SUSTAINABLE SCHOOLS
Saving our energy for education

August 26, 2026

Can air-to-water heat pumps be a practical pathway to decarbonization for K-12 schools?

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Participant instructions

- Use the Q&A option for questions related to the content
- Questions may be answered during the webinar, otherwise in a Q&A document after the event
- Reserve the chat for technology questions

Today’s team

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Land acknowledgment

We acknowledge with respect the ancestral and unceded territory of the Inuit, Métis, and First Nations people that share these lands with us. This is a virtual meeting with attendees from across Canada on the traditional lands of many indigenous peoples. I am speaking from Toronto which is the traditional home of the Huron-Wendat, Haudenosaunee, Anishinaabe, and the Mississaugas of the Credit River, and governed by Treaty 13 with the Mississaugas of the Credit River. It is our hope that the work we do together today contributes meaningfully to our collective responsibility as stewards of the environment.

Agenda

1. Context:
    i. Navigating the energy transition
    ii. Four pillars for decarbonization
    iii. Previous air source heat pump (ASHP) rooftop unit (RTU) research
2. ASHP boiler application (heating, cooling)
    i. Strengths and weaknesses
3. Not the answer we were looking for:
    i. Research methodology
    ii. The economic case
    iii. Examining primary variables
4. Future scenario analysis
5. Grants and incentives
6. Recommendations
7. Audience poll and Q&A

Navigating the energy transition

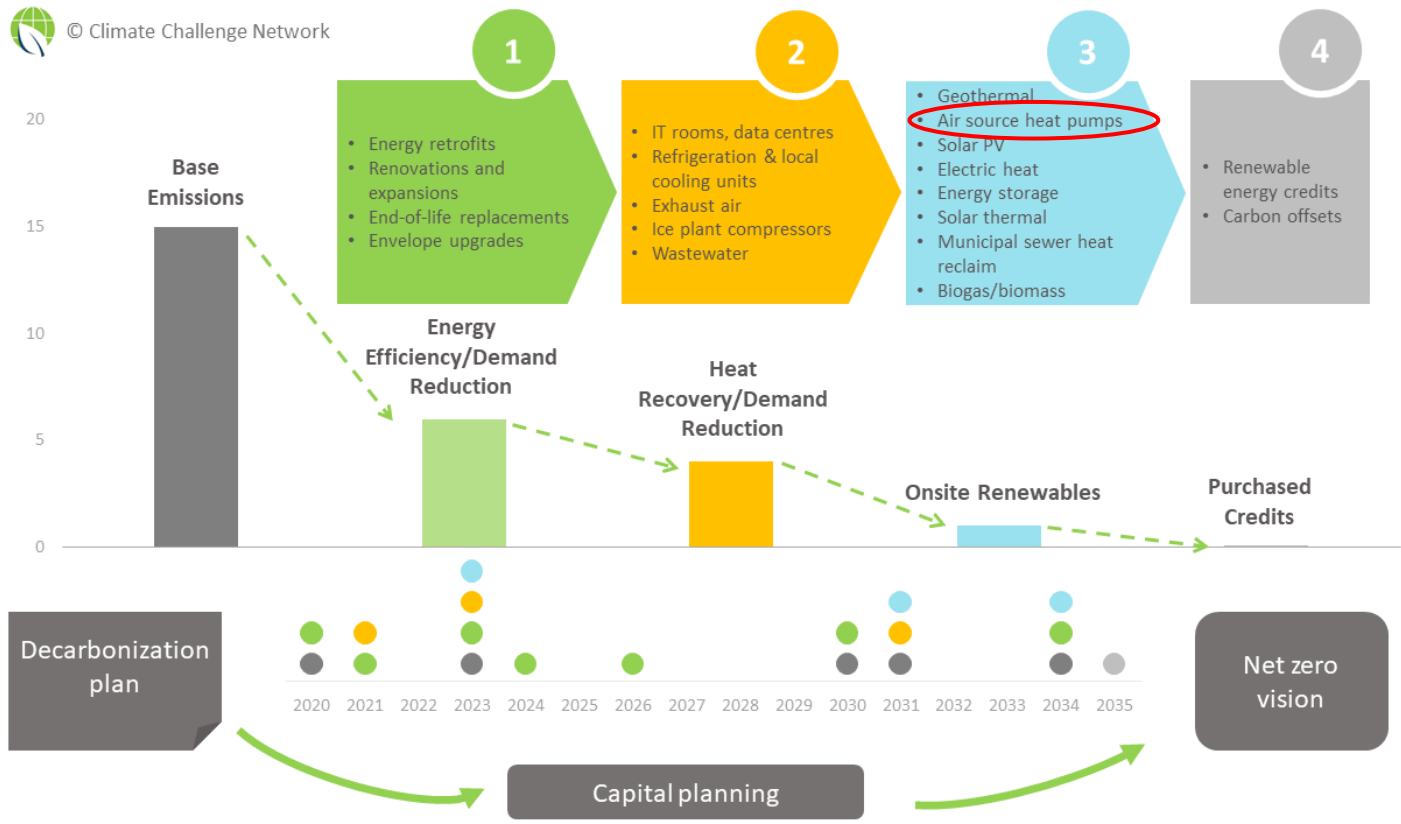
Complexity, uncertainty and risk:

1. International commitments to net zero greenhouse gas emissions by 2050, interim 2030 targets
2. Reduction/elimination of fossil fuel combustion
3. Electrification – heat pumps, storage, EVs
4. 65% - 75% growth in Ontario's electricity demand by 2050 (42,000MW to 88,000MW after 2030)
    1. $1,000 (gas turbine) to $25,000 (SMR) per kW for new generation
    2. Additional transmission, distribution and buildings' infrastructure
5. Sharp increases in natural gas system charges due to reduced demand
6. Sharp increases in electricity prices due to increased demand
7. Uncertain government policy and regulatory responses over time

Four pillars of decarbonization

4-steps to decarbonization – reducing peak electrical, heating and cooling demand lowers capital cost, system complexity and operational risk:

1. Energy efficiency first – HVAC, lighting and envelope operations and retrofits
2. Exhaust air and process heat recovery
3. On-site renewables
4. Renewable energy credits and carbon offsets

