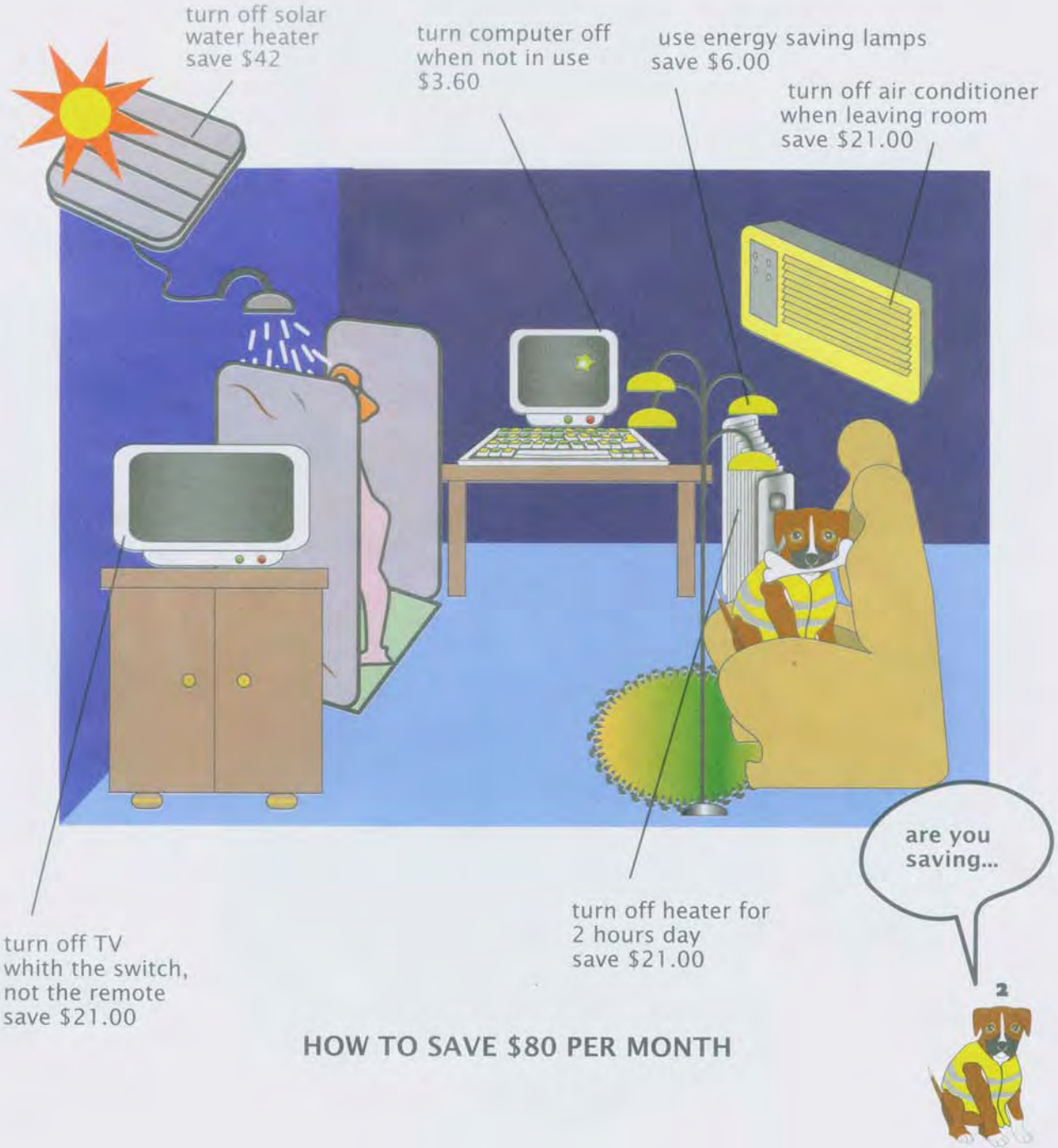
ENERGY book

INTRODUCTION

It is the year 2060 and you are walking home from school. Your teacher has just told you that from tomorrow the school will be closed, as there will be no heat or electricity in the building. The powerstation has closed down: there is no fuel to run the boilers which make steam to turn the turbines which produce electricity.
So no school till further notice; it seems like great news, but is it? There's a problem on the roads; you wanted to get a bus back home but the roads are empty, no buses, no cars: maybe because there is no gasoline.
When you get home, you find there is no light, no heat and dinner is being cooked on a fire in the garden. You want to phone your friends to ask if they have electricity and TV, but the phone doesn't work.
Obviously all your friends are in the same situation.
By now you are hungry, but there will only be a hot meal if you go looking for more firewood. There is no TV or computer so you pass the evening huddled round the fire with your family trying to keep warm. You all remember when you had as much electricity as you wanted.
How did this happen and what could you have done to prevent it?
Energy is an essential part of our lives today. Nearly everything that makes our lives comfortable, easier and enjoyable needs electricity, gas or gasoline. The sources of energy are varied but there are two main groups; non-renewable sources and renewable sources.
Non-renewable sources are coal, oil, natural gas and uranium (nuclear power). These sources are becoming more scarce and difficult to find, and therefore more expensive.
Transport and industrial products like plastics, steel and most other goods we know will cost more. It took 200 million years for the earth to produce oil and coal; it is estimated that within the next 50 years there will be none left.
Renewable sources are water, wind and the sun, they will always be available. These sources are already used to produce energy, but a great deal of research is underway as to how to harness energy from these sources on a much larger scale for the future.
In this book we will explain to you how energy is wasted and how to prevent it.
You will learn how to be "Energy Watch Dogs" and how to conserve energy.
We will explain some of the methods used to produce electricity today; these include wind power, solar energy, hydroelectric power, tidal waves, chemical reactions, geothermal and ocean thermal energy.

By Henry Bunzel / Edited by Alison Ginbar / Illustrations by Holger Rivadeneira

The energy console will show you how electricity can be produced with some of the renewable sources of energy: wind, solar energy, chemical reaction and by mechanical means.
Electricity, the energy we all know and use every day is one of several kinds of energy. Other forms of energy in everyday use are gasoline for cars and oil and gas for heating. Factories and industrial plants use enormous amounts of coal, oil and gas to produce plastics, steel and other metals.
How can we conserve energy? If everybody did just a little to save energy the total effect would make a great difference to energy supplies. We could walk more, ride bicycles, use public transport.
If this is impossible you could arrange that you take other children with you in the car to school. Turn off lights and heating when you are not in the house. Recycle plastic, paper, aluminum and glass.
You do not have to read the entire book; you can just work with the Energy Console; but in this day and age it is important to understand about energy, its sources and how to conserve it. We will explain how you and your family can save energy and reduce your electricity bills. You and your friends will become "Energy Watch Dogs".



HOW TO SAVE $80 PER MONTH

WHAT IS ENERGY?

Energy is one of the most fundamental elements of the universe.
Everything around us is a result of Energy in one way or another.
We could say energy is "the ability to work ".
Heating, lighting, and motion are all dependent on energy.

There are two types of Energy:
Moving Energy is called kinetic energy.
If you put a ball on a table and push it off, the ball uses kinetic energy.

Stored Energy is called potential energy.
When you pick up the ball from the floor and place it on the table you use your energy. Moving it up from the floor to a higher level adds energy to the ball; it now has potential energy.

Energy is measured in several ways, all rather difficult to understand.
One system is called BTU (British Thermal Unit).
One BTU is the amount of heat it takes to raise the temperature of water one
degree Fahrenheit. (0.555 degrees Centigrade)

For example it takes 2000 BTU to make a pot of coffee.

One piece of buttered bread contains about 315 BTU.
With this amount of energy you could:
Run for 6 minutes.
Cycle for 10 minutes
Light a 60 watt bulb for one and half hours.
Run a car for 7 seconds at 80 km /hour.

ENERGY - ELECTRICITY

Electricity is produced by several different sources of energy.

NON RENEWABLE SOURCES	RENEWABLE SOURCES
Coal	Hydroelectric
Oil	Wind
Nuclear	Solar
Gas	Biomass
	Geothermal
	Tidal
	Chemical reaction

The non renewable sources are used for creating steam, that drives turbines to turn generators, that produce electricity.

We will explain about the renewable sources in this book. The energy console will show you how electricity is produced by solar energy, wind energy and by chemical reactions. You will also produce electricity by mechanical means.

SOLAR ENERGY

For thousands of years people have worshiped the sun and created sun gods in honor of the sun's power. All of our energy comes indirectly from the sun and stars; without energy we could not exist on this planet. The sun gives us light and heat. Plants use its energy to make food, which in turn creates food for animals and humans. Even the coal and oil used to produce electricity is made of decaying plants and trees, which 300 millions years ago were swamps, which turned into peat, which then produced oil and gas. None of this could have happened without the sun. Even nuclear energy created by uranium atoms came from an exploding star.

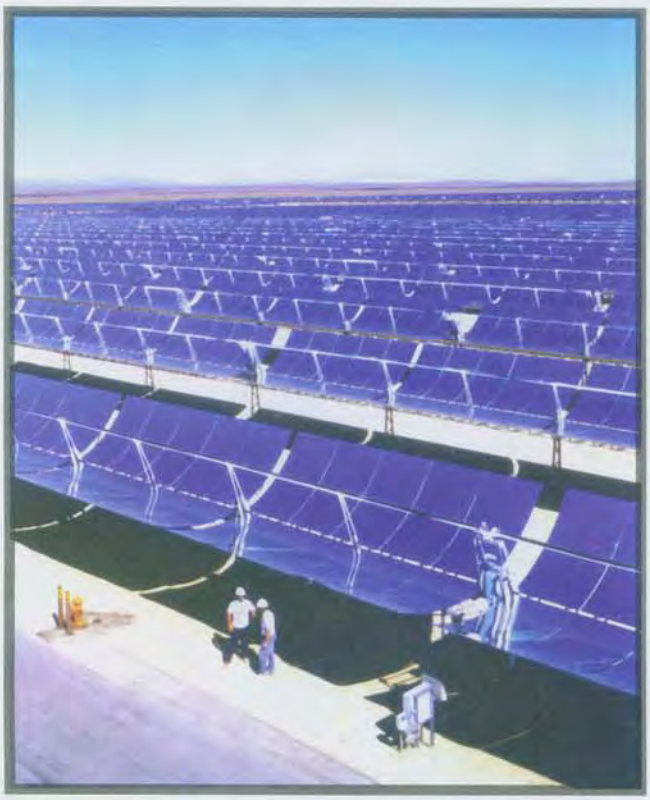
Solar Energy house

There are many ways Sun Energy is used to day; one of the best known are the Solar Water Heaters, first used 1890 by American settlers.To day millions of households get there hot water from solar panels usually placed on the roof. These panels are made of glass which covers copper tubes: the heat absorbed by the panels heats the copper, and the water in the tubes turns into hot water.

