



# Sustainable Transportation In the 21st Century



Student Workbook





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Mineta Transportation Institute

Dear Students,

Welcome to the Mineta Transportation Institute's (MTI) Garrett Morgan Sustainable Transportation Project. It's all about how we get around. How do you get to school? Do you take the bus or ride your bike? Are you driven to school or do you walk? Whatever you answered, your life is affected every day by the transportation issues that you will learn about in this workbook. What you learn will help you now and in the future to make important choices about sustainable transportation – something explained in this workbook.

After studying what it means to have sustainable transportation, you will develop a project that demonstrates that concept. Your teacher will select a project to represent your class during a national videoconference with other students from around the country. Each participating class will make a presentation at the video-conference, with one winner chosen. A student, parent, and teacher from the winning team will have their travel expenses paid to represent their class at MTI's annual banquet in June in San Jose, Calif. The winning school also will receive \$1000, the top three projects will win a plaque, and all students who participate will receive certificates.

The purpose of this workbook is twofold. First, it will help you learn about sustainable transportation issues. And second, it will help you create a project that addresses these issues. When you have completed the lessons, not only will you know a lot more about one of the most important issues we face in the 21<sup>st</sup> century, you also will have many ideas for your project.

This workbook is yours. Use it to write your ideas on topics that interest you or that you have questions about. Your notes will help as you proceed with your project. If you participate in the competition, you will interact with the Secretary of Transportation or his representative, along with other transportation leaders. You also will comment on the other teams' projects, and ask questions of the competitors and the transportation leaders.

Complete the workbook and your project using your best critical and creative skills. Someday you will be making important decisions about sustainable transportation. This education will help you make them wisely.

Best wishes,



Rod Diridon, Sr.  
Executive Director  
Mineta Transportation Institute



Donna R. Maurillo  
Special Projects Director  
Mineta Transportation Institute

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# Learning about Transportation



What do you know about transportation? Have you thought about all the reasons people use transportation? Have you thought about the modes of transportation, like a car or a bike? What fuel sources are used for transportation? If you're like most people, you probably don't think much about these issues, but answering these questions is the first step toward finding solutions to our transportation problems.





# Transportation History: News and Dates

Transportation history can give us an idea of how things have developed. As you read the following events, think about why they are important. There are no right or wrong answers. All the events illustrate different facets of transportation development. You may find that you are most interested in the technology associated with transportation history. Someone else may look at the oil embargo and fuel increases. Others may look at environmental or social costs caused by our reliance on fossil fuels. All these issues are important.



When you read something you think is important, write a few words in the space provided to help you remember why it is important. After you have finished reading all the events, choose five events that you think are most important and create a timeline on the page provided. When you have completed your timeline, write a sentence or two that explains why you think each is important.

# Transportation History: News and Dates

## Notes

January 2, 1900 – The first electric bus appeared on 5th Avenue in New York City. It seated eight people inside and four outside. The fare was five cents.

January 9, 1862 – The "Elizabeth Watts," a 224-ton ship captained by Charles Bryant, carried 1,329 barrels of oil. The crew was kidnapped into working because most sailors would not work above an oil cargo for fear of fire and explosions.

January 28, 1969 – An oil well blew out on a Union Oil Company drilling platform five miles off the coast of Santa Barbara, Calif. The beaches were covered with oil. In April 2010, the same thing happened in the Gulf of Mexico, where BP was drilling.

March 24, 1989 – The Exxon Valdez oil tanker ran aground in Prince William Sound off Alaska, spilling 232,000 barrels of oil. Only 25% of the migratory salmon population returned the following season, and thousands of otters and birds were poisoned. Many died.

March 29, 1927 – The first automobile to exceed 200 mile per hour was the "Mystery Sunbeam" driven by Major Henry O'Neil de Hane Segrave at Daytona Beach, Fla. He hit 203.79 mph.

April 7, 1913 – The first electrically propelled ship of the U.S. Navy, the U.S.S. Jupiter, was commissioned.

April 12, 1961 – The first human spaceflight was Vostok 1, on which cosmonaut Yuri Gagarin of the USSR made one orbit around Earth.

