BILTMORE®

Sustainable Energy

Biltmore's Legacy of Sustainability

When creating Biltmore, George Vanderbilt dreamed of a place that would support itself completely. He wanted it to be a model of conservation, stewardship, and sustainability. In order to do that, he hired experts, used the latest technology, and bought the best equipment. His efforts proved so successful that universities and local farmers visited often to learn his techniques.

Today Biltmore builds on that legacy by continuing to be self-sufficient, taking responsible care of its land and animals, and implementing environmentally-friendly practices.

In the Past, Biltmore:

- raised livestock to generate manure to enrich the over-farmed soil
- practiced scientific forestry by rotating the plots of forest harvested and planting new trees
- established a successful dairy business known for high milk production and prize-winning cattle
- created model farming operations producing poultry and eggs, pork, lamb, fruits, and vegetables

Biltmore Today:

- raises beef, lamb, pork, and eggs to serve in estate restaurants
- hydroponically grows vegetables, herbs, flowers, and micro greens for its Field to Table program
- harvests grapes for the Winery from the 40,000 vines in its vineyard
- uses Integrated Pest Management in its gardens
- maintains and uses a large compost heap from recycled plants, organic matter, and grape skins
- uses fallen trees to make mulch, firewood, furniture, and gift items
- uses low impact paving materials in new parking lots to allow water drainage rather than run-off
- plants natural grasses that require no extra watering and very little mowing
- recycles glass bottles and used corks from the Winery
- collects its used vegetable oil for use as biofuel
- serves Fair Trade coffee in its restaurants
- buys 10% of the food served at its restaurants from local farms

Energy Resources

Energy comes from many different sources which can either be nonrenewable or renewable. If an energy source is nonrenewable, there is a limited amount of it; once the source is depleted (used up), it is gone. A renewable energy source can either be replenished (restocked) or used over and over.

Nonrenewable Energy Sources

Most of the energy sources we use today—oil, natural gas, and coal—are fossil fuels. Coal was created from plants that decayed in swamps and bogs millions of years ago, and oil and natural gas were formed from the remains of marine organisms in shallow ocean areas. As these plants and animals were buried deeper and deeper into the earth, the intense underground heat and pressure squeezed and compressed them. Their chemical energy is released—along with carbon dioxide and carbon monoxide—when we burn them. Many scientists believe that the earth's atmosphere is getting warmer because of all the fossil fuels we are using. Coal produces the largest amount of carbon dioxide per energy unit.

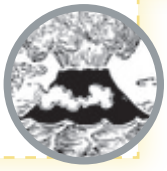
1. **Oil** is the most widely used fossil fuel. It is found deep within the earth and pumped to the surface, then sent through pipelines or shipped on tankers to refineries. Oil products include petroleum for cars, trucks, and other vehicles, home heating oil, plastics, and even clothing.

2. **Natural Gas** is usually found underground near oil. It is lighter than air and almost invisible. It burns easily and has no odor. After it is pumped out of the ground, it is mixed with a chemical to give it a strong smell so people can detect any gas leaks. Gas is sent through underground pipes to homes, schools, or businesses where it is used to cook food or provide heat. It is also used to generate electricity.

3. **Coal** is a black rock-like mineral. Coal is removed from the earth by underground mining or surface mining. Burning coal generates more than half of the electricity we use in the United States.

Renewable Energy is derived from sustainable sources and cannot be depleted.

Biomass energy is produced by directly burning plant or animal material. Burning wood is an example of biomass fuel. Methane gas released from manure is a form of biomass gas that is used as fuel. Ethanol made from sugar, corn, and other crops is another biomass fuel that can be blended with gasoline for use in cars.



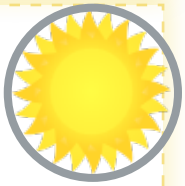
Geothermal energy is produced by the internal heat of the earth and comes to the surface through volcanoes, hot springs, and geysers. It can be used to heat buildings and generate electricity.

Hydropower energy is generated by the movement of falling water through a dam. The rushing water turns turbines which turn generators to produce electricity.

