Government of
Northwest Territories

LESSON # 8:

Auditing the Energy Guzzlers in Your Home

Introduction

Many homes in the NWT use non-renewable resources (diesel fuel), while others rely on a combination of renewable (alternative energy) and non-renewable sources to produce electricity. This means that each time we use an electrical appliance we are contributing to Greenhouse Gases (GHGs) in some way. Electricity is widely used to heat our homes, hot water, run appliances, electronic devises and produce light. By understanding our consumption of electricity we can make informed choices to reduce our consumption of electricity and increase efficiencies; by default we can reduce our contribution to GHG's and mitigate the effects of global climate change.

To ensure that students understand the concept of their "choices count", open the class discussion with "How can I reduce electrical energy consumption and dependence fossil fuels, at home, school, and on the land?" Quickly explore with students some instances where peoples' choices, their behavioural uses and cost of electricity has changes the way they want to generate electricity. This provides an opportunity for students to explore the social, technological, economical and environmental impacts of their choices on using and generating electricity. Use this as a segue to open a discussion on Greenhouse gases (GHGs) and how their choices for electrical usage, purchasing of electrical devices and generation of electricity whether at home or on the land can have an impact on GHG's emissions locally and globally. By understanding their consumption habits and the efficiencies of new technology of electrical applications and generation students can make simple choices on a daily basis to reduce GHGs. This will provide students with an opportunity to develop their own mitigation plan to reduce their GHG emissions and minimize their impact of global climate change.

Most northern communities rely on diesel fuel to generate electricity either directly or as back up to offset the other forms of electrical generation, such as hydro, solar and wind power. The more a community is dependent on diesel, for electrical generation, the higher the rate of GHG emissions per person per kilowatt-hour. This makes northerners one of the larger consumers of diesel fuel resulting in a much higher GHG emission rate per person. Conversely, the more sources of alternative energy we use, even for short periods, can lessen the per capital production of GHGs By monitoring ones' electrical consumption habits and appliance usage informed choices can be made to reduce ones' GHG emissions. This can be accomplished by using a combination of alternate forms of renewable green energy, increased efficiency of appliances and changing habits on electrical consumption and generation.

In 2015 the average Canadian was producing 20.1 tonnes of CO_2 per year. As northerners, who are more reliant on diesel fuel, our per capita emission rates would be much higher. To help reduce CO_2 emissions scientists and governments realize that by reduce the use of fossil fuels and educating the population on how they can implement their own migration strategies as part of a much bigger strategy will help reduce our CO_2 emissions locally, nationally and globally. These actions require that people be aware of their actions and make environmentally sustainable decisions on how and when they use electrical energy. Even a reduction of 20% would cut personal GHG emissions by thousands of kilograms of CO_2 per year. This activity challenges students to see what strategies they could use to reduce their electrical consumption without affecting their current standard of living by focusing on efficiencies in appliance usage.

Your local generation station can provide the basic information on how electricity is generated and distributed in your community. It is important to ask if they use or plan to use any renewable sources of energy to offset the use of diesel fuel for electrical generation. The NWT power corporation website, https://www.ntpc.com, provides information on sources of electrical generation as well as their long-term strategies to mitigate diesel usage.

The focus of this lesson is primarily on auditing household appliances and other electrical devises to determine their current electrical consumption. This will allow students to compare current technology usage with more efficient appliances and technologies that do the same thing but more efficiently. The goal is to see if students can reduce their electrical consumption by 20% by using more efficient forms of technology. This will act as a baseline for all students regardless if they are living in a multi-unit or detached home. Note: electrical hot water and heating of buildings consume more electricity but this is not easily calculated and for the purposes of this exercise will be omitted for expediency. However, students can make hot water production and home heating part of their over mitigation strategy to reduce diesel electric consumption thereby reducing their GHG emissions.

LESSON PLAN #8: AUDITING THE ENERGY-GUZZLERS IN YOUR HOME

Author: Yukon Conservation Society Curriculum Team

GOAL

Increase student awareness of electrical energy consumption, use energy wisely, make informed decision and develop a mitigation plan to reduce GHG's and save money on an electrical bill.

KEY WORD SEARCH

Climate change, green house gases (GHGs), alternative energy, sustainability, mitigation, energy audit, reducing household electricity, efficient appliances, green energy, energy calculator, and interpret appliance efficiency labels.

