Counting the Real Costs of Cars

An activity for high school students and adults

In this activity, students will use a method called "full cost assessment" to compare several vehicles on the basis of their costs of ownership and their contributions to the climate change problem. Students will gain an understanding of the economic and environmental costs of owning a vehicle.

Concepts

- The full cost assessment of a vehicle purchase reveals the many hidden costs, both environmental and financial.
- Transportation choices are an important factor in our personal environmental impact.
- Transportation is a major source of greenhouse gases.

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Objectives

When they have completed this activity, students should be able to:

- Conduct an abbreviated full cost assessment to compare the value of vehicles being considered for purchase.
- Describe a process for calculating the lifetime carbon dioxide emissions from a vehicle.
- Describe the process of assessing the full costs of other consumer products besides cars.

Resources and materials

- Fact Sheet: The Facts on Cars, Carbon and Climate Change (see page 52)
- Student Worksheet: "Calculating the Costs of Vehicle Ownership" (see page 50)

Preparation

Students may conduct this activity as a field research project or use data that you provide.

Activity plans

Introduction

Conduct a quick class survey of the total number of fossil-fuel-powered vehicles owned by students' families, including motorbikes, snowmobiles, jet skis and so on. Calculate the number of people per vehicle this represents. Compare this with a country such as China where there are as many as 200 people for every vehicle. Use this information to point out that not only do North Americans have the highest per capita carbon dioxide (CO_2) emissions in the world (the United States ranks first, Canada third), but that our transportation habits are responsible for a very large proportion of the greenhouse gases we produce.

Brainstorm all the ways that cars affect the environment and create an "effects web" to illustrate that they have costs and environmental impacts far beyond their day-to-day operating costs. Include upstream impacts such as pollution from the production of fuels and metals, as well as downstream impacts connected with the disposal of car components such as batteries and air conditioners. Explain full cost assessment as the notion of defining costs so as to include all those associated with the manufacture, use and disposal of a product.

Introduce the idea of comparing three vehicles on the basis of their purchase and operating costs and their emissions of CO_2, the principal greenhouse gas. Organize the class into project teams that will each research three vehicles. Teams may be assigned different sizes and classes of vehicles, such as sport utility vehicles, luxury cars and light trucks.

Calculating the costs

Distribute copies of the worksheet "Calculating the Costs of Vehicle Ownership" and explain that values in the worksheet indicated by "input" must be researched by the project teams. Sources for this data include sales representatives at local car dealerships, new vehicle buyers' guides, Natural Resources Canada *Fuel Efficiency Guide for New Vehicles* (or equivalent publication), and other publications such as Phil Edmonston's *Lemon Aid*, a guide to used cars.

Once the data is gathered, each team works through the step-by-step calculations on the worksheet.

Student Worksheet

Calculating the Costs of Vehicle Ownership

Vehicle Data

	Make	input			
	Model	input			
	Engine Size (L)	input			
	Fuel Type	gas or diesel			
	Retail Price (includes tax)	input			

Operating Costs

a	Fuel Efficiency (L/100 km)	input			
b	Annual Mileage (km)	assume 24,000	24,000	24,000	24,000
c	Fuel Price ($/L)	input			
d	Annual Fuel Consumption (L)	b x a ÷ by 100			
e	Annual Fuel Costs	c x d			
f	Annual Maintenance Costs	input			
g	Annual Insurance Premium	input			
h	Vehicle Registration Fee	input			
i	Other Annual Fees	input			
j	Total Annual Operating Costs	e + f + g + h + i			
k	Operating Costs Over 4 Years	4 x j			
l	Daily Operating Costs	j ÷ 365			

Ownership Costs

m	Down Payment	input			
n	Monthly Payments	input			
o	Term (number of payments)	assume 48	48	48	48
p	Financed Cost Over 4 Years	m + (n x o)			
q	Daily Cost of Ownership	p ÷ (365 x 4)			

CO_2 Emissions

r	Tailpipe CO_2 Emission Factor	select from below			
s	Annual Exhaust CO_2 Emissions (kg)	d x r			
t	Upstream CO_2 Emission Factor	select from below			
u	Annual Upstream Emissions (kg)	d x t			
v	Total Annual Emissions (kg)	s + u			
w	Emissions Over 4 Years (kg)	v x 4			

Summary

x	Total Costs Over 4 Years	k + p			
y	Average Daily Cost Over 4 Years	x ÷ (365 x 4)			
z	Average Daily CO_2 Over 4 Years	v ÷ 365			

CO_2 Emission Factors

CO_2 Source	Gasoline	Diesel
Tailpipe CO_2 Emissions from Fuel Combustion (kg/L)	2.36	2.77
Upstream CO_2 Emissions from Fuel Production (kg/L)	0.65	0.54

The CO_2 Emission Factors are estimates of how much CO_2 is released during the production and combustion of the fuels used by vehicles.

