



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

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*Methodology White Paper*

*Updated May 2020*



**SUSTAINABLE SCHOOLS**  
saving our energy for education



Sustainable Schools is a program of the Climate Challenge Network.

[sustainableschools.ca](http://sustainableschools.ca)

[climatechallengenetwork.org](http://climatechallengenetwork.org)

### **About Sustainable Schools**

Since 2007, [Sustainable Schools](#) has worked with school boards across Canada to build the knowledge and practice of energy efficiency in schools. It is a ground-breaking initiative, going beyond energy reporting and benchmarking to establish best practice energy targets for individual schools, and thus how much energy each school and school board can save. This knowledge of conservation potential provides the foundation and direction for effective conservation action.

Sustainable Schools is a program of the [Climate Challenge Network](#). Sustainable Schools acknowledges the support of [Enbridge Gas](#) and the [Independent Electricity System Operator](#) (IESO).

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## 1 Introduction

The Sustainable Schools program published the first annual Top Energy Performing Schools Report in 2008, recognizing some of the most energy efficient schools from across North America. Subsequent annual reports added to the body of knowledge about how much energy efficient school buildings need and the common characteristics of the most efficient schools. The work developed and refined a methodology for setting a rational energy target and derived savings potential for individual schools and board administration buildings.

We began reporting on the energy performance of whole school boards in 2015, with data for the 2012-13 school year. Results recognized the top-10 boards with the lowest targeted energy savings for all their buildings combined. Most boards have some efficient schools which are often due to an enlightened design team and/or an engaged and informed caretaking staff. Rolling up the results for all its individual buildings into board-wide totals provides a more useful assessment of the design and operating standards and management practices of the board as a whole.

Sustainable Schools has published this fifth Top Energy Performing Boards report in May 2020, using data for the 2017-18 school year. The report analyzes the energy use of all 72 Ontario school boards and their close to 5,000 schools and administration buildings to identify the top twenty most efficient boards in the province. The report presents the latest top-20 rankings along with the achievable savings potential for electricity, thermal energy (natural gas and oil), greenhouse gas emissions and utility costs for the province as a whole. The report also determines the actual savings achieved in the 2017-18 school year compared against the previous year. The report is for use by school boards, utility companies and product and service providers to help direct attention and resources to the biggest areas of opportunity and guide continuous improvement. It is also intended as a reference for government when developing energy and climate policy and supporting the K-12 schools' sector in meeting provincial environmental goals.

This White Paper details the methodology used to produce the 2020 results. Please visit the Sustainable Schools website at [sustainableschools.ca](https://sustainableschools.ca) for the 2020 and previous reports, the latest version of the White Paper and further information.

## 2 Methodology summary

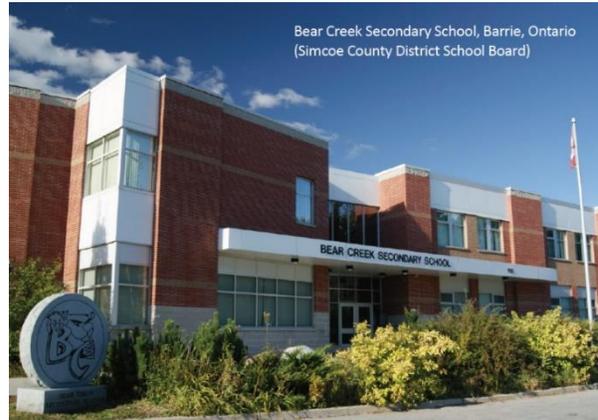
Ontario school boards are required by regulation to report annually on actual energy use together with certain high-level building information. Energy use data for the 2017-18 school year was obtained from the Ontario Ministry of Energy's [Broader Public Sector energy use dataset](#), released in March 2020. A site-specific energy target was set for every individual building based on top-quartile performance for its building type, which in turn established its energy savings potential as the difference between actual and target electricity and thermal energy consumption. Good-practice standard targets for elementary and secondary schools and administration buildings were established from the full dataset and adjusted for weather and school-specific variables to create the customized target for each building. The savings potential for the individual buildings was then rolled up to produce the overall board savings 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 combined – that is, those with the lowest overall targeted savings potential.

