JUNE 17, 2025

Optimizing high-efficiency heating systems for performance and savings

Presenters:
Stephen Dixon, Knowenergy
Michel Parent, Technosim

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SAVE ON ENERGY POWER WHAT'S NEXT

Save on Energy Program Enhancements DER/Solar Expansion Province Wide

June 2025

Vicki Gagnon, Advisor - Public Sector, DSM

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Demand-side management (eDSM) framework for 2025 to 2036

- **$10.9 billion**, **12-year** funding commitment from the Ontario government beginning in January 2025
- Moving away from the existing **time-bound**, start-stop DSM program model via four three-year program plans
- Offering all programs from previous framework
- **New programs:**
  - Home Renovation Savings Program
  - Peak Perks for Small Businesses Program
  - Solar Photovoltaic (PV) Systems for Businesses Program
- **Funding to local distribution companies (LDCs)** on an opt-in basis

Save on Energy programs for business

Save on Energy's business programs provide incentives to help Ontario businesses of all sizes implement retrofits and other energy-efficiency projects to lower their energy costs, including:

- **Instant Discounts Program**
- **Retrofit Program**
- Small Business Program
- Local Initiatives
- Strategic Energy Management Program
- **Existing Building Commissioning Program**
- **Energy Performance Program**
- Training and support

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Instant Discounts Program - lighting

- Incentives are paid directly to distributors to enable them to offer **instant point-of-sale discounts** to their customers on energy-efficient lighting
- **No paperwork** to apply for the program on the part of contractors, consultants or end users
- Eliminate wait times and application processing, resulting in a streamlined customer experience

Learn more at SaveOnEnergy.ca/InstantDiscounts

Retrofit Program spring 2025 enhancements

Enhancements effective June 30, 2025		Description
	Increased incentive rates for custom projects by ~50%	New incentives at greater of $1,800/kW or $0.20/kWh for achieved electricity savings*
	Updates to areas qualifying for regional adders and custom adders	Adders offer double the standard incentive for facilities located in constrained areas*
	New computer room measures (in addition to existing computer room air-conditioning measures)	ENERGY STAR® certified computer servers, computer virtualization, ENERGY STAR certified uninterruptible power supply

Learn more: SaveONenergy.ca/News-and-Updates

The next Retrofit Program enhancements are expected for fall 2025.

*Incentives are capped at 50% of project costs.

Retrofit Program – solar distributed energy resource (DER) rooftop solar PV

Now available across Ontario

Prescriptive incentives cover up to 50% of eligible project costs for load displacement only solar PV rooftop generation, including:

1. **Micro-generation** projects up to **10 kW**-DC are eligible for **$1,000/kW-DC**
2. **Small/medium** generation projects greater than **10 kW-AC up to 1 MW**-AC are eligible for **$860/kW-AC***

*Projects > 1 MW-AC are eligible, but the incentive is capped at 1 MW-AC.

Existing Building Commissioning (EBCx) Program

Investigation phase

- Investigation report prepared by **commissioning provider** (CP)
- Incentive up to **$0.06/square foot**, capped at 75% of cost paid by participant to CP or **$50,000** (per facility)

Implementation phase

- Implement recommended energy-efficiency measures
- Incentive of **$0.03/kWh** of confirmed energy savings, capped at 30% of annual facility electricity consumption (kWh) or $50,000, whichever is less

Persistence phase

- CP training to maintain systems
- At end of **12 months**, incentive of **$0.03/kWh** of confirmed savings, capped at 30% of annual facility consumption (kWh) or $50,000, whichever is less

Energy Performance Program (EPP)

- Holistic approach to energy savings: operational + behaviour + capital
- Savings determined by comparing metered annual consumption to baseline energy model
- Data normalized for weather and significant building operations, e.g. occupancy, production, COVID-19
- **Tiered incentive rates: $0.15/kWh on peak, $0.04/kWh off peak**
- Optional upfront incentive payment

Learn more at saveonenergy.ca/EPP

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Save on Energy program support

Retrofit contact:

Retrofit@ieso.ca or call the Save on Energy retrofit support line at 1-844-303-5542

Opening hours:
Monday to Friday, 8:30 a.m. to 5:00 p.m.

Sign up for the Save on Energy business newsletter
https://www.saveonenergy.ca/For-Business-and-Industry

Instant Discounts Program
info@instantdiscounts.ca

Small Business Program
info@smallbusinessprogram.ca

Peak Perks for Small Business
info@peakperks.ca

BizEnergySaver
info@bizenergysaver.ca

Existing Building Commissioning Program
EBCx@ieso.ca

Energy Performance Program
info@energyperformanceprogram.ca

Expanded Energy Management Program
info@energyperformanceprogram.ca

Training Opportunities
efficiency.training@ieso.ca

Thank you!

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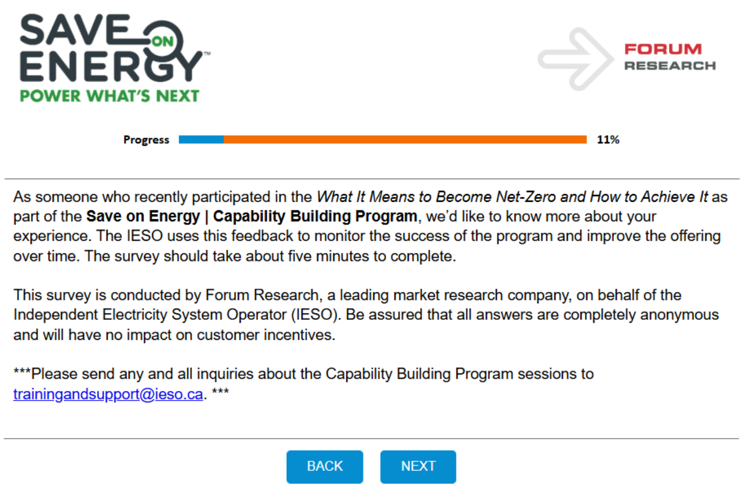
Sign up for Save on Energy's quarterly business newsletters for the latest program, resource and event updates

Vicki.Gagnon@ieso.ca

Upcoming survey: We want your feedback!



