

Title: Energy Innovations

Description: To encourage global consciousness, students research the impact of alternative fuel sources and how their daily decisions about energy will affect their quality of life, personally and globally. As a culminating project, students simulate the decision making process of buying their first car and investigate how data and statistics can impact their decision.

At a Glance

Grade Level: 9–10

Subject sort (for Web site index): Math, Algebra, Social Issues, Science

Subjects: Science, Algebra, Social Issues

Topics: Energy, Alternative Fuels, Graphing, Data Analysis

Higher-Order Thinking Skills: Decision Making, Analysis, Interpretation, Evaluation

Key Learnings: Organizing Data, Critical Thinking, Statistical Analysis, Alternative Energy Sources

Time Needed: 16 class periods, 55 minute classes. 2 weeks for homework project

Unit Summary

Students investigate the history of humankind's need to develop tools that enhance quality of life and satisfy the need for efficiency. Students quickly discover that survival depends on energy resources throughout history and technology dictates how energy resources are used. Students analyze the trade-offs associated with various energy sources. Students evaluate alternative energy sources, experiment with alternative fuels for cars, conduct an appliance survey, and compare how countries are similar or different in their energy use. As a culminating project, students simulate the process of buying a car using data and statistics that could impact their decision.

Curriculum-Framing Questions

- **Essential Question**

What is a quality life?

- **Unit Questions**

How can we use energy resources responsibly?

How can data and research affect your decisions?

What are the positive and negative impacts technology has had on our world's energy problems?

- **Content Questions**

What is the measurement process for an emissions test?

What are alternative energy sources and how can we use them?

What problems are associated with fossil fuels?

How can I use scatter plots, histograms, charts, and other data analysis methods to better understand the impact of alternative energy sources?

Assessment Processes

View how a variety of student-centered [assessments](#) are used in the Energy Innovations Unit Plan. These assessments help students and teachers set goals; monitor student progress; provide feedback; assess thinking, processes, performances, and products; and reflect on learning throughout the learning cycle.

Instructional Procedures

Part I: Presenting the Problem

Session 1

Have students respond to the Essential Question, *What is a quality life?* In pairs, have students list factors that contribute to a quality life and rank the factors from most important to least. Ask students to share their rankings within a team of four, and create a new ranking based on team consensus. Have each team report out, and then conduct a class discussion on commonalities among the factors. Guide students to the conclusion that many of the factors relate to energy.

Review with students their knowledge of energy concepts using an energy pre-assessment. Use this assessment to guide the development of lessons on energy concepts appropriate for their level.

Ask students to share what specifically has influenced them and their family to conserve energy and what methods they currently use to conserve energy, if any. Create a poster with the cumulative answers from each class. Post somewhere visible in the classroom.

Create a multimedia presentation that contains headlines from major newspapers and magazines around the world that focus on energy topics. Guide students to the realization that energy is a driving force behind many political issues, economic policies, and wars. Conduct an open-ended discussion by asking the Unit Question, *How can we use our energy resource responsibly?* and the question, *Are we using our energy resources wisely?* (As an alternative, have students create their own slideshow presentations that highlight major stories and events focusing on energy.) Have students journal how their decisions about conserving energy could impact their quality of life. Inform students that they will use their journals periodically throughout the unit to reflect on their learning.

Part II: Understanding the Problem

Session 2

Ask students the Content Question, *What are alternative energy sources and how can we use them?* Provide background information by assigning the [Clean Air Acts](#) activity as homework. This activity explains the history of energy conservation and the impact of alternative energy sources. As an alternative, plan with the social studies teachers to implement this assignment.

Sessions 3 through 7

Divide students equally into eight groups. Assign each group one of the following energy sources:

- Hydro
- Geothermal

- Nuclear
- Fossil fuels
- Wind
- Solar
- Ocean
- Biomass

Explain that each group will prepare a learning center on their assigned energy source from which other groups will learn. Present the [project plan](#), which helps each group organize their learning center. Show students how to use bookmarking systems—such as *del.icio.us*, *Diigo*, and *Furl*—to keep track of Internet research. Hand out [research notes template](#) for students to use for their research information.

