

R·E·S·O·U·R·C·E · G·U·I·D·E



green**ENERGY**machine





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WHAT IS... THE GREEN ENERGY MACHINE?

The Green Energy Machine is a powerful way for you and your students to observe energy transformation involving alternative energy sources. As the photovoltaic cell and wind turbine operate, they produce DC electric current which is displayed on DC ammeters and is stored in the 12 volt battery, or be changed to AC current by a 500 watt inverter to power something in your classroom.

The portable unit houses the extendible wind turbine, photovoltaic cell, 12 volt battery, inverter and two AC plugs. By wheeling the Green Energy Machine outside and exposing the photovoltaic cell to sunlight or the wind turbine to wind currents electricity can be generated.

The DC electricity flows into the Green Machine where students will be able to see how many volts and amperes of electricity are being generated, and how the energy can be put to use powering lights or something in the classroom.

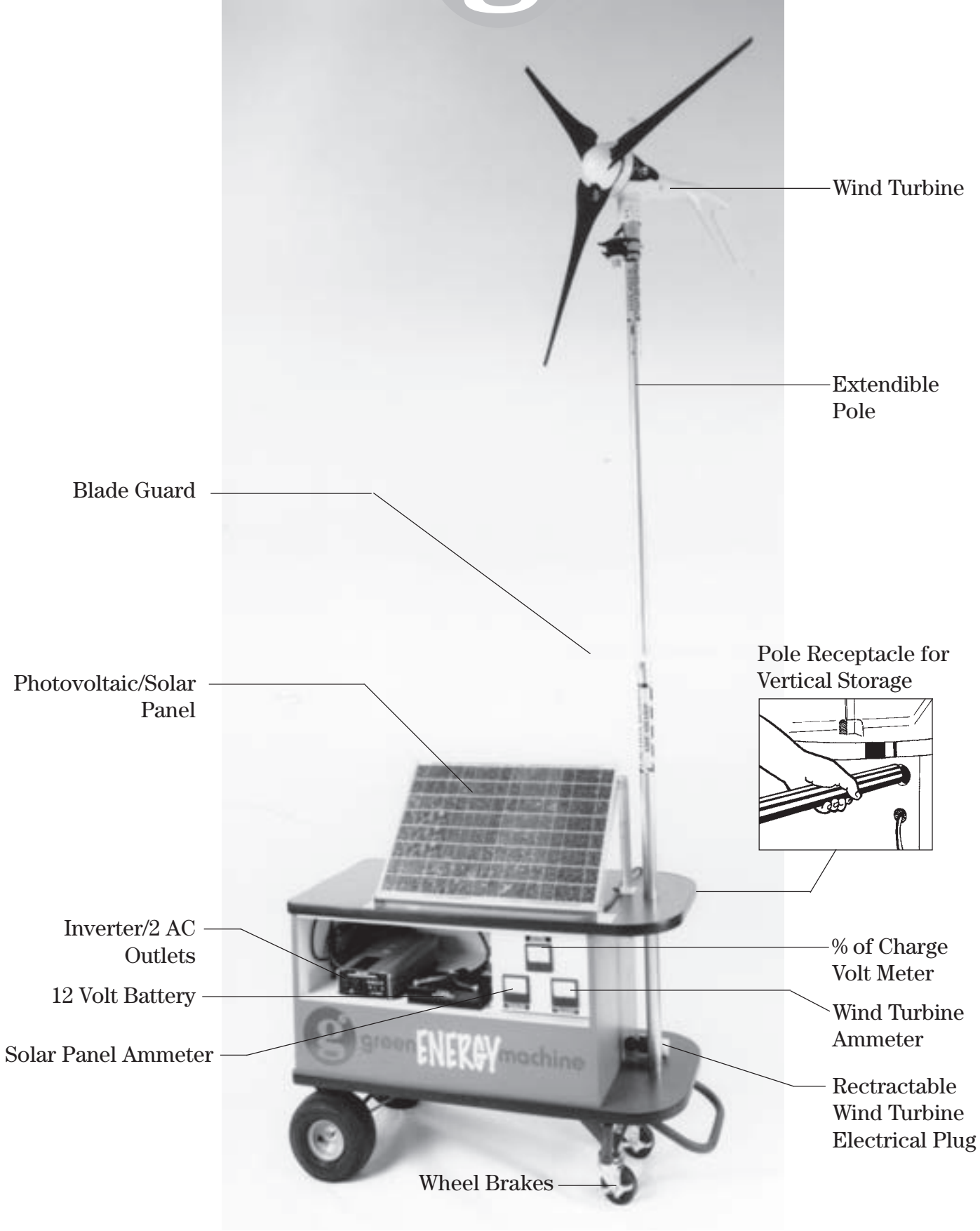


WHY... THE GREEN ENERGY MACHINE?

It's timely. It's current. It's the present and the future. The Green Machine will expose your students to some exciting ideas. It will educate them about the possible ways to generate electricity. In this day and age of energy deregulation (opportunity for individuals to generate electricity, not just the large electric companies) choice is the keyword; choice as to the consumer's provider of electricity but also choice as to the way in which the electricity is being generated (produced).

In order to understand the implications, some background information is necessary. (See page 16 for basic energy information).

NOMENCLATURE

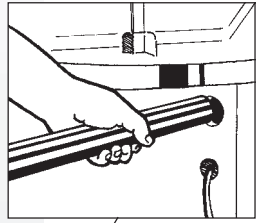


Wind Turbine

Extendible Pole

Blade Guard

Pole Receptacle for Vertical Storage



Photovoltaic/Solar Panel

Inverter/2 AC Outlets

% of Charge Volt Meter

12 Volt Battery

Wind Turbine Ammeter

Solar Panel Ammeter

Retractable Wind Turbine Electrical Plug

Wheel Brakes

SAFETY & MACHINE SET-UP

3. Periodically check all nuts and bolts for tightness. For your convenience, we have included a tool tray with necessary tools which is located behind the ammeter gauge door.



4. Do not allow anyone to place their hands inside the Green Energy Machine electrical component area. Keep the plastic doors shut or partially opened if you need to plug something into the inverter.



