While waiting for the workshop to start…

Get ready to participate!

- Turn on your camera
- Find the unmute button and say "Hi" to check your audio

- Find the "raise hand" button

Answer our opening question!

What is energy to you?

Answer in chat or raise hand and unmute

MARCH 28, 2025

Energy fundamentals: Energy literacy basics

Adam Dixon
Knowenergy

ieso Connecting Today. Powering Tomorrow.

SAVE ON ENERGY POWER WHAT'S NEXT

By the end of this workshop, you will be able to:

- Define basic energy concepts
- Understand the difference between kW and kWh
- Identify different sources of energy
- Learn energy-efficiency and conservation tips
- Access free tools and resources to support energy literacy

Welcoming our guest speaker

Adam Dixon, *Knowenergy*

Knowing energy since 2013, he brings a new and fresh approach to energy management, specializing in energy performance analysis and residential sector services. He also works behind the scenes as an energy analyst in support of energy audits while also providing support to the development of TdS Dixon's well known energy training services.

What is energy?

Energy is defined as the ability to produce change or do **work**, and that work can be divided into several main tasks we easily recognize:

- Energy produces light
- Energy produces heat
- Energy produces motion
- Energy produces sound
- Energy produces growth
- Energy produces technology

BUT it all ends up as heat

Question: What produces more heat, a 15 watt incandescent or 15 watt LED light bulb?

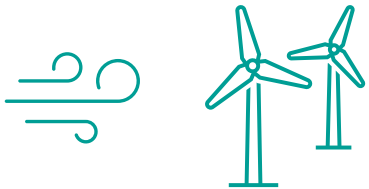
Forms of energy

Energy can be in **action** or it can be **stored**.

The two main categories of energy are:

Kinetic energy

- (energy of motion, energy in action)
- Light from a lamp
- Steam from a kettle



Potential energy

- Stored energy released when needed
- Energy in a battery
- Cut wood for your fireplace

Forms of energy continued

Kinetic energy

- **Thermal energy**: Related to the temperature of an object; the total kinetic energy of particles
- **Radiant energy**: Energy carried by light and electromagnetic waves
- **Electrical energy**: Produced by moving electric charges

Potential energy

- **Chemical energy**: Stored in the bonds between atoms, like in batteries or food
- **Nuclear energy**: Stored within the bonds of an atom nucleus (uranium)
- **Gravitational energy:** The energy of place or position, like water at the top of a mountain has ability to flow

Mechanical energy: The sum of kinetic and potential energy in physical systems

Units of energy

Power is the rate at which work is done.

The most common unit when discussing electric power is the watt (W).

The watt describes how fast energy is used.

Energy is the total amount of work done over an amount of time.

The most common unit when discussing electric energy is the kilowatt-hour (kWh).

It describes the amount of power used over time.

ENERGY = POWER multiplied by TIME (kWh = kW x h)

- 1 kWh of energy =
  - A 1 kW POWER device used for one hour (1 kW x 1 h) or
  - a 2 kW POWER device used for 30 minutes (2 kW x 0.5 h)

Units of energy continued

What is a watt?

- 1 watt = 1 Joule per second
- 1 kilowatt =1,000 watts
- A microwave or solar array might be rated as 1 kilowatt.

But … not all power is electrical.

Motors (vehicles, fans, pumps) are often rated in horsepower.

HVAC equipment capacity is rated in British Thermal Units per hour (BTUh) or tonnes (T).

A Btu per hour is power??

A British Thermal Unit (Btu) is a measurement of energy. Like calories, this unit describes the amount of energy needed to raise the temperature of water.

Energy is also measured in Joules. One Joule is a metric unit equal to one Newton-meter, the work done when a force of one Newton moves an object a one-meter distance.

When comparing different systems, it is important to convert units into an equivalent, such as ekWh.

Electricity and natural gas

How Fast $

How Big x How Many

Demand (Peak)