Another method of using the sun's energy is to place large mirrors in desert areas. The mirrors reflect the heat from the sun onto a central point. Tremendous heat is created that can turn water into steam which then turns turbines.
The same principle is used when you hold a magnifying glass to the sun.
You can concentrate a small point of sunlight onto paper or twigs to light a fire.

In the Energy Console we use a Solar Cell or a Photovoltaic Energy.
This was developed for the US space satellites, and is used to day in many small appliances like calculators, lights for road signs and other appliances that use small amounts of electricity. As there is only a limited amount of sunlight during the day, most of these appliances contain batteries which are charged by the solar cell for use when there is no sunlight.

Solar cells are made of two layers of silicone, which is melted sand.
Each layer is mixed with different chemical elements, so that one layer has an extra electron and the second layer has one electron missing.
Those of you that read about electrons and protons at the beginning of the book, will remember that electricity is produced when an electron moves to an element where an electron is missing.
When sunlight strikes the solar cell, electrons start to flow from one layer to the other. On both sides of the two layers of silicone there is a thin metal contact, one is "+" and the second is "-". When these two contacts are connected, electricity starts to flow, similar to the way a battery works.



World larges solar power facility California USA, capacity to power 150.000 homes

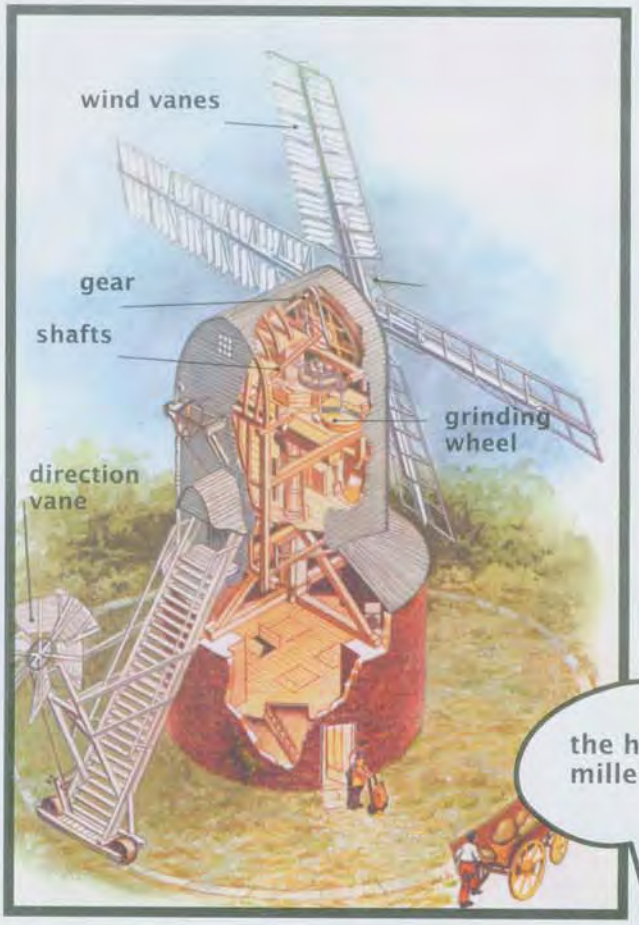
WIND ENERGY

Wind energy has been used for thousands of years. 5000 years ago the Egyptians used wind to sail their boats. Later the Persians built windmills to grind wheat. The Dutch improved on these simple windmills and use them to this very day to pump water and generate electricity.
Windmills for generating electricity were first used in the 1920's in remote areas of the USA, where there was no connection to an electricity supply.

The principle is very simple; wind is caught by the blades of the windmills which turn a shaft connected to gears that drive the generator.
From one large wind generator you can supply enough energy for 100 to 300 homes.The height and size of the blades and the strength of the wind determine how much electricity is generated. Nowadays, large numbers of wind generators are set up on high ground to catch the maximum amount of wind.
However electricity from these "wind farms" is connected to the main electricity network, so that on days when there is very little or no wind, electricity can be supplied by the main network.

The advantages are clear, electricity is produced by wind which is a renewable form of energy and it does not cost anything.
The disadvantage is that you must have an additional source of electricity when there is not enough wind. There is also a problem for migrating birds that may not see the blades turning and can be drawn into them by the strong currents of air, just like a large fan.

typical windmill still in use



one of the first windmills used in the 13th century

Wind Turbines

Wind Turbines at the Hutterite Colony USA

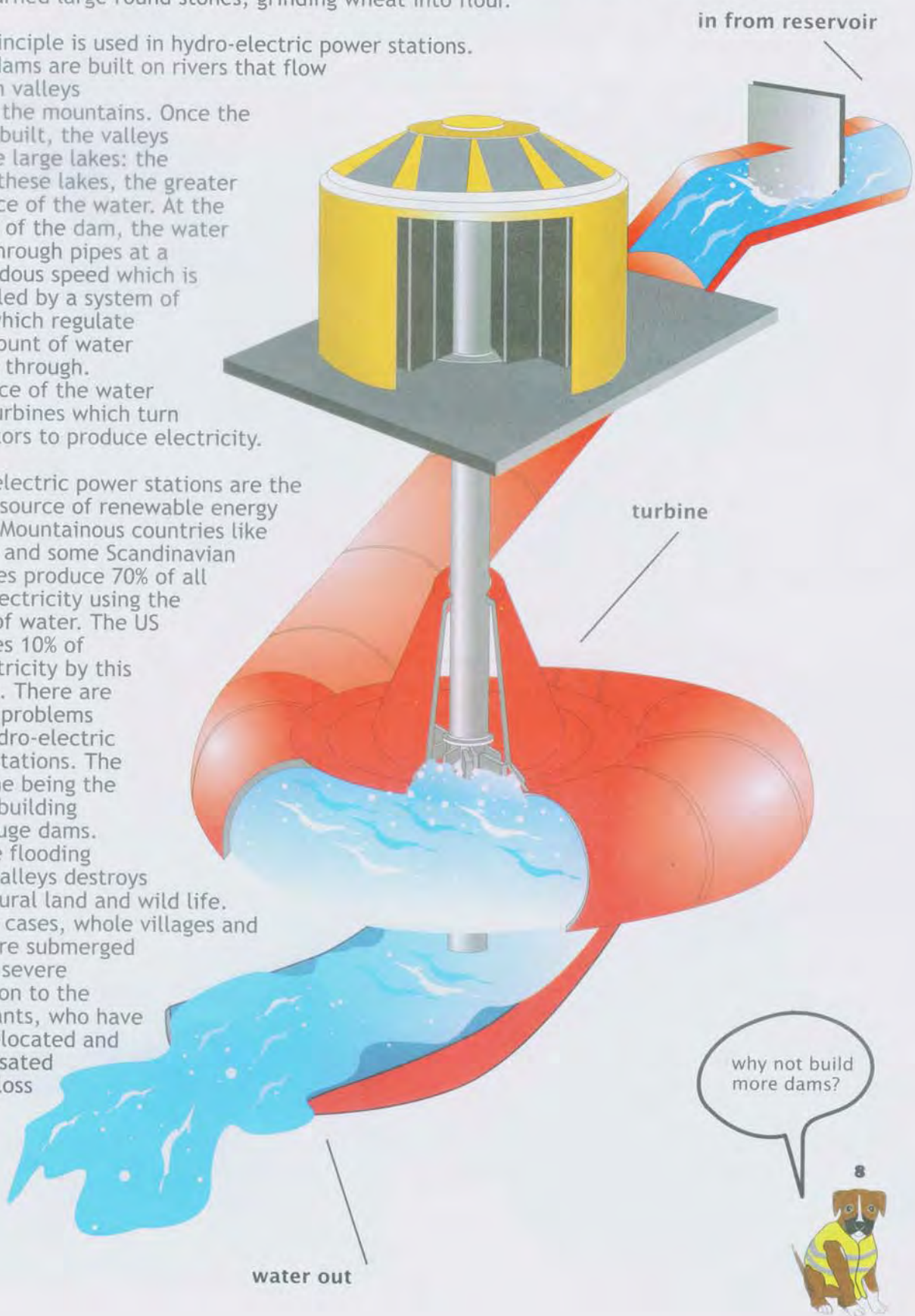
Image by National Renovable Energy laboratory

HYDRO-POWER

For hundreds of years, fast moving water has been used to turn wooden turbines to produce energy. In recent times these have been replaced by steel turbines. We have all seen pictures of water mills next to streams, where fast moving water was used to turn wooden wheels. These in turn were connected to gears that turned large round stones, grinding wheat into flour.

This principle is used in hydro-electric power stations. Large dams are built on rivers that flow through valleys high in the mountains. Once the dam is built, the valleys become large lakes: the higher these lakes, the greater the force of the water. At the bottom of the dam, the water flows through pipes at a tremendous speed which is controlled by a system of gates which regulate the amount of water flowing through. The force of the water turns turbines which turn generators to produce electricity.