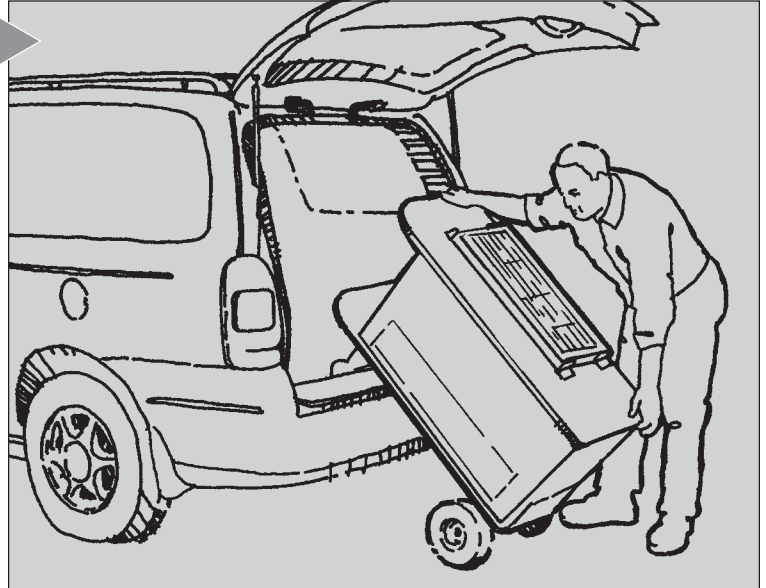
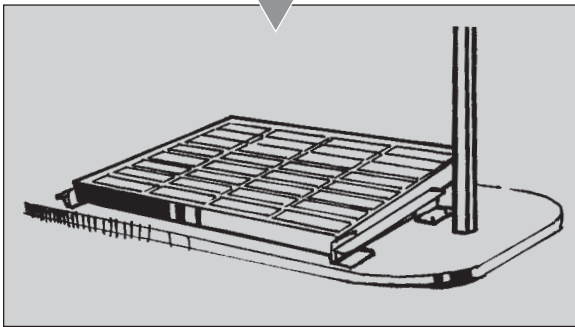
5. When demonstrating the Green Energy Machine or transporting it in a automobile, **always use the wheel brakes to contain the machine.**



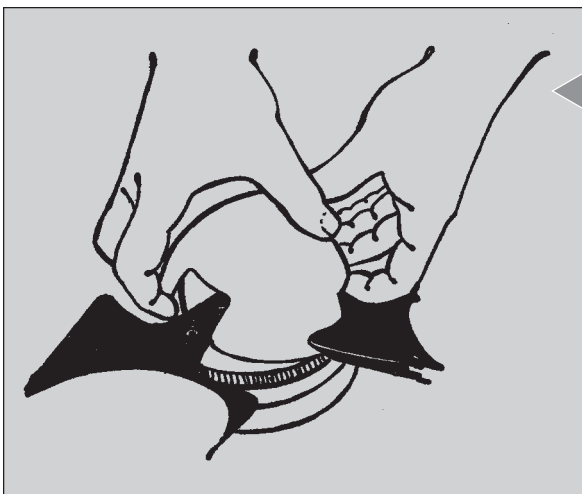
TRANSPORTING & STORAGE

The Green Energy Machine can be easily transported in a mini-van.

1. Unscrew the solar panel braces and lay the panel flat against the top of the machine.

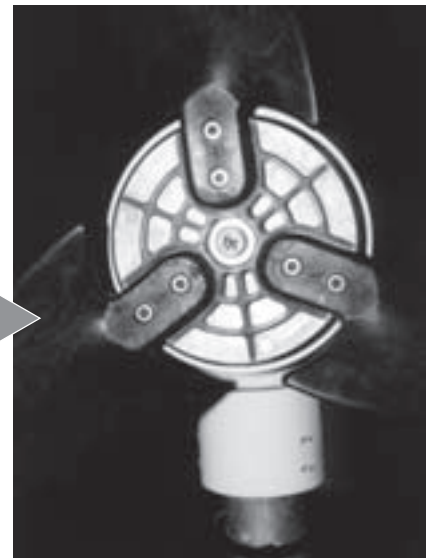


2. Then remove the wind turbine hub and unscrew main blade nut (this nut has a reverse thread so that the blades are always tightening when in use). Caution should be taken removing the hub to the wind turbine head. The blades are sharp. The hub is easily unsnapped to expose the main nut the holds the blades. Find the large allen wrench which is in the tool tray located behind the ammeter gauge door. Hold the blades and loosen the 5/8" nut. Place the removed blade housing in the van preferably in a flat location.



Remove turbine hub

Exposed turbine housing and 5/8" Nut



TRANSPORTING & STORAGE

3. Next pull out the extendible pole (minus the wind turbine blades) and place it in the van.

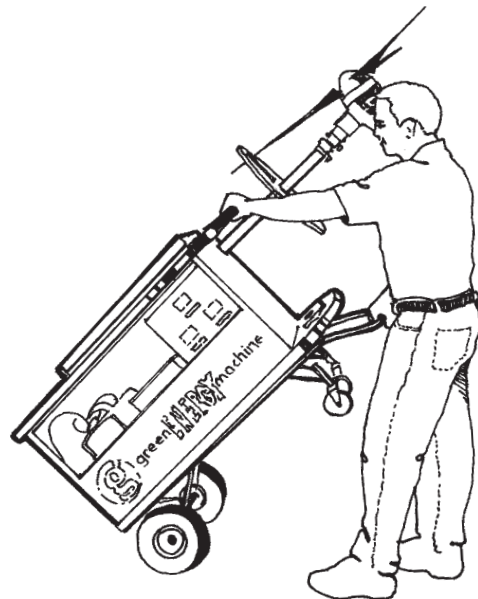


4. Roll the Green Energy Machine up to the rear of the van. With the help of another person lift and place only the front smaller wheels into the van. Then grab the Green Energy Machine back by the larger wheels and lift and roll the machine into the van.

5. Apply the wheel brakes and for extra safety block the rear larger wheels or trap the machine behind the seats. **REMEMBER:** Round things like to roll! Any extra care taken to insure that the Green Energy Machine will not move while transporting it is a sound safety measure.