Power

Kilowatts

kW / kVA = Power Factor

Kilovolt-amps

1 HP = 746 watts

1 Tonne = 12,000 Btu/hr
(Refrigeration)

When

How Much $

How Fast x How Long

Consumption

Energy

Kilowatt x hours

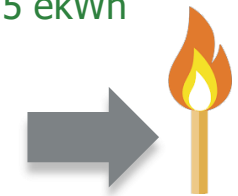
kWh

1 kWh = 3,412 Btu

m^3 (Nat gas) ~ 10.5 ekWh

J, kJ, MJ, GJ

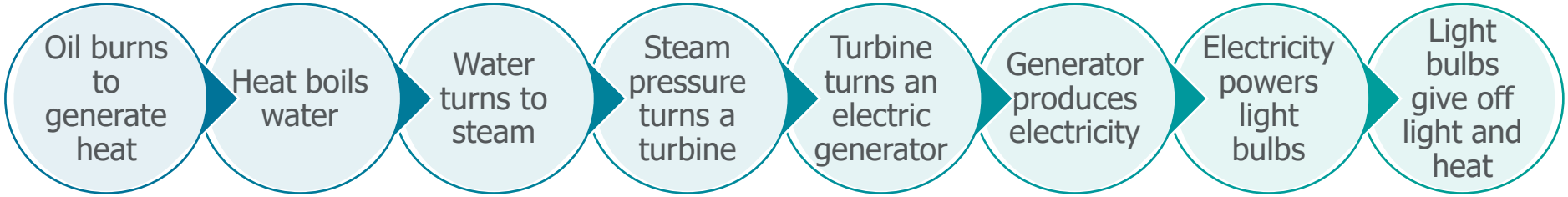
Approx. 1 Btu



Law of conservation of energy

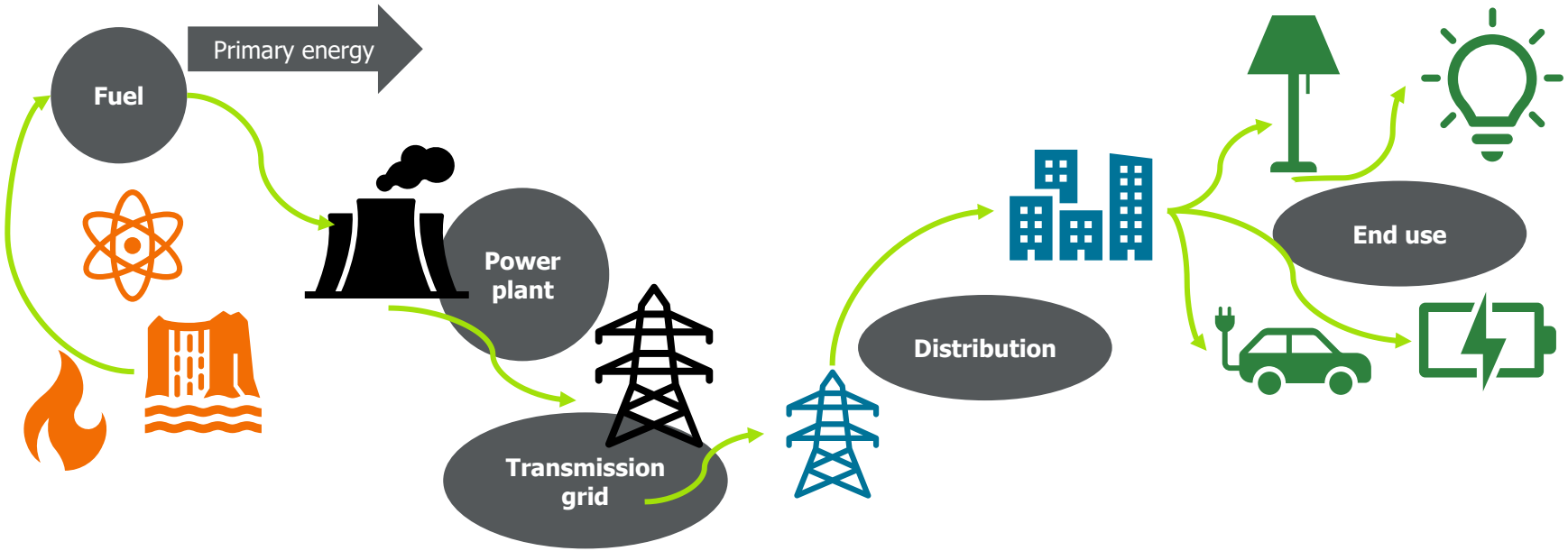
Energy cannot be created or destroyed, only transformed or transferred.

- This means the total energy in a closed system remains constant
- When we use energy, we do not use it completely—we just change its form, and each change results in losses; non-useful energy or **entropy**



The greater number of conversion stages, the lower the overall energy efficiency

Electrical energy – where losses occur



Calculating power and energy

Power

volt-amps = volts x amps
watts = volts x amps x power factor
power factor = watts / volt-amps
kilowatts = watts / 1,000

Power factor

Describes losses in an energy system such as an electricity distribution system

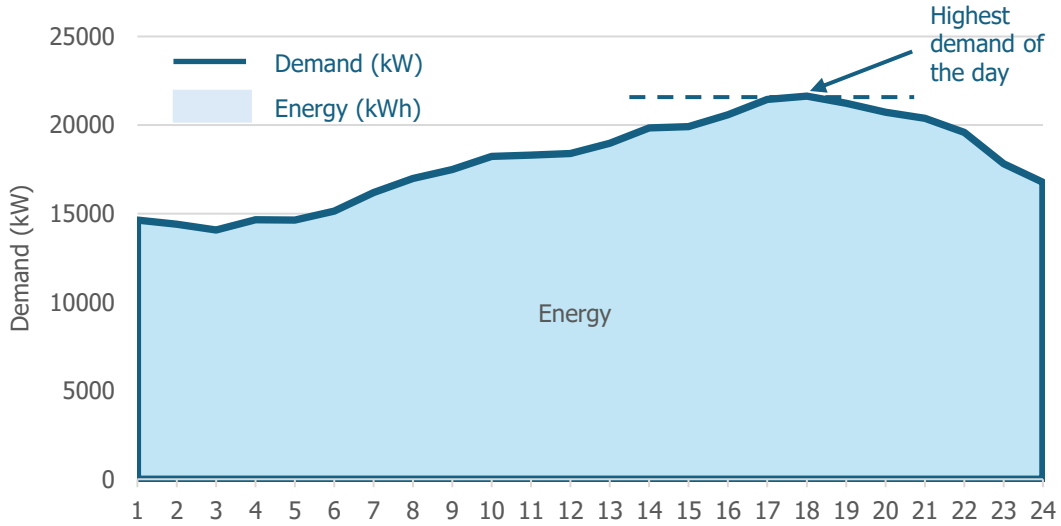
Energy

energy = power x time
kWh = kW x hours

Electrical energy versus demand

Energy

- Typically in kWh (or MWh)
- Refers to the total amount of energy used over a period of time (i.e. the customer used 12 kWh)



Demand

- Typically in kW (or MW)
- Refers to the amount of power consumed at a point in time (i.e. the industrial plant has peak demand of 10 MW)

