

LESSON PLAN

Fuel Wise or Fuelish?

Grades 9 to 12



SUMMARY

In this lesson, the students will explore the different impacts using alternative fuels has on the economy.

The students will research and compare different cars. They will determine the cost of operation for one year to include price, fuel, insurance, property taxes, title, tag, and maintenance, as well as determine the most cost-effective choice of vehicle, based on their research.



LESSON OBJECTIVES

Upon completing this lesson the students will:

- Learn how world events affect supply and demand for petroleum;
- Explore why it is important for South Carolinians to use alternative fuels; and
- Make decisions pertinent to choosing a fuel-efficient car.



ESSENTIAL QUESTION

How have alternative fuels impacted the economy?



DURATION

The activity requires about one to two weeks to complete.



2014 S.C. SCIENCE STANDARDS CORRELATIONS

Standard H.P.3: The student will demonstrate an understanding of how the interactions among objects can be explained and predicted using the concept of the conservation of energy.

CONCEPTUAL UNDERSTANDING

H.P.3A.: Work and energy are equivalent to each other. Work is defined as the product of displacement and the force causing that displacement; this results in the transfer of mechanical energy. Therefore, in the case of mechanical energy, energy is seen as the ability to do work. This is called the work-energy principle. The rate at which work is done (or energy is transformed) is called power. For machines that do useful work for humans, the ratio of useful power output is the efficiency of the machine. For all energies and in all instances, energy in a closed system remains constant.

PERFORMANCE INDICATOR

H.P.3A.5: Obtain and communicate information to describe the efficiency of everyday machines (such as automobiles, hairdryers, refrigerators, and washing machines).

SCIENCE AND ENGINEERING PRACTICE (SEP)

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| <ul style="list-style-type: none"> • Ask questions and define problems. • Develop and use models. • Plan and conduct investigations. • Analyze and interpret data. | <ul style="list-style-type: none"> • Use mathematical and computational thinking. • Construct explanations and design solutions. • Engage in scientific argument from evidence. • Obtain, evaluate, and communicate information. |
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CONNECTION TO CLASSROOM ACTIVITY

Analyze and interpret data from informational texts and data collected from investigations using a range of methods (such as tabulation, graphing, or statistical analysis) to 1) reveal patterns and construct meaning, 2) support or refute hypotheses, explanations, claims, or designs, or 3) evaluate the strength of conclusions.



MATERIALS

- **Alternative Fuels** from the S.C. Energy Office (provided)
- Current Year **Fuel Economy Guide** from the U.S. Environmental Protection Agency (EPA) at www.fueleconomy.gov.
- Internet Access (to gather various price quotes)
- **Buying My First Car Worksheets 1 and 2** (provided)



EXPLORE

Introduce the **CAR-BUYING SCENARIO** (left). Tell the students that they will be conducting an in-depth analysis of the car buying process. The information they learned in the “Alternative Fuels” handout will assist them in the process. The scenario will describe multiple steps the students will need to complete to make a full analysis of the car buying process.



CAR-BUYING SCENARIO

Your generous Uncle Bill has just offered you \$5,000 toward the purchase of your first car. The money, however, comes with some strings attached. In order to get the money, you must first prove that you are mature enough to handle the responsibilities associated with car ownership including financing, insurance, maintenance, and everyday operating expenses.

To provide the proof your generous uncle needs, you decide to conduct an in-depth analysis of the car buying process. The analysis begins with the car search. Begin exploring various auto buying websites to find a car you would like to purchase.

Choose three different cars you would like to purchase. Choose one new car, one used car, and one alternative fuel vehicle. Complete “Buying My First Car Worksheet 1” which will compare the costs of these car models.



EXPLAIN

Once you have selected the cars of your choice, check the financing options that are open to teenagers. **Are you going to pay cash for the car, make a down payment and monthly payments, or buy one for more than the \$5,000 and finance the rest?**

Research different lending institutions and record their interest rates on Worksheet 1. You must also research the car tax information. You must find how much it will cost to register the car, the cost of the title, and the license tag fee. Record this information on Worksheet 1.

Insurance will be the next item of major concern. It is assumed that you will be paying for your own insurance. Conduct research on three insurance companies and compare the prices of the policies based on your age, gender, academic achievements, prior convictions of offenses, etc. The type of car selected will also affect insurance coverage. Complete the insurance section on Worksheet 1.



ENGAGE

1. Begin the class period by reading **Alternative Fuels** from the S.C. Energy Office (provided).
2. Have the students read through this handout independently or read as a group. While the students are reading have them highlight at least two interesting facts that they could share with the class.
3. Have a robust discussion about the information learned from the handout. Students need an opportunity to share the two interesting facts.
4. OPTIONAL: For an E-learning activity, this handout could be assigned prior to class so that a robust discussion about the reading could take place during the class time.





