Energy Drill! Unique Demand Response in Schools

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Abstract

The Energy Drill Program™ is an innovative demand response program modeled after fire drills. Piloted in eight Toronto-area schools in the 2006-2007 school year, this demand response program actively engaged students, teachers and staff in reducing electricity use during times of peak demand.

An Energy Drill is a response to forecast need for demand reduction whereby students and staff, led by designated and trained Energy Teams, carry out electricity-use reduction measures. Measures include turning off lights and computers, deferring use of equipment and adjusting HVAC. Demand reductions achieved on Energy Drill days during the pilot averaged 5.4% across all participating schools, but reached as high as nearly 30%, attesting to the potential of the program.

Catering to a unique audience in a unique environment was key to the design of this demand response program. Moving away from the typical characteristics of a traditional demand response program that can be prohibitive in schools, as well as implementing effective media and social marketing techniques, proved necessary to allow demand response in schools and to capture and engage the school community.

The success of the Energy Drill program pilot was most evident in its contribution to raising awareness of energy and environmental matters and effecting behavioral change. This success has been attributed to the action-oriented, empowering nature of the Energy Drill program, and the flexibility provided to participants. Suggestions of how to improve the program in a Phase 2 pilot, particularly in terms of improving demand reduction results, have been put forward.

Introduction

Educating school-age children in responsible energy management is an essential ingredient in developing a sustainable energy future. Empowering them to act takes this education one step further, creating tangible real-time results and cultivating a culture of conservation. Schools are a natural choice of location in which to launch an energy management education program. School communities and school-age children form a unique audience within a unique setting, with a populace of varied age, ability and motivation operating in a highly scheduled, often resource-challenged environment. However, there are many competing priorities within schools and school boards.

One key to successful programming in the unique and busy school environment seems to be adaptive, flexible and empowering design, with tangible actions backed by comprehensive and attractive educational messaging. This paper introduces the Energy Drill as a program with these unique attributes. The unique school environment and elements of the Energy Drill's program design will be discussed, followed by program results, and the future of the Energy Drill.

Background – what is the Energy Drill?

The Energy Drill Program™, trademarked by Milton Hydro Distribution Inc., is a unique demand-response program in schools and is modeled after fire drills. Instead of a fire, however, one or a combination of forecasted extreme high or low temperatures, smog, electricity supply constraints and high market prices trigger an Energy Drill. Schools are notified by email when an Energy Drill is called and trained Energy

Teams consisting of students, teachers, caretakers and staff respond by carrying out a number of no-cost, predetermined measures specific to their school. Measures include selectively turning out lights, turning off computers and monitors, deferring use of electrical equipment away from identified peak demand times-of-day and adjusting HVAC where possible (adjusting thermostat set points, cycling fans, etc.). The result is an educational opportunity for all participants, an opportunity to develop energy conservation behaviour and encourage a conservation culture, as well as a tangible demand reduction at times of need that is documented with trackable results in the form of report cards to the participating schools.

The Energy Drill program was piloted in the 2006-2007 school year in eight Toronto-area schools (four in Halton Region and four in Toronto), involving three school boards and with sponsorship from the Ontario Power Authority, Milton Hydro, Toronto Hydro, the City of Toronto and BigStudios as a media partner. IndEco designed and delivered the Energy Drill Program pilot on behalf of the school boards and sponsors.

Context for demand response

Traditionally, demand response programs involve participants taking actions to immediately reduce demand in direct reaction to supply conditions, typically over a short period of time during which supply is most constrained. Demand response can be 'requested' by the electricity system operator (ISO, or IESO), whose responsibility is to ensure the reliability of the integrated power system, along with administering wholesale markets and forecasting supply requirements (Independent Electricity System Operator, 2007). Emergency demand response programming is in place in Ontario and is intended to mitigate the adverse impact of shortages of energy under stressed system supply conditions. When Ontario's IESO experiences emergency supply conditions, it calls for voluntary response of participants to reduce electricity demand (Independent Electricity System Operator, 2007).

