



www.sustainableschools.ca



Rating Ontario School Boards' Energy Efficiency: Top Energy Performing Boards Report

Methodology White Paper

Revised May 10, 2016



About Sustainable Schools

[Sustainable Schools](#) has been working since 2007 with hundreds of schools from many boards across Canada and in the United States, establishing the magnitude of energy savings potential in individual schools, highlighting where those savings are to be found, and providing tools and training to help boards achieve high performance energy targets. It is a program of [The Living City](#) delivered across Canada by Toronto and Region Conservation with technical direction by Enerlife Consulting Inc.

About Toronto and Region Conservation Authority

The [Toronto and Region Conservation Authority](#) (TRCA) is one of 36 Conservation Authorities serving communities across Ontario. TRCA has more than 50 years of experience in watershed management and leadership in developing and applying sustainability practices. TRCA works with governments, businesses, and individuals to build a greener, cleaner and healthier natural and built environment. TRCA's vision is for a new kind of community, The Living City, where human settlement can flourish forever as part of nature's beauty and diversity.

About Enerlife Consulting Inc.

Based in Toronto, Ontario, [Enerlife Consulting](#) works at the leading edge of high performance green buildings. Enerlife is an applied research firm as well as a practitioner, responsible for a number of major developments and important publications in the field of energy efficiency for commercial and institutional buildings. Clients include governments and utility companies as well as commercial landlords, municipalities, school boards, universities, healthcare organizations and multi-unit residential building owners, who use our services to design, direct and verify comprehensive energy efficiency programs for individual buildings and whole portfolios.

About the Author

Ian Jarvis has been President of Enerlife Consulting since 2001, and is an authority in the fields of energy efficiency and green building performance. From 1992-1999 he was CEO of a leading energy performance contractor responsible for several of the largest energy retrofit projects in North America. From 2003-2007, Ian served as founding chair of the Canada Green Building Council. He is a member of the National Advisory Council on Energy Efficiency which advises the federal Office of Energy Efficiency. Ian co-chaired the working group of the Race to Reduce, a program of CivicAction which engaged commercial office landlords and tenants across the Greater Toronto Area working together to improve energy efficiency.

Please direct any questions or comments to:

Bernie McIntyre
Senior Manager, Community Transformation Programs
Toronto and Region Conservation Authority (TRCA)
T: 416-661-6600 x 5326
E: BMcIntyre@trca.on.ca

Table of Contents

1. Summary	1
2. Foundations	1
2.1. 2015 Top Energy Performing School Boards Report.....	1
2.2. Real Property Association of Canada 20 by '15 White Paper	2
2.3. Town Hall Challenge White Paper (an initiative of Mayors' Megawatt Challenge).....	2
2.4. Canada Green Building Council Pilot Projects.....	3
2.5. Green Energy Act, 2009	3
3. Methodology.....	3
3.1. Data Collection.....	3
Data cleaning	4
Data processing.....	4
3.2. Weather-Normalization and Target-Setting	4
Adjustment for portables.....	5
Adjustment for swimming pools.....	6
Adjustment for all-electric buildings and heat pumps.....	6
3.3. Establishing Savings Potential	7
Appendix A: Weather Stations.....	8

1. Summary

Toronto and Region Conservation Authority (TRCA) has published the 2016 Top Energy Performing Boards report in May 2016 as part of our Sustainable Schools program. This report follows the success of the 2015 report which analyzed the energy efficiency of 45 Ontario school boards to identify the top ten boards with the lowest savings potential. The 2016 report covers 71 Ontario boards, refines the methodology, and recognizes this year's top ten winners. This White Paper presents the methodology used to produce the 2016 results. For the reports and White Paper and further information visit the Sustainable Schools program website at www.sustainableschools.ca.

The 71 school boards provided annual energy use data for the 2013-14 school year for all of their schools and administration buildings. A site-specific energy target was set for every building, which in turn established its energy savings potential as the difference between actual and target consumption. A standard, good-practice energy target for elementary and secondary schools and administration buildings is adjusted for weather and school-specific variables to create the site-specific target. The savings potential for the individual buildings is then rolled up to produce the overall board potential, and to arrive at our ranking of all the boards. The top ten boards are those with actual energy use closest to the target for all of their buildings – that is, those with the lowest overall savings potential.

