Best in Class: Using Energy Efficiency & Emission Reductions

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ABSTRACT

Ontario Power Generation (OPG) is preparing for an open and competitive electricity market. To compete successfully requires lower costs and higher output. OPG must also meet increasing environmental obligations, either self-imposed or through regulations. The marketplace will ultimately determine who will be successful – based on the best-perceived price, product, and service.

One of Ontario Power Generation's successful responses to these challenges is the internal Energy Efficiency Program. Energy efficiency (EE) is saving OPG over two billion kWh/yr, worth over $85 million/yr. The program started in 1994 with a target of a 5% improvement over four years in the energy used or lost in generating, transmitting, and distributing electricity. In 1995 the program was expanded to include conversion and thermal efficiency improvements. The target is now 200 GWh/yr across the generation assets between 2001-2005 and equivalent to about a 3% reduction in the annual energy use of OPG. The success of the program won Canada's Industry Tier-One Energy Efficiency Award in 1999.

The benefits of the EE program were expanded in 1997 to calculate a reduction in greenhouse gas emissions. An EE project must demonstrate a reduction in fossil generation as a result of an energy improvement in order to calculate the emission savings. Therefore, in addition to lower costs or an increase in production, there is now an ability to quantify the environmental improvements through the creation of emission reduction credits (ERCs). The ERCs created from energy savings are now registered through the Pilot Emission Reduction Trading project or "PERT". For example, ERCs from OPG lighting improvements between 1995 and 1999 have generated $800,000. Energy savings from Hydroelectric turbine runner upgrades registered between 1998-1999 are equivalent to about $1.4 million. Thus, the approximate value of the emission credits created from eligible energy savings is in the order of 0.4¢ per kWh. It is important to reinforce that the proponent of an energy savings project must prepare a protocol that clearly demonstrates, to the satisfaction of the Pilot Emission Reduction Trading team, that the energy savings resulted in less fossil production. Ontario Power Generation volunteers to remove 10% of the credits from each transaction to ensure a net environmental benefit, i.e., 'retires' 10% of the credits.

To ensure that this seven-year program continues to demonstrate how energy efficiency can help transform assets, increase productivity, and reduce waste, the Energy Efficiency Best Practice Guide was drafted. The Guide will be used in cooperation with OPG's business units to ensure successful practices continue and are enhanced.

Details of OPG's energy efficiency program and the emission trading program are available on the websites: www.Energy-Efficiency.com and www.PERT.org respectively. The Energy Efficiency Best Practice Guide is outlined in this paper and provides the critical criteria to sustain energy efficiency in an industrial setting. These programs are helping

transform OPG from a previously regulated utility to a "manufacturer" of electrical energy in a competitive marketplace – similar to other industries.

Introduction

Ontario Power Generation (OPG) recognizes that it is not alone in North America's transition from a monopoly to a competitive market. OPG manages the generation assets from the former Ontario Hydro as a result of the electricity sector restructuring within the province of Ontario. The need for innovation, market choice, and the removal of market dominance is moving the electricity industry to a new deregulated or, as some insist, a "re-regulated" environment. The change from the familiar position of an energy producer in a monopoly environment to a "kWh" commodity producer within a competitive market requires new ways of thinking.

The ways and means of managing this transition vary across North America and result in different outcomes. Energy related issues routinely make front-page news. For the first time in recent memory, capacity constraints and price spikes that are orders of magnitude higher than the norm are occurring. The California situation is well documented and emphasizes the need for proactive attention to the energy business. Coupled with these changes, environmental pressures are increasing and impacting every part of the business. Each generation source (nuclear, fossil, and hydroelectric) has their opponents, and at the same time, more energy and cleaner energy is required.

Fortunately, there is good news. Staff within the respective utilities are responding positively to the challenges. Information systems are evolving and have the capacity to provide real-time information that will change the way the energy business operates. Information networks are also growing, with advantages available to build synergistic opportunities. Progressive companies are helping with the transition to a competitive market through innovative and market-directed programs. Program examples include Ontario Power Generation's Energy Efficiency Program and Emission Trading.

Ontario Power Generation recognizes the market power that customers will yield through the power of choice, particularly with the desire for low prices and higher service. Companies are expected to operate in an environmentally responsible manner. Consequently, Ontario Power Generation capitalized on these issues and championed the Energy Efficiency Program and invested in the development of emission reduction trading. These programs achieve many objectives, including:

- helping Ontario Power Generation maintain its low-cost position;
- increasing energy output through improved technology;
- developing flexible production capability;
- ensuring positive market presence.

