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The role of energy efficiency in buildings, 2025 and beyond
Supporting decarbonization efforts

Presenters:
Adam Dixon, Knowenergy
Dragos Paraschiv, Exergy Associates

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Agenda

1. Welcome and introductions
2. What is energy efficiency and how does it support decarbonization?
3. Tried and tested solutions for energy efficiency
4. Emerging technologies
5. The future of energy sustainability
6. Questions and answers

Objectives

- Understand the role of energy efficiency in supporting decarbonization efforts
- Explore Ontario-specific strategies, technologies and incentives
- Learn how energy efficiency contributes to achieving carbon reduction targets in the building sector

Introduction to energy efficiency

What is energy efficiency?

- The process of implementing change that results in reduced energy consumption while maintaining or improving performance and comfort
- Achieved by optimizing heating, ventilation and air-conditioning (HVAC) systems, technologies and processes with a focus on reducing energy waste, decreasing operational and maintenance costs and reducing environmental impacts

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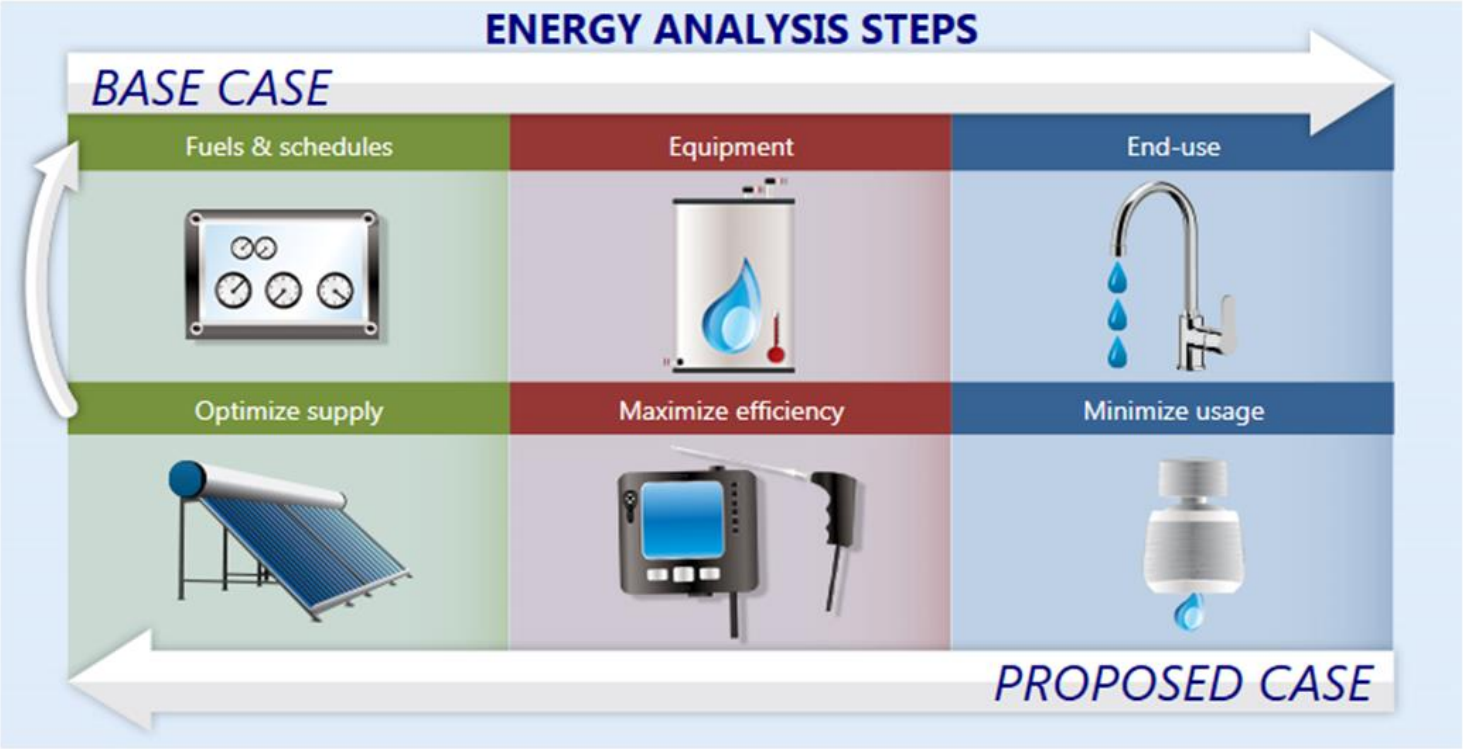
Code: 3274 0246