The formulas may be entered in a spreadsheet program to speed up the calculations. The CO_2 Emission Factors at the bottom of the worksheet give estimates of how much carbon dioxide is released during the production (upstream emissions) and combustion (tailpipe emissions) of the fuels used by the vehicles.

Processing the results

When the students have finished their calculations, the data may be organized and presented in various ways:

- Rank the vehicles according to operating costs, costs of ownership and carbon dioxide emissions.
- Group the costs and emissions by vehicle category (family vans, sport utility vehicles, compact sedans, full-size passenger cars, trucks, etc.).
- Prepare bar charts to graphically represent the grouped and ranked data.

Follow-up discussion

The following questions may be the basis for individual or group work or class discussion.

1. Together as a class, rank the vehicles surveyed in order of popularity and preference (not fuel efficiency). Compare this ranking with their ranking on the basis of fuel efficiency and cost. How are the lists different, and what factors determine the relative popularity of different models?

2. Is it realistic to expect that young people will place their priority on fuel economy when purchasing new vehicles? Why or why not?

3. What are the barriers to wide acceptance of electric vehicles or other "zero emissions" vehicles? How important are perception and image in the marketing of domestic vehicles?
An important barrier to wide acceptance of zero-emissions vehicles will likely be their high initial cost. These vehicles will depend on exotic technologies such as high-tech batteries, flywheels or hydrogen fuel cells. They may, in the interest of reducing aerodynamic drag, have unconventional body designs, which may be difficult for consumers to accept.

4. One strategy suggested to curb greenhouse gas emissions is for governments to assess a special charge on fossil fuels or other greenhouse gas-emitting technologies. How might this affect preferences for new vehicles?
A greenhouse gas emission charge will raise the cost of buying fuel, which will give people incentives either to buy more fuel-efficient cars or to drive their vehicles less often. This plan could also make alternative transportation such as public transit much more attractive.

5. Make a list of the environmental impacts associated with vehicles besides greenhouse gas emissions. Try to agree on which impacts are most important in your area. Suggest ways of reducing these impacts.

6. The choice between purchasing high- and low-efficiency vehicles has a relatively marginal impact on greenhouse gas emissions compared with the impact of avoiding the use of cars altogether. Describe several transportation alternatives. For each, identify the associated environmental and social benefits and costs.


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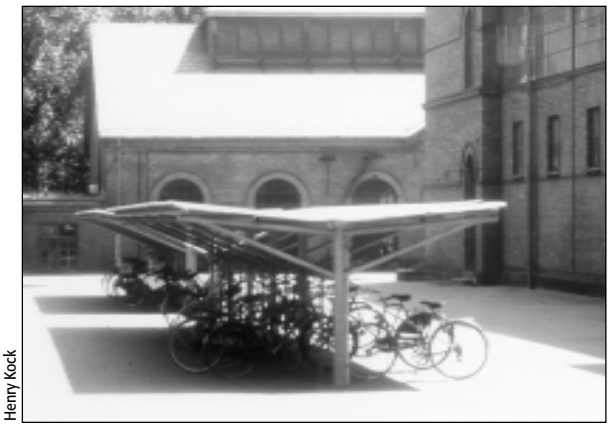
Henry Kock

Top: Staff parking lot, Canada.
Bottom: Staff parking lot, Denmark.

Extension ideas

1. Use the results of the research on vehicle efficiency and costs to create a display for the school, a regional education conference or the local mall.

2. How much could you reduce your costs and personal greenhouse gas emissions by not owning a car? What lifestyle adjustments would be needed to get by without a vehicle?

3. Extend the concept of full cost assessment to compare other items. For example, compare:

- electric and natural-gas hot water heaters
- ethanol-blended and regular gasoline
- incandescent light bulbs and equivalent compact fluorescent bulbs
- light rail transit and diesel buses for urban mass transit

This activity and accompanying fact sheet are adapted from "Cars and Climate — Counting the Cost" in Climate Change: Awareness and Action Education Kit *by the Pembina Institute for Appropriate Development in Drayton Valley, Alberta (see Organization and Resources section).*

The Facts on Cars, Carbon, and Climate Change

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Our Automobile Addiction

North Americans are addicted to cars. Most of us depend on motorized transport every day. We use cars to go to work, take a vacation, earn a living, or simply to go buy groceries. In fact, we find it hard to imagine life without cars.

In Canada, there is roughly one car for every two people, and many homes have more than one car. Once the purchase cost, insurance, registration, fuel, repairs and traffic tickets are added up, the average Canadian car owner spends approximately $8,000 a year to own and operate a car. This is more money than the average spent on food, housing, or education in a year. In the United States, it has been estimated that drivers spend an average of 1,600 hours per year either driving in their cars, working to cover the cost of owning and operating the car, or working to pay the income and fuel taxes that are used to build the road system. That is equal to 200 eight-hour days, all dedicated to the car.