Understand the cost (and price) of electricity

Example – electricity

January ’05	250,000 kWh	$19,670
February ’05	250,015 kWh	$20,032

Energy up 0.01%	Cost up 1.8% ?	>$24 per kWh

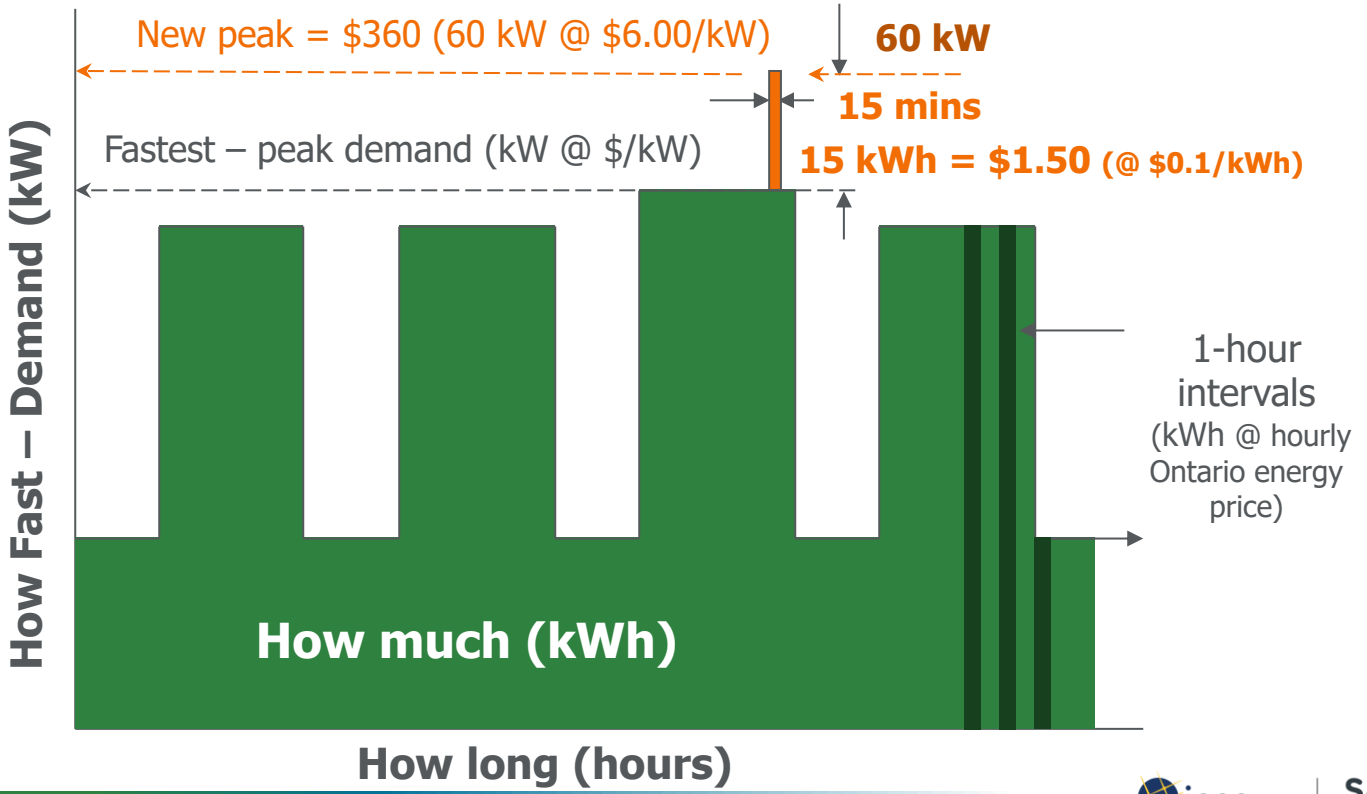
Upon investigation…

- +15 kWh @ $0.10/kWh
- +60 kW @ $6.00/kW

60 kW heater for 15 mins

Note: Rates are example only, check with your utility for local rates

A simple demand profile



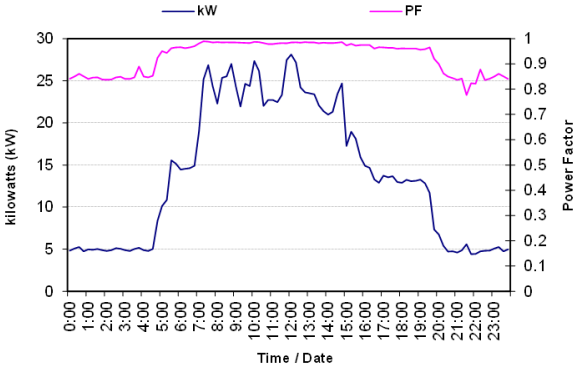
A couple of demand myths

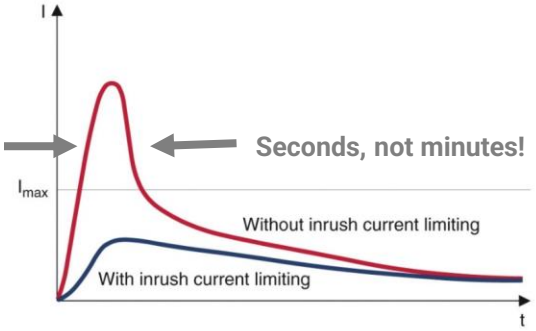
Start-up of facility sets the peak demand

- Peaks often occur mid day, at end of shift or not significantly at all
- Let the profile tell you

Soft start saves demand

- Soft start suppresses inrush current lasting a few seconds; the demand meter averages power over 15 minutes





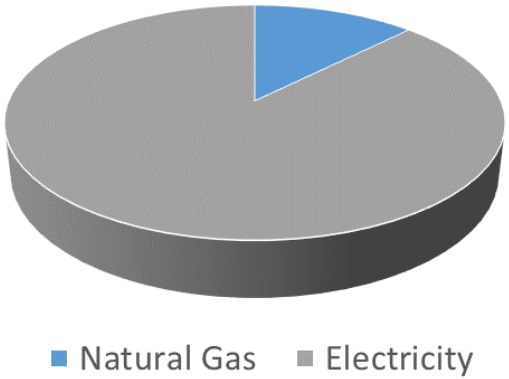
Which uses more energy, clocks or cooking?