Hydro-electric power stations are the largest source of renewable energy to day. Mountainous countries like Canada and some Scandinavian countries produce 70% of all their electricity using the power of water. The US produces 10% of its electricity by this method. There are several problems with hydro-electric power stations. The main one being the cost of building these huge dams. Also the flooding of the valleys destroys agricultural land and wild life. In some cases, whole villages and towns are submerged causing severe disruption to the inhabitants, who have to be relocated and compensated for the loss of their homes.



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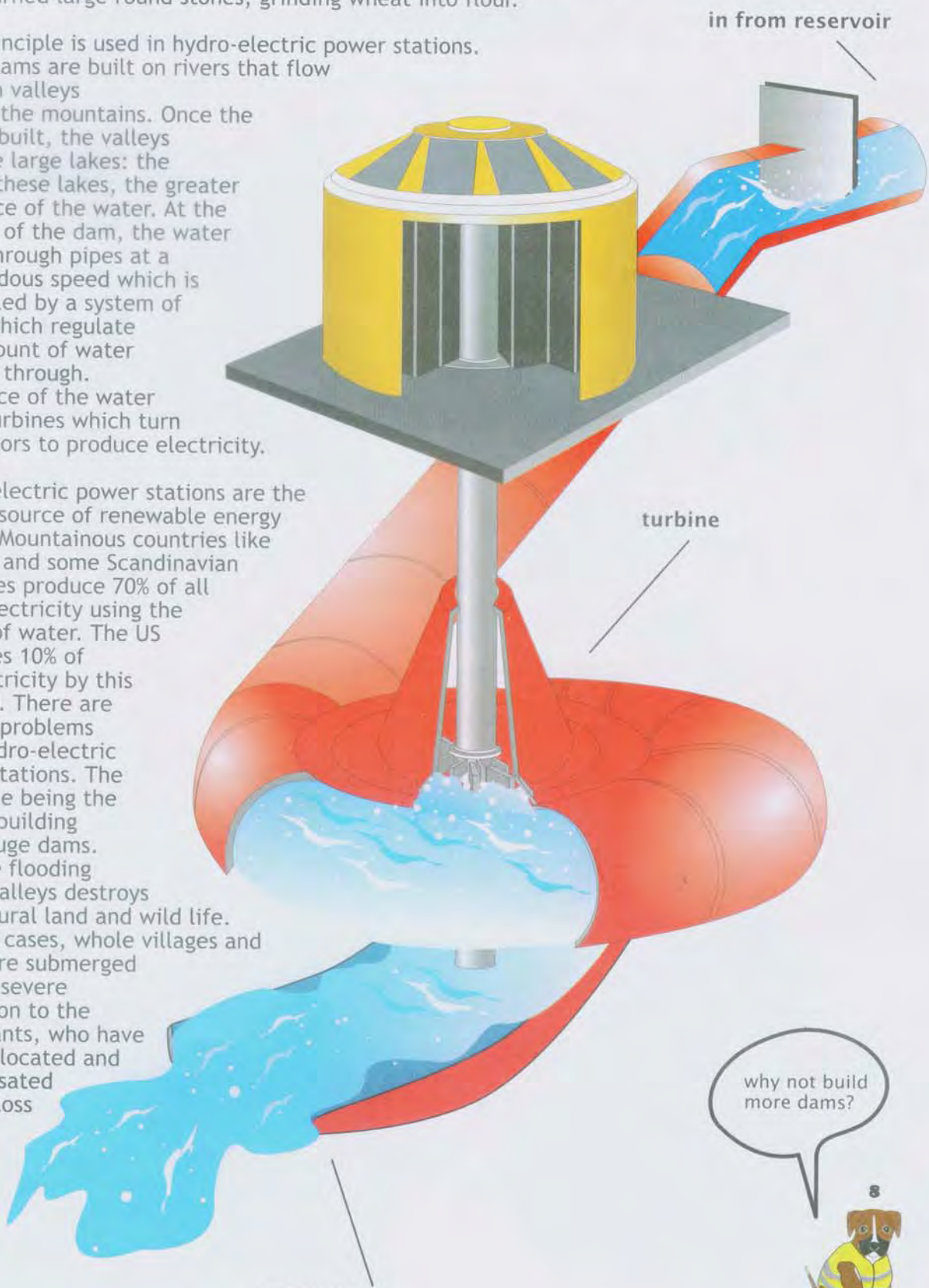
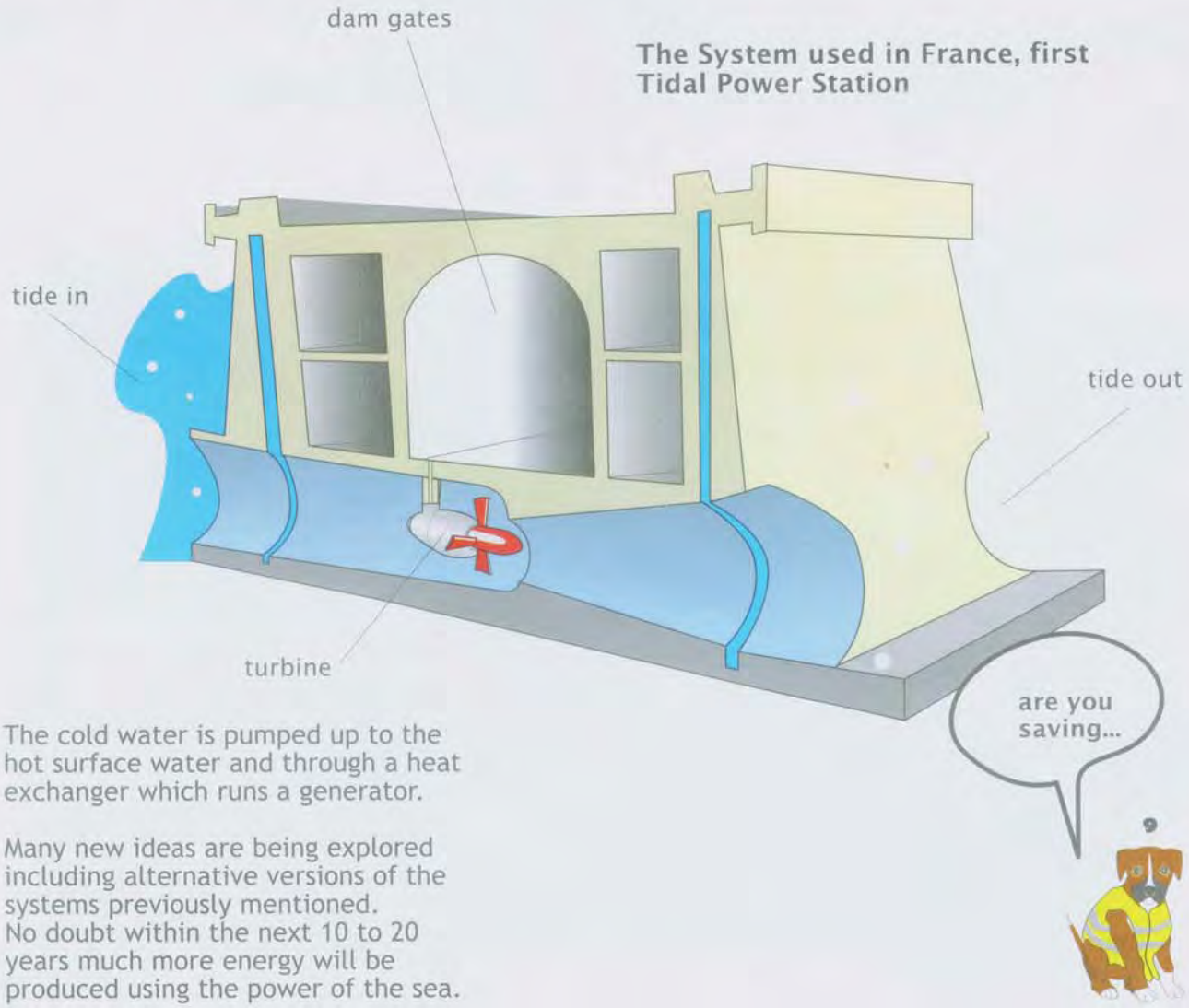


TIDAL POWER

Tidal power is one method of harnessing energy from the sea.
Tides from the oceans move huge amounts of water twice a day.
This energy supply is reliable and totally renewable; however it is not easy to convert it to electrical power.
It works very much like the Hydro-electric power station. Large dams called "barges "are built over the estuary of a river in locations where there are great differences between high and low tide: there must be at least a 5 meter (16ft) difference.

When the tide comes in from the ocean, the water is forced through tunnels in the barge causing the water to flow fast and with great force When the tide goes out the same thing happens.
The force produced by the sea water turns turbines and electricity is produced.
As of today the only place using this system commercially is on the River Rance estuary in France; it was built in 1966 and produces electricity for 100,000 homes.

Several other ideas on how to utilize the sea to produce electricity are in various stages of development.
Off shore tidal turbines are being built in some countries.
This is like an underwater wind farm except that the turbines are under the water and are driven by the sea.
Wave Energy, using the movement of the ocean waves is also being experimented with.
Ocean Thermal Energy Conversion; this can only be used in tropical regions where the surface of the water can reach 40 degrees Centigrade and the bottom of the ocean is at least 25 degrees colder. The difference in temperature can be used to produce energy.



The cold water is pumped up to the hot surface water and through a heat exchanger which runs a generator.

Many new ideas are being explored including alternative versions of the systems previously mentioned.
No doubt within the next 10 to 20 years much more energy will be produced using the power of the sea.

How is this waste turned into energy?
There are at least two methods used today. One process is to burn the waste material in special furnaces; the heat produced from them is used to produce hot water or steam. This can be used to generate electricity or for domestic heating purposes.

There is nothing new in this method; Biomass has been used for generations. Today in rural India, 90% of the population uses Biomass for heating and cooking .In the USA 3% of electricity is produced from Biomass.