Wind energy is one of the oldest forms of energy used by man. Today wind is used to generate electricity with wind turbines.

Ocean energy or Marine energy is carried by the ocean waves and tides. This energy can be harnessed to generate electricity.

Solar energy is the original source of almost all other forms of energy. The stored energy in fossil fuels, wood, food, wind, and waves was generated from the sun's hot core. The amount of solar energy that reaches the earth is equal to only one billionth of all the total solar energy generated.

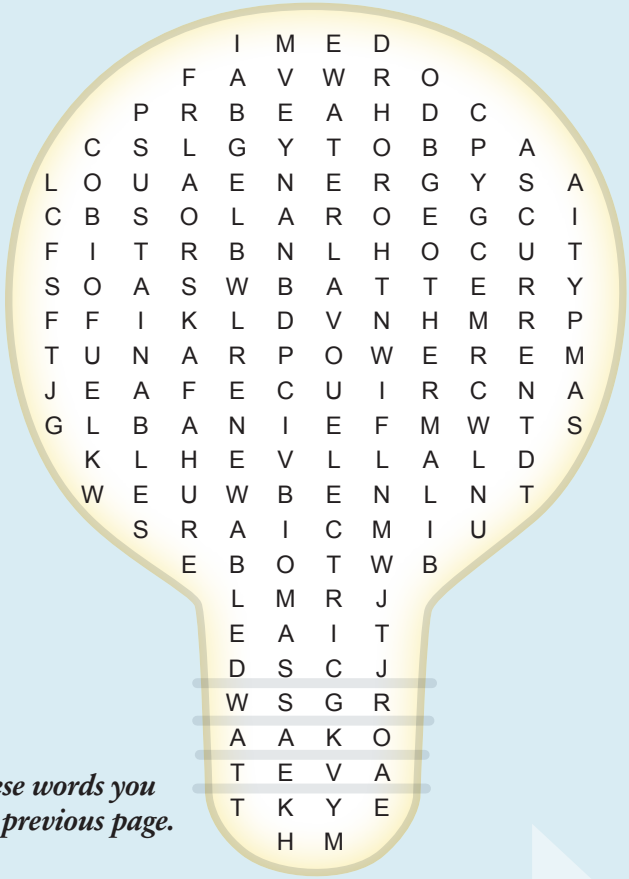


your turn

Renewable Energy Word Search

Find the following words hidden in the light bulb. They may be horizontal, vertical, or diagonal!

BATTERY
BIOFUEL
BIOMASS
BULB
CELL
CURRENT
ELECTRIC
ENERGY
GEOTHERMAL
POWER
RENEWABLE
SOLAR
SUSTAINABLE
WATER
WATT
WAVE
WIND



See which of these words you can find on the previous page.

Energy Acrostic

An acrostic is a poem in which the first letters of each line combine to spell out a word or message. Complete the themed acrostic below by filling in a word or phrase for each line.

E _____

N _____

E _____

R _____

G _____

Y _____

Word Scramble

Use only the letters found in the word "RENEWABLE" to rearrange into new words. See how many you can make from just one word! Bonus points if your new word is energy-related. An example is given.

RENEWABLE

near _____

_____

_____

_____

_____

_____

_____

_____

_____

Biltmore and Biofuel

Biofuel is an alternative fuel made from renewable sources. It is non-toxic, biodegradable, and can be used in regular engines with little or no modification. Since biofuel is made from living or previously living matter such as corn, corn cobs, sugarcane, soybeans, flaxseed, rapeseed, Canola seeds, vegetable oils, waste cooking oils, algae, and wood, it is a sustainable form of energy unlike fossil fuels.

There are two types of Biofuels:

1. **Bioethanol**—alcohol made by fermentation of sugarcane or corn. It is usually used as a gasoline additive.
2. **Biodiesel**—diesel fuel made from vegetable oils and animal fats; usually used as a diesel additive to reduce levels of carbon monoxide and hydrocarbons in diesel-powered vehicles.