The average school day peak demand of the schools in our study was approximately 115 kW; with over 5,000 schools in Ontario (Ontario Ministry of Education, 2007), representing an approximate combined peak demand of 575 MW, the potential impact of schools participating in demand response is significant. In addition to the potential tangible demand reduction, the school-age population that can be reached through programming of this nature is a key population. By bringing programming to schools, there are tremendous educational opportunities; spreading the message of energy conservation and the building of a culture of conservation is key to the future of energy conservation and management.

Issues with typical demand response in schools – a unique audience in a unique environment

The typical characteristics of a traditional emergency demand response program can present problems to schools in a number of ways. The characteristics of traditional demand response and the related problems in schools are discussed in turn below.

Typical demand response is immediate and sudden

It is difficult for schools to react immediately and suddenly to the call for demand response. Teachers have a tremendous number of responsibilities during the school day, running a number of programs and covering a full curriculum. Receiving a demand response trigger, often times, cannot result in a teacher organizing an immediate reaction. Teachers and staff require time to prepare for each response by rescheduling activities if and when possible, and spreading the message to students. School activities vary from day-to-day and certain activities can not tolerate certain demand response measures and cannot be

rescheduled (such as exams). In addition, school days are full, and streamlined with a set of activities of relatively short durations, and students benefit from following regular routines.

The need for a demand response event needs to be communicated quickly

It is difficult to spread the message of an urgent call for response to all school occupants. Most school occupants don't have regular access to phone or email. In order for a response to be effective, all school occupants need to participate and be aware of the program such that response actions are not reversed (i.e. lights inadvertently turned back on).

A demand response event is typically short-lived

The educational benefits, degree of response and visibility of the program will be lessened if response is short-lived as demand response measures typically are. Some students may not have an opportunity to become aware of, or participate in, the program activities if the response lasts for only a short time.

Demand response measures can be technical and may be automated

The nature of demand response can be relatively technical, involving precise adjustments to heavy or sensitive equipment. Students, particularly younger ones, need a predetermined response which they can be trusted to carry out safely and efficiently, with minimal disruption to scheduled school activities. The level of understanding and ability to participate varies between students within each school and between schools. As well, students don't have access to certain equipment, and cannot be granted such for safety and security reasons.

In addition, demand response activities may be automated with building or equipment automation systems that react directly to an electronic trigger. Using such systems could make a demand response event virtually invisible, thus removing the educational potential from it.

Demand response measures can create less comfortable conditions

Demand response has the potential to create less comfortable conditions, such as lower light levels, warmer or cooler temperatures and decreased air circulation. Safety and health concerns related to these conditions may limit the ability of the school to carry out certain measures to the extent they could otherwise be carried out. Children's tolerance, perceived or otherwise, to less comfortable conditions brought about by demand response measures is often low. As well, simple demand response measures involving lowering light levels is not an option in certain areas such as washrooms, change rooms or other isolated or unsupervised areas due to safety and security reasons.

Demand response is just a set of actions without messaging

The actions associated with traditional demand response are simply that – a set of actions. Adding a required set of actions to the schedule of students, teachers and school staff is meaningless without messaging attached as to the reasons for, and importance of, those actions. Simply asking students to carry out demand response actions can be added to the list of actions already expected of them during a typical school day.

To address these issues, the Energy Drill demand response program was uniquely designed.

Energy Drill program design – adapting demand response to schools

As necessitated by the unique needs of schools, the Energy Drill program in schools is a unique demand response program. Its design components are such that the problems in schools that would be brought about by the characteristics of traditional demand response are addressed, and flexibility is built in to allow participating teachers, staff and students to adapt as necessary. The unique design components are discussed below, according to the traditional demand response characteristic they address.

Typical demand response is immediate and sudden

To address the issue of schools' difficulty in immediate and sudden reaction to the call for demand response, an Energy Drill was designed to include a day-ahead warning. As typical demand response is reactionary (directly reacting to supply conditions), a new problem was introduced: how can demand response have a day-ahead warning in reaction to supply conditions that fluctuate greatly throughout the day, day-to-day, and seasonally?

