Solar and Electric Cars

RENEWABLE ENERGY
THE INFINITE POWER OF TEXAS

For Grades 4 and 5

OVERVIEW

This lesson introduces students to vehicles that use alternative fuels for transportation and contrasts them to conventionally fueled vehicles. Students will familiarize themselves with alternative fuels that can be used in vehicles by engaging in an introductory class discussion, reading and answering questions from the Reading Passage, working in groups to conduct Internet research on assigned topics related to vehicle fuel usage and giving final presentations of assigned topics. Each student should have a science notebook (a spiral notebook is suggested) to write their vocabulary words, information-organizing webs, and other required information.

OBJECTIVES

See Elementary School Teacher Resource Guide for TEKS objectives and additional information regarding this and other elementary school units.

SUGGESTED TIMEFRAME

Teacher will need to determine how many class periods to devote to each activity, based on the suggested timeframe and length of classes.

Day	Time	Activity Title	Content Area	Activity Task
1	***60 minutes*** 10 minutes 20 minutes 30 minutes	 **Activity 1** – Teacher Introduction **Activity 2** – Assessment of Student Knowledge **Activity 3** – Vocabulary	 Science Assessment Vocabulary & Language Arts	 Information synthesis Identify and describe learned knowledge Vocabulary development and application
2	***45 minutes***	**Activity** – Reading and Cooperative Group Work	Reading & Language Arts	Reading for meaning Looking for vocabulary in context Use of graphic organizer
3	***70 minutes*** 60 minutes 10 minutes	 **Activity** – Group Research Work Homework Assignment	 Language Arts Science	 Collect and analyze information using computers and the Internet
4	***60 minutes***	**Activity** – Group Research Work (continued)	Language Arts Science	Collect and analyze information using computers and the Internet Analyze and interpret information Construct simple graphs to organize, examine and evaluate information
5	***90 minutes*** 70 minutes 20 minutes	 **Activity 1** – Group Presentations **Activity 2** – Review	 Science Math	 Application of learned knowledge in verbal & graphical format Information synthesis
6	***45 minutes***	**Activity** – Assessment	Science Math Language Arts	Review of learned material

REQUIRED MATERIALS

- copy of Reading Passage for each student
- list of vocabulary words displayed so the entire class can view it (i.e. overhead transparency, chalkboard, poster, etc.)
- copy of Assessment Questions for each student
- copy of Group Research Report Form for Groups 1 through 4, (or displayed so each group can view it, i.e. photocopy, overhead transparency, chalkboard, poster, etc.)
- four (4) large sheets of paper

DAILY ACTIVITIES

Day 1 – 60 minutes

Activity 1 – Teacher Introduction (10 minutes)

Begin the unit with an anticipatory set that sparks the class's attention and makes the subject relevant to the students' lives. Check with your school district, local utility or other local business to see if they have any alternative-fueled vehicles that can be brought to the school for "show and tell." Or if time and resources are available, build a model solar car and demonstrate it running outside on a sunny day. (See Teacher Resource Guide for other suggestions.) Continue the introduction by telling students that for the next unit of study they will be learning about cars that use fuels different from gasoline. Explain to students that they will work in groups and research assigned topics using the Internet and gather information as outlined in their Group Research Report Form. Students will present their information using written explanation, graphics or other visual aides.

Activity 2 – Assessment of Current Student Knowledge (20 minutes)

To assess what students already know, prompt a class discussion based on the 3 questions listed below. A graphic organizer (such as a web) is a good tool to use during this discussion because it allows visual learners to make connections to concepts they already know. Organizing webs can be any shape or size and can be drawn quickly on the board or a large sheet of paper. Sample graphic organizers are included in the Teacher Resource Guide. The graphic organizer should be formatted so that information can be added to it throughout the unit of study.

Questions for class discussion:

1. What kind of fuel does your car run on?
2. Do you think cars can use renewable energy as a power source?
3. How can renewable energy and transportation be connected?

