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

Methodology White Paper

June 5, 2015

Enertife consulting

Toronto and Region Conservation for The Living City

About Top Energy Performing School Boards

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 and boards in North America. The latest (2015) report uses publicly available data from 45 Ontario school boards to determine the top ten most energy efficient boards. These are the boards whose overall energy efficiency is closest to the target energy use for all of their schools – that is, those with the lowest savings potential.

About Sustainable Schools

Sustainable Schools has been working since 2007 with hundreds of schools in more than 35 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, green building performance and sustainable communities. 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, and of the Ontario Energy Minister's Advisory Committee. Ian co-chairs the working group of the Race to Reduce, a program of CivicAction which engages commercial office landlords and tenants across the Greater Toronto Area working together to improve energy efficiency. Contact Ian Jarvis at *ian.jarvis@enerlife.com*.

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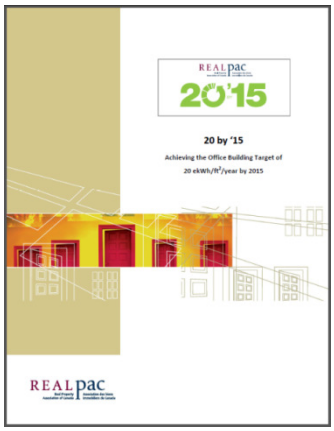
1. Summary

Toronto and Region Conservation will be publishing the Top Energy Performing Boards report at the end of June as part of our Sustainable Schools program. This white paper presents the methodology used to produce the report. For this project we analyzed energy use data posted by 45 school boards to their websites as a requirement of Ontario's Green Energy Act. The 45 boards represent almost three-quarters of all schools in Ontario. Every school has been assessed, adjusting for weather and school-specific variables, to establish its energy savings potential relative to good performance standards from the Sustainable Schools national database. The savings potential for all individual schools has been rolled up to arrive at our ranking of the top ten boards. These are the boards whose overall energy efficiency is closest to the target energy use for all of their schools – that is, those with the lowest savings potential.

2. Foundations

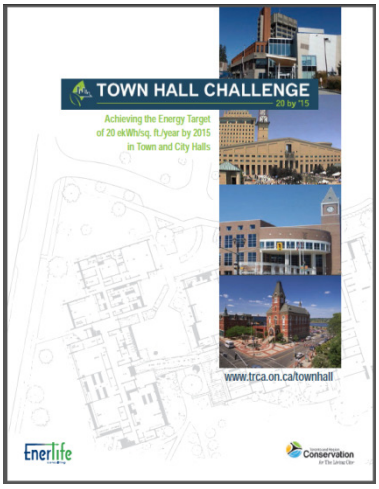
2.1. Real Property Association of Canada 20 by '15 White Paper



In September 2009, following extensive research and consultation, the Real Property Association of Canada (REALpac) announced the 20 by '15 national energy consumption target for office buildings. 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 methodology[1]. This methodology informed the weather normalization and target-setting process used in the Top Energy Performing Boards analysis.

[1] See http://www.realpac.ca/?page=RPEBP21Methodology.

2.2. 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 presented in the Town Hall Challenge white paper.

2.3. 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 and utility administration buildings, retail 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, many of which are used in this analysis.

2.4. Broader Public Sector Energy Use Data

Beginning July 1, 2013 the Green Energy Act, 2009 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 available on their websites. Ontario school boards are complying with this regulation, making available the data on which the Top Energy Performing School Boards report is based.

3. Methodology

3.1. Data Collection

As of December 2014, two years' worth of energy use data has been made publicly available by Ontario school boards: for 2011-2012 school year (due on July 1, 2013) and for 2012-2013 school year (due on July 1, 2014). The data file that the Ministry of Energy provides online[2] has a date range from January 1, 2011 to December 31, 2012 which does not match the school boards' fiscal year. Therefore it was decided to collect information for 2012-2013 school year directly from individual school board websites. Information collected represents what we were able to retrieve and process as of December 2014. We are aware that more boards have submitted data, and expect that all boards' energy use will be available for reporting in 2016.

Data for this report were collected for all schools and administration buildings for 49 out of 72 Ontario school boards. School boards are required to use the Ministry's reporting template for submission to the Ministry, but not for posting the energy use data on their own websites, and some boards posted it in a different format. We endeavoured to process such non-standard-format energy use data, but for 4 of the 49 boards, this was not possible due to time constraints. Therefore, data from a total of 45 Ontario school boards with a total of 3,670 buildings were used for analysis to create the Top Energy Performing School Boards report.

Each board is required to report on the energy use by all facilities currently in use by the board, including leased facilities. 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). It should be noted that the template does not indicate whether a facility is leased or owned, therefore, all facilities included by a board in the reporting template were analyzed. Please see Appendix C for a sample reporting template.

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

[2] http://www.ontario.ca/data/energy-use-and-greenhouse-gas-emissions-broader-public-sector, as of April 30, 2015.