- Check your email! A survey is coming your way soon
- Why? Help us improve our training programs
- Who? Conducted by Forum Research on behalf of the IESO
- Time? Takes only 5 minutes to complete
- Confidentiality: Your responses are anonymous and will not impact participation or incentives

The survey will be sent from: surveyinfo@forumresearch.com

Agenda

1. Welcome and introductions
2. System types and applications
3. Commissioning guidelines
4. Performance improvements with optimized controls
5. The business case for high-efficiency heating systems
6. Questions and answers

Objectives

- Understand the types of high-efficiency heating systems
- Learn the importance of efficient distribution systems before considering switching to high-efficiency systems
- Understand what to look for when proceeding with the design and installation phases of a project
- Perform standard maintenance strategies for each system
- Demonstrate an understanding on optimized controls and operation using smart thermostats, improved zoning control and heat pump controls

System types and applications

Poll

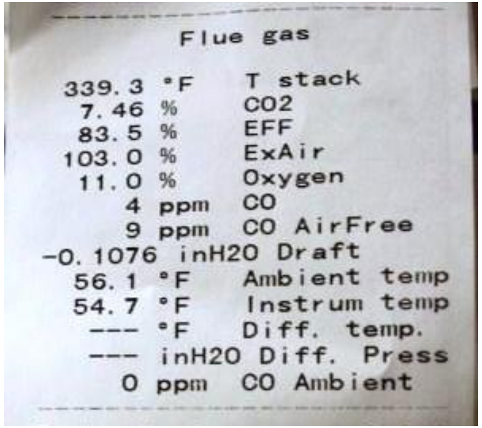
What do you think of first when you hear high-efficiency heating systems?

Unmute or type in the chat!

Annual and nameplate efficiencies

- For some equipment, both an annual and steady-state efficiency is available.
- Nameplate efficiency (steady state)
  - Thermal efficiency of any combustion equipment
  - COP, EER and kW/ton for heat pump and air conditioning equipment
- Annual efficiency
  - AFUE (Annual fuel usage efficiency) - residential size furnaces and boilers
  - SEER (Seasonal EER) – small air conditioner and heat pumps for cooling
  - HSPF (Heating seasonal performance factor) – small heat pumps for heating
  - IPLV (Integrated part load value) – for commercial chillers and heat pumps
  - IEER (Integrated EER) – for commercial air conditioner

Thermal equipment efficiencies



- Combustion efficiency
  - Instantaneous efficiency of burning fuel (Ex. 86%)
  - Represents unburned fuel and/or excess air loss
- Thermal efficiency
  - Instantaneous efficiency of producing hot water (air), steady state (Ex. 80%)
  - Introduces convection and radiation
- Seasonal efficiency
  - Over time (heating season) efficiency of producing hot water (air): around 72%
  - Incorporates the effect of actual operating temperatures, cycling, stand-by and off cycle losses.

The range of annual efficiencies

- Atmospheric combustion equipment: 50% to 75%
- Power combustion equipment: 75% to 85%
- Condensing combustion equipment: 85% to 95%
- Electric boilers and heaters: 98% to 100%
- Air-source heat pumps: (coefficient of performance, COP, of 1.5 to 3.5) 150% to 350%
- Variable refrigerant flow systems: (COP of 2.5 to 4.0+) 250% to 400%
- Water or ground-source heat pumps: (COP of 2.5 to 5.0+) 250% to 500%

Atmospheric combustion equipment

- Unit heaters
- Atmospheric boilers
- Roof-top units (RTIs), induced draft
- Hot water heaters

Atmospheric combustion equipment applications

- Boilers: small to large buildings with hydronic heating loops, no longer available
- Unit or force-flow heaters: Areas with no ventilation requirements other than possible exhaust, ancillary/service spaces
- RTUs: small to medium buildings with no hydronic loops, dedicated areas (single zone); lower cost option compared to built-up or hydronic systems
- Hot water heaters: widely used in all sectors

Power combustion equipment

- Steam boilers
- Hot water boilers
- Domestic hot water (DHW) heaters

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Power combustion equipment applications

- Steam boilers: common in industrial, large institutional buildings and used for humidification in some large commercial buildings
- HW boilers: identical to that of atmospheric units, can be swapped with minimal impact other than the flue
- DHW heaters: identical to less efficient atmospheric models

Condensing combustion equipment

- Boilers
- Furnaces
- RTUs and make-up air (MUA) units
- DHW heaters

Condensing combustion equipment applications

- Due to regulation, used basically everywhere boilers and furnaces are used
- Best application for boilers: low temperature loops such as reheat and AHU/MUA loops
- Dual inlet boilers can have a hot return and colder return to maximize efficiency
- For DHW heaters, cold inlet is required to achieve maximum, recirculation loop above 53°C is not favourable