TIME

2 hours in class time, 1-2 evenings to collect data

CURRICULUM CONNECTION

Experiential Science 10, Unit 2 Climate and Meteorology
General Learning Outcome:

- Students will investigate the natural cyclical nature of climate change, the human factors and technologies that allow scientists to study and make predictions about climate change.

Specific Learning Outcome:

- Students will gain an understanding of climate change and climatology by: Becoming "actively aware" of current climate change issues by: Taking the "One Ton" challenge

Experiential Science 10, Unit 4 Resource Management and Population Dynamics
General Learning Outcome:

- Students will gain an understanding of the basic processes to ensure sustainable resources.

Specific learning Outcome:

- Students will gain an understanding of the foundations of a sustainable future, economics and ethics by: Investigating the uses of renewable resources in the sub-Arctic and Arctic to reduce the ecological footprint with regard to: Renewable sources of energy, and cost effectiveness

Experiential Science 20, Unit 4, Petrology and the Ocean Environment
General Learning Outcome:

- Students will gain a general understanding of the petroleum industry including the processes involved in manufacturing petroleum products, the environmental impact of this industry and the careers available related to the petroleum resource industry.

Specific Learning Outcome:

- Students will gain an understanding of the environmental issues surrounding the petroleum resource industry by: Evaluating alternative renewable forms of energy (e.g. wind, geothermal, solar, biomass, heat pumps) by considering: i. Availability ii. Cost and efficiency iii. Environmental impact iv. Other relevant "cultural" considerations

Associated Curricular Connections:

- Language Arts, Social Sciences, reading, analysis, interpretation of information, synthesis, cooperative group work

Progression And Methods

Part A: Understanding Home Electricity and The GHG Link

1. As a class generate a checklist of all appliances students have in their home or used on the land. Include everything that uses electricity, including appliances, technologies, ways of heating water and their home (i.e. oil, wood, natural gas, propane or electricity).

2. Using the above list, for each appliance, technology and source of heating, list each application vertically in a numbered table. Create two columns beside this list and determine which source of energy that could be used, renewable, non-renewable or both, as a source of energy to power the devise. Now create two more columns, renewable and non-renewable to the right and indicate the primary source of where the energy comes from. Note: some communities use hydro as their primary source of energy and diesel only for back. These sources should be recorded as renewable. Now, students can start their audit by determining the power source for these items. The lists may differ for students depending if they are living on or off the grid, which will open up the discussion on personal choices.

3. Open a discussion on "How can personal choices affect climate change?" Students should realize that every time they use energy they have a personal choice on what source of energy they will use to generate the electricity. This will have a direct impact on their personal contribution to GHG's and climate change. This also opens the discussion for the use of renewable and sustainable carbon-neutral sources of heat such as wood and other forms of biomass to heat water and homes. The use of carbon-neutral sources of energy is considered GHG neutral because it is just recycling a renewable source of carbon in the local environment.
4. Using the appliance list, group the items into similar categories. I.e. sources of light, kettles, toaster ovens, hair dryers, washer, dryer etc. Choose the top 10 items that everyone will have on their personal home list to allow student to share and compare information. Student can now conduct a quick internet search on what wattage different appliances use per hour of use. This will also provide them with a list of the most efficient appliances, within a group, that could be used to do similar tasks including those items that are carbon neutral. As students are going through this activity they may take note that some appliance are using only for minutes (hair dryer) and others throughout the day (refrigerators). This will be an opportunity to discuss usage of items and their consumption per unit time and how efficiency plays into the equation.

5. *Note: Entertain the discussion on payback through savings on energy efficiency. This will better help students understand the over all economics of paying forward to save money and energy by replace old inefficient technology with new efficient forms of technology. This also encourages STEM thinking for developing new applications and more efficient technologies.

6. For those items that are carbon neutral (i.e. tea kettle on wood stove) get students to write this on a sticky note and place it on a separate piece of chart paper labels CARBON NEUTRAL (NO GHG's). This can be used later on to inform students of strategies to offset and mitigate GHG emissions through personal choice.

