Evaluation of the Environmental Impacts of the Espanola Power Savers Program

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The Espanola Power Savers Project was designed to achieve maximum energy and demand savings through direct installation of demand management measures. While the primary objective of this community conservation project was to maximize megawatt savings, it was the first of its kind to incorporate environmental management in the project design and delivery. The project achieved savings of 2 MW from a total electrical load of 12 MW. This paper reports on an evaluation of the environmental impacts of the Espanola project.

Residential and commercial buildings with electric space heating were eligible for air sealing measures; insulation of walls, attics, floors, basements and crawl spaces; replacement of windows and doors; replacement of the heating system; and installation of ventilation systems. Buildings with an electric water heater were eligible for a water heater tune-up. All buildings were eligible for lighting measures and block heater timers. Participation rates exceeded 85%.

The Espanola project generated approximately 2,885 cubic yards of solid waste of which 2,275 cubic yards were sent to the local landfill and the remainder was reused or recycled. Approximately 90% of the waste sent to landfill consisted of siding, wallboard and other building materials. Most of the remaining waste consisted of lighting retrofit waste and cardboard packaging. However, the energy savings reduced the wastes related to electricity generation. The generation wastes avoided include various atmospheric emissions as well as an estimated 5,280 cubic yards of ash. Thus, the project reduced the total amount of waste generated. It also improved the handling of PCB ballasts.

Recommendations to enhance the environmental benefits of future demand management programs are provided.

Introduction

The Espanola Power Savers Project is Ontario Hydro's first attempt to use a "community-based conservation initiative" to expedite delivery of demand management measures to the residential and commercial sectors. A community-based conservation project uses the community infrastructure, direct customer contact and a whole-building approach to maximize the energy and demand savings and to change attitudes and behavior related to energy use. The objective is to maximize megawatt savings in the shortest period of time while facilitating a cultural shift towards the wise use of electricity.

Espanola, located in northern Ontario, has a population of 5,517 and a total electrical load of 12 MW. The 2,011 eligible sites are primarily (almost 90%) residential. Approximately 40% of the residential buildings and 35% of the commercial buildings have electric space heating. The Espanola Power Savers Project, with a budget of close to $6.6 million, achieved an 86% participation rate for the residential sector, and 87% for the commercial sector. The project achieved savings of 2 MW.

Environmental impacts, especially potential impacts on indoor air quality, were an integral part of the project design and delivery.[1] The project included extensive building shell improvements for buildings with electric space heating. The potential impacts on indoor air quality of the building shell measures was the principal environmental concern related to the project. Extensive air quality testing and monitoring was undertaken, but analysis of those data is not yet complete. This paper focuses on an evaluation of the solid waste management aspects of the

project; including identification and quantification of waste streams, estimation of generation wastes avoided, and waste management/mitigation opportunities for future demand management projects.

Energy Conservation Measures Installed

The Espanola Power Savers Project offered customers a comprehensive package of conservation, retrofit and replacement measures installed by contractors. The measures for which a building was eligible depended upon whether it had electric or gas space and water heating. The 1,081 residential buildings and 130 commercial buildings with natural gas space heating were eligible for low cost lighting efficiency improvements and a block heater timer. If they had an electric water heater, they were also eligible for a water heater tune-up.

The 726 all-electric residential and 74 all-electric commercial buildings were eligible for air sealing measures; insulation of walls, attics, floors, basements and crawl spaces; replacement of windows and doors to increase energy efficiency; replacement of the heating system; and installation of ventilation systems in addition to the lighting and water heating measures.

Types and Quantities of Waste Generated

The energy conservation measures offered under the Espanola Power Savers Project generated a variety of wastes. The types and quantities of waste estimated are:

- Existing products and materials-such as light bulbs, showerheads, doors and windows removed by contractors and siding and basement wall materials removed by property owners–to permit installation of energy conservation measures.

- Wastes, such as scrap and damaged products, generated in the course of installing energy conservation measures.

- Packaging material wastes from the products and materials installed.

Environmental impacts that occur at earlier stages of the product life cycle are outside the scope of the analysis.

