Heating

Home Energy Audit (math based)

Most of our homes are heated with natural gas. Natural gas burns cleaner than oil or coal, but still creates CO_2 emissions that contribute to climate change. Making our homes more energy efficient lowers those emissions and saves us money.

Some changes we make are more expensive, like replacing an old furnace with a high efficiency furnace, or adding insulation to the attic or walls of our home. There are also many easy and inexpensive things we can do to make our homes more energy efficient, like turning down the heat, and using low flow showerheads. Some of them are described in this audit.

Teacher Note:

In this audit there are two ways of calculating savings.

In **Method #2**, students will read the gas meter at their home 4 times. Two will be before they audit and make any changes, and two will be after. To include this in a heat and temperature unit, set aside time to introduce and begin the reading process in advance of making changes. **Ideally the meter readings would be a month apart, but that requires 3 or more months to complete the readings.** If this is too long, but you still want to use this method, shorten the time between readings to one or two weeks. Just use the same length of time for your "before changes" and "after changes" periods

Method #1 uses estimates, so it doesn't need the time before and after changes.

The purpose of this audit is to determine if you are using heat efficiently in your home, and to help you calculate greenhouse gas emission reductions from making your home more efficient.

Heating Your House:

1. What temperature is the thermostat set to:
   - During winter months when you are at home?
   - During winter months when you are sleeping?
   - During winter months when you are away? (at school, work or on vacations)

Note: In **winter**, indoor temperatures of 20 to 22°C are reasonable. Turning down the heat 2 to 5°C when you are sleeping or away is comfortable. Save 2% on your heating bill for every 1°C you turn down your thermostat overnight.
In **summer**, indoor temperatures around 24°C are reasonable.

2. Does your family have a programmable thermostat in your home? Because they can be programmed ahead to turn heat up or down, they help us to save energy by remembering for us!

3. Can you feel drafts around doors, windows and electrical outlets? Make a note of which ones so retrofits can be made. Use a tissue taped to a pencil, or anything else that will react to a subtle breeze to find where the drafts are. This works best on a very cold or windy day.

Note:
Weather stripping: Weather stripping seals openings like doors and windows from drafts and heat loss. It is often made of foam or vinyl and creates a seal by squishing against both the door and frame (or window and frame) when the door (or window) is closed. Damaged or missing weather stripping allows drafts to enter the building, and heat to be lost.

Caulking: Caulking is used to seal around windows and door frames. It is a pliable material that goes on as a thick liquid, and sets in place to seal cracks or joins. If it becomes brittle or breaks off, the gap it leaves allows drafts to enter the building, and heat to be lost.

Outlet Gaskets: Foam outlet gaskets fit behind electrical outlets and switches. Placed on perimeter wall outlets, they block air leaks.

4. Is the furnace high efficiency? If your furnace has vents that go out the wall, it is high efficiency. If it has a chimney that goes out through the roof it is not.

To estimate your greenhouse gas emission savings:

Method #I

Action	**Potential Savings***	**% Savings at my house***
Turn down the heat overnight	**2%** savings for each degree it's turned down	2%/^{o}C x ___ ^{o}C = _____%
Turn down the heat during the day	**2%** savings for each degree it's turned down	2%/^{o}C x ___ ^{o}C = _____%
Caulk and weather strip	If your house felt windy before and isn't now: **20%** If you found and fixed a few things: **5%**	
Install a high efficiency furnace	If you do some of these things, and upgrade to a high efficiency furnace, add **30%**. If you do none of these and upgrade to a high efficiency furnace, add **35%**.	
Total		%

*These are very rough estimates. Savings from heating are tricky, because each saving affects the others. That is why doing more than one action reduces the savings per action

The average Saskatchewan house uses 2800 m^3/year of gas. You can use that number in the next calculation or get your parents to help you figure out what your annual gas consumption is. To find your annual gas consumption add up the "Usage in m^3" off all your gas bills for a year, or by looking at your on-line account.

Natural Gas savings = Total % x annual gas consumption (m^3)
Greenhouse gas emissions savings = gas savings x 1.88 = kg CO_2 for that year.

For example:

I turned down the heat in my house 5^{o}C at night.
2%/^{o}C x 5^{o}C = 10% (10% = 10/100)
2800 m^3/year x 10% = 280 m^3/year.
280m^3/year x 1.88 kg CO_2/m^3 = **526 kg CO_2/year**

Method #2:
This method works best if you can complete the whole thing during the winter, when the weather before and after your changes is similar.

Before you make any changes, read your gas meter. A month later read your gas meter again. Then make your changes. After your changes, read your meter, and read it again in a month. Keep track of the dates you read the meters. Make sure your Before Changes time period and After Changes time period are about the same length. For example, if one is a month, the other should be a month. If one is two weeks, the other should be two weeks.