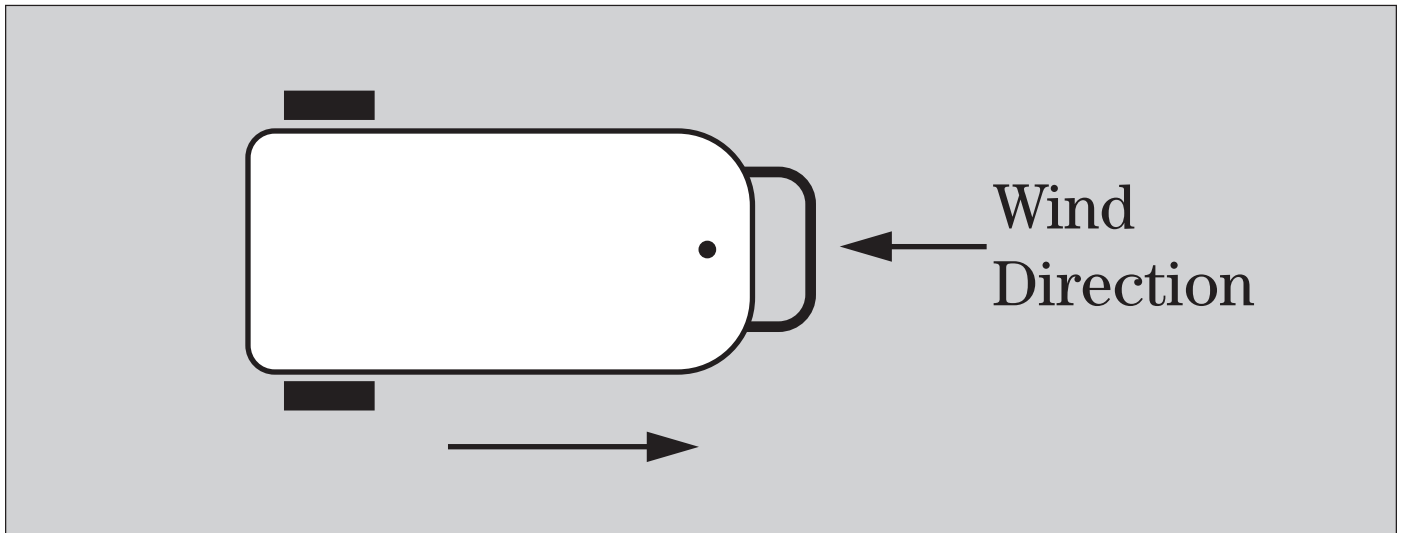


The Green Energy Machine when assembled, is designed for one-person to transport the entire unit



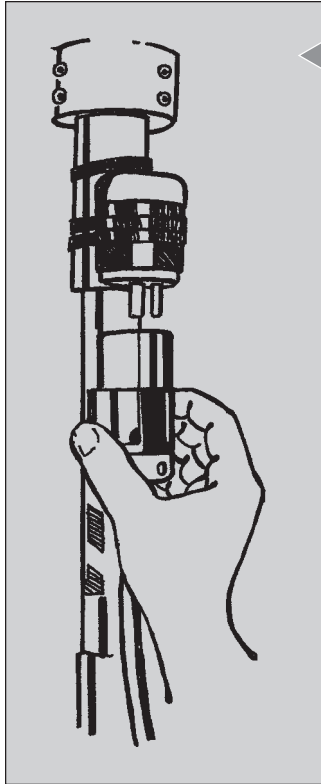
HOW TO OPERATE THE GREEN ENERGY MACHINE

1. The setting up of the Green Energy Machine must be done with **adult supervision** and done in **dry weather** conditions (the turbine head is opened for viewing and is therefore exposed to the weather).
2. Move the machine to the desired location either in the verticle or horizontal configuration.
3. Set up location must be **flat**. The more open the site is the better. For the wind turbine the best location is one with minimal obstructions in the southwest direction (this is the direction that the wind normally comes from). The turbine head will always rotate into the wind, but if there are marginal winds during your demonstration manually turn the head towards the wind. **For maximum stability, point the Green Energy Machine into the direction that the wind is coming from.** (See illustration below).

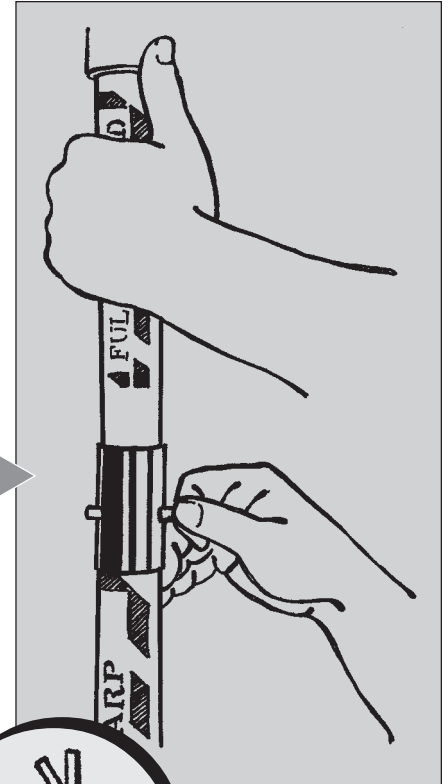


For the solar panel it depends on the location of the sun. Typically a southern exposure is the best. The angle of the solar panel will determine how much current it will produce. The more perpendicular the panel is to the sun, the more electricity it will produce.

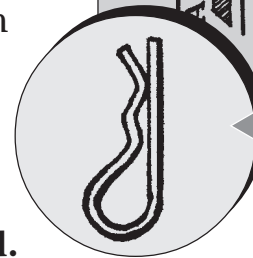
HOW TO OPERATE THE GREEN ENERGY MACHINE



4. Next pull out approximately 7 feet of the retractable extension cord from the Green Energy Machine and attach it to the plug located at the wind turbine head.