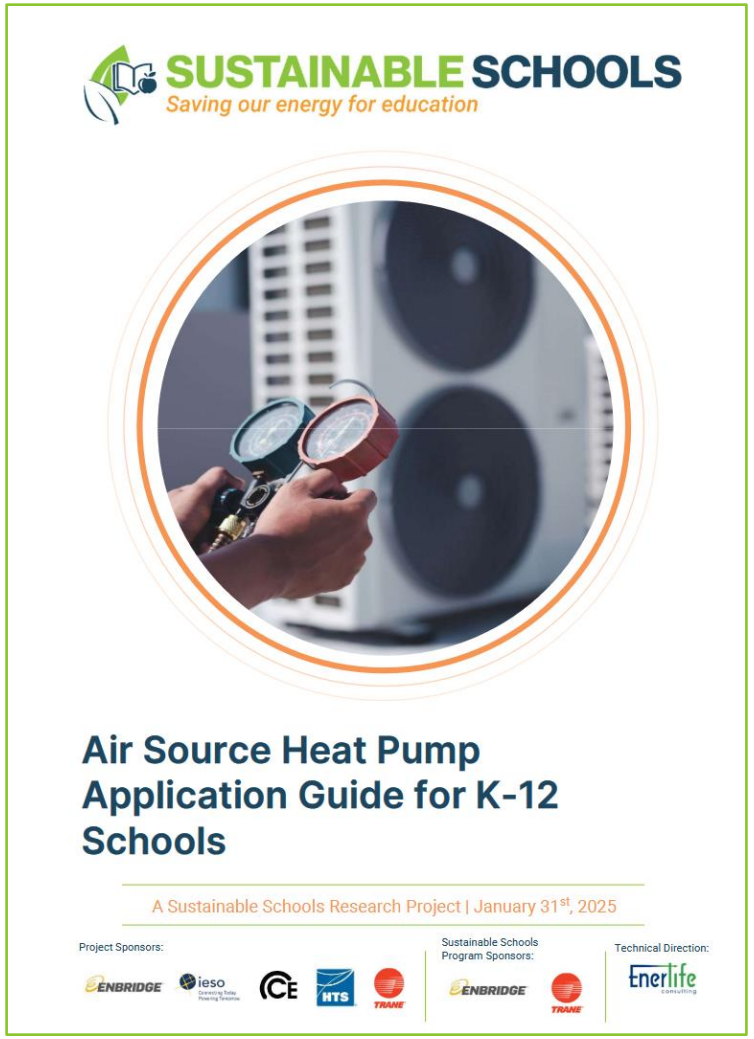


Revisiting previous ASHP research

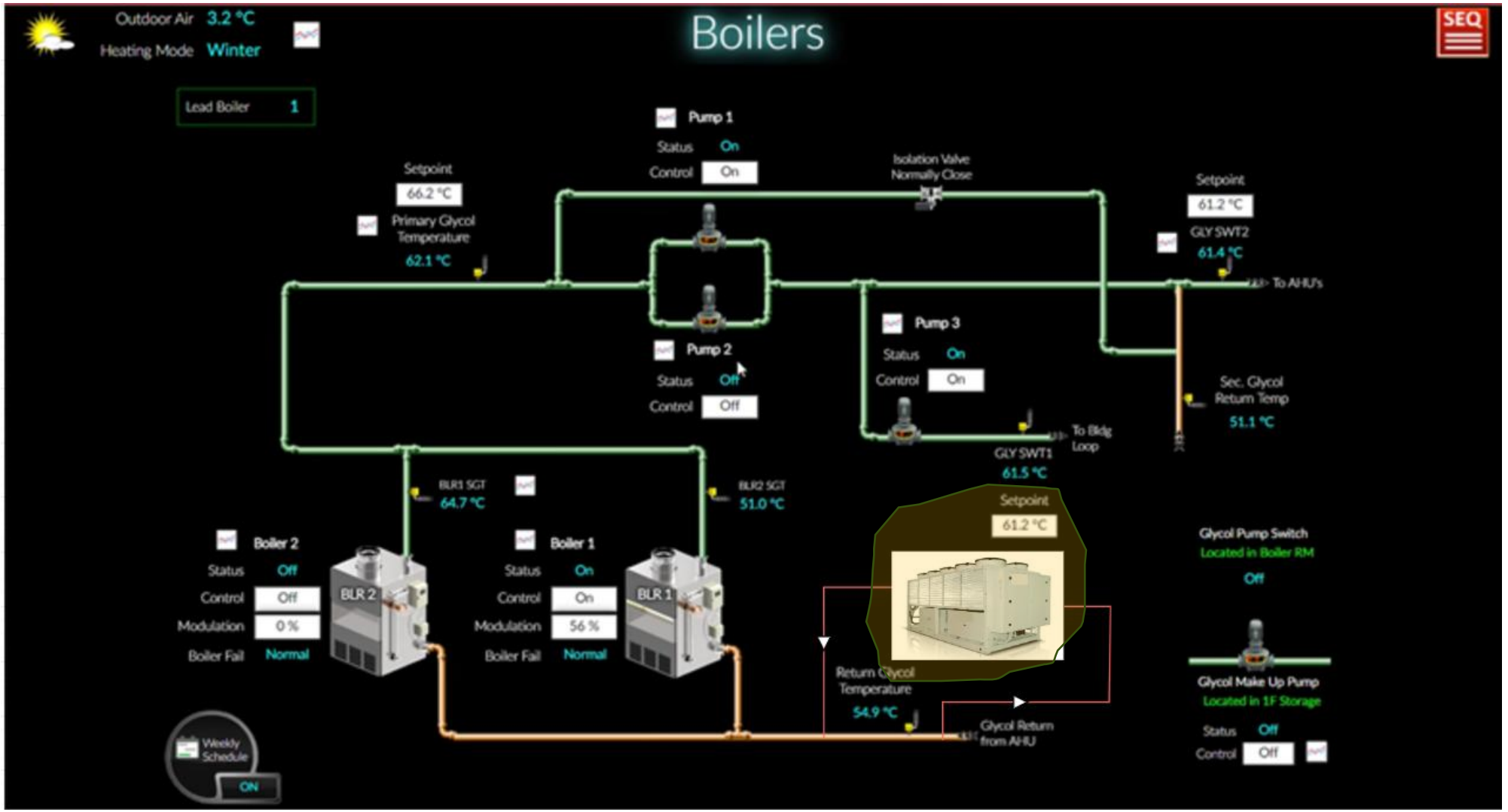
Recommendation to procure ASHP (air to air) equipment rather than conventional RTUs.

Involves 5-10% additional cost which is recovered well within the equipment lifetime. This electrification strategy positions the board to better manage the uncertainties of the energy transition (future-proofing).

- Hybrid heating systems (heat pumps with supplementary/backup gas)
- Energy efficiency first: setbacks, scheduling, and outside air (OA) controls reduce energy and emissions, lower peak heating and electrical demand, and enable extended ASHP operation
- Heat recovery next: energy recovery on exhaust systems (enthalpy wheels, crossflow PHEX, runaround loops), further reduces peak heating demand and energy use

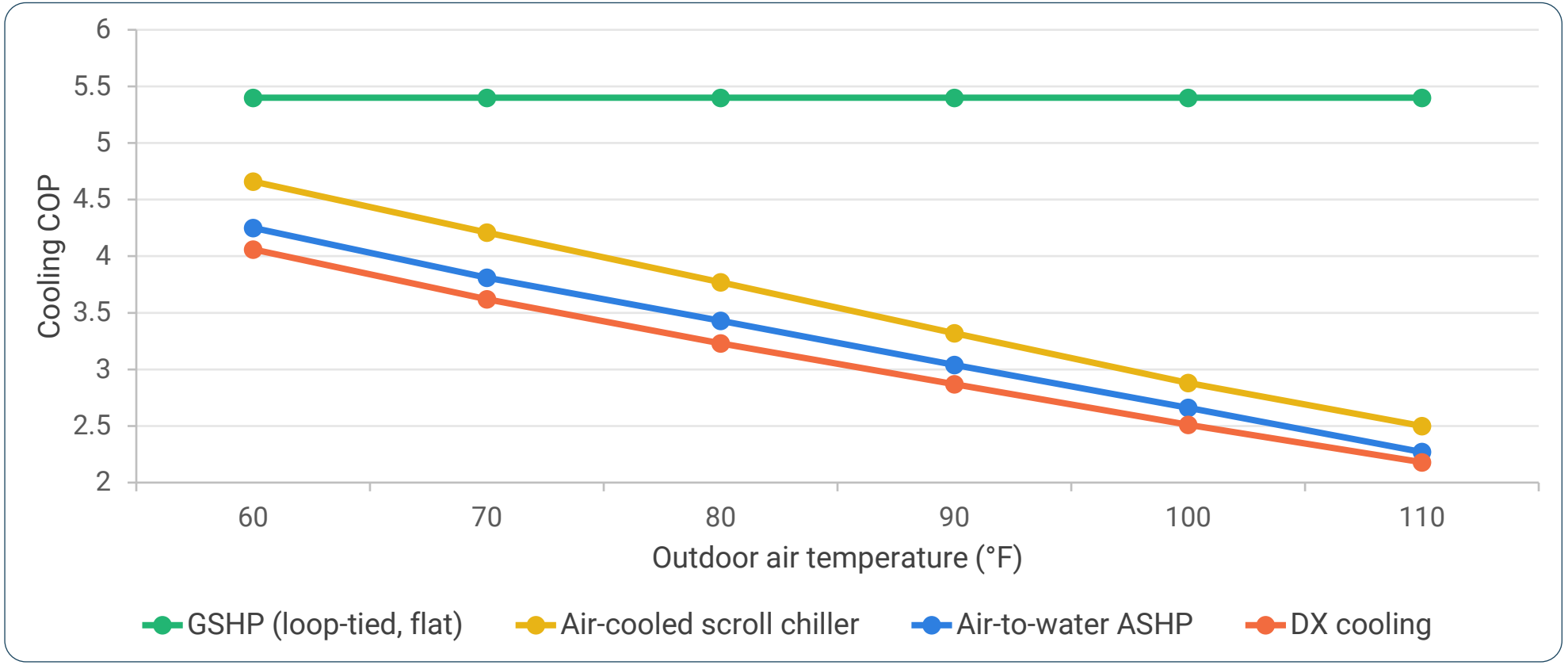


ASHP boiler applications



Cooling coefficient of performance (COP) vs outdoor air temperature (OAT)

Representative full-load curves by system type (illustrative, not vendor-specific).



Strengths and weaknesses

Strengths

1. Displacing a high proportion of fossil fuel combustion
2. Can also generate chilled water with higher COP than DX systems
3. Gaining experience with heat pump technology

Weaknesses

1. Loss of capacity and efficiency at low ambient temperatures:
    - Backup heating plant required for high heating demand operation
    - Little reduction to peak heating demand
2. High installed cost, may require electrical upgrade
3. New technology for operations staff and service contractors

Not the answer we were looking for

The economic case

Heating only

Base case
Condensing boiler

$500,000

With ASHP
ASHP boiler — optimum size

$630,000

Added utility cost vs. base case ($/year)

Unconstrained		**+ $6,704**
Demand-constrained		**+ $3,308**
Cost-constrained	*no penalty*	**$0**

Heating + cooling

Base case
Condensing boiler + scroll chiller

$770,000
$500,000 + $270,000

With ASHP
ASHP boiler / chiller — sized for cooling

$1,085,000

Added utility cost vs. base case ($/year)*

Unconstrained		**+ $12,528**
Demand-constrained		**+ $3,987**
Cost-constrained	*no penalty*	**$0**

Cost-constrained operation avoids the utility cost penalty in both cases, but severely reduces operation and emissions reductions

- *No savings assumed for ASHP operating as a chiller*
- *Cost of upgrading the electricity infrastructure for additional demand is not included*

8,760-hour optimization model (primary variables)

Baseline:

- Day type, occupied/unoccupied
- Outdoor air temperature
- Electricity, gas demand
- ***Hourly electricity, gas, carbon prices (input)***
- Annual electricity, gas, carbon costs

Energy efficiency (target):

- Electricity, gas demand
- Electricity, gas, utility cost, emissions impacts

Exhaust air heat recovery:

- Heat recovered, net gas demand
- Electricity demand
- Electricity, gas, utility cost, emissions impacts

ASHP:

- Percent load
- ***COP (input ~ OAT)***
- Heat output
- Electricity demand
- Optimal sizing

Operating modes (unconstrained, demand/cost constrained):

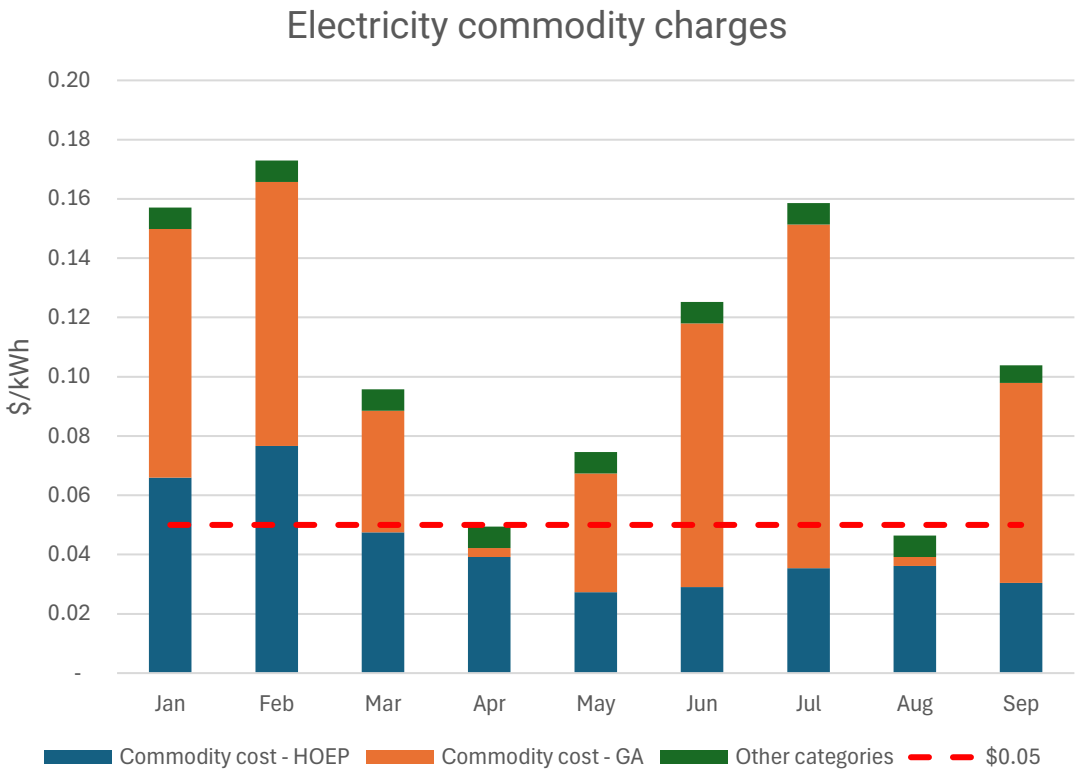
- ASHP operating hours
- Net electricity, gas demand
- Electricity, gas, utility cost, emissions impacts