PART B: HOMEWORK RESEARCH

1. Show examples of appliance information labels and how to read them for energy usage (watts). They can now use student handout #1 to record the watts used by their appliances at home. If this is not an option you and your students can create a fictional family of 4 that would re representative of their community. NOTE: as an extension by comparing grid vs. non-grid homes allows student to see how energy saving devises and or manual devises can further reduce personal and household GHGs.

2. Using the appliance list make a table indicating the item and its watts used per hour of operation. Using the number of watts used get students to think of ways to reduce their consumption by 20%. For example, if students use a kettle and have the option of using a wood stove they could use the wood stove to heat the kettle water thereby reducing their electrical usage and reduce their personal GHG emissions.

3. Using the student generated information in Part A, brainstorm ways of reducing electrical consumption by item, e.g., hang cloths outside to dry vs. using an electric dryer. This will provide students with a functional mitigation plan that will reduce GHG's as well as save them money and mitigate the impacts of climate change.

4. Student can now generate an Energy Audit report showing their current consumption of electricity and demonstrate that by using more efficient appliances or carbon-neutral alternatives their personal / family mitigation plan they can reduce GHG emissions and lessen the use of non-renewable resources.

ENRICHMENT ACTIVITIES/FAST FINISHERS

Students can apply their understanding of energy consumption, audits and alternative forms of renewable resources to on the land activities. This audit would further spark their creativity in using carbon-neutral forms of energy to do similar jobs that would be done in tier home. For example, dry vs. cloths line, LED lights from solar and or wind power, electric trolling motor, wood stove for cooking and heating vs. fuel stoves, thermo-electric generators etc.

SHARING THE MESSAGE

Students can share their finding and strategies on social media or post them on the school website.

STUDENT HANDOUTS

- Making renewable energy look cool video https://www.youtube.com/watch?v=BBFBODPndPI
- High School Backgrounder #1: Climate Change Agreements – What's the Big Deal?
- High School Backgrounder # 13: Renewable Energy Opportunities,
- High School Backgrounder #14: Helping in your own way.
- Student Handout #1: Auditing the Energy Guzzlers
- Student Handout #2 : Energy Use in Your Home
- Student handout #3: Ways of reducing your HGH Emissions through Awareness

EVALUATION

As a class generate a scoring rubric that reflective of the student outcomes, skills, knowledge and attitudes that should be focused on in the Energy Audit. This is a perfect opportunity to integrate Language Arts, Social Science, Science, Technology, Engineering and Mathematics (STEM) and Indigenous knowledge / language into the activity and mitigation strategies. This process will encourage students to reflect on their learning and better articulate methodologies to reduce GHGs.

Name_____ Date_____

AUDITING THE ENERGY GUZZLERS

STUDENT HANDOUT #1

Step #1 - Have a walk around your home (this is homework!) and fill in the number of watts these household items use. Remember that Wattage is measured on an hourly basis. For example, the electric kettle would need to be boiling water for one hour to consume 1500 watts of electricity.

*If the Wattage is not clearly stated, check for the model number and google it. Here is an example of how the Wattage for a TV was found.

This model number was found just behind the television. It may not be obvious at first glance, but a little investigation should be enough to find it (you should not need to drag your dishwasher away from a wall)

Along with a long list of information about the tv, under Full specifications - Power and energy savings the wattage is stated.

In this case, for a 43 inch Sony HD TV the wattage is 110.

Name_____ Date_____

How much Energy is Consumed Per Hour				
Item	**Watts (General)**	**Brief Description of the Item (i.e. 43 inch Sony HD TV)**	**Watts (at Home)**	**Most Efficient Item**
Cloth dryer	5060			
Oven	3060			
Electric kettle	1500			
Clothes washer	1400			
Microwave	1350			
Hair dryer	1300			
Iron	1200			
Toaster	1200			
Dishwasher	900			
Older refrigerator (pre 1994)	460			
Furnace fan motor	432			
Halogen floodlight	300			
New Refrigerator	250			
Computer/printer	215			
Incandescent light bulb	100			
TV	89			
Compact fluorescent bulb	20			
LED light (=60 watts incandescent bulb)	10			

Name_____ Date_____

Item	Watts (General)	Brief Description of the Item (i.e. 43 inch Sony HD TV)	Watts (at Home)	Most Efficient Item

Step #2 - As a class, discuss the makes and models that had the Lowest energy consumption, and fill in the last column of the chart. Are these items new or old? Do they state their energy efficiency? What about these items makes them energy efficient?