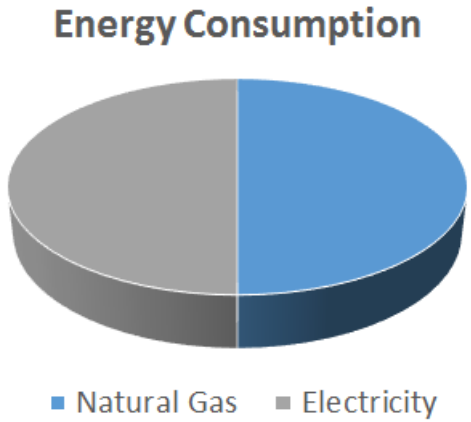
$2.00 per watt per year!

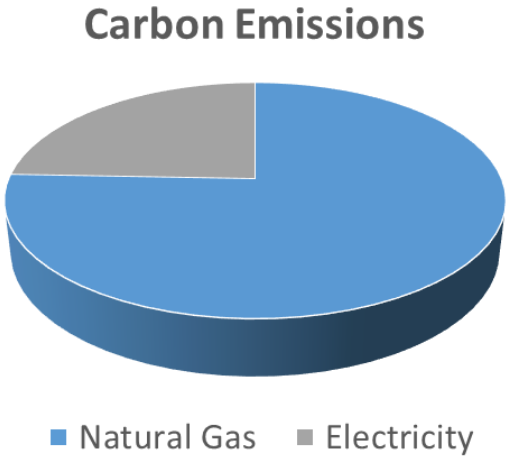
(a little less during pandemic)

Smart plugs/power bars to reduce phantom load … hey Google…

Energy, cost and carbon (Ontario)







Energy and carbon

1 m^3 of avoided natural gas avoids the emission of 1.86 kg in carbon dioxide (CO_2) equivalent

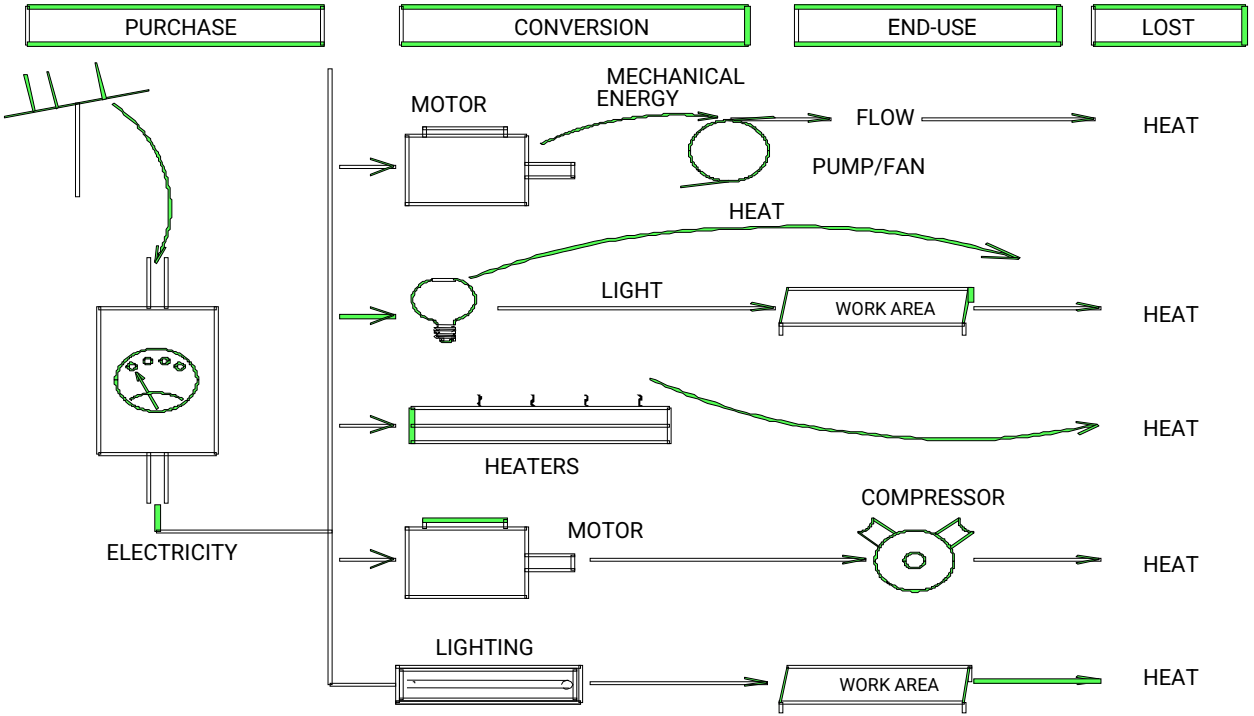
1 kWh of avoided electricity avoids about 0.0 to > 0.6 kg in carbon dioxide (CO_2) equivalent

What is efficiency?

$$\text{Efficiency} = \frac{\text{useful output}}{\text{input}} \times 100\%$$

Device	Efficiency	Input – Output
Electric heat	100%	Elec. – Heat
Lighting	2-20%	Elec. – Light
Motors	50-95%	Elec. – Power
Pumps and Fans	20-60%	Elec. – Flow
Compressed Air System	5-15%	Elec. – Air
Atmospheric boiler	50-80%	Gas – Heat
Condensing boiler	80-95%	Gas – Heat