Poll

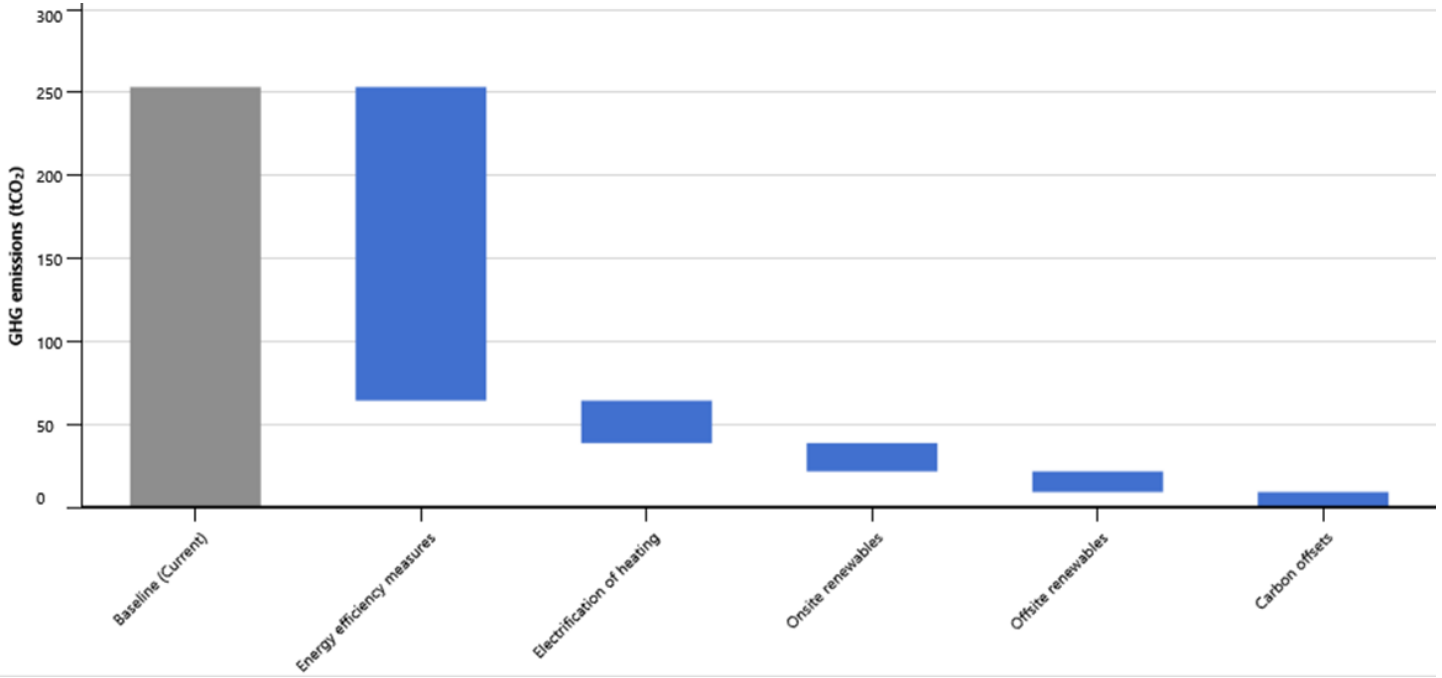
Tell us about yourself.

Where are you in the energy management framework?

How to approach energy efficiency projects



How energy efficiency supports decarbonization

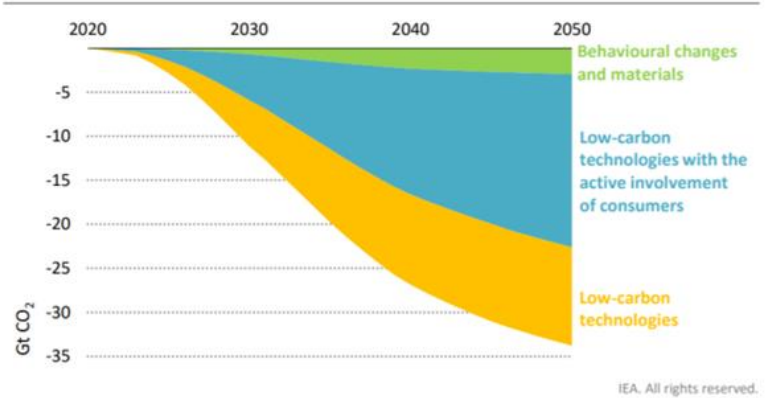


Tried and tested energy efficiency solutions

Behavioural change

- Awareness about energy management initiatives:
  - Assemble the team
  - Develop key messages
  - Select communication tools
  - Include it in activities and events
  - Share progress updates

Figure 2.14 ▷ Role of technology and behavioural change in emissions reductions in the NZE



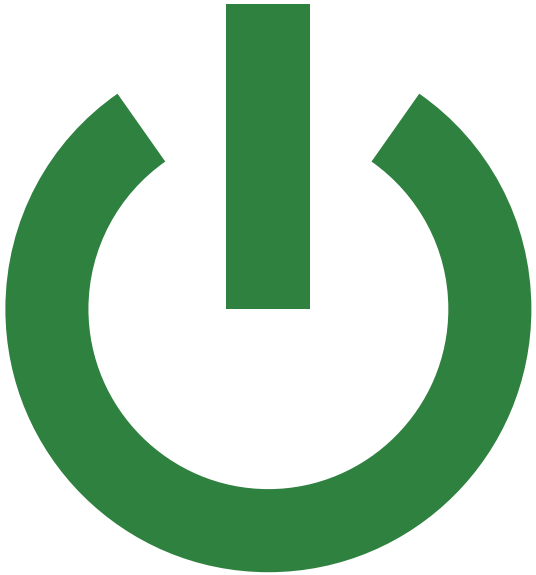
Around 8% of emissions reductions stem from behavioural changes and materials efficiency

Notes: Low-carbon technologies include low-carbon electricity generation, low-carbon gases in end-uses and biofuels. Low-carbon technologies with the active involvement of citizens includes fuel switching, electrification and efficiency gains in end-uses. Behavioural changes and materials efficiency includes transport mode switching, curbing excessive or wasteful energy use, and materials efficiency measures.