2. Foundations

2.1. 2015 Top Energy Performing School Boards Report

In 2008, Toronto and Region Conservation Authority published the first annual Top Energy Performing Schools Report, which identified and recognized some of the most energy efficient schools in North America. Subsequent annual reports added to the body of knowledge about how much energy school buildings need, and the common characteristics of the most energy efficient schools.

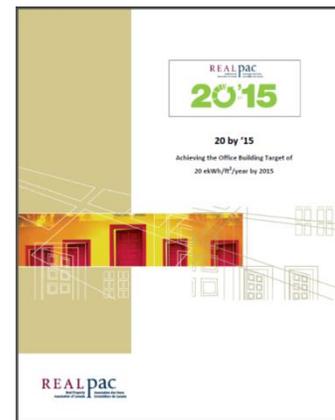
The 2015 report shifted focus by examining the overall energy performance and savings potential of school boards rather than individual schools. While many boards have a few schools which are particularly energy efficient due to exceptional technology, design and/or operations, overall board performance speaks more to policy and management practices which produce consistently good results across large portfolios and geographies. We used publicly available data from 45 Ontario school boards to determine the top ten most energy efficient boards (those with the least savings potential), and interviewed those boards to learn more about what sets them apart. The interviews were used to create case studies posted on the Sustainable Schools website.

The work developed a methodology for setting a rational energy target and derived savings potential for each individual school and administrative building. The analysis also highlighted the range of energy use between comparable buildings within and between boards, and flagged the high-potential buildings (those with greater than \$10,000 per year in savings potential) as the focus for improvement.

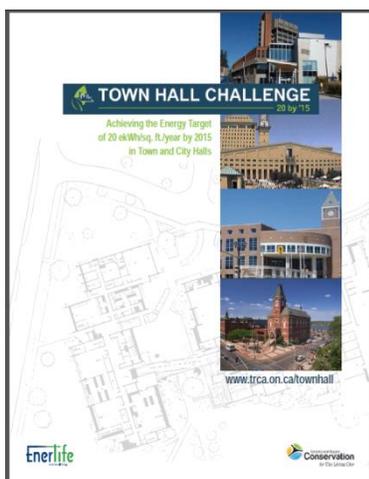
The report served useful purposes in quantifying the opportunity for energy, utility cost and emissions savings in this important sector, and helping boards, utility companies and government consider policy, strategy and program options for making improvements. It attracted significant interest from various stakeholders, raising the profile of and commitment to active energy conservation.

2.2. Real Property Association of Canada 20 by '15 White Paper

The Real Property Association of Canada (REALpac) announced the 20 by '15 national energy consumption target for office buildings in September 2009, following extensive research and consultation. The goal of REALpac's 20 by '15 initiative is to achieve the target of 20 equivalent kilowatt hours of total energy use per square foot of rentable area per year (20 ekWh/ft²/year), in office buildings, by the year 2015. A white paper, describing how the target was derived, was published in 2009, and led to establishing of REALpac's energy benchmarking and target-setting methodology¹. This methodology informed the weather normalization and target-setting process used in the Top Energy Performing Boards analysis.



2.3. Town Hall Challenge White Paper (an initiative of Mayors' Megawatt Challenge)



Toronto and Region Conservation's Mayors' Megawatt Challenge (MMC) program brings together leading municipalities to achieve exceptional levels of energy and environmental performance in municipal facilities. In 2011, MMC introduced the Town Hall Challenge, which engaged cities and towns from eight provinces in identifying and recognizing some of the most energy efficient city and town halls in Canada. This national initiative added substantially to the range of benchmarking, best practices and experience with all types of municipal facilities. A peer-reviewed white paper was published in 2013 to present the methodology used to establish a national energy efficiency target of 20 equivalent kilowatt-hours (ekWh) of total energy use per square foot per year, based on Ottawa weather conditions, to be achieved by 2015. The Top Energy Performing Boards Report uses a methodology similar to that

¹ See <http://www.realpac.ca/?page=RPEBP21Methodology>.

presented in the Town Hall Challenge white paper.