Electricity: purchase to end use

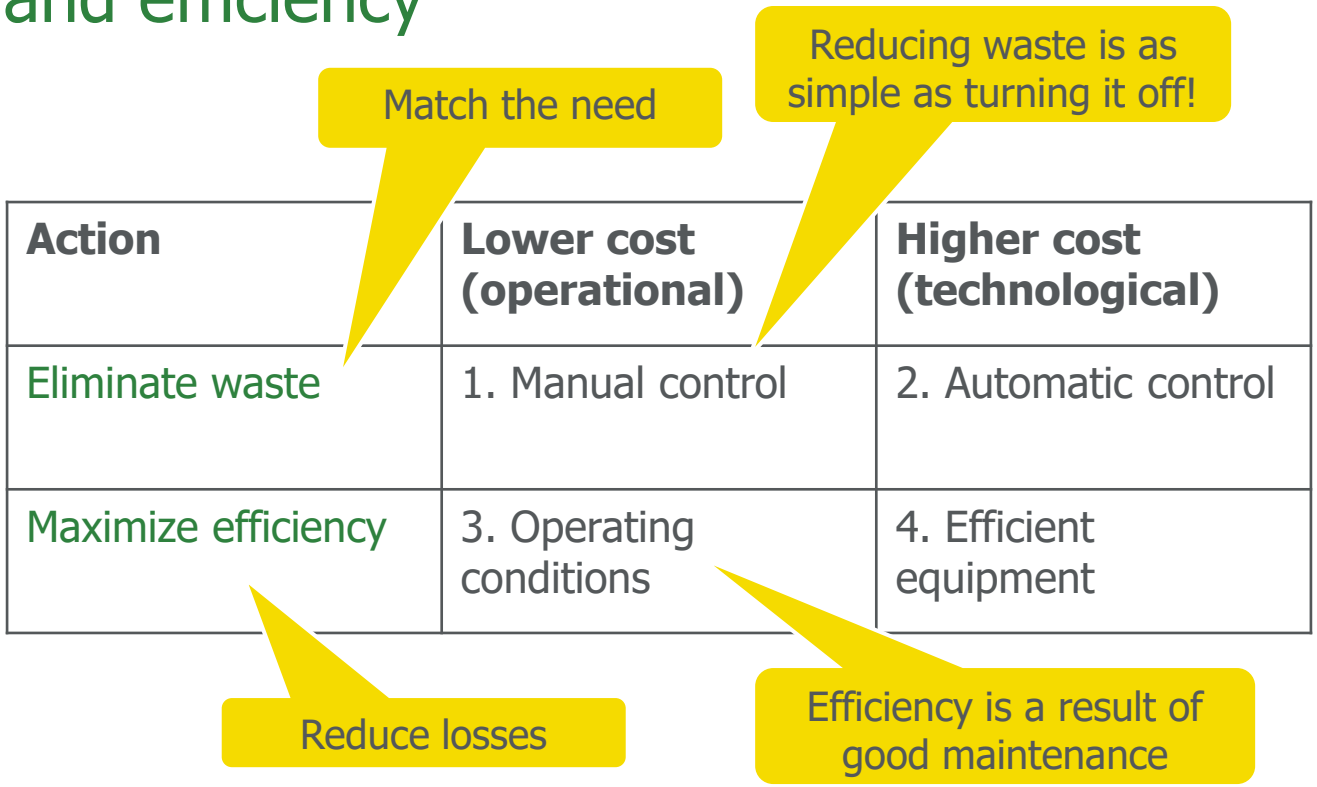


Three steps to reduce energy…

Foolproof approach to reducing your energy bills and carbon footprint

Waste and efficiency – and then supply!

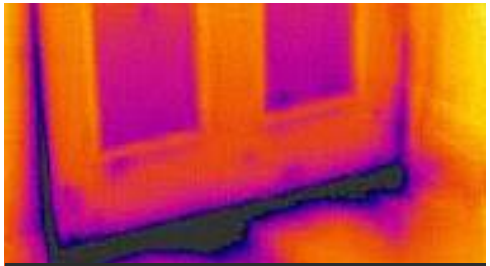
Waste and efficiency



Action	Lower cost (operational)	Higher cost (technological)
Eliminate waste	1. Manual control	2. Automatic control
Maximize efficiency	3. Operating conditions	4. Efficient equipment

First, **eliminate energy waste** - reduce usage (step 1)

- **Turn it off**
  - Leaky buildings
  - Leaky doors and windows
  - Dripping taps
  - Leaky dampers
- **Turn it down**
  - Thermostat Temperature
  - Water temperature
- **Control it**
  - Bathroom exhaust fans (as much as $300 per year)
  - Pool filter pumps - half time or full time?



Waste might be invisible!

Waste? Maybe not - check the specs!

Next, **maximize efficiency** (step 2)

Maintenance

- Filters and lubrication
- Clean heat furnace, ducts and fridge coils
- Optimize how things operate
- Refrigerator controls
- Appliance controls

More efficient equipment

- Lighting
- Lamps and/or re-design
- Appliances
- Furnace and air conditioner
- Insulation

Finally, **optimize supply** (step 3)

- Heat recovery
- Drain water
- Air-to-air heat exchanger
- Heat pumps
- Ground and air source
- Renewable energy
- Solar electricity

- Photovoltaics (PV)
- Solar air
- Solar hot water

Benefits beyond energy and carbon reduction

Direct and indirect energ savings

ncrease comfort, ality, productivity and safety

proved reliability and reduced maintenance

Environm impact reduction

Benefits beyond energy – example tires and safety

The effects of under-inflation on tire wear and fuel use

Percentage of under-inflation	Percentage wear increase	Fuel use increase
10%	5%	2%
20%	16%	4%
30%	33%	6%
40%	57%	8%
50%	78%	10%