Hand out the [energy source rubric](#), which explains that students will investigate the technology, advantages/disadvantages, history, environment and economic costs, and application of each energy source. Explain to students that this is the type of information that will be displayed in their learning center. Review with students data analysis methods, such as scatter plots, box plots, linear regression, and histograms. Describe how the data analysis methods might be used in the project. Review various types of data and have students practice identifying the types of data from graphs collected prior to the lesson.

Explain that a brochure can also be used as part of their learning center. Show students the [brochure sample](#). Discuss how the brochure can be improved by adding data analysis methods. Brainstorm, as a class, specific data analysis methods that could be used on this brochure. Encourage students to ask questions that can be answered using data analysis methods.

Tell students that they will also prepare and participate in a debate and try to persuade others why their assigned energy source is the best for society and Earth. Have each group create a poster that displays their data and research, and uses spreadsheet software to help analyze their data to use during the debate. As an extension, show student how to work as a group using the [Showing Evidence Tool](#). Explain how claims are made about an energy source and how information is inserted to back up the claims. Encourage students to access their information from the [Showing Evidence](#) workspace during the debate.

During this project, set aside time for whole class experiments on combustion, endothermic/exothermic chemical reactions, particulate concentrations, and conservation of energy to help students gain a better understanding of the general principles and impact of energy. If available, have students use science probeware to collect data and practice representing data graphically.

Hand out the [group assessment](#) and have students assess their group process and individual work at a designated point during the work sessions. Hand out the [debate checklist](#) to inform groups of the expectations during the debate. This checklist could also be used as a scoring guide during the debate.

Session 8

Conduct the class debate. Instruct each group to assign a debate leader. Have each group review the [debate checklist](#). Allow time for students to assess their groups again using the [group assessment](#) after the debate. Provide time for students to complete another entry in their journals on new learning and insights gained through the activities experienced.

Session 9

After the debate, allow time for students to walk through each learning center. Hand out the [data assignment worksheet](#) that explains how each student will use data analysis methods to culminate the information from each learning center; specifically, students analyze gaseous and particulate pollution, efficiency, production and consumption of each energy source. Use the Content Question, *What problems are associated with fossil fuels?* as an assessment question. Use the [fossil fuel essay checklist](#) to help students understand what information to include in the answer to the question.

Part III: Finding Solutions

Session 10

Now that students have gained a foundation and global perspective on our world's energy problems, ask students to brainstorm ways they can be part of the solution as a citizen of this world. Present the Unit Question, *How can data and research affect your decisions?* Ask students how they decide to buy certain products. Conduct a class discussion defining the methods and procedures currently used by students. Have students share methods their parents might use as well. Emphasize any decision making process that uses data and research.

Show pictures of large cities in which air pollution is prevalent to get students thinking about automobiles and their impact on our environment. Explain to students that they will conduct research on how their quality of life is impacted by two major factors:

- Impact of vehicle emissions on our environment
- Development of alternative fuels

Present a mini-lesson on the process of measuring vehicle emissions. Have students take notes in their journals. As homework or an extension, instruct students to find information on how emissions testing and standards vary from state to state as well as by country. Have them investigate five large cities from different countries (such as Mexico City, Cairo, Hong Kong, New York, and Los Angeles) to compare the impact of vehicle emissions on the specific city.

Sessions 11 and 12

If materials are available, plan for whole class experiments on solar and hydrogen vehicles, byproducts of combustion, and emissions.

Session 13

Show students how to use the [Visual Ranking Tool](#) to organize their research and evaluation of the different types of fuels sources for vehicles. Prepare the workspace to include the following factors:

- Hydrogen
- Gasoline
- Ethanol (E85)
- Electric
- Natural Gas
- Biodiesel
- Methanol (M85)

Working in pairs, have students conduct Internet research of the different fuel sources and rank which ones they believe to be the best option for most cars. Explain that students are to list major advantages and disadvantages of each and include their reasoning of their rankings. Show students how to compare their thinking with other pairs in the class. Explain the correlation coefficients and how to interpret the numbers. Allow students time to change their ranking based on new insights gained from their peers. Remind students to use their bookmarking systems to keep track of their Internet sources.