Eliminate waste

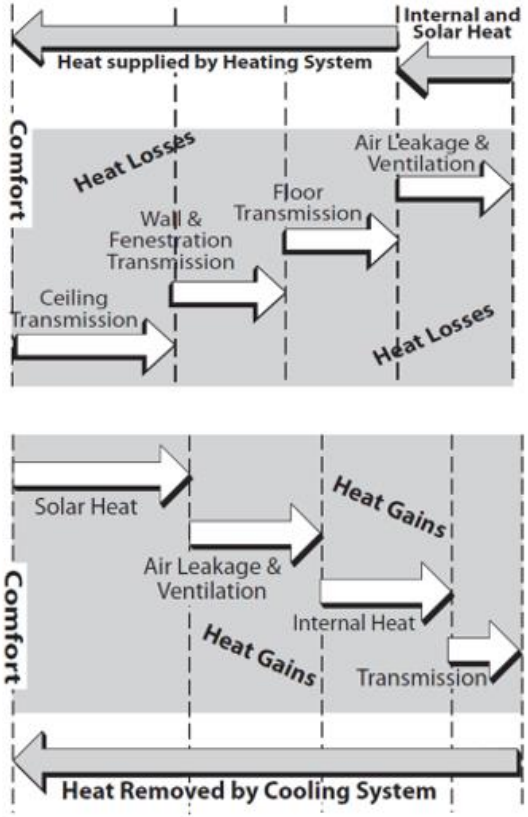
- Energy conservation complements energy efficiency in reducing energy consumption

- Turning lights off in unused areas
- Using programmable thermostats
- Unplugging electronics to avoid phantom loads
- Powering off unused appliances
- Optimizing loads for equipment cycles

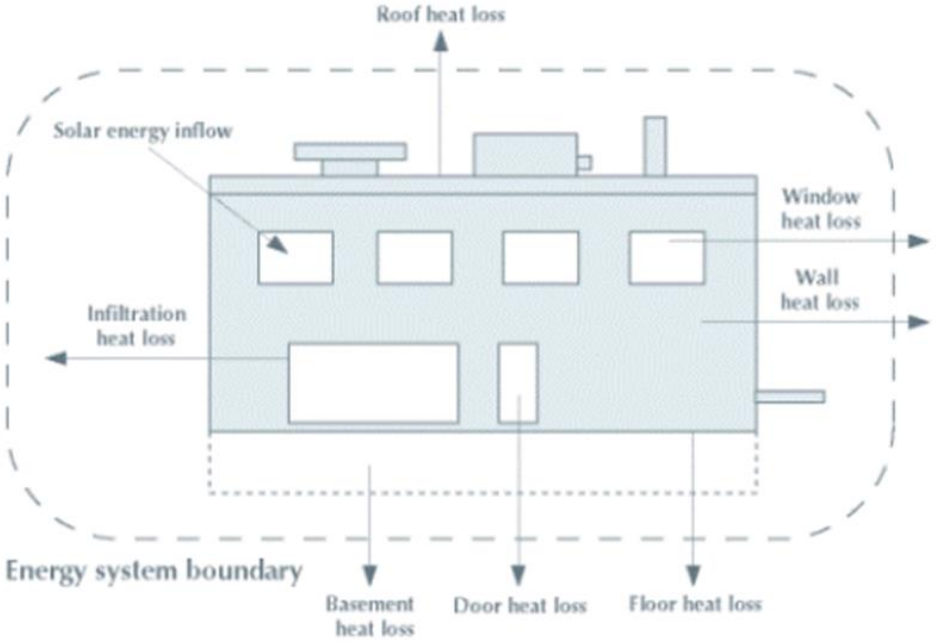


Building envelope

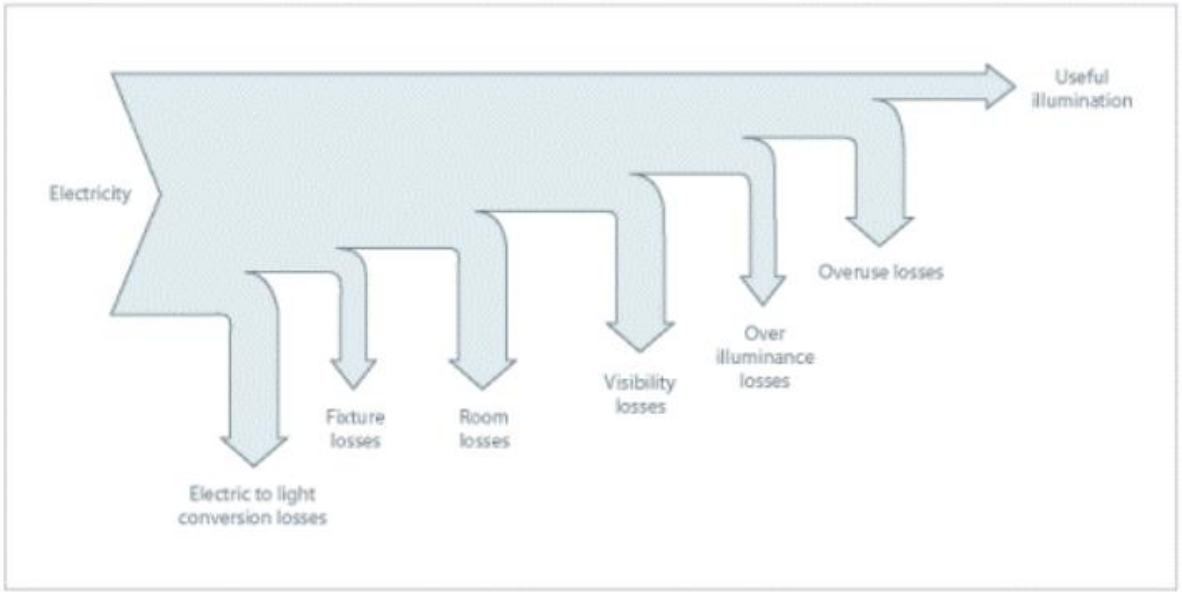
- Heat transfer through the building envelope is the largest energy demand for many buildings.
  - For homes, over 60% of energy demand is the result of heating and cooling loads
- To maintain comfort, heating and cooling systems supply or remove heat at a rate roughly equal to the rate of heat transfer through the envelope