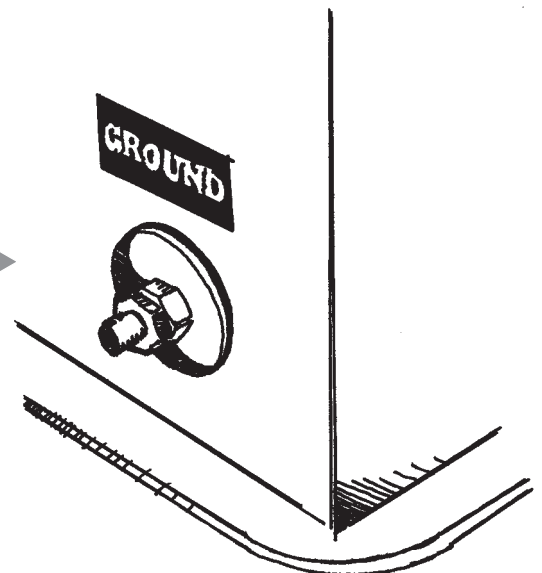


5. Pull the hitch pin clip and then the clevis pin from the extendible wind turbine pole. Raise the pole until the arrows line up (never pull the pole past the black line). Reinsert the clevis pin and hitch pin clip. The white blade guard can be pushed up out of the way while extending the pole. **Never remove the blade guard.**



Hitch Pin Clip

6. Next you must **ground** the Green Energy Machine by using the supplied cable with alligator clamps stored behind the ammeter gauge door. Clamp one end to the **ground bolt** on the machine. Connect the other end to any metal post or pole that is fixed into the ground. The other way that the machine can be grounded is by plugging in the inverter to any outlet (This sounds like we're cheating! But it is a legitimate way to ground the machine.)



HOW TO OPERATE THE GREEN ENERGY MACHINE

7. You are now ready to measure wind and solar readings.

Note: Both the wind turbine and solar cell have self-regulating internal electronics. This keeps the battery from becoming over charged. The standard joke is that batteries don't die, they're murdered by overcharging. **So to take readings the battery must be somewhat discharged** so that the self-regulating electronics will allow current to flow. A battery discharged to 75% on the volt meter is sufficient. All that is needed to discharge the battery is to use the Green Energy Machine in the classroom to run your computer or TV. Plug any electrical device into the two AC outlets located on the inverter.

Inverter/Charger



HOW TO TAKE READINGS

The Green Energy Machine is designed so that both the solar panel and wind turbine supply electrical current to the battery. The power to run the inverter comes from the stored energy in the battery. Whatever current is being generated is shown on the individual ammeter gauges (as long as the battery is somewhat discharged as mentioned earlier). Everything on the solar panel, wind turbine and battery side of the electrical system is direct current (DC). What the inverter does is take the DC electricity and invert it to alternating current (AC) like is used in our homes.

The Green Energy Machine is also a functioning generator that can be used in a power outage.

HOW TO OPERATE THE GREEN ENERGY MACHINE

Wind Turbine

It usually takes 7 to 8 MPH of wind to start the wind turbine spinning. If the wind is blowing and the blades are not turning, you can help them along by manually spinning the blades (they spin clockwise) using a yardstick. Use something relatively soft so as not to damage the blades.

CAUTION: Wind turbine blades are sharp. Never remove the blade guard. Only allow blades to spin when the turbine pole is fully extended.



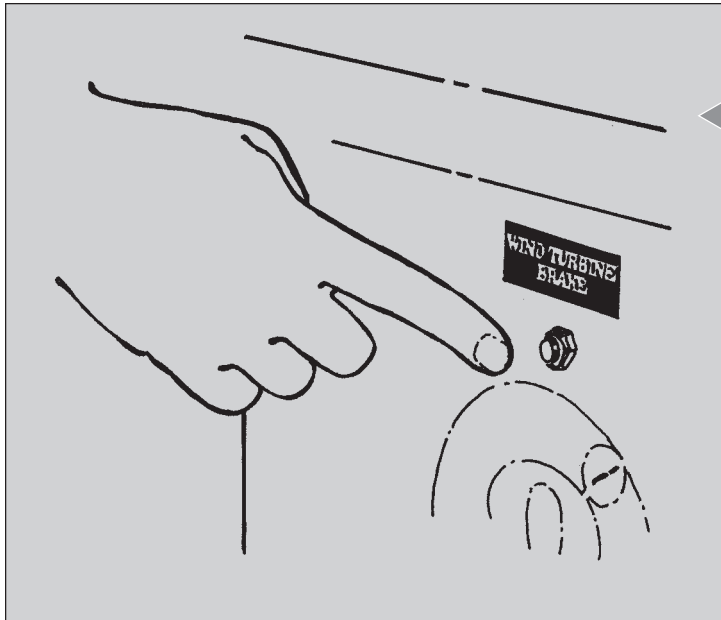
To measure how much power is generated by the wind turbine. Use the relationship $\text{voltage} \times \text{amperage} = \text{watts}$.

The wind turbine transforms mechanical energy into electrical energy by making magnets and wire windings rotate around each other, thus producing an electrical current. Because of all the moving parts there is more maintenance involved with wind generated electricity. Currently wind energy is the fastest growing renewable energy form. It is now producing electricity at competitive prices with coal generated electricity.

The wind turbine that is on the Green Energy Machine is rated at 400 watts. If you need more information on the turbine please refer to the owner's manual for the wind turbine that is supplied with this Resource Guide.

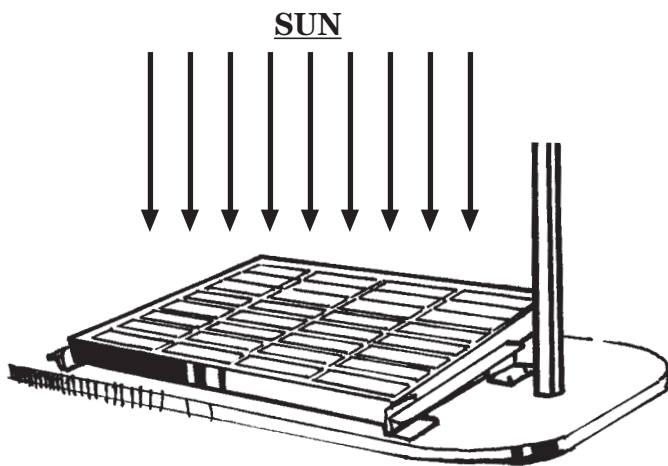
Also turn to Teachers Handout B to compute energy produced.

