



# UNIT E

## **TRANSPORTATION FUELS & ALTERNATIVE TRANSPORTATION**

### **NM Standards and Benchmarks**

#### **Social Studies**

*Economics Strand, Content Standard IV-B:*

Analyze and evaluate how economic systems impact the way individuals, households, businesses, governments, and societies make decisions about resources and the production and distribution of goods and services.

*Performance Standard #8:*

Evaluate economic systems by their ability to achieve broad societal goals (e.g., efficiency, equity, security, employment, stability, economic growth).

#### **Science**

*Strand III, Science and Society, Content Standard I:*

Examine and analyze how scientific discoveries and their applications affect the world, and explain how societies influence scientific investigations and applications.

*Performance Standard #4:*

Understand the scientific foundations of common technologies (e.g., kitchen appliances, radio, television, aircraft, rockets, computers, medical X-rays, selective breeding, fertilizers and pesticides, agricultural equipment).

#### **Career Readiness, Content Standard III and IV**

Students will demonstrate the technological knowledge and skills required for future careers.

Students will develop and demonstrate responsible and ethical workplace behaviors.

## **Content**

Moving people, goods and services around the planet is something we have taken for granted during the age of cheap and convenient petroleum fuels. However, our dependence on foreign sources of petroleum (in 2010 49% of the oil we use is imported) has made the U.S. vulnerable to unstable supplies and prices. The transportation sector contributes one-third of U.S. carbon dioxide emissions, and according to EPA, mobile sources (on-road and off-road vehicles) are the biggest emitters of air pollution in many urban areas and the largest source of air toxics emissions nationally. New transportation vehicles, fuels and systems are needed to abate these serious impacts. Alternative fuel vehicles, public transportation, human-powered transportation, and high-speed rail are modes of transportation being developed and brought to market to create energy independence, reduce air pollution and mitigate climate change. Approximately 700 new jobs in the biofuels industry are expected in New Mexico over the next few years. Explore the new world of transportation. What are the job prospects in this green industry sector and the training programs for these green jobs?

## **Vocabulary**

alternative transportation  
alternative fuels  
fuel economy  
CAFE standards  
internal combustion  
byproduct  
bicycle transport  
emissions  
hydrocarbons  
carbon dioxide  
carbon monoxide  
nitrogen oxides  
tune-up  
electric vehicle (EV)  
solar-powered EV  
fuel cell  
hybrid vehicle  
flex fuel  
true cost  
walkable communities  
smart streets

## **Time Allocation**

2.5 weeks

## **Essential Questions**

- In the alternative transportation sector, what careers are emerging in the effort to reduce our dependence on fossil fuels, to reduce the advance of rapid climate change, and to make responsible use of our natural resources?
- What career paths interest me and suit my talents?
- What are the skill sets needed to be successful in these career pathways?
- How and where can I learn the necessary skills to land a good green job in a field that interests me?

## **Focus Questions**

- What is alternative transportation vs. alternative-fuel transportation?
- How does the internal combustion engine contribute to climate change?
- What are the available alternative fuels and alternative transportation methods that can reduce impacts to the environment?

# Introduction

(1 class)

## **Objective:**

Students will demonstrate understanding of the environmental, social, and economic implications of alternative transportation vehicles, fuels, and systems.

## **Activities:**

### 1. Discussion: Americans' addiction to the automobile

Why do some interests favor continued use of the gasoline-powered engine and others do not? Explore the possible reasons why we have the technologies to produce electric vehicles, the air-powered car, solar-powered cars, yet few to none are available to the consumer. Explore the recent legislation for corporate average fuel economy (CAFE) standard of 34.1 miles per gallon for model years 2012 – 2016. Is it good or bad? What about poor people who can't afford new cars? What about conversion kits for existing cars? What public transportation and alternative fuel options are out there?

View the DVD, "Who Killed the Electric Car?" (Sony, 2006) Order at:  
<http://www.whokilledtheelectriccar.com/> (Study Guide in Appendix E.1)

*Materials:* projector and screen, laptop, speakers, DVD "Who Killed the Electric Car?" study guide.