The advantages in using Biomass are that it renewable, it helps to dispose of garbage and waste material and it does not add carbon dioxide to the atmosphere. It can be compressed into small cubes and used in the same way as coal. It can then be used in existing power stations without changing equipment.

The second method is to use Biomass to produce methane gas. This is a natural process occurring when waste material decomposes.
Some countries grow special crops to ferment and produce ethanol as an alternative fuel for cars and industry.

Aerial photo of the Grayling generation station- Biomass plant.

Image by National Renovable Energy laboratory

GEOTHERMAL ENERGY

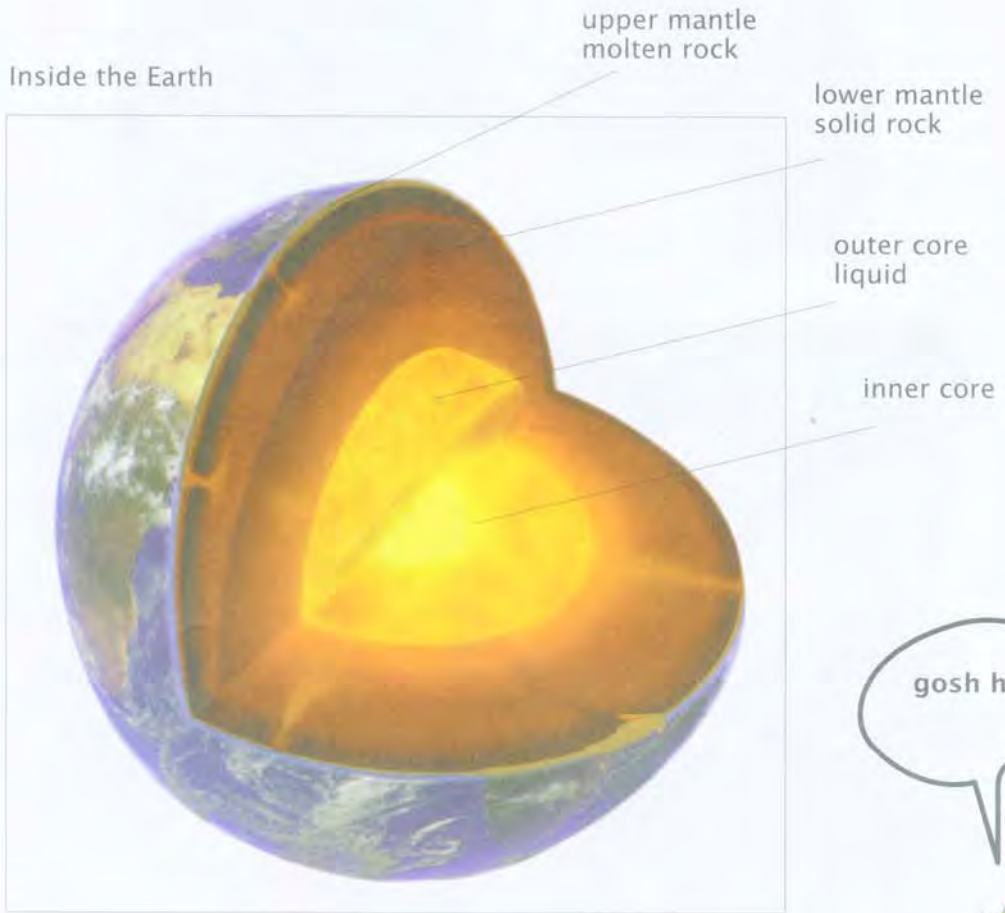
The name Geothermal is from Greek - "Heat from the Earth".
From the earliest times people have used geothermal water that flowed freely from the earth's surface as hot springs. The Romans used these hot springs for relaxation and health cures, and also for heating their houses. Hot Springs are still used today for various health cures.

Geothermal energy is used to day in many countries. The most advanced country is Iceland, where there is a large concentration of hot springs. Most of Iceland's electricity is produced by the geothermal energy from the springs.

Where does geothermal energy come from? The center of the earth is called the earth's core. This is 4000 miles down from the surface of the earth where temperatures reach over 9000 degrees Fahrenheit. (5000 C).
This heat continuously flows outward to the surrounding rocks, called the mantle. As the pressure builds up, some of the rocks melt and become Magma, which being lighter than the rock, rises to the Earth's crust carrying the heat with it. Sometimes this crust erupts as a volcano and then we call it Lava.

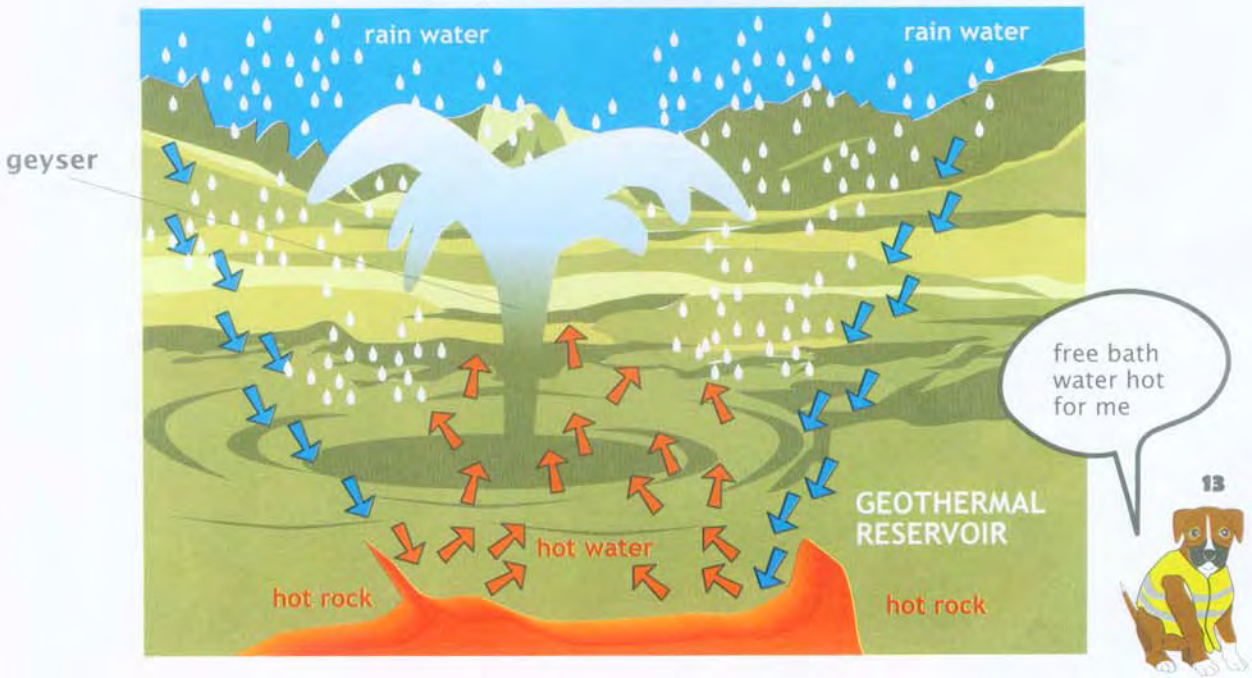
However, most of the Magma remains under the earth's crust. The temperature can be as high as 700 degrees Fahrenheit (380 C). Rain water that penetrated the earth's crust becomes hot water or steam and. some of this seeps up through the Earth's crust and becomes a hot spring or geyser.

From this it is easy to understand how this heat and hot water can be turned into energy such as electricity, heating for houses, and industrial purposes. It is renewable and is a very inexpensive alternative to fossil fuels.



Castle Geyser Yellostone Park USA

Image by National Renovable Energy laboratory



ELECTRICITY

In this kit we deal with Electrical Energy: the console in your kit is for experimenting with Electricity.
All of us use electricity, at home and in school. Look around you: nearly everything you see uses electricity directly or from batteries.
Much of what you see around you has been manufactured using electricity.

So what is Electricity?
It is very difficult to explain the flow of electricity, as it can't be seen except in very severe circumstances, such as lightning or sparks from static electricity.
Electricity is very often explained by using water as an example.
The electron is the smallest known particle in the world. When an electron moves, it is Electricity! We call the flow of electrons "Current".
We have all heard the word "Voltage"; this is what pushes the electrons to flow and creates useful current and electricity.
Just like water, electrons (current) will not flow down a wire (pipe) from which they cannot return. That is why the current needs to be in a loop or "circuit" in order to make it flow and conduct electricity.
Electricity flows from a source, such as a generator or battery and can power an appliance, like a light bulb or a radio. The electricity flows and loses the energy needed to power the appliance; it continues to flow and always returns back to its source.

If there is a break in the circuit, this is an open circuit and the electricity does not flow. This is different to water because when a pipe breaks the water runs out of the pipe.

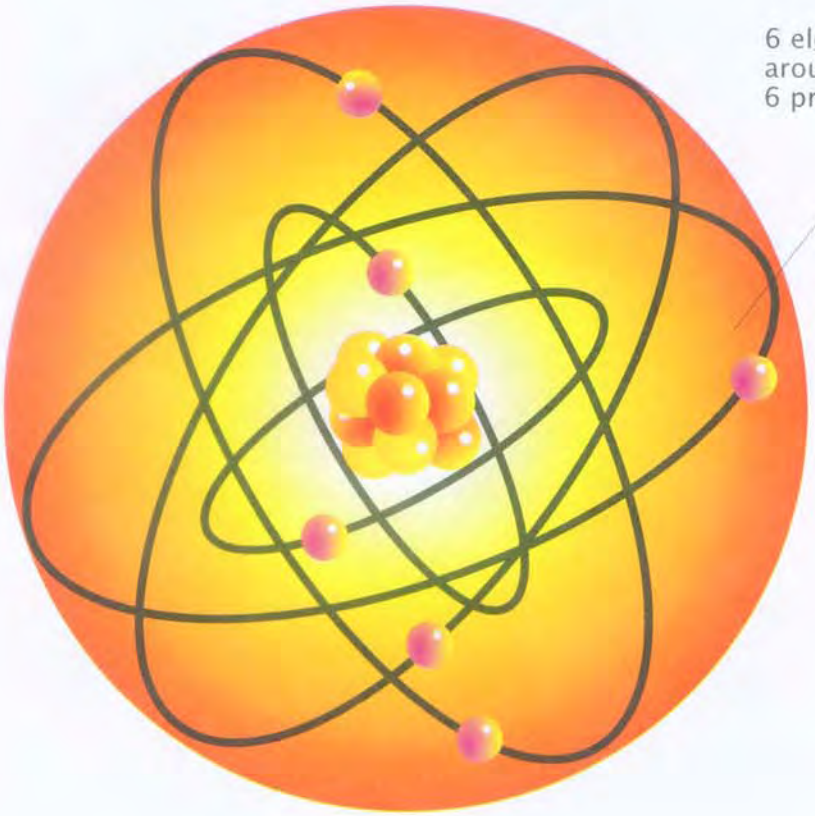
·Voltage causes current (electrons) to flow in a circuit.
·Pressure causes water to flow in a pipe.
·A battery or a generator produces voltage to cause current (electrons) to flow.
·A pump generates pressure to cause water to flow.