Activity 3 – Vocabulary (30 minutes)

Have the students use dictionaries or the Internet if available to find the definitions of the vocabulary words or word pairs and record them in their science notebooks. See list of vocabulary words on page 5. Teacher may have to provide definitions for some word pairs. Students should create meaningful sentences with each word that reflect an understanding of the definition. If you began the alternative vocabulary activity suggested in the Teacher Resource Guide, ask students to pull the cards with words relevant to this unit. Students can first quiz each other using the flash cards they prepared, or students can play the board game they created, and then create sentences in their science notebooks using each word.

Day 2 – Reading and Cooperative Group Work (45 minutes)

1. Organize the students into 4 equal groups, attempting to cluster reading skills. Assign each group to one of the reading topics listed below based on sections from the Reading Passage. Assign the longer sections to the more advanced readers. Distribute to each student a copy of the Reading Passage. Distribute to each group a copy of the Group Research Report Form based on each group's assigned topic. If resources allow, distribute a copy of each Research Report Form to each student so they can record information from other groups during each presentation. Assessment Questions will include topics covered by all groups.
2. In addition to their assigned reading section, all student groups should read the first section of the Reading Passage titled "Renewable Energy and Transportation" as an introduction. In the small groups, instruct the students to read aloud individual sentences or paragraphs from the first section, "Renewable Energy and Transportation," and their assigned section of the Reading Passage.
4. Once all of the paragraphs have been read, each group should answer the assigned questions for their section as written on the Group Research Report From. Each group will add information to this form as they complete their Internet research on the following days. The groups will also make a presentation about the information they learned from their Reading Passage and their Internet research. Inform the class that Assessment Questions will include information from

each group. (See Teacher Resource Guide for group presentation and Internet research guidelines.)
5. Inform the class that they will remain in their assigned groups to conduct the Internet research on the following days.

Day 3 – 70 minutes

Activity – Group Research Work
(60 minutes)
Students will work in their same groups as assigned the previous day and further research the topic they began. Provide students with a list of Internet resources and instruct them to research the information as outlined on their assigned Group Research Report Form. Explain to the class that each group will make a presentation on the information they gathered and recorded on their Group Research Report Form. Each group should also use visual or graphic aides, including the drawing or graph they created per their assignment. A sample graph for teacher use is provided for group 2. (See page 4.)

The groups will be assigned the following tasks:

Group 1: Model Solar Cars
This group will be assigned the task of finding all the parts necessary to make a model car. The group should identify the quantity of each part needed and the price and record it in Table 1 of their Group Research Report Form. Students must calculate the total cost of one model solar car, the cost for each group to build a car, and the cost for each student in their class to build a car. On a large sheet of paper, the group should create a drawing of a sample model solar car design. Students should also answer the questions listed on their Form.

Group 2: Solar Car Races
This group will be assigned the task of researching solar car races to find information on three such races. The group should research and record in Table 1 of their Group Research Report Form statistics on the top three vehicles in each race including total miles traveled, top speed traveled (miles per hour), length of the race (number of days) and one other interesting statistic or fact that the group selects. Students should create a bar graph on a large sheet of paper that compares one selected variable of each car researched (such as the top speed that each car reached, the total miles traveled by each car, etc.). Students should also answer the questions listed on their Form.

Group 3: Electric and Hybrid Cars
This group will be assigned the task of researching three hybrid cars that are available on the market today. The group should research and record in Table 1 of their Group Research Report Form statistics on each car including the mileage rating, the size of the battery bank, the price and any interesting information they learned in their research. Students should create a bar graph on a large sheet of paper that compares one selected variable of each car researched (such as the mileage rating, the price, etc.). Students should also answer the questions listed on their Form.

Group 4: Gasoline, Cars and Pollution
This group will be assigned the task of researching gasoline-powered cars and their effect on air pollution. The group should research and record in Table 1 of their Group Research Report Form statistics on 3 gasoline-powered cars including mileage (miles per gallon) and pollutants that each car emits (nitrogen oxide and carbon dioxide). Students can obtain mileage information from car manufacturer websites. Usually the websites are simply the car manufacturer's name followed by ".com" (i.e. www.ford.com, www.toyota.com, etc.). Pollutant information and interactive calculators will be available on websites such as the U.S. Environmental Protection Agency or other similar environmental groups. Students should create a bar graph on a large sheet of paper that compares one selected variable of each car researched (such as the mileage, the amount of nitrogen oxide emitted or the amount of carbon dioxide emitted). Students should also answer the questions listed on their Form.