Energy flows through the building envelope



Lighting retrofits



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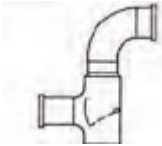
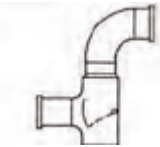
HVAC system tasks and components



Intake / Exhaust	**Production/motion** **Movers, converters, processors**	**Distribution** **Supply and return trees, delivery and control components**	**Results**
Heat Fuel combustion air Heat CO_2	Boilers Furnaces Pumps Fans Filters Heat pumps	Pipes, ducts Electricity conduits Diffusers, grilles Radiators Thermostats Valves, dampers	Warm air or surfaces Air motion often controlled Humidity control sometimes needed

HVAC system tasks and components (Cont'd)



	Production/motion	Distribution	Results
Cool Air, water, fuel Air, vapour, water, heat CO_2	Evaporative coolers Heat pumps Chillers, cooling towers Coils Pumps Fans Filters	Pipes Ducts Diffusers, grilles Radiators Thermostats Valves, dampers	Cool air or surfaces Air motion usually controlled Humidity control usually provided
Vent Air Air	Fans Filters	Ducts Diffusers Grilles Switches Dampers	Fresh air Air motion usually controlled Air quality control often needed

Efficient HVAC systems

- Energy recovery ventilators, heat recovery ventilators (ERVs/HRVs)
- Demand controlled ventilators (DCVs)
- Condensing boilers
- Hot water heat reclaim
- Electronically commutated (EC) fan motors
- Optimized fan cycling (staging)
- Variable air and water flow systems (using variable speed fans and pumps)
- Heat pumps

Typical efficiencies of HVAC systems

Heating system type	Typical annual heating system seasonal efficiency
Standard boiler/furnace (with pilot light)	55 to 65%
Mid efficiency boiler/furnace (spark ignition)	65 to 75%
High efficiency or condensing boiler/furnace	75 to 85%
Electric resistance	100%
Heat pump - air-source	130 to 200%
Heat pump - ground source	250 to 350%

Cooling system type	Typical annual cooling system seasonal COP
Compressor - centrifugal	5 to 6.7
Compressor - reciprocating	3.8 to 4.6
Compressor - screw	4.1 to 5.6
Compressor - scroll	4.6 to 7
Heat pump - gas	1.1
Heat pump - air-source	1.3 to 2
Heat pump - ground-source	3 to 3.5
Absorption - single stage	0.5
Absorption - two stage	0.7
Steam jet refrigeration	0.2 to 0.3

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Heat pumps

- The two principal modes of heat pump operation are heating and cooling. A third mode, the defrost cycle, is used to protect coils from excessive frost buildup
- The two common types found in Canada are:

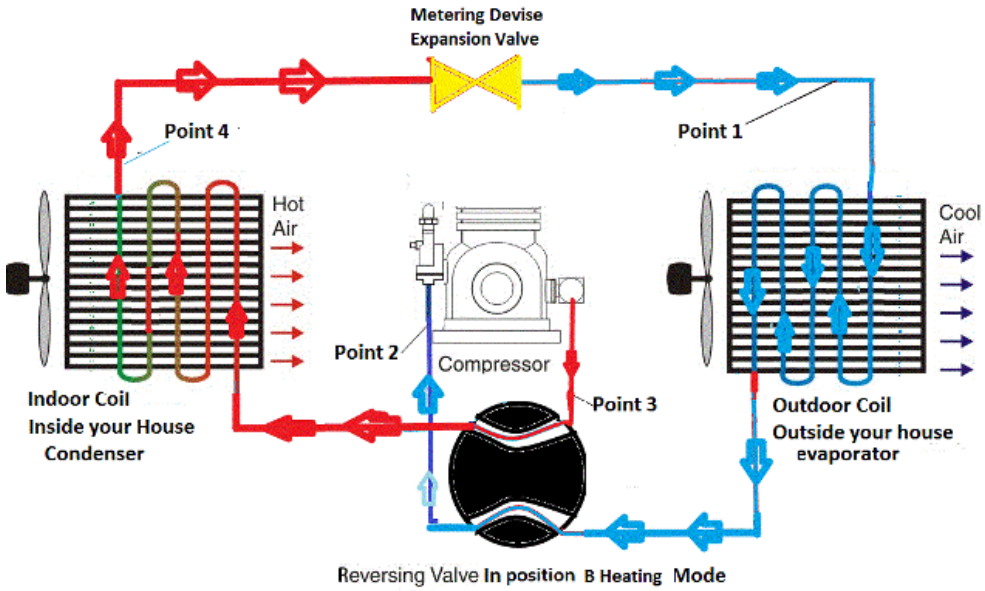
Air-source:

- An air-source heat pump draws heat from the outside air during the heating season and rejects heat outside during the summer cooling season

Ground-source:

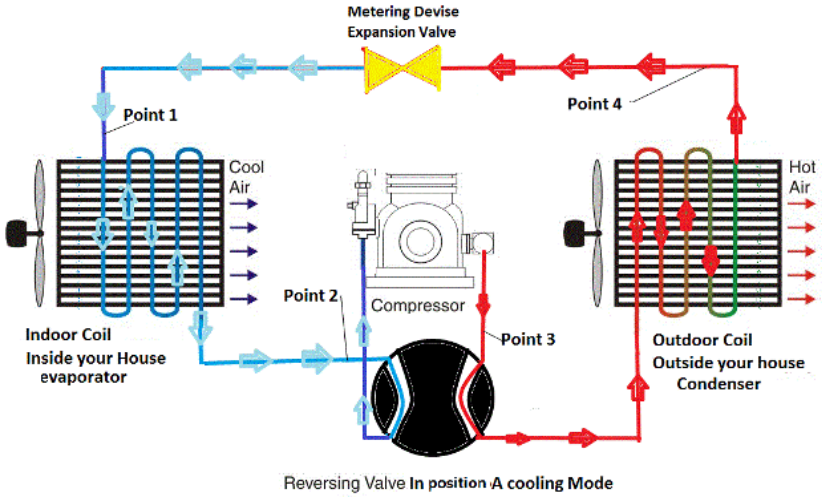
- A ground-source heat pump uses the earth, ground water or both as the source of heat in the winter and as a reservoir to reject heat removed from the home in the summer

Heat pump modes



Heating mode

Cooling mode

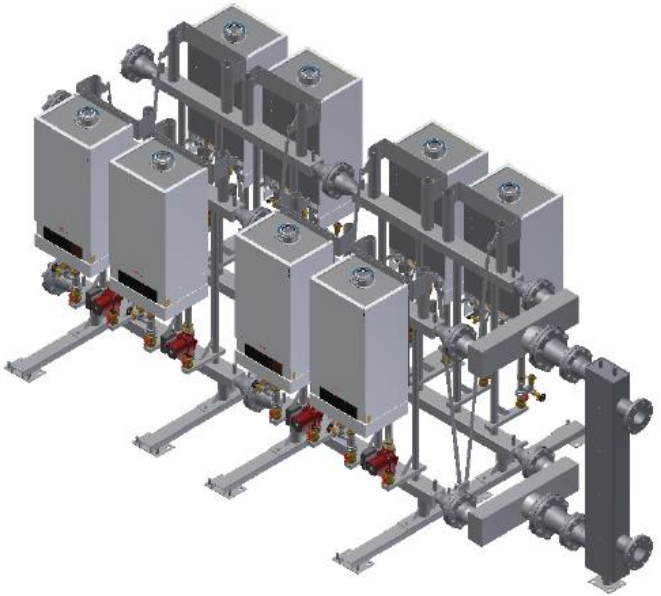


Active climate controls

- Most HVAC systems are actuated and regulated by automatic controls
- Most control systems are computerized (BAS) in larger buildings
- The most obvious HVAC control function is to maintain desired thermal comfort conditions
- HVAC controls are just now starting to be focused on independently maintaining the desired level indoor air quality
- Controls regularly increase energy efficiency by promoting optimum operation
- They act as safety devices limiting or overriding mechanical and electrical equipment
- Automatic controls also serve to eliminate human forgetfulness and bias
- Controls usually maintain only a range of conditions, not a specific setpoint