2.4. Canada Green Building Council Pilot Projects

In 2008, to support its commitment to lowering greenhouse gas emissions through improved energy efficiency in buildings, the Canada Green Building Council ([CaGBC](#)) initiated a series of large-scale, national pilot projects aimed at establishing current energy use of existing buildings, documenting top performers, and setting the stage for efforts to substantially improve performance. CaGBC engaged Enerlife to conduct the projects in K-12 schools, commercial offices, government administration buildings, bank branches, universities, and municipal arenas. The pilots proceeded in parallel with and informed the technical development of the Canadian version of LEED for Existing Buildings: Operations & Maintenance.

The pilot projects developed a great deal of new and important knowledge about energy performance in buildings. No apparent correlation was found between building age and performance. The projects documented that how a building is operated and maintained is just as important in achieving high performance as how it is designed and what kind of building codes are in effect at the time of construction. The combined database of hundreds of buildings served to identify and characterize top-performing buildings, and to establish for the first time whole-building and system-level metrics and standards.

2.5. Green Energy Act, 2009

Beginning July 1, 2013 the Green Energy Act requires Ontario's Broader Public Sector (BPS) to report their annual energy use and greenhouse gas emissions, every year, to the Ministry of Energy, and to make the data publicly available on their websites. Ontario school boards are complying with this regulation, making available the data on which the Top Energy Performing School Boards reporting is based.

3. Methodology

3.1. Data Collection

In the fall of 2015 TRCA, with Ministry of Education support, requested that the school boards forward their 2013-2014 school year data for this analysis. In addition, the boards were asked to indicate use of electric heat or ground-source or water-source heat pumps, and the size of any swimming pools.

Each board reported on all facilities currently in use by the board, including leased buildings. The data include general information about the facilities (building name, address, operation type,



total floor area, average hours of use per week, swimming pools and numbers of portables) and energy use information (consumption of electricity, natural gas, oil, propane, coal, wood, district heating, and district cooling, in appropriate units). All facilities included by a board in the reporting template were analyzed, whether leased or owned.

Data cleaning

To avoid distortions, a number of facilities were removed from the analysis as follows:

- Total energy intensity of less than 5 ekWh per square foot, indicating incomplete data or abnormal use (36 facilities)
- Substantial anomalies likely due to energy data or building area issues (7 facilities)
- Closed/demolished/sold/unoccupied/vacant (79 facilities)
- Multiple buildings at one address and energy use split not clear (11 facilities)

Data processing

Oil, propane and district heating were converted into natural gas equivalents, and district cooling into electricity equivalents, using the following conversion factors:

Conversion factors	
Litre of oil	= 1.023 m3 of gas
Litre of propane	= 0.6818 m3 of gas
District heating to gas (m3)	26.8384326
District cooling to kWh	79.0177774 *0.75

3.2. Weather-Normalization and Target-Setting

A weather station was assigned to each facility in the analysis, based on geographic proximity and weather station data completeness and reliability. Weather data for the September 2013-August 2014 period was obtained from Climate Data Online website at <http://climate.weather.gc.ca/>. Balance temperatures of 15 and 10 degrees Celsius were used to calculate heating and cooling degree-days respectively.

The following standard targets (based on 2012-2013 Toronto International Airport weather) are used for buildings with conventional heating systems, before adjustment for weather and site-specific characteristics (portables, water- and ground-source heat pumps, and swimming pools):

Building type	Targets		
	Electricity	Natural Gas	Total Energy
Elementary	5.5 kWh/ft ²	6.5 ekWh/ft ²	12 ekWh/ft ²
Secondary	7.5 kWh/ft ²	7.5 ekWh/ft ²	15 ekWh/ft ²
Administrative	12.5 kWh/ft ²	7.5 ekWh/ft ²	20 ekWh/ft ²

These standard targets for schools and administrative buildings are based on good practice benchmarked energy use intensities from Sustainable Schools and Mayors' Megawatt Challenge

databases, are considered readily attainable, and are already being met or surpassed by a growing number of buildings.

Standard targets were weather-normalized to the current year and the assigned weather station of each individual building using the weather-sensitive proportions below for different building types (elementary, secondary, and administrative):

Building type	Proportion of energy target that is weather-sensitive	
	Electricity	Natural Gas
Elementary	0%	91.5%
Secondary	0%	92.5%
Administrative	7.0%	97.5%

Proportions of gas use target in school buildings that are considered non-weather-sensitive were derived from top quartile benchmarking of conventionally-heated schools (without heat pumps) from the Sustainable Schools database, and determined separately for elementary and secondary schools.