#### *Resources:*

- More information on "Who Killed the Electric Car"  
<http://www.sonyclassics.com/whokilledtheelectriccar/presskit.pdf>
- Excellent teacher guide for transportation fuels  
[http://www1.eere.energy.gov/education/pdfs/transportation\\_fuelsfuture.pdf](http://www1.eere.energy.gov/education/pdfs/transportation_fuelsfuture.pdf)
- Corporate Average Fuel Economy Standards – FAQ's  
<http://www.nhtsa.gov/cars/rules/cape/overview.htm>
- "What's the real cost of new CAFE regulations? Millions, billions, nothing?"  
<http://green.autoblog.com/2010/04/05/whats-the-real-cost-of-new-cape-regulations-millions-billions/>
- "NREL's Prius Hits 100 Miles per Gallon"  
[http://www.nrel.gov/features/20080601\\_prius.html](http://www.nrel.gov/features/20080601_prius.html)
- Videos on improving fuel economy, hybrids, alternative fuel vehicles, and new transportation technologies  
<http://www.fueleconomy.gov/feg/motorweek.jsp>
- High speed and inter-city passenger rail  
<http://www.fra.dot.gov/rpd/passenger/31.shtml>
- "Pike Research projects alternative fuel buses to represent 50% of total transit bus deliveries by 2015"  
<http://www.greencarcongress.com/2011/05/pikebus-20110512.html>

# Applied Science in Automotive Technology

(2 - 3 classes)

## Objective:

Student will demonstrate basic competency in the applied science involved in automotive technology.

## Conceptual Science Application:

(1 – 2 classes)

### 1. How does an internal combustion engine work?

Pre-read “How Car Engines Work.” Discuss combustion chemistry of the gasoline-powered internal combustion engine. What are the emissions that are a byproduct of combustion? Why is it important to keep the car engine tuned up? Show 3:14 minute video from monkeyseevideos.

*Optional:* Invite a local mechanic into the classroom to demonstrate how an engine works.

*Materials:* screen or projector, laptop

*Resources:*

- Brain, Marshall. "How Car Engines Work" 05 April 2000. HowStuffWorks.com. <http://auto.howstuffworks.com/engine.htm> 16 November 2010.
- Combustion Chemistry – Toyota Motor Sales - <http://www.autoshop101.com/forms/h55.pdf>
- “4-Cycle Internal Combustion Engine – Mechanical Parts”, (monkeyseevideos, 3:14 min., 2008) <http://www.youtube.com/watch?v=wRIKJ6Av5zo>

### 2. How does the electric motor work?

Explore the basics of circuitry by using the PHet interactive circuit simulator (see resources below). How do the basics of circuitry relate to electric vehicles and hybrid vehicles?

*Materials:* screen or projector, laptop

*Resources:*

- Circuit construction kit (simulation) <http://phet.colorado.edu/en/simulation/circuit-construction-kit-dc>.
- How Electric Motors Work <http://www.howstuffworks.com/motor.htm> articles & video
- How Hybrids Work <http://www.fueleconomy.gov/feg/hybridtech.shtml> articles & video

## **Laboratory Component in Combustion Engines and Atmospheric Chemistry** (1 class)

This laboratory experiment demonstrates emissions from a diesel engine vs. a biofuel engine and is best conducted in a chemistry laboratory.

[http://www.teachbiofuels.org/biodiesel%20lessons%202007/Chemical%20Reactions\\_%20Combustion%20Engines%20&%20Atmospheric%20Chemistry.pdf](http://www.teachbiofuels.org/biodiesel%20lessons%202007/Chemical%20Reactions_%20Combustion%20Engines%20&%20Atmospheric%20Chemistry.pdf)

*Resources:*

- Using Biofuels in the Classroom: Lessons for High School Science  
<http://www.teachbiofuels.org/Biodiesel%20Lessons%20&%20Labs.html>

## **Applied Science in Alternative Transportation** (2 classes)

### **Objective:**

To recognize that local transportation needs, transporting people, goods, and services, could be met using bicycles.

### **Activities:**

#### Day One:

1. Point out that the best forms of transportation for the environment and for human health are powered by humans rather than fossil fuels, and don't pollute the air. These forms are called, "active transportation" and include activities like biking, walking, rollerblading, riding scooters, skateboarding, etc. In addition to helping the environment, active transportation is good exercise, reduces traffic congestion, is typically less stressful than driving, and is significantly cheaper and more fun. When active transportation isn't possible, the next best methods of transportation are to use mass transit or to carpool. These options also reduce traffic congestion, and they have a lower environmental impact than driving alone. Given our existing transportation infrastructure, most Americans use cars and trucks to get around, and this has a major impact on the environment. In fact, the U.S. Environmental Protection Agency says driving a private vehicle is one of our most polluting daily activities.