ASHP modes of operation

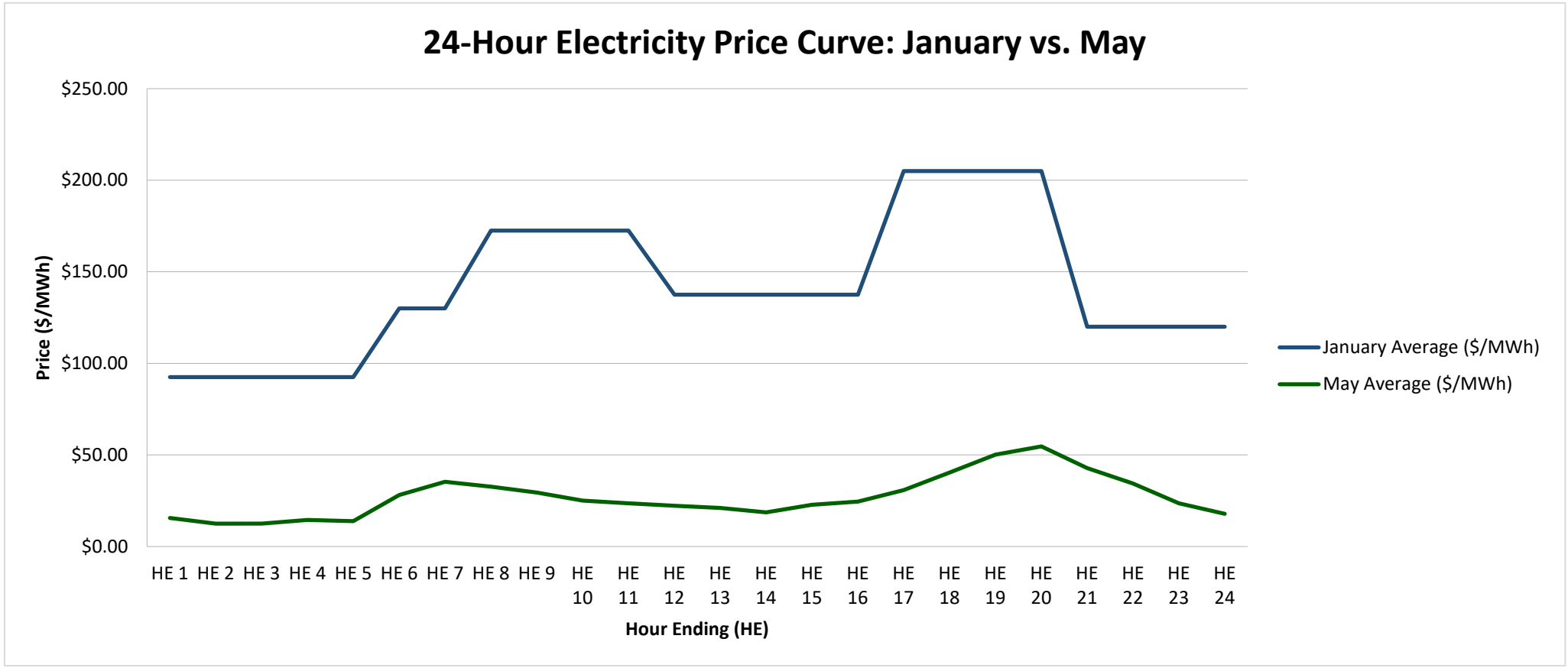
- Unconstrained – no demand or cost limitations
  - ASHP runs whenever there is **heating demand**
- Demand-constrained
  - ASHP operation limited to the **baseline monthly peak** demand to avoid:
    - Additional electrical demand charges
    - Internal electrical upgrades
- Cost-constrained
  - ASHP operates only when **hourly heat cost** is equal to or lower than for natural gas

Electricity rates (hourly based)

- Commodity charges (2/3 of the bill):
  - HOEP – Replaced by OEMP (Ontario Price) since May 2025
  - GA – Global adjustment
- Distribution charges (includes demand charges)
- Transmission charges (includes demand charges)
- Regulatory charges



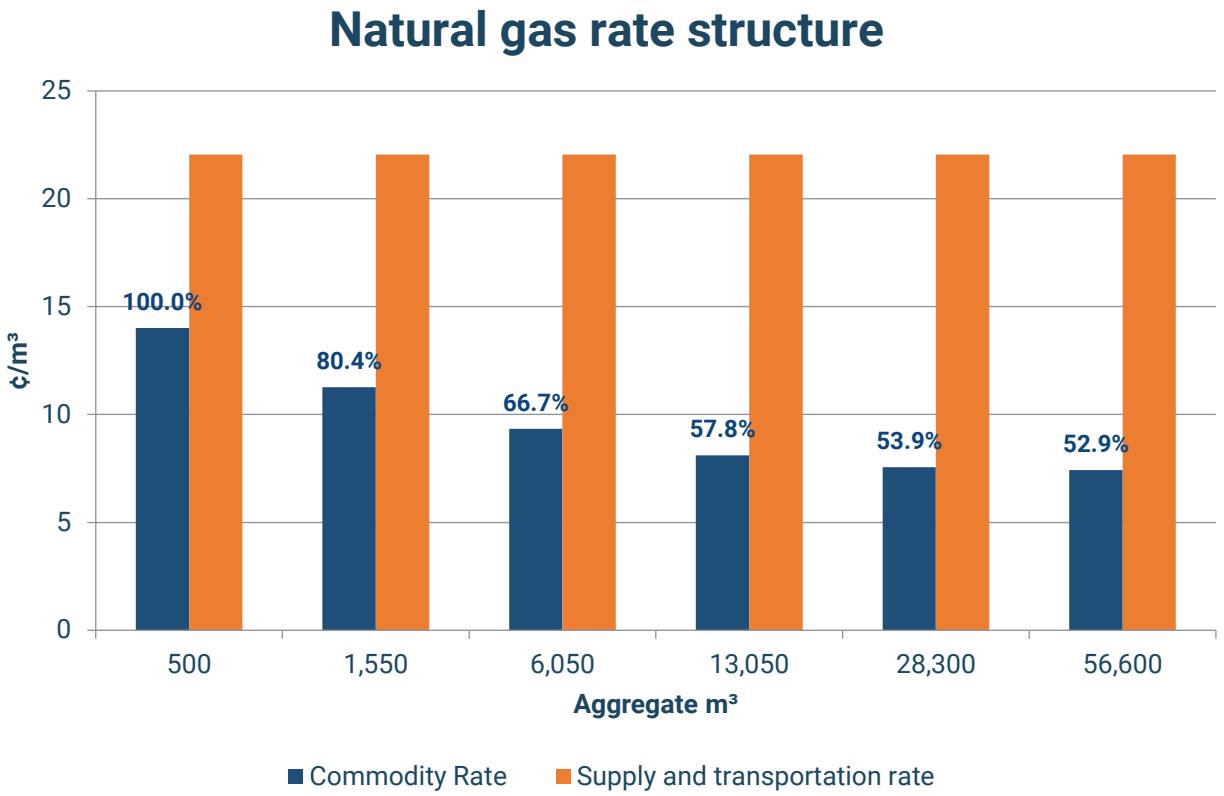
Ontario zonal (hourly) price (OZP)



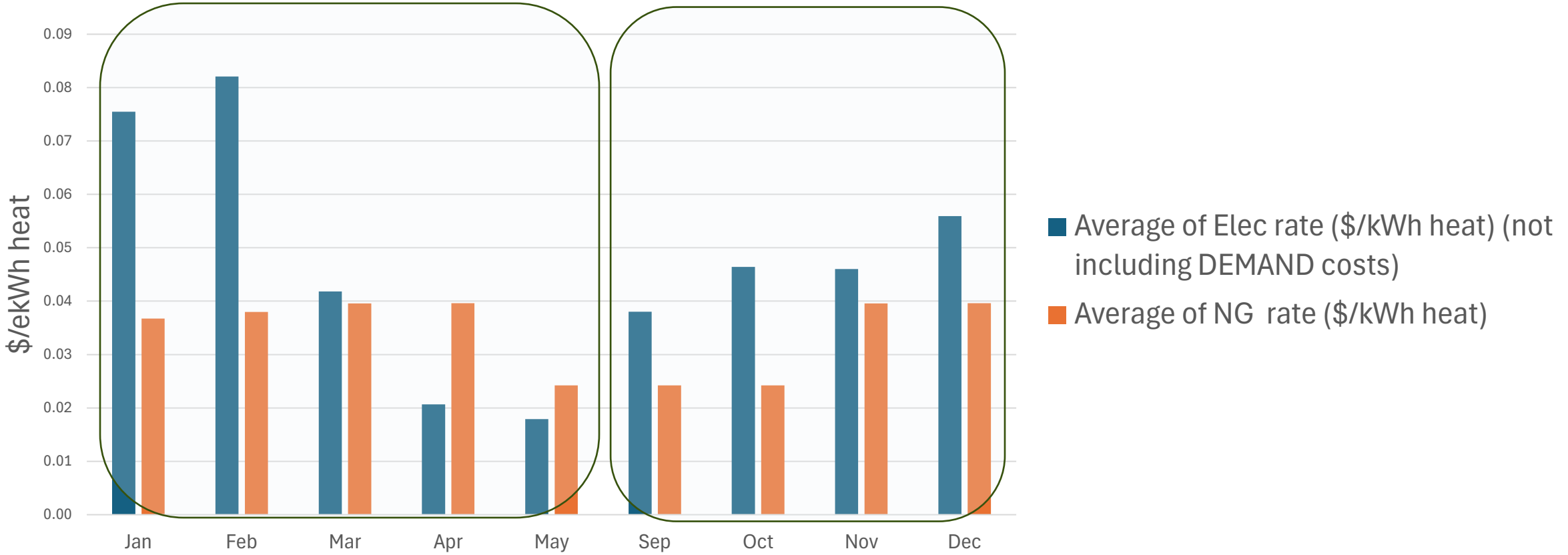
Values are proxy data (based on 2026 averages). May values are published IESO hourly data (3-day average, May 28–30, 2026)