Finally, you will need to determine the annual fuel cost based on an average of 100,000 miles traveled annually for the three different cars. Record this information on Worksheet 1.



EVALUATE

Have the students complete the **Buying My First Car Worksheet 2** by compiling the information gathered from your research.



ELABORATE

1. Using the information from Worksheet 1, have the students create a spreadsheet that compares all the information gathered.
2. Using this spreadsheet the students can create multiple graphs, which will help them compare the three cars.
3. Have the students write an explanation on which car they would choose and provide reasons for their choice.



E-LEARNING ACTIVITY

As an alternative to researching three different cars, students can use this WebQuest to learn more about one type of alternative fuel vehicle – the Hybrid Electric Vehicle (HEVs).

Visit www.glencoe.com/sec/science/webquest/content/hybridt.shtml for more details.



ALTERNATIVE FUELS

WHAT ARE ALTERNATIVE FUELS?

The term “alternative fuel” is used to describe fuels other than gasoline that can be used to fuel our cars. In 1992, the U.S. Congress passed a law called the “Energy Policy Act.” This Act made it a law for governments and utilities to use alternative fuels made in the United States to power part of their vehicle fleets. Some fuels defined in this Act were: ethanol, biodiesel, propane, electricity, hydrogen, and natural gas. To learn more about this Act, visit <https://epact.energy.gov/faqs/?question=which-fuels-are-quot-alternative-fuels-quot-under-epact>.

WHY ARE ALTERNATIVE FUELS IMPORTANT?

The United States consumes **about 20 million barrels of petroleum per day**, about three-fourths of which is used for transportation. Transportation also has a significant economic impact on American businesses and families, accounting for **nearly one-sixth of the average household’s expenses** (second only to housing). Increased economic and energy security aren’t the only benefits. Widespread use of alternative fuels and advanced vehicles can reduce the emissions that impact our air quality and public health. Learn more at <https://cleancities.energy.gov/about/>.

THE ALTERNATIVE FUELS

- **Compressed Natural Gas (CNG) and Liquefied Natural Gas (LNG)** – Natural gas is comprised
- **Propane** – Also known as liquefied petroleum gas (LPG) or propane autogas, propane is a clean-

mostly of methane which is commonly captured in geologic deposits, such as shale (see www.eia.gov/energyexplained/natural-gas/), and from renewable sources such as landfills, wastewater, and agriculture/dairy operations (www.eia.gov/energyexplained/biomass/landfill-gas-and-biogas.php). It is transported to South Carolina through interstate pipelines and compressed or liquified to obtain greater volumetric storage capacity. Many South Carolinians use natural gas every day to cook and heat their homes but using natural gas in vehicles has proven benefits too. Natural gas is one of the most abundant fossil fuels found in the United States (www.eia.gov/tools/faqs/faq.php?id=58&t=8). Natural gas, when extracted, is an odorless and colorless gas. To provide added protection, public safety regulations dictate natural gas companies to add an odorizer called mercaptan. This common nose-wrinkling rotten egg smell helps individuals realize gas leaks well below explosive levels and contact the appropriate authorities. Utilizing natural gas for transportation can lower tailpipe emissions, reduce dependence on foreign oil, and boost economic development. CNG is primarily used in medium to heavy duty vehicles whereas LNG is found mainly on tractor trailers, ships, and trains. To learn more about natural gas sources and uses, visit https://afdc.energy.gov/fuels/natural_gas.html.



burning alternative fuel that's been used for decades to power light-, medium-, and heavy-duty propane vehicles (<https://afdc.energy.gov/vehicles/propane.html>). Propane is a three-carbon alkane gas (C₃H₈). It is stored under pressure inside a tank as a colorless, odorless liquid. As pressure is released, the liquid propane vaporizes and turns into gas that is used in combustion. An odorant, ethyl mercaptan, is added for leak detection. Fueling stations are fairly inexpensive compared to other alternative fuels. To learn more about propane autogas, visit https://afdc.energy.gov/fuels/propane_basics.html.

- **Electricity** – Electricity can be used to power plug-in electric vehicles (PEVs), including all-electric vehicles (https://afdc.energy.gov/vehicles/electric_basics_ev.html) and plug-in hybrid electric vehicles (https://afdc.energy.gov/vehicles/electric_basics_phev.html). These vehicles can draw electricity directly from the grid and other off-board electrical power sources and store it in batteries. In contrast, hybrid electric vehicles are fueled with liquid fuels, like gasoline, but use batteries to recapture energy otherwise lost during braking (ultimately boosting fuel economy). Using electricity to power vehicles can have significant energy security and emissions benefits. Learn more about electric vehicles, visit <https://afdc.energy.gov/fuels/electricity.html>. Charging equipment for plug-in electric vehicles PEVs – which include plug-in hybrid electric vehicles (PHEVs) and all-electric vehicles (EVs) – is classified by the rate at which the batteries are charged. Charging times vary based on how depleted the battery is, how much energy it holds, the type of battery, and the type of charging equipment. The charging time can range from less than 20 minutes to 20 hours or more, depending on these factors. Charging the growing number of PEVs requires a robust network of stations for both consumers and fleets. Learn more about electric vehicle charging at https://afdc.energy.gov/fuels/electricity_infrastructure.html.
- **Ethanol** – Ethanol is manufactured exclusively from biomass sources such as agricultural grain products (https://afdc.energy.gov/fuels/ethanol_fuel_basics.html). E85 fuel is created by mixing 85 percent ethanol with 15 percent conventional gasoline. Vehicles that can run on E85 and conventional gasoline are called flex-fuel vehicles. Multiple auto manufacturers now host models with the flex-fuel capability as a standard feature. E85-compatible vehicles are equipped with a yellow gas cap. E15, a blend of 15 percent