The Energy Drill's unique solution to this problem is, rather than to react to supply conditions, the Energy Drills are called in response to forecasted predictors or indicators of constrained supply or high electrical demand that could potentially exceed available supply. In Ontario, high electrical demand is generally correlated with extreme cold or hot temperatures which necessitate the increased use of electrical heating or air conditioning, respectively. Smog, due to its creation of uncomfortable ambient conditions, general correlation with hot temperatures and tendency to cause people to close windows, also tends to increase air conditioner use and thus, it is also correlated with high electrical demand. Extreme temperatures and smog are thus predictors of the need for demand response, and both can be forecast relatively accurately a day in advance.

High market electricity prices and constrained supply are indicators of the need for demand response. Through Ontario's IESO, market electricity prices are systematically predicted a day in advance, with a fair degree of reliability. Supply constraints are also predicted in advance by the IESO, and involve a combination of contributing factors ranging from their own environmental predictors of high demand, scheduled generator maintenance, generator failure and real-time conditions. High market prices and supply constraints are indicators of the need for demand response and can be forecast with some accuracy a day in advance.

Thus, a system for calling an Energy Drill demand response event a day ahead is in place. As part of the Energy Drill program, forecasts of these triggers are monitored at 3 p.m. every day. When the forecasts of these triggers show the need for demand response, an Energy Drill is called for the following day and an e-mail notification goes out to schools before the end of the school day. A reminder notification is sent at 8 a.m. on the morning of the Energy Drill. It should be noted that with the need for forecasting of supply and demand, there is the potential for false positives and false negatives, but these situations can be addressed in educational messaging.

Calling an Energy Drill a day in advance directly addresses schools' needs for being able to plan. It gives teachers and staff an opportunity to organize a response and the surrounding educational messaging, as well as rescheduling activities when necessary and if possible. Teachers and staff are also given the flexibility to cancel, shorten or limit the times of the Drill response as may be deemed necessary by previously scheduled activities that cannot be rescheduled (such as exams). The day-ahead notification allows rescheduling of the day's activities such that students can still operate in a routine way.

The need for a demand response event needs to be communicated immediately and urgently

Addressing the difficulty of spreading an urgent message to an entire school community is partly mitigated by the day-ahead notification. The day-ahead notification removes the urgency from the need to spread the message, and allows more time for the message to spread. It allows for signage to be put in place at school entrances on Energy Drill days to alert students that it is an Energy Drill day, as well for Energy Drill messages to be incorporated into standard morning announcements over the P.A. system.

Additionally, the demand response of the Energy Drill is designed to last over the course of the full day, further reducing the urgency of the message.

Teachers, staff and students were also given the flexibility and encouragement to devise new and unique ways of communicating the message in their schools.

A demand response event is typically short-lived

The short-lived nature of traditional demand response programs shortens the length of time available for participants to learn about and participate in the response. The Energy Drill in schools has been lengthened to incorporate a full day of response, maintaining action and education around time-of-use issues vis-à-vis seasonal dependent timing of equipment use deferral. Specifically, in summer time, when peak demand in Ontario is in the heat of the afternoon, Energy Drill measures include the deferral of the use of electrical equipment from afternoons to mornings. During winter time, peak demand in Ontario is in the early morning and early evening, thus Energy Drill measures include the deferral of the use of electrical equipment from mornings to afternoons.

With full-day demand response events, the Energy Drill program allows leeway in the time it takes to spread the notification around the school, as well as allowing flexibility in the timing of response and of education activities around the Drill. This allows schools flexibility in rescheduling activities or response to best suit their schedules. Due to the fact that the Energy Drill responds to forecasted indicators and/or predictors or the need for demand response, rather than emergency supply conditions directly, a full-day response is also more likely to cover the true time of the need for demand response.

Demand response measures can be technical and may be automated

Allowing school-age children to participate in a demand response program can be problematic due to the potential for a response to be very technical in nature. The Energy Drill is designed to encompass a number of measures varying in difficulty, from simply turning off lights to adjusting building automation system modes and HVAC settings. Schools are given the flexibility to determine which participants will carry out which actions. Energy Teams can consist of any combination of students, staff, caretakers and teachers, with responsibility for implementing measures allotted among them. Younger students can implement lighting measures, older students can ensure the deferral of use of equipment and the powering down of equipment, caretakers can implement building automation system and HVAC adjustments and teachers and staff can implement measures in areas where students are not permitted.