Natural gas monthly rates (tiered)

Tiered use (m³)					
Tier	**Cap**	**Rate**	**Unit**	**Rate**	**Unit**
First	500	14.0142	¢/m³	1.3540	¢/ekWh
Second	1,050	11.2662	¢/m³	1.0885	¢/ekWh
Third	4,500	9.3418	¢/m³	0.9026	¢/ekWh
Fourth	7,000	8.1055	¢/m³	0.7831	¢/ekWh
Fifth	15,250	7.5561	¢/m³	0.7301	¢/ekWh
Sixth	28,300	7.4182	¢/m³	0.7167	¢/ekWh
	Supply and transportation	22.054	¢/m³	2.1308	¢/ekWh
	Customer Charge	85.77	$		



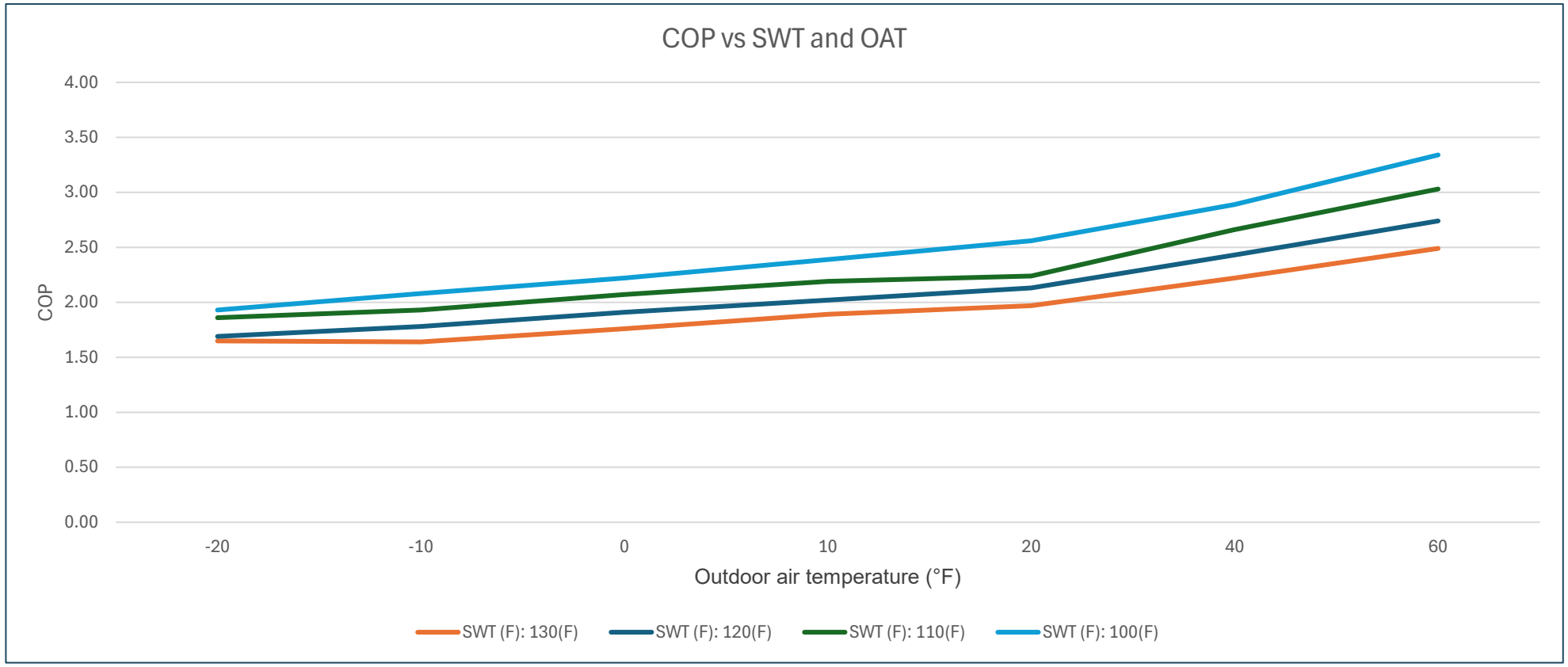
Heat cost by ASHP (electricity) vs. natural gas
Heating season



This chart is generated based on:

- Hourly electricity rates
- Tiered natural gas rates (natural gas profile of TDSB case study)
- Hourly COP of the heat pump
- Boiler efficiency of 88%

COP vs supply water temperature (SWT)



ASHP boiler – cost per tonne CO_2e

1. ASHP boilers are **add-on to gas boilers**
2. For cases with no central cooling, optimal size based on case study around 10-20% of peak heating demand (for TDSB case: Cost of 300 MBH (88 kW) @ 47°F unit is around **$130,000** installed)
3. Gas-fired condensing boiler plant around **$500,000** (installed)

Scenarios	Greenhouse gas (GHG) emissions offset (tCO_2e)	Capital cost impact ($/$tCO_2e$)	Additional utility cost impact ($/$tCO_2e$/year)
Unconstrained ASHP boiler	52	$2,381	$128
Demand-constrained ASHP boiler	44	$2,819	$75
Cost-constrained ASHP boiler	8	$14,812	$0
Demand-constrained ASHP boiler (with Carbon Pricing)	44	$2,819	$0

Case studies

School Board	TDSB	YCDSB
School	**Roselands PS**	**St. Margaret Mary CES**
School type	Public elementary (JK-8)	Public elementary (JK-8)
Gross floor area	46,592 sf	49,622 sf
Standard operating hours	School day: 6:00 am – 6:00 pm	School day: 6:00 am – 6:00 pm
Heating type	Natural gas (boiler)	Natural gas (boiler + gas rooftop unit)
Cooling	All of school area	Part of school area
Year of energy data	September 2024 – August 2025	October 2024 – September 2025
Boiler capacity	3 x 1,100 MBH (1 redundant) Net output (1,760 MBH)	2 x 2,325 MBH (1 redundant) Net output (1,951 MBH)
Actual peak heating load (2024-2025 data)	1,365 MBH	2,100 MBH

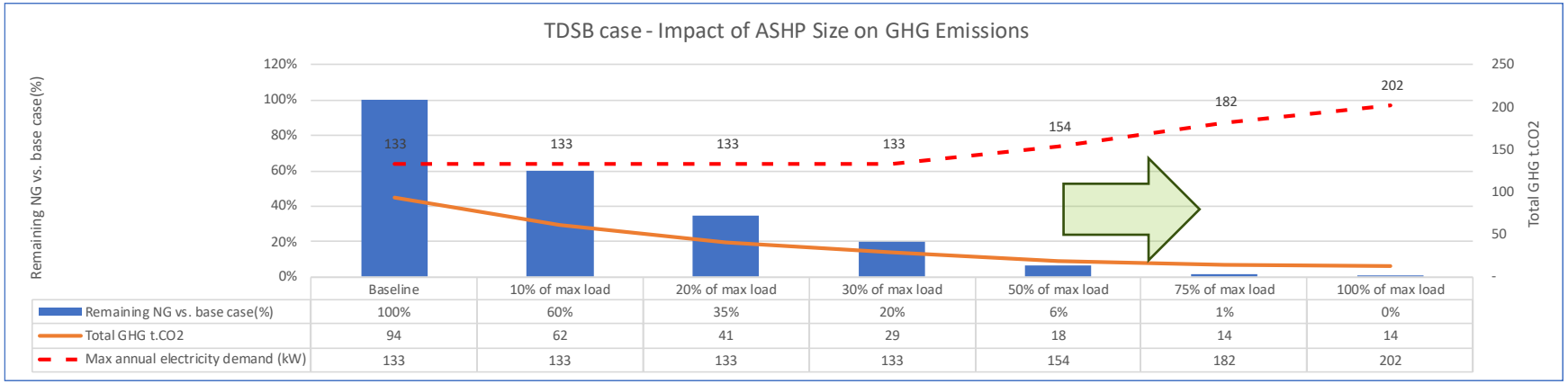
Baseline, energy efficiency and heat recovery

2024 – 2025 data

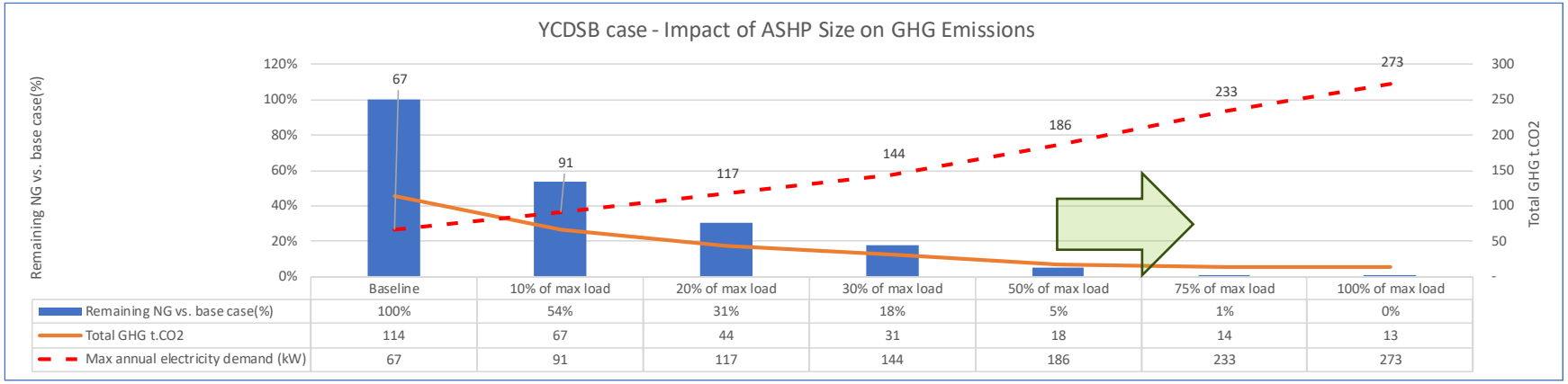
	Natural gas (m^3)		Thermal energy use intensity (EUI) (ekWh/sf)		Electricity (kWh)		Electricity EUI (kWh/sf)		Total GHG emissions (t.CO2)	
	TDSB	YCDSB	TDSB	YCDSB	TDSB	YCDSB	TDSB	YCDSB	TDSB	YCDSB
Baseline	44,443	55,513	9.9	11.6	280,902	234,111	6.0	4.7	94	114
Energy efficiency (target)	35,886	48,704	8.0	10.2	224,722	210,700	4.8	4.2	76	100
Exhaust heat recovery	26,439	38,753	5.9	8.1	224,722	210,700	4.8	4.2	58	81