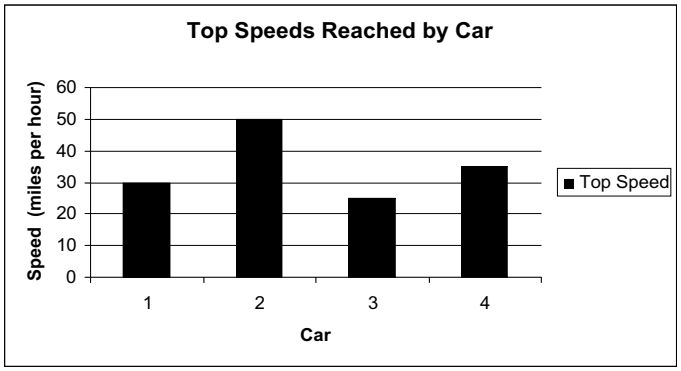
Homework Assignment – (10 minutes)
Instruct students to write a short story that includes characters using transportation of the future that use alternative energy sources. A Language Arts grade could be taken from this assignment. TEKS classificatory writing strategies should be used to fully develop a short story about future transportation and the use of alternative energy. Encourage students to draw pictures to illustrate the short story. Collect the assignment the following day.

Day 4 – 60 minutes

Activity – Group Research Work (continued)
1. Collect, grade and return the homework assignment from the previous day. Display student's short stories and illustrations as time permits.

2. Working in the same groups assigned the previous days, students should continue their research and complete their Group Research Report Forms. During the last half of this activity, students should spend time preparing for their presentation, deciding who will be presenting which information and in what order. Each group's presentation should be approximately 10 to 15 minutes in length.

   Groups 2 through 4 are required to prepare a bar graph of their data. Review with these groups which factors to include on the x- and y-axes of their graphs. The independent variable (typically the car in these activities) should be graphed on the x-axis and the dependent variable (i.e. car mileage, top speed, car battery size, etc.) should be plotted on the y-axis. Following is a sample



   graph that can be shared with these groups.

Day 5 – 90 minutes

Activity 1 – Group Presentations

(70 minutes)

1. Allow students 5 -10 minutes to meet in their groups and review the material they will include in their presentation (topics from the reading questions, graphic created, Internet research results, etc.). Remind each group that they should present their topic with the mandatory elements as outlined in their Group Research Report Form. Remind the students that everyone will be assessed on the topics from the presentations, so they should all pay close attention. The listeners should be encouraged to generate questions in order to broaden their scope of understanding and to successfully complete their Assessment Questions at the end of the unit.
2. Bring students together as a class and have each group present their topic. Allow 10 - 15 minutes for each group.

Activity 2 – Review (20 minutes)

Summarize all the information by referring to the graphic organizer created on Day 1. With the entire class, add to the graphic organizer all the new concepts that were presented. Emphasize the topics that are included in the Assessment Questions.

Day 6 – 45 minutes

Activity – Assessment Questions

(45 minutes)

(The teacher may conduct another review if the assessment cannot be given the day following the presentations.) Distribute the handout of Assessment Questions to each student. Working individually, students should write down answers to the questions in the space provided. Once everyone has completed the questions, review the answers with the entire class.

ADDITIONAL ACTIVITY

Let's Compare the Energy Used

Explain to the class that during this activity students will compare the amount of energy used by four kinds of transportation: a bicycle, a solar car, an electric car and a gasoline-powered sport utility vehicle. There are a number of ways to measure energy. For this comparison, we'll use doughnuts.

1. A 60-pound girl, riding her bike at 10 miles per hour burns up 24 kilocalories per mile. A typical glazed doughnut provides her body 245 kilocalories. About how much doughnut-energy does she burn per mile?

