

## APPENDIX A

# CONSERVE FIRST: NET ZERO RESEARCH STUDY

## *Executive Summary*

*“... If you are successful, you will win some false friends and some true enemies;  
Succeed anyway. ...  
What you spend years building, someone could destroy overnight;  
Build anyway. ...  
Give the world the best you have, and it may never be enough;  
Give the world the best you’ve got anyway ...”*



*inscribed on the wall of Mother Teresa's children's home in Calcutta,  
the "Anyway" Poem, or The Paradoxical Commandments, was written by Kent M. Keith in 1968*

**Purpose of this study:  
to help refine the TCDSB's 2016 resolution & chart a path forward**

In 2016, the TCDSB passed a resolution to “become a Net Zero energy school board.”\* The Chair was to write to the Minister of Education and to the provincial and federal Ministers of the Environment and Climate Change (to request financial support). Staff were to work in partnership with the Ministries of the Environment and Climate Change (assuming commitments were made by the other agencies) and report back to the Board on progress.

In 2017\*\*, Facilities Services Staff tabled a number of issues or questions requiring research, among them:

- which of the various definitions of “Net Zero” to adopt (i.e. where to aim?),
- how to understand the implications of adopting one definition over another,
- which design or procedural strategies have the greatest potential to deliver value,
- whether it would be technically feasible to offset all energy used in existing schools with renewable energy generated at new schools, and
- how to prepare a project to take advantage of external funding support, should it materialize, in future.

This *Conserve First* report responds, by describing how the concept of Net Zero might be applied to the design, construction and ongoing operation of the TCDSB's elementary and secondary schools. It introduces broad policy options for the long term. It also highlights an array of small practical steps that might be taken right away.

The TCDSB may, with the information presented here, choose to revise, continue, or revoke its 2016 resolution regarding Net Zero. **We hope the Board will renew its commitment to energy conservation and greenhouse-gas reduction in all of its daily actions** respecting buildings - as the poem (opposite) says, anyway.

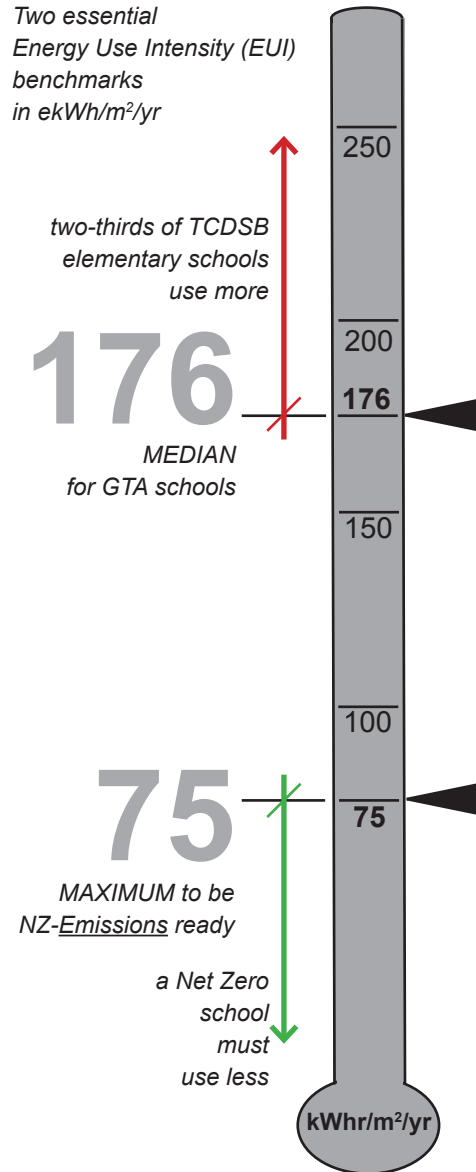
\* *Corporate Services, Strategic Planning and Property Committee meeting, March 10, 2016*

\*\* *Net Zero Energy Status Update (All Wards), Report to Regular Board, First Tabling April 19, 2017 and*

*Net Zero Energy Study Consultant Appointment, Report to Associate Directors' Council, Review December 4, 2017*

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Figure ES.01  
Two essential  
Energy Use Intensity (EUI)  
benchmarks  
in  $\text{ekWh}/\text{m}^2/\text{yr}$



Net Zero is an ideal state in which measures are taken to balance a load that human activity places on an ecosystem. In 2016, the TCDSB expressed an interest in “Net Zero Energy”, and this report addresses energy consumption and the resulting emission of greenhouse gasses (which are associated with climate change) in TCDSB school buildings.

This report neither promotes the continued pursuit of Net Zero, nor argues for abandonment of the TCDSB’s 2016 resolution. Rather, it aims to help the TCDSB understand what may lie ahead - by suggesting an overall approach, and a number of steps with which to start, immediately, to travel the long road toward its goal. We suggest re-naming the goal “Net Zero Emissions readiness”, which has a technical definition that is related to, but distinct from “Net Zero Energy”. (See Core Observation 2.)

The first step on the path to Net Zero (no matter how it is defined) is ambitious energy conservation. Figure ES.01 illustrates two key benchmarks that are used throughout the *Conserve First* report. Energy Use Intensity (EUI) is for buildings what calories per serving is for a food label or miles-per-gallon is for a car. Lower is more conserving.

As Figure ES.01 shows, there is a very wide gap between today’s typical TCDSB school and that of a Net Zero school. To close it will require not just careful design, but continuous monitoring and adjustment of behaviours in reference to these benchmarks.

In renewing its commitment to energy conservation and greenhouse-gas reduction, we hope the TCDSB would endorse the following approach:

- **Make a host of small decisions, daily, in alignment with its values.**
- **Conserve first, conserve anyway.** Set an energy budget for every building. Track and communicate real energy usage to everyone who occupies, manages,

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helps build, or helps design every TCDSB building.

- **Adopt step goals**, to increase conservation over time. To begin, try to realize an ambitious level of conservation in many buildings, and Net Zero Emissions readiness in a few.
- **Employ construction quality-control strategies**, as well as an array of design strategies to help optimize building performance.
- **Involve everyone**. Ambitious conservation depends on the active participation of occupants, throughout the life of a building.

At the end of this Executive Summary, we list all of the many ideas about how the TCDSB might proceed toward its goal, which are contained in the chapter summaries, within the longer *Conserve First* report. Each of the following ten core observations stems from what that research has shown us. Together they describe what “becoming Net Zero” would mean for the TCDSB.

1. Accept that the road to Net Zero will involve a journey of decades
2. Target for buildings: Net Zero Emissions ready
3. Hold fast to values expressed in the 2015 *Laudato Si'*
4. Technical strategies: Commit to do more than the minimum
5. Human factors: important as technical strategies
6. Responding to the financial challenge
7. Defer construction of renewable energy generation until usage is reduced
8. Focus on heating
9. Help everyone continue to learn about what drives energy use
10. Further study