Emission trading helps monetize environmental benefits. The details of Ontario's emission trading program are evolving and the best available information is available from www.PERT.org. The trading process is new and still very much in the pilot and development stage. Many of the market mechanisms and rules are not fully developed as the

various stakeholders negotiate a process and trading system that they believe will work when and if emission caps are set. OPG took the leadership position of working within emission limits provided emission credits could be used to meet CO_2, NO_X and SO_X limits. Simply stated, EE projects that can clearly demonstrate a reduction in fossil emissions of CO_2, NO_X and SO_X, can create an emission reduction credit (ERC). For convenience, and to simplify a complex calculation, the ERC that is created from an energy saving is valued at approximately 0.4¢/kWh based on the cumulative market value of the above emissions. At this point in time, OPG is purchasing ERCs to meet required emission limits. Ontario Power Generation volunteers to use or sell only 90% of credits from each transaction. The remaining 10% of the ERCs will not be used, due to a voluntary commitment to ensure a net environmental benefit. Other industries are participating in the PERT process with the expectation that emission reduction trading can evolve into a mature market. There are too many variables and conditions to provide a complete explanation and those interested in the details of this exciting and evolving market are encouraged to visit the above web site. OPG, and as the former Ontario Hydro, has been involved from the very early stages and active for the past decade. For the purpose of this paper, the important point is the belief that an active ERC trading system will provide an additional economic incentive to energy efficiency projects.

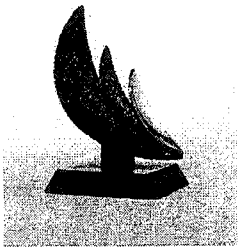
To help ensure progress in energy efficiency is maintained and that Ontario Power Generation's leadership position is sustained, the Energy Efficiency Best Practice Guide was drafted. The Guide is available to help ensure OPG's business units (i.e. nuclear, fossil, and hydroelectric facilities) have an additional tool to continually improve performance through employee participation and 'best practice' principles.

Ontario Power Generation's Energy Efficiency Program

Between 1994 and 1998, Ontario Hydro operated an energy efficiency program across the generation, transmission, and distribution assets. Ontario Hydro was a vertically integrated utility. The EE program was unique from most utility-run programs in that it focused on energy used within the utility and not with end-use customers. Interestingly, many of the programs elements were borrowed from the lessons learned by working with energy efficiency programs developed for end-use customers during the aggressive demand management programs. On April 1, 1999, Ontario Hydro ceased to exist and Ontario Power Generation was created to operate the generation assets. This was the first step in the restructuring of Ontario's electricity industry. The generation assets include nuclear, hydroelectric, and fossil facilities – referred to as business units. These business units collectively generate almost 30,000 MW with an annual revenue exceeding $5.8 billion. Details on OPG are available by visiting www.OPG.com. The energy efficiency program migrated to OPG and has continually improved.

The original target of the energy efficiency program was to reduce energy use by five percent over four years. This target was exceeded in year two. To date, the program is saving over two billion kWh per year. This achievement was assisted by expanding the definition of energy savings in 1995 to include conversion and thermal efficiency improvements. Essentially, conversion and thermal efficiency is defined as increased energy

production from the same amount of fuel. Energy savings alone are worth over $85 million per year based on an average unit of 0.4¢/kWh. The environmental benefits are calculated based on the reduction in fossil emissions. The energy savings can be converted to the reduction in fossil generation since fossil generation is the fuel on the margin. Explained another way, if an energy efficiency project can demonstrate that the savings are real, verifiable, and quantifiable, then the equivalent emissions can be calculated based on the generation source, which is often fossil power in Ontario. The energy efficiency program continues to evolve within Ontario Power Generation and became a comprehensive program integrated into the business planning process. In 1999, the program won Canada's Energy Efficiency Award in the top industrial category.



Canada's Energy Efficiency Award – Comprehensive Industry

The 2001-2005 Energy Efficiency Program has annual energy efficiency (EE) targets of 200 GWh, and is complimented with a number of supporting business unit objectives. The annual incentive program for Ontario Power Generation staff is also tied directly to the EE achievement.

Figure 1 shows the energy savings of the program, comparing the original targets with the revised targets and annualized results. Annualized energy savings are defined as savings that are averaged over a typical year and that can reasonably be expected to be sustained for a ten-year period. Each year, the annualized results not only surpass the original target but also the revised, more aggressive target. Note that with the inclusion of conversion/thermal process improvements, the savings almost tripled in 1995 compared to 1994.