April 16, 2009 – President Obama unveiled his administration's blueprint for a national network of high-speed passenger trains. He said it was necessary to reduce traffic congestion, cut dependence on foreign oil, and improve the environment.

May 3, 1869 – Passenger traffic began on the first pneumatic subway invented by Alfred Ely Beach. The Beach Pneumatic Underground Railway of New York City included a 312 foot-long circular tube, 9 feet in diameter. The cars carried 22 passengers and were propelled by a blast of air from a rotary blower.

# Transportation History: News and Dates

## Notes

June 10, 1999 – Three were killed, including two 10-year old boys, when a gasoline pipeline exploded in Bellingham, Wash.

June 27, 1652 – The first traffic law was passed in New Amsterdam (New York City). The law stated, "...in order to prevent accidents (we) do hereby ordain that no wagons, carts or sleighs shall be run, rode or driven at a gallop within this city of New Amsterdam, ... on the penalty of two pounds Flemish for the first (violation)."

June 28, 1979 – OPEC raised prices on crude oil again. The price of a barrel increased 50% over a year earlier.

July 15, 1979 – President Jimmy Carter announced a massive six-point effort to reduce American dependence on foreign oil, including alternative energy development.

August 9, 1803 – Robert Fulton creates a steamboat that operates up the River Seine in Paris, moving 3-4 miles per hour upstream.

September 3, 1931 – An experimental electric passenger train, designed by Thomas Alva Edison, was used on the Lackawanna Railroad between Hoboken and Montclair, N.J.

September 14, 1924 – Monterey Pipeline exploded. Two people were killed and many more were injured. Thousands of gallons of flaming oil moved across the surface of Monterey Bay.

October 27, 1904 – The New York City Subway was the first rapid transit underground and underwater railway in the world. It ran from City Hall to West 145th St. About 111,881 people paid 5¢ each to ride for 26 minutes on the express train and 46 minutes on the local train.

December 26, 2009 – China introduced the world's fastest train, with average speeds of 217 miles per hour.

December 31, 1973 – President Nixon announced stand-by gasoline rationing in light of the Arab oil embargo. Gasoline stations had already begun voluntarily closing on Sundays.

# Your Transportation History Timeline

In the space below, select five transportation events and create your own timeline based on the readings in the workbook and/or other sources. After you have created your timeline, write a sentence or two on each event you selected.

Date	Why is it Important?	If negative impact, possible solutions?		
Event				
<table border="1"><tr><td data-bbox="224 810 474 890"></td></tr><tr><td data-bbox="224 890 474 1037"></td></tr></table>				
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# Current Issues

By now, you may notice many social, environmental and economic issues related to transportation. Examining the issues thoroughly is an important part of finding solutions to those problems. In this section you will continue to investigate the problems based on our dependence on fossil fuels.

Fossil fuels were formed from the remains of animals and tiny plants that lived in the oceans many millions of years ago. The main forms of fossil fuels are oil, coal, and gas. According to some experts, at the rate we are burning fossil fuels we will run out of oil and gas in 35-70 years and coal in less than 300 years.



The estimated annual world consumption of oil is about 2.8 billion tons. Half is used for transportation as a whole, with about one-third going into internal combustion engines (cars and trucks). The U.S. uses more fuel per person than any other country.

Today researchers and social scientists are looking at many consequences of our dependence on fossil fuels. Gas rationing, embargoes and oil spills are consequences of this dependence. Emissions in exhaust or smoke are another result of burning fossil fuels. Some of these emissions cause acid rain.

**Acid rain** forms when a chemical reaction occurs between the oxides of nitrogen and sulfur dioxide. These two chemicals react with the moisture in the air and produce the nitric and sulfuric acids present in acid rain. The sulfur and nitrogen compounds that contribute to acid rain primarily come from burning fossil fuels – such as coal and oil – in power plants and transportation. These are called fossil fuels because they were formed from the decayed plants and animals that lived millions of years ago. Fossil fuels are not “renewable – that is, they cannot be replenished – because it takes far too long for living things to become coal or oil.