### TWO ESSENTIAL TERMS

#### EUI

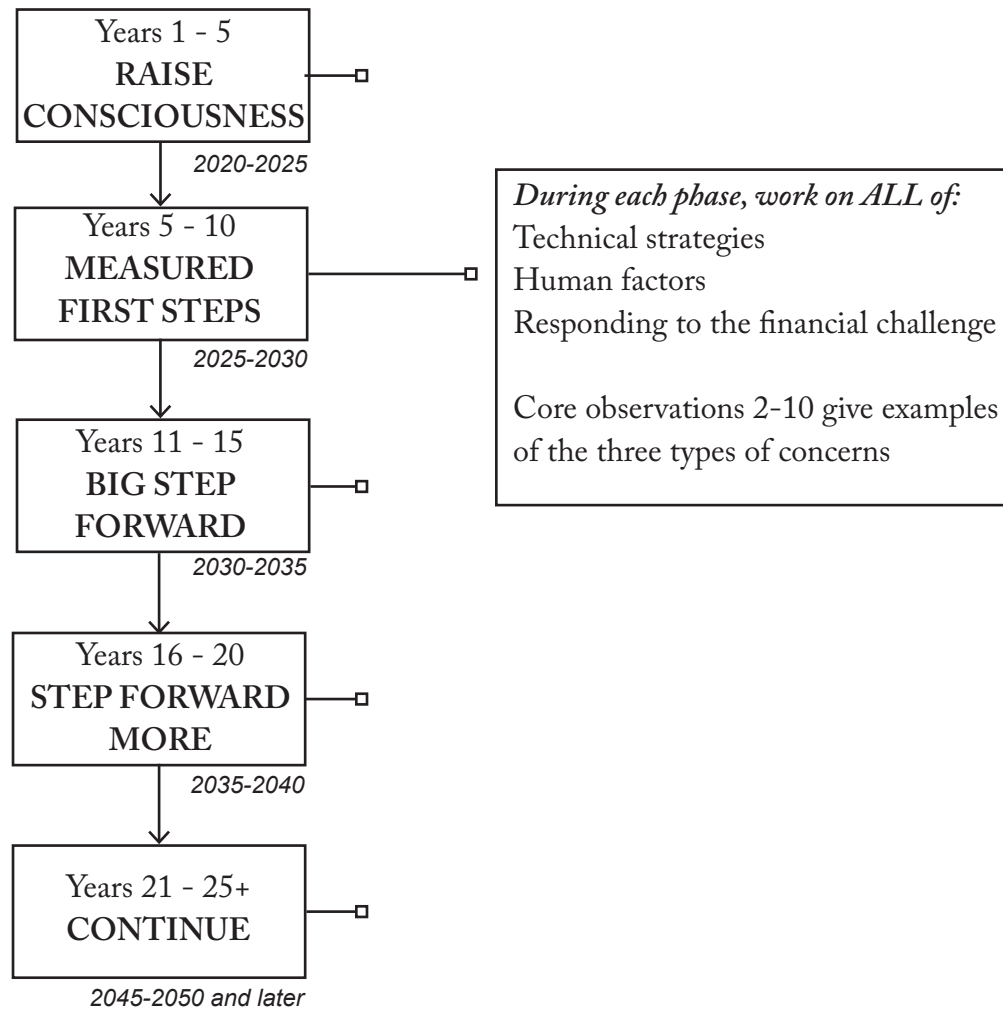
**Energy Use Intensity** allows a comparison of how much energy is used in two or more buildings of unequal size. It should include all usage of all fuels for all purposes, namely: space heating and cooling, ventilation, and site and indoor lighting, as well as any equipment that is plugged in. It can be measured in  $\text{ekWhr/m}^2/\text{yr}$  or other units.

#### $\text{ekWhr/m}^2/\text{yr}$

**Equivalent kilowatt-hours per meter squared per year** measures the EUI of a building. All usage reported on all fuel bills is captured in one unit. In the TCDSB's case, bills are for natural gas and electricity. Alternative units, which measure the same thing, are presented with conversion factors in Part 1 of the *Conserve First* report.

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Figure ES.02  
Roadmap to Net Zero readiness:  
The first 25 years



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### 1. A journey of decades

The road to a state of Board-wide Net Zero Emissions readiness will be a long one: likely to take at least 40 years to travel, if not more. Figure ES.02 outlines the first few phases.

The TCDSB's starting position lengthens the journey. Today, on a per-square foot basis, the TCDSB is one of the most intense consumers of energy among the GTA Boards. It has the largest proportion of floor area operating above the GTA median Energy Use Intensity (EUI) and no floor area operating within the "exemplary" top 2% of GTA schools. Some TCDSB schools consume four times the energy that others consume, and many exhibit wild variations in energy use from year to year.

Net Zero is a long way away for many other school boards in Ontario, as well. Net Zero schools are very special buildings, consuming less than 75 ekWhr/m<sup>2</sup>/yr of energy - less than 40% of the energy that a middle-of-the-pack GTA school uses. To sustain this level of conservation, they must be very carefully monitored and occupied conscientiously.

Further, at the current "rate of churn", not all 200 TCDSB schools will be replaced or substantially renewed during the next 40 years. To walk the road from here to Net Zero, the TCDSB would need to turn in new directions (labelled NDs), namely:

- Lower the EUI of every school to 40-75% of 2017 levels (ND1),
- Narrow the range from energy-consuming to energy-conserving (ND2), and
- Establish more control over energy use than has been feasible to date (ND3).

Technically speaking, ND1, ND2 and ND3 would have to take precedence over every other recommendation made in the *Conserve First* report. Though the road will be long, the approach to Net Zero can only be made by taking the first step.

### CORE OBSERVATION

#### 1

#### *Responses requested to Core Observation 1:*

a - Will the Board adopt New Directions ND1, ND2, and ND3, starting its efforts in these respects now?

b - Given, 1a, will the Board accept 2060-2080 as the horizon at which to reach Board-wide Net Zero readiness?

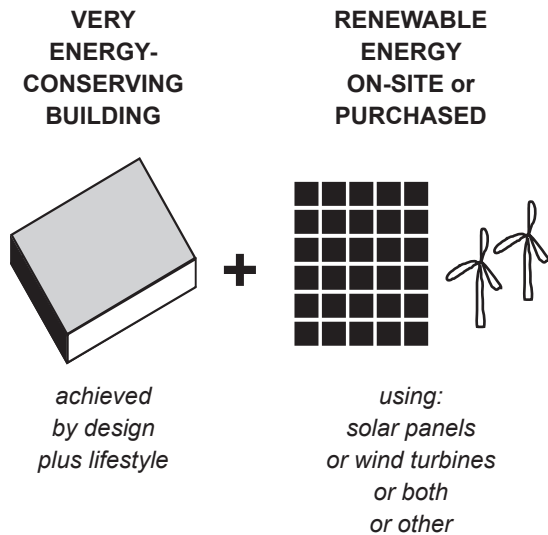
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### 2. Target for buildings: Net Zero Emissions ready

#### CORE OBSERVATION 2

The TCDSB's 2016 resolution may be characterized (we think fairly) as extremely ambitious. While some cities are working to realize Net Zero districts, and more than one college or university hopes to create a Net Zero campus, the TCDSB is the first agency we've heard declare an intent to reach Net Zero across a portfolio of buildings which occupy small sites that are dispersed throughout a large region. There is not, as yet, a Net Zero school in the GTA, and there is just one in all of Ontario.

The general concept of Net Zero (which is illustrated in Figure ES.03) is not new, but its application to real, occupied buildings is still being tested. Only recently, have various agencies in the USA and Canada defined the term - and it may be defined in a variety of ways. When designing a single Net Zero building, the choice of one definition or the other will have a significant impact on capital cost, space allocation, and how the building is operated. To envision the future of the entire portfolio, it is essential to choose the version of Net Zero that best suits the values and intentions of the agency who is taking the initiative. There are three main variations:



- Net Zero Energy
- Net Zero Emissions
- Net Zero Emissions ready

In a **Net Zero Energy** building, every unit of energy that is used (on an annual basis) is matched by energy generated by renewable energy equipment on the site (solar panels, wind generators, or both). To reach Net Zero Energy, the renewable energy power plant must be large enough to produce 100% of the energy that everyone at the site uses for every purpose – heating, lighting (indoors and out), ventilation, cooling, and any equipment that is plugged in, such as computers, printers, water coolers, and so on. While

Figure ES.03  
The general concept of Net Zero applied to energy use and GHG emissions in a building



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Net Zero Energy can be reached at any level of EUI, the higher the EUI, the larger the space needed to construct the power plant. Costs naturally increase or decrease in proportion to the size of the equipment. In the rare places where we have seen Net Zero Energy achieved to date, there has been either a driving research interest or concerns about the local energy supply. Given that Ontario's electricity grid is largely free of greenhouse gas (GHG) emissions, we see no compelling environmental reason for the TCDSB to prefer Net Zero Energy to the alternate definitions of Net Zero, at this time.