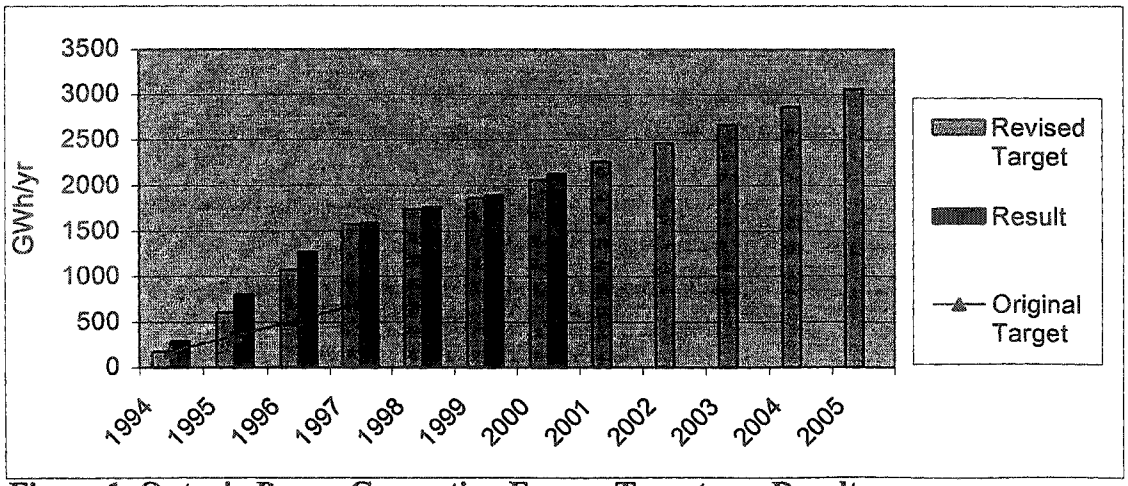


Figure 1. Ontario Power Generation Energy Targets vs. Results

Energy efficiency has also been achieved in harmony with a number of complimentary objectives such as environmental leadership. Table 1 illustrates the estimated cumulative emission savings resulting from EE projects between 1994 and 2000 by each business unit for SO_2, CO_2, and NO_X. The business unit identified as "Other" includes transmission, distribution, and facility savings that were part of the original program.

Table 1. 1994-2000 Emission Saving Summary by Business Unit

	Fossil	Nuclear	Hydroelectric	Other	Total
SO_2 (Mg)	1,060	780	3,700	6,130	**11,670**
NO_x (Mg)	600	430	2,080	4,790	**7,900**
CO_2 (Mg)	209,150	201,970	708,790	1,251,540	**2,371,450**
TOTAL	**210,810**	**203,180**	**714,570**	**1,262,460**	**2,391,020**

Energy savings from Ontario Power Generation's three generation groups – Nuclear, Hydroelectric, and Fossil – account for 1,633 GWh/yr, or more than 76% of the total energy savings. Combined with Ontario Power Generation's Business Services, the savings amount to 2,131 GWh/yr. Figure 2 shows the breakdown in energy savings by generation group.

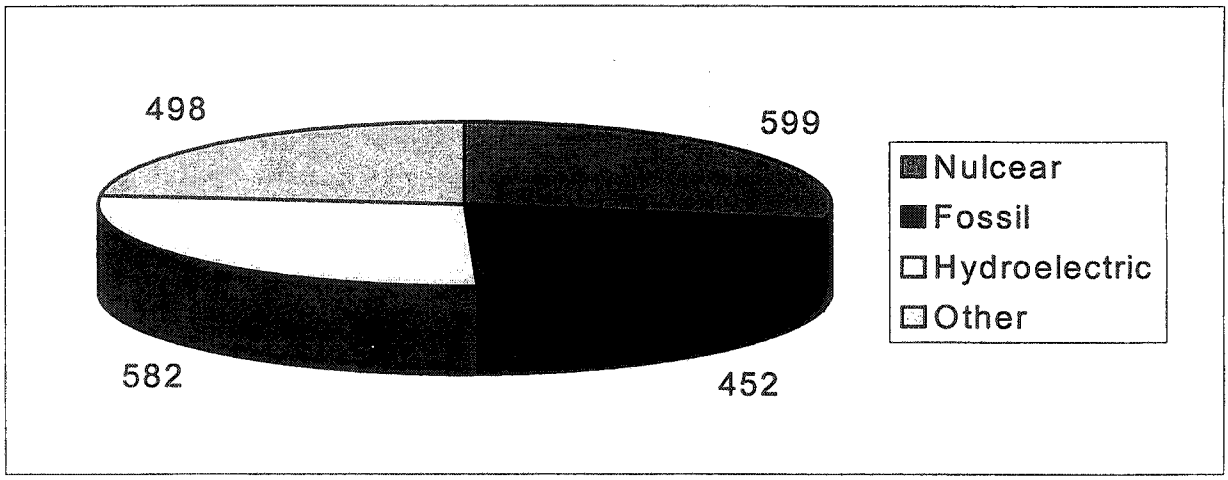


Figure 2. Business Unit Annualized Energy Savings Rate 1994-2000 (Total: 2,131 GWh/yr)