Hand out the [alternative fuels checklist](#) to guide students' thinking during this activity. Provide time for students to add another journal entry on new insights and reflections on their current learning.

Session 14—The Homework Project

Explain to students that they will simulate the process of choosing a vehicle to purchase. Instruct students to first pick two vehicles to compare side by side. One vehicle is their choice but the second vehicle must be a brand new *green car*. Explain the terminology *green car* and show examples from Web sites of these types of vehicles, also known as *Alternative Fuel Vehicles (AFVs)*.

Hand out the [purchase guide instructions](#) that explain the steps required for this project. Have students use the [purchase guide checklist](#) and [purchase guide self-assessment](#) to assess their work as well as each other's work throughout the project. Explain that students will investigate the technology behind the alternative fuel source for the AFV they chose and conduct in-depth research on both vehicles' emissions and the technologies used in their chosen vehicles. They will use data analysis methods to analyze gaseous and particulate pollution, efficiency, production and consumption, and compare each vehicle's fuel costs for one year based on their individual commuting situation.

Pass out several consumer magazines and have students observe the structure and data included for the products highlighted. As a class, create an electronic consumer magazine that has all the [individual projects](#) compiled into one magazine. This magazine should feature the current technologies of vehicles with the independent data collected from each student.

As an extension, students can apply for extra credit to serve on the editorial staff responsible for putting the magazine together with a cover, table of contents, and unifying structure.

Session 15

Allow students two weeks to complete this project at home. Midway through the project, provide time in class for students to conference with each other on their progress. Provide another copy of the [purchase guide checklist](#) for students to use during their peer conference. Explain that students are to continue writing in their journals during the homework project, including insights and reflections on their learning.

Session 16 (after students have completed the vehicle project)

As a final assessment, ask students to answer the following questions reflecting on the projects they completed during the unit:

- *How can we maintain a quality life and still use our energy resources responsibly?*
- *How can data and research affect your decisions?* Give specific examples.

- *What are the positive and negative impacts technologies have had on our world's energy problems? Create a chart and give specific examples.*
- *How have data analysis methods helped you to better understand the impact of alternative energy sources? Give specific examples.*

Hand out the [essay rubric](#) as a guide for students to use while answering the questions.

After the editorial staff has completed the class consumer magazine, post the magazine on a Web site for all students and parents to read.

Prerequisite Skills

- Basic understanding of the various energy forms, the structure and action of an atom, and an understanding between renewable and nonrenewable sources
- Basic understanding of the properties and uses of carbon
- Understanding of data analysis and statistics (recommend implementing this unit after the math teachers conclude their data and statistical units)
- Some experience with creating multimedia presentations, newsletter publications, and Web pages as well as conducting Internet research

Differentiated Instruction

Resource Student

- Reduce the number of energy concepts required to master
- Break down the steps to the project with a daily timeline of tasks to be completed
- Preselect Web sites or print information in advance with important concepts highlighted
- Provide a visual representation of each major concept
- Create a skeleton outline for each data analysis activity
- Reduce assignment or allow more time as needed

Gifted Student

- Provide entrance into engineering competitions online as it pertains to energy innovation
- Provide extensive experiments with hydrogen fuel cell technology and solar vehicles
- Preselect Web sites with extended information
- Use as technical troubleshooters