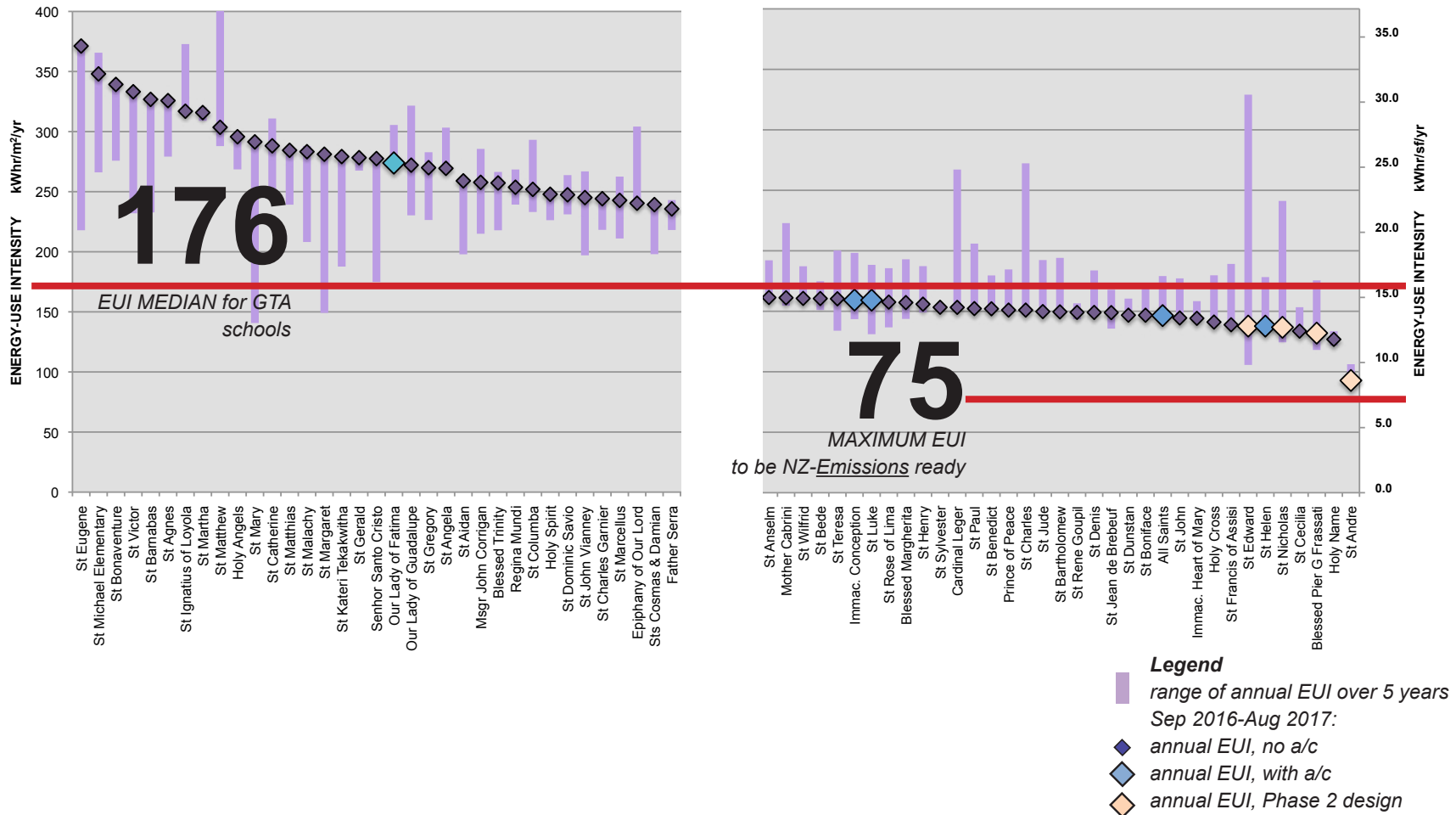
2

In a **Net Zero Emissions** building, some of the energy the users consume is balanced by renewable energy – which is either generated on the site, or purchased from someone who runs an off-site renewable energy plant. How much offsetting renewable energy is needed depends on how much GHG-emitting energy is used. Since space heating has proven the most GHG-emitting user of energy, every effort is made to keep the heat in and deliver supplementary heat with utmost efficiency, while conserving in all other areas as well. From the limited evidence we have so far, it appears that Net Zero Emissions schools operate with an overall EUI in the range of 40-95 kWhr/m<sup>2</sup>/yr (perhaps higher). In some of the cases where space heating is powered electrically (which is relatively costly to install and operate), renewable energy offsets as little as 5-10% of the overall energy usage.

A **Net Zero Emissions ready** building is similar in almost every respect to a Net Zero Emissions building – except it does not incorporate a power plant to generate electricity on site on opening day. The agency that constructs it has a plan to achieve balance in the future in one of two ways: to physically install electricity generation equipment (such as solar panels) on site, or to buy “clean” energy, generated off-site, from a larger-scale generator. The option remains open - to build or buy, or to combine building and buying - at such time as funding becomes available and a cost-benefit analysis is deemed acceptable.

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Figure ES.04  
Energy use in TCDSB elementary schools at the high (left) and low (right) ends of the EUI spectrum (excerpts from Part 1 of the Conserve First report)



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The TCDSB is, in a way, “starting with a handicap”. As Figure ES.04 (left) shows, many TCDSB schools operate well above the GTA median for schools. Meanwhile, as Figure ES.04 (right) shows, very few schools operate below the benchmark.

Also, TCDSB school sites are typically in built up areas, and not large enough to contain much generating equipment. The Board must work with very constrained funding parameters. Given these challenges, Net Zero Emissions readiness is an ambitious goal.

Net Zero Emissions (rather than Net Zero Energy) would:

- focus the TCDSB’s efforts on addressing climate change, by lowering the greenhouse gas emissions associated with space heating, and
- in so doing, align the Board with the principles driving the City of Toronto’s emerging policies.

Readiness (rather than full Net Zero on opening day) would:

- avoid costs related to renewable energy generation equipment in the near term (which ran in the millions of dollars, in the cases we studied),
- help the Board focus its first-stage efforts on the all-important challenge of reducing EUI to something like 40% of today’s norm, and
- retain the option, long term, to realize Net Zero Emissions status - assuming that, during the design of new schools, plans are made to either build or buy future renewable energy capacity. (See Core Observation 7.)

The *Conserve First* report highlights alternative ways to reach toward Board-wide Net Zero Emissions readiness, in incremental steps. Core Observations 4, 5 and 6 suggest approaches that might be taken individually, but ideally should be taken in tandem.

## CORE OBSERVATION

### 2 continued

*Response requested to Core Observation 2:*

Would the Board to modify the 2016 resolution to:

“move toward Net Zero Emissions readiness”.

## Executive Summary

### 3. Net Zero as an expression of firm values

#### CORE OBSERVATION 3

The TCDSB has guidance that not all agencies have, in Holy Father Francis' 2015 Encyclical, *Laudato Si'*. Among other ideas expressed there, the following “starting assumptions” seem to be of particular relevance to the TCDSB's interest in Net Zero:

*“What kind of world do we want to leave to those who come after us ...? ... what is at stake is our own dignity.” (LS1, article 160)*

#### *Response requested to Core Observation 3:*

The Board's affirmation of the beliefs expressed in the 2015 *Laudato Si'* is assumed.

*“The climate is a common good, belonging to all and meant for all.” (LS2, article 23)*

*“The gravest effects of all attacks on the environment are suffered by the poorest.” (LS3, article 48)*

Studying other agencies who own very-conserving buildings, we have often witnessed firmly held values at work. Focussing on the education sector, this report features:

- three institutions of higher education that teach and do research about environmental issues (*The Joyce Centre at Mohawk College, the Adam Joseph Lewis Center at Oberlin College, and Vermont Law School*),
- a municipal library that serves a community in which energy research institutes are the major employers (*Varenes Library*),
- a school/community centre devastated by tornados and a changing economy, which found new purpose (*Greensburg-Kiowa County K-12*), and
- two schools with extra focus on environmental protection in their curricula (*Dr. David Suzuki Elementary, and Locust Trace AgriScience High*).