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Electric heating systems

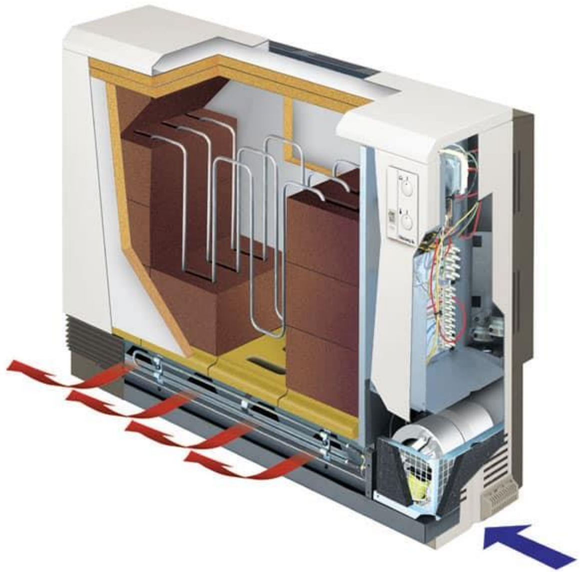
- Electric boilers
- Thermal storage heaters
- Baseboard heaters
- RTUs, furnaces, unit heaters

Electric heating system applications

- Baseboards/unit heaters: commonly used in ancillary spaces when natural gas service is unavailable or too complex/expensive
- Electric boilers: used to be present in some commercial buildings but are uncommon due to required electrical service and peak demand cost
- Utilized in hybrid systems (gas/electric) with peak demand control

Electric heating system applications continued

- Thermal storage: small to medium size commercial buildings with either hydronic or forced-air systems
- Allows peak demand management but the off-peak kWh must be relatively low (comparable to gas rate)



Air-source heat pumps

- Central heat pumps – hydronic and air distribution
- Mini-split systems
- RTUs
- Water heaters

Applications

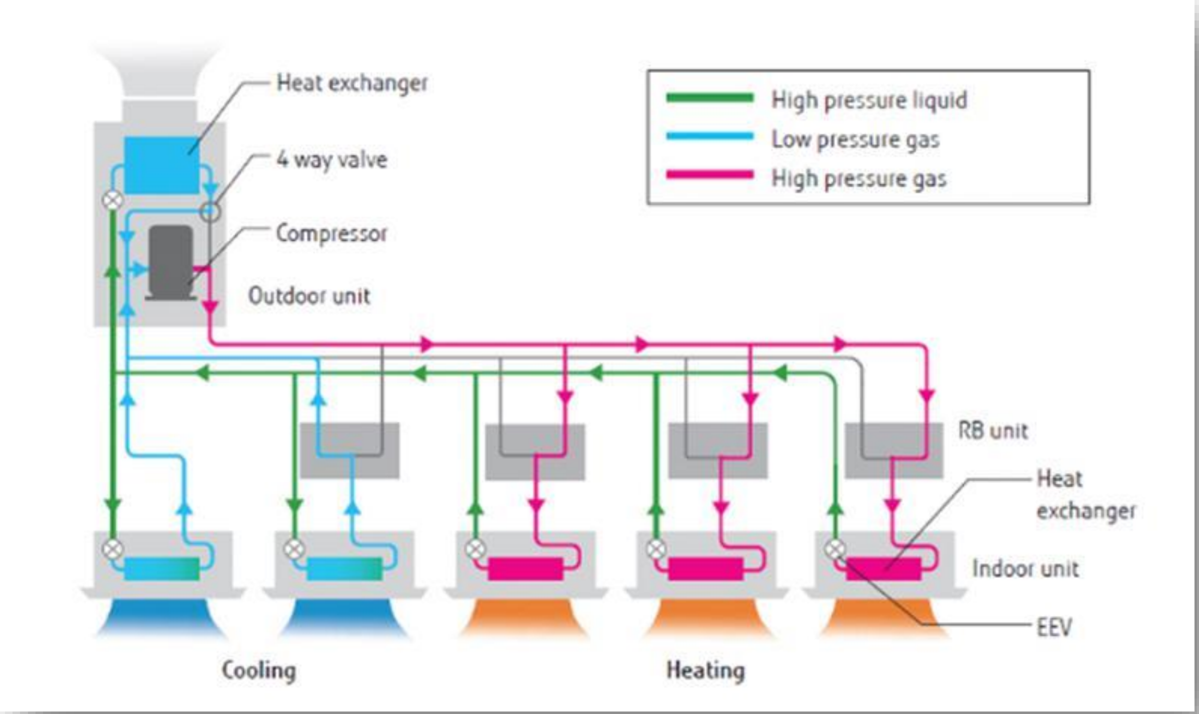
- Central heat pumps: small to large commercial buildings with low temperature hydronic loops or air-side heating distribution
- Typically requires a supplemental heating system (natural gas)

Applications continued

- Mini-split: known for high efficiencies but limited to small areas not served by central system or where additional heating/cooling is needed
- RTUs: identical to any in the RTU market, usually requires supplemental heating (electric or natural gas)
- Water heaters: installed in spaces with high internal heat gain for maximum efficiency