English Language Learner

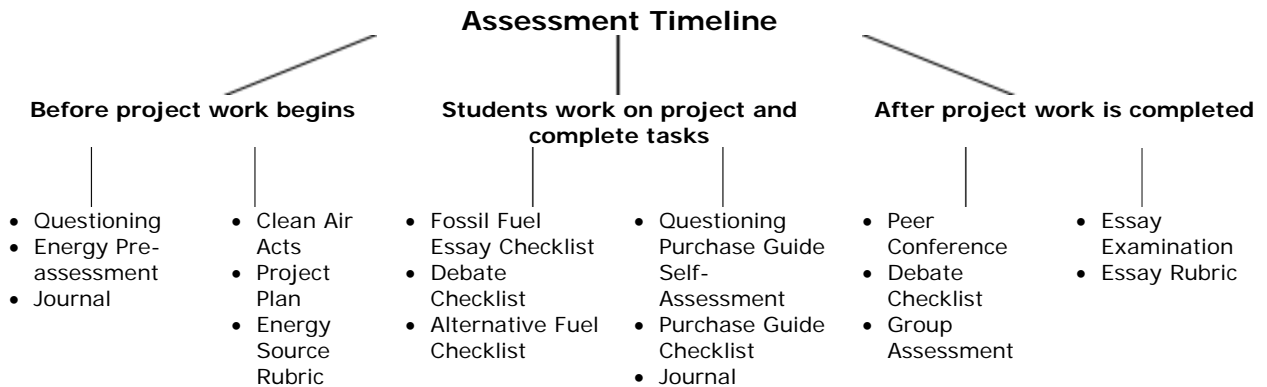
- Provide visual representation for each energy form, alternative energy sources, and appliances to have as a reference in the student's notebook
- Allow assignments to be first created in the student's first language and then translated to English
- Allow the student to access Internet sites in the student's first language
- Pair the student with a peer

Credits

A teacher participated in the Intel® Teach Program, which resulted in this idea for a classroom project. A team of teachers expanded the plan into the example you see here.

THINGS YOU NEED (highlight box)

Assessment Plan



Questioning is used throughout the unit to help students develop their higher-order thinking skills and process content as well as to monitor learning. The energy pre-assessment is used to determine student's current knowledge of energy concepts and guide in lesson development. Students journal their current thinking on energy conservation at the beginning to help students establish a mindset for the unit. They continue to journal insights and reflections throughout the unit. The [Clean Air Acts](#) activity provides background information and ensures that students are on track. The [project plan](#) helps each group organize their learning center and meet expectations. The [energy source rubric](#) guides students' research and data analysis. The [fossil fuel essay checklist](#) helps students to focus on key areas while answering the assessment questions at the end of part two. Students use the [debate checklist](#) to prepare for the energy debate and can also be used as a scoring guide. The [purchase guide self-assessment](#) and [purchase guide checklist](#) are used to help guide students' learning, help students stay on track, and help students self-assess their progress. The [purchase guide checklist](#) provides an opportunity in which peers can assist each other through feedback. The [group assessment](#) allows student to reflect on their collaborative skills as well as their peers. Use the [essay rubric](#) to assess the essay examination as the final assessment for the unit. Provide this same [essay rubric](#) to students so they can self-assess.

Targeted Content Standards and Benchmarks

National Science Education Standards and Benchmarks for Science Literacy: Project 2061

Science Process Standard

- Technology influences society through its products and processes. Technology influences the quality of life and the ways people act and interact. Technological changes are often accompanied by social, political, and economic changes that can be beneficial or detrimental to individuals and to

society. Social needs, attitudes, and values influence the direction of technological development.

Science Content Standards:

- The total energy of the universe is constant. Energy can be transferred by collisions in chemical and nuclear reactions, by light waves and other radiations, and in many other ways. However, it can never be destroyed. As these transfers occur, the matter involved becomes steadily less ordered.
- Chemical reactions may release or consume energy. Some reactions such as the burning of fossil fuels release large amounts of energy by losing heat and by emitting light. Light can initiate many chemical reactions such as photosynthesis and the evolution of urban smog.