3.2. Weather-Normalizing Energy Use

As a first step of weather normalization, annual consumption of electricity and natural gas (or gas equivalent of other sources of thermal energy) was divided into *weather-sensitive* energy use and *non-weather-sensitive* energy use, using the proportions below for different building types (elementary, secondary, and administrative).

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

Proportions of gas use in school buildings that are considered base or non-weather-sensitive are derived from the top quartile benchmarking of conventionally-heated schools (without heat pumps) from the 2011 Sustainable Schools database, and determined separately for elementary and secondary schools.

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

For administrative buildings, 7% of electricity use and 97.5% of gas use is considered weather-sensitive and is weather-normalized as described below. These proportions are consistent with the energy benchmarking and target-setting methodology adopted by Real Property Association of Canada (REALpac)[3].

For more information on how the targets were established, please see Section 3.3 Target-Setting.

Weather-sensitive portions of energy use were normalized to weather conditions at Toronto Lester B. Pearson International Airport by multiplying the weather-sensitive portion by the respective *Weather Normalized Factor.* Electricity uses the *Weather Normalized Factor Cooling Degree-Days,* and natural gas uses the *Weather Normalized Factor Heating Degree-Days*. Weather data for the September 2012-August 2013 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, which we have found to be typical for school buildings.

The *Weather Normalized Factors* are calculated as the ratio of degree-days for Toronto Lester B. Pearson International Airport to degree-days observed at a reliable weather station closest to the school board (please see Appendix B for the list of weather stations and their heating and cooling degree-day data).

[3] See http://www.realpac.ca/?page=RPEBP21Methodology.

Here is an example of weather normalization for an elementary school of the school board whose local weather station is Shanty Bay:

> *Actual energy consumption in the reporting period: 119,586 kWh of electricity, 35,043 m3 of natural gas*
> *Degree-days based on local weather data (Shanty Bay): 3218.2 HDDs and 1237.0 CDDs*
> *Degree-days based on weather data from Toronto Int'l Airport: 2847.5 HDDs and 1436.6 CDDs*
>
> *Weather Normalized Factor CDD = 1.161 (1436.6 CDDs (Toronto Int'l A) / 1237.0 CDDs (Shanty Bay))*
> *Weather Normalized Factor HDD = 0.885 (2847.5 HDDs (Toronto Int'l A) / 3218.2 HDDs (Shanty Bay))*
>
> *Electricity consumption normalized to weather in Toronto = weather-sensitive portion (0%) *Weather Normalized Factor CDD (1.548) + non-weather-sensitive portion (100%) = 119,586 * 0% * 1.161 + 119,586*100% = 119,586 kWh*
>
> *Gas consumption normalized to weather in Toronto = weather-sensitive portion (91.5%) *Weather Normalized Factor HDD (0.885) + non-weather-sensitive portion (8.5%) = 35,043m3 * 91.5% * 0.885 + 35,043m3 * 8.5% = 31,356 m3*

For analysis and reporting purposes, weather-normalized actual annual consumption of different energy types was converted to the common unit of measurement, equivalent kilowatt-hour (ekWh).

Data cleaning

Any building with total energy intensity of less than 5 ekWh per square foot (after weather-normalization) was removed from the analysis. Such low energy use intensity indicates that data could be incomplete or meters could be defective (as was noted for some buildings by the boards themselves).

3.3. Target-Setting

The following standard targets were used for buildings with conventional heating systems before adjustment for 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/ft²	6.5 ekWh/ft²	12 ekWh/ft²
Secondary	7.5 kWh/ft²	7.5 ekWh/ft²	15 ekWh/ft²
Administrative	12.5 kWh/ft²	7.5 ekWh/ft²	20 ekWh/ft²

These standard targets for schools and administrative buildings are based on top quartile benchmark energy use intensities (rounded) from the 2011 data in the Sustainable Schools and Mayor's Megawatt Challenge databases, respectively.

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 building. The adjustment was then added to the standard target for Total Electricity.

Based on previous analysis of individually metered portables, the standard adjustment applied is 5,500 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 2,500 kWh (heating). No allowance was made for air conditioning. The weather-sensitive portion of the electricity consumption adjustment was multiplied by the *Weather Normalized Factor HDD*.

Adjustment for swimming pools

The reporting by the school boards indicates only whether a swimming pool is present or not. The adjustment was calculated based on a typical pool size of 23 by 11 metres, or 2,723 square feet[4].

The top quartile 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 tank area. Hence, the annual adjustment applied for a swimming pool is 136,165 kWh of electricity and 762,522 ekWh (or 73,674 m3) of natural gas. If a board's reporting template indicated that a swimming pool was present, this annual energy adjustment, divided by total floor area of the building, was added to the standard targets for electricity and gas.

Adjustment for all-electric buildings and heat pumps

The reporting template used by the boards does not indicate whether a school is electrically heated. If zero gas use is reported for a particular building, it is assumed that the building is ***all-electric***. The standard gas use target is then multiplied by 75% as a deemed gas-firing efficiency and added to the electricity target.