This section is very difficult as most people have a problem understanding electricity. You may want to skip this part or talk to your teacher later.
However, other explanations in the book about various forms of energy are interesting and will add to your general knowledge.

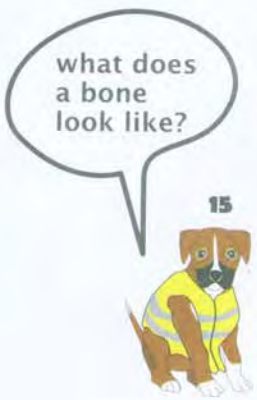
All matter is made of atoms and each atom is made of smaller particles.
The main particles are protons, neutrons and electrons.
The center of the atom (nucleus) consists of protons and neutrons.
The electrons spin around the nucleus, the same as the moon spins round the sun.

Electrons have a negative charge.
Protons have a positive charge.
Neutrons have no charge.

Carbon atom



Each atom has a specific number of electrons, protons and neutrons. No matter how many particles the atom has, the number of protons and electrons is usually the same.
Some atoms have loosely attached electrons.
If the atom loses an electron then the atom has more protons and becomes positively charged.
An atom that gains an electron, has more electrons than protons and becomes negatively charged.
Electrons can be made to move from one atom to another. The movement of the electrons creates an electrical current. The electrons move from one atom to another: one electron is attached and another electron lost...
All elements are made of different atoms, which each have a specific number of electrons, protons and neutrons. Some have more, some have less; this determines how the electrons move from one atom to the other.
In some materials the flow of electrons is easy; these are called "conductors'.
Other materials do not allow a flow of electrons; these are called "insulators.



FUEL CELLS AND CHEMICAL REACTION

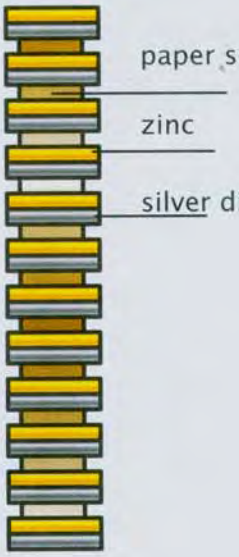
We are all familiar with a battery, which produces electricity by chemical reaction.
A battery consists of three basic parts: a Carbon electrode in a Zinc case filled with a electrolyte, usually ammonium chloride paste. There are many types of batteries, the main difference being which type of electrolyte is used.

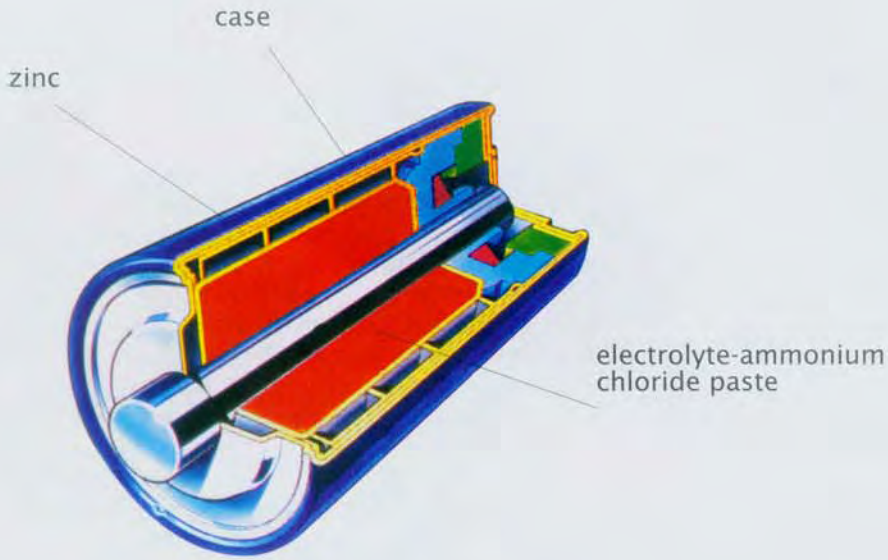
The first Battery was made 1800 by Alessandro Volta. He took pieces of zinc, silver and paper soaked in salt water and placed one on top of the other in several layers. He called this a voltaic pile and so created the first battery.

So how does a battery work? Batteries work by making electricity from a chemical reaction, but first you need to know what a battery is made of.
A battery consists of three basic parts: an Anode, a Cathode and a electrolyte. The material used for the Anodes and Cathodes vary, but the most commonly used are Zinc, Carbon, Alumminum, Copper or Brass. Each of these materials has a different electrical potential. The electrolyte conducts the electricity and can be acid, alkaline or neutral. Standard carbon batteries such as the AA, C and D batteries, have electrodes of Zinc and carbon with an acidic paste between them as the electrolyte.
Alkaline batteries such as Duracell have zinc and manganese oxide electrodes with an alkaline electrolyte.

In your console you have four cells which work with zinc and brass electrodes.
You can use water as an electrolyte, but you can also use soap, lemon, coke, ketchup, and many other things even tooth paste. In the cell, two chemical reactions take place at the same time. At the Anode (-), the chemical reaction causes a depletion of electrons. This leaves the Anode with a net negative electrical charge, and the Cathode (+) with a net positive electrical charge. When the cell is connected to an electrical circuit, (light, heat, etc), the ecess electrons flow from the Anode (-) through the circuit back to the Cathode (+). As the electrons flow through the circuit, they lose energy. It is the energy that operates your transistor radio etc. The flow of electrons is called "current" and the energy that the electrons lose is called "voltage". Eventually the zinc rod will be eaten away, or the electrolyte will cease to function. To replenish your battery you may have to replace the zinc electrodes or refresh the electrolyte.

original Volta's battery



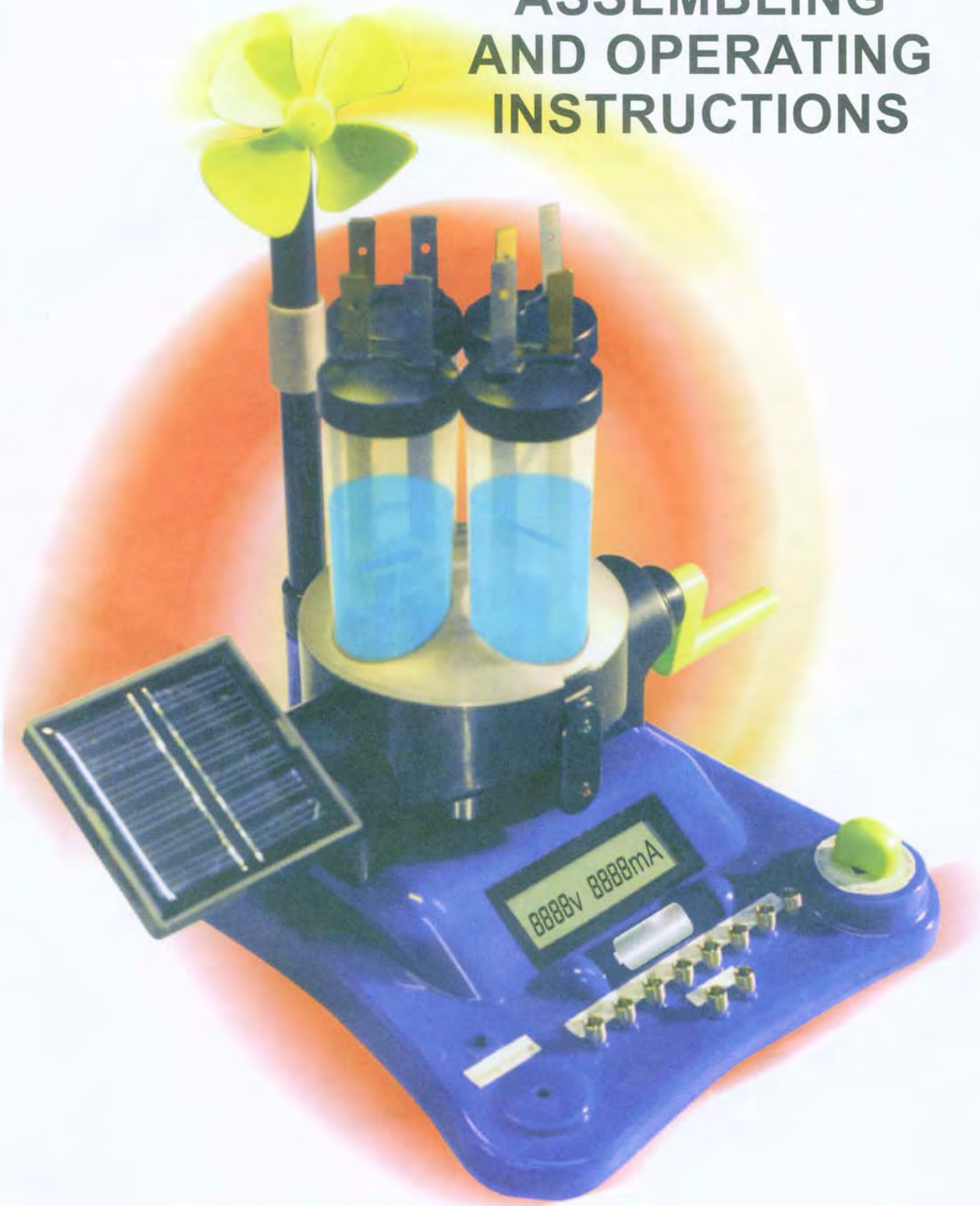


REGULAR DRY CELL BATTERY

As the world's supplies of oil deplete, scientist are trying to find a cheaper and cleaner way to run motorcars, one of the main user of fuel derived from oil.
One of the ideas is to make a fuel cell (like a battery). The fuel cell would convert oxygen and hydrogen to water and in the process produce electricity to run an electric car. The main problem that still need to be solved is to fin a way to supply hydrogen as it cannot be piped to the gas station, and it is very difficult to store. Efforts are being made to find an easy way to produce hydrogen.
The oxygen would be no problem as it could be pumped from the air into the cell.
There are many versions of fuel cells in development and in the near future this problem should be solved so that we can all benefit from cleaner and cheaper fuel.