Name_____ Date_____

ENERGY USE AT YOUR HOME

STUDENT HANDOUT #2

GREEN HOUSE GASES PER KILOWATT-HOUR (KWH)

If your community uses hydro-generated electricity, 1 kWh results in 0 grams of GHG emissions for the purposes of this activity. However, it is important to note that hydro dams increase GHGs once the head pond is flooded due to methane produced from rotting vegetation (trees, peat moss etc.).

If your community uses diesel-electricity, 1 kWh =795 grams of GHG emissions. However, it is important to note that it takes diesel fuel (truck or barge) to get the fuel to the power station.

As an example if a truck carries 45,000 litres of fuel, it uses approximately 0.625 litres of diesel per kilometre traveled. A litre of diesel fuel produces approximately 2830 grams of GHG's therefore for each liter burned in getting the fuel to the community power station produces 1769 gms of GHG per kilometre. i.e. 2830 gms/L x 0.625 L x 1 km = 1769 gms/km GHG's.

Therefore, if the truck has to travel 1000 kms it results in a total GHG emission per truck load, it will add 39.3 grams / litre to your consumption rate, i.e. 1769 gms/L x 45,000L x 1000 kms = 39.3 gms/L.

Once on site the 45,000 litres of fuel will produce 3.56 kWh of electricity per litre. Therefore one truckload of fuel will produce 45,000 L x 3.56 kWh/L= 160,200 kWh of electricity. Calculate the distance travelled for your fuel to reach your community. Assume the fuel originates in Edmonton Alberta.

If your home or camp uses wind, solar or biomass to generate electricity, 1 kWh results in 0 grams of GHG emissions.

Name_____ Date_____

How Many Watts? How Many GHGs?

Look at your electricity bill, or one supplied, to see how many kilowatt-hours (kWh) your family has used during the billing period. Fill in the chart to get an idea of how your family consumes all that electricity.

Getting to know your Electrical consumption:

a) Write down your major appliances and other electrical devises you and your family use.
b) As part of your homework for this activity ask members of your family approximately (estimate) how many hours per week the specific appliances are used.
c) Using the data you have collected on watts used per hour for an appliance, write the number of watts used per hours and the estimated number of hours you use the appliance.
d) Multiply b and c to determine the total number of watts used per week.
e) To determine the number of kilowatts (kWh) divide your answer by 1000. This will give you the number of kilowatt-hours used per week for that appliance.
f) Determine the cost per kilowatt-hour for your community (what you are charged for each kilowatt used) from your bill or utility provider. Now you can figure your costs based on your consumption by multiplying e. by f.
g) For example say electricity cost 28.5 cents per kilowatt-hour. To change that to dollars, divide by 100, which is 28.5/100 = .285 per kilowatt-hour. So, if you use 32.5 kWh for your lights x .285 $/kWh = $9.26 per week to operate your lights.
h) Using the GHG's per Kilowatt-hour table, write in the number of grams of GHG per kWh for your types of energy generation.
i) To determine the total GHG emissions created by an appliance / device n a week, multiply e and g.
j) Total the columns at the bottom and this will give you an estimate of your GHG emissions.

(a) Appliance / devise	(b) Hrs used per week	© Watts used per hr.	(d) Total watt-hours per week	(e) Kilowatt hrs per week	(f) $ per kWh	(g) Cost/wk	(h) GHG/ kWh	(i) Grams of GHGs / week
Oven	4	3060	12,240	12.24	$0.20	$2.45	795	9730
Totals								

Name_____ Date_____

EXTENSION:

Creating Realistic GHG emission numbers. To figure out how to calculate the energy used to heat water and your home follow the extension exercise.

Two major GHG emitters are heat hot water and your house. In the north the majority of homes are still using fossil fuels of some sort to do these tasks.

As hot water and heating a home are essential for northern living we can play an active role in how this done through the choices we make. Investigate the following processes to better understand how you can have hot water and a warm home while reducing your GHG emissions and lessen your impact climate change.

The creation of hot water takes a great deal of energy. Investigate ways other countries around the world heat hot water. Make a list of these methods and categorize them into viable option that you could use in your community. Which ones would you choose and why? Are some alternative forms of energy seasonal / year round?