See Core Observation 5, for more from 2015 *Laudato Si'* to guide the way forward.

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### 4. Technical strategies: Commitment to do more than the minimum

Net Zero Emissions readiness is technically feasible but not easy to achieve in Toronto's climate. An exceptional effort is needed to produce an exceptionally energy-efficient or Net Zero building. Committing to do "more than the minimum" would entail:

- exceeding the requirements of today's mandatory codes,
- exceeding today's "standard practice" in school construction,
- expanding the scope of renewal work to address energy-conservation,
- perhaps working with a third-party guideline (voluntarily),
- allocating additional staff time, and
- investing in additional time and expertise from consulting design professionals.

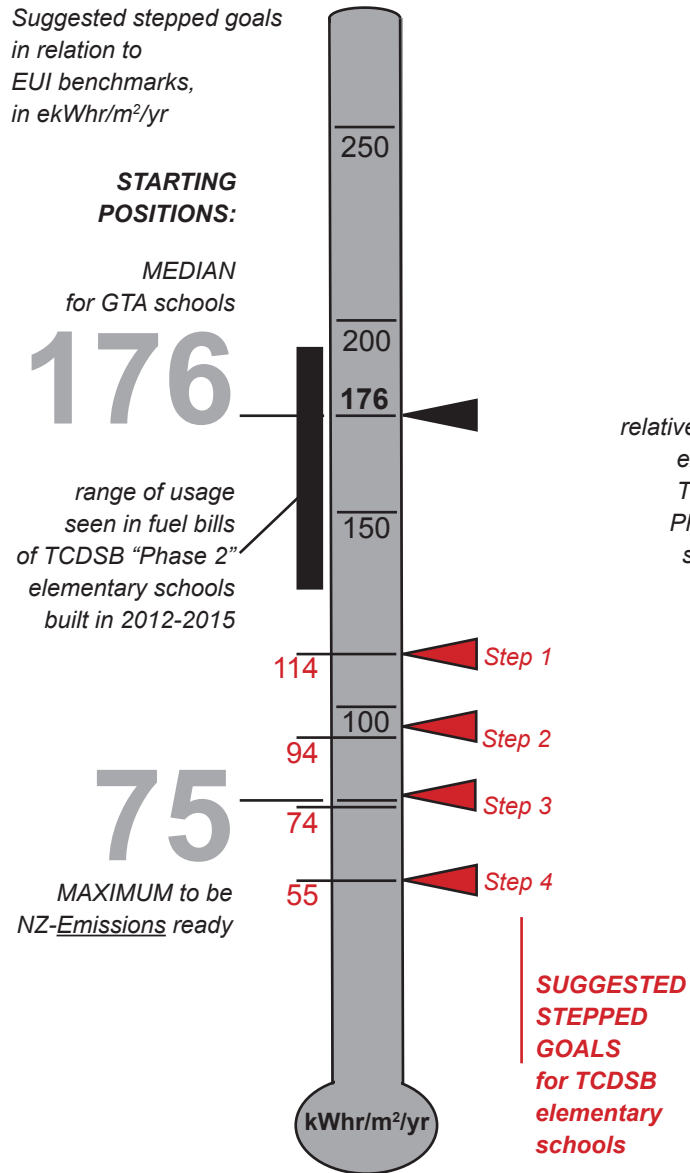
Exceeding the mandatory minimum requirements of the *Ontario Building Code (OBC)* or the *Toronto Green Standard (TGS)* by a substantial margin is a hallmark of the Net Zero schools featured as case studies in the *Conserve First* report. While these regulations have evolved in significant ways to encourage more energy conservation, they lack three critical elements that would help drive a design all the way to Net Zero.

The City of Toronto's *Zero Energy Buildings Framework (ZEB)*, picking up where the *OBC* and *TGS* leave off, describes regulations-to-come - and includes all three of these elements. The TCDSB will not (according to public documents available today) be obliged to comply with the *ZEB* - but it might elect to develop its own goals in a way that mirrors the City's "step goals" for other building types. Doing so might help the TCDSB better collaborate with the City to co-ordinate aspects of mutual benefit, such as the planning of district energy zones or renewable energy generation sites.

CORE OBSERVATION  
4

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Figure ES.05  
Suggested stepped goals  
in relation to  
EUI benchmarks,  
in ekWhr/m<sup>2</sup>/yr



relative to an existing TCDSB Phase 2 school:

TCDSB Stepped Goals - for NEW elementary schools				
	Step 1	Step 2	Step 3	Step 4
83%	must v3 T1 EUI 114, TEDI 64	n/a	n/a	n/a
68%	may v3 T2 EUI 94, TEDI 54	must v4 T1 EUI 94, TEDI 54	n/a	n/a
54%	may v3 T3 EUI 74, TEDI 45	may v4 T2 EUI 74, TEDI 45	must v5 T1 EUI 74, TEDI 45	n/a
40%	may v3 T4 EUI 55, TEDI 35	may v4 T3 EUI 55, TEDI 35	may v5 T2 EUI 55, TEDI 35	must v6 T1 EUI 55, TEDI 35

Note: "v3 T1" refers to Toronto Green Standard (TGS) version 3, Tier 1, which is now mandatory for all building types, including schools. Compliance with Tiers 2-4 is voluntary.

Neither the TGS nor Toronto's ZEB Framework stipulates EUI or TEDI targets for schools; the figures here are tabled for the consideration of the TCDSB, and have been developed based on assumptions, which are described in Part 2 of the Conserve First report

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Figure ES.05 suggests how the City's *ZEB Framework* might be filled with goals for new TCDSB schools. All figures are preliminary, and may be subject to later refinement - but this illustrates an approach in which goals are "stepped" to be increasingly demanding, over time. The City of Toronto's *Framework* demands that a step be taken every four years (with Step 4 in 2030), but the TCDSB might elect to take its steps at another interval. At each step, yesterday's least ambitious EUI goal drops out of the framework. Core Observation 8, "Focus on heating" suggests that every EUI goal be accompanied by a goal to limit Thermal Energy Demand Intensity, or TEDI.

### CORE OBSERVATION 4 continued

Exceeding today's standard of practice is another hallmark of the Net Zero case study school designs. When design and construction quality control measures were compared, using a 24-point diagnostic, the Net Zero case studies (as a group) employed 20 strategies regularly. Each individual Net Zero school used at least 14 of the strategies in its design. The selection and arrangement of components and measurement of air tightness of the whole building exceeded those in what are considered the finest of the GTA's current schools. Both a high-performance enclosure (roof, exterior walls, windows and floors), and ultra-efficient heating and cooling equipment were always used. In short, there is no "magic bullet" design tactic which alone can leverage a Net Zero result.

Expanding the scope of renewal work to address energy conservation will be one of the most challenging - yet one of the essential - initiatives on the road to Net Zero. As Figure ES.04 shows (in Core Observation 2), there is much to be gained by conserving in the 130+ TCDSB schools that today operate at a very high-EUI. Annual operating costs may be saved and greenhouse gas emissions may be eliminated where both are currently running high. If stepped goals are to be confirmed for new TCDSB schools, then ambitious energy-conservation goals for renewal projects should also be developed. The challenge will be to find a reasonable goal for each individual school to be renewed - depending on its design, and its future life expectancy (as determined by many other factors).

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### CORE OBSERVATION 4 continued

Voluntary compliance to guidelines that exceed today's minimum regulations might help the TCDSB hone its short- and mid-term goals and inform the design of a Net Zero school. Among nine alternatives, the *Conserve First* report identifies some with good potential to be adopted now, as-is, and others that have potential to be tailored to the TCDSB's needs, including:

- EUI targets, air tightness testing & feedback loops,
- Passive House certification (by external or newly trained staff),
- step goals for new school designs,
- step goals for all schools, using an approach similar to REALPac's 20 by '15 (a successful program formerly run by owners of commercial buildings),
- a transition plan for heating systems in new designs (described by the CaG-BC), or
- an internal "Road to Net Zero" Challenge Award program.