NCTM Standards:

- Formulate questions that can be addressed with data and collect, organize, and display relevant data to answer them

Student Objectives:

Students will be able to:

- Conduct research, using print and electronic resources, to collect statistical data on a subject

Math Objectives:

- Compute basic statistics and understand the distinction between a statistic and a parameter
- Understand histograms, parallel box plots, and scatter plots and use them to display data
- Understand the meaning of measurement data and categorical data, of univariate and bivariate data, and of the term *variable*

Science Objectives:

- Determine the range of the data and the mean and mode values of the data; plot the data; develop mathematical functions from the data; and look for anomalous data
- Understand that at times, environmental conditions are such that plants and marine organisms grow faster than decomposers can recycle them back to the environment, and that layers of energy-rich organic material have been gradually turned into great coal beds and oil pools by the pressure of the overlying earth
- Understand that by burning fossil fuels, people pass most of the stored energy back into the environment as heat, releasing large amounts of carbon dioxide
- Understand that a large number of important reactions involve the transfer of either electrons (oxidation/reduction reactions) or hydrogen ions (acid/base reactions) between reacting ions, molecules, or atoms
- Understand that in some reactions, chemical bonds are broken by heat or light to form very reactive radicals with electrons ready to form new bonds

- Understand that radical reactions control many processes, such as the presence of ozone and greenhouse gases in the atmosphere, burning and processing of fossil fuels, the formation of polymers, and explosions

Materials and Resources

Supplies-optional

- Model vehicle kits for that demonstrate how alternative fuels work, such as solar and hydrogen
- Class set of graphing calculators

Internet Resources

Alternative Fuels for Automobiles

- Drive Clean California
www.driveclean.ca.gov/en/gv/home*
Information on the different types of automobiles that use alternative fuels
- United States Department of Energy
www.fueleconomy.gov/feg/feg2000.htm*
Downloadable fuel guides for the years 2000–2007
- United States Department of Energy
www.eere.energy.gov/afdc/afv/afvehicles.html*
Alternative fuel data center
- United States Department of Energy
www.eere.energy.gov/fleetguide/hevcalc.html*
Clean Cities' HEV Cost Calculator allows fleets to compare the costs, benefits, and emissions of hybrid electric vehicles (HEV) with those of conventional vehicles
- Energy Information Administration
www.eia.doe.gov/fuelrenewable.html*
Data and statistics for alternative fuel vehicles
- National Energy Foundation
www.nef1.org/ftf*
Information on alternative fuel vehicles
- American Hydrogen Association
www.clean-air.org*
Facts and figures for automobiles fueled by hydrogen
- California Energy Commission
www.energyquest.ca.gov/transportation/electric.html*
A student's guide to alternative fuel vehicles
- National Biodiesel Board
www.biodiesel.org/resources/fuelfactsheets/default.shtm*
Biodiesel fact sheets
- National Energy Foundation
www.nef1.org/ftf/links.html*
An extensive list of Internet resources on alternative fuels
- Drive Clean Across Texas
www.drivecleanacrosstexas.org/for_teachers/grades_9-12*
A collection of lesson plans on air quality and alternative fuels
- National Biodiesel Board
www.biodiesel.org/pdf_files/fuelfactsheets/emissions.pdf* (PDF; 2 pages)
Facts and figures on biodiesel emissions

- All About Hybrid Cars
www.allabouthybridcars.com/alternative-fuel.htm *
Advantages and disadvantages to hybrid automobiles
- Alternative Fuels Data Center
www.fueleconomy.gov/feg/current.shtml *
Information of tax incentives, alternative fuels, and alternative fuel vehicles

Clean Air Acts

- American Meteorological Society
www.ametsoc.org/sloan/cleanair *
A history and description to the Clean Air Acts
- Foundation for Clean Air Progress
www.cleanairprogress.org/classroom/cleanairact.asp *
Lessons for students on the Clean Air Acts
- Environmental Defense
www.environmentaldefense.org/documents/2695_cleanairact.htm *
An easy-to-read timeline of the Clean Air Acts

Technology—Hardware

- Computers for conducting research and completing slideshows, publications, and Web pages
- Graphing calculators to complete mathematical activities (optional)
- Internet connection for research
- Printer to print notes or if warranted newsletters
- Projection system for presentations

Technology—Software

- Database or spreadsheet for graphs
- Desktop publishing to complete the publication newsletter
- Internet web browser for research
- Presentation software to complete slideshow presentations
- Web page development to complete Web page
- Word processing for note taking