HOW TO OPERATE THE GREEN ENERGY MACHINE

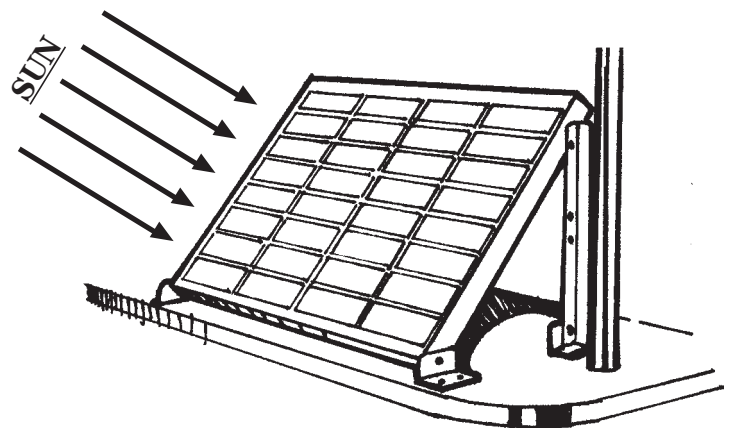


To stop the wind turbine after the demonstration is over the electrical turbine brake can be pushed to slow down the blades.

Solar Panel



Noon Set-up



Morning/Evening Set-up

Locate the Green Energy Machine so that the sun will strike the solar panel at an optimum angle (if its noon lay the panel flat, if its morning or evening angle the panel so that the sun is as perpendicular as possible).

To calculate the power being produced by the panel, use the relationship volts X amperage = watts.

HOW TO OPERATE THE GREEN ENERGY MACHINE

See Teacher Handout B for examples of other experiments that can be done with the Green Energy Machine.

Solar panels transform radiant energy from the sun into electrical energy. The transformation occurs in the silicon wafers that make up part of the panel. Unlike the wind turbine, a solar panel has no moving parts. So maintenance costs are almost nil. The lifetime span of a solar panel is guaranteed for 25 years (same life span as a nuclear reactor). Because there are no moving parts the manufacturers believe that the panels can last even longer.

Currently, solar panels are not as economically competitive as wind turbines. However prices continue to decline. In 1980, a solar panels cost was \$11.00 per watt. In 2001, the cost was less than \$3.50 per watt.

The solar panel on The Green Energy Machine has a rating of 35 watts. If you need any additional information on this cell please read the enclosed solar panel manual.

DIFFENT WAYS TO CHARGE THE GREEN ENERGY MACHINE

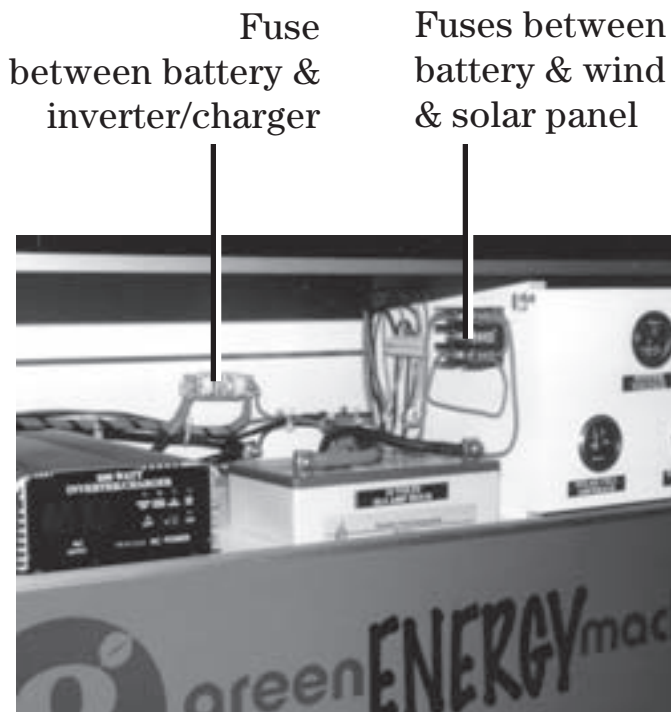
Because the inverter is also a battery charger the Green Energy Machine can be charged either by the solar panel, wind turbine or from the electrical outlet on the wall (the electrical grid). We have already discribed how to charge the battery by using the sun or the wind (any time you're taking readings you're also charging the battery). To charge the battery using the electric grid simply plug in the inverter. The inverter will automatically go to charger mode and charge the battery. Once the inverter/charger has charged the battery, it will automatically go into a trickle charge mode. Leaving the inverter/charger plugged in will not harm the battery. If you have further questions about the inverter/charger locate the manual (floppy disc) also included with the teachers guide.

FACTS AND TECHNICAL DATA

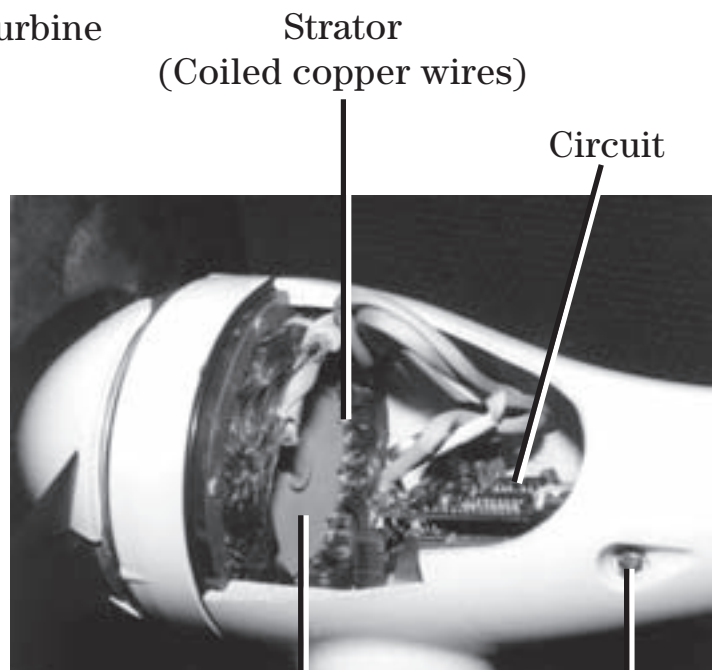


PARTS/OPERATION

The 500 watt inverter/charger changes the DC electricity into AC electricity. It can also be used to charge the battery. The two AC plugs can be used for most electrical appliances from televisions to lights. If you overload the inverter (by demanding more than 700 watts), the overload light will illuminate and the inverter will not operate for a few minutes.