Types and Quantities of Waste Generated

Estimates of the types and quantities of waste generated by the project were developed from the work orders for individual buildings, supplemented by discussions with contractors and waste management officials. The work orders provide information on the products and materials installed. Scrap and packaging wastes are estimated from these quantities. The quantities of materials removed are also estimated from the data on the measures installed. Estimates of reuse, recycling and disposal are based on information provided by contractors and waste management officials.

The total quantity of solid waste generated was estimated at just over 2,885 cubic yards. The quantities of wastes generated and sent to landfill are shown in Table 1. The quantity of waste sent to landfill was estimated at 2,275 cubic yards, or almost 80% of the total waste generated. The largest components of the waste stream were the siding and wallboard removed by building owners to permit installation of insulation, each accounting for about 36% and 33% respectively of the waste sent to the landfill. Other significant components of the waste stream include scraps from installation of insulation (13%), siding (6%) and wallboard (5%), and cardboard packaging (4%).

Aluminum siding, showerheads, doors, furnaces and window glass were largely reused or recycled. All of the aluminum siding and showerheads removed were recycled. The doors replaced with more energy-efficient doors were substituted for poorer quality doors in cottages, camps, garages or friends' homes. The furnaces replaced were retained by the heating contractor as a source of spare parts. During the early stages of the project most of the glass removed was sent to the landfill for disposal at the contractor's expense. Almost all of the glass was broken in the process. Subsequently, the landfill operator established an exchange for window glass. The contractor deposited reusable window glass in a designated location and anyone that wanted glass could take it free of charge. As a result an estimated 80% of the window glass removed was reused. Some vinyl siding, lighting fixtures and fluorescent tubes were reused in appropriate locations.

The residential all-electric participants generated almost 95% of the waste, 2,730 cubic yards, of which 2,155 cubic yards were sent to the landfill. The average volume per dwelling is 3.5 cubic yards which is about 1.6 pickup truck loads. Commercial all-electric buildings accounted for most of the rest of the waste, 115 cubic yards of which 100 cubic yards were sent to landfill. However, the average volume of waste per commercial building (2.3 cubic yards) is two-thirds that of a residential dwelling. The reason is that exterior insulation and siding and basement insulation are less common measures for commercial buildings.

Nonelectric buildings generated much less waste than all-electric buildings. This is not surprising since they were not eligible for the insulation and other building shell

Table 1. Estimates of Actual Wastes Sent to Landfill

	Units	Quantity	Fraction Reused or Recycled	Quantity of Waste (cu yds.)
		Wastes Removed		
Incandescent Bulbs	No	56,000	-	2
Fluorescent Tubes	No	26,000	0.10	12
Ballasts	No	12,000	-	15
Fixtures	No	6,000	0.05	55
Showerheads	No	1,000	1.00	-
Siding	Sq. Ft.	350,000	0.35	820
Wallboard and Framing	Sq. Ft.	190,000	-	750
Window Glass	Sq. Ft.	60,000	0.80	12
Doors	No	1,000	1.00	-
Furnaces	No	20	1.00	-
		Installation Wastes		
Siding	Sq. Ft.	35,000	-	125
Insulation	Sq. Ft.	60,000	-	300
Wallboard	Sq. Ft.	25,000	-	100
Window Glass	Sq. Ft.	600	-	1
		Packaging Wastes		
Cardboard	Sq. Ft.	155,000	-	82
Plastic	Sq. Ft.	7,500	-	3
Total				**2,275**

measures that generated most of the waste. The commercial nonelectric buildings generated an average of 0.6 cubic yards (less than two 45 gallon drums) of waste consisting of light fixtures, ballasts, and fluorescent tubes. The nonelectric residential buildings generated very small amounts of waste; an average of almost 32 incandescent bulbs and 0.7 showerhead per home for a total of less than 0.002 cubic yards.

Handling of Ballasts That Contain PCBs

Ballasts were collected by the contractor responsible for installing the lighting measures. The ballasts removed were inspected to determine whether they might contain PCBs. Approximately 12,000 ballasts were removed. Less than 5% of the ballasts removed were identified as possibly containing PCBs. The non-PCB ballasts were sent to the landfill for disposal. Although about 10% of the fluorescent tubes removed were reused, none of the ballasts were reused.