This acid rain harms forests by depleting the nutrients in the soil and contributing to damage of buildings and statues. Acid rain can pollute bodies of water and harm the wildlife that lives there. Researchers are still studying the possible effects on human health, but many experts say that acid rain contributes to diseases such as emphysema and asthma. The damage to statues on this page shows the effects of acid rain. The gargoyle on the right has been restored after acid rain damage. The tree on the left shows acid rain’s effects. Its branches are thin and long. The tree on the right has a normal crown.



### See for Yourself

You can perform a simple experiment with chalk (limestone) and vinegar (an acid) to see the effects of acid rain on buildings and statues. Scratch a design on a piece of chalk, place it in a glass of vinegar, and watch what happens.



# Problems with Fossil Fuel

Based on your class discussions and previous reading, identify and explain five problems associated with using fossil fuels for transportation.

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# Transportation Energy Sources

You already have thought about and discussed one energy source, fossil fuels. Other energy sources are important to consider for transportation that meets today's needs without compromising future needs.

Energy sources can be divided into two main categories – renewable and non-renewable. Renewable sources can be used over again or created in a short time. Wind, sun, and food are renewable energy sources. Fossil fuels like oil, gas and coal are nonrenewable. It will take millions of years for the earth to replace the fossil fuels we have used.

Although most of earth's energy is renewable, we use non-renewable energy sources for many of our needs. On the following pages are names and descriptions of some fuels and energy sources that can be used for transportation.

**Oil** is a non-renewable fossil fuel. When oil is burned, it produces emissions that create acid rain. These pollutants are produced both during the refining process (making oil into gasoline) and when gasoline is burned in engines. Another drawback is that when oil is burned, it releases carbon dioxide. This is a “greenhouse gas” that traps the sun's heat close to earth's atmosphere and causes global warming. Below is a picture of an oil refinery. The smoke you see contains carbon dioxide, sulfur and nitrogen.



**Uranium** is a non-renewable fossil fuel with atoms we split to create heat that is converted into electricity. Nuclear power accounts for about 17% of the electricity produced in the world. People have learned that uranium's constant radiation is very dangerous to living things.

**Natural Gas** is considered by many experts to be the cleanest of all fossil fuels. Because it has no harmful chemicals like sulfur or nitrogen, it does not cause acid rain. However, it does produce methane, which is a worse greenhouse gas than carbon dioxide. To the right is a truck that runs on compressed natural gas. The tank holds the compressed gas before it is burned in the specially adapted engine.



**Coal** is used to make almost half the electricity in the world. Like oil, one of coal's drawbacks is that when it is burned, it releases the chemicals that cause acid rain. Coal is found close to the earth's surface and deep within the earth's crust. Coal that is deep must be mined with tunnels. If it is close to the earth's surface, it is obtained through a process called strip-mining. In some places coal is mined from big holes or pits in a process called "open-pit mining." Open-pit and strip-mines are better for coal miners, but they destroy the habitats of plants and animals. Although the land can be returned to its natural state, it is difficult and expensive. To the left you can see coal being prepared for use in a power plant and an oil refinery.



A growing number of electric vehicles are now on the road. Government emission regulations and car owners are demanding more environmentally friendly cars. Electric cars "charge up" at special stations and store the electricity in batteries. The car to the right runs on electricity.