Average energy cost	Watts/hr	Average use per day hr	Per month hrs	Kwh/mnth	cost /kwh	total in $			
Lamp 60w	60	8	240	14	0.1	1.44			
Energy saving lamp 60w	18	8	240	4	0.1	0.43			
Refregerator	500	12	360	180	0.1	18.00			
Chandalier 5 lamps 60w	300	8	240	72	0.1	7.20			
Chandalier 5 lamps 18w	90	8	240	22	0.1	2.16			
TV	180	18	540	97	0.1	9.72			
Sterreo	30	5	150	5	0.1	0.45			
Computer	200	12	360	72	0.1	7.20			
Microwave oven	960	1.5	45	43	0.1	4.32			
Water Heater	3500	6	180	630	0.1	63.00			
Air Conditioner	3500	6	180	630	0.1	63.00			
Ceiling Fan	60	6	180	11	0.1	1.08			
Electric heater	1000	3	90	90	0.1	9.00			
					total month	184.84			
How to save cos							saving $		
TV	180	12	360	65	0.1	6.48	3.24	Switching off by switch	
Computer	200	6	180	36	0.1	3.6	3.60	Switching off by switch	
Air Conditioner	3500	4	120	420	0.1	42	21.00	Using 2 hrs less per day	
Electric heater	1000	4	120	120	0.1	12	6.00	Using 2 hrs less per day	
Chandalier 5 lamps 18w	90	8	240	22	0.1	2.16	5.04		
Solar water heater	3500	2	60	210	0.1	21	42.00		
							80.88	Total saving per month	
							970.56	Total per year	
	How can you work out the cost of using one 100watt lamp for 8 hours								
	100 watts	x 8 hours =	800 watts	electricity is sold in units of 1000 watts = 1 k/w hour					
	Average price is .10 cents per k/w hour.								
	Therefore	800 watts =	0.8 kwh	cost 8cents					

ASSEMBLING AND OPERATING INSTRUCTIONS



Assembling the Console.

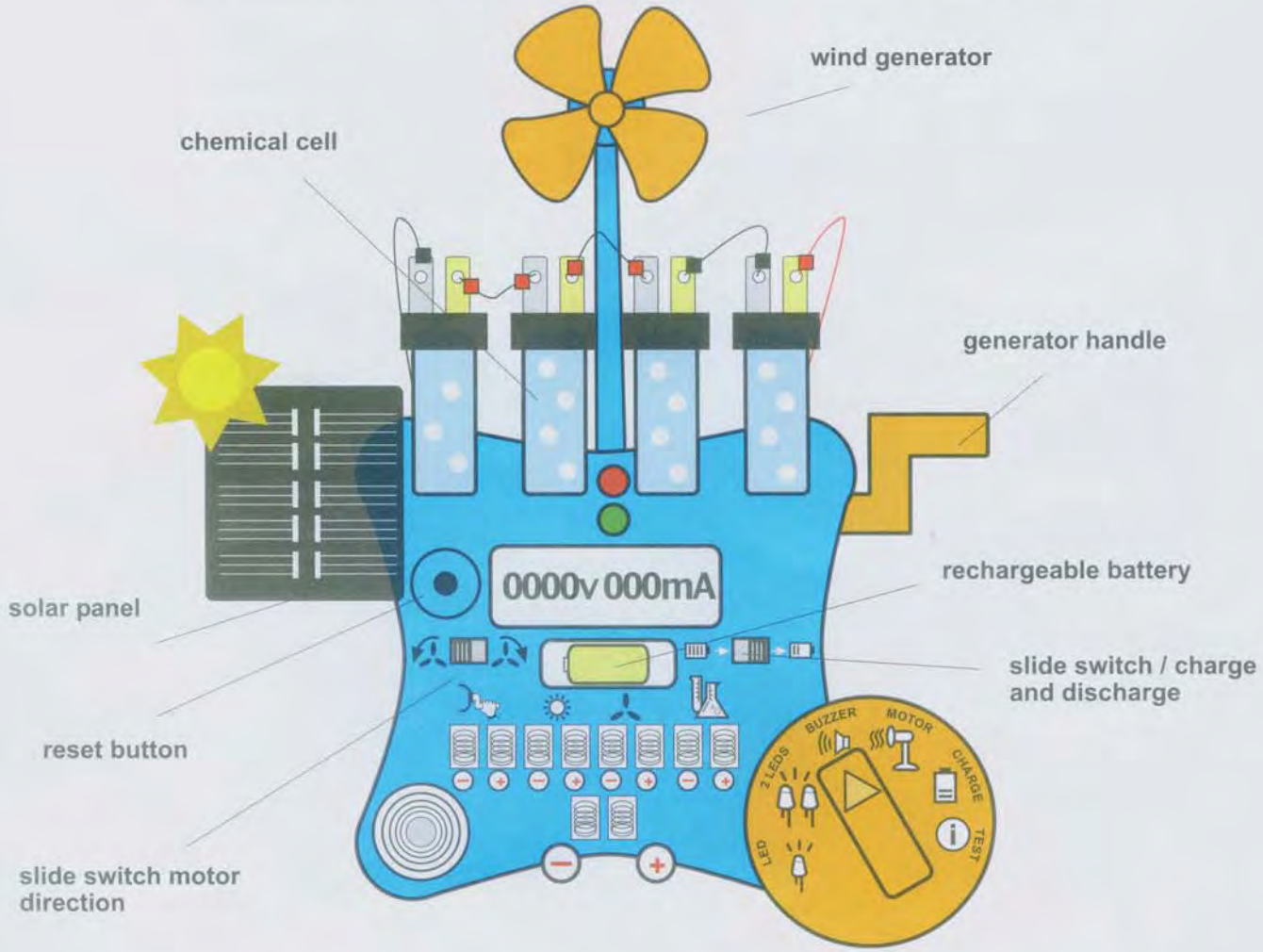
1. Insert 2 x 1.5 Volt AA batteries in the battery compartment at the bottom of the console.
The batteries are ONLY for operating the volt meter.
2. Attach the Generator handle to the base at the right hand side of the console.
3. Plug the Solar Panel carefully into the left hand side of the console.
4. Plug the Wind Generator into the back of the console.
5. Prepare the Chemical Cells and insert them according to the instructions in the section dealing with Chemical Cells.

Operating the Energy Console

To start you need to press the Reset button.
As long as the console is in use and the current is flowing, the volt meter will function. When no current flows and the volt meter reads 0000 it will shut down after 60 seconds
To wake the volt meter press reset.

WARNING

Do not connect any current to the Console.
The volt meter can measure a maximum of 9 volts DC only.
Do not fill the Chemical Cells while they are in the console.
When finished or changing the liquid in the cells dispose of the liquid in the toilet.



THE CONSOLE

The console has five different sources of energy.
1. Hand dynamo (generator)
2. Chemical Cells
3. Wind generator
4. Solar cell
5. Rechargable battery

Each of these can be activated separately. With the energy produced it is possible to measure the amount of voltage produced with a voltmeter. You can light one or two Leds, operate a buzzer, turn a motor, and charge a battery.

The volt meter can be used to measure voltage in batteries up to 9volts.
DO NOT CONNECT ANY OTHER SCOURSE OF ELECTRICTY TO THE CONSOLE!!!!

1. Dynamo. Generates electricity by turning the dynamo (by hand).
With the electricity produced you can operate:
Voltmeter
Light one or two Leds.
Motor (Fan)
Buzzer.
Charge the battery.

2. Chemical Cells can produce a limited amount of electricity.
With the electricity produced you can operate:
Voltmeter.
One Led
Buzzer.