Biltmore is currently growing Canola plants with the ultimate purpose of generating biofuel. This year we planted 50 acres of non-GMO Canola on the estate and will continue to do so annually. The seeds are sold to a company that crushes them to produce food grade oil which Biltmore uses in its restaurants to fry food. A local biodiesel processing plant cleans the used oil and produces biodiesel fuel to power some vehicles and equipment on the estate. The production process also produces glycerin, which is used to make soap. Eventually Biltmore hopes to produce food-grade Canola oil which will be used by restaurants for frying food, then converted into quality fuel for diesel vehicles.

50 acres of Canola = 2,520 pounds of seeds/year = 100 gallons of oil per acre = 5000 gallons of oil/year

What's so great about Canola Oil? It is low in saturated fat which makes it healthier for you by not clogging your arteries

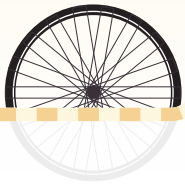
- It is high in mono-unsaturated fat which lowers the "bad" LDL cholesterol and helps control blood sugar
- It is high in omega-3 fat which is very good for your heart
- It is a good source of vitamins E and K, which help protect the heart and maintain normal blood flow.
- It has a high heat tolerance making it good for stir-frying and deep frying.

Canola Oil

Canola oil comes from the seeds of the Canola plant. Canola stands for **Can**adian **O**il **L**ow **A**cid. It is mainly grown in the US, Canada, and Australia but is used all over the world. The Canola plant is from 3–5 feet tall and produces small yellow flowers. It belongs to the same family as mustard, broccoli, Brussels sprouts, and cauliflower. As the plant matures, it produces small pods of seeds. Once harvested, the Canola seeds are crushed and the oil extracted. The average Canola seed is 45% oil. The seed pods and skins are then processed into Canola meal and used as high protein animal feed.

your turn

Math Exercises



Cycling Math

Riding your bike somewhere, instead of driving a car, is a very eco-friendly way to travel. And it's great exercise! Solve the bicycling math problems below.

You'll need to know the following:

Time = distance ÷ speed **1 mile = 5,280 feet**

1. Cornelia rides her bike to a friend's house 16 miles away. If her average speed is 12 miles per hour, how long will it take her to get there? _____

2. Edith's bike travels 9 feet every time her wheels go through one complete revolution. How many times do her wheels have to rotate to travel 1 mile? _____

3. Each time George turns his pedals all the way around, his bike travels 8 feet. If he turned his pedals 2,640 times, how many feet would he travel?

4. Using what you got for #3, calculate how many miles George traveled when he turned his pedals 2,640 times. _____

Recycling Math

1. Recycling aluminum cans saves 95% of the energy used to make new cans. Recycling 1 aluminum can saves enough energy to run your TV for 3 hours. If you recycle 150 cans, how many hours of energy do you save? _____ hours

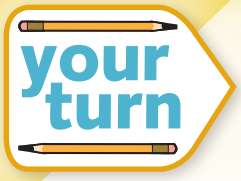
2. Every ton (2,000 pounds) of recycled mixed paper saves the energy equivalent of 185 gallons of gasoline. How much gasoline equivalent is saved by recycling 5 tons of mixed paper? How many pounds is 5 tons? _____ gallons _____ pounds

3. The amount of paper and wood consumed by Americans each year comes out to about 43 cubic feet of wood and 681 pounds of paper per person. How much paper would the average American use in a 90-year lifespan? _____ pounds

4. 40% of our landfills are filled with papers (like newspapers, magazines, and office papers)—or 40 items out of every 100. If 20 of those 40 items were recycled instead, what would be the percentage of paper items in the landfills? _____ percent

Answers: Cycling Math
1. 1.3 hours 2. 586.6 rotations 3. 21,120 feet 4. 4 miles

Answers: Recycling Math
1. 450 hours 2. 925 gallons / 10,000 pounds 3. 61,290 pounds 4. 20%



Recyclables Word Search

Find the words listed below in each word search somewhere in the grid: forwards, backwards, vertical, horizontal, or diagonal.

Non-Recyclables Word Search

These items cannot be recycled.

