FEBRUARY 28, 2024

Efficient Building Electrification: The Efficient Electrification Toolkit

Presented by Stephen Dixon

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SAVE ON ENERGY POWER WHAT'S NEXT

Agenda

1. Introduction
2. What is efficient electrification?
3. The efficient electrification toolkit
4. Planning for efficient electrification
    a. Technology
    b. What's next?
5. Q&A

Workshop objectives

1. Review upcoming Save on Energy Training and Support programming, including:
    a. The efficient electrification toolkit: decision support tools
    b. Training and information sharing sessions
    c. Technical assistance and coaching

2. Help to develop understanding about electrification technologies and decision-making processes

Save on Energy Program Updates

- **Retrofit program** prescriptive incentives for most **non-lighting measures** increased as of October 30, 2023. Many **doubled**, including for air source heat pumps. Visit the Retrofit program website for the updated measures and incentives.
- The **Instant Discounts program** for lighting launched **December 18, 2023.** Program incentives are directly to distributors, enabling them to offer instant point-of-sale discounts on energy-efficiency lighting to customers.
- **Strategic Energy Management program** offers a two-year, cohort-based learning model to organizations with at least 3,000,000 kWh annual energy consumption.
- The **Existing Building Commissioning program** provides financial incentives for businesses to hire qualified commissioning providers and to receive pay-for-performance incentives for savings achieved.

Save on Energy Training and Support

- **Save on Energy's Training and Support program** delivers webinars, coaching workshops and information resources to energy professionals across Ontario on a range of topics, including energy data, efficient electrification and heat pumps, all at no cost to participants.
- We also offer **incentives of up to 50% for 18 energy-efficiency training courses** and of up to 75% to Enbridge customers for several courses.
- All of our training and support resources, including webinar recordings, information sheets, guides and case studies can be found on the **Training and Support page** of the Save on Energy website. For more information reach out to us at trainingandsupport@ieso.ca

What is efficient electrification?

What is driving electrification?

Environment, social and governance (ESG) goals across commercial, institutional and industrial sectors

Many shared attributes, including:

- Climate/emissions targets, with target dates approaching quickly
- Building electrification is a major contributor to the feasibility of achieving emission-reduction goals
- Key challenges

Sector-specific distinctions:

- Facility types
- Budget availability and planning horizons

What is efficient electrification?

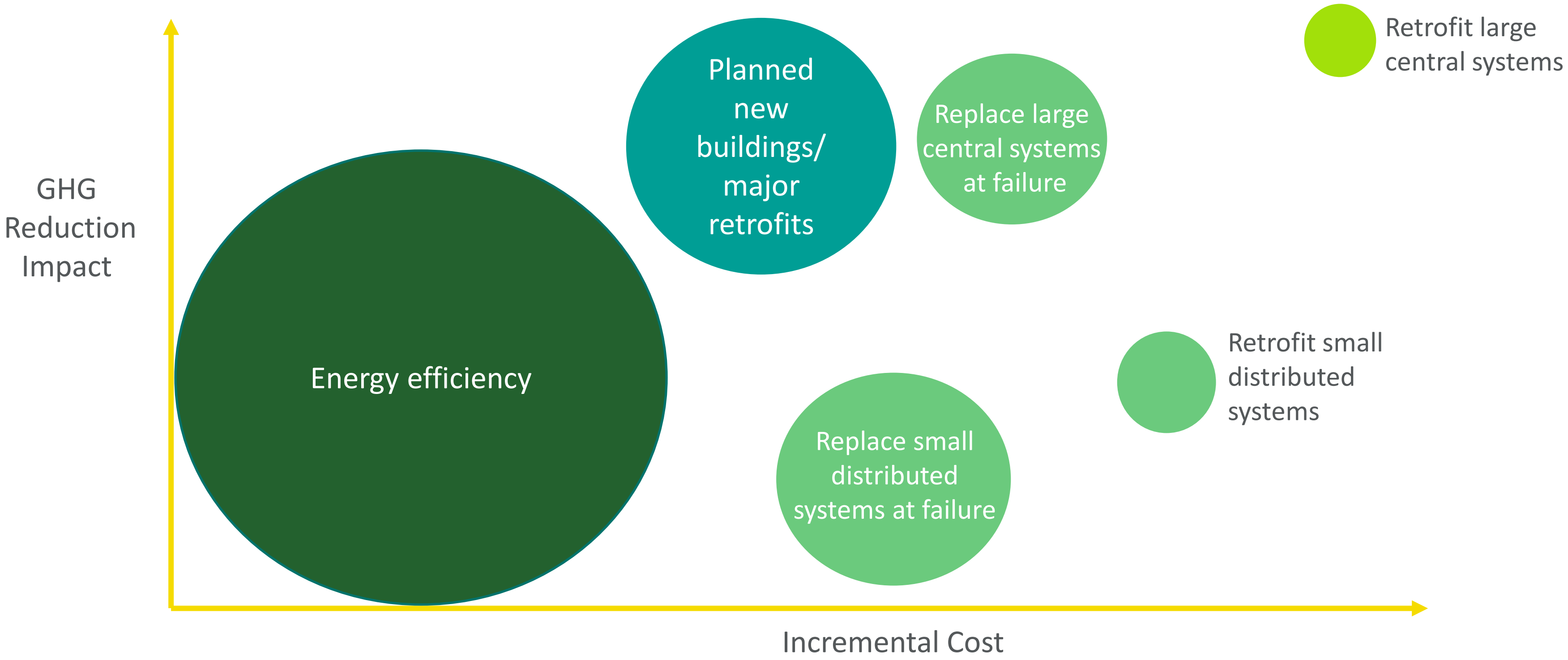
Considerations when planning to electrify end uses in buildings:

- Have we eliminated waste?
- Have we optimized our systems, schedules and operations?
- Have we reduced our loads as much as feasibly possible?

Benefits of considering efficiency when planning electrification projects:

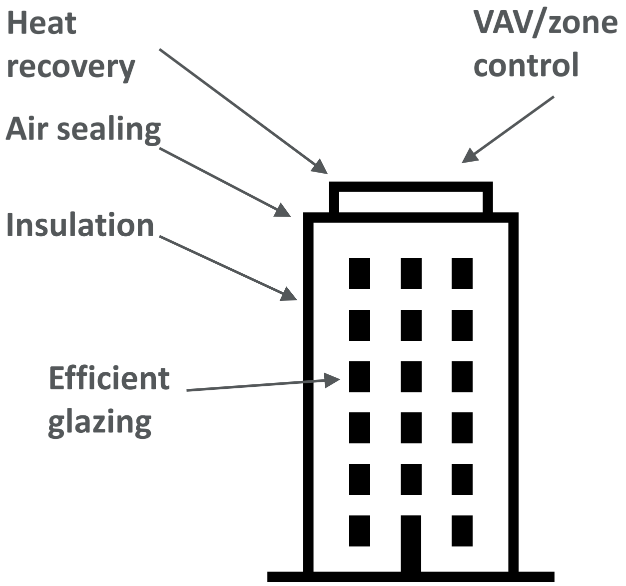
- Reduced capital cost
- Ideal design for building and business needs
- Lowest operating cost

Prioritizing efforts



Energy efficiency and right sizing

100,000 sq. ft. building	Energy Use Intensity	Cooling Load	Capital Cost
Without efficiency measures	30 ekWh/sq.ft.	~175 ton refrigeration	~$700k plant at $4000/ton
With efficiency measures	22 ekWh/sq.ft.	~130 ton refrigeration	~$520k plant at $4000/ton



~$180K First cost plant savings

Energy Efficiency as the first fuel

Your energy-efficiency game has to be on point!

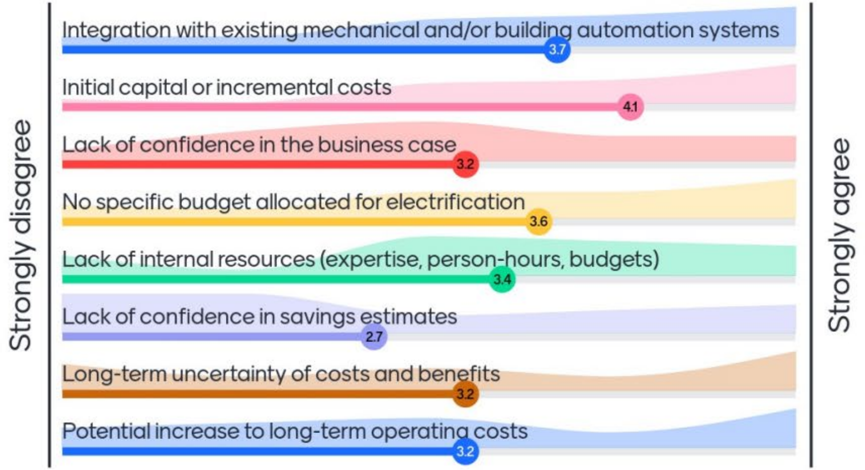
1. Reduce load
2. Match load
3. Reuse energy
4. Generate/ Switch fuel

Size your new heat pump only after 1,2,3 are done!