Optimal ASHP sizing (heating)

Demand vs. GHG emissions



	Baseline	10% of max load	20% of max load	30% of max load	50% of max load	75% of max load	100% of max load
Remaining NG vs. base case(%)	100%	60%	35%	20%	6%	1%	0%
Total GHG t.CO2	94	62	41	29	18	14	14
Max annual electricity demand (kW)	133	133	133	133	154	182	202



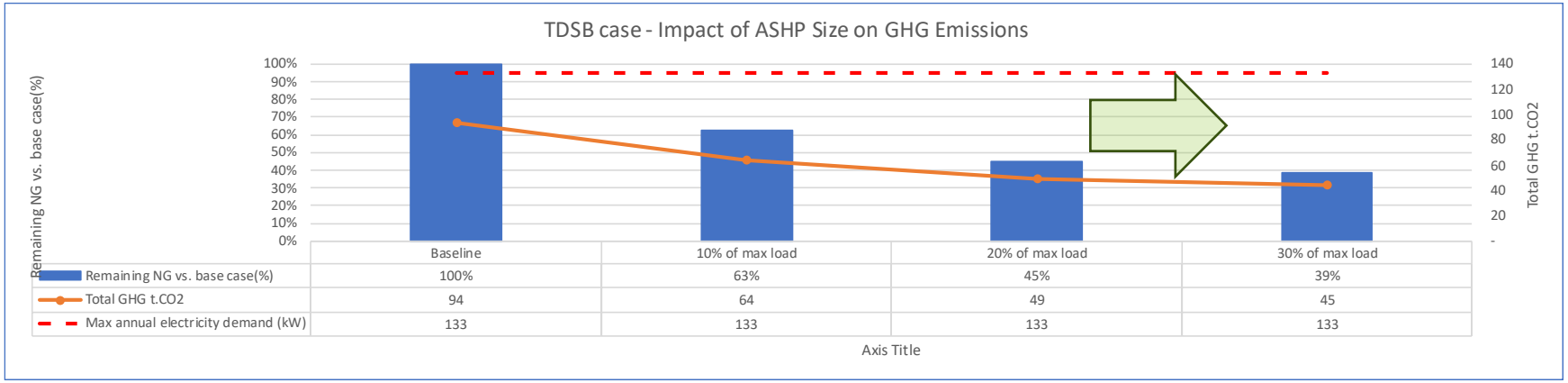
	Baseline	10% of max load	20% of max load	30% of max load	50% of max load	75% of max load	100% of max load
Remaining NG vs. base case(%)	100%	54%	31%	18%	5%	1%	0%
Total GHG t.CO2	114	67	44	31	18	14	13
Max annual electricity demand (kW)	67	91	117	144	186	233	273

- Diminishing returns with higher capacity units
- Larger units more expensive + electrical, space and infrastructure impacts

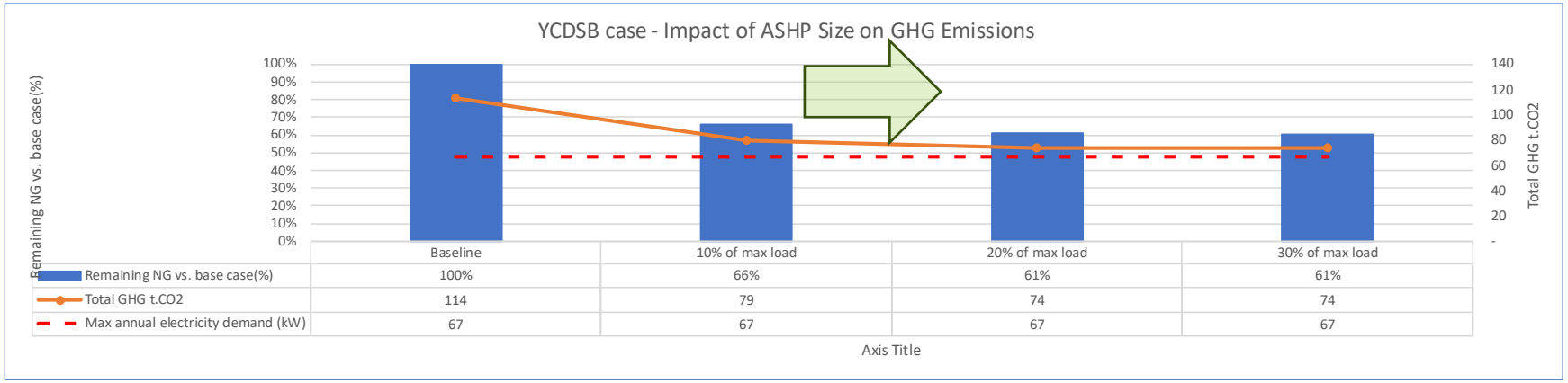
Note: Percentages represent ASHP capacity relative to the maximum hourly heating load observed during the analysis period (2024–2025)

ASHP size optimization

Demand-constrained operation



	Baseline	10% of max load	20% of max load	30% of max load
Remaining NG vs. base case(%)	100%	63%	45%	39%
Total GHG t.CO2	94	64	49	45
Max annual electricity demand (kW)	133	133	133	133



	Baseline	10% of max load	20% of max load	30% of max load
Remaining NG vs. base case(%)	100%	66%	61%	61%
Total GHG t.CO2	114	79	74	74
Max annual electricity demand (kW)	67	67	67	67

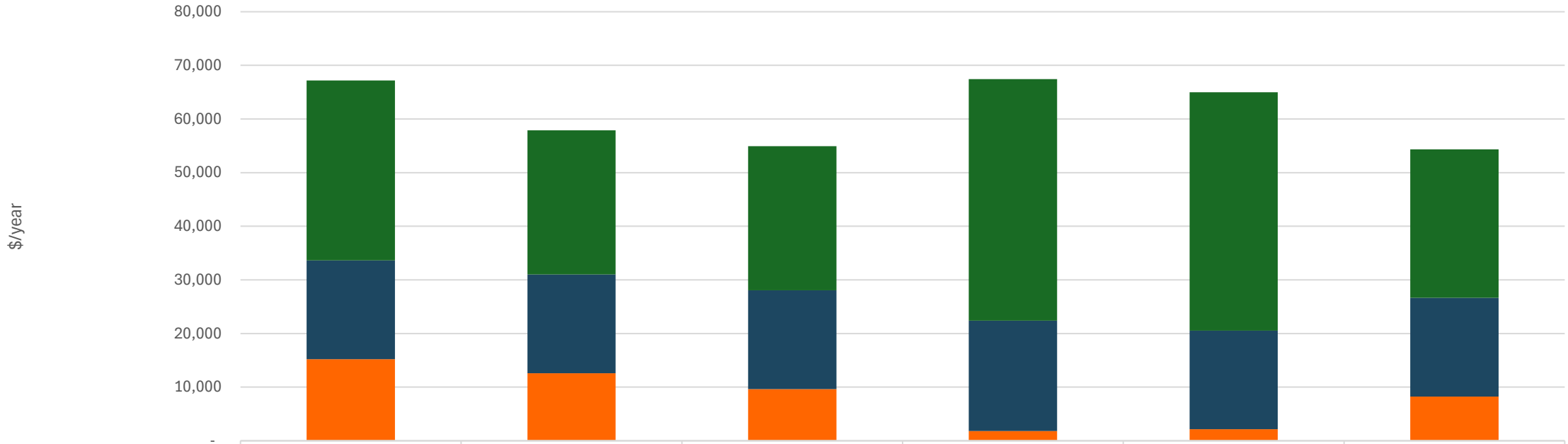
- Optimal 20% of peak heating demand within available electricity demand

- Optimal 10% of peak heating demand within available electricity demand

Note: Percentages represent ASHP capacity relative to the maximum heating load observed during the analysis period (2024–2025)

Annual utility costs – TDSB case study

Optimum ASHP size 20% of peak heating load (2024-2025 data)