S C S W T N E M E C T G E C G U S L
K P Y T I Z Z H D H R W A W N E J A
T A O S O N J I Z F I N A G I T L M
O B T N H O D B Z D D X B R R I O I
P J C F G P T O M Y E S E Q O S P N
Z V I H N E A H W D S T V Y O S A A
X V T R J A S R P G T E U D L U P T
J L S O A C A A G A L G H C F E E E
V P A O A P P S B O S A D S W S R D
K U L R P E R D K A T T S R I R C P
A G P E R E I C L F D O E S Z D L A
G E R A G C O D B C O R H T J Y I P
T S D N A R M I R R O R S P U W P E
F H A D R U B B E R B A N D S B S R
N H A F O I L C O A T E D P A P E R
R E P A P N O B R A C M G X X D I S
L Q V M A O F O R Y T S Z Y U Y K N
J H I L B I F U W E Z Y P V O S E Z

CANDY WRAPPERS
CARBON PAPER
CARPET
CEMENT
DIRT
DISHES
FLOORING
FOIL COATED PAPER
HANGERS
LAMINATED PAPER
LEAD ACID BATTERIES
MIRRORS
PAPER CLIPS
PHOTOGRAPHS
PLASTIC TOYS
ROCK
RUBBER BANDS
SPONGES
STYROFOAM
TISSUES
TOOTHPASTE TUBES
WAXED PAPER
WINDOW GLASS

Recyclables Word Search

These items ***can*** be recycled!

S V T S P D U S S T Y S A H N V W Y
K U I P T F R E K I I S J U Y R S S
R E Y D X I N A D O E R D H A A G E
O Y I X E I C S O P O R E P G L A P
C G Z Q Z O S K T B A B P S C U B O
S F J A T A T I Y O D I E T E M Y L
M K G E L Q C A B N N R R I L I R E
S A S G O S R R P G O J A N L N E V
M F I I V V E N P E R T C C P U C N
S C S I D T C A P M O C E D H M O E
H P E U S Y P F Q X I N Y S O L R T
N M I O Q E P J R A A C A N N C G D
E L P N R T F P B P V E X E E B T J
I S K O O B E N O H P H K S S O Y O
S T E E L H H Z C L S R E T N I R P
V H Z F M V J I J O F D M C D L S B
N E W S P A P E R Q A W D S E T T K
P R O D U C E B A G S P D Z W B M A

ALUMINUM
ASEPTICS
BOOKS
CARDBOARD
CELL PHONES
COMPACT DISCS
CORKS
ENVELOPES
FLOPPY DISKS
GLASS
GROCERY BAGS
MAGAZINES
NEWSPAPER
PHONE BOOKS
POSTERBOARD
PRINTERS
PRODUCE BAGS
STEEL
STICKY NOTES
TIN
TIRES
VIDEO TAPE
WRAPPING PAPER

What is Carbon and how did it get here?

All living organisms contain carbon. Plants take in carbon dioxide, which is an invisible gas made up of carbon and oxygen. During photosynthesis plants keep the carbon and release the oxygen. Animals breathe in oxygen and breathe out carbon dioxide. We all depend on each other to stay alive.

How does this happen?

Photosynthesis is the process used by plants to convert light energy from the sun into chemical energy. Photosynthesis is a Greek word meaning light (photo) and putting together (synthesis). Plants make sugars (carbohydrates) from carbon dioxide and water. In the process oxygen is released into the atmosphere as a waste product. When people and animals eat green plants or algae, the stored energy and carbons within the plant enter their bodies. Everything living contains carbon. If you weigh 100 pounds, 18 pounds (or 18%) of you is carbon. Plants are about 45% carbon.

What happens to the carbon?

The carbon within living things is stored. As plants and animals die and decay, their bodies continue to contain carbon. For instance, as a tree grows, it stores carbon in its trunk, branches, and roots. When a tree is cut, the carbon continues to be stored in the wood products. When wood is burned, carbon is released into the atmosphere.