Cascade control systems

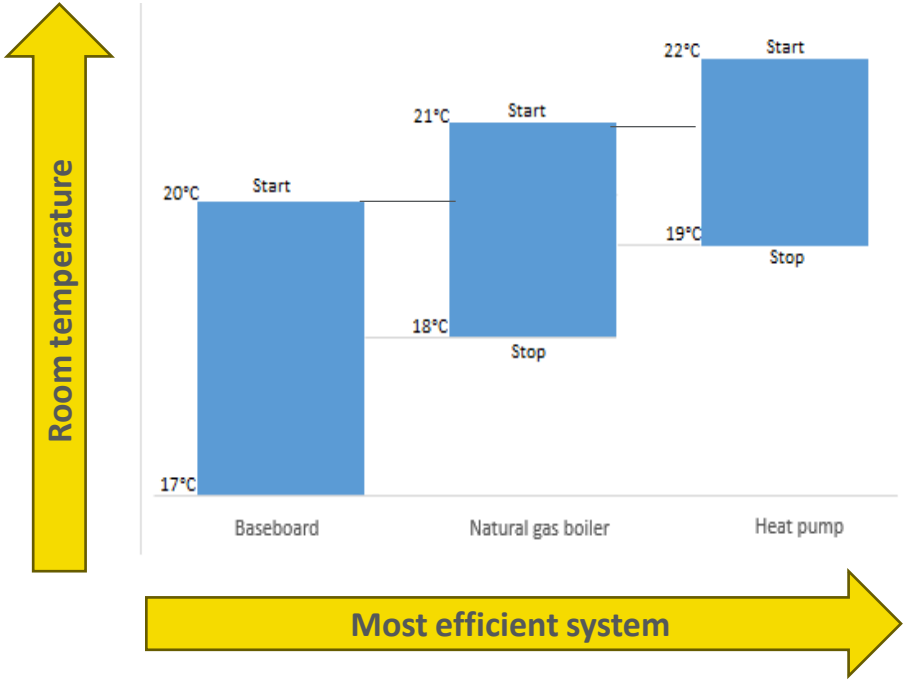
- A cascade system uses multiple units (for example boilers, modular chillers) as required to meet fluctuating heating/cooling demand
- It maintains maximum efficiency at all times by precisely matching the load and, if applicable, using the most efficient equipment first
- Controller will modulate, stage and rotate equipment, regulate water equipment and common supply temperature



8-boiler cascade system in back-to-back configuration

Advantages of cascaded systems

- Greater energy efficiency
- Greater equipment life expectancy
  - Increased modulation ratios
- Beneficial redundancy
  - Multiple units available as backup
- Flexible installation
- Appropriate approach for efficient operation of hybrid heat pump systems



Recommissioning (RCx)

- Over time, changing building use patterns and unintended consequences of "quick fixes" alter building operations from how it was initially designed, decreasing energy performance
- RCx is required and can lead to:
  - Reducing building energy use
  - Improving equipment performance and overall asset value
  - Lowering operating and tenancy costs
  - Improving indoor air quality (IAQ)

New trends that enhance commissioning

- New technologies allow for smart and ongoing commissioning (SOCx) with the aid of artificial intelligence (AI)
- Assist building operators in diagnosing problems while constantly monitoring building system performance and identifying areas of potential energy savings
- SOCx systems have two key functions:
  - Fault detection and diagnosis (and resolution where possible)
  - Energy optimization
- There are a few key barriers:
  - Need for standardized approaches for data collection and analysis
  - Cost to deploy, maintain and (re)calibrate sensors
  - High cost of developing models to predict building performance and estimate energy use
  - Challenges to scale these solutions from local demonstrations to full-scale implementation

Emerging technologies/trends

What could the future look like?