*Resources:*

- Complete Streets: It's more than Bike Lanes, [www.streetfilms.org](http://www.streetfilms.org)
- People Powered Transportation Blog  
<http://www.motherearthnews.com/blogs/blog.aspx?blogid=2147484038>

2. Environmental writer Colin Beavan wonders if our cars make us happy. In his book, *No Impact Man*, he assembled some statistics that show what he calls the "true cost" of our cars. Display the book excerpt and review each bullet point.

Discuss:

- Why do students think that people are willing to spend so much time and money working to

pay for their cars?

- What impact would using active transportation have on our health, wallets, quality of life, and the environment?
- What barriers prevent more people – including students – from using active transportation, mass transit, or carpooling?
- If more people and businesses used bicycles for local transportation, what sorts of jobs could become more readily available?

*Resources:*

- *No Impact Man*, Colin Beavan  
<http://noimpactman.typepad.com/>
- No Impact Man Curriculum Guide
- Video: Bike Ride to the Beach – need to register for free access to video clip at:  
<http://noimpactproject.org/educators-middle-high-school-environment-curriculum-html/>

Day 2:

1. Point out that streets in the U.S. have been built to favor cars, rather than pedestrians, cyclists, and others who use active transportation. To illustrate this point, tell the class that they are going to watch a video clip (length 1:17) that shows Beavan and his wife in New York City on a bike excursion to the beach. Focus student viewing by having them evaluate how well the streets along their route are designed to serve cars, cyclists, and pedestrians. You may need to watch the clip a couple of times to notice fine details. (Note: To help students better understand the dialogue in the clip, you might want to remind students that the man in the video writes about environmental issues.)
2. Discuss:
  - What method of transportation did the streets shown in the video favor? Use evidence to support your answer (ex: street markings, presence or lack of designated bike lanes).
  - Which parts of the couple’s journey seemed the safest for cyclists? Which seemed the most dangerous? Why?
  - How was the couple rewarded for using their bikes for transportation?
3. Look at the Xtracycle equipment (<http://www.xtracycle.com/>) and bicycle pull-carts that allow service providers and vendors to transport their goods and equipment on their bicycles, making it possible for them to conduct business in a fossil fuel-free manner. Discuss: What types of jobs could be done from the back of a bicycle?
4. Math Exercise:  
Compare the CO<sub>2</sub> emissions and the gasoline used in one week for a truck vs. a bicycle. Assume that the truck is driven 60 miles/week, fuel economy = 12 miles per gallon; emissions of CO<sub>2</sub> per mile driven = see emissions table in Appendix E.2

*Materials:* *No Impact Man*, Colin Beavan, pp. 93-94 with bulleted points, video clip “Bike Ride to the Beach” (length: 1:17), screen, laptop, speakers.

*Homework:* If it is safe, ride a bike to school this week and compare with the time it took to arrive by car or bus.

*Assessment:* Journal about your ride to and from school. Completed math assignment given data on the board on pounds of CO<sub>2</sub> emitted per mile driven.

## **Applied Science in Fuel Cells**

**(1 - 2 classes)**

### **Objective:**

Students will recognize the components of a fuel cell and learn how thermodynamics apply to fuel cells.

### **Activities:**

Choose one of the three experiments (e.g., fuel cell experiment, catalyst experiment, or thermodynamics experiment) from the California Fuel Cell Partnership (see Resources below) to demonstrate the objectives above.

*Materials:* Listed in “Fuel Cells in Transportation, Teacher’s Guide” and are based on the lab activities you choose. One activity requires platinum wire, which turns out to be VERY expensive. Unless you have a good science budget for lab materials, you may want to avoid this activity.

*Resources:*

- California Fuel Cell Partnership – Lesson Plans  
<http://www.cafcp.org/sites/files/Fuel%20Cell%20Lesson.pdf>
- Hydrogen basics: how to produce hydrogen for use as a fuel?  
[http://www.nrel.gov/learning/eds\\_hydrogen.html](http://www.nrel.gov/learning/eds_hydrogen.html)

## **Experiential Component in Alternative-Fuel Vehicles**

**(1 – 2 classes)**

### **Objective:**

Students will gain hands-on experience with alternative-fueled vehicles and their performance.

