



sustainableschools.ca



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

Methodology White Paper

Updated March 2019



About Sustainable Schools

[Sustainable Schools](#), established in 2007, is analyzing energy use of thousands of schools from hundreds of school districts and boards across Canada and in the United States, evaluating savings potential, recognizing top-performers and providing tools and training to help boards achieve high performance energy targets. The program is managed and delivered by [Enerlife Consulting Inc.](#)

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, program developer and manager and energy engineering company, responsible for 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 major 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 initiatives for individual buildings, portfolios, sectors and campuses.

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.

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1. Summary

Sustainable Schools has published the fourth Top Energy Performing Boards report in February 2019, analyzing the energy efficiency of all Ontario schools and administration buildings to identify the top twenty most efficient boards in the province. The report recognizes the 2019 winners and presents the actual energy savings achieved in the 2016-17 reporting year compared with the 2014-15 energy use reported on in 2017, along with the remaining achievable energy conservation potential. This White Paper presents the methodology used to produce the 2019 results. For the reports, latest version of the White Paper and further information, visit the Sustainable Schools website at sustainableschools.ca.

Ontario school boards are required to report annually on actual energy use together with certain high-level building information. Energy use data for the 2016-17 school year was obtained from the Ontario Ministry of Energy's Broader Public Sector energy use dataset¹. A site-specific energy target was set for every individual building, which in turn established its energy savings potential as the difference between actual and target consumption. The good-practice standard energy targets for elementary and secondary schools and administration buildings are derived from top-quartile benchmarks. Standard targets are adjusted for weather and school-specific variables to create the site-specific targets. 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 energy performing 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.

Actual energy savings over the two-year period from the 2014-15 school year to 2016-17 are estimated by comparing targeted savings (using the 2014-15 weather-normalized targets) for the two years.

2. Foundations

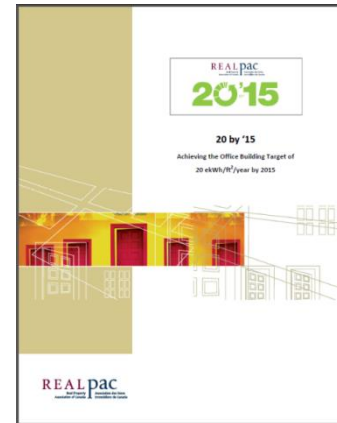
2.1. Previous Top Energy Performing School Boards Reports

In 2008, the first annual Top Energy Performing Schools Report was published, recognizing 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 work developed and refined a methodology for setting a rational energy target and derived savings potential for individual schools and administrative buildings. The analysis also highlighted the range of energy use between comparable buildings within and between boards and flagged the high-potential buildings as the focus for improvement.

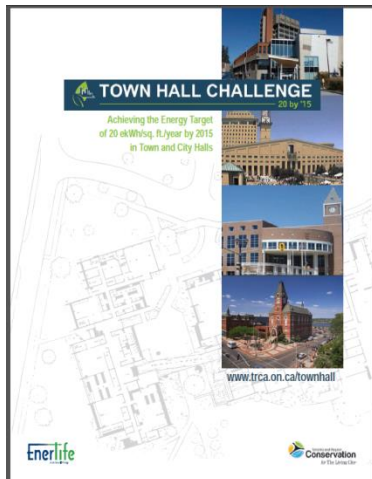
¹ The 2015-16 school year was not analysed. In order to make the analysis more current, Sustainable Schools reported on the 2016-17 school year data set that was most recently published by the Ministry in December 2018.

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 was to achieve the target of 20 equivalent kilowatt hours of total energy use per square foot of rentable area per year (70 kBtu/ft²/year), in office buildings by the year 2015 based on Toronto weather. A white paper, describing how the target was derived, was published in 2009, and led to establishing REALPAC's energy benchmarking and target-setting methodology². 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)



The [Mayors' Megawatt Challenge \(MMC\)](#) program brings together leading municipalities to achieve high 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, presenting 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. The Top Energy Performing Boards Report uses a methodology similar to that 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](#)) conducted a series of large-scale, national pilot projects, analyzing current energy use of hundreds of existing buildings along with engineering inspections which documented key building and system metrics including power densities, age and envelope thermal factors. Correlation of energy intensity with building metrics uncovered new insights into energy performance of buildings, in particular the relative importance of building operations.