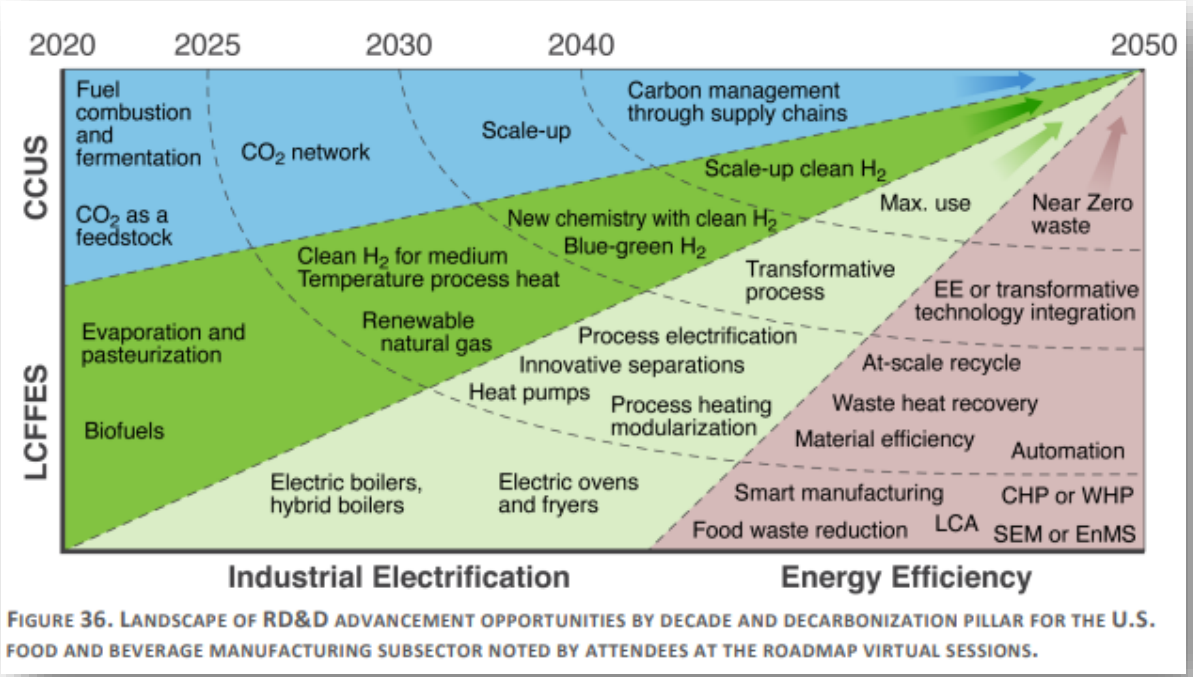


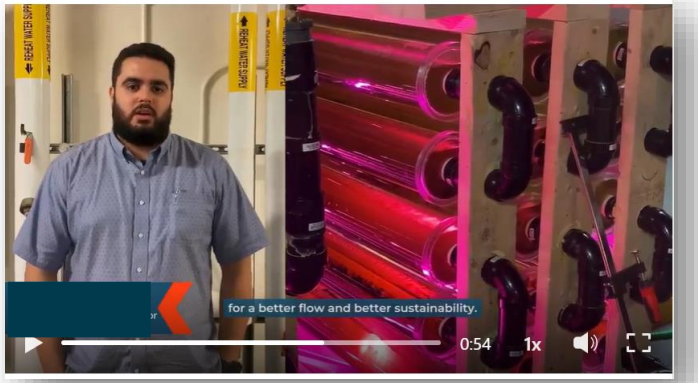
FIGURE 36. LANDSCAPE OF RD&D ADVANCEMENT OPPORTUNITIES BY DECADE AND DECARBONIZATION PILLAR FOR THE U.S. FOOD AND BEVERAGE MANUFACTURING SUBSECTOR NOTED BY ATTENDEES AT THE ROADMAP VIRTUAL SESSIONS.

https://www.energy.gov/sites/default/files/2022-09/Industrial%20Decarbonization%20Roadmap.pdf

Carbon capture, utilization and storage (CCUS)

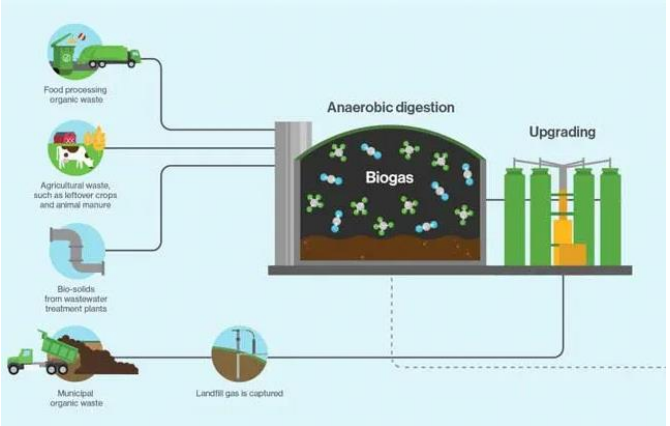
CO_2 storage in under-studied reservoirs

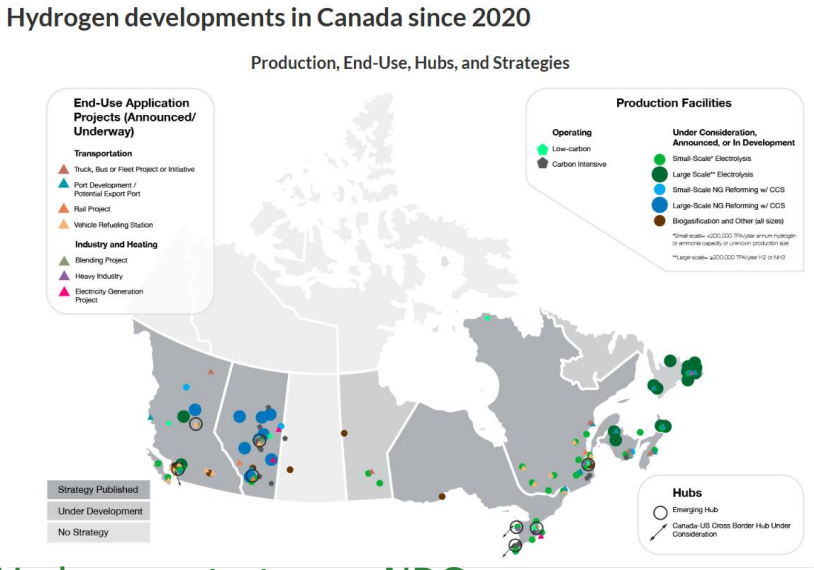
Bioenergy with carbon capture, utilization and storage



https://www.linkedin.com/posts/dexterraservices_forensicservicesandcoronerscomplex-fscc-activity-7257028462870224896-DsRA/

Low carbon fuels, feedstocks and energy sources (LCFFES)





Renewable natural gas (biofuel)