Variable refrigerant flow

- Heat pumps
- Heat recovery

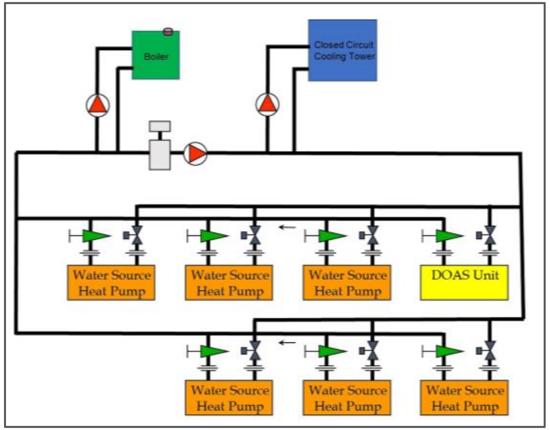


Variable refrigerant flow applications

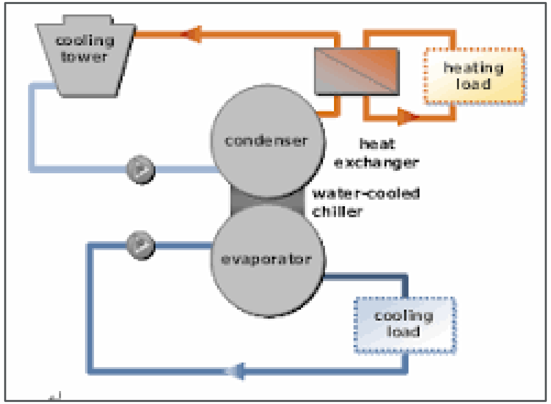
- Small to medium commercial buildings – or portion of large ones
- Often used in retrofits as it does not require large mechanical spaces and ducting
- Allows for individual zone control
- Significant amount of refrigerant in the system ad moving throughout the building
- Efficiency decreases with increasing length of refrigerant piping

Water-source heat pumps

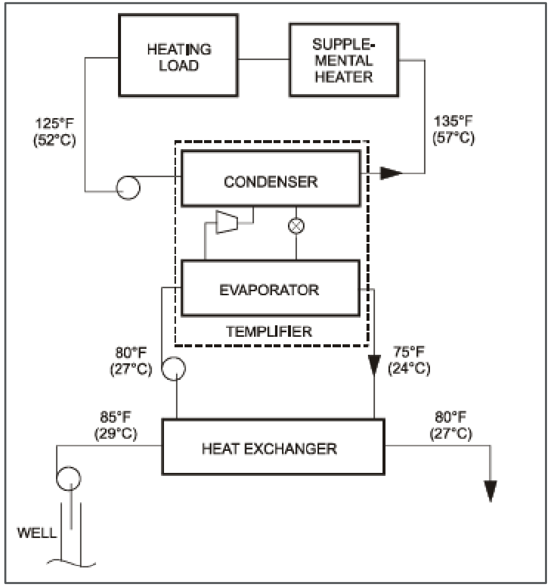
Water loop heat pump



Heat recovery chillers



Geothermal (ground-source heat pumps, GSHPs)



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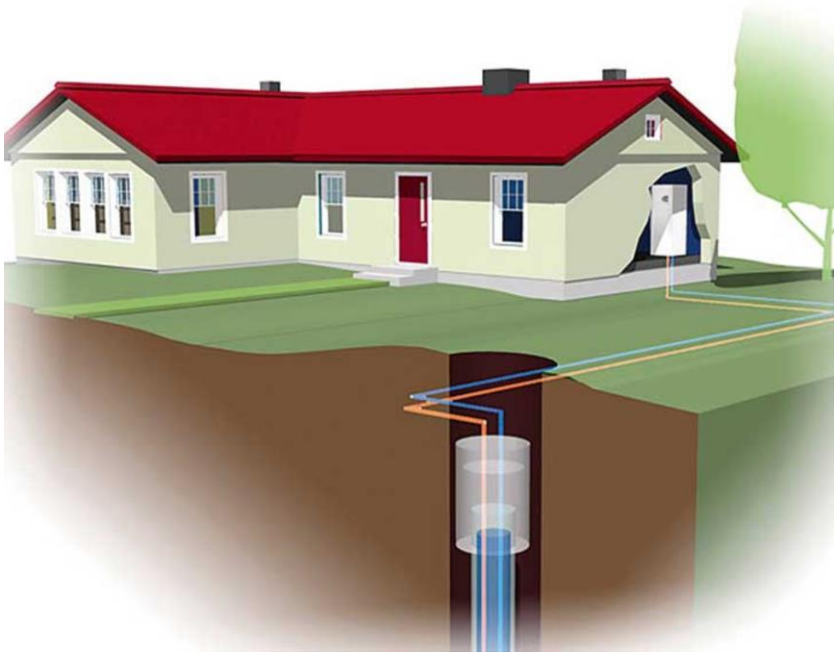
Water-source heat pump applications

- Medium to large commercial/institutional buildings
- Heat recovery chillers: replacements for existing chillers when low temperature heating loops are available
- Cascade system is possible to achieve higher temperatures

Water-source heat pump applications continued

- Heat pump loop: since it is a low temperature loop, the boiler can be replaced by an air-source heat pump
- GSHP: either distributed (i.e. water loop heat pump) or with a central heat pump that can serve a hydronic loop



Hybrid systems

- Hybrid systems use a combination of equipment
- Benefits of hybrid systems are broad:
    - Potential reduced equipment costs by sizing systems for partial loads
    - Potential for operating cost savings by using the most cost-effective equipment at the appropriate time
    - Consistent comfort
    - Improved efficiency
    - Reduced operational emissions

Hybrid systems continued

- Gas, heat pump or electric systems
- Both are enabled during the heating seasons
- Electric/heat pump operates as lead until the building demand reaches a pre-defined value
  - This value is typically optimized on a monthly basis to minimize the overall utility cost
  - For greenhouse gases (GHG), the monthly set point can also be adjusted to meet specific GHG targets
- Common technology with low technical risks

Applications

- Small to large commercial/institutional buildings.
  - It does not require hydronic loops
  - Can be done with air-based systems.
- Ensure you have sufficient electric supply to avoid the often-significant and costly upgrade to the electrical service.
- For optimal results, requires the presence of a BAS with tracking of the total electric demand.

Pre-installation and commissioning guidelines

Message in chat

What actions have you taken or believe you should take prior to installing high-efficiency heating equipment?

Unmute or type in the chat!