In the Ontario climate cooling electricity consumption accounts for 5% or less of total electricity consumption of a well-performing school. Many schools are not air-conditioned and those with air conditioning are generally closed during July and August, when most cooling-degree days are recorded. Therefore no adjustment was made for cooling-degree-days for school buildings.

For administrative buildings, 7% of electricity use target and 97.5% of gas use target is considered weather-sensitive and was weather-normalized as described below. These proportions are consistent with the energy benchmarking and target-setting methodology adopted by the Real Property Association of Canada (REALpac)².

Weather-sensitive portions of energy use targets were normalized based on degree-day ratios between 2012-13 weather conditions at Toronto Lester B. Pearson International Airport and current reporting year (2013-2014) conditions at the weather station assigned to each facility.

Adjustment for portables

Adjustments for portables were calculated as the number of portables multiplied by weather-normalized standard annual electricity consumption required for one portable and divided by Total Floor Area of the associated building. The adjustment was then added to the standard target for Total Electricity.

The standard adjustment applied is 9,000 kWh/year, including a non-weather-sensitive portion of 3,000 kWh (to account for lighting, HVAC and computers) and a weather-sensitive portion of 6,000 kWh (heating based on Toronto International Airport 2012-13 weather data). This allowance has been increased from the 2015 analysis based on updated data from individually metered portables.

² See <http://www.realpac.ca/?page=RPEBP21Methodology>.

No allowance was made for air conditioning. The weather-sensitive portion of the target is normalized based on degree-day ratios between 2012-13 weather conditions at Toronto Lester B. Pearson International Airport and current reporting year (2013-2014) conditions at the weather station assigned to each facility.

Adjustment for swimming pools

The 2016 analysis incorporates new information from boards on the size of their swimming pools. The standard developed by TRCA's Mayors' Megawatt Challenge for operation of a swimming pool is 50 kWh of electricity and 280 ekWh of natural gas per year per square foot of water surface area. The adjustment to gas and electricity targets is applied to each facility based on the size of its swimming pool. If a board has reported the number of pools but not the water surface area, a default pool size of 2,723 sf was used (23m by 11m, 6 lanes).



Adjustment for all-electric buildings and heat pumps

The 2016 analysis incorporates new information from boards on the heating systems in their facilities. The adjustments to energy use targets were introduced as follows:

1. All-electric: The standard gas use target is then multiplied by 75% as a deemed gas-firing efficiency and added to the electricity target.
2. Ground-source or water-source heat pump:
 - a. Electricity targets increased by

Heat pump	Elementary	Secondary
GSHP	1.1 kWh/sf	1.3 kWh/sf
WSHP	1.2 kWh/sf	1.4 kWh/sf

- b. Gas targets reduced by

Heat pump	Elementary	Secondary
GSHP	6.0 ekWh/sf	6.9 ekWh/sf
WSHP	1.6 ekWh/sf	1.9 ekWh/sf

The assumptions behind these adjustments are tabulated below.

Deemed boiler plant efficiency (conventionally heated school)	75%
% of heat required that is extracted from the ground (GSHP)	90%

% of electrical energy required to produce the same amount of heat	25%
Coefficient of Performance for the heat pump	4.0
Domestic hot water heated by heat pump	100%

As in case of targets for a conventional gas-fired system, the targets for electric heat and heat pumps were weather-normalized to current year and local weather station.

3.3. Establishing Savings Potential

The energy savings potential for each individual school and administrative building was calculated as the difference between actual energy use intensity and adjusted, weather-normalized target energy use. The savings potential was calculated separately for electricity and for gas, and is presented in %, energy units, emissions and dollars. The dollar savings potential is based on the following prices per unit of energy:

Electricity: \$0.13/kWh

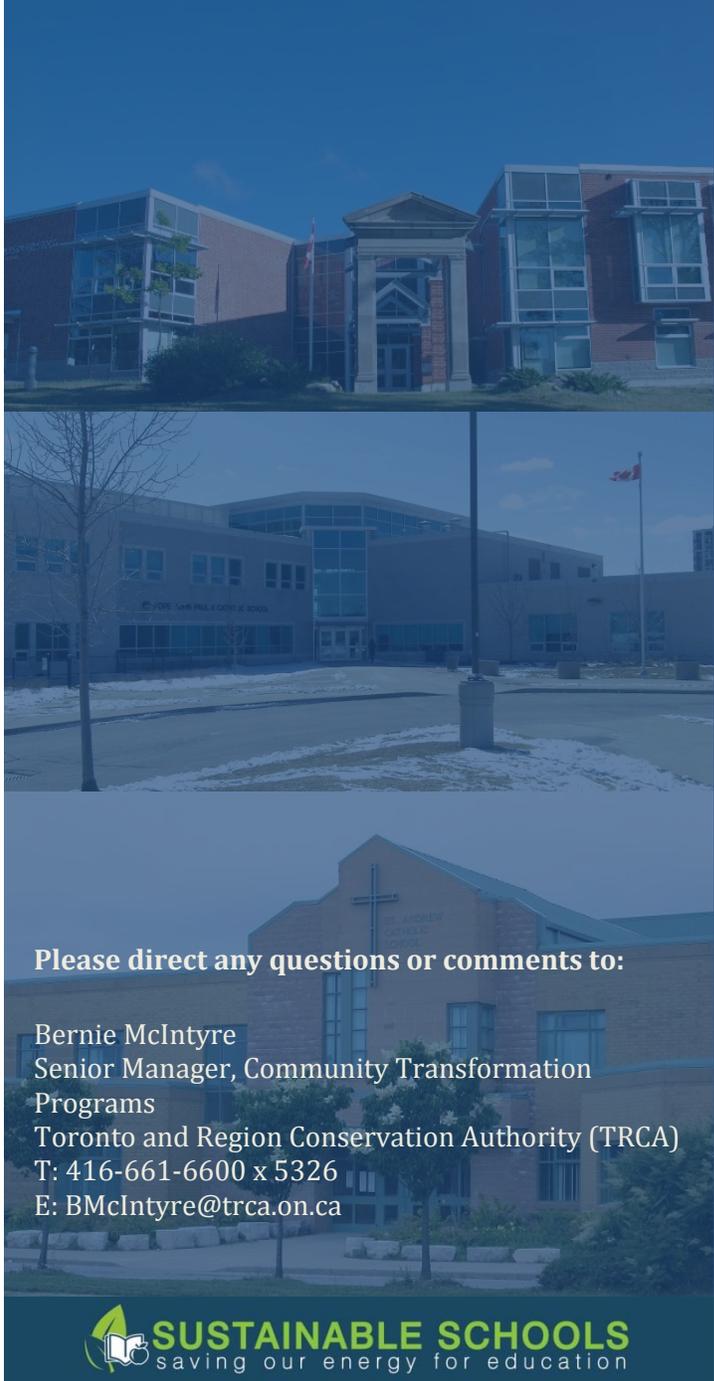
Gas: \$0.20/m³

The board's total dollar savings potential is the sum of dollar savings potential values for all of its facilities. The board's total % energy savings potential, the metric which defines a board's placement in the Top Energy Performing Boards analysis, is the % difference between actual total energy use intensity for all buildings (weighted average of each building's actual total energy use intensity) and target total energy use intensity (weighted average of each building's target total energy use intensity). Thus the Top Ten Energy Performing Boards are the ten boards with the lowest total % energy savings potential, that is, their overall energy use intensity is closest to their target energy use intensity.

Appendix A: Weather Stations

Weather stations were selected based on completeness and reliability of data collected at the stations (<http://climate.weather.gc.ca/>). A weather station was assigned to each facility based on geographical proximity. The weather stations used in the 2016 report are as follows:

HAMILTON A
KENORA A
KINGSTON CLIMATE
KITCHENER/WATERLOO
LONDON A
MOOSONEE
OTTAWA INTL A
PETERBOROUGH
RAVENSCLIFFE
SAULT STE MARIE A
SHANTY BAY
SUDBURY CLIMATE
THUNDER BAY
TIMMINS A
TORONTO INTL A
WELLAND-PELHAM
WIARTON A
WINDSOR A



Please direct any questions or comments to:

Bernie McIntyre
Senior Manager, Community Transformation
Programs
Toronto and Region Conservation Authority (TRCA)
T: 416-661-6600 x 5326
E: BMcIntyre@trca.on.ca



www.sustainableschools.ca