In the energy business, energy efficiency can be accomplished in two ways. The first method is to reduce the amount of energy consumed in the production of electricity, commonly referred to as a station service or electrical efficiency improvement. The second way is to increase the amount of electricity generated for a given amount of fuel or hydraulic energy input. This is referred to as thermal efficiency and conversion efficiency respectively. Energy savings are converted to megawatt-hours based on the heat value for the amount of fuel saved (in Joules) and then multiplied by an efficiency factor. This efficiency factor accounts for the efficiency of converting fuel to electricity. Over the seven-year program, there has been a shift from electrical efficiency to conversion and thermal improvement projects because of the large opportunities available in the power conversion process.

Generation Conversion and Thermal Efficiency

Conversion/Thermal Efficiency improvements were achieved from both operational changes and new technology installations. Operational projects are those resulting from a change in equipment operation (e.g., optimizing performance, improving unit operation), or process improvements (e.g., reducing heating requirements). Specifically, fossil improvements within OPG's operations were mainly from boiler, turbine, and HVAC performance improvements. Nuclear improvements were realized largely in boiler operation (e.g., reduced boiler blow down) and generator operation. In Hydroelectric, most of the savings reported were from optimizing turbine operation.

Technology related projects are those resulting from installation of the new high-efficiency technology. The largest savings in the conversion category were achieved through application of new technology. Specifically, Fossil improvements were mainly boiler and operator related; Nuclear and Hydroelectric improvements were mainly turbine related. In Hydroelectric, many of the turbine upgrades involved increasing capacity.

In Fossil, operational and technology savings were approximately equal, while in Nuclear and Hydroelectric, technology savings were much greater than operational savings.

Energy Efficiency Best Practice Guide

Energy efficiency (EE) is recognized and generally accepted as an economic means of improving the profit position of a company. However, energy efficiency is also achieved concurrently with a number of complementary objectives, such as environmental leadership, corporate citizenship, and employee comfort. In particular, energy efficiency projects are converting energy efficiency savings to an equivalent emission reduction, provided there is a reduction in fossil-derived energy production. Emission reduction trading is evolving as an effective means to monetize environmental improvements, and energy efficiency is an effective means to realize these savings.

Unlike other disciplines, energy efficiency is usually not measured at a business unit level. The difficulty is that energy used by each business unit can differ dramatically. Uniformity and the structure to recognize and compare 'best practices' becomes too difficult because of the many variables involved and unique situations that exist.

Dr. Douglas Norland, from the Alliance to Save Energy, prepared a white paper discussing companies that used energy efficiency 'best practices'. Coincidentally, Ontario Power Generation's seven-year energy efficiency program had evolved from a target-driven annual activity into an integrated multi-year program. The results from several conversations prompted the development of the Energy Efficiency Best Practice Guide. Numerous sources support the Guide and are referenced within it.

The goal of the Best Practice Energy Efficiency Guide is to help business units meet and exceed their energy efficiency targets through continuous improvement in seven key areas. The supporting objectives are threefold:

- to provide an easy-to-use structure for measuring relative energy performance;
- to identify key 'success' and 'gap' areas;

- to quantify seven key criteria.

The Guide was structured to compliment and enhance existing programs. The Guide uses the philosophy of placing the emphasis on developing existing strengths. There is of course recognition on improving weaker areas, but effort in this area is deemed secondary. Equally important is the need for better communication. Communication includes many things, such as reporting progress, providing information, allowing access to resources, providing timely and accurate energy and cost data, etc. The Guide itself is a communication instrument intended to engage staff towards a better understanding of energy use within their business unit.

Implementing the Energy Efficiency Best Practice Guide

The Guide is one of the tools developed by the Energy Efficiency Department to help Ontario Power Generation's business units meet and exceed their energy objectives. The use of the Guide is voluntary and encourages business units to objectively assess their EE position with respect to the seven criteria at a given point in time. An energy advisor is available to assist and facilitate an annual review. Supporting information is available at: www.Energy-Efficiency.com

A matrix was developed to help implement the application of the following seven criteria:

1. Top level commitment
2. Clearly defined goals tied to rewards and a communication plan
3. Assignment of responsibility
4. Documented energy use tracking system
5. Process of project identification with appropriate risk vs. return
6. External comparison and information exchange
7. Recognition of achievement

Within the matrix, each criterion has three distinct components:

Part I Subjective evaluation (i.e., "What is the relative position of this criterion?")
Part II A brief status bar of 'success' and a means to identify an obvious 'gap'
Part III Objective measure (i.e., "What is a tangible and meaningful for this criterion?")

