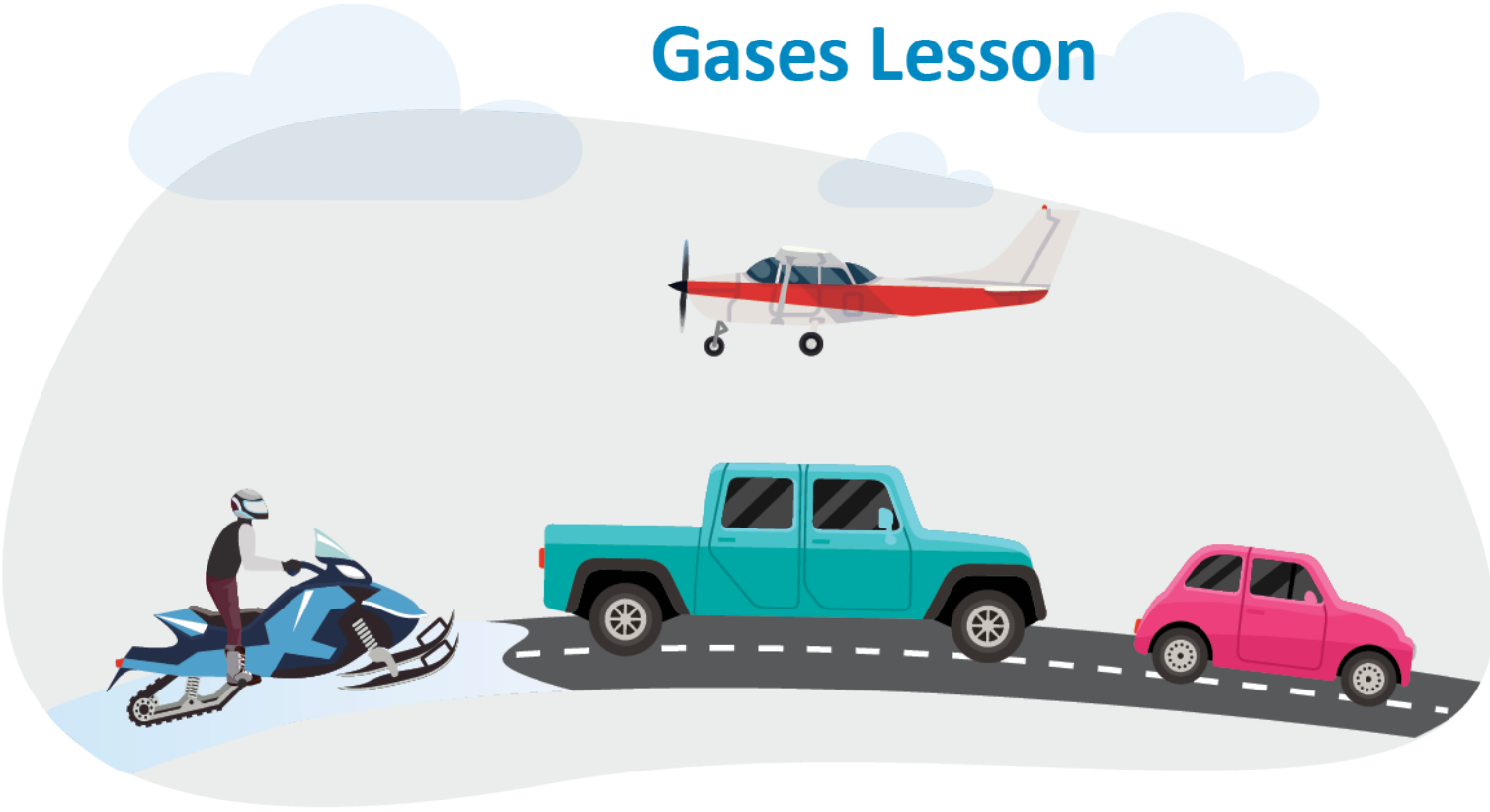
Government of
Northwest Territories

LESSON # 7:

Calculating Your Travel Green House Gases Lesson



INTRODUCTION

Nationally, transportation accounts for 24% (Stats Canada 2015) of our national GHG's (carbon dioxide equivalent) emissions. For northern and other remote areas this number is significantly higher due to a greater reliance on air transportation and trucking for goods and services.