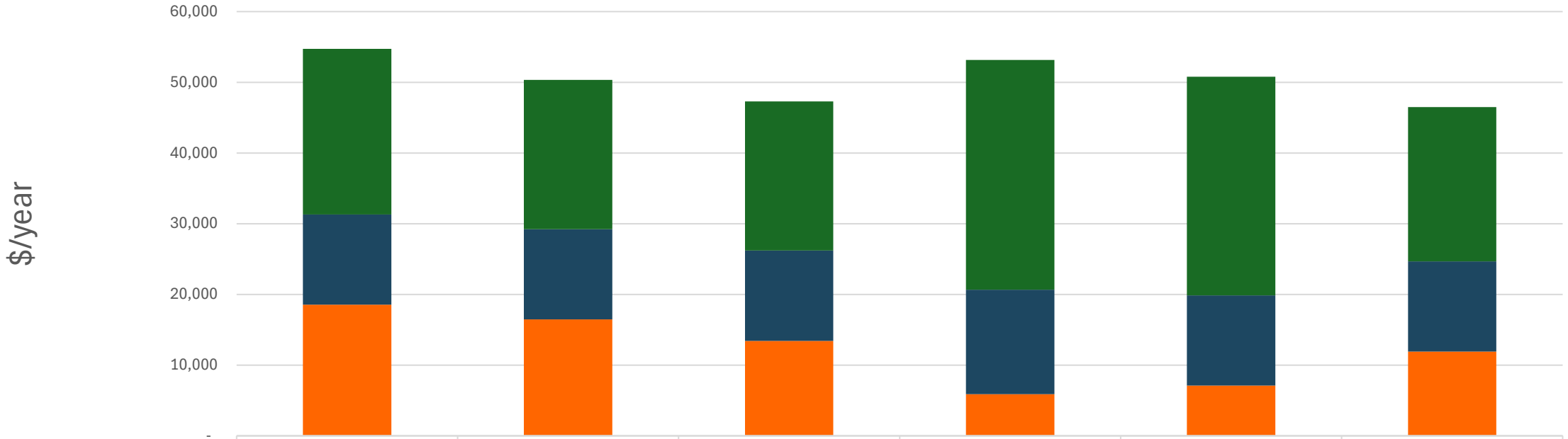


	Baseline	Optimized Operation	Heat Recovery	ASHP - Unconstrained operation	ASHP - Constrained-DEMAND operation	ASHP - Constrained-COST operation
Electricity commodity charges	33,550	26,857	26,857	45,009	44,424	27,672
Electricity demand charges	18,412	18,412	18,412	20,585	18,412	18,412
NG cost	15,211	12,603	9,657	1,825	2,145	8,247
Thermal EUI (ekWh/ft^2)*	9.9	8.0	5.9	0.5	0.7	4.9
Electricity EUI (kWh/ft2)	6.0	4.8	4.8	7.9	6.6	5.1
Total GHG t.CO2	94	76	58	15	17	51
Run hours	4,312	4,312	4,184	4,184	4,184	814

* DHW use not considered

Annual utility costs – YCDSB case study

Optimum ASHP size - 10% of peak heating load (2024-2025 data)



	Baseline	Optimized Operation	Heat Recovery	ASHP - Unconstrained operation	ASHP - Constrained-DEMAND operation	ASHP - Constrained-COST operation
Electricity commodity charges	23,439	21,095	21,095	32,473	30,938	21,810
Electricity demand charges	12,761	12,761	12,761	14,795	12,761	12,761
NG cost	18,535	16,472	13,434	5,880	7,101	11,912
Thermal EUI (ekWh/ft^2)*	11.6	10.2	8.1	3.1	3.8	7.1
Electricity EUI (kWh/ft2)	4.7	4.2	4.2	6.4	5.6	4.5
Total GHG t.CO2	114	100	81	38	45	73
Run hours	4,112	4,112	4,051	4,051	4,051	950

* DHW use is assumed negligible

Future-proofing against uncertainty

Core principles:

- School boards are responsible for operating their facilities at least cost
- Governments are responsible for climate and energy policy and regulations

Managing risks and opportunities:

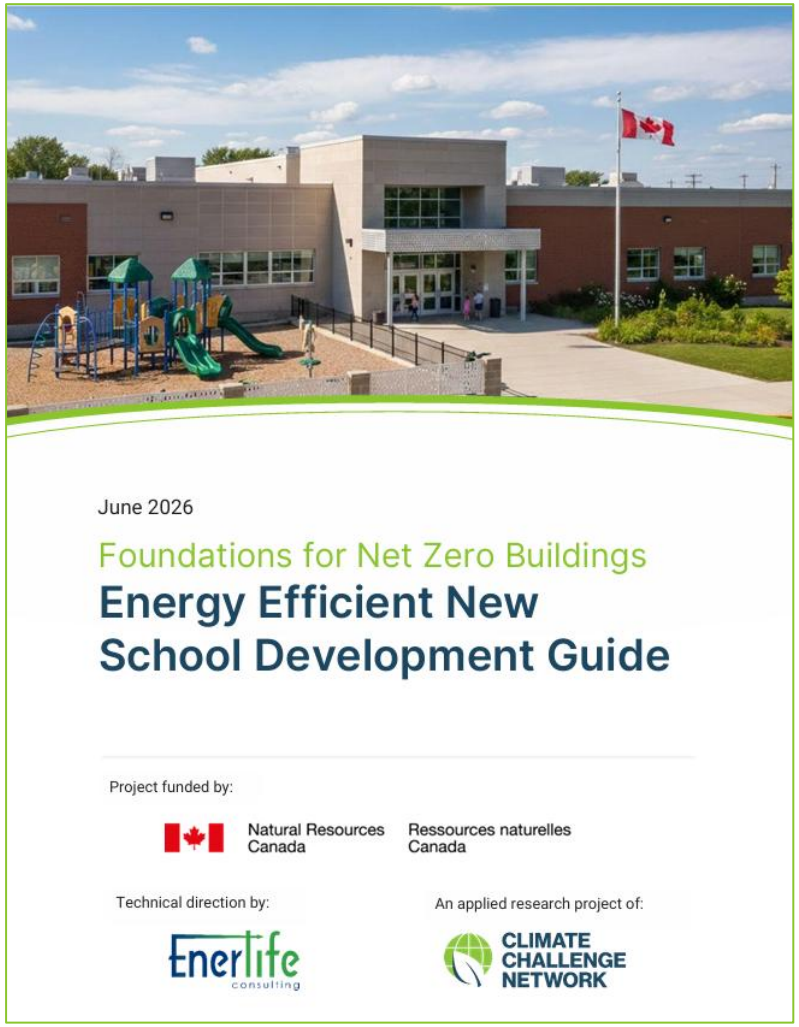
1. Climate crisis and the energy transition
2. Energy efficiency first
3. Capital planning and organizational readiness – heat pumps, energy storage, technology advancements
4. Utility prices, rate structures and carbon pricing (by any other name)
5. Government grants and utility incentives

Urgency, opportunity, and responsibility

1. Climate change is the defining issue of our times, which will disproportionately impact the education sector, particularly affecting children's physical and mental health
2. Despite government policy and best intentions, emissions due to commercial and institutional buildings continue to climb. ***With the present trajectory we will miss 2030 targets by a wide margin.***
3. Think globally but act locally. Despite political, economic and technological uncertainty, every government and school board has a role to play in closing the gap.

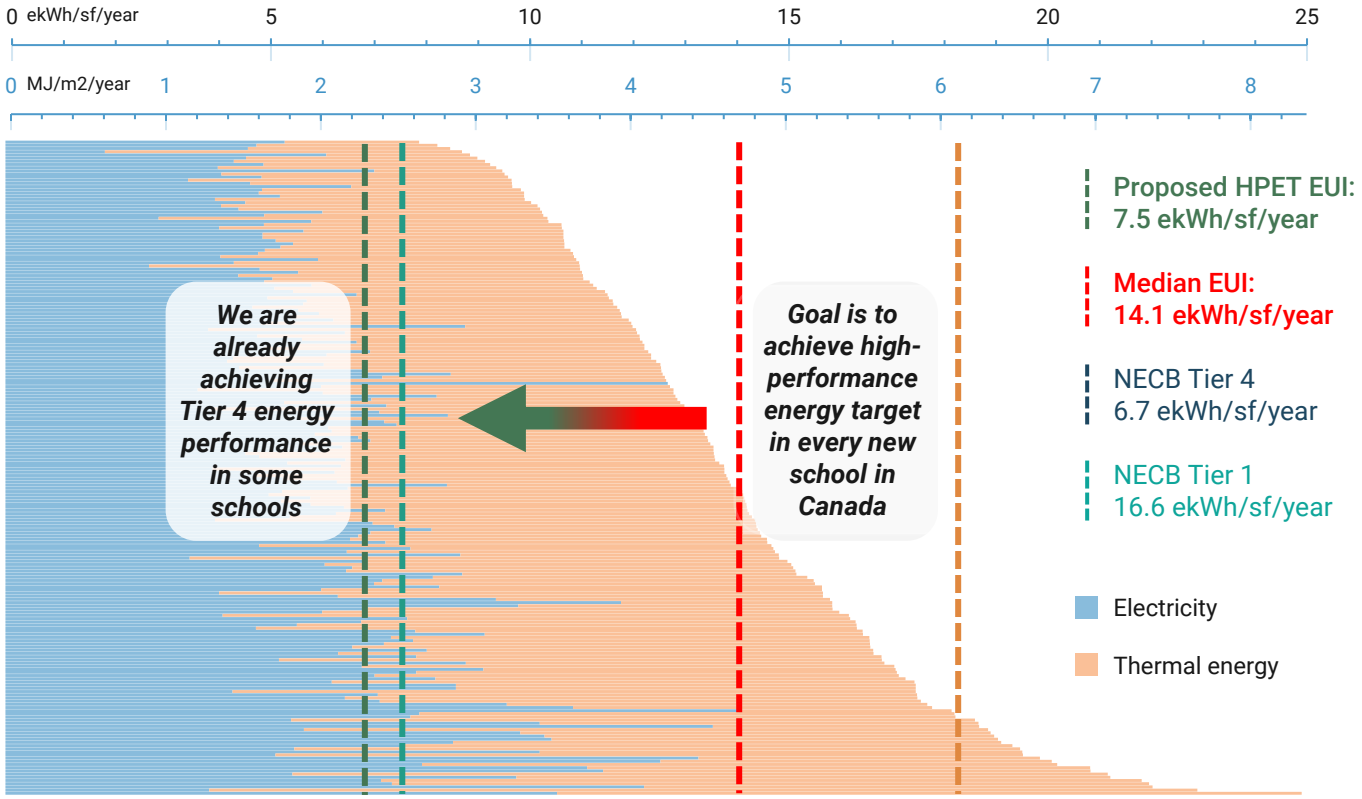
The new energy efficiency normal

Energy Efficient New School Development Guide available here.