The actual savings achieved in the 2017-18 school year compared against 2016-17 were determined from the change in targeted savings over the two years.

### 3 Data analysis

The 2020 report uses energy data and building information for the 2017-2018 school year for Ontario’s 4,968 schools and education centres as publicly reported by the 72 school boards. Energy use data were 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 2017-2018 school year). All facilities included by a board in the reporting template were analyzed, whether leased or owned. Additionally, information on heating sources – conventional (gas or oil-fired), electric heat or ground-source or water-source heat pumps, as well as the size of any swimming pools, was used in the analysis as supplied by the school boards to Sustainable Schools.



#### 3.1 Data merging

As a first step, records from the BPS dataset were merged with records from the 2019 Top Energy Performing Boards analysis. As in previous analyses, data cleaning and filtering were required, including correctly matching facility names to the ones in the existing database, as the buildings reported to the Ministry of Energy do not have unique identifiers.

#### 3.2 Data processing and screening

Oil, propane and district heating energy use was converted into natural gas equivalents, and district cooling into electricity equivalent, 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 screened for apparent data gaps, and the facilities which failed one or more of the following filters were removed from the analysis (112 total):

- a. Too low total energy intensity less than 5 ekWh per square foot;
- b. Too high total energy intensity greater than 100 ekWh per square foot;
- c. Too low electricity use intensity less than 2 kWh per square foot; or
- d. No fuel consumption reported 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 ranking (6 boards total).

Additionally, facilities were removed from the analysis (122 total) 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, 4,734 facilities (95% of the total) were ultimately included in the analysis.

#### 4 Weather-normalization and target-setting

A weather station was assigned to each facility based on geographic proximity to a weather station data with complete and reliable data. Weather data for the September 2017-August 2018 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 2020 standard targets (based on 2012-2013 Toronto International Airport weather) have been used for buildings with conventional heating systems, before adjustment for weather and site-specific characteristics (portables, electric heat, water- and ground-source heat pumps, electric A/C, and swimming pools):



Building type	2020 Energy Use Targets		
	Electricity	Natural Gas	Total Energy
Elementary	4.0* kWh/ft <sup>2</sup>	6.5 ekWh/ft <sup>2</sup>	10.5* ekWh/ft <sup>2</sup>
Secondary	5.0* kWh/ft <sup>2</sup>	7.5 ekWh/ft <sup>2</sup>	12.5* ekWh/ft <sup>2</sup>
Administrative	13.0 kWh/ft <sup>2</sup>	7.5 ekWh/ft <sup>2</sup>	20.5 ekWh/ft <sup>2</sup>

*\*updated in 2019. These values include the cooling component that was used to adjust electricity targets for electric A/C (0.15 kWh/ft<sup>2</sup> for schools and 0.91 kWh/ft<sup>2</sup> for administrative buildings)*

These standard targets for schools and administrative buildings are based on top-quartile (good practice) benchmarked energy use intensities from Climate Challenge Network’s Sustainable Schools and [Mayors’ Megawatt Challenge](#) (for administration buildings) program databases. They are considered readily attainable through good operating practices and cost-effective retrofits and are already being met or surpassed by one quarter of all the buildings.

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	3.8%	91.5%
Secondary	3.0%	92.5%
Administrative	7.0%	97.5%

These proportions are derived from regression analysis of monthly billing data for over 100 conventionally heated schools and determined separately for elementary and secondary schools. The proportions for administrative buildings are determined from analysis of the Mayors’ Megawatt Challenge dataset and are consistent with the energy benchmarking and target-setting methodology adopted for commercial office buildings by the Real Property Association of Canada (REALPAC)<sup>1</sup>.

These 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 (2017-2018) at the weather station assigned to each building.

#### 4.1 Adjustment for air-conditioning

Target adjustments for air-conditioning were calculated as a standard 0.15 kWh/ft<sup>2</sup> for elementary and secondary schools or 0.91 kWh/ft<sup>2</sup> for administration buildings weather-normalized to the assigned weather station and multiplied by the percentage of building area served by electric A/C.