### **Activities:**

1. If you have a local electric car club or fleet operators running electric or flex-fuel work vehicles, invite them to your school for a “show and tell” session. Get under the hoods, have the owners explain the mechanics and the performance aspects of their vehicles.

2. Have your students set up a one-hour car show with all of the owners and their alternatively fueled vehicles on the lot for inspection, demonstration, Q & A.

*Resources:*

- Alternative Fuels and Advanced Vehicles Data Center – Information for New Mexico  
<http://www.afdc.energy.gov/afdc/states/NM>
- My Charge Point for Electric Vehicle Owners – Network of charging stations for EV's  
<http://www.mychargepoint.net/>
- Hydrogen fuel cells – NREL Advanced Vehicles and Fuel Research -  
[http://www.nrel.gov/vehiclesandfuels/project\\_hydrogen.html](http://www.nrel.gov/vehiclesandfuels/project_hydrogen.html)

## **Employment and Training Prospects in Alternative Fuel/Alternative Transportation**

(1 - 2 classes)

### **Objective:**

The student will identify green jobs in alternative fuel and alternative transportation, training resources and skill sets necessary for a career in these occupations.

### **Activities:**

Share and discuss the following information:

### **Background:**

- NM Green Jobs Guidebook estimates increased demand for employees with specialized skills related to eco-friendly transport assessment, logistics, and planning.
- If fuel cells are improved, there would be an estimated 20,000 new jobs by 2050 related to fuel cells.
- There is also estimated increased demand for railroad conductors and locomotive engineers.
- The guidebook highlights the need for employees with enhanced skills, such as auto specialty technicians, transportation managers, and electronics engineers.
- New and emerging occupations include fuel cell engineers and technicians, automotive engineers and technicians.

#### Green Jobs in the transportation sector include:

Aerospace engineers  
Aircraft and avionics equipment mechanics and service technicians  
Automotive service technicians and mechanics  
Bus mechanics  
CAD operators  
CNC operators  
CNC programmers  
Diesel service technicians and mechanics



Drafters  
Electrical and electronic equipment assemblers  
Electrical engineers  
Electronic drafters  
Electronics engineers  
Engine and other machine assemblers  
Engineering technicians  
Industrial machinery mechanics  
Machinists  
Mechanical drafters  
Mechanical engineers  
Motorcycle mechanics  
Truck mechanics

The Pathway Knowledge and Skills Chart for Transportation, Distribution, Logistics

This document describes what all/most learners/workers need to know and be able to do to demonstrate competence within career pathways in this cluster.

<http://www.careerclusters.org/clusters/16cc.php?cluster=tdl>

*Resources*

- Recharging Transportation - Aptera  
[http://www.youtube.com/watch?v=z1YGF\\_9aMac&feature=related](http://www.youtube.com/watch?v=z1YGF_9aMac&feature=related)
- Training programs in Aerospace, Avionics, Automobile/Automotive Mechanics Technology/Technician  
<http://www.greenjobs.state.nm.us/pdf/EducationOccupations.pdf>
- Green job occupations typical educational requirements - Programs and Courses  
<http://www.greenjobs.state.nm.us/programs.html>
- Training Programs for Alternative Fuels Vehicle Technician  
<http://www.automotive-schools.us/altfuelstechnician.html>
- National Alternative Fuels Training Consortium  
<http://www.naftc.wvu.edu/>

**Experiential Component:**

(1 class)

**Objective:**

Students will demonstrate understanding of jobs in alternative fuel transportation through direct experience in the field.

**Activities:**

- Visit local car dealership repair department that services electric, alternative fuel and flex-fuel vehicles.
- Visit business or government agency that has electric, alternative fuel and flex-fuel vehicles as part of their fleet.

- Visit public Electric Vehicle charging station (to date only one in New Mexico at City of Albuquerque - Department of Municipal Development Parking Facility)  
<http://www.afdc.energy.gov/afdc/locator/details.php?id=38529&apptype=stations>
- Visit an alternative fueling station – find one near you by searching locator at:  
<http://www.afdc.energy.gov/afdc/states/NM>

## **Formal Weekly Assessment**

### **Objective:**

Student will demonstrate with a 70% proficiency or better, his/her understanding of concepts and employment opportunities in this career cluster.

**Assessment:** weekly assessment based on Weekly Grading Rubric (See Appendix I.8)