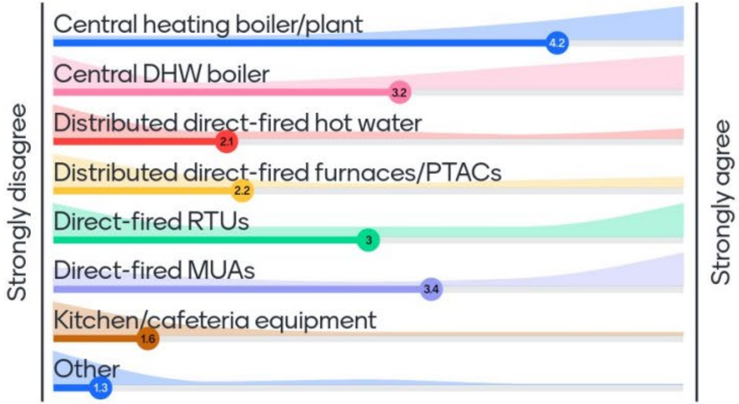
Electrification must be an extension of the EE continuum

Polling:
1. The challenges of electrification
2. End uses of interest

Major challenges for electrification



What building systems are you considering for electrification?



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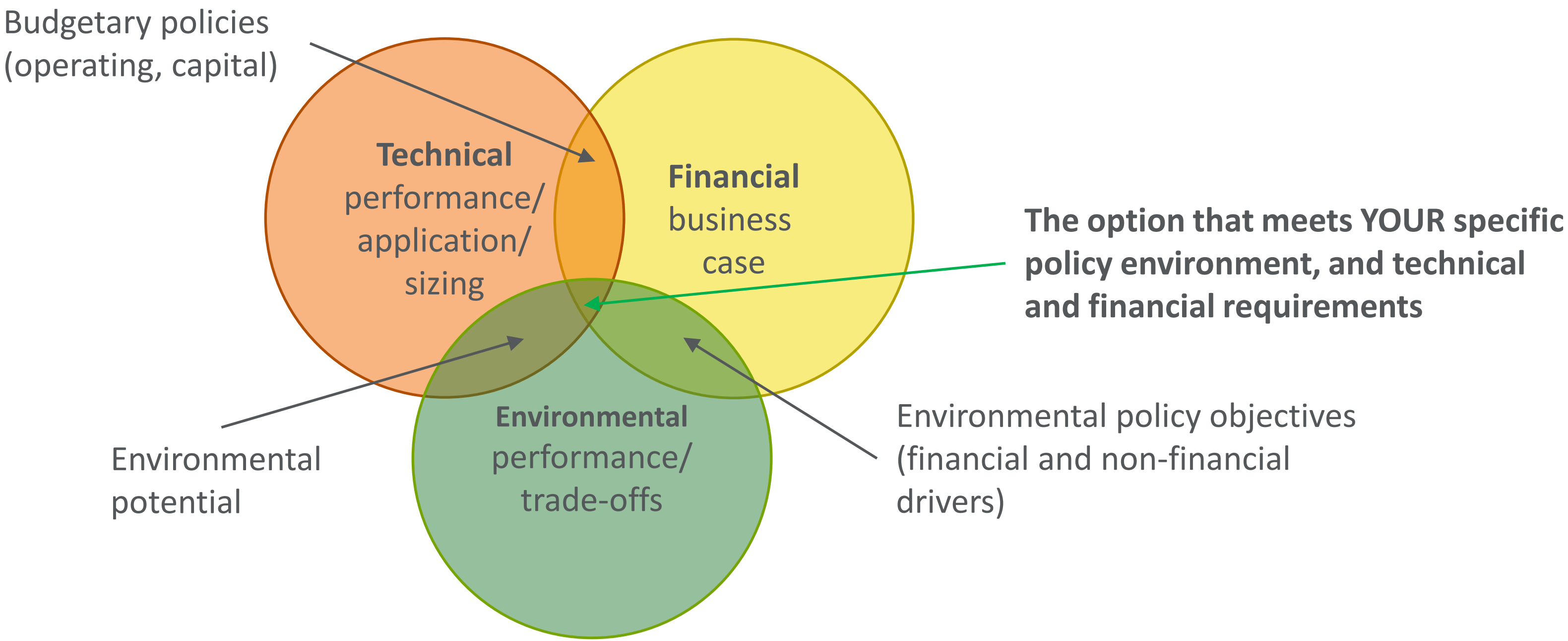
Other systems considered for electrification?