#### 4.2 Adjustment for portables

Adjustments for portables were calculated as the number of portables multiplied by the weather-normalized standard annual electricity consumption allowance for one portable and divided by the total floor area of the associated school. The adjustment was added to the standard target for Total Electricity.

The standard adjustment was increased from 7,000 kWh/year in the previous report to 10,000 kWh/year in this report based on consensus feedback from boards with sub-metered portables. The non-weather-sensitive portion is 3,000 kWh/year (lighting, HVAC and equipment) and the weather-sensitive portion is 7,000 kWh/year (electric heat). Further research is needed to establish an evidence-based good practice

<sup>1</sup> See [REALPAC Energy Benchmarking Program Data Normalization Technical Bulletin](#).

(top quartile) target for portables and this adjustment will be reviewed again in future reports. No allowance was made for air conditioning in portables.

### 4.3 Adjustment for swimming pools



The 2020 analysis uses information provided previously by the boards on the size of their swimming pools and assumes those have remained unchanged. There are 88 schools reporting a swimming pool in this year’s analysis. Target adjustments are established from a community centre research project by the Mayors’ Megawatt Challenge program as follows: 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 presence of pools but not the water surface area a default pool size of 2,723 sf was used (23m by 11m). Target adjustments for pools are not weather normalized.

### 4.4 Adjustment for all-electric buildings and heat pumps

The 2020 analysis uses information provided by the boards on the heating system types in their facilities. Heating system type definitions are provided below:

1. Conventional Heating Plant  
Predominantly gas- or oil-fired boilers supplying hot water/glycol heating systems and/or gas-fired rooftop units.
2. Steam Heating Plant  
Predominantly gas- or oil-fired steam generators supplying steam radiators and heating coils.
3. Electric Heat  
Predominantly electric space heaters and air handling unit heating coils.
4. Water Source Heat Pump  
Predominantly heat pumps with condenser water loop supplemented by gas- or oil-fired boilers.
5. Ground Source Heat Pump (Geothermal)  
Predominantly heat pumps with condenser water loop connected to geothermal field as well as supplementary gas- or oil-fired boilers.

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 pump<sup>2</sup>):

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. All-electric buildings with thermal energy use (gas-fired rooftop or DHW heaters)
  - a. Gas use converted to electric equivalent and then added to the electricity use:
    - i. Add gas use \* 0.75 deemed seasonal gas-firing efficiency to actual electricity use = adjusted electricity
    - ii. Subtract all-electric target (weather-normalized) from adjusted electricity = target savings
    - iii. Calculate target savings % and apply that same number to both electricity and gas
3. 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)

- b. Gas targets reduced by the amounts in a. divided by 75% deemed seasonal gas-firing efficiency.

4. 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 (weather-normalized).

<sup>2</sup> 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.

## 5 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: \$0.164/kWh

Gas: \$0.282/m<sup>3</sup>

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.

### 5.1 Low-Carbon Stars

While recognizing the most energy efficient school boards, Sustainable Schools is also celebrating the 307 individual schools across the province (6.7% of the total) with less than 1 kg CO<sub>2</sub>e/ft<sup>2</sup> of 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:

20 grams GHG emissions (CO<sub>2</sub>e)  
per kWh of electricity

1,915 grams GHG emissions (CO<sub>2</sub>e)  
per m<sup>3</sup> of gas

*Source:* National Inventory Report 1990 – 2017: Greenhouse Gas Sources and Sinks in Canada (submitted in 2019), Part 3, Annex 13 Electricity in Canada: Summary and Intensity Tables and Part 2, Annex 6 Emission Factors.



### 5.2 Estimating actual energy savings

Estimated energy savings in 2017-18 (current year) compared with 2016-17 (previous year) were determined using a subset of 4,374 buildings where the reported building area has not changed by more than 5%. Electricity and gas savings achieved are determined using the difference between the savings potential % for the current year and the previous year multiplied by the current year consumption using the same standard targets and adjustments as were used in the previous year.

## 6 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 2020 report are as follows:

HAMILTON A  
KENORA A  
KINGSTON CLIMATE  
KITCHENER/WATERLOO  
LONDON A  
MOOSONEE  
OTTAWA INTL A  
PETERBOROUGH A  
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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