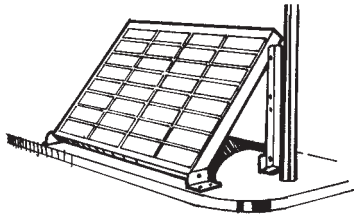
Fuses isolate electrical components from damage in case of an electrical short or amperage overload.



FACTS AND TECHNICAL DATA



Green Energy Machine Technical Information



- ▶ **21" wide ,46" long and either 36" high or 108" high**
- ▶ **storage height 80"**
- ▶ **weight 200lbs.**
- ▶ **Photovoltaic cell**

Kyocera 35 watt, 2.33 amp, 15 volt aluminum framed cell.
Self-regulating, 25 year warranty. Dim. 25.7" X 18.5".

Cell is mounted with predrilled holes for angles 30°, 35°, 40°

For more information see www.Kyocerasolar.com



▶ **Wind Generator**

Air 403 wind generator. Rotor diameter 46", weight 13 lbs.,
startup speed 7 mph, voltage 12 volts. Rated output 400 watts
at 28 mph. Self regulating, 3 year warranty.

▶ **Inverter/Charger**

Vanner 500 watt inverter/ battery charger.

Peak power output 500 watts

output power surge 700 watts

output power continuous- more than 400 watts

output wave form - modified sine wave

efficiency 90%

number of AC outlets - 2



▶ **Battery**

Sealed lead acid rechargeable battery - **Green Energy Machine
can be stored in horizontal or vertical position.**

12 volts, 55.0 amp hour

Percent of charge volt meter and separate amp meters
for PV cell and wind turbine.



▶ **Misc.**

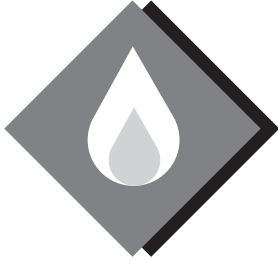
All components are fused.

Ground is supplied either by plugging in the inverter/charger
and using the grid or by an exterior ground bolt located on
the left side of the Green Energy Machine (grounding cable
is included).

Four wheel dolly is a 600 lb. capacity Milwaukee with
pneumatic rear tires and lockable front tires.

All components, brakes and safety features are labeled.

BASIC ENERGY INFORMATION



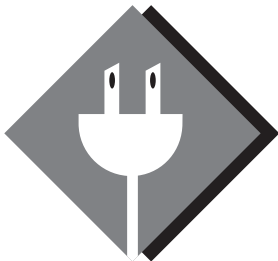
4. THERMAL ENERGY - Heat energy. Heat is produced by the vibration or movement of molecules. The faster the movement of the molecules, the more heat energy is produced. Heat energy is always released when one form of energy is converted to another form of energy.



5. MECHANICAL ENERGY - Energy of motion or movement. If something moves mechanical energy is involved. Running, walking, jumping, throwing, pushing, and pulling are examples of mechanical energy doing work.



6. SOUND ENERGY - Energy caused by vibrations of matter. Anything moving causes vibrations, thus causing sound.



7. ELECTRICAL ENERGY - Energy produced by the movement of electrons. All matter is made of atoms. Atoms are made of smaller particles named protons, neutrons, and electrons. The protons and neutrons lie within the nucleus of each atom. The electrons, however, orbit around the nucleus in shells. When the electrons move from atom to atom, electricity is produced. Electricity is conducted through wires from where it is generated to where it is used somewhat like water flowing through a pipe. When mechanical energy operates a generator, electricity is produced in the coils of copper wire that spin in a magnetic field.

Energy Can Change Forms

The law of conservation of energy states that: Energy cannot be created or destroyed; it may be transformed from one form into another, but the total amount of energy never changes. For example, when you turn on a light, electrical energy in the wires is turned into thermal and radiant energy. The electricity was produced by the mechanical energy of a generator being turned by steam produced by the thermal energy from the chemical energy of burning fuel. This chemical energy came from plants that were able to change nuclear (sun) energy into chemical energy through photosynthesis.



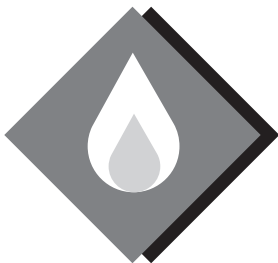
BASIC ENERGY INFORMATION

SOURCES OF ENERGY

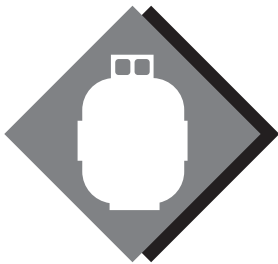
▶ **A. NON-RENEWABLE** Non-renewable sources of energy are of **limited supply** and cannot be replaced once they have been used up. The right conditions and millions of years were necessary for their formation. There are five major non-renewable sources of energy. They are coal, natural gas, propane, petroleum, and nuclear.



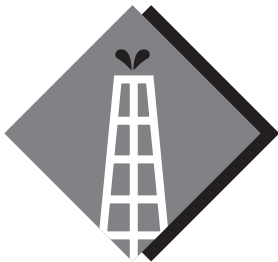
1. COAL - A fossil fuel created from the remains of plants from hundreds of million years ago. It is solid black rock. Coal is retrieved using underground mining or surface mining. When coal is burned carbon dioxide and other pollutants are emitted. Considerable money is spent by electric companies each year to reduce these emissions. Coal is the main source of electricity in the U.S. accounting for more than 50 % of its production.