ethanol and 85 percent gasoline, is more widely accepted in vehicles (https://afdc.energy.gov/fuels/ethanol_blends.html). Check your owner's manual for more information. To learn more about Ethanol, visit https://afdc.energy.gov/fuels/ethanol_fuel_basics.html.

- **Biodiesel** – Biodiesel can be produced from different types of oils such as soybean oil and used cooking oil. Future feedstocks could include algae oil and oils from other native crops. Biodiesel is commonly blended into diesel in a range from 2 percent to 99 percent. However, the most common blend is called B20 (https://afdc.energy.gov/fuels/biodiesel_basics.html), which contains 80 percent regular diesel fuel mixed with 20 percent biodiesel. To learn more about biofuels, visit https://afdc.energy.gov/fuels/biodiesel_basics.html.
- **Hydrogen** - Hydrogen (H₂) is an alternative fuel that can be produced from diverse domestic resources (https://afdc.energy.gov/fuels/hydrogen_benefits.html). Light-duty Fuel Cell Electric Vehicles (FCEVs) are now available in limited quantities to the consumer market in localized regions domestically and around the world. The market is also developing for buses, material handling equipment (such as forklifts), ground support equipment, medium- and heavy-duty trucks, marine vessels, and stationary applications. To learn more about hydrogen, visit https://afdc.energy.gov/fuels/hydrogen_basics.html.

WHERE DO WE GO FROM HERE?

Alternative fuel use is very important for our state and our country because of our dependence on fossil fuels. There are many organizations in our state that want to help increase the types and amount of alternative fuel that we use, and **Palmetto Clean Fuels** (www.palmettocleanfuels.org) is trying to organize all the groups and their efforts. This local group is part of a national effort called "Clean Cities" which is coordinated by the U.S. Department of Energy. Palmetto Clean Fuels is committed to working towards developing stronger networks of alternative fuel users in the state. Acting as the primary alternative fuels entity for South Carolina, Palmetto Clean Fuels works to build partnerships with local public and private entities, develop unbiased information, provide technical assistance and training to fleets, and empower local decision makers to increase their air quality and decrease their petroleum dependence, reducing emissions of ozone, carbon monoxide and particulate matters associated with motor vehicle usage.

BUYING MY FIRST CAR WORKSHEET 1

Your generous Uncle Bill has just offered you \$5,000 toward the purchase of your first car. The money, however, comes with some strings attached. In order to get the money, you must first prove that you are mature enough to handle the responsibilities associated with car ownership including financing, insurance, maintenance and everyday operating expenses.

- **STEP 1:** Choose three different cars you would like to purchase. Choose one new car, one used car and one alternative fuel vehicle. Complete "Buying My First Car Worksheet 1" which will compare the costs of these car models.
- **STEP 2:** Once you have selected the cars of your choice, check out the financing options that are open to teenagers. Are you going to pay cash for the car, make a down payment and monthly payments, or buy one for more than the \$5,000 and finance the rest? Research different lending institutions and record their interest rates in the worksheet. You must also research the tax situation.
- **STEP 3:** Insurance will be the next item of major concern. It is assumed that you will be paying for your own insurance. Look at three insurance companies and compare the prices of the policies based on your age, gender, academic achievements, prior convictions of offenses, etc. The type of car selected will also affect the insurance coverage. Complete the insurance section on the worksheet.
- **STEP 4:** Determine annual fuel cost based on an average of 10,000 miles traveled annually.
- **STEP 5:** Complete the "Buying My First Car Worksheet 2" by compiling the information gathered from your research and creating a spreadsheet. From this spreadsheet create a graph, which will help you compare and make a wise automotive choice.

	NEW CAR	USED CAR	ALTERNATIVE FUEL CAR
Car Model			
Base Price			
Insurance Costs (Yearly)			
Driver's Training Costs			
Financing Costs (Yearly)			
Maintenance Costs (Yearly)			
Registration Costs			
Tax			
Title			
License Tag			
GRAND TOTAL			