New school energy target (HPET)

2021-22 Total EUI benchmark for new elementary and secondary schools built since 2015 (weather normalized to Toronto 2023-24 school year)



1 MJ/m2 ≃ 3 ekWh/sf

NECB: National Energy Code of Canada for Buildings
HPET: High performance energy target

- 234 schools provided annual electric and thermal utility data
- Most with conventional heating (condensing natural gas boilers/furnaces)
- No significant capital cost premium for the high-performance energy target (HPET) schools
- 30-year net present value (NPV) (Ontario) of median vs HPET school - $1.7 to $6.8 million utility cost savings and 1,250 to 5,000 tonnes of GHG emission savings (school size ranging from 50,000 to 200,000 sf)

HPET breakdown by system

Target by end use for climate zone 5 (Toronto Pearson Airport) based on the specified school archetype

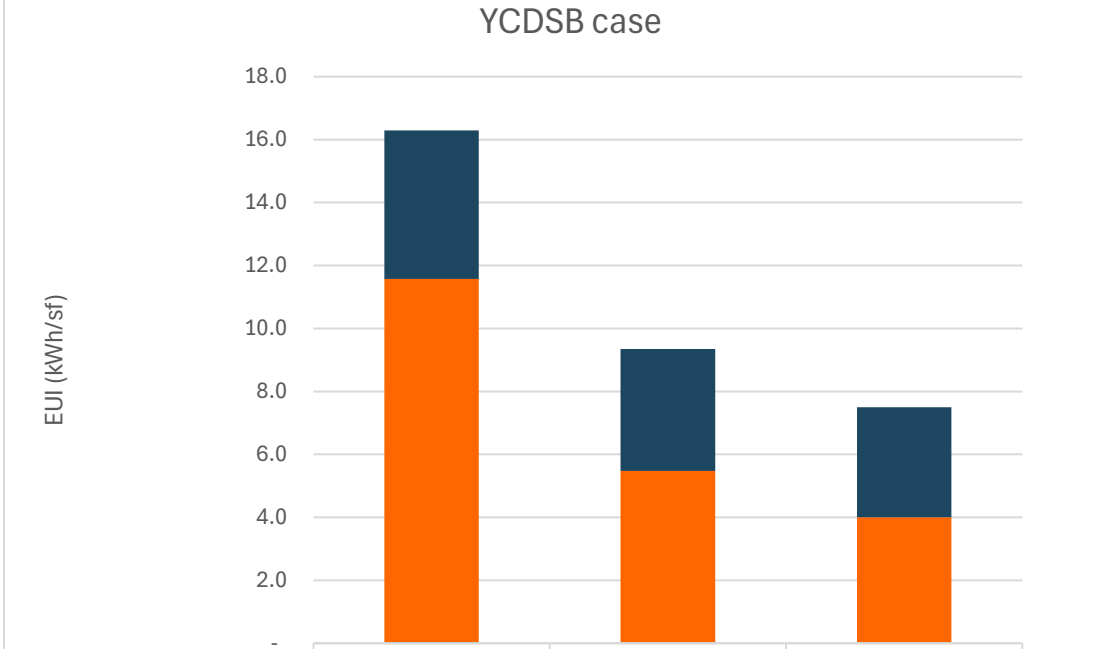
		ELECTRICITY EUIs (2023-2024) - ekWh/sf					GAS EUIs (2023-2024) - ekWh/sf		
School	**Total EUI excluding portables**	**Electricity EUI excluding portables**	**Lighting**	**Cooling**	**Plug load**	**Pumps and fans**	**Gas EUI**	**Heating**	**Domestic hot water**
Any zone 5 school	**7.5**	**3.5**	0.7	0.3	0.2	2.3	**4.0**	3.8	0.2

HPET archetype school parameters

Climate zone	5
Building area	74,401 sf
Standard school day operating hours	6:00 AM to 6:00 PM
Permitting hours per year	6% (percent additional school day operating hours based on actual permit hours multiplied by percent of school in use)
Heating system	Hydronic, gas-fired condensing boilers
Air distribution	Variable air volume air handling units (AHUs) (x2) Rooftop units (RTUs) (x4) serving library, stage, and gymnasium
Terminal equipment	Series fan-powered VAV boxes with hydronic heating, standard VAV boxes for internal spaces, hydronic cabinet heaters at entrances and stairwells
Cooling system	Air-cooled chiller (scroll) – whole school air conditioned
Heat recovery	Enthalpy wheels on both AHUs
Building automation system	In place. Real-time utility monitoring (electricity, gas, water), All equipment including unit heaters controlled by BAS
Lighting	LED throughout, advanced lighting control system
Domestic water heaters	Gas-fired condensing
Energy metering	Hourly interval data for both electricity and gas, including submetering for electricity

Energy efficiency first

	Baseline	SUS energy target	HPET
Electricity EUI (kWh/ft2)	6.0	3.9	3.5
Thermal EUI (ekWh/ft^2)*	9.9	5.5	4.0
Total GHG t.CO2	94	53	39
% of basline GHG	100%	57%	42%
Total utility cost ($)	67,902	42,558	36,751



	Baseline	SUS energy target	HPET
Electricity EUI (kWh/ft2)	4.7	3.9	3.5
Thermal EUI (ekWh/ft^2)*	11.6	5.5	4.0
Total GHG t.CO2	114	56	42
% of basline GHG	100%	49%	37%
Total utility cost ($)	55,468	39,044	33,802

Capital planning and organizational readiness

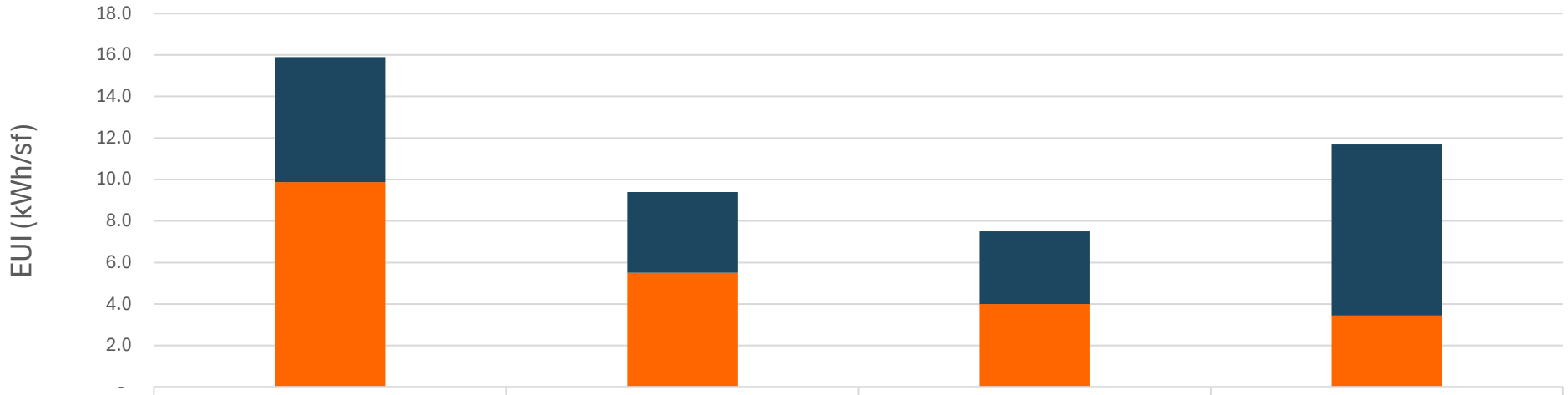
Infrastructure priorities

- Reduce heating loads through envelope upgrades
- Expand ventilation heat recovery
- Design for low-temperature heating-water systems
- Adopt ASHP RTUs instead of like-for-like standard RTUs
- Plan electrical capacity, controls, and space for future PV and storage

Organizational readiness

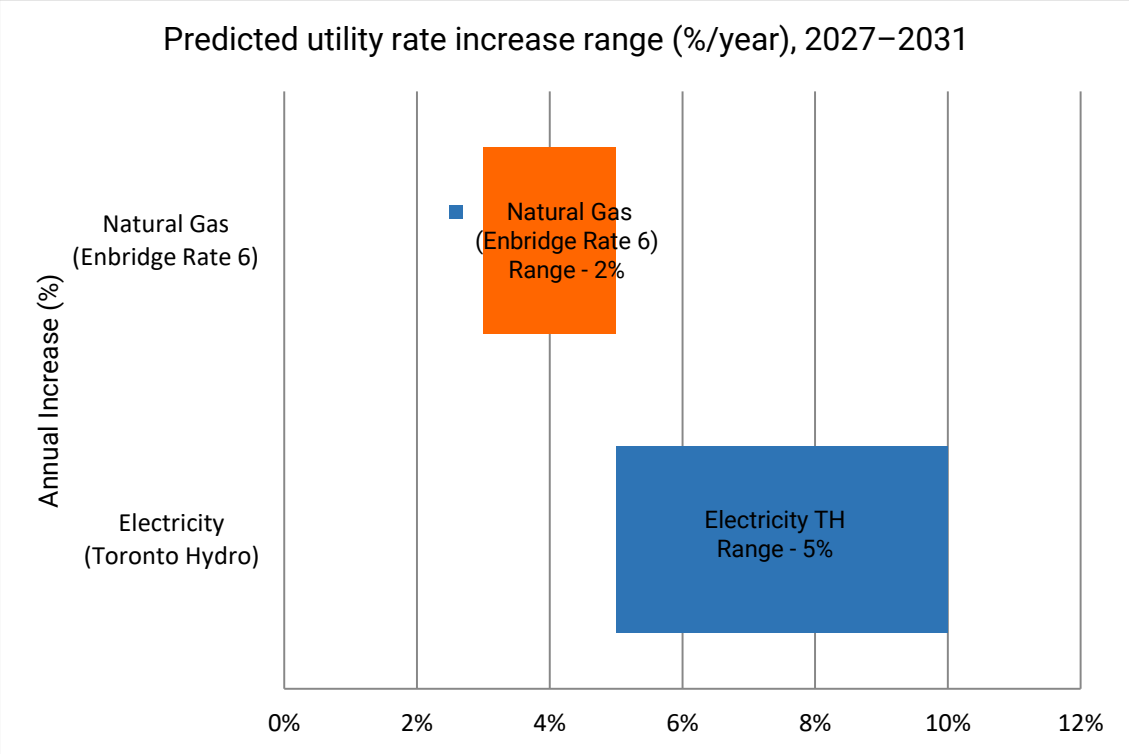
- Build staff experience through demonstration projects
- Train operations and maintenance teams
- Strengthen commissioning and performance monitoring
- Align budgets, procurement, and implementation timelines