The PCB-contaminated ballasts were collected for storage in a manner approved by the Ontario Ministry of the Environment. The volume of PCB-contaminated ballasts was four 45-gallon drums, or 0.8 cubic yards. The Ministry of the Environment has not approved any PCB destruction technologies, so the contractor is responsible for storing the ballasts in an approved manner. Although the ultimate fate of the PCB-contarninated ballasts is not yet known, it is virtually certain that the Espanola Power Savers Project improved the handling of these wastes relative to replacement of lighting fixtures by building owners.

Quantities of Waste Generated Indirectly

A homeowner may use installation of energy conservation measures as the occasion to undertake other renovations, such as enclosing a porch or remodeling a kitchen or basement. Wastes generated as a result of such renovations are considered to be indirect impacts. There was no

evidence of significant amounts of waste generated indirectly by the project.

The amount of renovation work undertaken in conjunction with the Espanola Power Savers Project is subject to considerable uncertainty. Contractors indicated that the amount of renovation activity was normal. Estimates by project staff suggest that renovation work was equivalent to 5% to 10% of the value of project work. There is no necessary relationship between the cost of the work and the quantity of waste generated, but 5% to 10% of the project waste suggests 100 to 250 cubic yards of waste generated by renovation activity and indirectly attributable to the project.

Quantities of Generation Waste Avoided

The energy conservation measures installed by the Espanola Power Savers Project reduce the demand for electricity and hence the wastes associated with electricity generation. An estimate of the wastes avoided by the Espanola Power Savers Project is summarized in Table 2.

Measures for residential and commercial buildings were grouped on the basis of their expected life. The demand and energy impacts of each measure were estimated for each of four costing periods that comprise a year. The wastes associated with the mix of marginal generation during each costing period were applied to the energy savings during that costing period. The wastes avoided were accumulated over the life of the measure. Thus, the figures shown in Table 2 are the wastes avoided by the measures installed over their respective lives.

All of the wastes avoided, except ash, are atmospheric emissions. Although some ash is used to produce gypsum, much is sent to landfills. Assuming all of the 2,627 tonnes of ash avoided would have gone to landfills, it would represent 5,280 cubic yards of waste. Thus, the Espanola Power Savers Project reduced the waste sent to landfill by avoiding the need to dispose of up to 5,280 cubic yards of ash while generating 2,275 cubic yards of waste sent to landfill in the course of installing the conservation measures. The net saving could be as much as 3,000 cubic yards of solid waste, although the locations and types of the wastes differ.

Environmental Impacts of Other Community Energy Efficiency Projects

We are familiar with other community energy conservation projects in Hood River (Oregon), Jasper (Alberta), Osage (Iowa), and Rock Valley (Iowa). We are not aware of any studies that report the environmental impacts of those projects. Thus, it is not possible to compare the environmental impacts of the Espanola project with the impacts of energy efficiency projects in these other communities.

In any event, comparisons of the environmental impacts of community energy efficiency programs should not be made at such an aggregate level. The quantity of waste generated by the Espanola project is dominated by the all-electric homes. A community retrofit project with few electrically heated homes would produce much lower quantities of waste. Jasper, for example, has virtually 100% natural gas space and water heating in the residential sector, so that project does not include any residential insulation or weatherization measures. As a result, the total quantity of waste generated in Jasper is likely to be much lower than in Espanola as a result.

Opportunities for Improved Waste Management Practices

Opportunities for waste reduction, reuse of items removed, and recycling of wastes were reviewed. The opportunities for improved waste management practices may be restricted by a variety of barriers, including cost and local infrastructure.

The Espanola Project was structured to provide contractors with incentives to minimize waste. Unit prices for the energy conservation measures were established through competitive bidding. Contractors installing measures were responsible for purchasing the materials and for waste disposal. Thus, they had a double incentive to minimize waste; to reduce the cost of the materials purchased and to reduce the tipping fees incurred.