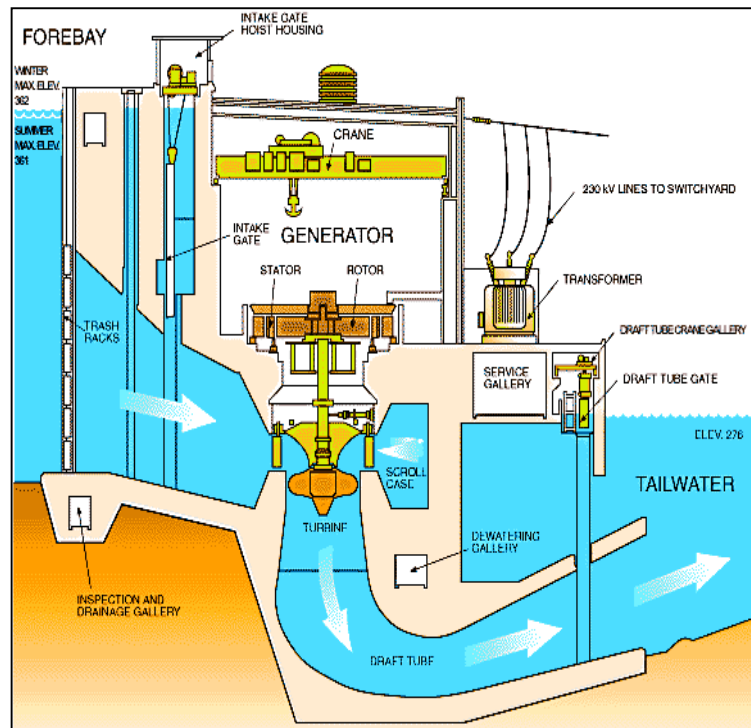


**Electricity** is generally produced in power plants. Power plants often use turbines to power generators that produce electricity. The generators in these plants have electromagnets that spin inside huge copper coils that produce electric current. The energy used to turn the turbines can be created from nonrenewable sources like gas, oil, coal and uranium or from renewable energy sources like solar, wind, geothermal and hydropower. Hoover Dam uses the force of channeled water to turn the turbines that produce electricity.

**At Hoover Dam** water flows from the forebay or reservoir through channels past the turbines in a draft tube. The water makes the turbines spin.

If you hold your hand under a faucet that is turned on high, you can feel the water's force. This same energy moves the turbines at Hoover Dam.

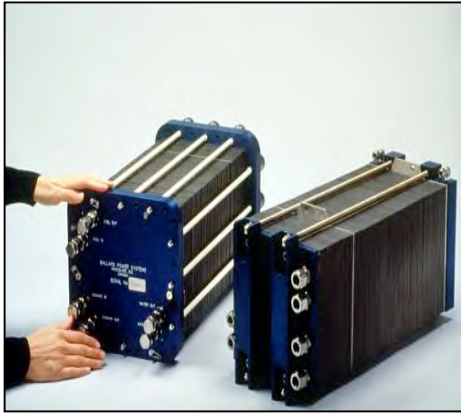
Producing electricity in this way doesn't produce greenhouse gases or acid rain, but building a dam does change the environment. Animals are affected because the river flow is changed and areas are flooded to form the dam's reservoir.



### Inside Hoover Dam

Hoover Dam is on the left. You can see how strong the water force is. To the right are the huge generators powered by turbines at Hoover Dam. When the turbine shafts spin, the magnets inside the generators rotate and produce electric energy.





**Fuel Cells** produce energy from the oxygen and hydrogen in the air. Unlike turbines, which create mechanical energy, fuel cells create chemical energy. While the fuel cell powers the engine, the car still needs a liquid or gaseous fuel to keep the chemical reaction going. Unlike a gas engine that gets from 15-40 miles per gallon, a car equipped with fuel cells could get 60- 100 miles per gallon.

Fuel cells are not new. In the 1960s, the Gemini Space Project used fuel cells to supply electricity to the space capsules. Today fuel cell buses are used in Ontario, Canada and Chicago, Illinois. Fuel cells are also used to produce electricity in power plants. The largest fuel cell power plant is in Santa Clara, California. A fuel cell is above.

**Geothermal Energy** is produced by using very hot water created by the movement of the earth's plates. Many volcanoes and geysers are the result of this movement. Engineers can now pump this very hot water and use the steam or water vapor to turn turbines in power plants that produce electricity. Geothermal power plants are very expensive to build, but once they are built, they are inexpensive because the hot water is free. Today more than 250 geothermal power plants have been built. Like many renewable energy sources, geothermal energy is non-polluting.



**Biomass Energy** is produced in different ways. Burning wood is a form of biomass energy that produces heat energy. Fermenting crops into alcohol, such as corn and sugarcane, can also produce biomass energy called **ethanol**. Biomass fuels are relatively clean burning, but to produce ethanol, the biomass product must be heated, which often uses fossil fuels and creates pollution. In Brazil, ethanol is a major source of fuel for transportation.



**Anaerobic Digestion** is another method to produce fuel from biomass products. Anaerobic digestion converts human, animal, and agricultural wastes into **methane** and carbon dioxide. In this process, the biomass is mixed with water and stored in an airtight tank to produce methane gas. Then the gas is reclaimed and used as fuel that can power turbines in power plants.