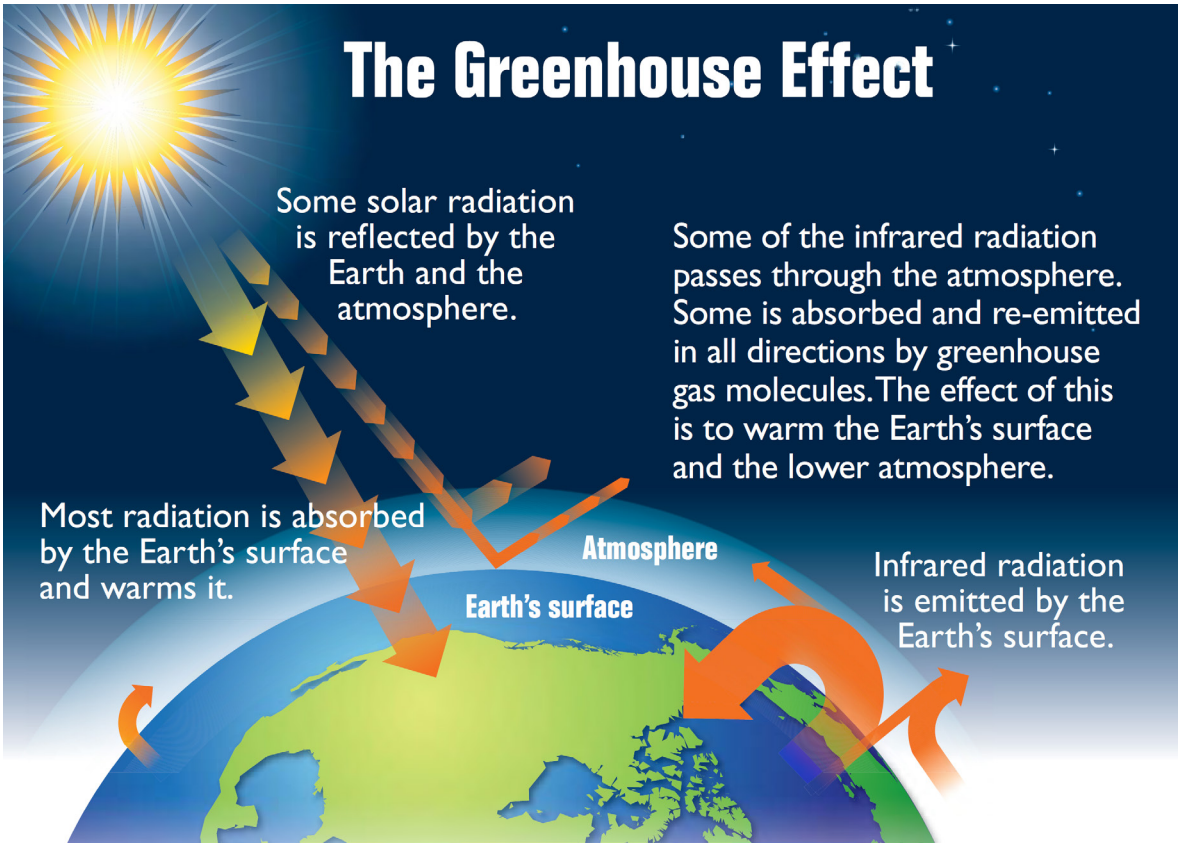
Plants and animals that lived millions of years ago contained carbon, too. Over time their bodies were buried by dirt and rocks. Mountains and new earth covered their bones. The intense heat within the earth and enormous pressure over them turned them into oil, natural gas, and coal. We use these ancient plants and animals today as fossil fuels. When we burn these carbon-rich materials in cars, trucks, planes, trains, power plants, and heaters, etc., the carbon is released back into the atmosphere as carbon particles, soot, and grease. Carbon is also released by natural processes like erupting volcanos and decomposition.

Is carbon a bad thing?