In addition, the Energy Drill program incorporates extensive training such that students can learn and rehearse their response, eliminating confusion and maximizing response on Energy Drill days. Regularly scheduled Practice Energy Drills occurring two weeks since the previous naturally triggered Drill also serve to reinforce the training of the Energy Drill response.

Automation of demand response measures was not included in the Energy Drill program in order to ensure maximum visibility and active participation in demand response, encouraging participants to feel empowered to make a contribution to the demand response effort.

Demand response measures can create less comfortable conditions

The design of the Energy Drill program addresses the creation of less comfortable conditions in a number of ways. First, as a full-day response, an Energy Drill lowers demand over the full course of the day, and thus, measures need to create conditions that are sustainable throughout the day. Rather than creating less tolerable conditions for a short period, the Energy Drill creates tolerable conditions for a longer period. For example, rather than a one-hour demand response event that turns off air conditioning, air conditioning set points are simply lowered throughout the course of the day.

Regarding lighting and the deferral of the use of electrical equipment, reduction in use is limited to that which generally allows regularly scheduled activities to proceed, or be deferred for an acceptable amount of time. Lights in areas sensitive to safety and security issues are not included in the Energy Drill. Teachers and staff have the flexibility to adjust response based on the feedback from school occupants.

Demand response is just a set of actions without messaging

To enhance the Energy Drill as a demand response event beyond being simply a set of actions, the Energy Drill program incorporates a number of educational messages and activities into the response routine. A number of media materials, social marketing techniques and curriculum-related educational activities are used in the program to educate participants about the reasons for, and importance of, demand response. Media materials included promotional movies, posters and fact sheets. Social marketing techniques included asking for the commitment of schools to participate in the program, providing prompts for action (stickers at light switches, clipboards with lists of actions, and the calling of Energy Drills) and, naturally, educating participants. Curriculum-related educational activities involved engaging teachers throughout the school to carry out suggested activities, incorporating electricity conservation and demand response messaging into every day activities.

Overall, the unique design of the Energy Drill demand response program addresses many of the schools' concerns associated with traditional demand response activities.

Energy Drill pilot results

Three types of results were measured for the Energy Drill program: educational and culture change, actual electrical peak demand reduction, and program evaluation.

Educational and culture change results

Educational and culture change results were measured by pre- and post-pilot surveys with questions to indicate behaviour, attitudes, knowledge and belief, as well as post-pilot interviews of the Energy Champions in each participating school.

A pre-pilot baseline survey was designed, printed and administered to staff and students before formal school-wide introduction of the Energy Drill program. A post-pilot follow-up survey was designed to be identical to the baseline survey in order to facilitate direct comparison of the two. The post-pilot survey was printed and administered at the end of the pilot program school year. The surveys were designed using multiple choice questions for the most part, which facilitate easy tabulation and comparison. Some 'fill in the blank' style questions were also used.

All staff in participating schools were surveyed, while random representative sample sets of students were surveyed in each of the pre- and post-pilot rounds. A total of 208 post-pilot surveys were available for comparison to pre-pilot surveys. The sample of 208 gives a +/-5% confidence interval with a confidence of 95%. No control groups were available for the evaluation.

Survey results: Behaviour. A number of questions related to behaviours around the use of electricity were asked. Students taking responsibility for electricity use in the home before and after the pilot tended to increase with more answers stating that everyone participated, and less saying it was their parents' job. There was little change before and after the pilot in the reasons why students may not turn out lights, with the primary reasons remaining that they would forget or that they still needed the light. Students made little headway through the pilot in claiming to take responsibility for electricity use in the school, stating more often that teachers turned out the lights. They did, however, show more awareness after the pilot about turning out lights, with fewer answering that they didn't know who turned out lights at school. The most significant self-reported behavioural change related to turning off computer monitors – while 22% of respondents claimed to always turn off monitors prior to the program, 45% claimed to always turn off monitors after the program. Reasons indicated included that the students were more apt to think about it unprompted, and were more likely to feel it was their responsibility. This statistic represents a significant behavioural change over the course of the pilot.