2 responses

radiant tube heater

laundry

Efficient electrification considerations



Electrification: good news/less-good news

Good News:

- Electrifying heating end uses will yield large environmental benefits
- Technologies exist today for electrification of most end uses
  - Air- and water-source heat pumps
  - Solar-thermal boilers
- Heat pump performance continues to improve - COPs reaching over 5
- **Modeling and simulation approaches can facilitate decision-making**
- New construction economics are rapidly improving

Less-Good News:

- Initial cost of heat-pumps and renewables is still posing challenges in retrofit scenarios (but prices are coming down)
- Difference in cost of gas versus electricity is still a challenge in many jurisdictions. Gas prices remain low, and GHG pricing policy will take until 2030 to reach operating cost parity with heat pumps in Ontario.
- Decision-making is obfuscated by information and capacity barriers

Electrification overview

	Combustion heating	Resistance heating	Heat pump heating/cooling
			

All values approximate

Efficiency	80% – 98%	Close to 100%	250% – 400% (2.5 - 4.0 Coefficient of Performance (COP))
Energy cost	\$0.45/m3	\$0.15/kWh	\$10/GJ - \$20/GJ
Emissions	1900 gCO2e/m3	30 gCO2e/kWh	2 – 4 kg CO2e/GJ

Electrification overview

Combustion heating

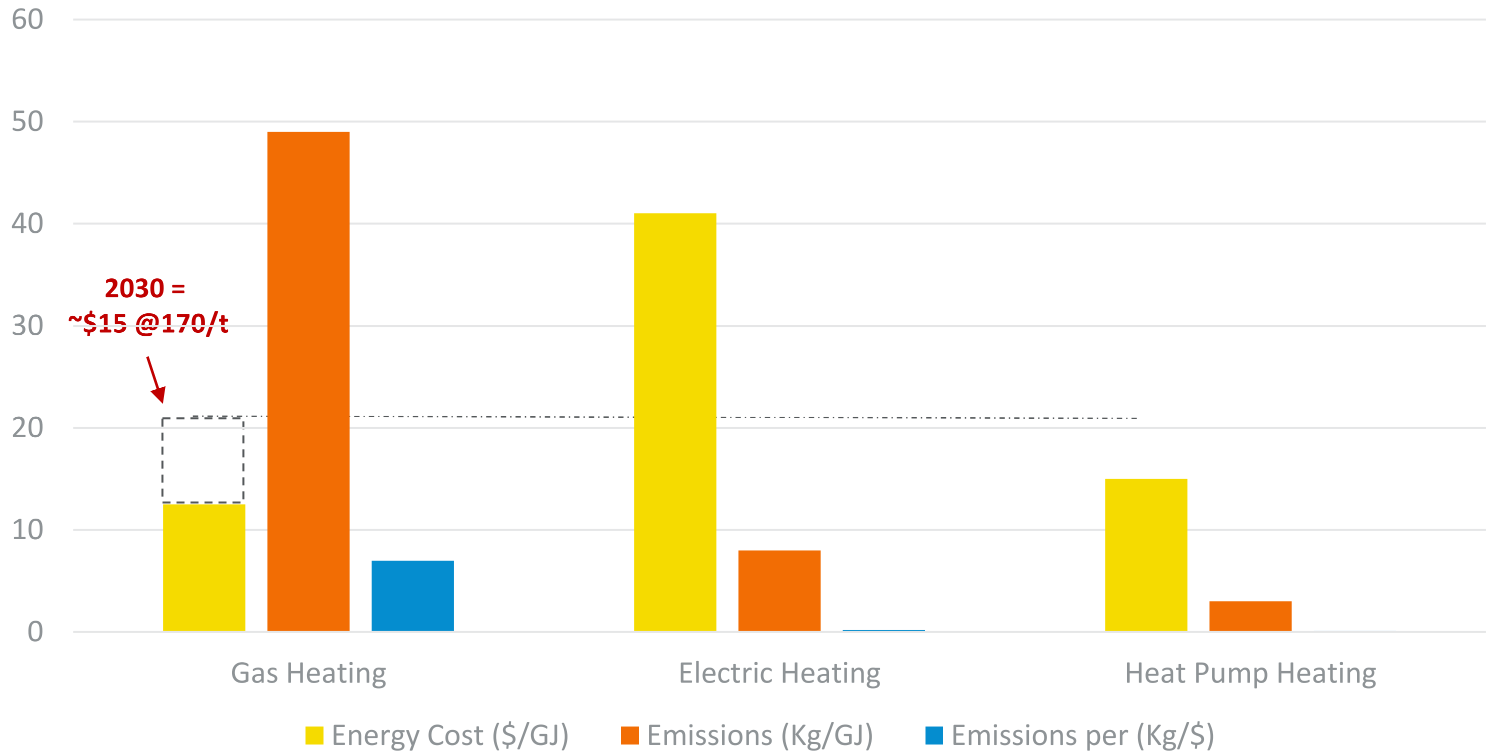
Resistance heating

Heat pump heating/cooling

All values approximate

Efficiency	80% – 98%	Close to 100%	250% – 400% (2.5 - 4.0 Coefficient of Performance (COP))
Cost of Energy Delivered	$12.5/GJ *(~$20.5/GJ by 2030 @$170/t)*	$41/GJ	$10GJ - $20/GJ
Emissions	49 kgCO2e/GJ	8 kgCO2e/GJ (Margin)	2 – 4 kgCO2e/GJ
Emissions/$ spent	4 kgCO2e/$ Spent	0.2 kgCO2e/$ Spent	0.04 – 0.1 kgCO2e/$ Spent