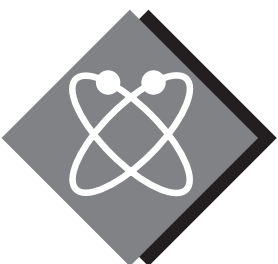
2. NATURAL GAS - A colorless, odorless fossil fuel that is the result of the decomposition of many small dead sea plants and animals millions of years ago. Made mostly of methane it is used to produce approximately 12 % of the electricity in the U.S. It is fairly clean burning, and heats more than 50% of the homes in the U.S. It is one of industry's favorite energy sources.



3. PROPANE - A colorless, and odorless gas fossil fuel that comes from the processing of natural gas and the refining of petroleum. Propane is a favorite energy source in rural areas where it is used in farms and homes for heating buildings, heating water, and cooking. We also use propane in barbecue grills.



4. PETROLEUM (Oil)- A black liquid fossil fuel produced from the remains of marine plants and animals millions of years ago. When petroleum is refined it produces numerous usable products such as gasoline, jet fuel, kerosene, plastics and many more. Used mostly for transportation it is the leading source of energy in the U. S. accounting for close to 40% of all energy used in the U.S.



5. NUCLEAR - Energy which comes from the splitting of uranium atoms. The process (fission) produces a great deal of energy (heat to mechanical to electricity) from a limited amount of uranium. Approximately 20% of the electricity in the U.S. is produced in nuclear power plants. The plants are regulated but dangers associated with radioactive waste and radiation exposure exist.

BASIC ENERGY INFORMATION



SOURCES OF ENERGY



B. RENEWABLE = GREEN ENERGY

Renewable sources of energy have **unlimited supply** because they can be replaced in a relatively short period of time. There are five renewable sources of energy. They are hydropower, biomass, geothermal, solar, and wind.



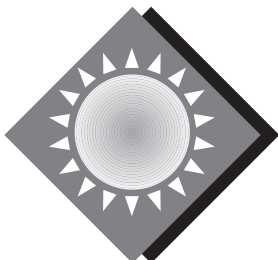
6. HYDROPOWER - Energy produced by water moving downhill due to gravity's pull. It is an old technology that is clean and relatively cheap. The moving water turns a turbine connected to a generator inside a dam to produce electricity. Approximately 10% of the total U.S. electricity is generated by hydropower. Building dams is expensive and flooding behind the dams alters the ecosystem above and below the dam.



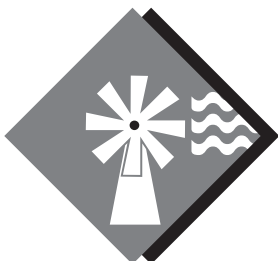
7. BIOMASS - Energy from trash, plant materials, and animal waste. The energy is released by burning the fuel, whether it be wood, agricultural products, animal waste, or ethanol alone or with gasoline (gasohol).



8. GEOTHERMAL - Energy that comes from the heat and/or steam within the earth. The heat is produced by the earth's core of molten and solid iron. Geothermal energy can heat homes and generate electricity. Although electricity generation is site specific, any house can be heated geothermally. Hot springs, volcanoes and geysers are excellent examples of geothermal energy.



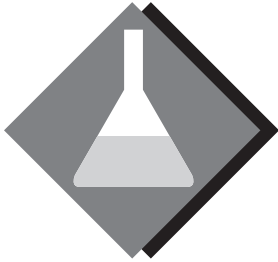
9. SOLAR - Energy from the rays of the sun. Being the ultimate source of energy in the universe, the sun produces its energy by the process of nuclear fusion. Solar energy can heat buildings and water. It also can produce electricity in two ways. First, using the solar thermal method, the sun heats a liquid and produces steam which turns a turbine connected to a generator to produce the electricity. The second method uses a photovoltaic cell (PV cell) to convert radiant energy directly to electricity within the cell itself.



10. WIND - Energy from moving air. Wind is moving air produced by the uneven heating of the earth's surface by the sun. Electricity is produced by a generator which is connected to a shaft attached to large turbine blades. As the wind makes the blades move the shaft turns the generator thus changing mechanical energy to electricity. Wind farms are popping up in many states across the U.S.

BASIC ENERGY INFORMATION

SOURCES OF ENERGY



11. FUEL CELL - Energy produced by a chemical reaction, almost always involving the combination of hydrogen and oxygen to form water. The fuel cell converts this chemical energy directly into electrical and thermal energy. There are different types of fuel cells. The fuel cell can be classified as either a renewable or a non-renewable source depending on the initial fuel used.

IMPORTANCE / VERSATILITY OF ELECTRICITY



The production of electricity has been mentioned many times when talking about the various sources of energy. Although it is not considered a primary source of energy it is considered a secondary source of energy, one much prized for its versatility. All ten of the sources of energy mentioned above are used to produce electricity. Why? Because electricity can make things move, light things up, heat things or cool things, power appliances, communication systems, and entertainment systems. It is essential to commercial, industrial and residential users and is easy to transport.