Survey results: Attitude. A small number of questions in the survey related to participants' attitudes around energy conservation and perceptions about themselves as energy conservers. 65% of respondents stated after the pilot they wanted to be energy conservers, a slight increase from those who stated so before the pilot. There was also a slight increase (9%) in those who definitively considered themselves to *be* energy conservers. Most significantly, the number of students surveyed who thought their schools were good energy conservers more than *doubled* (to 75%), while there was little change before and after the pilot in the respondents who thought their families were good energy conservers.

Survey results: Knowledge. A number of survey questions sought to test respondents' knowledge around electricity and electricity use. Both before and after the program, students demonstrated confusion between electricity sources and equipment that consumed electricity, with nearly 60% stating appliances or equipment as sources of electricity. About 40% could name at least one true source of electricity (including hydro, wind, solar, nuclear, fossil fuels). Similarly, there was little change in demonstrated knowledge with other questions – both before and after the pilot students tended to understand the general correlation between equipment size and electricity demand, with almost all knowing that electricity was not free. More significantly, there was a demonstrated improvement through the pilot period of knowledge linking electricity use to pollution and the effect of greenhouse gas pollution. There was a 23% increase in the number of respondents who thought electricity could pollute the air we breathe, while there was a 20% increase in the number of respondents who linked greenhouse gases to pollution. Finally, there was a slight increase (9%) in knowledge that in Ontario, hot summer days tend to see higher electricity use than cooler summer days.

Survey results: Beliefs. Questions probing about beliefs around electricity use did not show significant differences, with almost all respondents stating both before and after the pilot that the amount of electricity we use matters.

Interview results. The most striking results of the post-pilot Energy Champion interviews was the reported success of the program in creating united action that persisted beyond Energy Drill days. One

teacher remarked that '*in 17 years of teaching and running eco-programs at schools this was the first program that brought the whole school together and really made a difference*'. Energy Champions generally shared the sentiment that the benefits of the program lay in the interactive, action-oriented, adaptive nature of the program whereby students could feel important and empowered to contribute and make a difference. It was generally reported that conservation behaviour (such as turning off lights and computer monitors) became more habitual day-to-day throughout the program.

Summary. The results show that an impact was made on attitude toward, behaviour around, and knowledge of, energy conservation, and with prolonged exposure to the program over longer timeframes, it can reasonably be expected that messages will be reinforced and the culture of conservation will be more wholly developed. The addition of Energy Drill programming to the curriculum will also reinforce the messages. The program made important inroads into developing a more energy aware school population and an increased culture of conservation in schools. Reported increase in energy conserving behaviour was high.

Electrical demand reduction results

A traditional demand response program can measure actual demand reduction by comparing demand at the time of the trigger to demand after demand response measures have been implemented. Graphed over time, it would be expected that demand would show an obvious and significant drop at the time of program implementation, and results attributed to the response are readily apparent. With the full day response of the Energy Drill, however, the school does not reach non-program demand before the Drill begins in the morning. Thus demand reduction over the course of the demand response throughout the day cannot be directly seen as a drop. Instead, the demand must be compared to an expected demand which needs to be calculated using a model.

Electricity demand baseline modeling. The expected demand for participating schools was modeled using historical daily peak demand correlated to outside temperature on the day – maximum daily temperature during summer months and minimum school-day temperature (between 7 a.m. and 5 p.m.) during winter months. Peak demands were used as they were expected to be most representative of the absolute Energy Drill response of the school. The expected peak demand as related to outside temperature formed the expected 'baseline' peak electricity demand and was unique to each school.

Historical electricity-use data used to form these baselines was taken from interval meters, while historical daily temperature data was taken from Environment Canada. In four of the participating schools (in Halton Region), a number of years of interval meter data was available to form these baselines, and data was taken from the year and a half previous to the Energy Drill pilot. In the other four participating schools (in Toronto), only two to four months of interval meter data was available to form baselines. Due to the limited amount of data to form baselines and the fact that the data did not cover the full temperature range or the air-conditioning season, these baselines were not of high quality and were not considered to provide wholly accurate comparative results for the Energy Drill program. Thus, the baselines are considered 'available baselines', and the results presented here for the Energy Drill program are referred to as 'available results'.