Electrification cost and carbon emissions



The efficient electrification toolkit

Five-step approach to efficient electrification

Step		
1	**Establish goals and constraints**	Understanding each building's constraints and establishing intelligent, realistic objectives are key to project success.
2	**Reduce Heating Demand**	Reducing the amount of energy needed to heat a building through envelope and mechanical upgrades improves energy performance and reduces capital costs of new systems.
3	**Optimize the HVAC system**	Reduce energy waste in building mechanical systems through temperature controls, zoning and heat recovery.
4	**Electrify Heating Systems**	Use the life-cycle cost analysis section to compare the energy and emissions reductions and operating costs of electric heating systems over the lifecycle of systems under consideration.
5	**Balance Heating and Cooling Sources**	Explore the cost and GHG emissions implications of different fuels, including hybrid and all-electric HVAC systems.

What's in the toolkit?

The Efficient Electrification Toolkit is a resource for anyone considering, planning or designing building electrification projects in Ontario.

This toolkit can be used to support informed decision-making based on your organization's goals and constraints.

Using a five-step decision-making process, The toolkit helps building operators across Ontario address energy and/or GHG reduction objectives in an energy efficient and cost-effective manner.

Technical planning tools

- Fuel-switching calculators
- Life cycle cost assessment tools
- RETScreen templates

Training Opportunities

- Net zero planning with RETScreen
- Financial analysis
- Electrifying HVAC with heat pumps

Hands-on Support

- Technical support with the tools or post training support
- Contact trainingandsupport@ieso.ca

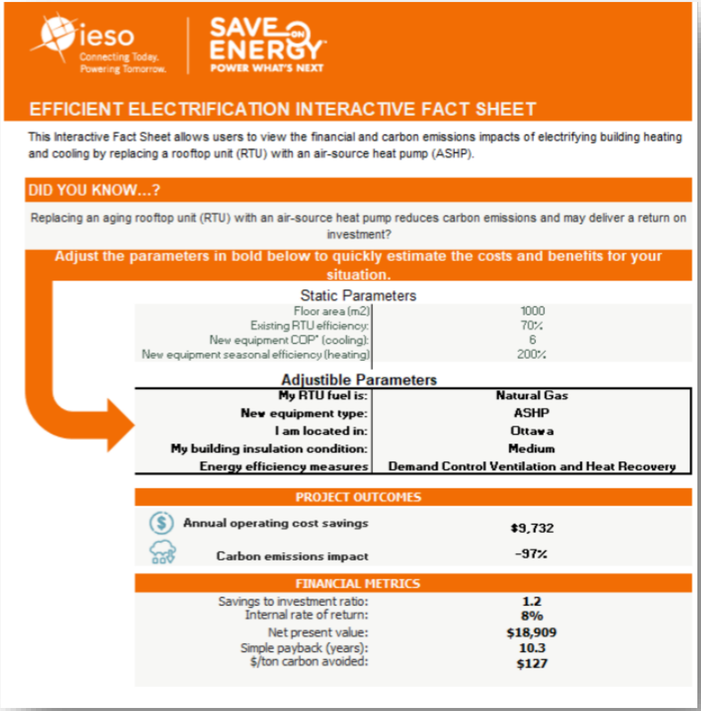
Step	Toolkit resources
1. Establish goals and constraints	- Fact sheet: Summary of efficient electrification tools - Fact sheet: Guide to planning - Fact sheet: Fuels comparison – cost and carbon
2. Reduce heating demand	- Fact sheets: envelope upgrades, right sizing, capital vs operational costs - Integrated design process resources and training - RETScreen training: feasibility modelling
3. Optimize the HVAC system	- Fact sheet: Heat recovery - RETScreen training: HVAC system modelling
4. Electrify heating systems	- Fact sheets: Air source heat pumps - Interactive fact sheets: fuel switching energy, emissions, and financial calculator - RETScreen templates: building archetypes - Webinar: Efficient building operations with heat pumps - RETScreen Training: Net zero planner - RETScreen Training: how to use the toolkit archetypes and virtual energy analyzer
5. Balance heating and cooling sources	- Interactive fact sheets: fuel switching energy, emissions, and financial calculator - RETScreen templates and training - Calculators: Basic and enhanced lifecycle cost analysis

Efficient electrification interactive fact sheet

The interactive fact sheet calculates outcomes and financial metrics for a rooftop unit to air source heat pump retrofit:

- Annual operating cost
- carbon emissions impact
- Savings to investment ratio
- Internal rate of return
- Net present value
- Simple payback

Users input static (project specific) parameters and select from a series of adjustable parameters.