Clean fuel standards (CFS) – NRCan

Hydrogen strategy - NRCan

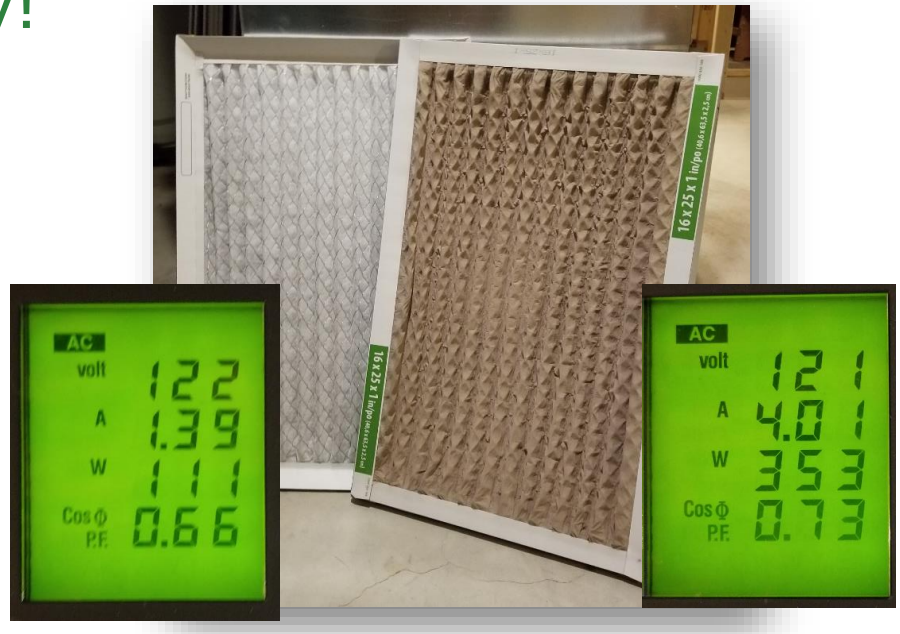
Energy efficiency investments

- Investment opportunities
  - Opinion: How big is the decarbonization investment opportunity?
  - Forbes Media article – Climate-proof buildings with sustainable real estate upgrades

"Climate-proofing your property with sustainable upgrades transcends environmental responsibility, representing a strategic economic choice that can increase asset value, reduce operational expenses and ensure adherence to evolving standards."

Forbes Media, November 2024: Independent contribution by Ali Hoss, Ph.D, P.Eng, Chief Sustainability Officer at Triovest

A case for maintenance: Clean filters save energy and money!



Two weeks more with a dirty filter costs:
0.24 kW x 336 hours x $0.165/kWh = $13.30

Where energy efficiency is going

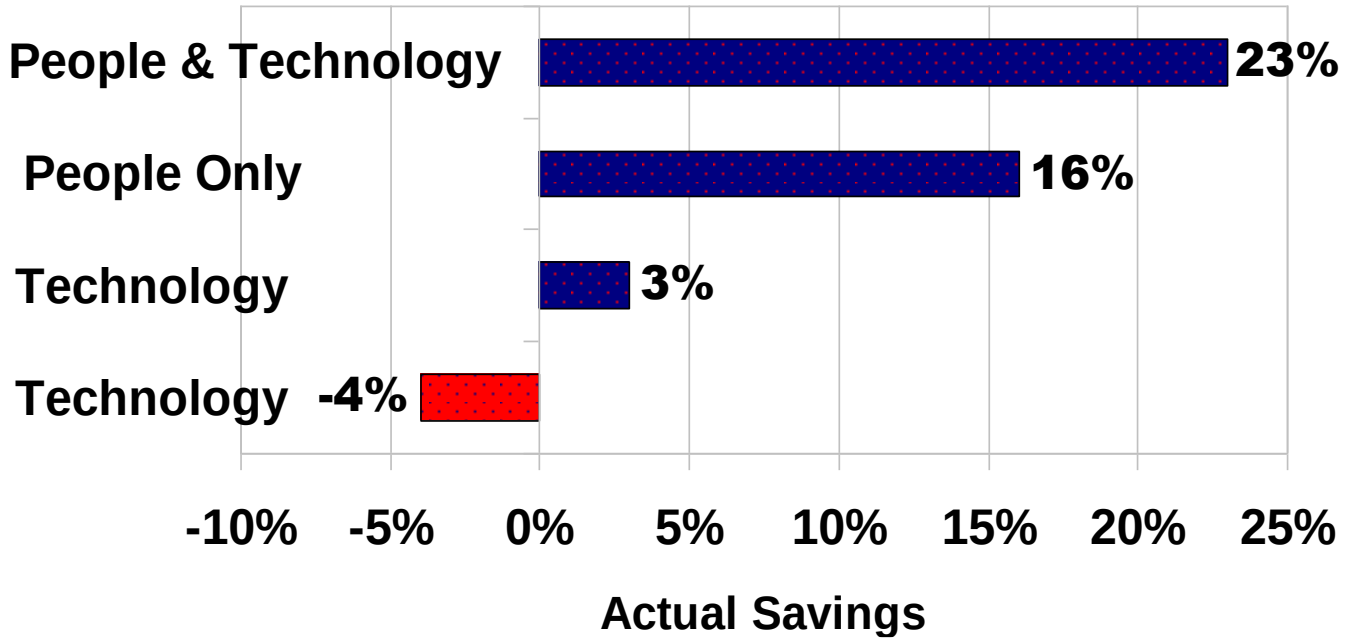
The future

Rethinking the role of efficiency

"The need to scale energy efficiency faster and further, the need to diversify the sources of energy efficiency, **measuring and ensuring persistence of energy savings**, alignment of energy efficiency with a carbon reduction agenda and utilizing energy efficiency as a power system resource in the context of small-scale variable renewables."

The role of artificial intelligence

WHAT REALLY CREATES SAVINGS?



Source: Good Practice Guide 84 Managing and Motivating Staff to Save Energy

Wrap up

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Poll - 2

Surprising insights from today
Your next action

Recapitulation

- Consider efficiency improvements before on-site generation
- Prepare for AI impacts on energy efficiency in buildings
- Develop an awareness plan for energy efficiency

Questions and answers

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

Thank you!

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