² See [REALPAC Energy Benchmarking Program Data Normalization Technical Bulletin](#)

The resulting database served to identify and characterize top-performing buildings, and to establish for the first time evidence-based whole-building and system-level metrics and standards.

3. Methodology

3.1. Data analysis

This 2019 report uses energy data and building information for Ontario’s 4,968 schools and education centres as publicly reported by the 72 school boards. Energy use data for the 2016-2017 school year was collected from the Ontario Ministry of Energy [“Energy use and greenhouse gas emissions for the Broader Public Sector”](#) (BPS) dataset. The data include general information about school board 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



(annual electricity, natural gas, oil, propane, coal, wood, district heating, and district cooling use for the 2016-2017 school year). All facilities included by a board in the reporting template were analyzed, whether leased or owned. Additionally, information on electric heat or ground-source or water-source heat pumps, and the size of any swimming pools, was used in the analysis (as supplied by the school boards to Sustainable Schools as part of the 2016 Top Energy Performing Boards analysis).

Data merging

As a first step, records from the BPS dataset were merged with records from the 2017 Top Energy Performing Boards analysis. As in the previous analysis, significant cleaning and matching was needed to correctly match the facility names to the ones in the existing database, as the facilities reported to the Ministry of Energy do not have unique identifiers.

Data processing and screening

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

Conversion factors	
Litre of oil (L to m3)	= 1.023 m3 of gas (for Fuel Oil 1 & 2) or 1.1111 m3 of gas (for Fuel Oil 4 & 6)
Litre of propane (L to m3)	= 0.6818 m3 of gas
District heating (GJ to ekWh)	District heating in GJ * 26.8384326 M3/GJ * 10.35 ekWh/M3
District cooling (GJ to ekWh)	District Cooling in GJ * 79.0177774 TH/GJ * 0.75 kWh/TH

The data were then screened for apparent data gaps, and the facilities which met one or more of the following conditions were removed from the analysis (156 total):

- a. Total energy intensity less than 5 ekWh per square foot;
- b. Total energy intensity greater than 100 ekWh per square foot;
- c. Electricity use intensity less than 2 ekWh per square foot; or
- d. Thermal energy intensity 0 ekWh per square foot for facilities indicated as having conventional heating systems.

School boards in which more than 10% of buildings were screened out of the analysis due to the above reasons were not eligible for inclusion in the Top 20 boards ranking (8 boards total).

Additionally, 86 facilities were removed from the analysis if any of the data fields indicated that the facility is closed, sold, demolished, unoccupied, or has meters shared with other buildings. Boards which had schools excluded for this reason were still eligible for inclusion in the Top 20 boards ranking.

After screening, 4,726 facilities were ultimately included in the analysis.

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 2016-August 2017 period were obtained from Historical Climate Data 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, electric heat, water- and ground-source heat pumps, and swimming pools):

Building type	Energy Use Targets		
	Electricity	Natural Gas	Total Energy
Elementary	4.0* kWh/ft ²	6.5 ekWh/ft ²	10.5* ekWh/ft ²
Secondary	5.0* kWh/ft ²	7.5 ekWh/ft ²	12.5* ekWh/ft ²
Administrative	13.0 kWh/ft ²	7.5 ekWh/ft ²	20.5 ekWh/ft ²

**updated in 2019*

These standard targets for schools and administrative buildings are based on top-quartile (good practice) benchmarked energy use intensities from the Sustainable Schools and Mayors' Megawatt Challenge (administration buildings) databases, are considered readily attainable, and are already being met or surpassed by a growing number of buildings.

The electricity targets for this analysis have been lowered compared with those used in the previous report, reflecting the overall electricity use intensity improvement of the dataset and the corresponding

reduction in the top-quartile performance level. Electricity intensities have been trending downwards over the last few years due to improvements the boards are making such as LED lighting retrofits.

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

Building type	Proportion of energy target considered weather-sensitive	
	Electricity (cooling DD)	Natural Gas (heating DD)
Elementary	0%	91.5%
Secondary	0%	92.5%
Administrative	7%	97.5%

Gas use target proportions are derived from analysis of monthly billing data for over 100 conventionally-heated schools and determined separately for elementary and secondary schools.

Current reporting does not include percent air conditioning for schools so target adjustments cannot be made. In the Ontario climate, cooling electricity consumption accounts for 5% or less of total electricity consumption for a well-performing school. Many Ontario 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, zero adjustment was made for cooling-degree-days for school buildings.