Carbon on its own is not very dangerous, since it is nontoxic and nonreactive. Some forms of it, however, such as carbon monoxide, can be harmful. Carbon dioxide is what is called a "greenhouse gas". Other greenhouse gases are water vapor, methane, ozone, CFCs, and nitrous oxide. Greenhouse gases in the atmosphere work to trap heat close to the earth, just like the glass walls of a greenhouse trap the sun's heat inside of it. This is a good thing because if all of the sun's heat leaked back into space, the earth and the oceans would turn into ice. Carbon dioxide is especially effective at holding in the sun's heat.

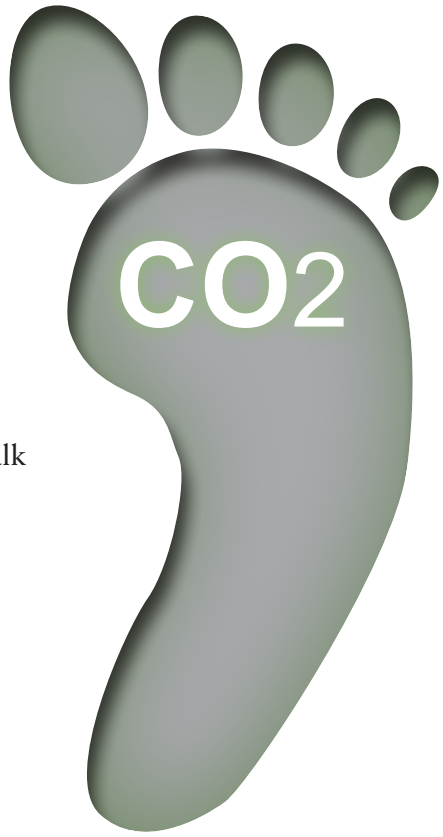
The Greenhouse Effect

The problem is that even a small increase in the amount of greenhouse gases can raise the temperature of the earth. Although there is a natural rise and fall in the earth's temperature, there is mounting evidence to suggest that humans have caused damage to the atmosphere through their increased use of fossil fuels and land clearance. This "greenhouse effect" can lead to climate changes, temperature extremes, higher sea levels due to melting polar ice caps and melting glaciers, changes in forest composition, and damage to coastal lands. It can affect people by increasing diseases related to temperatures, or from the effects of damaged land.



What is a Carbon Footprint?

A carbon footprint is the amount of carbon dioxide emitted by one person, organization, event, or product in a year due to its use of fossil fuels. Most carbon footprints for the average US household come from "indirect" sources such as fuel burned to produce goods far away from the final consumer.



The average US household carbon footprint is 48 tons per year. The single largest source of emissions is driving (or gasoline use).

Ways to reduce your carbon footprint:

- Reduce, Reuse, Recycle
- Drive less—consolidate errands, carpool, ride the bus, bicycle, or walk
- Turn off lights and unplug appliances when not in use
- Switch to a sustainable resource for home heating and energy
- Buy locally grown food as much as possible
- Cut down on the amount of meat you eat
- Insulate your house to reduce the amount of heat and air conditioning needed
- Set your thermostat lower

To figure out your family's carbon footprint go to: marioninstitute.org

Solar Energy

During the Homeschool Festival, you will get a unique chance to visit Biltmore's solar fields! Learn more about solar energy before you go.

Solar Cells

Photovoltaic (pronounced foe·toe·vol·tay·ik) comes from the words "photo," meaning light, and "voltaic," meaning electricity. A photovoltaic cell, commonly called a solar cell or PV, converts solar energy directly into electrical power. Most solar cells are made from silicon, which is a semiconductor. One cell produces 1 or 2 watts of electricity, a very low amount. To increase the power output, individual PV cells are grouped into modules, which are packaged into large panels, which can then be grouped into larger panels forming an array. Small cells are used to charge calculators and watches, large groups of cells can power single homes, and several acres of cells can provide the electricity for large power plants.

How Does it Work?

Sunlight is composed of photons that carry various amounts of energy. When the photons strike a surface, they may be reflected, go through it, or become absorbed. Only the absorbed photons provide energy to generate electricity. Photovoltaic cells are made with an anti-reflective coating which ensures that the photons will be absorbed (captured) within the semiconductor, and not reflected away.