Source: Rubber Association of Canada, http://www.betiresmart.ca

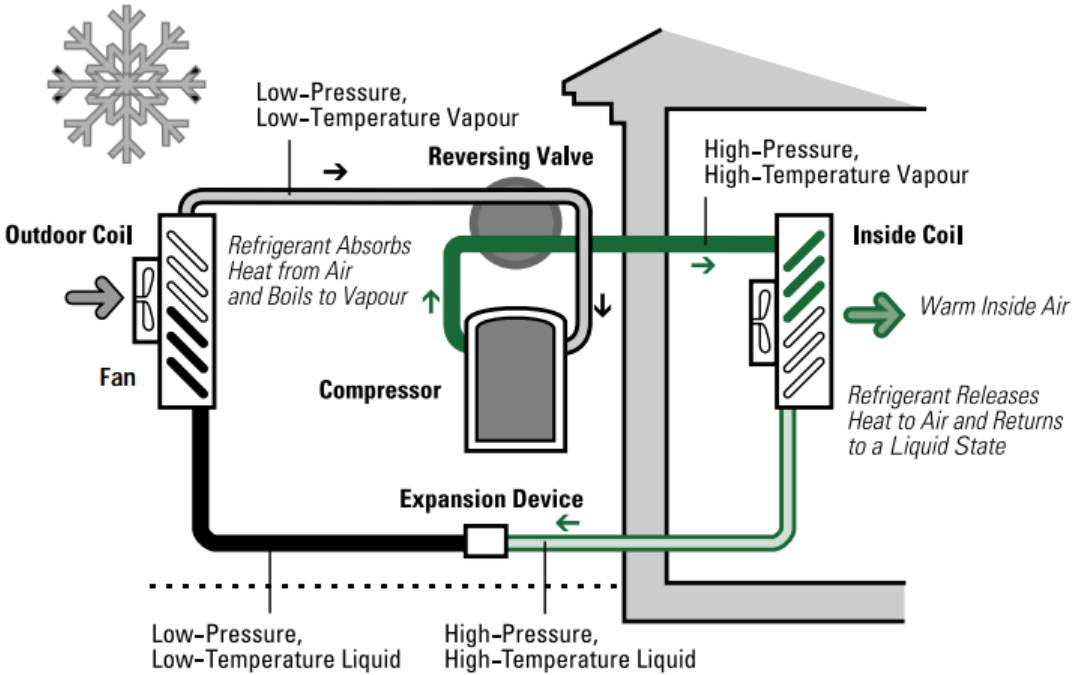
Think about a heat pump

Heat pumps reduce energy consumption up to 32% in retrofits,

BUT reduce your waste and maximize efficiency first.

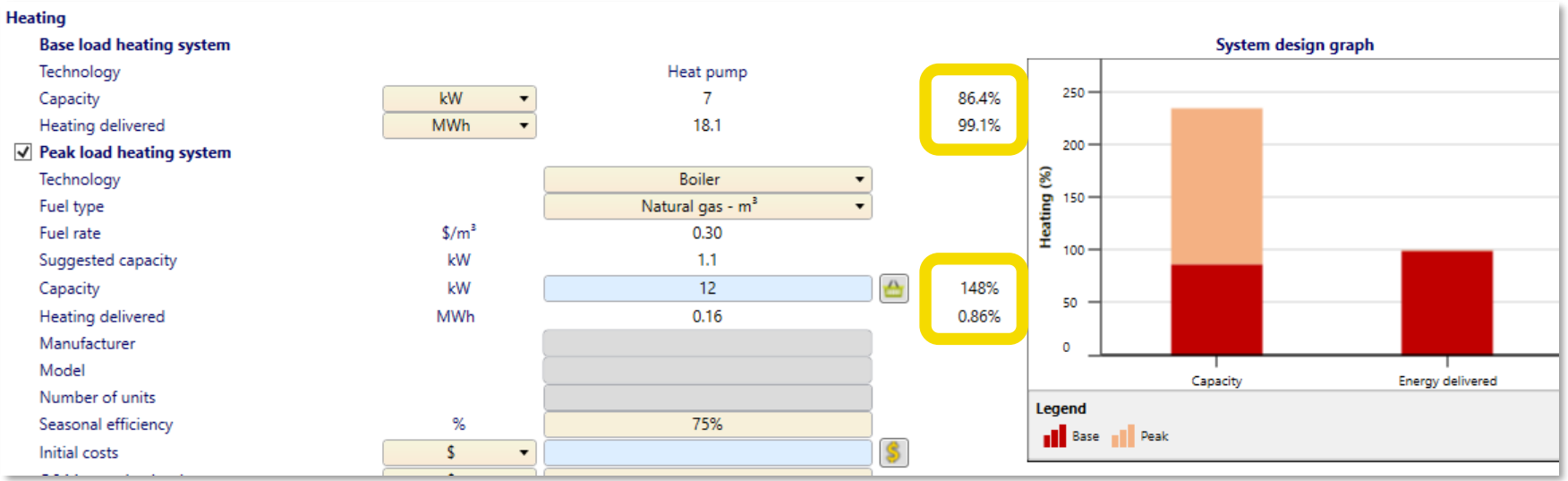
https://taf.ca/heat-pumps-reduce-energy-consumption-32-retrofits/

How a heat pump works!



The new cold climate air-to-air heat pumps work very well in our Canadian climate, providing heat when outdoor air drops to -25°C.