EFFICIENT ELECTRIFICATION INTERACTIVE FACT SHEET

This Interactive Fact Sheet allows users to view the financial and carbon emissions impacts of electrifying building heating and cooling by replacing a rooftop unit (RTU) with an air-source heat pump (ASHP).

DID YOU KNOW...?

Replacing an aging rooftop unit (RTU) with an air-source heat pump reduces carbon emissions and may deliver a return on investment?

Adjust the parameters in bold below to quickly estimate the costs and benefits for your situation.

Static Parameters

Floor area (m2)	1000
Existing RTU efficiency:	70%
New equipment COP* (cooling):	6
New equipment seasonal efficiency (heating)	200%

Adjustible Parameters

My RTU fuel is:	**Natural Gas**
New equipment type:	**ASHP**
I am located in:	**Ottawa**
My building insulation condition:	**Medium**
Energy efficiency measures	**Demand Control Ventilation and Heat Recovery**

PROJECT OUTCOMES

Annual operating cost savings	**$9,732**
Carbon emissions impact	**-97%**

FINANCIAL METRICS

Savings to investment ratio:	**1.2**
Internal rate of return:	**8%**
Net present value:	**$18,909**
Simple payback (years):	**10.3**
$/ton carbon avoided:	**$127**

RETScreen Expert archetype models

Archetypes for common institutional building types have been created and model a transition from natural gas heating to air source heat pumps:

- Fire station
- Laboratory
- Small office
- Recreation centre

Additional building archetypes are available through RETScreen's virtual energy analyzer (VEA) and Net Zero Planner. Training and coaching on RETScreen will be provided throughout 2024.

Archetype

Fire station

Commercial/Institutional - Public order and safety

Life-cycle cost assessment (LCCA) tools

Basic LCCA tool

With minimal user input, compare two or three retrofit project scenarios over a 30-year lifecycle.

Advanced LCCA tool

The advanced tool includes an introduction and written how-to guide. Users can input each variable considered in life-cycle cost analysis, providing greater accuracy.

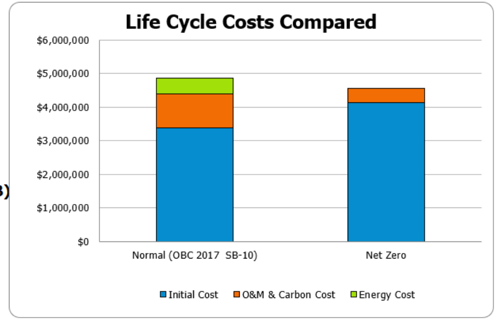
Life Cycle Costing Summary

	Option A Normal (OBC 2017 SB-10)	Option B Net Zero
Initial Cost	$3,395,500	$4,142,088
O&M & Carbon Cost	$996,469	$420,460
Energy Cost	$473,193	$0
Total Cost	$4,865,162	$4,562,548

Financial Value Indicators (Option A vs B)

Net Investment	$746,588
Net Present Value	$302,613
Internal Rate of Return	5.4%
Savings to Investment Ratio	1.41

Time Horizon (1-30 years) 30 years



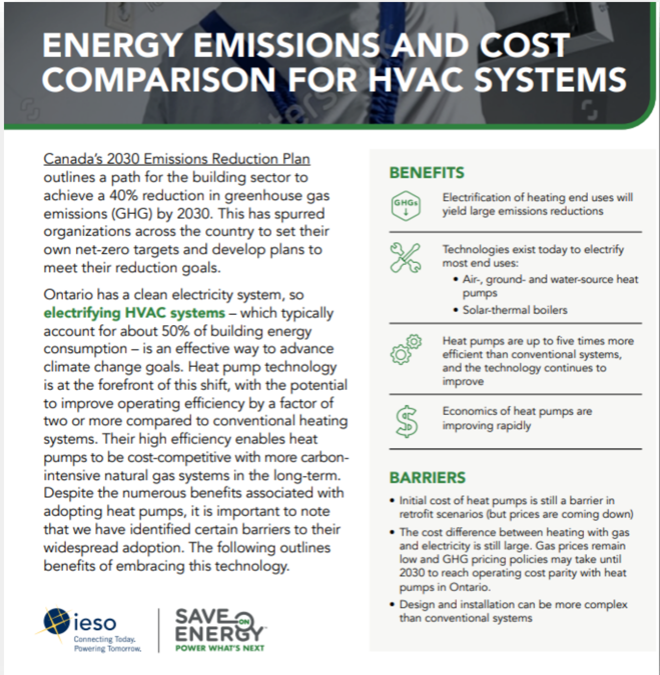
Additional resources

Additional resources available:

- Fuel comparison fact sheet
- How to use the toolkit guide

Continued development of resources include:

- Building envelope upgrades
- Right sizing HVAC equipment
- Heat recovery opportunities



ENERGY EMISSIONS AND COST COMPARISON FOR HVAC SYSTEMS

Canada's 2030 Emissions Reduction Plan outlines a path for the building sector to achieve a 40% reduction in greenhouse gas emissions (GHG) by 2030. This has spurred organizations across the country to set their own net-zero targets and develop plans to meet their reduction goals.