By making informed choices about driving, flying and transportation of goods, individuals can reduce the need for non-renewable fossil fuels thereby reducing their GHG, carbon dioxide equivalents for emissions that they produce which will have an effect climate change. Carbon dioxide (CO2) equivalents are used because 98% of the GHG emissions are CO2 and the other GHGs produced are equated to the impact of CO2. Therefore other GHG's, such as methane and carbon monoxide which affect climate change to different degrees, can be equated to one source of GHG. This allows people to better understand and interpret data that is supplied by government and non-government agencies around the world. Further, this creates a process for individuals to start monitoring and understanding their own choices of fossil fuel use can impact the environment and climate change as a whole.

For example, just one litre of gasoline (0.75 kg) produces roughly 2.4 kg of CO2 when the fuel is burned in an engine. Therefore each time you choose to not to use a litre of fossil fuels for transportation you are saving the equivalent of 2.4 kgs of CO2 from entering the atmosphere. By quickly doing some mathematical calculations students can see how their choices on a yearly basis could account for thousands of kilograms of CO2. This process of reduction, by using alternate forms of transportation, that do not produce GHGs is a mitigation strategy that could be employed locally as well as globally because it is a simple change in behaviour. The decision requires a conscience effort on the part of the individual, who leads by example, which can slowly cause a change in the behaviour of others through greater social awareness.

Both the Governments of Canada and the NWT are committed to reducing GHG and are making information available to individuals on how monitoring ones own emissions of GHGs can change behaviours and save money as well as reduce (mitigate) GHG emissions locally and nationally.

In 2015 the per capital emissions of GHG (CO2 equivalent emissions) for Canadians was 20.1 tonnes per person, where other industrialized countries were at slightly over 12 tonnes CO2 per person. For remote and northern residents the consumption and emission rate would be significantly higher than the Canadian average, due to a greater reliance on fossil fuels for energy. In 2013, the NWT average GHG emissions was 33.21 tonnes per person. This is why the choices made and actions taken by northerners can have a greater impact on mitigating climate change as individuals and small groups.

Many students may feel that the issue of Climate Change is far too big of a challenge for them, as individuals, to make a difference. However, an individual's actions, collectively extended to a population, can and would have an effect on climate change. One such mechanism is to create an awareness of the choices individuals can make and being aware their own carbon footprint. This activity helps students to better understand that the choices they make, whether is it at home, school, on the land, going on vacation or participating in sports and adventure activities, all contribute to ones' carbon foot print.

In this activity students will record, calculate and present their own CO2 emissions, based on their transportation choices, and provide viable options for reducing their consumption of fossil fuel and reduce their overall CO2 emissions by making informed choices.

LESSON PLAN #7: CALCULATING YOUR TRAVEL GHGS

Author: Yukon Conservation Society Curriculum Team

GOAL

To increase student awareness of how choices in transportation can contribute to greenhouse gas emissions and climate change globally. To better ensure that students understand the concept of their "choices count", open the class discussion with "Does social activism cause change?" Quickly explore with students some instances where social activism has caused behavioural changes in people's behavioural choices. Although this is a social sciences concept, students will see that their choices do have an impact on society at both the local and global level. Use this as a introduction to open a discussion on Greenhouse gases (GHGs) and how their choices for transportation can have an impact on GHG's emissions locally and globally. By making simple choices on a daily basis students can develop their own mitigation plan to reduce their own GHGs and reduce the impact of global climate change.

KEY WORD SEARCH

Climate change, greenhouse gases, alternative energy, sustainability, mitigation,
Greenhouse gas sources, transportation GHGs, green transportation, reducing carbon-foot print, green efficient modes of transportation.

TIME

Budget for 1 hour of time in class to review greenhouse gasses, the math involved in calculating Greenhouse Gasses, 1 or 2 evenings for the data collection, and 1 hour for group discussion and goal setting exercise

CURRICULUM CONNECTION

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
- Researching and developing a media promotion campaign that would encourage people to gain an appreciation of the "Beauty of the Land" and the need to preserve it for future generations.

Experiential Science 20, 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, research, oral and written presentations using a variety of genre. Cultural Land Based activities to demonstrate applications of green technologies, and Social Studies, citizenship, ethics and social activism.

Progression And Methods

1. Ask students open-ended question on climate change and how they as individuals contribute to climate change. Then direct the conversation to focus in on the use of fossil fuels used for transportation (people, good and services) and modes of transportation used in your community to move people and good around.

2. Start the next set of discussions with creating the understanding of the relationship between our activities, the consumption of fossil fuels, the quantity of GHGs emitted and the connection to climate change. Consider showing grabber video How do Greenhouse Gasses Work? (attached)

3. Students can now list all of the modes of fossil fuel transportation they use in the daily lives, throughout the seasons. (i.e. ATV, snowmobile, outboard motor, car, ½ ton truck, aircraft, ship, transport truck etc.) This would include cultural, on the land activities, as well as transportation within and between communities.