2. The fastest solar car is almost as efficient as the girl on her bike. It uses 30 kilocalories per mile. How much doughnut-energy does it use?

3. One of the most efficient electric cars you can buy is the General Motors EV-1. Since it can store more energy than a solar car, it doesn't have to be as efficient as the solar car. The EV-1 would use 214 kilocalories per mile. How much doughnut-energy would it use per mile?

4. One of the least efficient cars you can buy is the General Motors Chevy Suburban. A Suburban uses 2,729 kilocalories per mile. How much doughnut-energy would it need per mile?

Vocabulary Words

alternative – other or substitute

biomass – organic matter, such as plants or garbage, that can be used as an energy source

drive shaft – steel tube that transfers rotating motion from transmission to rear wheels of a car

fossil fuel – a hydrocarbon deposit, such as oil, coal or natural gas, created from previous living matter

hybrid car – a car that uses two or more sources of power

motor – a machine that produces motion or power for doing work

photovoltaic – technology for converting sunlight directly into electricity

pollution – a material that is harmful to living things

power (as in power system) – the capacity for doing work

power outlet – receptacle providing a place in a wiring system where current can be taken to run electrical devices

recharge – to apply energy again (as into a battery)

reduce – to make less

renewable energy – forms of energy that derive and quickly replenish from the natural movements and mechanisms of the environment, such as sunshine, wind, movement of the seas and the heat of the earth

smog – a combination of smoke and other particulates, ozone, hydrocarbons, nitrogen oxides, and other chemically reactive compounds; under certain weather conditions they may produce a murky brown haze that causes harmful health effects. The cause is often a result of burning fossil fuels with impurities, which can originate from the exhaust pipe of vehicles.

solar – relating to the sun

transportation – the act of moving something or someone to another place

Group Research Report Forms

Group 1: Model Solar Cars

Reading Passage Questions

1. A solar panel changes energy from sunlight into electricity.
2. A family car typically uses gasoline, but may also use diesel.
3. Electricity travels to the motor by a wire that makes the drive shaft turn; when the drive shaft turns, the wheels spin.

Research Analysis

Typical parts needed for the car would include:

- solar panels
- motor
- wheels & tires
- gears
- axle
- wire, leads
- car body

a) answers will vary, $30 – 45, depending on the sources found
b) multiply answer a) by 4
c) multiply answer a) by the number of students in the class

Group 2: Solar Race Cars

Reading Passage Questions

1. Solar race cars use batteries to store the sun's energy when the car does not need it and to run the car if more power than the panel can provide is needed.
2. The motor uses all the power from the solar panel.
3. If a car needs more power than the solar panel makes, it gets it from the batteries.

Research Analysis

Items under consideration when building a solar race car include:

- weight of vehicle
- battery bank size
- aerodynamics
- total power required (size and number of panels)
- material used to make body of vehicle
- gear ratios
- speed, acceleration, total miles needed to race

Group 3: Electric and Hybrid Cars

Reading Passage Questions

1. Electric cars get their energy from batteries.
2. When an electric car's batteries run out, they must be recharged by plugging the car into an electric power outlet.

3. An electric car does not burn any gasoline, so the car itself does not make any pollution. If the electricity from the outlet comes from a power plant that does not pollute, like a wind farm, then the electric car does not make any pollution.

Research Analysis

a. A hybrid car uses two or more sources of power. Typically, it has an engine powered by gasoline and an electric motor powered by batteries.
b. Both an electric and a solar car are powered by electricity, but only the solar car generates that electricity with solar panels. Electric cars recharge their batteries by plugging into a power outlet.

Group 4: Gasoline, Cars and Pollution

Reading Passage Questions

1. An electric car is more efficient than a gasoline-powered car.
2. Gasoline is non-renewable. It cannot last forever and it makes air pollution.
3. Air pollution can be harmful to human health and it makes the air look dirty, making it hard to see pretty sights.