#### *Response requested to Core Observation 4:*

Will the Board support:

a - further development of step goals followed by an exploratory conversation with the City of Toronto Planning Department about ways to work together to realize the interest shared by the TCDSB in conservation,

b - development of an energy-conservation target for every school to be renewed, and

c - further evaluation of selected voluntary guidelines for their suitability to a TCDSB project (e.g. Passive House Canada or a re-tailored version of REALPac's 20 by 15).

Finally, doing "more than the minimum" naturally implies investing more time and attention to the myriad choices that are made when designing a school, whether it will be new or is being renewed. Additional staff time will be required to measure progress, share information and reflect lessons learned from one project to the next. Additional consulting time (and fees) will be required to evaluate alternative components, assemblies, and systems, predict the energy-conservation impact of various combinations of alternates, document and communicate requirements to the builders, and monitor air tightness tests.



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### 5. Human factors are as important as technical strategies

Effective environmental stewardship requires technical expertise, but that alone is insufficient to achieve and sustain it. Where Net Zero has been realized, success has been the product of the sustained efforts of a host of people over a period of years, even decades. These truths have surfaced repeatedly during our research.

Ontario's most energy-conserving school boards cite a "conservation culture" as critical to the successes they have enjoyed so far. Its elements are:

- a substantive commitment from Trustees, Directors, and staff for 15 years or more ("substantive" entails time and money),
- the engagement of teachers and students,
- the training of building operations staff,
- the optimization of retrofits as well as new buildings, and
- non-stop benchmarking (feedback loops about what worked and what didn't).

The Net Zero schools featured in the *Conserve First* report were all made in a different process environment than the one that typically surrounds projects in the GTA today. Figures ES.06 and ES.07 show two examples. The important human factors included:

- engagement of staff and students in conservation - during all project stages,
- very careful monitoring and analysis of energy use (in real time) and comparison to benchmarks established during design,
- training of operations and maintenance staff throughout the entire process of design, construction and occupancy, and
- external partners - agencies of the city, province/state and federal governments, local utilities or research institutes - in combinations unique to each project.

## CORE OBSERVATION 5

*Holy Father Francis' new notion of growth:*

*"learning to live wisely, to think deeply and to love generously."*

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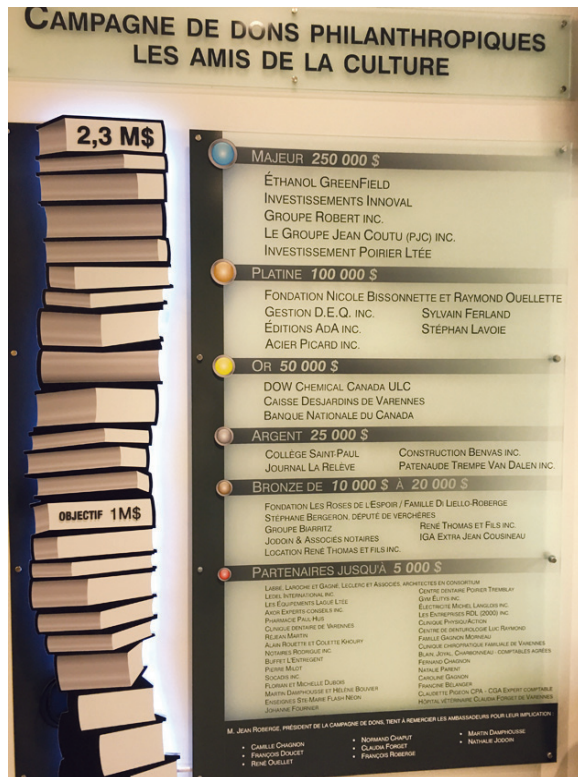


Figure ES.06  
Varenes Library, near Montréal - a product of many community partnerships and a high level of staff engagement - characterizes Net Zero buildings.

Take a tour online (with french narration) at:  
<https://ici.radio-canada.ca/tele/decouverte/2015-2016/segments/reportage/3145/edifice-net-zero>



Figure ES.07  
Grade 5 students help University of Kansas President understand energy use in their school (Photo warrencountyschools.org)

Watch a video at:  
<https://vimeo.com/156705254>

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The acknowledgement of the importance of human factors is consistent with ideas expressed in the 2015 *Laudato Si'*, in which the climate is valued as a common good, climate change seen as a global problem with grave implications, and the environment is defined as a set of relationships, not a mere physical setting. Three guiding principles found in the 2015 *Laudato Si'* (labelled GP) seem to have particular relevance to the TCDSB's interest in Net Zero, namely:

- cautions against partial solutions (that is, those that are purely technical), in favour of projects which invest in both natural systems and people (GP1),
- cautions against harmful habits (of consumption), in favour of a new notion of growth (GP2), and
- cautions against a “superficial ecology”, in favour of the poor (GP3).

All of the above also applies to efforts the TCDSB might make to reach an interim energy-conservation goal, such as an elementary school at 80 to 100 kWh/m<sup>2</sup>/yr (the level that the *Conserve First* report labels as “exemplary”).

All evidence suggests that it is essential for any building project to which an energy-conservation goal is introduced (new or retrofit) to incorporate the elements listed above. We suggest the following New Directions as first steps:

- Encourage experienced EcoSchools to realize measurable effects. (ND9)
- Keep everyone aware of energy conservation all year. (ND10)
- (Perhaps) Use the existing framework of wards to stimulate energy-conservation initiatives. (ND6)

## CORE OBSERVATION 5 continued

### *Response requested to Core Observation 5:*

Whether the goal is Net Zero or “exemplary” energy conservation, will the Board commit to:

- a - Help develop a “conservation culture”, including all elements identified by Ontario’s most energy-conserving school boards
- b - Reflect on the three guiding principles from the 2015 *Laudato Si'* (identified here) to identify areas for improvement within TCDSB projects, and
- c - Support the active pursuit of one, two or all of New Directions ND6, ND9 and ND10 within the next 1-5 years.

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Figure ES.08  
Energy  
Conservation  
Capital Fund

If TCDSB runs new schools at 176 EUI		Savings/Premiums Year over Year New GFA vs Vacated GFA										
		2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	Total
Utility Escalation excluded	0%											
1 St Andre Catholic School (2019)		\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0
2 St Raymond/ St Bruno		\$57,388	\$57,388	\$57,388	\$57,388	\$57,388	\$57,388	\$57,388	\$57,388	\$57,388	\$57,388	\$573,875
3 St Leo			-\$5,991	-\$5,991	-\$5,991	-\$5,991	-\$5,991	-\$5,991	-\$5,991	-\$5,991	-\$5,991	-\$53,922
4 St Matthias/Our Lady Guada/+1				\$9,552	\$9,552	\$9,552	\$9,552	\$9,552	\$9,552	\$9,552	\$9,552	\$76,413
5 St Antoine Daniel/+1					-\$1,953	-\$1,953	-\$1,953	-\$1,953	-\$1,953	-\$1,953	-\$1,953	-\$13,673
6 Holy Angels/+1					-\$9,025	-\$9,025	-\$9,025	-\$9,025	-\$9,025	-\$9,025	-\$9,025	-\$54,148
<b>Accumulated Savings</b>		<b>\$57,388</b>	<b>\$108,784</b>	<b>\$169,732</b>	<b>\$228,726</b>	<b>\$278,696</b>	<b>\$328,666</b>	<b>\$378,636</b>	<b>\$428,606</b>	<b>\$478,576</b>	<b>\$528,546</b>	<b>\$528,546</b>