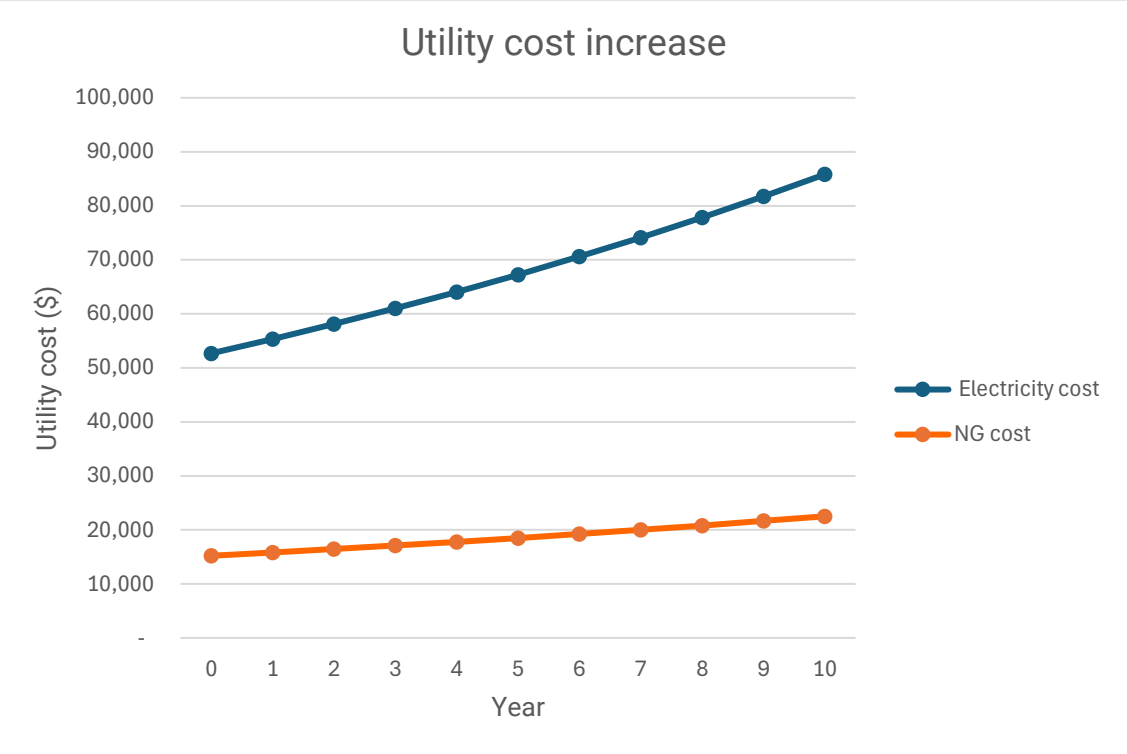
ASHP vs. energy efficiency measures



	Baseline	SUS energy target	HPET	ASHP - Unconstrained operation
Electricity EUI (kWh/ft2)	6.0	3.9	3.5	8.2
Thermal EUI (ekWh/ft^2)*	9.9	5.5	4.0	3.4
Total GHG t.CO2	94	53	39	41
% of basline GHG	100%	57%	42%	44%
Total utility cost ($)	67,902	42,558	36,751	74,605

Electricity and natural gas price futures





There is no clean-cut 5-year electricity and natural price forecast easily available. The above estimations are based on the trend of historical increases, what rate frameworks have been approved by the OEB (i.e. Toronto hydro 2025-2029 Dx rates, Hydro One 2023-2027 Tx rates, Enbridge 2024-2028 delivery rates) and what rate framework is currently before the OEB (i.e. OPG regulated payment, which contributes significantly to the electricity commodity charges).

Combining all above:

- The electricity bill of a Toronto Hydro customer (GS 50-999kW, a typical TDSB school) will be subject to an increase of 5% to 10% per year in the next 5 years.
- Natural gas bill of a rate 6 customer (a typical TDSB school) will be subject to an increase of 3% to 5% per year in the next 5 years.

Utility and carbon pricing levers

Total annual utility cost ($)	Fuel at current rates		Fuel at propane price*	
	No carbon price	With carbon price**	No carbon price	With carbon price**
Baseline	67,902	83,848	98,324	114,271
Baseline + ASHP — electricity at current rates	74,605	81,627	86,871	93,893
ASHP electricity at $0.05/kWh	65,799	72,821	78,065	85,087

*Propane price three times natural gas price
**Carbon pricing at $170/tCO2e (previously projected 2030 carbon tax rate)

Grants and incentives

Jurisdiction	Program	ASHP boiler relevance for schools	Financial contribution	Project type	Incentive mechanism
Federal	Clean Technology ITC	Potentially applicable — eligibility must be confirmed for public school boards	30% of eligible capital cost	New + retrofit	Prescriptive (technology adoption)
Federal	FCM Green Municipal Fund	Applicable mainly through municipal partnerships / deep retrofit projects	Grants and loans vary	Retrofit + new	Project-based
Ontario	Save on Energy Retrofit Program	Boiler replacement and electrification projects	Up to $1,800/kW demand reduction or $0.20/kWh savings (max 50% project cost)	Retrofit	Performance-based
Ontario	Save on Energy - Energy Performance Program	Better suited for operational optimization than HP installation alone	Based on verified savings	Existing buildings	Performance-based
British Columbia	CleanBC Commercial Express	Applicable for eligible heat pump installations	Up to $100k	Retrofit	Prescriptive
British Columbia	CleanBC Custom-Lite	Applicable for larger ASHP Boiler projects requiring analysis	Up to $72k	Retrofit	Performance-based / custom
Quebec	Hydro-Québec Solutions efficaces (OSE 5.1)	Strong fit for institutional heat pump electrification	Up to $5M + analysis funding	Retrofit + major upgrades	Performance-based
Nova Scotia	Efficiency NS Commercial Heat Pump Rebate	Direct ASHP Boiler incentive	$200–$600/ton	Retrofit	Prescriptive
Manitoba	Efficiency Manitoba HVAC Rebates	Potential fit (confirm institutional eligibility)	Varies by system size	Retrofit	Prescriptive
Alberta	No provincial institutional ASHP Boiler program identified	Limited provincial support	—	—	Federal/local programs only

Recommendations

To school boards

- Energy efficiency first – meet high-performance energy targets
- Exhaust air heat recovery – specify for all new construction and AHU/RTU replacement projects
- Specify ASHPs for all RTU applications
- Implement cost constrained control strategies for existing hybrid heat pump systems
- Consider ASHP boiler pilot projects with submetering, instrumentation and staff training

To governments

- Set policy with respect to ASHP applications in decarbonization and energy transition planning
- Adopt utility rates, grants, carbon pricing and incentive programs to achieve cost parity for K-12 schools
- Implement Energy Efficient New School Development Guide recommendations

To utility companies

- Support hybrid heat pump system optimization

Audience poll on ASHP boiler applications

1. **How much experience do you have with air-to-water heat pumps?**
    1. Multiple completed projects
    2. One or two pilot projects
    3. Currently designing one
    4. None yet

2. **Are air-to-water heat pumps being considered in your new-construction designs?**
    1. Standard strategy
    2. Considered case by case
    3. Not currently considered

3. **Where do you see the strongest application?**
    1. New construction
    2. Boiler plant upgrades
    3. Retrofit air-cooled chillers with ASHP chillers

4. **What are the biggest barriers to adoption?**
    1. First cost (cost premium)
    2. Equipment and control complexity
    3. Electrical capacity
    4. Existing high-temperature heating systems
    5. Incurring higher utility costs

5. **How likely are you to specify an air-to-water heat pump within the next three years?**
    1. Very likely
    2. Somewhat likely
    3. Unsure
    4. Unlikely

Questions, suggestions, comments

We'd love to hear from you

Questions

Ask us anything
about today's session

Suggestions

Share ideas to improve
our work together

Comments

Tell us what you think
about what you've seen

The floor is yours — no bad questions

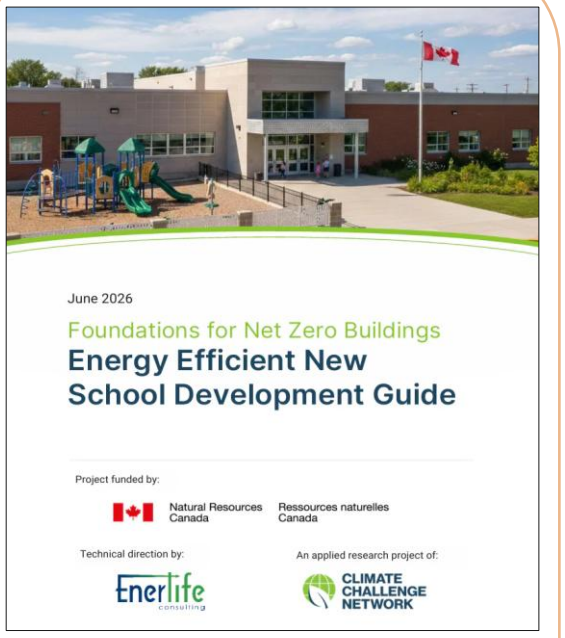
Upcoming events

Geothermal cohort project technical working groups

Fall 2026 and Spring 2027

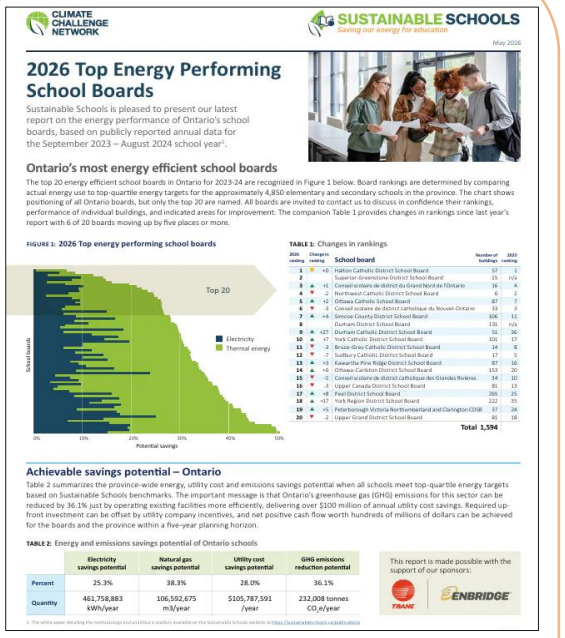
Geothermal cohort project guide launch webinar

Summer 2027



Guide implementation with governments, utilities and school boards

2026-2027



2027 Top energy performing school boards report webinar

June 2027

Thank you

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