The reporting template does not indicate whether heat pumps are present. Since heat pumps significantly change energy use intensities for electricity and gas use, the following thresholds were used to infer that a water-source or a ground-source heat pump was present (for schools only, not administrative facilities):

> *A school with actual gas use intensity of less than 3 ekWh/ft² is deemed to have a ground-source heat pump (GSHP).*
>
> *A school with potential electricity savings greater than 25% (after adjustments for portables and swimming pool) is deemed to have a water-source heat pump (WSHP).*

Depending on the inferred heat pump type, electricity targets (before adjustment for swimming pools) were increased by the following values:

[4] Based on publicly available information on sizes of pools in Toronto District School Board: http://torontolandscorp.com/index.php?option=com_content&view=article&id=93&Itemid=9

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

Gas targets were reduced by the following values:

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 efficiency (conventionally heated school)	75%
% of heat required that is extracted from the ground	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 assumed heated by heat pump	

3.4. Establishing Savings Potential

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

Electricity: $0.10/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 Ten Energy Performing Boards analysis, is the % difference between actual total energy use intensity for all buildings (weighted average of each facility's actual total energy use intensity) and target total energy use intensity (weighted average of each facility'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 energy use intensity is closest to the target energy use intensity.

Appendix A: Ontario School Boards Included in the Analysis

1	Algoma District School Board
2	Algonquin and Lakeshore Catholic District School Board
3	Bluewater District School Board
4	Brant Haldimand Norfolk Catholic District School Board
5	Conseil scolaire de district catholique Centre-Sud
6	Conseil scolaire de district catholique de l'Est ontarien
7	Conseil scolaire de district catholique des Aurores boréales
8	Conseil scolaire de district catholique du Nouvel-Ontario
9	Conseil scolaire de district catholique Franco-Nord
10	Conseil scolaire de district du Grand Nord de l'Ontario
11	District School Board of Niagara
12	District School Board Ontario North East
13	Dufferin-Peel Catholic District School Board
14	Durham District School Board
15	Greater Essex County District School Board
16	Halton Catholic District School Board
17	Halton District School Board
18	Hamilton-Wentworth Catholic District School Board
19	Hamilton-Wentworth District School Board
20	Hastings & Prince Edward District School Board
21	Huron-Superior Catholic District School Board
22	Kawartha Pine Ridge District School Board
23	Keewatin-Patricia District School Board
24	Kenora Catholic District School Board
25	Lakehead District School Board
26	Lambton Kent District School Board
27	London District Catholic School Board
28	Niagara Catholic District School Board
29	Ottawa-Carleton District School Board
30	Peterborough Victoria Northumberland & Clarington Catholic DSB
31	Rainy River District School Board
32	Simcoe County District School Board
33	Simcoe Muskoka Catholic District School Board
34	St Clair Catholic District School Board
35	Sudbury Catholic District School Board
36	Superior North Catholic District School Board
37	Thames Valley District School Board
38	Toronto Catholic District School Board
39	Toronto District School Board
40	Trillium Lakelands District School Board
41	Upper Canada District School Board
42	Upper Grand District School Board
43	Windsor-Essex Catholic District School Board
44	York Catholic District School Board
45	York Region District School Board

Appendix B: Weather Data

Weather Data (September 1, 2012 to August 31, 2013)		
Weather Station	**HDD**	**CDD**
Peterborough Trent U	3376.9	1106.3
Kitchener/Waterloo	3246.7	1139.1
Sudbury A	4237.4	927.8
Hamilton A	3002.2	1278.2
Shanty Bay	3218.2	1237.0
Windsor A, ON	2608.6	1637.9
Hartington IHD, ON	3331.2	1195.4
Ottawa Intl A	3589.6	1225.0
Toronto Intl A	2847.5	1436.6
Thunder Bay, ON	4521.0	707.4
Source: http://climate.weather.gc.ca/		

Weather stations were selected based on completeness and reliability of data collected at the stations. Weather station selected for each board is the one closest to most schools within that board.

Appendix C: Ministry of Energy's Energy Use Reporting Template

	Energy Consumption and Greenhouse Gas Emissions Reporting - for 2012
Confirm consecutive 12-mth period (mth-yr to mth-yr)	Sept 2012 to Aug 2013
Sector	
Agency Sub-sector	School Board
Organization Name	Name

Please fill in the mandatory fields indicated in red, in addition to submitting data on your energy usage.

Operation Name	Operation Type	Address	City	Postal Code	Total Floor Area	Unit	Avg hrs/wk	Swimming Pool (Y/N)	Number of Portables	Energy Type and Amount Purchased and Consumed in Natural Units																						Total (calculated in			
										Electricity		Natural Gas		Fuel Oil 1 & 2		Fuel Oil 4 & 6		Propane		Coal		Wood		District Heating				District Cooling				GHG Emissions (Kg)	Energy Intensity (ekWh/sqft)	Building / Operation Identifier	Comments
										Quantity	Unit	Quantity	Unit	Quantity	Unit	Quantity	Unit	Quantity	Unit	Quantity	Unit	Quantity	Unit	Quantity	Unit	Renewable?	If Yes, enter Emission	Quantity	Unit	Renewable?	If Yes, enter Emission Factor				

Please direct any questions or comments to:

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