Research Analysis

a. Nitrogen oxide (NO_x) is a gas formed in high temperature environments such as coal combustion. It is reported to contribute to ground level ozone and visibility degradation.
b. Carbon dioxide (CO_2) is a colorless, odorless, incombustible gas formed during combustion in fossil-fuel electric generation plants. Large amounts of CO_2 in the atmosphere cause more heat to be kept in, causing global warming.

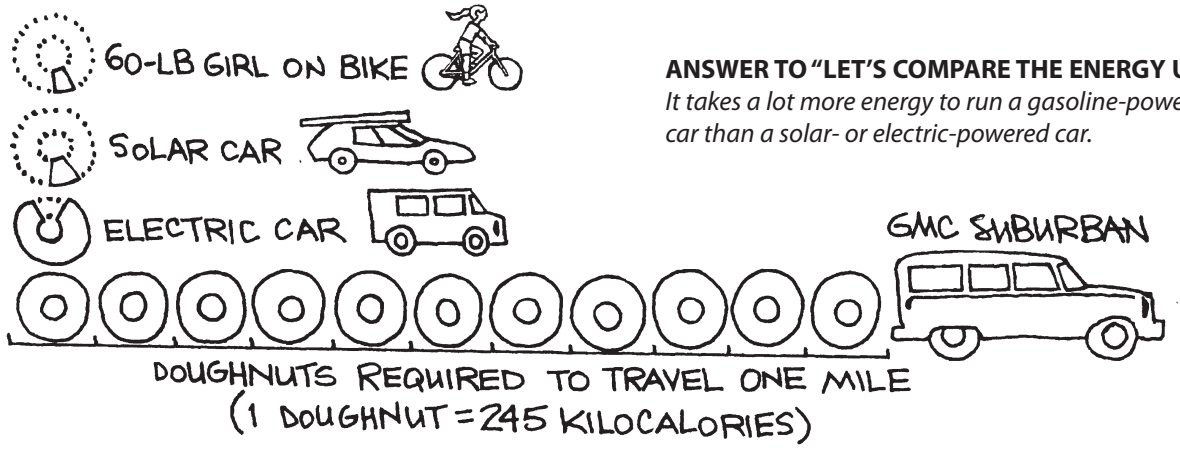
Assessment Questions

A.1. Biomass is all living matter.
A.2. plants and garbage
A.3. Wind generators can produce "green" electricity to supply energy or power for electric cars.
A.4. We cannot depend on fossil fuels because their supply is limited, and they pollute our atmosphere.
A.5. Two alternative forms of transportation are solar and electric cars.
A.6. Electric cars plug into an electric outlet for energy while a solar car uses a solar panel. Electric cars don't have to carry fragile solar panels so they can be larger and carry more people.
A.7. Both solar and electric cars don't burn gasoline, so the motor does not produce air pollution. (However electricity to charge-up the vehicle may be from coal, oil or gas power plants.)
A.8. Gas-powered cars are less efficient than electric.
A.9. A model solar car gets its power from a solar panel that converts light from the sun into electrical power. It is then transmitted by a wire to the motor, causing the drive shaft to turn, which causes the wheels to spin and moves the car.
A.10. An electric car can avoid creating pollution by charging its battery bank with electricity produced by a renewable energy source, such as a green power provider generating with wind.

Additional Activity: Let's Compare the Energy Used

It will be helpful to the class to display the graphic answer to the questions as well. (See below.)

1. The girl burns about one-tenth of a doughnut per mile.
2. It uses about one-eighth of a doughnut per mile.
3. It would need about nine-tenths of the doughnut.
4. About 11 doughnuts!



ANSWER TO "LET'S COMPARE THE ENERGY USED"
It takes a lot more energy to run a gasoline-powered car than a solar- or electric-powered car.