3. Wind Generator. With the electricity produced, depending on the strength of the wind, you can operate:
Voltmeter
One Led
Buzzer
Charge the battery

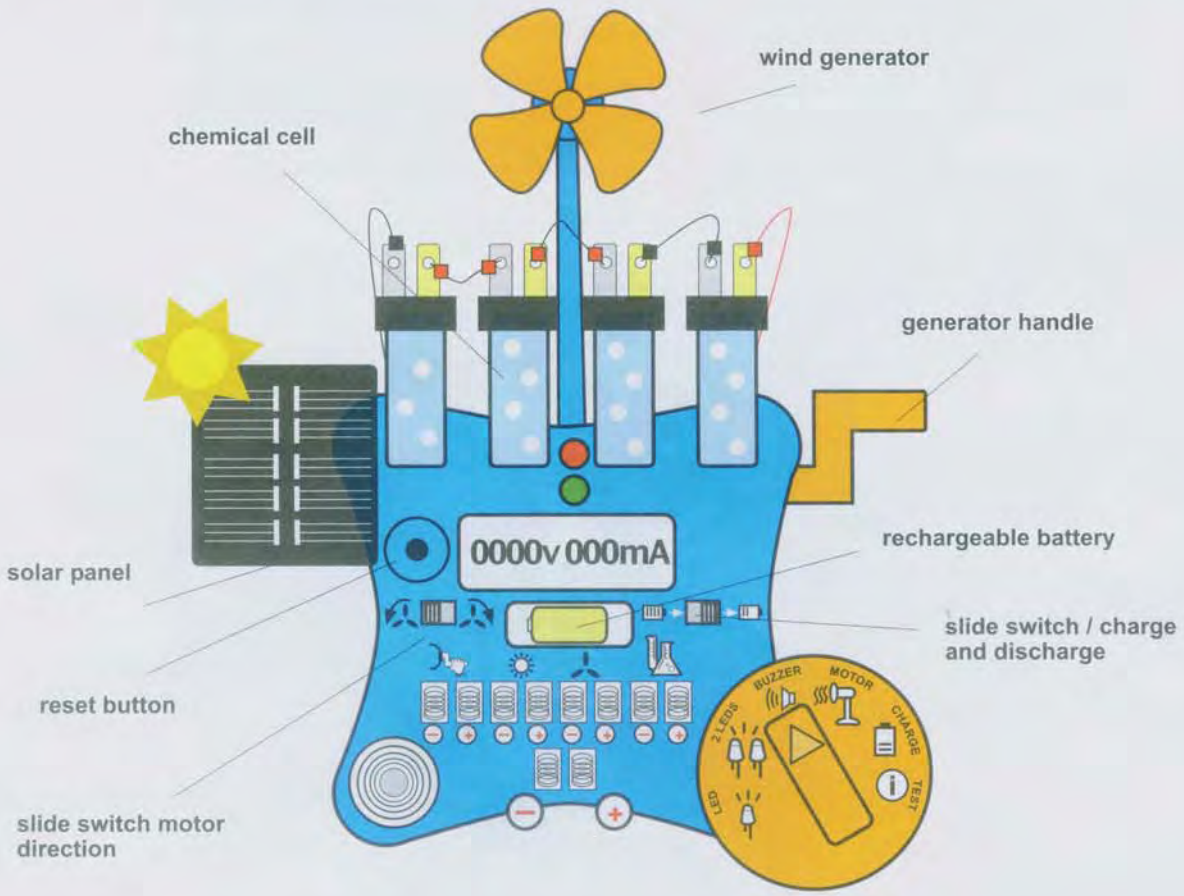
4. Solar Cell will produce electricity depending on how much light hits the cell; sun light is by far the best. A 60 watt lamp placed 30 cm from the cell will produce enough electricity to run:
Voltmeter
One or two Leds
Buzzer
Motor (fan)
Charge battery

5. Rechargeable battery 2.4 volt.
After it has been charged, the rechargeable battery can operate:
Voltmeter
Motor (Fan) in both directions for up to 15 minutes.
One or two Leds.
Buzzer

On the console there are two switches, one on the left and one on the right. These need to be switched over to change the functions of the motor and the rechargeable battery.

Left switch: this is used for the Motor Direction only. In one position - anti clock wise it turns the motor into a fan to cool. In the other position it turns the motor clock wise.

Right switch: in one position you charge the battery, in the other position you discharge the battery by using it to operate all the different functions.

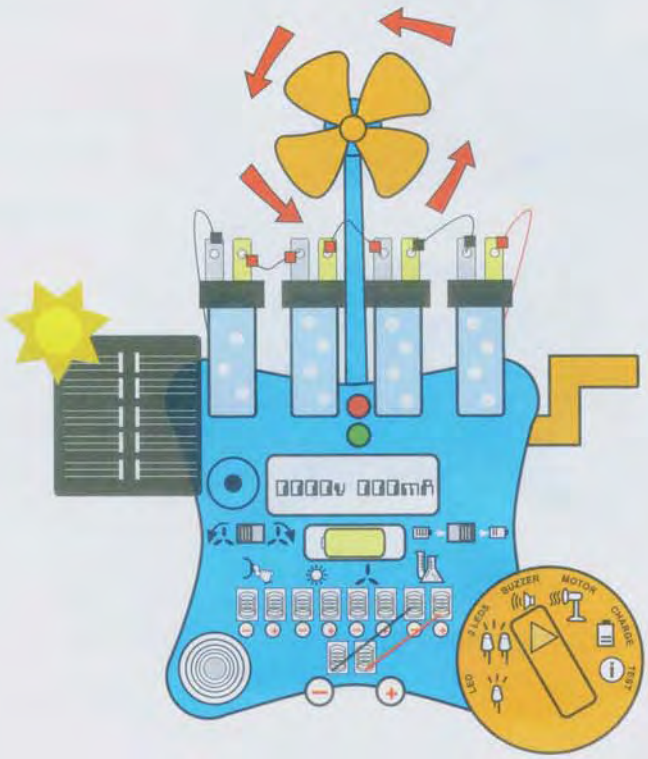


NEVER FILL THE CELLS WHILE IN THE CONSOLE

Chemical Cells (Batteries) - Assembly

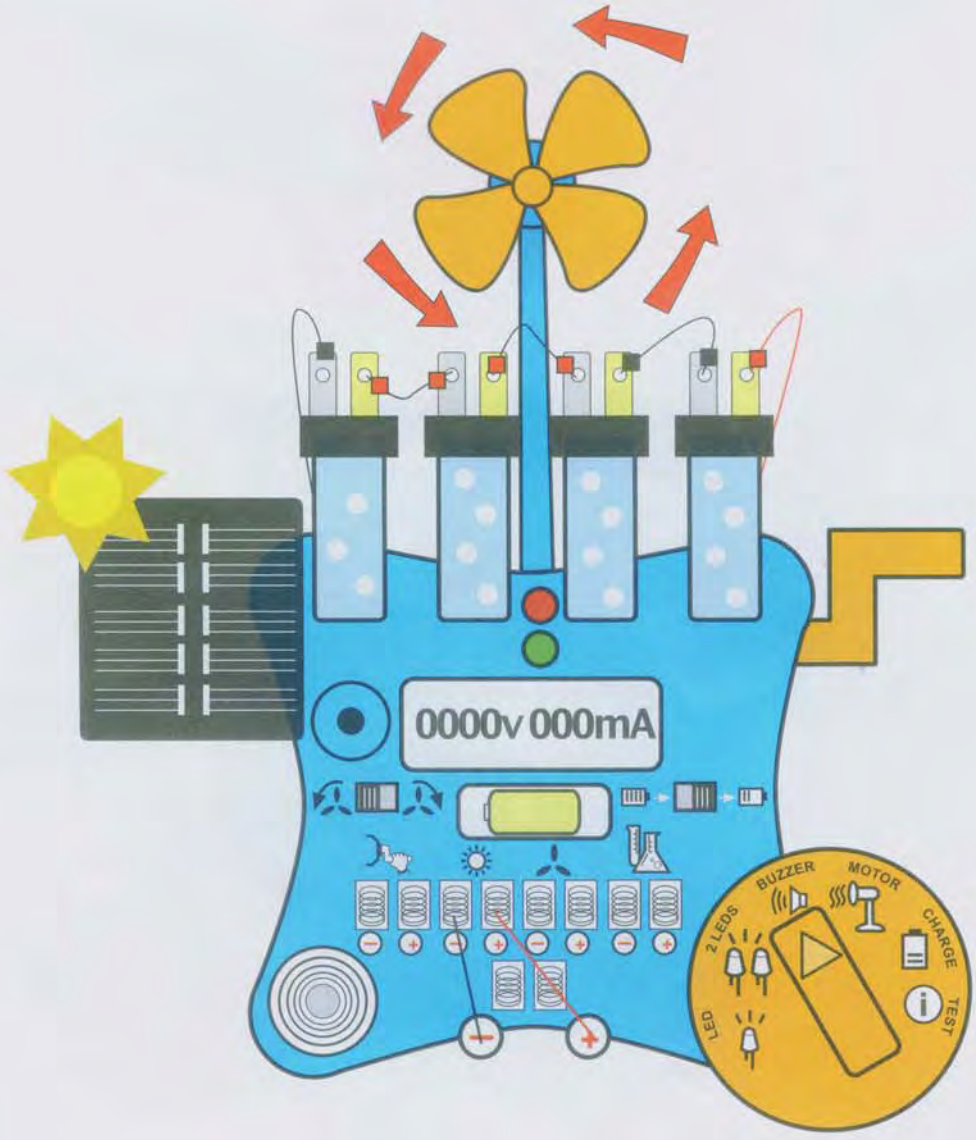
Take the 4 tubes and rinse them out with water.
Sort out the electrodes; you will need one Brass (yellow) electrode and one Zinc (silver) electrode for each cell.
Push one brass and one zinc electrode into each cap and separate the electrodes with the separator in the middle of each cell.
Fill each cell with water and insert the electrodes into the water and close the cell with the top.
You now have 4 cells, each one is like a battery. Each cell produces approximately 0.7 volts; you can check this with your volt meter. To make a battery that will give 3.0 volts you must connect them in series,
This is done by connecting the brass electrode in the first cell to the zinc electrode in the second cell.
Now connect the brass electrode in the second cell to the zinc electrode in the third cell.
Continue connecting in this fashion: when you finish you will have one brass and one zinc electrode free.
The brass electrode is the + and the zinc is the -, check this with your volt meter.
To connect these cells to the console connect the + and the – to the 2 terminals at the back of the console. Make sure the wires are not obstructing the fan behind the cells.
Turn the rotor switch to test and see how much electricity you are producing.
Try lighting one Led and then two Leds, now try the buzzer.
With the cells it is not possible to run the motor or charge the battery as the output in voltage may be enough but the current is too low: it is approximately 1mA whereas the other sources on the console are between 10 to 300mA

However it is worth while making a chart to see which materials produce the most electricity Try using coke, lemon juice, vinegar, ketchup, toothpaste, all of these will produce different amounts of electricity.
The Leds will be brighter and the buzzer makes a stronger noise.