Ontario has a clean electricity system, so **electrifying HVAC systems** – which typically account for about 50% of building energy consumption – is an effective way to advance climate change goals. Heat pump technology is at the forefront of this shift, with the potential to improve operating efficiency by a factor of two or more compared to conventional heating systems. Their high efficiency enables heat pumps to be cost-competitive with more carbon-intensive natural gas systems in the long-term. Despite the numerous benefits associated with adopting heat pumps, it is important to note that we have identified certain barriers to their widespread adoption. The following outlines benefits of embracing this technology.

BENEFITS

- Electrification of heating end uses will yield large emissions reductions
- Technologies exist today to electrify most end uses:
  - Air-, ground- and water-source heat pumps
  - Solar-thermal boilers
- Heat pumps are up to five times more efficient than conventional systems, and the technology continues to improve
- Economics of heat pumps are improving rapidly

BARRIERS

- Initial cost of heat pumps is still a barrier in retrofit scenarios (but prices are coming down)
- The cost difference between heating with gas and electricity is still large. Gas prices remain low and GHG pricing policies may take until 2030 to reach operating cost parity with heat pumps in Ontario.
- Design and installation can be more complex than conventional systems

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Planning for efficient electrification: Technology

What can we electrify?

List of Acronyms

HVAC: Heating, ventilation and air conditioning
ASHP: Air-source heat pump
WSHP: Water-source heat pump
DHW: Domestic hot water
MAU: Make-up air unit
PTAC: Packaged terminal air conditioner

Central Water Heating

Central Modular WSHP

https://www.hotwater.com/

Design Considerations:

- Design temperature regime (high temp possible, but more costly)
- Electric service capacity
- Instantaneous heating demand
- Modular installation = space
- Matching cooling load ideal

Financial Considerations:

- Leverage existing capital renewal budgets
- Incremental/supplemental approach
- Maintenance budgets

Environmental Considerations:

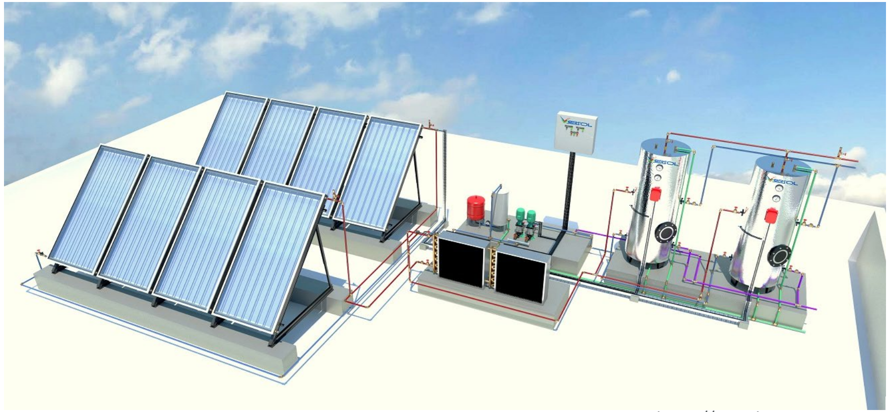
- Largest end-user (~40-50% in commercial) with most direct GHG emissions (in most applications)
- Solar thermal can be used to pre-heat incoming H_20
- Drain and sewer heat recovery can be used for preheat

Decision-Making Tools:

- Gas billing history
- RetScreen Expert
- Building modeling (esp. solar expos.)

Central Domestic Hot Water

Central Modular WSHP (with Solar Pre-Heat)



https://versolgroup.com

Design Considerations:

- Design temperature regime (high temp possible, but more costly)
- Electric service capacity
- Instantaneous heating demand
- Modular installation = space
- Matching cooling load ideal

Financial Considerations:

- Leverage existing capital renewal budgets
- Incremental/supplemental approach
- Maintenance budgets

Environmental Considerations:

- Second largest end-user for gas after space heating, (~10-15%)
- Solar thermal can be used to pre-heat incoming H_20
- Drain and sewer heat recovery can be used for preheat

Decision-Making Tools:

- Gas billing history (simple)
- RetScreen Expert
- Building modeling (esp. for combo systems)

Distributed Domestic Hot Water

Distributed Unitary ASHP Heater W/Electric Peaking

https://www.hotwater.com/

https://www.homedepot.ca/

Design Considerations (WSHP/ASHP)

- Often feature electric resistance back-up/peaking
- Serves “residential-style” loads (office kitchenettes, dorm rooms, etc.)
- Dehumification options
- Space may be a factor w/existing tankless

Financial Considerations:

- Replace at failure more of an option with 1-for-1 replacement-at-failure program
- Storage/resistance backup options may offset some of the cost of HP capacity.