A If TCDSB runs new schools at 130 EUI		Savings Year over Year (130 EUI vs 176EUI)										
		2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	Total
Utility Escalation excluded	0%											
1 St Andre		\$11,198	\$11,198	\$11,198	\$11,198	\$11,198	\$11,198	\$11,198	\$11,198	\$11,198	\$11,198	\$111,982
2 St Raymond/ St Bruno			\$9,977	\$9,977	\$9,977	\$9,977	\$9,977	\$9,977	\$9,977	\$9,977	\$9,977	\$89,789
3 St Leo			\$12,701	\$12,701	\$12,701	\$12,701	\$12,701	\$12,701	\$12,701	\$12,701	\$12,701	\$114,305
4 St Matthias/Our Lady Guada/+1				\$14,002	\$14,002	\$14,002	\$14,002	\$14,002	\$14,002	\$14,002	\$14,002	\$112,016
5 St Antoine Daniel/+1					\$13,823	\$13,823	\$13,823	\$13,823	\$13,823	\$13,823	\$13,823	\$96,764
6 Holy Angels/+1					\$15,915	\$15,915	\$15,915	\$15,915	\$15,915	\$15,915	\$15,915	\$95,488
<b>Accumulated Savings</b>		<b>\$11,198</b>	<b>\$45,073</b>	<b>\$92,951</b>	<b>\$154,651</b>	<b>\$232,267</b>	<b>\$309,882</b>	<b>\$387,497</b>	<b>\$465,113</b>	<b>\$542,728</b>	<b>\$620,343</b>	<b>\$620,343</b>

B If TCDSB runs new schools at 100 EUI		Savings Year over Year (100 EUI vs 176EUI)										
		2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	Total
Utility Escalation excluded	0%											
1 St Andre		\$16,962	\$16,962	\$16,962	\$16,962	\$16,962	\$16,962	\$16,962	\$16,962	\$16,962	\$16,962	\$169,622
2 St Raymond/ St Bruno			\$15,112	\$15,112	\$15,112	\$15,112	\$15,112	\$15,112	\$15,112	\$15,112	\$15,112	\$136,007
3 St Leo			\$19,238	\$19,238	\$19,238	\$19,238	\$19,238	\$19,238	\$19,238	\$19,238	\$19,238	\$173,138
4 St Matthias/Our Lady Guada/+1				\$20,250	\$20,250	\$20,250	\$20,250	\$20,250	\$20,250	\$20,250	\$20,250	\$162,004
5 St Antoine Daniel/+1					\$19,992	\$19,992	\$19,992	\$19,992	\$19,992	\$19,992	\$19,992	\$139,943
6 Holy Angels/+1					\$23,016	\$23,016	\$23,016	\$23,016	\$23,016	\$23,016	\$23,016	\$138,096
<b>Accumulated Savings</b>		<b>\$16,962</b>	<b>\$68,274</b>	<b>\$139,836</b>	<b>\$231,390</b>	<b>\$345,960</b>	<b>\$460,530</b>	<b>\$575,100</b>	<b>\$689,670</b>	<b>\$804,240</b>	<b>\$918,810</b>	<b>\$918,810</b>

C If TCDSB runs new schools at 75 EUI		Savings Year over Year (75 EUI vs 176EUI)										
		2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	Total
Utility Escalation excluded	0%											
1 St Andre		\$25,056	\$25,056	\$25,056	\$25,056	\$25,056	\$25,056	\$25,056	\$25,056	\$25,056	\$25,056	\$250,558
2 St Raymond/ St Bruno			\$22,322	\$22,322	\$22,322	\$22,322	\$22,322	\$22,322	\$22,322	\$22,322	\$22,322	\$200,902
3 St Leo			\$28,416	\$28,416	\$28,416	\$28,416	\$28,416	\$28,416	\$28,416	\$28,416	\$28,416	\$255,748
4 St Matthias/Our Lady Guada/+1				\$31,331	\$31,331	\$31,331	\$31,331	\$31,331	\$31,331	\$31,331	\$31,331	\$250,645
5 St Antoine Daniel/+1					\$30,930	\$30,930	\$30,930	\$30,930	\$30,930	\$30,930	\$30,930	\$216,509
6 Holy Angels/+1					\$35,609	\$35,609	\$35,609	\$35,609	\$35,609	\$35,609	\$35,609	\$213,652
<b>Accumulated Savings</b>		<b>\$25,056</b>	<b>\$100,850</b>	<b>\$207,976</b>	<b>\$346,031</b>	<b>\$519,695</b>	<b>\$693,358</b>	<b>\$867,022</b>	<b>\$1,040,686</b>	<b>\$1,214,350</b>	<b>\$1,388,013</b>	<b>\$1,388,013</b>

## Executive Summary

### 6. Responding to the financial challenge

The GTA's construction context is full of challenges for those who would try to improve energy conservation and reduce GHG emissions in buildings. Overall construction activity is as intense as anywhere in North America, which tends to inflate costs. The pressure to work quickly argues against making changes to established procedures. A dire lack of skilled trades is reported in the popular press. Because of these challenges - and the fact that the capital cost of the Net Zero case studies exceeded the 2018 Ministry of Education funding allocation by roughly 50% to 130% - the *Conserve First* report tried to imagine what a stepped approach to financing the journey to Net Zero might involve.

First, professional cost consultants estimate that upgrades to the building skin (to mimic the Net Zero case studies) would add in the order of at least 10%-12% to the capital cost of a 50,000 sf elementary school, bid in the fall of 2019. Upgrades to heating systems would be over and above these amounts. This has the potential to reduce the EUI of the school by roughly 15-25% (assuming construction-phase quality control procedures optimize the potential performance of the design). Given today's utility rates, to realize a full return on such an investment would take in the order of at least 25 years.

Next, we wondered how long it might take to save enough in fuel costs to be able to afford the cost premium to upgrade the building skin. Figure ES.08 shows the potential for the TCDSB to accrue funds from energy conservation during the next ten years, should it be able to monitor its savings and earmark funds not spent on utilities - in an "Energy Conservation Capital Fund". It seems six buildings operating for roughly 7 years may pay for building skin upgrades at one building, depending on how much the EUI is reduced. This is a very preliminary exploration, to get a sense of the orders of magnitude involved. If the concept of earmarking operating savings to top up capital funds for new construction is realizable, then the inputs and results could be refined.

### CORE OBSERVATION

## 6

*Response requested to Core Observation 6:*  
Will the Board ...

a - endorse an investment of 10% over the 2018 Ministry of Education funding formula, in a new school project during the next five years,

and

b - support further exploration of the mechanisms needed to create an Energy Conservation Capital Fund.

## Executive Summary

### 7. Defer renewable energy generation until usage is reduced

#### CORE OBSERVATION 7

Were it to embark on widespread development of power plants on school sites (to generate renewable energy from wind, solar or another source) - without changing its current patterns of use - there are at least three significant challenges that would face the TCDSB.

#### *Response requested to Core Observation 7:*

Will the Board defer the installation of equipment to generate renewable energy for at least the next 5-10 years in order to focus its efforts on energy conservation?

First, very few of the TCDSB's sites are large enough to accommodate the equipment to balance the current rate at which GHG-emitting natural gas is consumed for space heating. Lowering the rate of consumption would mean that less power generation equipment would be needed to achieve balance. One of the principal reasons why Net Zero schools operate below 75 kWhr/m<sup>2</sup>/yr (and many convert to all-electric heating systems) is to make it practical to build renewable energy generation equipment on site.

Next, looking at the whole portfolio (of roughly 200 schools), balancing the TCDSB's current rate of consumption with renewables would require a utility-scale power plant, and many hundreds of hectares of land. We imagine that the TCDSB's 2016 resolution did not anticipate entry into the electricity utility business.

Finally, a technical question is emerging about the readiness of the Ontario electricity grid for widespread generation of power from a large number of dispersed sites. This question is unanswerable at the present time, but does appear to be driving limitations in even the most advanced Net Zero standards on how much independently-generated power can be uploaded into the grid from a single site.