Clearly, our addiction to cars is serious, and we will go to great lengths to satisfy it. And just like many addictions, our addiction to the car has a number of nasty side effects.

Cars and Climate Change

Cars are one of the largest single sources of the greenhouse gases that are changing global climate. In North America, the average car produces more than five metric tonnes (11,000 lbs.) of carbon dioxide (CO_2) every year. Passenger cars and trucks produced about 15 percent of Canada's CO_2 emissions in 1994, and about 29 percent of nitrous oxide emissions in 1993. Car air-conditioning systems are one of the biggest sources of emissions of chlorofluorocarbons (CFCs) and hydrofluorocarbons (HFCs). These figures do not include the greenhouse gases produced in the manufacture of cars, or in the exploration, development and refining of the gasoline used to power them.

The contribution of cars to climate change will become even more significant in the future. While transportation makes up only a small percentage of greenhouse gas emissions in many developing countries (e.g., there is only one car for every 455 people in India), this is changing rapidly. Globally, new cars are being put on the road at the rate of one per second. As a result, transportation is the fastest growing source of greenhouse gases in the world.

Other Environmental Impacts of Cars

Air Pollution: Cars contribute to acid rain (nitrogen oxides) and urban smog (nitrogen oxides and hydrocarbons), and release hazardous chemicals such as benzene into the atmosphere.

Death and Injury: Around the world, road accidents kill nearly a million people a year and injure over 10 million.

Wilderness Destruction: Automobile infrastructure (highways, roads, driveways, parking lots) makes up nearly 50 percent of the surface area of most North American cities.

Oil Spills: Most oil is produced to fuel automobiles, and transporting that oil causes damage to waterways. Since 1990, an average of 100,000 metric tonnes of oil have been spilled each year worldwide, amounting to the equivalent of 30 *Exxon Valdez* accidents.

Waste Disposal: As an example, 230 million tires need to be disposed of in the United States each year.

Climate-Friendly Transportation

If we are to reduce greenhouse gas emissions, we must break our addiction to the automobile. In the short term, this means using other modes of transportation whenever possible. A person driving alone in a car produces about eight times as much CO_2 as someone taking public transit. Bicycles are one of the most Earth-friendly modes of transportation. They use no fuels and produce virtually no pollution. Repairing and maintaining them requires simple tools and skills. Bicycle routes are far less costly than roads and highways to build and maintain. A final bonus is that bicycles are easy to recycle when they can no longer be used.

In countries like Canada and the United States, choosing modes of transport other than automobiles is not always simple. Our cities have been designed around the car. Few of us live close to where we work, shop or play. In Europe, cities are much more dense (there are more people and services in each square kilometer), making alternative modes of transportation more attractive. In fact, it has been shown that people living in large North American cities use four times as much energy for transportation as people living in large European cities. Breaking our dependence on cars in the long term will require us to redesign our cities so that alternative modes of transportation will be more attractive and cars much less necessary.

Reducing the Impact of Today's Cars on Global Climate

While it is relatively easy for most North Americans to reduce their use of the car, many will still want to own one. Cost, color and style are some of the things people consider when buying a car. To protect global climate, however, we also need to consider fuel efficiency. Buying fuel-efficient cars makes both economic and environmental sense. When less fuel is burned, less greenhouse gas is produced and costs to the driver are lower. As illustrated below, these differences can be substantial:

Fuel Economy (L/100 km)	CO_2 Emissions (20,000 km/yr)	Fuel Cost (@$0.70/L)
8.7	4.1 tonnes	$1,218
6.0	2.8 tonnes	$ 840

Tomorrow's Cars

Is it possible to build a climate-friendly car? Doing so will require us to abandon gasoline as a motor fuel. While some alternative-fuel vehicles exist (e.g., natural gas, propane, and hybrids using both electricity and gasoline), these vehicles still use fossil fuels and produce greenhouse gas emissions. The outlook is very good for climate-friendly transportation. For example, technologies have been developed which make ethanol (the same fuel used in high-performance race cars) from biomass such as wood and agricultural wastes. Using ethanol as a vehicle fuel produces CO_2, but the crops used to make the ethanol would take just as much or more CO_2 out of the atmosphere. Until we find a substitute for the internal combustion engine, ethanol and other biomass fuels may be a good interim solution.

At the moment, work continues on several alternatives to fossil fuels for transportation. Engineers have demonstrated cars powered by electricity and by hydrogen fuel cells, both of which emit no significant greenhouse gases during their operation. As long as the electricity used to charge them up comes from renewable sources (such as solar, hydroelectric or wind), these vehicles will be the climate-friendly choices of the future.