Environmental Considerations:

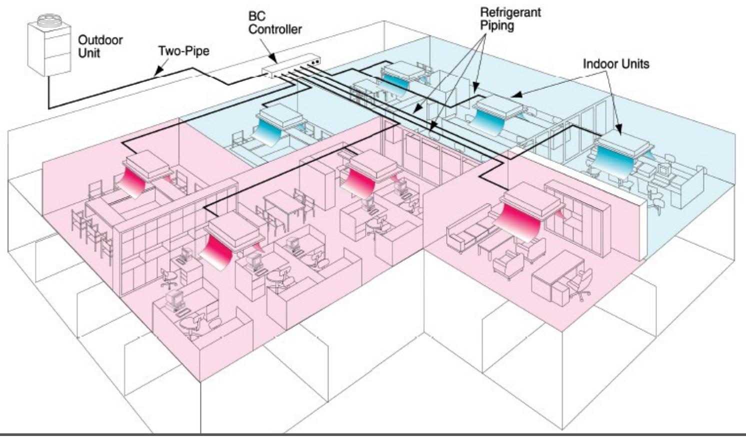
- Peaking will still be served by the grid for units with resistance heating
- Important to consider grid peak emission factors
- Drain and sewer heat recovery can be used for preheat

Decision-Making Tools:

- System level: capacity of unit/efficiency calculation
- Data logging for non-seasonal load
- Retscreen Expert

Commercial HVAC

Multi-Split Modular Variable Refrigerant Flow ASHP



Design Considerations:
- Limited retrofit options
- Make-up air unit (MAU) required - not ideal for mixed-air VAV applications
- Mix of heating and cooling loads ideal
- Very small thermal transport piping

Financial Considerations:
- May be an option for whole-building deep retrofit and or major floor-by-floor retrofit scenarios.

Environmental Considerations:
- Very high COPs can be achieved with balanced heating and cooling loads.
- Occupant fresh air still requires a ducted solution

Decision-Making Tools:
- Complex system requiring design support for option consideration.
- Retscreen Expert
- Building modeling

Direct Fired Roof-Top Units (RTU)

Packaged WSHP/ASHP MAUs/RTUs

https://www.trane.com

Design Considerations (WSHP/ASHP):

- ERV/HRV an important consideration in conjunction with the RTU to minimize HP capacity
- Condensate management can be a concern when retrofitting heating-only units.

Financial Considerations:

- Replace at failure more of an option with 1-for-1 replacement-at-failure program
- Leverage existing capital renewal budget

Environmental Considerations:

- Traditional RTUs (esp. older units) can be performing even worse than you think – worth a close look
- ERV/HRV important for maximum efficiency
- Direct-Control Ventilation (DCV) and VAV-based control for maximum efficiency

Decision-Making Tools:

- System level: capacity of unit/efficiency calculation, calibrate with gas use
- Data logging through seasonal loads
- Retscreen Expert

Distributed Furnaces/PTACs

Design Considerations (ASHP):

- ERV/HRV an important consideration in conjunction with the furnace to minimize HP capacity
- Outdoor unit may pose visual/space challenges

Financial Considerations:

- Replace at failure more of an option with 1-for-1 replacement-at-failure program
- Leverage existing capital renewal budget

Environmental Considerations:

- ASHP should be paired with HRV/ERV where possible for maximum efficiency

Decision-Making Tools:

- System level: capacity of unit/efficiency calculation, calibrate with gas use
- Retscreen Expert
- Building modeling

Planning for efficient electrification: What’s next?

Efficient Electrification toolkit and helpdesk

The webinar recording and materials will be shared with you by email.

The tools can be accessed at SaveonEnergy.ca/Training-and-Support.

For questions and technical support regarding the Efficient Electrification Toolkit, contact trainingandsupport@ieso.ca.

Please use "EE toolkit helpdesk" as your email subject line. Requests will be triaged and addressed in the order they are received.

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Efficient Electrification webinar series

Next event: How to use the efficient electrification toolkit

March 21, 2024, 2:00 to 3:30 p.m.

Register now!

View upcoming events on our calendar.

Sign up for our bulletin to stay informed of future events.

Thank you!

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