Pre-installation considerations

- Ensure the distribution system is suitable for the system prior to installation.
  - Example: Check if the ductwork is well insulated or hydronic loops are sized for low-temperature supply
- Assess the additional electrical capacity that might be required for heat pumps and electrical boilers; ensure the building can maintain the new electrical load
- Conduct a site walkthrough of all the mechanical systems to identify existing conditions or constraints and provide designer/installers with accurate information

Commissioning of high-efficiency systems

- For most systems, efficiency and performance are highly dependent on how the system is sized, configured and operated
  - All aspects that fall under the umbrella of proper commissioning
- Commissioning must commence at the onset of the project and not just during construction and startup
- An independent third-party commissioning provider should be favoured or an experienced in-house commissioning agent to overview the contractor commissioning work

The steps

- From project conception to final delivery
- Phases of Cx are:

Design	Construction	Acceptance	Warranty

Know your objectives and requirements

- Commissioning a system requires having a clear idea of the service to be provided
  - Owner project requirements (OPRs): must define specific performance for the heating system and that can be measured during commissioning, such as:
    - COP typically under various conditions (such as outdoor temperature)
    - Performance of supplemental heating source
    - Control sequence for the use of supplemental heating
    - Impact on building peak demand
- Compare the results to the basis of design (BOD), which is basically what the contractor/installed proposed to the owner

Prior to installation

- The submittal review phase is a necessary part of commissioning
- Equipment specifications provide an overview of how the system is intended to function; the sequence of operation must also be reviewed
- Commissioning authority will review to ensure compliance to OPRs and BODs
- Submittals: a basis for developing the commissioning pre-functional checklists (PFCs) and functional performance test (FPT) plans

Checks during construction

- Checklists: fundamental component of the commissioning process; typically provided by the contractor and include electrical and mechanical verifications; They serve to confirm that the heat pump system has been fully installed
- All required balancing work is to be completed (air, hydronic, geothermal)
- Once the checklist is complete and verified by the commissioning authority, the system is ready for performance testing

Verify the performance

- The commissioning authority must be present when the performance test of the heat pump system is performed
- Demonstration of the expected sequence of operation as specified, switch-over to supplemental heating, alarms safeties, schedules and setpoints
- More than one season is required to test the heat pump performance
    - Within the warranty period 5-10 years

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Issues log

- The commissioning authority keeps an issues log throughout the entire process
- Issues are reported to the contractor and often require resolution prior to moving to the next installation phase
- Items are tracked until resolution
- Full payment of the project is not made until all performance tests are completed and issues log is clear

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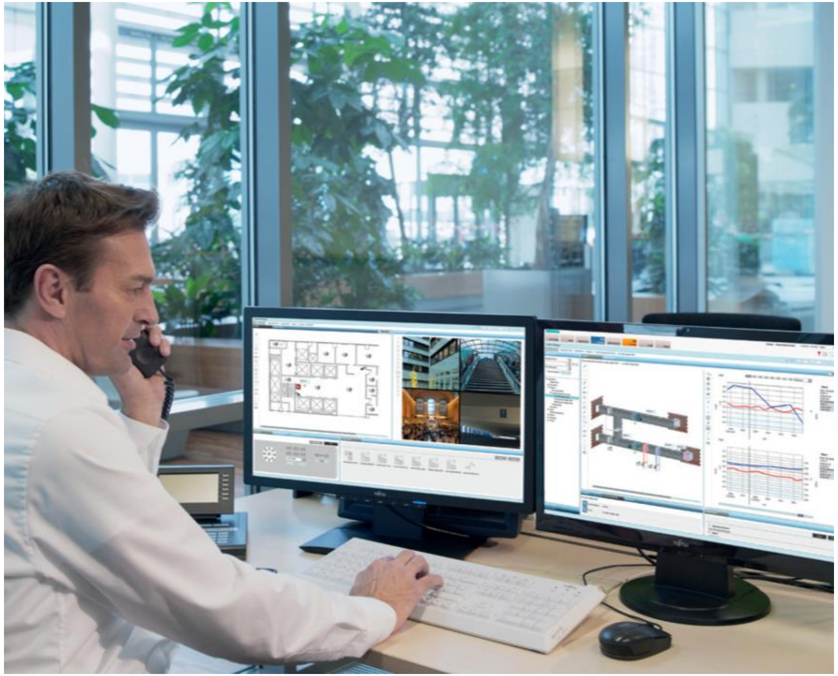
Performance improvements with optimized controls

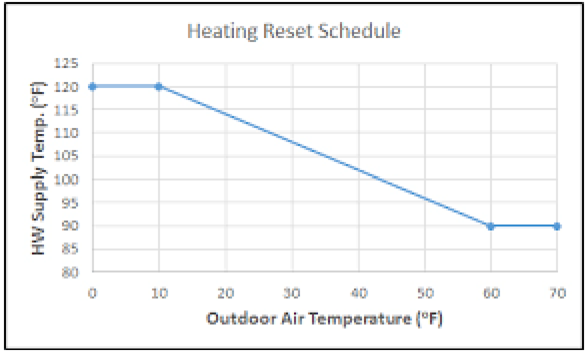
New system – old sequences

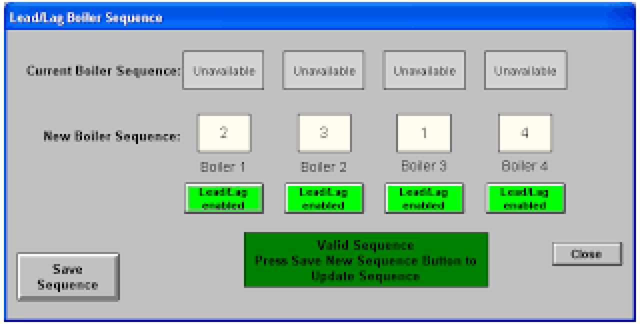
- High-efficiency heating systems require changes to control sequences
- Often performed during commissioning but constantly updated as staff become more knowledgeable about operation
- Ensure that all required points are available on the building automation system (BAS)
- Captured though the commissioning process



Typical changes - boilers

- Some of the most typical and important changes include:
  - Modify the reset schedules of condensing boilers to lower the supply set point as much as possible – typically requires some testing
  - Modify the operation sequence of the equipment to maximize part-load efficiency
- Avoid rules-of-thumb and use functional testing to optimize the sequence.





