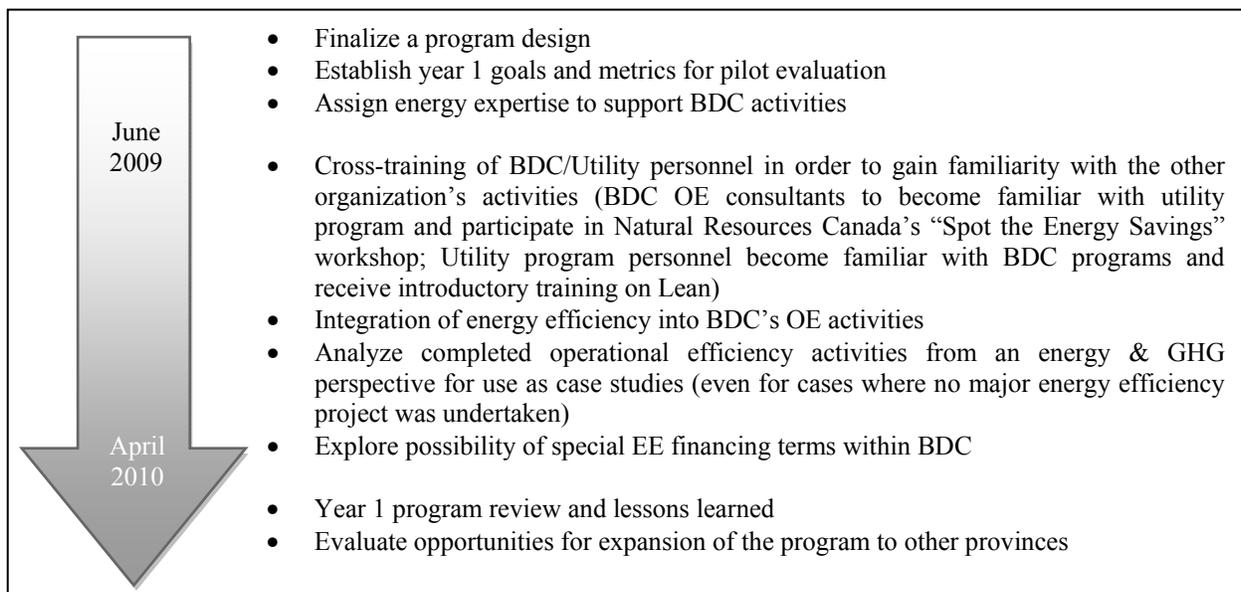
Partner Organization	Benefits
Manufacturers	<ul style="list-style-type: none"> • More competitive & profitable business • Low-cost business improvement
BDC	<ul style="list-style-type: none"> • Performance improvements in client base • Expanded service role • Leadership in climate action
Utilities	<ul style="list-style-type: none"> • Helps fill the SMM gap in DSM plans • Expanded marketing channel
BC Government	<ul style="list-style-type: none"> • Progress towards meeting Climate Action and Energy Plan goals • Progress towards developing a conservation culture in BC

Source: Ciccateri 2009

Because the BDC is a new partner to energy efficiency activities, modest goals are planned for the initial pilot activities, which include:

- Build awareness of energy efficiency opportunities with SMMs
- Integrate energy efficiency into existing BDC core activities – develop awareness and linkages; make energy efficiency a routine consideration for core services to clients
- Develop the knowledge and methodologies for introducing energy expertise to client operations when appropriate
- Document case studies which help develop a benchmark for the typical impacts on energy efficiency and GHG emissions reductions attributable to Lean activities
- Use the BDC pilot as launching point for program that could be taken across Canada

Figure 3. BDC Partnership Lean Initiative Action Plan



Source: Ciccateri 2009

Figure 3 describes a potential path for British Columbia's Ministry of Energy, Mines and Petroleum Resources, in partnership with the BDC, to move forward with exploring the possibilities of this exciting new avenue for market transformation.

Conclusion

Through a partnership with BDC, and a focus on Lean, the Ministry is confident that energy efficiency and climate action can be introduced to small and medium manufacturers in a manner that is consistent with the both provincial strategies for conservation and environmental stewardship as well as the economic reality for small businesses, of increasing costs and competition in the marketplace. A Lean approach will be pursued for manufacturers of all sizes with the ultimate goal of creating a truly Lean, clean and green industrial sector across British Columbia.

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