Solar and Electric Cars

RENEWABLE ENERGY
THE INFINITE POWER
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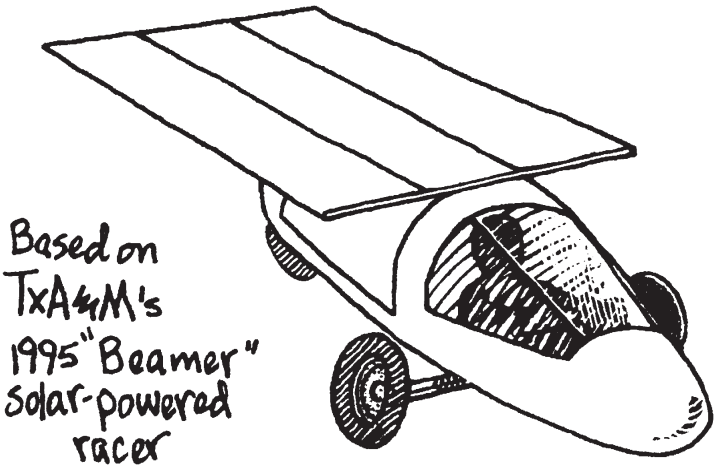
HIGHLIGHTS

- Renewable energy for transportation
- Solar-powered model cars: The Junior Solar Sprint Project
- Electric- and gasoline-powered cars and air pollution



POWERED BY THE SUN *A solar car has a solar panel that changes sunlight into electricity.*

RENEWABLE ENERGY AND TRANSPORTATION

Renewable energy was used for transportation long before any other energy source.

For hundreds of thousands of years, humans used only their own energy to get around, like walking and running. Later, they learned to use animals to get around like riding horses, camels, donkeys, or even elephants! People and animals get their energy from food. Since the energy in food comes from sunlight, food is a form of renewable energy.

We eat plants, and plants are sometimes called biomass. Biomass is plants or garbage that can be used for energy. Biomass can also be used to make fuels to power our cars.

A few thousand years ago, people discovered that they could use the wind to get around. Think about how fast sailboats can move on a lake or the Gulf of Mexico. Wind is another type of renewable energy.

But less than 200 years ago, people started using fossil fuels like coal and oil

for transportation. These fuels cannot last forever, so they are not renewable. And they cause air pollution.

Today with new technology, there are many ways we can use renewable energy to help us get around and reduce air pollution.

MODEL SOLAR CARS

Just like toy and model cars, you can also build model solar cars. Solar cars have some parts that are like your family car, but solar cars do not use gasoline. Here is how they work:

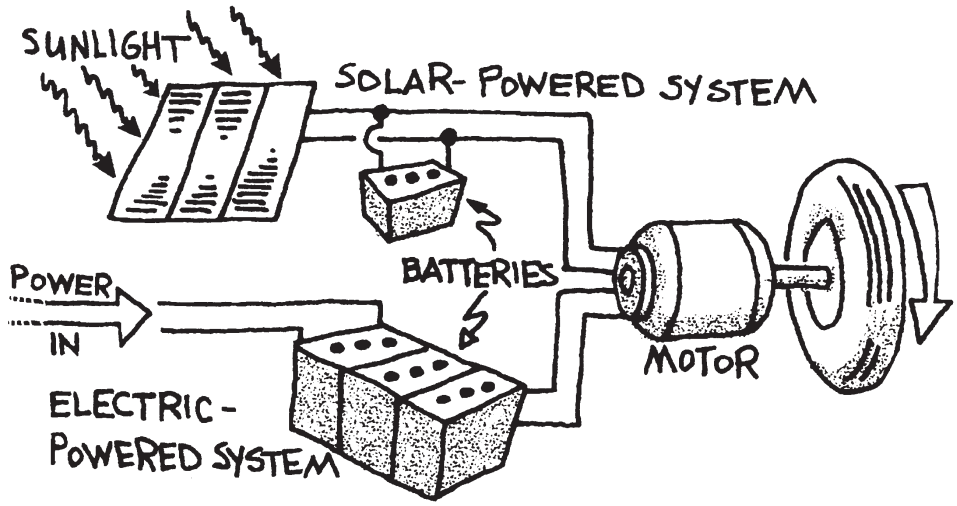
- a solar panel changes energy from sunlight into electricity
- electricity travels to the motor by a wire that makes the drive shaft turn
- when the drive shaft turns, the wheels spin
- the spinning wheels move the car forward

THE JUNIOR SOLAR SPRINT PROJECT

In this project, students form small teams to design and build model solar-powered cars. Teams then compete to determine the fastest car. For more information, check the internet at **www.txses.org/tjss/index.htm**

SOLAR RACE CARS

Solar cars also come in large sizes that a person can drive and even race. Since a race car is much larger than a model car, it needs a larger solar panel than a model car would use. Therefore, it can make more electricity. Solar cars use batteries to store the sun's energy when the car does not need it, like when it is stopped or driving slowly.