4. Present to students the general chemical equation for the complete combustion of a hydrocarbon with oxygen i.e. $CH_4 + 2O_2$ yields $CO_2 + 2H_2O$. Show them the mathematical relationships that exist for the complete combustion of fossil fuels i.e. 1 litre of fuel (gasoline) produces roughly 2.4 kgs of CO_2. This is a good time to show the students what happens if you reduce your consumption of fuel by just 1 litre a day the potential impact this would have in their own personal carbon foot print. i.e. 1L x 0.75 kg x 2.4kg CO_2 x 365 days = 657 kg of CO_2.

5. Play with the mathematics to show what happens when we start to include the collective contributions or reductions of others and their use of fossil fuels.

6. Walk the students through a couple of examples, using the student handout for GHG emissions for average CO_2 emissions, then let them determine the CO_2 equivalent emissions they produce. Now extend this to their transportation uses and distance travelled to the mathematical relationship between fuel consumption and mode of transportation.

7. Using the student handout for GHG emissions for average CO2 emissions, they can now start to calculate the their own personal GHG emissions based on their activities. As the total amounts of GHGs will differ between individuals, for the same activity due to duration of activity, it is important to share the data as a class and discuss these differences. This will encourage students to reflect on their activities, the duration of the activity and the collective emissions for activities of the class and possible mitigation strategies.

    a) Create a bar graph showing all of the students GHG emissions by related activity, such as, ATV, outboard motor etc. This will provide students with a better understanding of which activity produces the greatest amount of GHGs. Then ask "what if questions", such as, what if we walk vs. drive a snowmobile to school. This will now allow students to create a leger or table to demonstrate mathematically how their behavioural choices either contribute to or act as a mitigating strategy to reduce GHGs.

    b) The student's own ledger can now be used to see if they are above or below the national average for CO2 emissions and identify mitigation strategies. The national average for GHG emissions of 20.1 ton/individual, where 24% is attributed to transportation, would yield an average GHG transportation budget of 4.824 tonnes of CO2 or 4824 kgs of CO2 per individual.

    c) Students can now extend their calculations to see the CO2 contributions of their family emissions.

8. As per step 5; play with the mathematics to see how this data can be extrapolated to weekly, seasonal and yearly emission rates. This will give students a much better understanding of the scope of impact an individual's choices and group size can have on climate change mitigation.

9. As a class, create a list of strategies to reduce CO2 emissions from the use of fossil fuels, i.e. walk, bike, canoe, ski, take a bus, car pool, use new efficient technologies etc. Students can set a personal goal as outlined in Student Handout #7 Goal Setting.

10. Break students up into groups where they will use their findings to create a motivational info-graphic to inform others about how their choices can impact / mitigate CO2 emissions to foster behavioural changes.

Enrichment Activities/Fast Finishers

As students are generating info-graphs, they can translate the information into any of the official languages of the NWT. This would encourage students to use their local indigenous language and integrate cultural practices into their info-graphic.

Sharing The Message

Students can share their findings, info-graphic and mitigation practices with others using the web or social media.

STUDENT HANDOUTS

- How greenhouse gasses work video https://www.youtube.com/watch?v=sTvqIijqvTg
- Lesson #7 Student Handout: Calculating Your Travel GHGs.
- Lesson #7 Student Reading
- How do greenhouse gasses work? video
- Lesson #7 Student Handout (goal setting)
- Infographics Handout
- Lesson #7 Rubric

EVALUATION

The info graphic and presentation can be evaluated using the *Lesson #7 Rubric* attached. Additional criteria can be added and assessed for outcomes in Language Arts, Social Sciences and Aboriginal Languages.

Group Members _____

	100%-85%	85%-70%	70%-65%	65%-50%
Content	The infographic clearly answers the question 'what are our travel GHG and how can we reduce them?' The infographic clearly and thoroughly provides information on where alternative energies could be used	The infographic answers the question 'What are our travel GHG and how can we reduce them? The infographic provides information on where alternative energies could be used	The infographic partially answers the questions What are our travel GHGs and how can we reduce them?' The infographic provides some information on where alternative energies could be used	The infographic fails to answer the questions 'how to reduce travel GHGs' The infographic provides little information on where alternative energies could be used
Visual Appeal	The Infographic is eye catching and clever Outstanding use of design colour and space Original and creative	Overall the infographic is pleasing and harmonious good use of colour design and space we see creativity and originality	Infographic lacks organization and thought little use of colour design and space and lacks creativity	Little attempt to use colour design and space appropriately Design is Dull Project is sloppy in appearance