For administrative buildings, analysis indicates that, on average, 7% of electricity use and 97.5% of gas use is weather-sensitive. These proportions are consistent with the energy benchmarking and target-setting methodology adopted by the Real Property Association of Canada (REALPAC)³.

Weather-sensitive portions of energy use targets were normalized based on degree-day ratios between 2012-13 weather at Toronto Lester B. Pearson International Airport and the current reporting year (2016-2017) at the weather station assigned to each building.

Adjustment for portables

Adjustments for portables were calculated as the number of portables multiplied by the weather-normalized standard annual electricity consumption (based on Toronto Pearson Airport 2012-13 weather) required for one portable and divided by Total Floor Area of the associated building. The adjustment was added to the standard target for Total Electricity.

The standard adjustment was lowered from 9,000 kWh/year in the previous report to 7,000 kWh/year. The non-weather-sensitive portion is 3,000 kWh/year (lighting, HVAC and equipment) and the weather-sensitive portion is 4,000 kWh/year (electric heat). The adjustment is currently under review. No allowance was made for air conditioning in portables.

³ See [REALPAC Energy Benchmarking Program Data Normalization Technical Bulletin](#).

Adjustment for swimming pools



The 2019 analysis uses information provided previously by the boards on the size of their swimming pools, assuming those have remained unchanged. There are 93 schools with a swimming pool in this year’s analysis. Through a community centre research project, the Mayors’ Megawatt Challenge program developed the following standard for operation of a swimming pool: 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 school based on the reported 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).

Adjustment for all-electric buildings and heat pumps

The 2019 analysis uses information provided previously by the boards on the heating systems in their facilities.

Assumptions:

Deemed boiler plant efficiency (conventionally heated school)	75%
% of heat required that is extracted from the ground (GSHP)	90%
Coefficient of Performance (COP) for the heat pump	4.0
Domestic hot water heated by heat pump	100%

Adjustments to energy use targets for each building were made as follows, based on heating system type indicated for each facility (all-electric, water-source heat pump, or ground-source heat pump⁴):

1. All-electric:
 - a. Electricity target increased by weather-normalized gas use target multiplied by 75% deemed seasonal gas-firing efficiency.
 - b. Gas target is 0.
2. Water-source heat pump (WSHP):
 - a. Electricity targets increased by the following standards weather-normalized to the building’s location:

Elementary	Secondary	
1.2 kWh/sf	1.4 kWh/sf	(standard gas targets multiplied by 75% deemed gas-firing efficiency times 1/COP)

⁴ Assumed that 100% of a facility’s area is served by a water-source heat pump or a ground-source heat pump or is all-electric, whenever these system types are reported.

- b. Gas targets reduced by the amounts in a. divided by 75% deemed seasonal boiler plant efficiency).
3. Ground-source heat pump (GSHP):
- a. Electricity targets increased by the following standards weather-normalized to the building's location:

Elementary	Secondary	
1.1 kWh/sf	1.3 kWh/sf	(standard gas targets multiplied by 75% deemed gas-firing efficiency times 1/COP times 90% of heat required that is extracted from the ground)

- b. Gas target is equal to 10% of the standard gas target (normalized to 2016-2017 and to appropriate 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: \$0.15/kWh

Gas: \$0.30/m³

The board's total savings potential is the sum of 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 all buildings' actual total energy use intensity) and target total energy use intensity (weighted average of all buildings' target total energy use intensity). The top energy performing boards are the boards with the lowest total % energy savings potential, that is, their overall energy use intensity is closest to their target energy use intensity.

Greenhouse gas emissions

The greenhouse gas emissions reductions potential for each building was derived from converting energy savings potential to tonnes using the following factors:

40 grams GHG emissions (CO ₂ e)	per kWh of electricity
1,888 grams GHG emissions (CO ₂ e)	per m ³ of gas

Source: National Inventory Report 1990 - 2016: Greenhouse Gas Sources and Sinks in Canada (submitted in 2018), Part 3, Annex 13 Electricity in Canada: Summary and Intensity Tables.

3.4. Estimating energy savings

Estimated energy savings in 2016-17 (current year) compared with 2014-15 (previous year) were determined using a subset of 4,272 buildings where the reported building area has not changed by more

than 5%. Electricity and gas savings achieved are estimated as the difference between the savings potential % for the current year and the previous year multiplied by the current year consumption. To provide an accurate comparison, analysis used the same electricity targets and the same portables allowance as was used in the previous analysis.

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 2019 report are as follows:

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



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