Once the TCDSB has several schools operating at an exemplary level (100 kWhr/m<sup>2</sup>/yr), consistently from year to year, its need for renewable energy will be much easier to estimate accurately. We think this will help it to choose wisely - where, when and how much renewable energy to generate or purchase.



## Executive Summary

### 8. Focus on heating

To achieve an exemplary or Net Zero ready level of EUI, it is essential to reduce the largest energy-consuming function - space heating. Energy use for heating represents more than 60% of all energy use in TCDSB schools. In nearly all TCDSB schools, at present, heating alone demands more than the maximum energy budget would be in a Net Zero school for all functions (such ventilation, lighting, cooling, plug-in equipment).

The advanced guidelines for Net Zero design all demand that a maximum budget be allocated for space heating energy, within the overall energy budget for a building. This is called TEDI (Thermal Energy Demand Intensity), and is referenced in the City of Toronto's *Zero Emissions Buildings Framework*, the CaGBC's *Zero Carbon Building Standard* and *Passive House Canada's* guidelines.

As for cooling, air-conditioned TCDSB schools today use noticeably more electricity than their non-air-conditioned counterparts. However, cooling has been achieved at schools with an otherwise very low overall EUI. Cooling remains a concern because the number of days requiring cooling in Toronto is predicted to increase, over the long term future.

A change of course, toward Net Zero, for the TCDSB would, therefore involve:

- explicit goals for the reduction of heating energy (TEDI) alongside goals for overall energy use (EUI) (ND7), and
- further design input to determine the most energy-efficient means to achieve comfort in schools on hot and humid Toronto days (ND8).

### CORE OBSERVATION 8

*Response requested to Core Observation 8:*

Will the Board ...

a-endorse the adoption of an “energy budget” approach for space heating energy (TEDI) and for overall energy use intensity (EUI), and

b-support a continuing search for design options with respect to cooling systems.

## Executive Summary

### 9. Help everyone continue to learn about what drives energy use

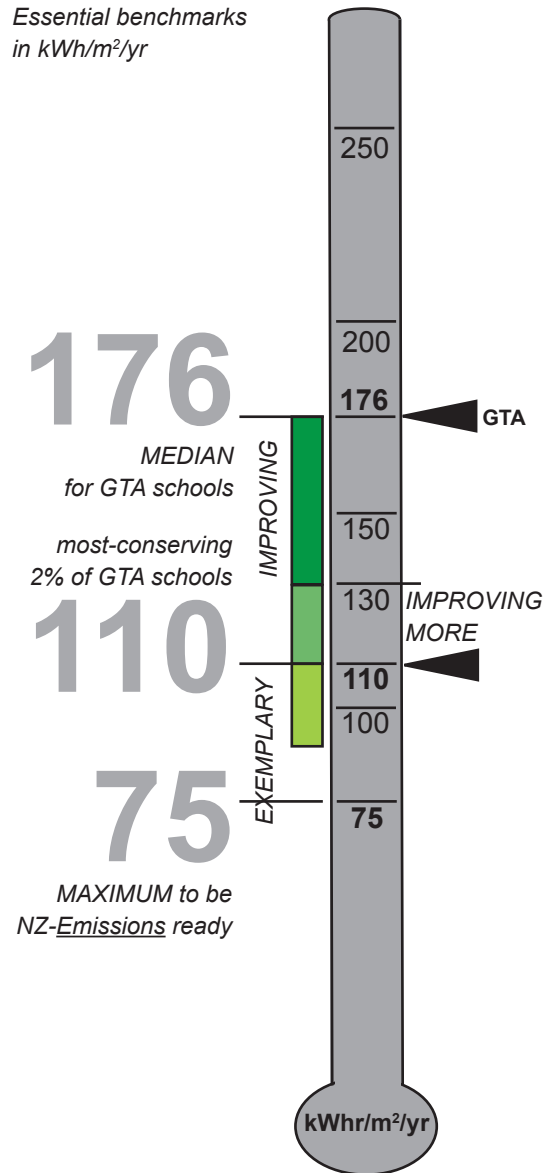
As both the target and actual EUI figures for TCDSB schools become known - to students, parents, teachers, staff, consulting architects and engineers, and trustees - everyone will be acquiring the foundation of energy literacy. The person who compares real-life numbers from the fuel bills of his or her school to the benchmarks in Figure ES.09 learns whether the school is “improving” (relative to the GTA median school), “improving more” (than other schools) or “exemplary” (in the top 2% of GTA schools).<sup>\*</sup> This creation of meaning in context is an essential to making the daily decisions necessary to achieve an “exemplary” level of conservation or to reaching toward Net Zero.

To build on the literacy foundation described above, certain commonly-held perceptions may need to be unlearned. The degree to which a TCDSB building’s age, size, and location influence energy use intensity have been clarified by the benchmarking exercise in the *Conserve First* report.

First, age of building does not seem to matter. There has been no consistent trajectory, over time, towards energy conservation. While today’s Ontario Building Code and Toronto Green Standard demand energy-conservation measures be incorporated in every design, they stop short of demanding that buildings in fact reach verifiable levels of energy use intensity. Also, energy use for equipment is on the rise. Therefore, newer schools in the TCDSB portfolio are not necessarily more energy-conserving than older schools. (The oldest 16 schools in the TCDSB portfolio operate at roughly 200 kWh/m<sup>2</sup>/yr, while the newest 16 operate at roughly 187 kWh/m<sup>2</sup>/yr. Even the six elementary schools constructed between 2012 and 2015 exhibit a notable range of energy use intensity, or EUI). We expect this is due to a combination of design and lifestyle factors. For designers and

<sup>\*</sup>The top 2% represented here was established by the data for the school year that ended in August 2015. It will change with the passing of time; in what direction and how much should be analyzed in the future.

Figure ES.09  
Essential benchmarks  
in kWh/m<sup>2</sup>/yr





## Executive Summary

occupants alike, this fact may serve as a caution against “*complacency and cheerful recklessness*”, to use the words in the 2015 *Laudato Si*’.

The overall size (floor area) of a building does matter - in elementary schools - even when designing to meet today’s advancing codes. Secondary schools are more consistent than elementary schools in both EUI and in size. Smaller elementary schools in the TCDSB portfolio tend to have a relatively high EUI, which also varies more, year-to-year, than the EUI of their larger counterparts.

Location does not seem to matter. No ward can lay claim to significantly better performance than another. While some wards use both more gas and more electricity per unit of floor area than others, every ward has schools that conserve and schools that consume much more than others.

To help change course, we suggest:

- Analysis of design components and testing of the air tightness of the building enclosures of the most and least energy-intensive schools (we think a more significant factor than building age). (ND4)
- Development of special (more stringent) building-enclosure standards for both the renewal and new construction of schools with a floor area of less than 30,000 sf - to help keep the heat in. (ND5)
- A Pilot program in one or two select wards to determine how much conservation can be effected when students and teachers work together (aided by environmental education programmers as well as operations and facilities services staff) toward explicit EUI goals. (ND6)

## CORE OBSERVATION 9 continued

*Response requested to Core Observation 9:*

Will the Board endorse one, two or all of initiatives ND4, ND5 and ND6?

## Executive Summary

### 10. Further study

#### CORE OBSERVATION 10

Several new questions surfaced during the research. The following lie outside the consulting mandate that commissioned the *Conserve First* report, but are suggested for consideration by the TCDSB, as it moves forward. They are listed in descending order of priority and are more thoroughly described in Part 1 of the report.

*Response requested  
to Core Observation 10:*

Will the Board endorse one, two or all of the further studies AQ1.1, AQ1.2, AQ.13, AQ1.4 and/or AQ1.5?