Often information is not available and reasonable guesses must be made. This is encouraged because a 'best guess' often becomes the working hypothesis that leads to interesting discoveries. Over time, better information becomes available as staff looks into the possibilities and a more accurate picture begins to emerge.

Implementation of the Guide is not a time-consuming activity. The Guide is completed at an annual review of the EE program respecting the 90/10 rule (i.e., focusing the first 10% of time and effort on the issues and rules that determines success will save 90% of the time and effort required to achieve success). The Guide represents the first 10% and will

help move the business forward to save valuable resources that are better utilized on project implementation.

Energy Efficiency Best Practice Criteria

1) Top Level Commitment: *company energy efficiency policy that clearly declares an energy efficiency commitment.*

The need for top level commitment is overused, and unfortunately a necessity. Senior management interest will direct the company's activities. The challenge is how to engage and sustain their interest. Fortunately, energy efficiency has three strong drivers:

- lower cost;
- higher production;
- lower emissions.

2) Clearly Defined Goals Tied to Rewards and A Communication Plan: *clear goals define expectations, and when recognized and communicated, drive success.*

Companies achieve what they reward – 'Management 101'. Providing staff an answer to the question, "What is in it for me?" can achieve significant results. An ideal system is one that can quantify goals, link those goals with a reward system, and effectively communicate the process to every employee.

3) Assignment of Responsibility: *clear responsibility and accountability ensures efficient and economic assignment of duties and helps to identify gaps.*

Ultimate responsibility for energy efficiency remains at the plant level where the energy is used or produced. In all cases, energy efficiency measures must not jeopardize safety, production, reliability, etc. Best success is provided through cross-functional facility EE teams.

4) Documented Energy Use Tracking System: *energy savings must be accurately tracked against well-defined rules.*

To help ensure goals can be met and to help establish future goals, the results must be tracked against clear and accepted rules. On the surface this sounds simple, however, tracking requires the means to measure the before and after of an energy improvement. Issues around measurement, conditions, etc. become a challenge. The reporting process and rules also needs to be understood and accepted.

5) Process of Project Identification with Appropriate Risk vs. Return: *properly valued energy efficiency projects will drive improvements without the need of artificial incentives.*

This is often a two-part criterion. First, a process is required to identify projects. Various means are available to help encourage ideas, solicit opinions, and obtain new projects or revitalize forgotten ones. The second part is to ensure the full cost approach is used with the appropriate risk vs. reward. The least capital cost or an artificially low internal energy cost can too often drive inefficiency.

6) External Comparison and Information Exchange: c*hanges happen too fast to rely solely on internal information channels particularly with non-core activities.*

Energy efficiency is most economical in the concept stage of a project before an investment is made in either time or money. Too often opportunities are lost because a retrofit is too costly and interferes with higher priorities or new projects.

7) Recognition of Achievement: *thank the people that made the achievement.*

In every best practice company, recognition of employee achievements in meeting energy efficiency goals is an integral part of their program's success.

Conclusions

OPG's energy efficiency program saves over two billion kWh/year - worth over $85 million annually. The energy savings also result in associated emission savings from reduced fossil production. The emerging emission trading market has the ability to monetize these savings, which can help improve the economics for future energy efficiency projects. Energy Efficiency and Emission Trading are working effectively towards a cleaner environment and are aligned to help industry successfully compete in a competitive market. These programs are equally available to other industrial businesses.

Based on our seven-year review of reported and audited energy projects, the types of energy savings come from projects 'core' to industrial processes. Projects met strict capital spending limits, used proven technology, and typically had a simple payback period of one to three years. Typically, projects start from safety, reliability, or maintenance concerns, further demonstrating that these are core business related projects. The energy savings help ensure success in the competitive market and strive for a cleaner environment. Best of all, benefits go directly to the bottom line and can be controlled internally.

The Energy Efficiency Best Practice Guide provides an effective tool to assist business units in maintaining focus and commitment to energy improvement. Discussion across industrial sectors demonstrates that both the energy efficiency and emission reduction trading programs can deliver success to other companies who care to copy the principles and practices to develop their own unique program. Finally, the Energy Efficiency Best Practice Guide is sufficiently generic to help promote progress across industrial sectors.

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	www.Energy-Efficiency.com	*Energy Efficiency Department*
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