Group Members _____

Presentation	Demonstrates full knowledge by answering all class questions with explanations and elaborations Provides clear purpose and subject; pertinent examples, facts, and/or statistics; supports conclusions/ideas with evidence Demonstrates strong enthusiasm for the subject Significantly increases audience understanding and knowledge of the topic, convinces the audience of the important of the subject	Demonstrates knowledge by answering class questions without elaborations, Uses pertinent examples facts and statistics Shows some enthusiasm for the subject Raises audience understanding and awareness of most points	Demonstrates little understanding and is only able to answer rudimentary questions Uses some pertinent examples facts and statistics shows little enthusiasm for the subject Raises audience understanding of some points	Does not have a grasp of information and cannot answer questions about the subject Provides weak examples, facts and statistics which do not adequately support the subjects includes thin data or evidence shows no interest for the subject Fails to increase audience knowledge of topic
Comments	_____ _____ _____ _____ _____ _____			

Name_____

CALCULATING YOUR TRAVEL GHGS

WHAT ARE SOME CHOICES THAT YOU COULD MAKE TO REDUCE YOUR PERSONAL CARBON FOOTPRINT?

- Ride my bike to school and soccer practice when the weather is nice
- Carpool with Andrew and Phil to hockey games on Saturday
- Sign up for a community garden plot to get more food from the garden instead of the grocery store
- Leave the snowmobile at home and go for a cross country ski instead

Now that you have an understanding of how to calculate your travel Green House Gasses and some strategies to reduce your personal carbon footprint, set a goal about reducing your carbon footprint. Your goal should adhere to the SMART principal:

S - Specific (what do I want to accomplish? why is this important? what resources will I need? who is involved? what restrictions might I encounter?)
M - Measurable (How will I track my progress? What is my deadline?)
A- Achievable (how can I accomplish this goal? how realistic is it?
R- Relevant (Is this goal worthwhile? why is it important to me?)
T- Time Bound (set a target date to work towards)

Name_____

MY CARBON FOOTPRINT GOAL:

Name_____

CALCULATING YOUR TRAVEL GHG'S

STUDENT HANDOUT #1

Public Transportation				
Type of transportation	**Average litres of fuel used per 100km**	**Average CO_2 emissions (kilograms per 100 km)**	**Average CO_2 emissions (grams per 1 km)**	**CO_2 emissions grams per person per km**
City Bus Av. # of people = 30	33	82.5	825	
Twin Otter DCH600 Av. # of people = 16	114	285	2850	
Boeing 737 Av. # of people =100	442	1105	11050	
Boeing 747 Av. # of people = 460	1653	4132.5	41325	
Helicopter (Bell 206 JR) Av. # of people =4	53	132.5	1325	
Other				
Other				
Other				

DETERMINING YOUR TRAVEL CO_2 EMISSIONS

(a)	(b)	(c)	(d)	(e)	(f)
Type of transportation (vehicle)	Km per __ (day, trip etc.)	CO_2 grams / km	Total CO_2 per ___ (day, trip etc.)	# Of people in vehicle	CO_2 grams per person
Small pick up	40/day	357	14280	2	7140

How much CO_2 do you emit when traveling? The table for individual and public transportation can help you figure this out. You can add to this list to reflect activities in your community.

Just follow these steps:

a) Choose the type of transportation that is closest to what you travel in.
b) Figure out approximately how many kilometers you travel in the activity you have chosen.
c) Find a reliable source for how many grams of CO2 are emitted by the vehicle per kilometer. Sources like the **International Council on Clean Transportation** are a good starting point.
d) Multiply columns (b) and (c) to get the total CO2 emissions.
e) Write in the number of people in a vehicle ("car pooling"). Only include the people who actually need to be transported. (for example, if your parent were driving you to school, and then going home again, the number would be 1 (you). If your parent were driving 3 students to school, the number would be 3. If your parent works at the school, then the number would be 4.)
f) Divide column (d) by (e) to get the per person emission of CO2.
g) To covert your totals to kgs divide (f) by 1000. Note: this will allow you to convert your total masses of CO2 emissions to compare with the national average.
h) Using the totals from (g), for all of your activities, and implementing your mitigation strategy e.g. walk to school each day, how much less GHG would you be putting into the atmosphere annually.
i) Using (h) subtract this from the Canadian average of GHG emission to demonstrate the impact one individual would have as part of the mitigation strategy on GHG emissions.