Why do the Phase 2 schools perform so differently? (AQ1.1)

- method: air-tightness tests in all six schools, plus follow-up analysis
- outcome: prioritize quality-control measures in new schools

What is the EUI and TEDI of each Ward per student? (AQ1.2)

- method: more detailed calculations, taking student population into account
- outcome: local targets for any Ward embarking on a Pilot program

Compare the 20 highest-EUI and 20 lowest-EUI elementary schools. (AQ1.3)

- method: review of designs, using the 24 diagnostic points used in Part 4
- outcome: identify productive opportunities to upgrade the building skin

Where are the highest-potential opportunities to test the concept of Net Zero Emissions readiness? (AQ1.4)

- method: planning exercise, involving mapping of various factors
- outcome: identify school sites that have a concentration of factors

Why do many of the air-conditioned elementary schools seems to use less gas for heating than their non-air-conditioned counterparts? (AQ1.5)

- method: field visits, review of documents, query staff
- outcome: predict the impact on EUI of introducing air-conditioning

## Executive Summary

### Contained in the *Conserve First* report

The Introduction, “What would “Net Zero” mean for the TCDSB?” defines:

- Net Zero Emissions readiness
- Energy Use Intensity (EUI) and
- Thermal Energy Demand Intensity (TEDI).

Parts 1 through 5 then each contain a single introductory page (which describes the theme of the material to come) and a chapter summary (which tables observations, options and recommendations). Some readers may choose to focus on just the introductory and summary pages within each Part. Illustrations and detailed analysis will be found in the body of each Part.

**Part 1, “Starting Position and Guiding Principles”** benchmarks the school buildings in the TCDSB’s portfolio and analyzes factors that are influencing energy use in them. The analysis suggested 12 New Directions that are critical to the pursuit of either Net Zero or an exemplary level of energy conservation, (beginning with those already identified in Core Observation 1):

- Lower the EUI in all schools in the whole portfolio. (ND1)
- Narrow the overall range of EUI in the portfolio. (ND2)
- Gain far greater control of energy use, across the portfolio. (ND3)

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- Verify whether heat loss through the building enclosure is the main reason why some schools use so much more energy for heating than others. (ND4)
- Develop specific solutions for small elementary schools. (ND5)
- Use the existing framework of wards to stimulate energy-conservation initiatives. (ND6)
- Set TEDI (heating energy) goals as well as EUI (overall energy use) goals. (ND7)
- Challenge designers to find the most energy-efficient means of cooling. (ND8)
- Encourage experienced EcoSchools to realize measurable effects. (ND9)
- Keep everyone aware of energy conservation all year. (ND10)
- Lower the EUI and TEDI of the median (middle-of-the-pack) TCDSB school. (ND11)
- Couple a normal rate of replacement with an aggressive approach to renewal. Sustain both programs for the next 30 years. (ND12)

Part 1 makes the following observations about renewable energy:

- For a school to balance its annual usage by generating power on site, it must consume much less energy than is typical today. (R1)

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- R2 Building (or buying) renewable energy costs less when energy is conserved first. (R2)
- R3 The Ontario electricity grid may not yet be ready for widespread two-way traffic. (R3)

Part 1 also discusses the reasons why some items are suggested for Further Study (listed above under Core Observation 10).

Finally, Part 1 contains a slightly extended discussion of the three guiding principles taken from the 2015 *Laudato Si'* (listed above in Core Observation 5), namely:

- Cautions against partial solutions, in favour of an “integral ecology” (GP1),
- Cautions against harmful habits, in favour of a new notion of growth (GP2), and
- Cautions against a “superficial ecology”, in favour of the poor (GP3).

**Part 2, “Regulations, Standards, and Conservation culture”** looks at the extent to which local laws encourage energy conservation in buildings, and at the potential in elective guidelines to realize Net Zero buildings. Also, it summarizes how some school boards in Ontario have made it onto the “ten most energy-conserving” list. Part 2 observes:

- Merely meeting today’s regulations will not create Net Zero ready schools. (2.1)

## Executive Summary

- Tomorrow's regulations may result in buildings that approach Net Zero readiness. (2.2)
- Selected strategies from voluntary programs may help the TCDSB progress. (2.3)
- A “conservation culture” is essential. (2.4)

Part 2 tables a number of options for the TCDSB to consider, as it develops future programs in detail. Listed in no implied order, these include:

*Option A.* Comply with all elements of the Toronto Green Standard, version 3, Tier 2 (as City of Toronto buildings are committed to do).

*Option B.* Apply new protocols to capital (and perhaps renewal) projects, including EUI targets, quality control and feedback loops.

*Option C.* Develop step goals (EUI and TEDI targets) to mirror the City of Toronto's *Zero Emissions Buildings Framework* (see Core Observation 4), and discuss with City Planning how else to work together (e.g. negotiate relief from project constraints, share plans for district energy zones, share in the development of criteria for procurement of renewably-generated electricity).

*Option D.* Certify a new school under the CaGBC's *Zero Carbon Buildings Standard*.

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*Option E.* Commission, as part of the initial design of a new school, a transition plan to switch heating systems to non-GHG emitting sources after the service life of gas-fired systems is over.

*Option F.* Establish step goals for every building in the portfolio, in the manner of REALPac’s “20 by ‘15” program.

*Option G.* Develop an internal “Net Zero Challenge” to celebrate each year’s most energy-conserving schools (using the evidence of fuel bills).

*Option H.* Apply Passive House Canada criteria to the design and construction of a new elementary school.

The summary to Part 2 indicates that Options B and H have good potential and are immediately adoptable, and that Options C, E, F and G also offer good potential, but would need to be tailored to the TCDSB’s needs. We recommend all of these options be carefully considered further by the TCDSB, as it develops its programs in detail.

**Part 3, “Cold-climate “Net Zero” schools: the few and the new”** features eight Net Zero case studies. It looks at the motivations behind the projects, and at partnerships that made the projects possible.

The designs are immensely inspiring, because they address a range of social issues while also achieving an exemplary level of energy-conservation. However, the case studies also highlight hurdles that had to be faced before and long after construction. We strongly urge the TCDSB to dispatch representatives to visit the case study buildings in person, to talk with people who occupy or were directly involved in these projects.

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As preparation for such visits, Part 3 makes the following observations:

- Net Zero schools are, so far, very rare. (3.1)
- The TCDSB operates in a very challenging construction context. (3.2)
- Technical expertise is essential, but insufficient on its own. (3.3)
- Ideas expressed in the 2015 *Laudato Si'* are evident in Net Zero schools. (3.4)

**Part 4, “An array of design strategies”** continues a comparison of the case studies featured in Part 3, in a way we hope will serve as a technical reference for Facilities Services staff, as they guide future projects.

This part of the research shows that there is no “magic bullet” to guarantee that a design will reach Net Zero readiness. Part 4 observes:

- Each cold-climate Net Zero design makes use of at least 14 strategies. (4.1)
- Strategies of three types are all used - including the selection of components, arrangements in the design and construction quality control procedures. (4.2)
- Both enclosure and equipment are high performance in Net Zero design. (4.3)
- Net Zero designs arrange high-performance components carefully. (4.4)
- Net Zero designs involve pro-active airtightness testing. (4.5)



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**Part 5, “Financing the transition toward Net Zero readiness”** looks at the potential relationship between capital cost premiums and operating cost savings in a Net Zero school. It demonstrates as follows:

- The capital cost of the Net Zero case studies ranged from 50% to 130% more than the 2018 Ministry of Education funding allocation. (5.2)
- To add only the enclosure upgrades seen in the Net Zero case studies (setting aside changes to indoor climate control systems and construction of renewable energy generation equipment) would add in the order of at least 10%-12% to the cost of a typical recent TCDSB design, perhaps more. (5.3)
- The payback on item 5.2 from operating cost savings would likely be in the order of magnitude of at least 25 years. (5.3)
- An Energy Conservation Capital Fund, should it be possible to create one, may have the potential to generate the funds to upgrade the building skin of a limited number of new schools. (5.4)

We hope the *Conserve First* report helps readers better visualize the contours of the road ahead. The journey toward Net Zero will demand that careful choices, small and large, be made by many participants, over a period of decades, toward a shared goal. We hope that the specific initiatives the research has identified will prove useful, as the TCDSB moves into its next phase.



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