A high potential for reuse exists for doors and window glass. Virtually all doors and most window glass removed was reused. Some of the vinyl siding removed was also reused. Ballasts and fluorescent tubes can be reused in “applications not eligible, or not economic, for energy efficient lighting, but this must be controlled so that the energy efficiency objectives are not compromised. While reuse of the incandescent bulbs, showerheads, and fluorescent light fixtures removed is also possible, it would jeopardize the energy efficiency objectives.

Many of the high volume waste materials generated, including aluminum, wallboard, window glass, wood, cardboard, vinyl and steel, can be recycled. However, with the exception of aluminum, markets in northern Ontario are unfavorable and recycling would result in higher costs than landfill disposal. In southern and southwestern Ontario tipping fees are much higher and many of the products are banned from landfills. Thus, the

Table 2. Wastes Avoided by the Espanola Power Savers Project

	TONNES									
	KW	**KWH**	**SO_2**	**NOx**	**CO**	**CO_2**	**Methane**	**Particulates**	**Ash**	**Trace Elements**
					Residential Buildings					
1 Year	34	236309	1.36	0.35	0.01	172.01	0	0.06	5.74	0.02
2 Years	8	48789	0.53	0.14	0.01	66.77	0	0.02	2.35	0.01
7 Years	11	54834	2.01	0.5	0.02	274.45	0	0.09	9.45	0.04
10 Years	1	2403	0.11	0.3	0	16.76	0	0.01	0.58	0
11 Years	57	1023437	50.65	13.2	0.66	7719.05	0.06	2.51	265.44	1
15 Years	79	595871	34.42	9.61	0.49	5805.35	0.04	1.88	196.75	0.72
20 Years	1222	3768734	229.78	66.04	3.44	40327.7	0.32	12.52	1328.83	5.48
Sub-total	1416	5730381	318.86	89.87	4.63	54382.09	0.42	17.09	1809.14	7.27
					Commercial Buildings					
1 Year	2	19774	0.11	0.03	0	14.12	0	0	0.47	0
3 Years	1	6272	0.10	0.03	0.00	12.63	0.00	0.00	0.44	0.00
5 Years	0	460	0.01	0	0	1.56	0	0	0.05	0
11 Years	5	94517	4.59	1.2	0.06	699.3	0.01	0.23	24.05	0.09
12 Years	38	340875	17.41	4.63	0.23	2765.82	0.02	0.89	93.65	0.35
15 Years	288	1479802	83.85	23.4	1.2	14142.54	0.11	4.57	479.3	1.76
20 Years	278	636497	38.07	10.94	0.57	6681.17	0.05	2.07	220.15	0.91
Sub-Total	614	2578200	144.14	40.23	2.06	24317.14	0.19	7.76	818.11	3.11
Total	2031	8308581	463.00	130.10	6.69	78698.23	0.61	24.85	2627.25	10.38

Source: Ontario Hydro

infrastructure for handling these recyclable materials is better developed and the economics of recycling are more favorable in these parts of the province. Specialized facilities exist in some parts of the United States, but not in Ontario, to recycle fluorescent tubes and ballasts.

The only source of hazardous waste generated by the project is ballasts that contain PCBs. They represent less than 5% of the ballasts removed and fill two 45 gallon drums. The Ontario Ministry of the Environment has not approved any methods for disposal or destruction of PCB wastes. The ballasts are being stored in accordance with Ministry of the Environment regulations.

Recommendations for Solid Waste Management

The Ontario Ministry of the Environment announced a Waste Reduction Action Plan to divert wastes from landfills by implementing the "3Rs" of waste management: reduction, reuse, and recycling. Industrial, commercial and institutional establishments, including construction and demolition contractors, will be required to conduct a waste audit, prepare a waste reduction workplan, to source-separate materials and to implement their waste management workplans.

For future energy conservation retrofit programs we therefore recommend that Ontario Hydro follow the provisions of the Waste Management Act and related regulations with respect to all wastes directly attributable to the program. Specifically:

- Prepare a *waste audit* before the project begins. The audit estimates the quantity of each type of waste likely to be generated by the program.

- Prepare a *waste reduction workplan* before the program begins. The waste reduction workplan should examine all opportunities for reduction of wastes, source separation of wastes, reuse of wastes and recycling of the remaining wastes.