Remember that even if alternative energy is used for only short periods, to heat water during the summer months it is reducing total GHG's emissions.

HEATING YOUR HOME

Heating your home with fossil fuels produces large amounts of GHG'. However, there are ways to mitigate the use of fossil fuels by knowing your consumption and working to reduce the amount of oil based fuels you use by using carbon-neutral sources of energy.

OIL GHG EMISSIONS:

To determine how much fuel you use to heat your house, ask you energy provider for last years oil bill "total fuel delivered". Remember that 2830 grams of GHG are produced by every litre of fuel burned. Therefore, a quick calculation, litres used x 2830 gms/L, would show your GHG emissions for that year, e.g. 2000 L x 2830 gms/L = 5, 660,000 gms of GHG's. To convert this to kilotons divide this figure by 1,000,000, which would work out to roughly 5.7 tons of GHG's. *

*Note: In many home northern home this amount of fuel may also include your hot water consumption.

Name_____ Date_____

Electric Heat – Home & Hot Water:

Some homes just use electricity for heat and hot water, in areas where electricity is inexpensive i.e. hydropower. To determine the amount of electricity used in your home for heat and hot water use the data collected from calculating the kWh used by appliances and subtract this from the total kWh used. This will give you an approximation of the number of kWh used to heat your house and hot water. For example, if your total consumption for a month was 1,800 kWh and your appliance use was 540 kWh, the amount of energy used to heat your house and hot water would be 1800 kWh – 540 kWh = 1,260 kWh.

*Note: An alternate method for calculating this would be to use the electrical meter attached to your house. This method would provide an estimate of electricity used per hour, which can be extrapolated to a week. Begin by taking a meter reading. Do an Internet search for how to read a meter. Once you have taken the reading turn off your heat and hot water tank and ask your family members to turn on the other appliances in the hours on for 1 hour. Once an hour has lapsed take a second reading and this will give the amount of energy used for appliances alone. Multiply this number by 168 hrs/wk x 4 wks/month to give the total kWh used per month for appliances. For example if the appliances use 0.75 kWh x 168 kWh/ wk x 4 wks = 504 kWh used monthly for appliances alone. Using the total kWh used from your electrical bill subtract the kWh used for just appliances. Using the example above, if your total electrical consumption for a month was 1800 kWh subtract the appliance usage 504 kWh and your heat and hot water electrical usage would be 1800 kWh – 504 kWh = 1,296 kWh for heating your home and hot water.

Alternative Fuels (Carbon-Neutral):

Many homes in northern Canada, in the tree line, use wood to heat or partially heat their homes and or hot water. Since wood is a renewable source of fuel is it considered carbon-neutral and the net GHG's produced are said to be zero. This means that if you are using wood or other forms of biomass to heat your home each time you use them you are reducing your GHG emissions and mitigating the impact on climate change. Therefore, by using wood you can reduce your GHG emissions by thousands of kilograms per person per year. This would be a major contribution, as individuals, to reducing GHG emissions locally and globally.

Name_____ Date_____

WAYS OF REDUCING YOUR GHG EMISSIONS THROUGH AWARENESS

STUDENT HANDOUT #3

Your task is to conduct Internet research on viable ways of reducing the direct use of energy from fossil fuels through a simple mitigation strategy. Note: A Mitigation strategy, in this case, refers to simple strategies you could use to reduce your overall emissions of GHG's. The chart below has a listing of some simple strategies that can save you money and also significantly reduce your GHG emissions. Fill in the spaces with your finding. Many forms of technology will tell you how much you could save based on kWh. Use this information to calculate your costs based on your rate per kWh. This can be extended to look at the payback on your investment. It is important to note that most payback periods in the north are much shorter because energy costs more due to our reliance on fossil fuels for energy.

Mitigation Strategy to reduce Household GHG's				
Energy Saving Option	**Approximate cost ($)**	**Savings per year ($)**	**Comments**	**Payback (Cost/Savings)**
Low volume shower head	$24	$15		1.6 years payback.
Cleaning furnace filters	$20/ yr.	$80		3 month payback
Set back thermostat 1C	$0	1-3% total fuel consumption		Saves 1-3%
Installing wood stove heater	$5000	>40% savings annually on fuel	Using wood to supplement	> Supplement gives >savings