	Dates	First reading A	Second reading B	Natural Gas use (m^3) (B-A)x2.721 C	Heating Degree Days* D	C/D
Before Changes						
After Changes						

* Heating Degree Days are a measure of how cold it was. To find Heating Degree Days, go to www.weather.gc.ca. Select your city. Near the bottom of the page select "Historical Weather". Choose the dates for when you read your meters, and add up all the "Heat Deg Days" from the table for your Before Changes dates, and for your After Changes dates.

Natural gas savings = (Before Changes C/D – After Changes C/D) x After Changes Heating Degree Days = m^3 of gas saved for that month.
Greenhouse gas emissions savings = gas savings x 1.88 = kg CO_2 for that month.

For example:

	Dates	First reading A	Second reading B	Natural Gas use (m^3) (B-A)x2.721 C	Heating Degree Days* D	C/D
Before Changes	Oct 31 Dec 5	102	219	=(219-102) x 2.721 =318	978.1	.325
After Changes	Dec 31 Jan 31	338	454	=(454-338) x 2.721 = 316	1022.8	.309

Natural gas savings = (0.325-0.309) x 1022.8 = 16.4m^3
Greenhouse gas emissions savings = 16.4 m^3 x 1.88kgCO_2/m^3 = **31 kgCO_2/month**

Heating Your Water:

5. What sort of water heater do you have?
   - Naturally Aspirated (large tank with a chimney 55-65% efficient)?
   - Power Vented or condensing (large tank with vent out the wall 80-96% efficient)?
   - Tankless (box on the wall, about 1 meter square, and ½ meter deep 80-98% efficient)?

6. What temperature is your water heater set to? Turn on a hot water tap near the water heater and run it until the water is as hot as it will get. Use a thermometer (maybe a cooking thermometer) to measure the temperature of the water. If it is hotter than 55°C, turn the temperature setting down slightly on the water heater. Several hours later, repeat this procedure to measure the temperature again. Don't set the temperature for less than 55°C, because there is a risk of bacteria growth. However, setting it higher than 55°C wastes energy. Note that a tankless heater can be set at whatever temperature works well for your home, because it doesn't store hot water, so there isn't the risk of bacteria growth.

7. Is insulation used to reduce heat loss around hot water pipes? If a pipe is warm to touch, insulating it will help reduce heat loss.

8. Do you have low flow showerheads and faucet aerators?

Action	**Potential Savings***	**% Savings at my house***
Upgrade water heater to high efficiency	6% savings	
Install low flow showerhead	2.5%	
Install faucet aerator	4%	
Total		%

*These are very rough estimates. Savings from heating are tricky, because each saving affects the others.

The average Saskatchewan house uses 2800 m3/year of gas. You can use that number in the next calculation or get your parents to help you figure out what your annual gas consumption is. You can find it by adding up the "Usage in m^3" off all your gas bills for a year, or by looking at your on-line account.

Natural Gas savings = Total % x annual gas consumption (m^3)

Greenhouse gas emissions savings = gas savings x 1.88 = kg CO_2 for that year.

For example:

I installed a low flow showerhead.

2800 m^3/year x 2.5% = 70 m^3/year. (2.5% = 2.5/100)

70m^3/year x 1.88 kg CO_2/m^3 = **132 kg CO_2/year**

9. What else could your family do to reduce heat loss, hot water consumption and greenhouse gas emissions at your house?

CURRICULUM CONNECTIONS

Mathematics Connections: There are many connections with this audit and mathematics in the grades 5-8 curriculum in numbers, patterns and relations, and statistics and probability. Charting of results and CO_2 reduction impacts can be done in a variety of formats.
Grade 7 Science: Outcome: HT7.1 Assess the impact of past and current heating and cooling technologies related to food, clothing, and shelter on self, society, and the environment. **HT7.3** Investigate principles and applications of heat transfer via the processes of conduction, convection, and radiation. **Social Studies: Outcome: RW7.3** Assess the ecological stewardship of economies of Canada and the circumpolar and Pacific Rim countries.
Grade 8 Social Studies: Outcome: RW8.3 Critique the approaches of Canada and Canadians to environmental stewardship and sustainability. **Health Education: Outcome: USC8.6** Examine and assess the concept of sustainability from many perspectives, and develop an understanding of its implications for the well-being of self, others, and the environment. **English Language Arts: Outcomes CC8.5, CC8.6, CC8.7**
Physical Science 20: PS20-HT2 Explain scientific principles of heating and cooling in industry and in our lives.