Typical changes – heat pumps

- Some of the most typical and important changes include:
  - Review air handlers supply air temperature set points to reduce them as much as possible. This allows for lower supply temperature from the heat pump (air or hydronic).
  - Review and optimize the switch-over to supplemental heating, often based on a building's peak demand or outside air temperature.
  - Review the warm-up ramp after a night or weekend set back to avoid creating a peak or unnecessarily switching to supplemental heating.
  - For multiple-stage and/or unit systems, review the sequence to use the most efficient part-load combination – requires functional testing.

The business case for high-efficiency heating systems

Poll - 1

What financial barriers or opportunities have you encountered in implementing high-efficiency heating systems?

Unmute or type in the chat!

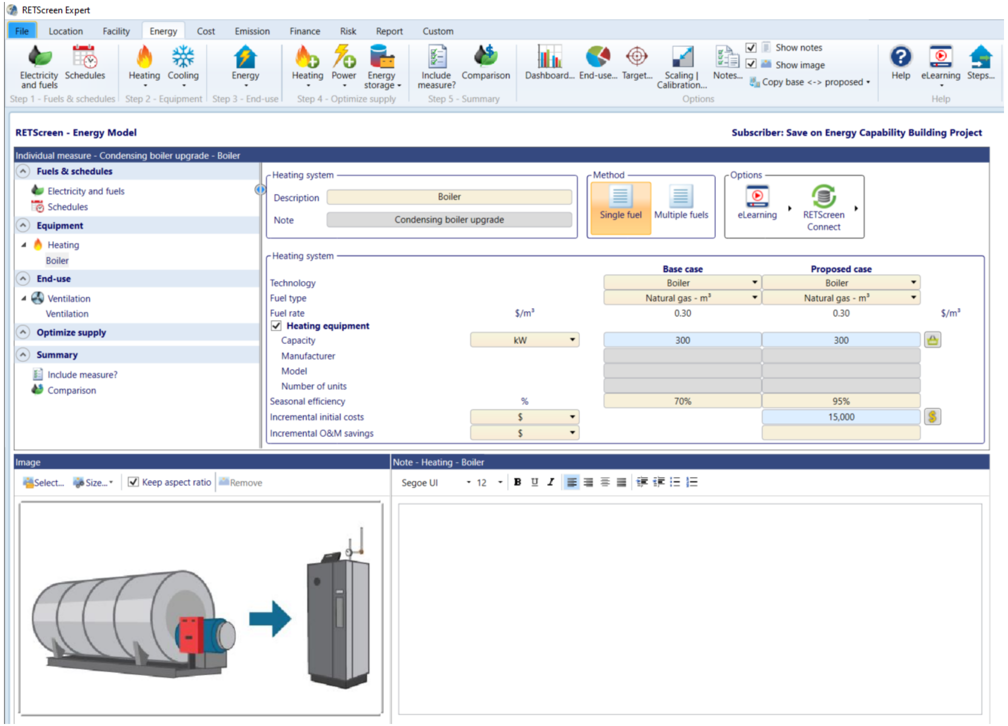
The price of delivered heat (not including demand)

- **Natural gas (10.5 ekWh/litre)**
  - \$0.40/m^3 -> \$0.038/ekWh @ 85% efficiency ~ \$0.045/ekWh
- **Electric heat**
  - \$0.14/kWh @ 100% efficiency -> \$0.14/ekWh
- **Air-source heat pump**
  - \$0.14/kWh @ 200% efficiency (COP = 2) -> \$0.07/ekWh
- **Ground-source heat pump**
  - \$0.14/kWh @ 350% efficiency (COP = 3.5) -> \$0.04/ekWh
- **Heat pump on class A rate**
  - \$0.05/kWh @ 200% efficiency (COP = 2) -> \$0.025/ekWh

Carbon associated with delivered heat

- **Natural gas (10.5 ekWh/litre)**
  - 1.86 kg/m^3 -> 0.18 kg/ekWh @ 85% efficiency ~ 0.21 kg/ekWh
- **Electric heat**
  - 0.03 kg/kWh @ 100% efficiency -> 0.03 kg/ekWh
- **Air-source heat pump**
  - 0.03 kg/kWh @ 200% efficiency (COP = 2.0) -> ~ 0.015 kg/ekWh
- **Ground-source heat pump**
  - 0.03 kg/kWh @ 350% efficiency (COP = 3.5) -> ~ 0.01 kg/ekWh