SOLAR AND ELECTRIC-POWERED CARS *Sunlight or electricity can be used to power a car's motor instead of gasoline or diesel.*

If the car is driving fast, the motor uses all of the power from the solar panel. In some cases, the car may need more power than the panel can provide. Then the motor uses energy stored in the batteries.

ELECTRIC AND HYBRID CARS

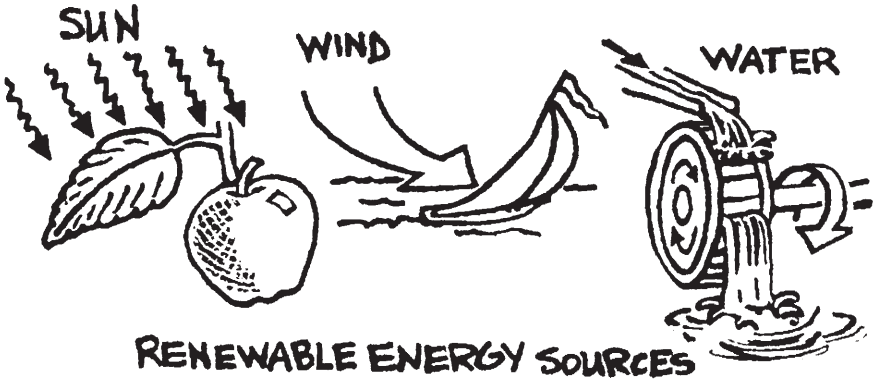
Electric cars are like solar cars. But instead of using a solar panel for energy, electric cars get their energy from batteries. When the batteries run out, they must be recharged by plugging the car into an electric power outlet like the ones in your classroom or at home. If you drove an electric car, you would recharge its batteries overnight while you slept.

Because electric cars do not have to carry the fragile solar panels, they can be larger and can carry more people. Just like solar cars, electric cars do not burn gasoline, so the car does not make air pollution. If the electricity from the outlet comes from a power plant that does not pollute, like a wind farm, then the electric car does not make any pollution.

There are also cars that use both gasoline and electric batteries. These are called "hybrid cars." A hybrid car uses gasoline to power an engine, and it uses batteries that power an electric motor. When the batteries are not being used, running the gasoline engine charges them. Hybrid cars have the best mileage rating of all cars. There are many hybrid cars available to buy today.

GASOLINE, CARS AND POLLUTION

Gasoline-powered cars are much less efficient than electric cars. And since gasoline comes from a non-renewable energy source, such as oil, it cannot last forever. They also make air pollution, such as smog. Air pollution can be harmful to your health. It also can make the air become and look dirty. Air pollution can make it hard to see pretty sights like city skylines and mountain ranges.



CLEAN POWER SOURCES FOR ELECTRIC CARS *Many renewable energy sources can be changed to electricity to power electric cars.*

Group Research Report Form

GROUP 1: MODEL SOLAR CARS

Reading Passage Questions:

1. Where do solar cars get their electricity from?

2. What kind of fuel does your family car use?

3. How does electricity make the wheels of a solar car spin?

Research

1. Using the Internet and the search engines or websites provided by your teacher, identify all the parts needed to build a model solar car. Find the price and quantities needed for each item to build one car and complete the following chart (if you need more room, continue on the back of your paper):

Table 1. Parts and price list for one model solar car

Item	Description	Price for 1	Quantity Needed	Total Price
TOTAL COST				

   a) How much would 1 model solar car cost? _____

   b) If your class was split into 4 groups and each group built a car, how much would it cost? _____

   c) If everyone in your class would build a car, how much would it cost? _____

2. On a large sheet of poster paper, create a drawing of what your solar car would look like.

Group Research Report Form

GROUP 2: SOLAR CAR RACES

Reading Passage Questions:

1. Why are batteries used in solar race cars?

2. When a solar race car is driving fast, where does the energy from the solar panel get used?

3. If the car needs more power than the solar panel makes, where does the car get it?

Research

1. Using Internet search engines, find and research three solar car races. Identify the top 3 cars in each race and complete the following chart (if you need more room, continue on the back of your paper):

Table 1. Top 3 solar cars in 3 solar car races

Race	Car Name	Total miles traveled	Top speed reached (miles per hour)	# of days to complete race	Other

List 3 items that designers must consider when building a solar race car:

a) _____

b) _____

c) _____

2. On a large sheet of poster paper, make a bar graph of one of the variables you researched for each car (such as the top speed of each car or the total miles traveled of each car).

Group Research Report Form

GROUP 3: ELECTRIC AND HYBRID CARS

Reading Passage Questions:

1. Where do electric cars get their energy from?

2. What happens when an electric car's batteries run out?

3. How can an electric car not make any pollution?

Research

1. Using Internet search engines, find and research three hybrid cars that you can buy today. Complete the following chart (if you need more room, continue on the back of your paper):

Table 1. Data on 3 hybrid cars

Car manufacturer and make	Battery size (volts or amps)	Mileage (miles per gallon) Note if city, highway or combined	Price	Comments

a) How does a hybrid car work? _____

_____

_____

b) How is an electric car different from a solar car? _____

_____

_____

2. On a large sheet of poster paper, make a bar graph of one of the variables you researched for each car (such as the price of each car or mileage rating of each car).

Group Research Report Form

GROUP 4: GASOLINE, CARS AND POLLUTION

Reading Passage Questions:

1. Which type of car is more efficient: a gas-powered car or an electric car?

2. Is gasoline a renewable or non-renewable energy source? What does that mean?

3. What are two effects of air pollution?

Research

1. Using Internet search engines and the websites provided by your teacher, research 3 gas-powered cars that you can buy today. Complete columns 1 and 2 based on information you have gathered.
2. Using the Internet and the website provided by your teacher, either calculate or obtain the amount of pollutants emitted from the cars you have researched. Complete columns 2 and 3 based on your findings. (If you need more room, continue on the back of your paper.)

Table 1. Data on 3 gasoline cars

(1) Car manufacturer and make	(2) Mileage (miles per gallon) Note if city, highway or combined	(3) Nitrogen oxide produced per mile	(4) Carbon dioxide produced per mile

a) What is nitrogen oxide (NO_x) and how can it be harmful to life? _____

_____

_____

b) What is carbon dioxide (CO_2) and how can it be harmful to life? _____

_____

_____

3. On a large sheet of poster paper, make a bar graph of the pollutants produced by each car per mile.

Assessment Questions

Q.1. What is biomass?

_____

_____

Q.2. What are two examples of biomass that can be used for energy?

1 _____

2 _____

Q.3. Wind is another form of renewable energy. How can wind be used to help with our transportation needs?

_____

_____

Q.4. What are two disadvantages of depending on fossil fuels for our transportation needs?

1 _____

2 _____

Q.5. What are two alternative types of transportation that do not use fossil fuels?

1 _____

2 _____

Q.6. List two ways electric cars are different from solar cars.

1 _____

2 _____

Q.7. How are solar and electric cars alike?

_____

_____

Q.8. Are gasoline-powered cars more efficient or less efficient than electric cars?

_____

_____

Q.9. How does a model solar car get its power to move?

_____

_____

Q.10. How can an electric car not create any pollution?

_____

_____

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Financial Acknowledgement This publication was developed as part of the Renewable Energy Demonstration Program and was funded 100% with oil overcharge funds from the Exxon settlement as provided by the Texas State Energy Conservation Office and the U.S. Department of Energy. Mention of trade names or commercial products does not constitute endorsement or recommendation for use.

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Texas Comptroller of Public Accounts
Publication #96-811B (03/05)