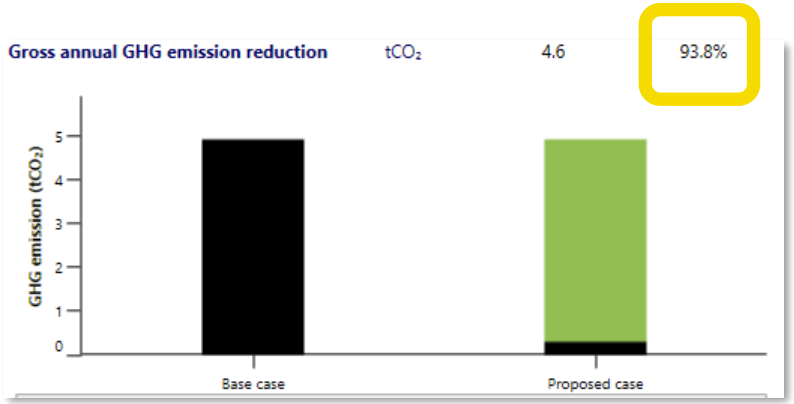
Hybrid heat pump systems



99% of energy is delivered by the air-source heat pump, thus a natural gas furnace is only needed on those really cold days, meaning……

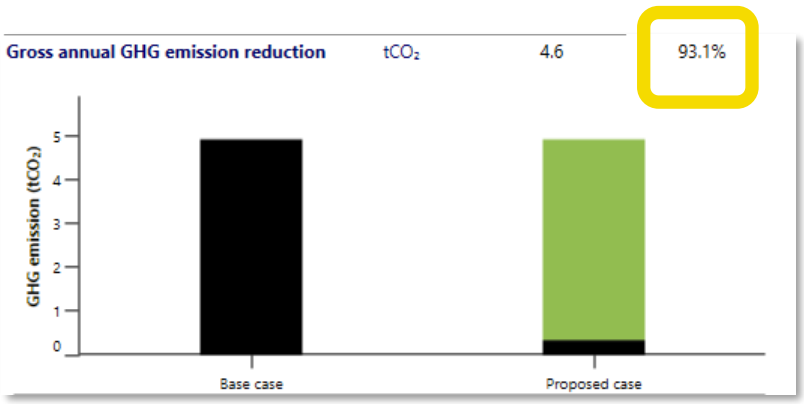
Greenhouse gases (GHGs) and heat pumps

Air-source heat pump



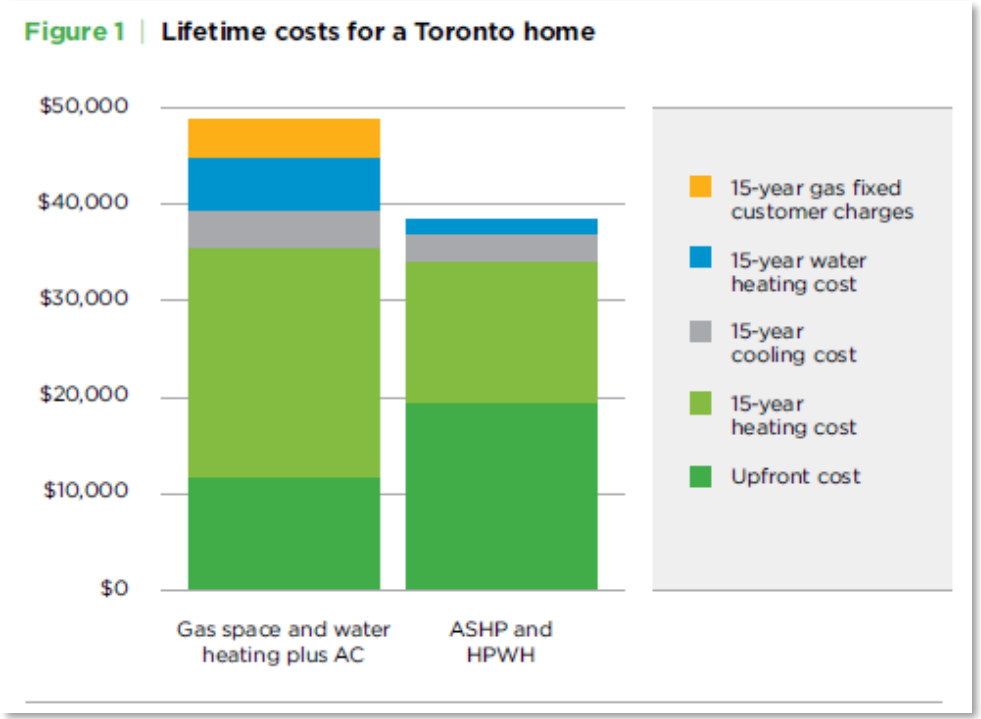
vs

Hybrid system



We can drastically reduce our carbon emissions with a smaller heat pump and still meet our heating and cooling needs and improve the building resiliency of your home (i.e. price changes)

The financials



https://www.cleanairalliance.org/electrifying-ontarios-gas-heated-homes-by-installing-air-source-heat-pumps/

Other benefits of heat pumps

No more risk of carbon monoxide poisoning

Improved indoor air quality

Lower insurance rates

Upgraded electrical panel for possible electric vehicle (EV)

35% reduction in GHG emissions in Ontario with current grid mix

(https://www.cleanairalliance.org/electrifying-ontarios-gas-heated-homes-by-installing-air-source-heat-pumps/)

With mini-splits – individual room control

And more …

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

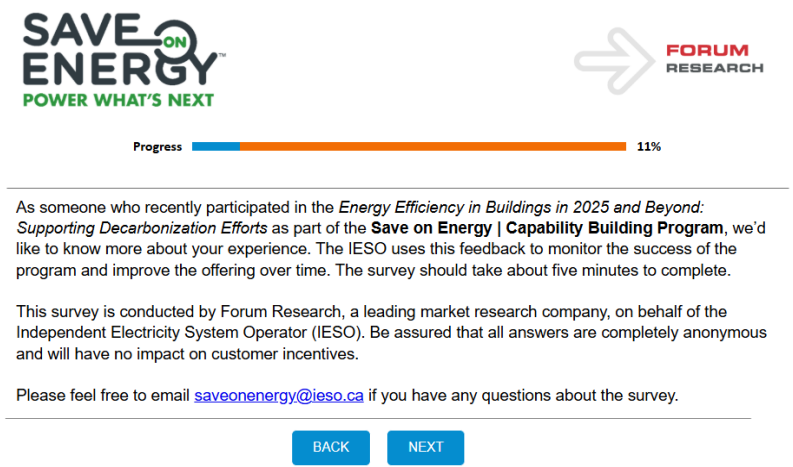
One-on-one coaching: Tailored support for managing energy resources effectively

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!