**Lightning Energy** One bolt of lightning could supply the energy needs for an entire city for a whole year. Scientists are trying to predict exactly when lightning will strike so we can begin to harness this awesome and tremendous energy source. This time-lapse photo shows lightning strikes in Boston.



**Solar Energy** is energy from the sun. You may have a solar watch or calculator that uses a photovoltaic cell to convert sunlight into electricity. When the sunlight hits the cell, the protons and electrons move and create electricity. Photovoltaic cells are expensive, but since we will always have sunlight, solar power is an exciting renewable energy source. To the left is an electric car preparing to charge its battery using solar power. A solar refractor is below.



# Energy Questions

Answer the following questions:

1. Can you name five renewable energy sources?

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2. Can you name three ways we produce electricity from renewable energy sources?

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3. Can you name three non-renewable energy sources?

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4. Why do you think we use non-renewable resources?

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5. What types of fuels are made from biomass?

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6. What produces acid rain?

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# Evaluating Transportation Modes

This table is similar to the first. This time write down all the transportation modes you know. Evaluate each transportation mode with the same three-point scale you used on the previous worksheet.

**Transportation Evaluation Table**

<b>Mode</b>	<b>Speed</b>	<b>Convenience</b>	<b>Cost</b>	<b>Access</b>	<b>Pollution</b>	<b>Fuel Efficiency</b>

# Sustainable Transportation



By now you already know a lot about transportation. If somebody asked you what sustainable transportation was, you'd probably have quite a bit to say. You could tell them about the different fuels available and explain the various social, economic and environmental costs associated with them. You could also talk about why transportation must be convenient and fast so people will use it. You could explain benefits and drawbacks of mass transportation. How much the transportation costs and whether it can be made universally available are other issues that you might discuss with someone who asked you about transportation.

But if someone asked you for a definition, you might have a bit of trouble. People who work in sustainable transportation have developed the following definition:

“Meeting the needs of the present without compromising the ability of future generations to meet their own needs.”

When you think about it, this definition includes many possibilities. Sustainable transportation can include using mass transit, like buses, trains, light rails, and carpools. It could also be about using fuel efficiently. It can be about how employers address transportation issues by allowing employees to telecommute, have staggered shifts, or work longer hours so they don't have to make so many trips to work or drive during rush hours. All these concepts and many others are part of sustainable transportation.

# Characteristics of Sustainable Transportation

Use the worksheet below to identify and explain six desirable characteristics of sustainable transportation.

**Characteristic**

**Why Is It Desirable?**

# Assessing Sustainable Transportation Options

List four sustainable transportation modes and several positive and negative attributes for each.

Mode	Positive Attributes	Negative Attributes
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	<hr/> <hr/> <hr/> <hr/>	<hr/> <hr/> <hr/> <hr/>
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# Transportation Jobs and Professions

Many people are employed in transportation – from operating transportation modes (e.g., pilots, bus drivers, train engineers) to designing and building the vehicles. Some are transportation planners, deciding how best to keep vehicles moving. Others may work in accounting, helping to budget and manage the money for construction projects. Some may work in road construction or maintenance, or they may communicate with the people who use the roadways and transit systems so everyone knows when a new highway will be built or when traffic must be re-routed. If you can think of a career, it's very likely that it can be applied to transportation in some way.

## Career Matrix

Research four transportation careers from web sites and other sources. For each career, write at least one work task, educational requirement, reward, and challenge.

<b>Career</b>	<b>Work Tasks</b>	<b>Education</b>	<b>Rewards</b>	<b>Challenges</b>

# **Career Choice Paper**

Write a paper in which you choose a transportation career and tell why you would make that choice for yourself based on the work tasks, educational requirements, rewards, and challenges.

# The Competition

It is not necessary to create a project based exclusively on material in this workbook. These exercises simply provide insight into transportation, energy sources, environmental effects, career choices, etc. Your project should incorporate any aspect of sustainable transportation, but you can be as creative as you like. For transcripts of previous competitions, along with their project descriptions, go to [www.transweb.sjsu.edu](http://www.transweb.sjsu.edu). Click on “Education” and then “Garrett Morgan Program.” Scroll down to the PDF links.

