Heat Pumps and Electric Resistance Heating Systems
Learning Objectives:

• Be familiar with different types of electricity based heating systems,
• Understand how heat pumps work,
• Know how to choose an energy efficient heat pump, and
• Be familiar with the relationship between electricity generation and Green House Gas emissions in New Brunswick.
Electric Resistance Heating

Electric furnaces, boilers and baseboards all work around the same basic principle of electric resistance.

An electric current is run through a metal wire or coil, called the heating element. When in contact with electricity, the element heats up.

This heat is then distributed throughout the home, either through electric baseboards, furnaces or boilers.
Efficiency of Electric Resistance Heating

Regardless of whether you have an electric furnace, boiler or baseboards, all electric resistance systems work the same way:

1 kw of electricity = 1 kw of heat

A new electric resistance heating system will never be more efficient than the old one. The only way to improve electric heating is to incorporate another fuel or technology.
Heat Pumps – an efficient heating option

A heat pump is a great example of a heating system that does not actually use electricity to heat your home.

Heat pumps come in two main types:

1. **Air source**  
   (heat from air)

2. **Geothermal**  
   (heat from the ground)
Heat Pumps – an efficient heating option

Instead of using electricity for heating, a heat pump uses electricity to run equipment such as fans, pumps, compressors and condensers. The actual heat transfer takes place via a refrigerant.
Heat Pumps – an efficient heating option

By taking advantage of the refrigerant’s ability to transfer heat, homeowners are able to get 2-3 times more energy per kWh of electricity than if they were using an electric furnace or boiler. Since you pay by the kWh, your heating bill could decrease by up to 75%, depending on the type and efficiency of the heat pump. AND you produce significantly less Green House Gases!
How Heat Pumps Work

When a refrigerant is circulated past the heat source (air or water) it will absorb heat energy. Heat up even more. The extra energy causes the refrigerant to evaporate into a gas. The gas is then compressed, causing it to heat up even more.

Representation of the outdoor unit of a split-system air source heat pump
How Heat Pumps Work

The compressed gas is then circulated past a heat exchanger, where energy is transferred into the home by a distribution system (either air or water). With the heat removed, the cooled gas condenses, turning back into a liquid.
How Heat Pumps Work

The liquid refrigerant is then circulated back to the heat source to repeat the cycle of heat absorption and transfer.
How Heat Pumps Work

Another advantage offered by heat pumps is cooling. This is done by simply reversing the heating cycle described previously: heat is absorbed from air within the home and then transferred to either the air outside or ground below. The cooled air is then recirculated throughout the home.

Representation of a split-system air source heat pump in cooling mode
Electricity and Green House Gases

Over half of New Brunswickers (58%) use electricity to heat their homes. But electricity is actually the biggest source of air pollution in our province and accounts for 42% of total Green House Gas emissions (GHGs).
Electricity and Green House Gases

While we do have some clean electricity (nuclear and hydro electric) the majority of electricity in NB comes from burning fossil fuel such as oil and coal. Due to inefficiencies in these large power plants and losses along the transmission lines, electric resistance heat can produce over 3 times more GHGs than other home heating systems.
Measuring Energy Efficiency

Since Heat Pumps operate differently than other heating systems, they use different energy efficiency measurements.

The efficiency of Air source heat pumps is measured using the **Heating Seasonal Performance Factor (HSPF)**, **Seasonal Energy Efficiency Ratio (SEER)**, **Energy Efficiency Ratio (EER)**.

The efficiency of Geothermal heat pumps is measured using the **Coefficient of Performance (COP)** and **Energy Efficiency Ratio (EER)**.
Energy Efficiency and Air Source Heat Pumps

**HSPF** is a ratio of the heat produced over the heating season to the energy used over the season.

\[
\text{HSPF} = \frac{\text{btus of heat produced}}{\text{Kwh used}} \text{ (calculated between October and May)}
\]

**EER** is a ratio of heat extracted at a temperature of 95F (35C) to energy used.

\[
\text{EER} = \frac{\text{btus of heat removed (@95F/35C)}}{\text{watts used}}
\]

**SEER** is a ratio of the cooling units produced over the cooling season to the energy used over the season.

\[
\text{SEER} = \frac{\text{btus of heat removed (between June and September)}}{\text{watts used}}
\]
Energy Efficiency and Geothermal Heat Pumps

**COP** is a ratio of the heat produced to the energy consumed. It is generally calculated at the average operating temperature for the year of 47F/8C.

\[
COP = \frac{\text{btus of heat produced} \ (@47F/8C)}{\text{btus energy used}}
\]

**EER** is a ratio of heat extracted at a temperature of 95F (35C) to energy used.

\[
EER = \frac{\text{btus of heat removed} \ (@95F/35C)}{\text{watts used}}
\]
The EnerGuide Rating

The EnerGuide rating shows a horizontal bar scale that enables consumers to compare typical efficiency ratings of equipment sold in Canada. Consumers can use this rating to identify which heat pump will consume the least amount of fuel and therefore cost the least over time.
ENERGY STAR®

The most efficient products may also have an ENERGY STAR label.

The ENERGY STAR rating identifies a product as having significantly lower energy consumption as compared to other similar products available on the market.
ENERGY STAR® Criteria

**Air Source Heat Pumps**
- HSPF of 7.1
- SEER of 14.5
- EER of 12.0

**Geothermal Heat Pumps**

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<thead>
<tr>
<th>Type</th>
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<th>COP</th>
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<tr>
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</tr>
<tr>
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**Electric Resistance**
Since all electric resistance heating systems work the same and can’t be improved for efficiency, you won’t find the ENERGY STAR rating on electric furnaces, boilers or baseboards.
Getting the most out of your heat pump

There are a few things you can do to ensure you are getting the best performance from your heating system:

*Regular maintenance* ensures that your system is working at its best. Most companies offer regular maintenance plans with installation.

*Clean/Change your filters* every few months. A clogged filter will reduce air flow, making your system work harder and use more electricity.
More Information

For more information on ENERGY STAR rated heating systems, visit:

www.energystar.gc.ca
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