Available results on Energy Drill days. To determine available Energy Drill day electricity demand reduction results, interval meter data was taken from each school for the course of the school day (7 a.m. to 5 p.m.), as was local temperature data. Using the electricity demand data, the actual peak demand for each school was determined. The expected demand was determined using the established available baselines and

the temperature data from the day. The actual Energy Drill day peak demand was subtracted from the available expected peak demand for each school, giving the available electricity peak demand reduction result. These available results are presented in Table 1.

Table 1. Available Energy Drill day demand reduction results

School	Drills during which demand reduction was achieved	Average peak demand reduction		Maximum peak demand reduction	
	%	kW	%*	kW	%*
Toronto schools					
Secondary School 1	60	6.8	6.7	28.3	29.8
Secondary School 2	35**	17.7	3.3	89.5	18.4
Elementary School 1	30**	2.9	3.7	16.7	20.8
Elementary School 2	100	5.2	14.9	9.4	26.6
Average Toronto schools	*56*	*8.2*	*7.2*	*36.0*	*23.9*
Halton schools					
Elementary School 3	61	7.1	3.4	24.1	13.0
Elementary School 4	90	11.6	7.9	21.7	14.8
Elementary School 5	35	3.2	2.9	22.2	22.0
Elementary School 6	17	0.6	0.7	4.3	5.6
Average Halton schools	*51*	*5.6*	*3.7*	*18.1*	*13.8*
All schools					
Average of all schools	***53***	***6.9***	***5.4***	***27.0***	***18.9***

* Percentage of the available expected (baseline) peak demand
** Toronto school with baseline not including air-conditioning season data

Available absolute kW demand reduction values have been included in Table 1, however for the purposes of discussion, only percent reductions will be considered. This is due to the fact that the schools in the pilot are all of different sizes with significantly different available baseline peak demands ranging from approximately 40kW to 630kW.

Peak demand reduction on Energy Drill days is an important indicator of the potential demand response of schools through the Energy Drill program. The target peak demand reduction of the Energy Drill program on Energy Drill days was 20 to 40%. On Energy Drill days, participating schools reduced peak demand by an average of 5.4%, with a range of 0 to 29.8%. While four of the eight schools in the pilot actually reached the target range during one or more of the Drills, no schools reached the target on average. The range of average peak demand reduction across all schools was 0.7% to 14.9%. The two participating secondary schools did not show significantly different average results over any participating elementary schools.

Success rates in schools achieving positive peak demand reductions on Energy Drill days is an important indicator of the ease and consistency with which schools perform the Drill measures. On average, schools achieved positive available results during 53% of Energy Drills. One school achieved positive results during 100% of all Energy Drills while another achieved positive results during 90% of Energy Drills. One school only achieved positive results during 17% of Energy Drills while the remainder of the schools achieved positive results during 30 to 60% of Energy Drills. These lower numbers indicate that with more consistency in achieving successful Drills, there is significant room for average reduction results to increase.

Summary. While actual available electricity peak demand reduction results on Energy Drill days fell short of program targets on average, it was demonstrated during certain response events that schools were in fact capable of reaching demand response targets. Mediocre rates of success in achieving any reduction at all indicate, however, that the program needs to facilitate greater ease and consistency with which schools can respond and participate.

Energy Drill program evaluation

As a means of evaluating the program and some of its specific components, the post-pilot survey included a number of questions about the Energy Drill program itself in addition to the same questions relating to education and culture change that were in the pre-pilot surveys, 394 surveys were returned from students, giving a confidence interval of +/-3.5% at a confidence level of 95%.

Opinions about the Energy Drill Program were generally positive. Over 80% of survey respondents tried to participate in Energy Drill activities on Energy Drill days. Over 65% of students stated they felt they could make a difference on Energy Drill days, and 40% felt they might want to be an Energy Marshal. Most impressively, nearly 90% thought the Energy Drill was important.

Over 70% of those surveyed wanted Energy Drills to continue in their schools in the 2007-2008 school year. Of those who stated they didn't, didn't know or didn't care, reasons cited were related to lack of light and air conditioning, disruptions, and feelings that the program didn't work or they simply didn't care about or like the program. Nearly half of the respondents claimed to have told their parents at least something about the program.