Electricity is formed by the movement of electrons within the PV cells creating currents. By placing metal contacts on the top and bottom of a PV cell, that current can be drawn off to power an object. The current, together with the cell's voltage (which is a result of its built-in electric field), determines how much power, or wattage, a cell can produce.

The performance of a photovoltaic cell or group of cells is dependent upon sunlight. Clouds or fog can impact the amount of solar energy received by the cells. Right now, most solar panels do not produce a lot of power; they are able to use only about 10-15% of the sunlight that falls on them. Scientists are working on creating panels which will be more efficient at converting sunlight to electricity in the future.

Advantages of Solar Power

- There is no pollution from solar cells and very little environmental impact
- No fossil fuels are used so no carbon is released into the atmosphere
- Since the conversion from sunlight to electricity is direct, no mechanical generators are needed
- Sunlight is free and endless
- The energy can be stored in batteries for later use
- PV cells can be installed quickly and in any size
- They do not need maintenance

Disadvantages of Solar Power

- Solar collectors only work in the daytime
- Climate conditions can affect the amount of sunlight captured
- Solar cells are expensive
- Currently they do not produce a lot of power
- Small amounts of toxic waste materials are produced in the manufacturing of PV cells
- Large solar power plants can harm fragile ecosystems if not properly managed

Uses of Solar Power and Photovoltaic Cells

- To heat homes, greenhouses, and other buildings
- To heat water, which can be used in homes, buildings, and swimming pools
- To heat water for use as steam to power turbine engines
- To power electric fences and small appliances
- To run calculators, watches, street lights, cars, radios, telephones, and medical equipment
- To power satellites and space craft
- To run solar thermal power plants which produce electricity for cities
- To power cell phones in areas where there is no nearby electrical supply

Energy Consumption and Production

- The use of energy is measured in watts
- 1 Kilowatt = 1000 watts, 1 Megawatt = 1 million watts
- Different objects use different amounts of energy
- One photovoltaic cell produces 1 or 2 watts of electricity
- Power plants produce several million watts (or several Megawatts)
- Biltmore solar fields produce 1.7 Megawatts of electricity per hour
- Family houses use a few thousand watts (or a few Kilowatts)

your turn

Estimating Appliance and Home Energy Use

Are you curious to know how much energy your household appliances are using per year? Use this formula to find out the watts used and the cost to you.

FORMULA:

# of Watts per appliance x # of hours per day of use x # of days used, divided by 1000 watts x the cost charged by your local utility company per kWh (kilowatt)

EXAMPLE: Window Fan

200 Watts x 4 hours/day x 120 days/year divided by 1000 watts

=96 kilowatts x 11 cents per kWh = $10.56 per year that you pay to run your fan

EXAMPLE: Personal Computer and Monitor

120 watts + 150 Watts x 4 hours/day x 365 days/year divided by 1000 watts

= 394 KWh x 11 cents/kWh = $43.34 per year

YOUR TURN: Microwave oven

1100 watts x 2 hours per day x 365 days per year divided by 1000 = _____kilowatts

x 11 cents/kWh = $_____per year

YOUR TURN: 36" Television

133 watts x 5 hours per day x 365 days per year divided by 1000 = _____kilowatts

x 11 cents/kWh = $ _____per year

Use the wattages listed below to figure out how much each appliance is costing your family each year.

Common Household Appliances:

Washing machines use 2500 watts. How many Kilowatts is that? _____

Electric iron: 1000 watts
Light bulbs: 40-100 watts
Clock radio: 50 watts
Coffee pot (10 cup): 1200 watts
Blender: 300 watts
Toaster: 800-1500 watts
Toaster oven: 1200 watts

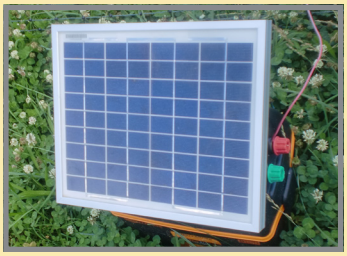
Check out **energy.gov** to find out the wattage of other appliances.
(Once you are on this site, click Energy and Appliances.)