Building the business case – RETScreen expert



The business case – financial analysis

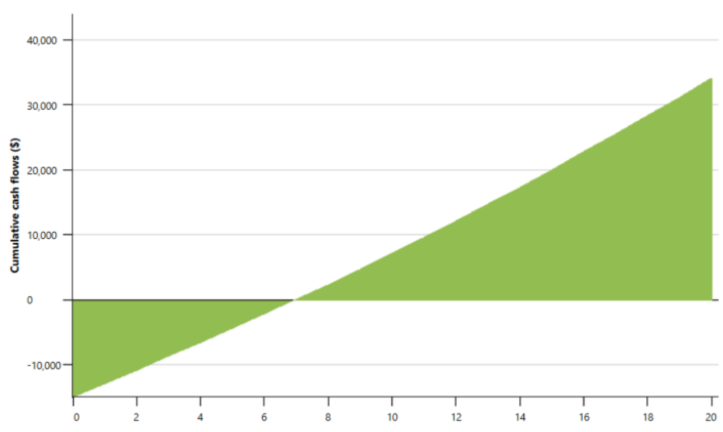
RETScreen - Financial Analysis

Subscriber: Save on Energy Capability Building Project

Financial analysis

Financial parameters		
Inflation rate	%	2%
Project life	yr	20
Debt ratio	%	0%
Total initial costs	$	15,000
Incentives and grants	$	
Annual costs and debt payments		
Fuel cost - proposed case	$	5,555
Debt payments	$	0
Total annual costs	**$**	**5,555**
Annual savings and revenue		
Fuel cost - base case	$	7,539
GHG reduction savings	$	0
Total annual savings and revenue	**$**	**7,539**
Financial viability		
Pre-tax IRR - assets	%	14%
Simple payback	yr	7.6
Equity payback	yr	7

Cumulative cash flows graph

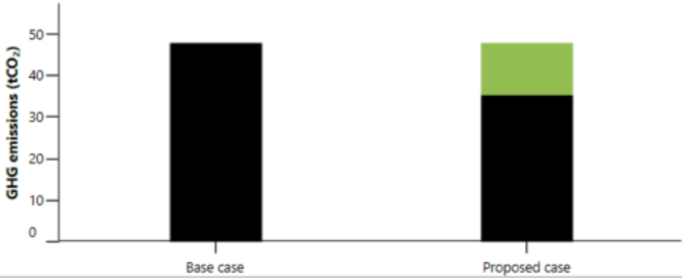


The business case – emission analysis

RETScreen - Emission Analysis **Subscriber: Save on Energy Capability Building Project**

Emission analysis

GHG emissions			
Base case	tCO_2	47.9	
Proposed case	tCO_2	35.3	
Gross annual GHG emission reduction	tCO_2	12.6	26.3%



Legend

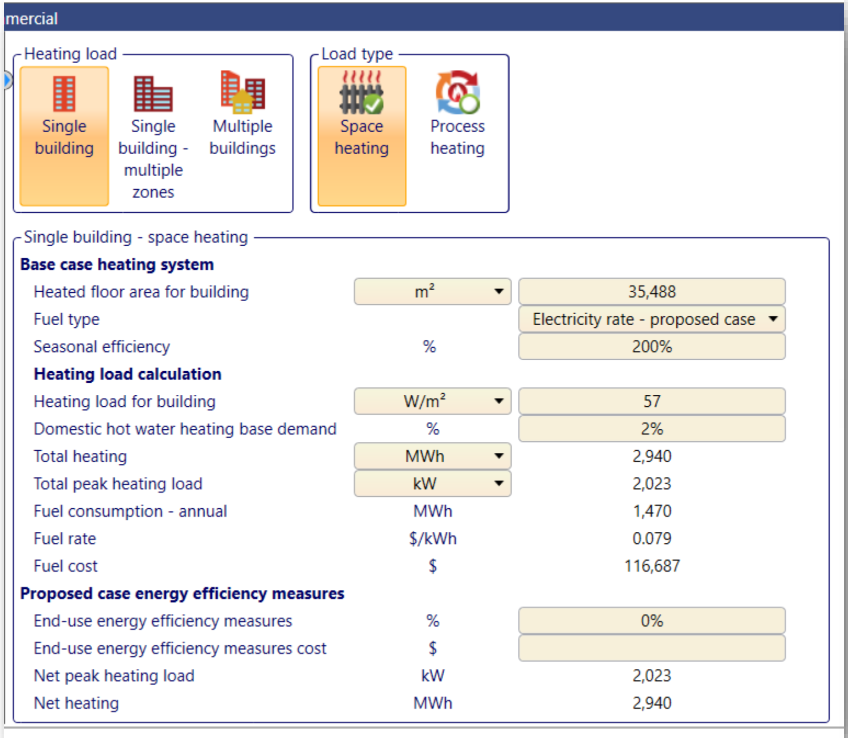
Gross annual GHG emission reduction (26.3%)

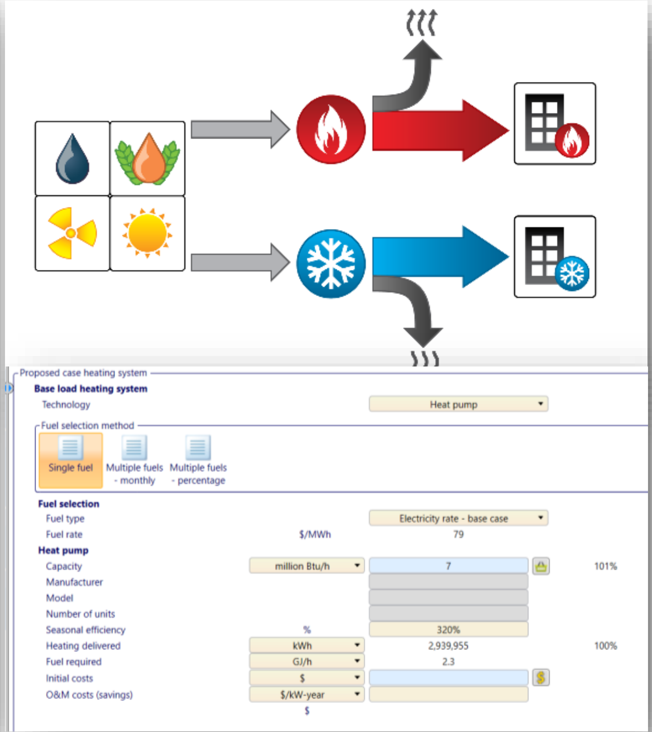
12.6 **tCO_2** **is equivalent to** **2.3**

Cars & light trucks not used

Heating, ventilation and air-conditioning (HVAC) rooftop unit - natural gas to heat pump

Advanced feature - heat pump sizing and conversions





In summary – the business case for electrification

The 20-year NPV is positive or neutral for commercial building electrification using cold-climate heat-pump RTU equipment.