SAVE ON ENERGY
POWER WHAT'S NEXT

FORUM RESEARCH

Progress 11%

As someone who recently participated in the *Energy Efficiency in Buildings in 2025 and Beyond: Supporting Decarbonization Efforts* 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 feel free to email saveonenergy@ieso.ca if you have any questions about the survey.

BACK NEXT

- 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.

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

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Thank you!

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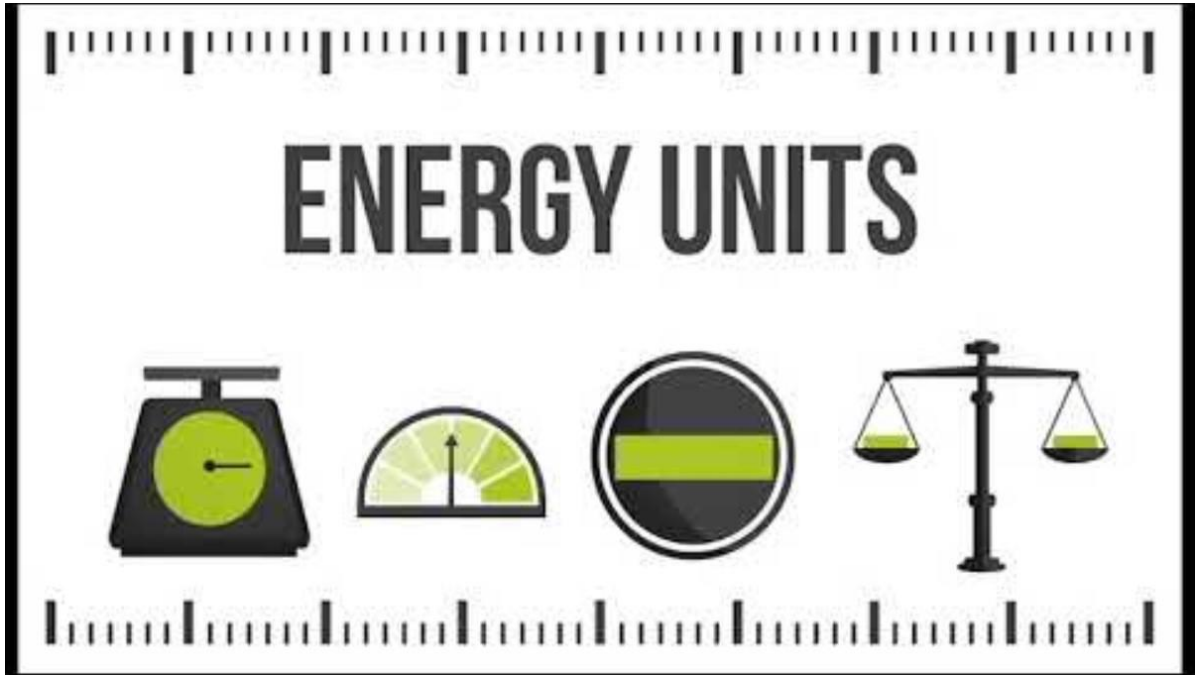
Energy units



You have decided to get a heat pump … what questions need to be asked … let's have a discussion

Incentives

Understand how they work

Backup power

Sizing/home age

Warranty and maintenance

Other … what are your experiences?

Heat pumps provide very efficient heating and cooling

Air-source heat pumps
(mini-splits and ducted)

https://www.youtube.com/watch?v=lH4g9fLSxPI

Ground-source heat pumps
(geothermal)

https://www.youtube.com/watch?v=f8GcqW_4KVg

Useful links

- https://www.hydro.mb.ca/your_home/heating_and_cooling/cold_climate_air_source_heat_pumps/?fbclid=IwAR2BxXQHX7c724xzbuI5Y_LlppQoeLh1XIVx7VAnkoSRDRuVjCXnYIp5YW8
- https://www.bchydro.com/news/conservation/2022/cold-weather-heat-pumps.html?fbclid=IwAR2GluVkNizpfN5xPm9WaDwI0CRtYOhHdMC38laLkioaq0KLKXPsOZ_Jfdg
- https://www.ottawahomeservices.ca/blog/guide-to-buying-heat-pump/?fbclid=IwAR3epc2rf0KpOVKYppy8LZOA_A8ez9ojMrUyL5qMnB3_sTyxl4El9phK5kU
- https://carbonswitch.com/best-cold-climate-heat-pump/?fbclid=IwAR3yYGM5T9jLAXf2aHwWg_Fi8pJ320EngxujvosQxISopUylevwmxZ6EJ7o
- https://www.maritimeelectric.com/energy-savings/frequently-asked-questions/heat-pump-faq/?fbclid=IwAR0WaeTeD2ACgpzDNbjLedVuehlaJXshSPhRCqyP3QKwWnigxCj0L6WAzhk
- https://betterhomesbc.ca/products/do-i-need-a-backup-heat-source-for-my-heat-pump/?fbclid=IwAR2zUUj_MxZl2f4-o8FXCbrE3KyvUMvoIU_Zb8jIz3hTRIRtEOnmZ4TzLIM
- https://www.nrcan.gc.ca/energy-efficiency/energy-star-canada/about/energy-star-announcements/publications/heating-and-cooling-heat-pump/6817?fbclid=IwAR2yclSy4sGwgtPmowIYxpZvXZAckNMHXCIRKBAdt-bwfFae-9zFF5iJZp4#e