Source: energy.gov

Biltmore's Solar Panels

- Biltmore has its own Solar Renewable Energy System.
- The electricity is pumped back onto the grid and offsets about 10–20% of the estate's energy use.
- We currently have 9 acres of solar panels on the northern edge of the estate.
- The total output of energy is 1.7 Mega watts per hour.
- There are 250 pods of solar panels. Each pod contains 28 individual panels.
- 1 pod generates enough electricity to light up 100 hundred-watt light bulbs.
- The pods are held onto the ground with a tree anchor called a platypus. The platypus is driven 8 feet into the ground. It can withstand winds of up to 120 miles per hour.
- Biltmore keeps a herd of sheep within its solar fields to keep the weeds and grass trimmed low.

Biltmore also uses solar energy to power electric fences around its livestock pastures. These solar collectors are small enough to be carried, allowing the animals and fences to be relocated to new areas as needed. The solar panel pictured at left provides electricity to the fence around the goat paddock. It has a 10-watt solar panel which can charge up to 60 acres, or 7 miles of multi-wire fence.



When the sun is shining, the solar panel charges the fence and a 12-volt battery which is used during the night and on cloudy days. When it is fully charged the battery can run for 72 hours. The electric fence produces 5000 volts of electricity, so it can also be used to fence horses and cattle.

1. Use the numbers above to figure out how many individual solar panels there are in 250 pods. _____
2. How many 100 watt light bulbs can Biltmore light up with 250 pods? _____
3. What important variable determines how successful a solar field will be? _____

_____

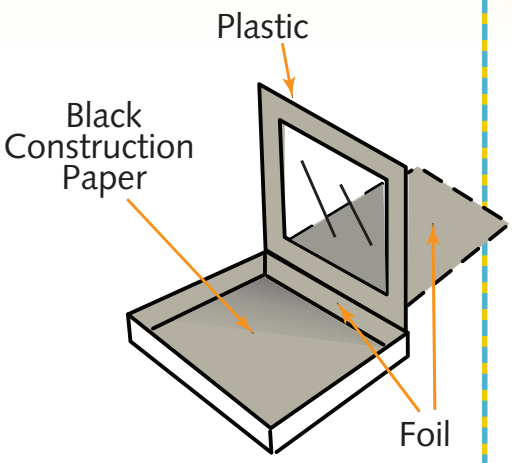
your turn

Build a Solar Oven at Home

Did you know that you can use the direct heat from the sun to cook? This is a great way to see the power of the sun at work! This activity works best on a sunny day so that your oven can get up to 200°.

Supplies:

- A clean pizza box. Recycle one from the next time you order pizza.
- Ruler
- Scissors
- Glue or tape
- Aluminum foil
- Plastic wrap
- Black construction paper



Steps:

1. Draw a border on the top of the pizza box, one inch from each side. Cut along the three sides that are not parallel to the seam of the box at the back.
2. Fold the cut piece gently back to create a flap.
3. Cut a piece of aluminum foil to fit on the inside of the flap. If it gets wrinkled, smooth it out before you glue or tape it into place.
4. Cut a piece of plastic to put over the opening in the box top; it should be a little bigger than the hole so that it can be attached to the cardboard around the hole. Glue or tape it over the hole. Try to stretch it tight and adhere it all the way around so that it is sealed and air can't escape.
5. Line the inner sides of the bottom of the box with aluminum foil.
6. Cover the bottom with black construction paper (or you can paint it black with acrylic paint).
7. Close the top of the box, leaving the flap open. Adjust the angle of the flap until the foil reflects the most sunlight through the window into the box. You can prop open the flap with the ruler you used earlier, a dowel, or a stick—just use what you have on hand.

Now try out your oven! Let it preheat in the sun for about 30 minutes before you use it. Be careful using it; it does get hot. You can heat up food that is already cooked—like pizza or hot dogs—or use it to melt things like cheese or chocolate. You can make solar s'mores!

This is a very basic solar oven that can be made with readily available and inexpensive materials. But if you find that you like it, you can look online for instructions to make a more efficient or more permanent one!