- Implement *source separation* of materials at the point of generation for wastes to be reused or recycled.

These wastes should include: aluminum, vinyl siding, glass, wallboard, wood, cardboard, ferrous metals, and plastic packaging, fluorescent tubes and ballasts.

- Implement the waste reduction workplan as the program is being delivered.

The waste reduction workplan could include mechanisms to:

- Inform property owners of their right to retain reusable items;
- Provide training for contractors on techniques for removal of materials without breakage or contamination;
- Require contractors to separate reusable and recyclable materials;
- Require that waste generated by property owners in preparation for installation of measures be source separated;
- Identify markets for recyclable materials prior to onset of the work to ensure that the materials recovered meet specifications;
- Implement waste exchange/notification services within or outside the community; and
- Determine the extent to which the project can subsidize recycling costs given local tipping fees and landfill disposal bans.

Finally, making contractors responsible for purchasing the materials and for waste disposal, as was done in Espanola, provides them with an incentive to reduce the waste they generate and to participate in reuse and recycling activities and should be a feature for future projects.

Conclusions

The Espanola Power Savers Project is the first of its kind to evaluate environmental impacts. The project design and delivery paid particular attention to its impacts on indoor air quality. The environmental evaluation also identified the types and quantities of solid waste generated directly and indirectly and the types and quantities of waste avoided through reduced generation requirements. A framework for ensuring improved waste management practices was also developed.

Did the project yield a net environmental benefit? It substantially reduced the volume of atmospheric emissions of sulphur dioxide, nitrogen oxides, carbon monoxide, carbon dioxide, methane, particulate, and trace elements associated with the electricity saved by the demand management measures. In addition, the need to dispose of up to 5,280 cubic yards of ash is avoided, more than offsetting the 2,275 cubic yards of wastes generated by the project and sent to the local landfill. In addition, the project almost certainly improved the handling of PCB ballasts.

The environmental evaluation developed a framework for waste management practices that has subsequently been utilized by other energy efficiency initiatives at Ontario Hydro. The evaluation of the environmental impacts of the Espanola Power Savers Program not only serves to document environmental issues associated with the community-based conservation effort, but results from the evaluation are now providing a framework to help manage program impacts to both air as well as solid wastes.

Endnotes

1. The potential impacts of energy conservation measures on indoor air quality were a significant concern in the design of the Espanola Power Savers Project. Indoor air quality concerns affected the implementation of energy conservation measures as follows:

   - Homes with evidence of moisture problems were required to install proper ventilation systems before major energy conservation measures were implemented.
   - As part of the water heater tune-up, the thermostat was set to 60°C to minimize the risk of Legionnaires disease.
   - Every all-electric residential building was tested for radon before the energy conservation measures were installed. To be eligible to participate in the program, a home had to have a radon level below the Canadian guidelines of 21.6 picoCuries per litre.

     Every all-electric residential building was tested for radon before any energy conservation measures were installed. The initial test was a short-term (2 to 5 days) test. If the initial test indicated radon levels over 15 picoCuries per litre (pCi/L), a more accurate, long-term (six months) test was performed. If the radon level recorded by the six month test as above 15 pCi/L, the homeowner was responsible for mitigation measures to reduce the radon levels below the Canadian guideline of 21.6 pCi/L.

     After the energy conservation measures had been installed, 170 of the all-electric homes received a

short-term (48 hours) test. If this short-term test gave a reading in excess of 10 pCi/L a second short-term (seven days) test was performed. Although all homes for which test data were reviewed fell within the Canadian standard, the readings suggest that radon levels in Espanola homes are high relative to those in other Canadian communities. Before and after test results will be compared to determine whether there has been a systematic change in radon levels due to the project.

Espanola is known to experience high humidity, so a relatively high frequency of moisture problems in homes was anticipated. Houses with moisture problems were identified by the auditors and those homeowners were required to install proper ventilators before the energy conservation measures were installed. Over 100 homes installed a ventilation system. Data available indicated that concentrations of individual pollutants were within the Canadian standards after installation of the energy conservation measures.