Each classroom team that completes a project may enter that project into the competition. If a classroom has more than one team, the teacher will make the first judging and send the best entry to the competition. After the teacher selects the winning project, a written description of that project must be mailed to:

Director of Communications  
Mineta Transportation Institute  
210 North Fourth Street  
Fourth Floor  
San Jose, California 95112

Project descriptions must be received at the Mineta Transportation Institute (MTI) by 5pm Friday, February 25, 2011 or postmarked by midnight on that date.

It is not necessary to mail large displays or prototypes along with the written description. Instead, send clear photographs that show the display and/or prototype in a way that sufficiently conveys the students’ ideas. For PowerPoint presentations, please print the slides, two per page, on 8.5”x11” paper.

The video conference for the top entries will take place in mid-March 2010, the exact date depending on the schedule for U.S. Secretary of Transportation Ray LaHood, who will attend the meeting. Winners will be notified by April 15, 2011.

MTI will provide transportation and two nights’ lodging for the Awards Banquet on Saturday, June 25, 2011 for the first place student team leader, the team teacher, and one parent or guardian. If desired, a teacher and two students may attend instead.

The winning school will receive \$1,000 and a plaque. Second- and third-place schools will receive a plaque. All participating students will receive a certificate. The decision of the judges is final.

# Types of Projects

By completing a team project, you can apply what you have learned in this unit and use your imagination to develop innovative sustainable transportation solutions. Each team can include up to five students in your class.

Your project should be based on a vehicle and/or a system of transportation. Your idea could be a contribution to solving part(s) of the sustainable transportation problem for the future. Below are some suggestions, but you may think of something else:

## Science & Technology

**Project.** Develop your own transportation systems. This can be a new car, a better bus, or a transportation system for a whole city or one just for friends. You can describe your idea in writing and with pictures, drawings, and graphs.

## Social Science

**Legislation.** Write some community, local, state, or federal legislation that will promote sustainable transportation today. After you write the legislation, explain why it will be beneficial.

**Research Study.** Document current sustainable transportation practices in your community. The project can include any transportation system mode, method, or anything related to sustainable transportation.

## Career Choice

1. Choose a transportation career and interview people who work in it.
2. Ask questions such as:
  - a. What are the tasks, educational requirements, rewards, and challenges of your career?
  - b. What can you recommend to students interested in entering your career?
  - c. How would you rate the mode of transportation with which you work in terms of its speed, safety, convenience, affordability, fuel efficiency, and pollution?
  - d. How can we make your mode of transportation energy-efficient and sustainable?
3. Write a report in which you document current or future sustainable transportation practices for one mode of transportation. Include supporting quotes and details from interviews conducted with professionals in the field.



## Project Format

**Paper Requirements:** Papers must be at least five double-spaced pages. You may include pictures, charts, graphs and references to make the paper no more than 15 pages.

**Display Requirements:** If you wish to make a display for your project, your description and graphics must be mounted on a self standing poster board no larger than 36" X 48". You can make a prototype to enhance your illustrations. Be sure the prototype is large enough to be clearly visible on a video conference screen.

**Video Requirements:** You may create a video up to 90 seconds to support your project. This could be an advertisement, a demonstration, examples of current technology, etc.

**PowerPoint Requirements:** PowerPoints are popular for these projects. Be sure your text is clear. Do not crowd too many words on a slide. Use no more than ten slides.

**Time Limit:** Your project presentation must be 8-10 minutes.

## Judging Criteria

The competition will have at least four judges, who will be anonymous until after the competition. They will award a maximum of 150 points (plus extra credit on the Q&A) based on several criteria, including:

- Is the project innovative and yet realistic?
- Is the presentation, PowerPoint or paper clearly done?
- Is the project sustainable and will it be positive for the environment?
- Do the students speak clearly and knowledgeably?
- Do the students ask and answer questions intelligently?
- Does the team work well together and are they prepared?

## Hints

- Judges like presentations that are enthusiastic and clear.
- Practice several times! Judges can tell when you haven't practiced.
- Have other students challenge your idea so you can learn how to defend it.
- Speak clearly and slowly. The judges want to hear you.
- Have fun. Everyone is really interested in your project!