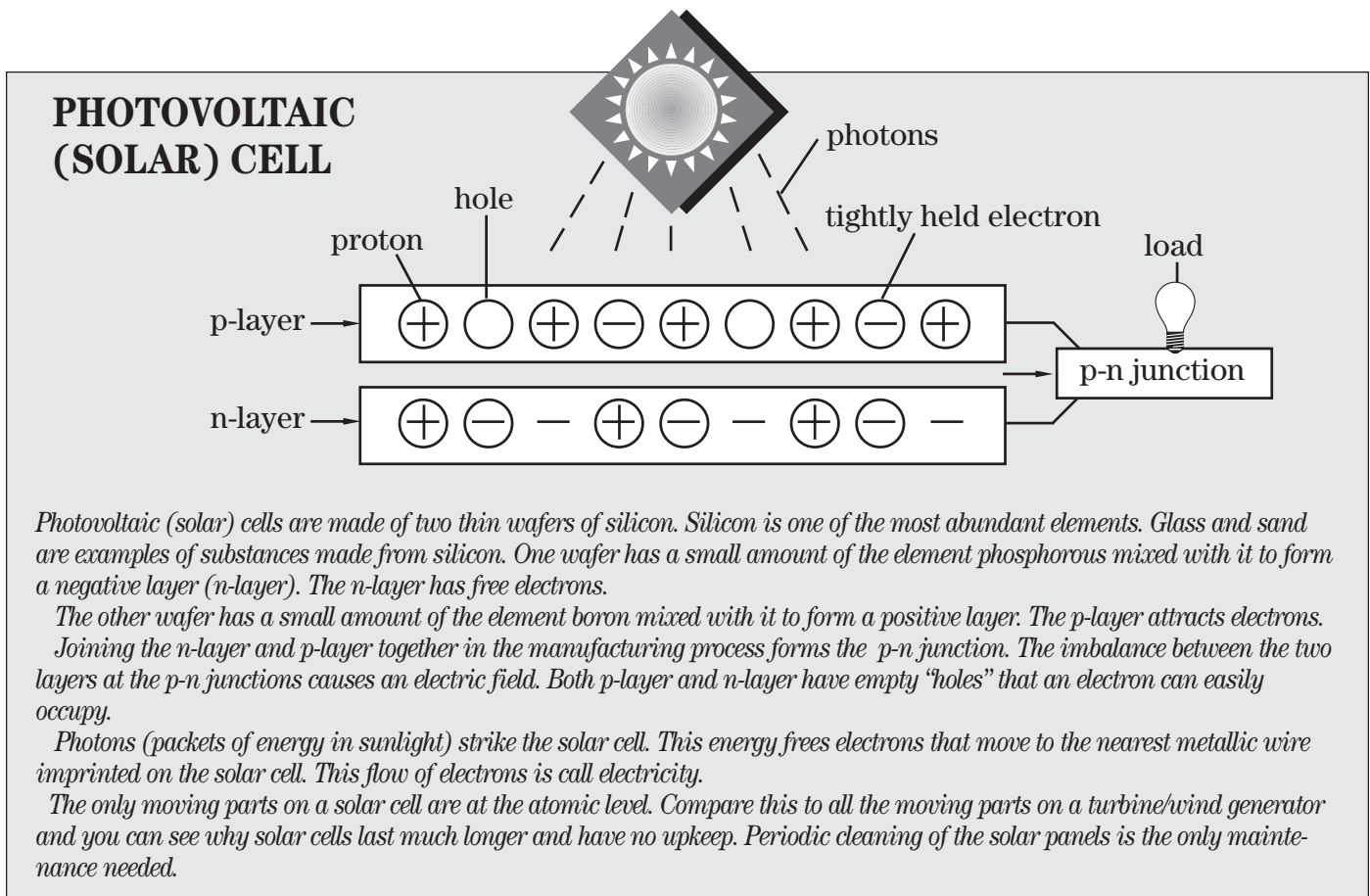
BASIC ENERGY INFORMATION

HOW ELECTRICITY IS PRODUCED USING THE GREEN ENERGY MACHINE

Electricity can be produced several ways, by electrochemical cells (batteries), fuel cells, photovoltaic cells, and most commonly by a turbine/generator combination. The *GREEN ENERGY MACHINE* illustrates the last two methods of electricity generation.

The wind turbine of the *GREEN ENERGY MACHINE* converts the mechanical energy of wind into electricity. The turbine is connected to a generator. Inside the generator is a coil of copper wire which rotates in a magnetic field to create electricity. The electrons in the copper coil become energized and begin to move from atom to atom, creating an electrical circuit. This current can be seen on the ammeters. The electrical energy is then stored in the 12 volt battery in the *GREEN ENERGY MACHINE*.

Mounted on the top of the *GREEN ENERGY MACHINE* is a 35 watt photovoltaic (solar) panel. The photovoltaic cell turns the radiant energy of the sun directly into electrical current.





BASIC ENERGY INFORMATION

Both the turbine/generator and the photovoltaic (solar) panel of the *GREEN ENERGY MACHINE* produce direct electric current (DC). Direct current flows in only one direction. Batteries (electrochemical cells) produce DC current.

Contained in the *GREEN ENERGY MACHINE* is an inverter. This device converts the direct current produced by the turbine/generator and the photovoltaic cell into alternating current (AC). Alternating current flows in alternate directions, switching directions at regular intervals. Most electricity used in homes is AC and switches directions 60 times a second. This enables the current to travel long distances.

AC is the type of current generated because it can easily be transformed between low and high voltages. Current travelling through power lines at higher voltages loses much less energy to heat than current travelling at lower voltages. However, in our homes, we want to use electricity at a lower, much safer voltage. In order to save energy during transmission (high voltage) and ensure safety in home use (low voltage), AC currents are used because they can easily be transformed between high and low voltages.

WEBSITES RELATED TO RENEWABLE ENERGY

Alliance to Save Energy	www.ase.org
Alternative Energy Institute	www.aceee.org
American Biofuels Asso.	www.biomass.org/index.html
American Hydrogen Asso.	www.clean-air.org
American Wind Asso.	wwwawea.org
American Solar Energy Asso.	www.ases.org
Center for Renewable Energy & Sustainable Technology	www.crest.org
Electric Power Research. Inst.	www.epri.com
Florida Solar Energy Center	www.fsec.ucf.edu
Healthy House Institute	www.hhinst.com
Interstate Renew.. Energy Council	www.irecusa.org
Million Solar Roofs	www.eren.doe.gov.millionroofs
National Renew.Energy Labs.	www.nrel.gov
Ohio Energy Project (OEP)	www.ohioenergy.org
Schools Going Solar	www.solarelectricpower.org/going_solar/schools.org
Union of Concerned Scientists	www.ucsusa.org/index.html
U.S. Dept. of Energy	www.eren.doe.gov

For additional websites related to renewable energy go to
www.greenenergyohio.org and click on links.

ABOUT ENERGY DESIGNS, INC.



Energy Designs is a custom manufacturer of display fixtures and commercial cabinetry located in Westerville, Ohio a suburb of Columbus, Ohio.

Originally started in 1984 as a product development company focusing on renewable energy powered products, the company has matured into a display fixture manufacturer. Now the business has come full circle (thanks to dropping prices with photovoltaics and wind turbines) to be once again enthusiastically involved in the promotion and general education of renewable energy, now known as green energy.

If you have any questions or concerns please contact:

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