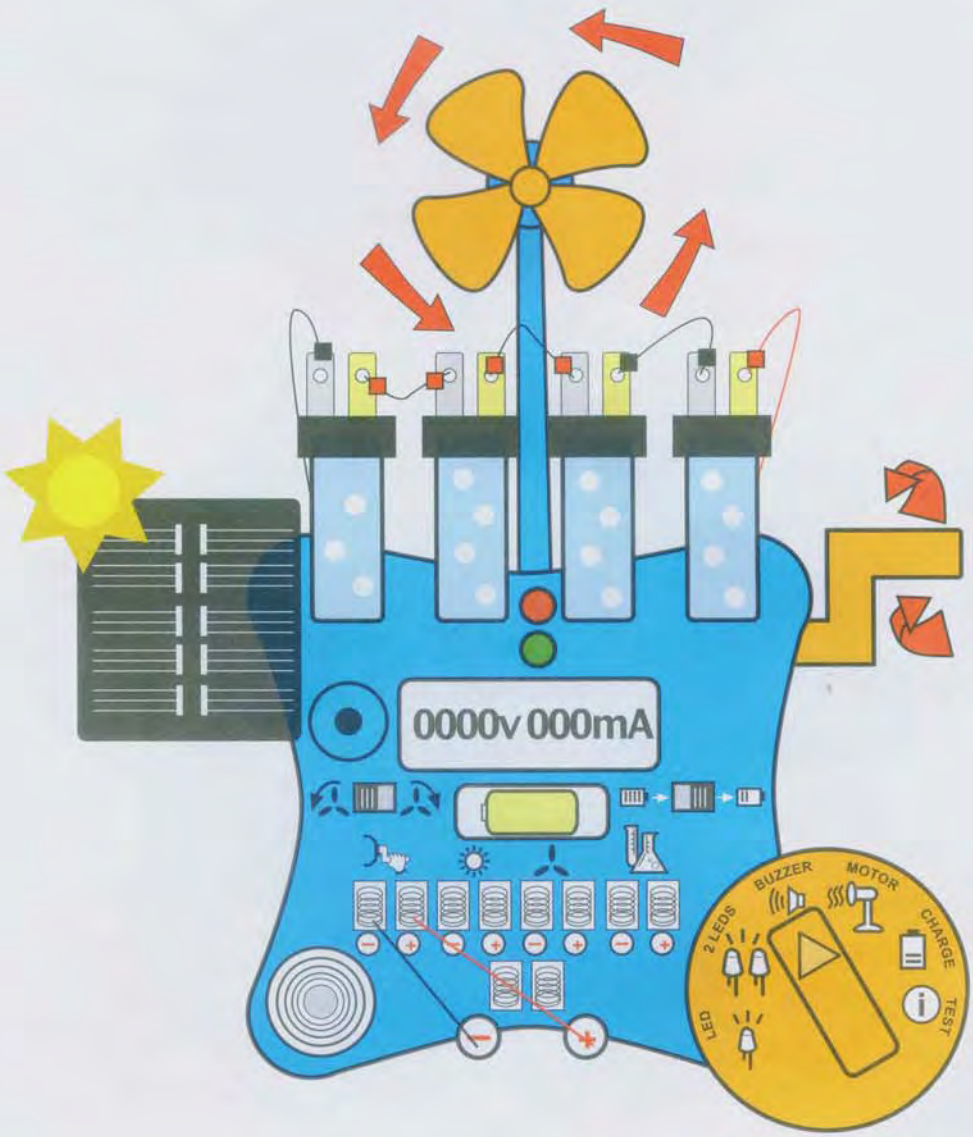
Solar Power

Produce electricity by solar power. The best results are in strong sun light.
Using a 60 watt bulb 30 cm from the cell will also produce enough electricity to run the fan.
To make the fan blow air it needs to turn anti clock wise (to the left). You can change the direction of the motor by moving the slide switch.
It is important that the angle of the solar cell is in a position to catch most of the light, you can check this by looking at the voltmeter and choosing the best angle for maximum voltage. You may need to help the motor to start, by flicking one of the fan blades anti clockwise (to the left). You can also give it a start by moving the slide switch to "discharge battery" for a second; it will start the fan and after wards it will run only on the solar cell power. The solar cell does not work with fluorescent lighting.
Turn to "test" to see which light gives the most voltage.
Try the buzzer, a red Led, two Leds and the motor (Fan).
To charge the battery with the solar cell, make sure that the rotor switch is on "Charge" and that the slide switch on the right is on" Charge" (to the right) It will take between 20 to 140 minutes to charge the battery.



Dynamo

Turn the handle in any direction to generate electricity.
Turn the rotor switch towards "test" to see how much electricity you generate.
Turn switch to Leds, buzzer and motor to see how they function. You can run the motor in both directions using the slide switch or by turning the dynamo handle in the other direction.
To charge the battery turn the rotor switch on to "charge" and the slide switch to "charge".
It will take 12 to 30 minutes to charge the battery.
If you have a flash light bulb you can connect that to the +/- terminal; turn the switch to "test" and turn the handle. The faster you turn, the brighter the light.
You will notice that it is much harder to turn the handle when ever you are using electricity to operate something like the motor or charging etc.

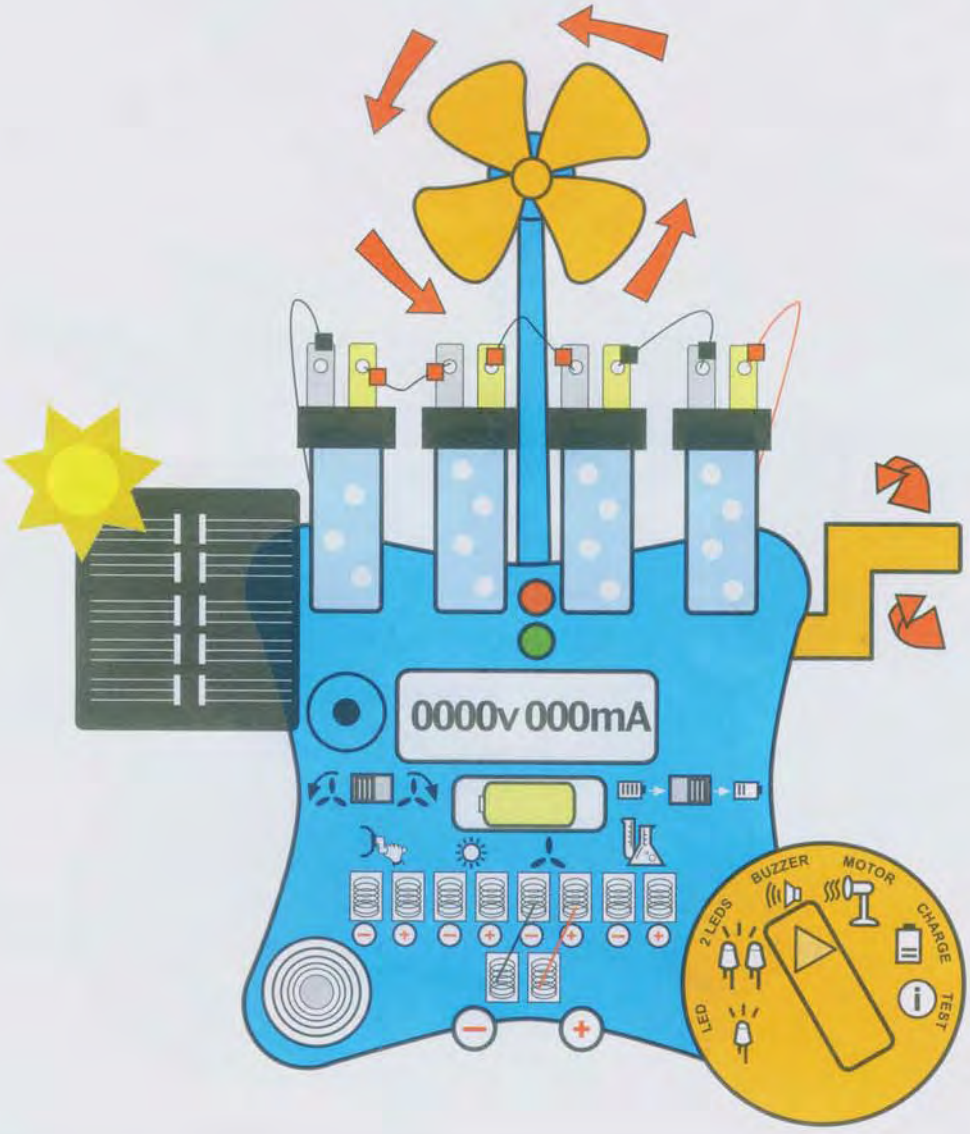


Wind Generator

To produce electricity with the wind generator you must first make sure the left slide switch is to the right.
For the wind generator to work the motor must turn anti clock wise.

Give the fan a flick with your finger to help start it. You can blow on the fan or try it outside when windy or place it close to an electric fan. Turn the switch to "test" and you will see how the wind determines the amount of electricity produced. Try one Led and two Leds, also the buzzer.
You can charge your battery with the wind generator. Turn the rotor switch on to "charge" and the slide switch on to "charge" (to the right)

However it will take a long time and very strong wind to charge the battery.



Rechargeable Battery

The rechargeable battery stores the energy (electricity) produced on your console. To use the stored electricity in your battery, slide the switch to "discharge". To test the amount of electricity you have stored move the rotor switch to"test". To operate the Leds, motor and buzzer turn the rotor switch to the chosen function. Remember that the battery has only a limited amount of energy; if you run your motor for 15 minutes you will use up all of the stored energy and you will need to recharge and this takes time.
When using the battery you can turn the fan in both directions by moving the slide switch to fan or wind generator. You do not need to connect wires.