These retrofits can be conducted as 1:1 equipment swap outs with limited system reconfiguration, reducing upfront costs.

Regional climate conditions and gas utility rates are primary drivers of the economics of decarbonization retrofits.

Electrification in commercial buildings can be paired with a suite of other energy retrofit measures, particularly ERV, peak heating load management, and on-site solar PV, to improve cost effectiveness and reduce grid impacts.

Increased availability and improved performance of cold-climate heat pump RTU equipment will make it easier and more beneficial to implement these retrofits.

Costs are likely to decrease over time with advancements in the heat pump product market and policy changes across states and at the federal level.

The business case enhancement

- Improved system performance – reliability and maintenance
- Increased building value – through building certification, tenant attraction and retention and resilience
- Incentives and funding - significant incentives, and financing mechanisms exist to support energy-efficient projects

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SAVE ON ENERGY POWER WHAT'S NEXT

Questions and answers

- Any questions?
- Training and support webpage: visit this page to access all training and support materials

Save on Energy's Capability Building Program

- Save on Energy's Capability Building Program helps increase awareness about energy-efficiency opportunities, enhance knowledge and develop skills in organizations and communities across Ontario so they can undertake energy-efficiency actions and participate in Save on Energy programs
- The program includes tools such as workshops, webinars, training courses, coaching, peer learning and information resources including guides and videos

Learn more at https://saveonenergy.ca/Training-and-Support
Register at www.saveonenergytraining.ca

Training courses – incentives

Save on Energy offers incentives of up to 50% for ~20 training courses plus certification exam fees, including:

- Achieving Net-Zero Buildings
- Energy Management and the ISO 50001 Standard
- HVAC Optimization for High Performance Sustainable Buildings
- Certified Energy Manager (CEM)
- Certified Measurement and Verification Professional® (CMVP)

Learn more at https://saveonenergy.ca/Training-and-Support/Training-Courses

Training courses – incentives for Enbridge customers

Enbridge customers are eligible for incentives of up to 75% for three courses:

- Dollars to $ense Workshops: up to $500 per day
- Certified Sustainable Building Operator® (CSBO): up to $2,250 for course fees
- Certified Energy Manager® (CEM): up to $2,500 for course fees

Stay connected with tools and resources

- Virtual one-on-one coaching: post-webinar support intake form for tailored support for organizations to manage energy resources effectively
- Monthly bulletin: sign up to receive monthly training updates on all Save on Energy training and support for new tools and resources
- Live training calendar: visit this page to easily register for upcoming events and workshops
- Training and support webpage: visit this page to access all training and support materials

Post-webinar support

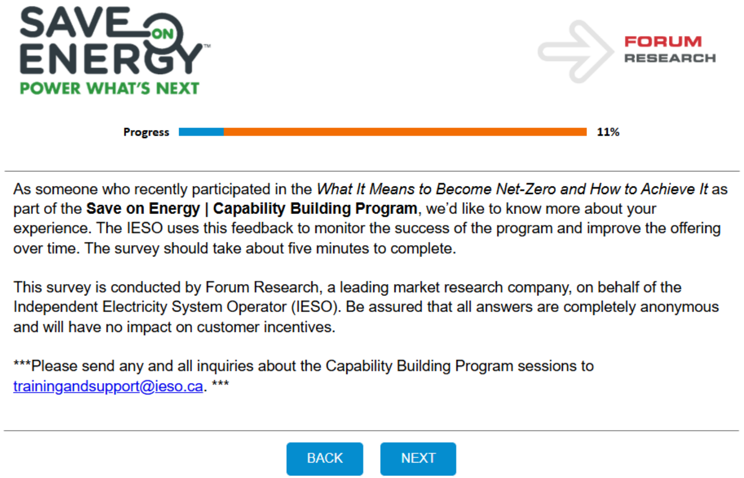
One-on-one coaching: tailored support for managing energy resources effectively

Post-webinar support intake form

Coaching sessions conducted virtually: phone, video calls and email

Designed for organizations, new or old, seeking guidance

Upcoming survey: we want your feedback! (bis)


Progress 11%

As someone who recently participated in the *What It Means to Become Net-Zero and How to Achieve It* as part of the **Save on Energy | Capability Building Program**, we'd like to know more about your experience. The IESO uses this feedback to monitor the success of the program and improve the offering over time. The survey should take about five minutes to complete.

This survey is conducted by Forum Research, a leading market research company, on behalf of the Independent Electricity System Operator (IESO). Be assured that all answers are completely anonymous and will have no impact on customer incentives.

***Please send any and all inquiries about the Capability Building Program sessions to trainingandsupport@ieso.ca. ***

BACK NEXT

The survey will be sent from: surveyinfo@forumresearch.com

- Check your email! A survey is coming your way soon
- Why? Help us improve our training programs
- Who? Conducted by Forum Research on behalf of the IESO
- Time? Takes only 5 minutes to complete
- Confidentiality: your responses are anonymous and won't impact participation or incentives

Thank you!

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