Regarding specific components of the program, students were asked about the learning impact of the range of media materials and program activities. The learning impact of a number of different media and program activities seemed to be consistently rated mid to slightly high, with a 63% average perceived effectiveness. No materials or activities were significantly different than the others with a possible unsurprising exception of the Energy Drill training session.

Finally, the program was evaluated regarding the knowledge it imparted by asking two questions about the program itself. Respondents were asked to name the four Energy Drill triggers and three ways to use less electricity during an Energy Drill. Only 17% of those surveyed could name all four triggers while over 40% couldn't name any. 39% of respondents could name three ways to use less electricity, 69% could name at least two, 82% could name at least one, leaving 18% not being able to name any. These numbers are likely to improve significantly with the number of Drills conducted over longer periods of time.

Summary. General program evaluation indicates that the program was visible, interesting and generally well received and regarded, with the actions and desired behaviours well conveyed. While the messages behind the program and the details about the implementation were somewhat lost, this is likely to be improved with the running of the program over time which will reinforce program knowledge and behaviours.

Unique Energy Drill program design as a driver of results – past and future

Many of the unique aspects of the Energy Drill demand response program simply facilitated the participation of schools in a demand response program. These included the day-ahead notification, the full-day nature of response, the variety of measures included and the flexibility for schools to adapt to their day-to-day needs.

The incorporation of media, social marketing techniques and educational activities into the program contributed to the impact on education and culture change, as did the action-oriented (non-automated) nature of the program. Allowing students to physically participate, and therefore empowering them to contribute on a regular, repetitive basis, helped to develop increased conservation behaviour. The non-automated aspects of the program, however, likely detracted from the demand reduction results, particularly as related to building automation system and HVAC related measures. While continuing with the interactive behavioural components of the Energy Drill Program, it is proposed that in the future, some measures related to building automation systems and HVAC be automated to improve actual demand reduction results.

The day-ahead notification and full-day response aspects of the program provided program visibility and the opportunity for the entire school population to participate and produce tangible demand reduction results. The full-day nature of the response, however, likely detracted from the absolute demand reduction as lesser reductions were made over longer periods rather than greater reductions being made over shorter periods as in traditional demand response events. However, greater total energy consumption reduction (decreased kWh) was achieved. The exclusion or lessening of certain measures for health, safety and security reasons also likely detracted from demand reduction results, but allowed the program to be accepted in the school community. These elements of program design are not anticipated to change in the future of the Energy Drill.

Mediocre rates of success in achieving reductions in each Energy Drill indicate that the program design should be further optimized to ensure easier, more consistent and dependable participation and tangible response. Program design aspects to improve in this area could include suggestions for greater organization of response on Energy Drill days, an expanded feedback system regarding actual demand reduction results and actions and organization on Energy Drill days, and increased education and prompting around Energy Drill measures.

Finally, the flexibility allowed for schools to adapt their day-to-day participation in the Energy Drill program empowered them to participate, gave them options to participate on days they may not otherwise have participated, and encouraged incorporation of their own ideas into the program. This flexibility was considered to be one of the most attractive aspects of the design of the Energy Drill program.

It is proposed that the Energy Drill program be carried forward into a second phase. This second phase is proposed to allow improvements to the baselines of electricity use in order to provide more reliable demand reduction results, to automate building automation system and HVAC measures to increase demand reduction results, to incorporate an improved and automated results analysis and feedback system, and to generally improve further on program design based on the analysis presented in the above paragraphs.

Conclusion

The Energy Drill program is a demand response program with unique design elements that allow demand response to be successful with the unique audience and environment found in schools. The design elements that form the Energy Drill program address many of the challenges schools would face in attempting to implement traditional demand response programs. In its first pilot, the Energy Drill program was successful in educating school-age children in aspects of responsible energy management within

schools, integrating educational messages into a busy curriculum while causing only a manageable disruption to regularly scheduled activities. Through its unique design, the Energy Drill was able to begin cultivating a culture of conservation among a populace of varied age, ability and motivation while achieving tangible demand reduction results. The future of the Energy Drill program will build upon the successes and challenges of the first pilot, maintaining its unique and flexible design.

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