The Story of Energy @ Tiny Hands

FOREWORD

Energy is the driving force of life. Planet Earth is enriched with different energy sources; be it renewable energy sources such as solar, hydro and wind or non-renewable sources such as coal and petroleum. We rely on one or all of them for the purpose of automobiles, electricity, and day-to-day chores. However, the rapidly growing population and rising per capita use of energy result in over exploitation of energy sources and result towards environmental pollution.

Considering the challenges related to energy resources, it is high time to take steps to save energy through education, training and awareness creation. Digital learning is one among the development strategies for energy conservation and resource efficiency, crossing the barriers of state or national borders. Since children will have to face the repercussions of energy exploitation, creating awareness among them is very important and this is the beginning of this manual creation process.

The booklet aims to impart the knowledge of fundamentals of energy, sources, and everyday energy conservation methods to school children.

ABOUT THIS MANUAL

The manual is created as part of the Public Private Partnership project called ENACT funded by DEG and PHOCOS further implemented by ASSIST and Pondicherry University. It introduces the basic concepts of energy conservation, types of energy and energy efficient technologies to school children in a child-friendly manner. As the booklet consists of both information and activity-based instructions, teachers are encouraged to use it as a toolkit for classroom activities to match with the curriculum and their interests.

Note to Teachers/instructors: Chapter 1 to 3 offers an array of basic information on energy, energy efficiency and renewable energies. Teachers and instructors may add complementary materials related to specific topics and are encouraged to engage in discussions with their students after each chapter to ensure optimal understanding and learning. The multiple choice quiz is suggested to be conducted afterwards to ensure understanding of the content from Chapter 1 to 3. Chapter 3 can also be concluded with the survey from Annex 5. This will provide students with the possibility to assess and apply the concepts of energy saving to their own everyday life. The projects and activities from Annex 2 to 4 should be conducted with the guidance from the teacher/instructor as seen fit for the respective context.

Our sincere appreciation to Plan International for formulating this idea along with ASSIST Asia on creating awareness among children, who will be tackling the energy challenges in the future.

PHOCOS and ASSIST wish you an engaging and informative experience with this manual. The overall design has been chosen carefully to match the needs and preferences of children and to make it more than just another lesson on renewable energy and energy efficiency.

DEG a member of the KFW Bankengruppe (KFW banking group), finances investments of private companies in developing and transition countries. As one of Europe's largest development finance institutions, it promotes private business structures to contribute to sustainable economic growth and improved living condition.

Asia Society for Social Improvement and Sustainable Transformation (ASSIST) is an international non-government organization focused on capacity building. It seeks to promote sustainable practices to address social problems in the developing world, with focus on Asia and Africa.

Phocos, Phocos India Solar Pvt. Ltd. (Phocos), a subsidiary of the German Phocos AG in Ulm, World's leading manufacturers of solar-powered charge controllers and components for autonomous power supply.

Pondicherry University Pondicherry University, established under an Act of Parliament in the year 1985, has grown from strength to strength in all possible ways all these years and has become a place on the educational hub of the country. It has all the state-of-the-art facilities in all the Schools and Departments paving the way for the students to have a student-friendly, result-oriented academic environment with green ambience.

Hello! We're **Mr. and Mrs. Bright** and we're here today to talk to you about the amazing world of energy.

WHAT IS **ENERGY?**

Energy is the ability to do anything.

Everyone uses energy. We use energy every day, often without realising it. We use it when we get out of bed in the morning and turn on the light or cook breakfast. We use it when we take the bus and charge our mobile phones. But it is also energy that makes the trees grow, the birds fly and the fish swim. Energy literally makes the world move!

The most powerful source of energy is the sun. It provides Earth with energy for plants to grow and heat for animals and humans to survive.

When our body needs energy, we eat meat and vegetables grown under the Sun. Energy makes our lives safe and convenient. When we cook food and heat water, heat energy kills bacteria that could make us sick. We use electric energy to light our streets and houses to avoid any accidents in the dark that could endanger us.

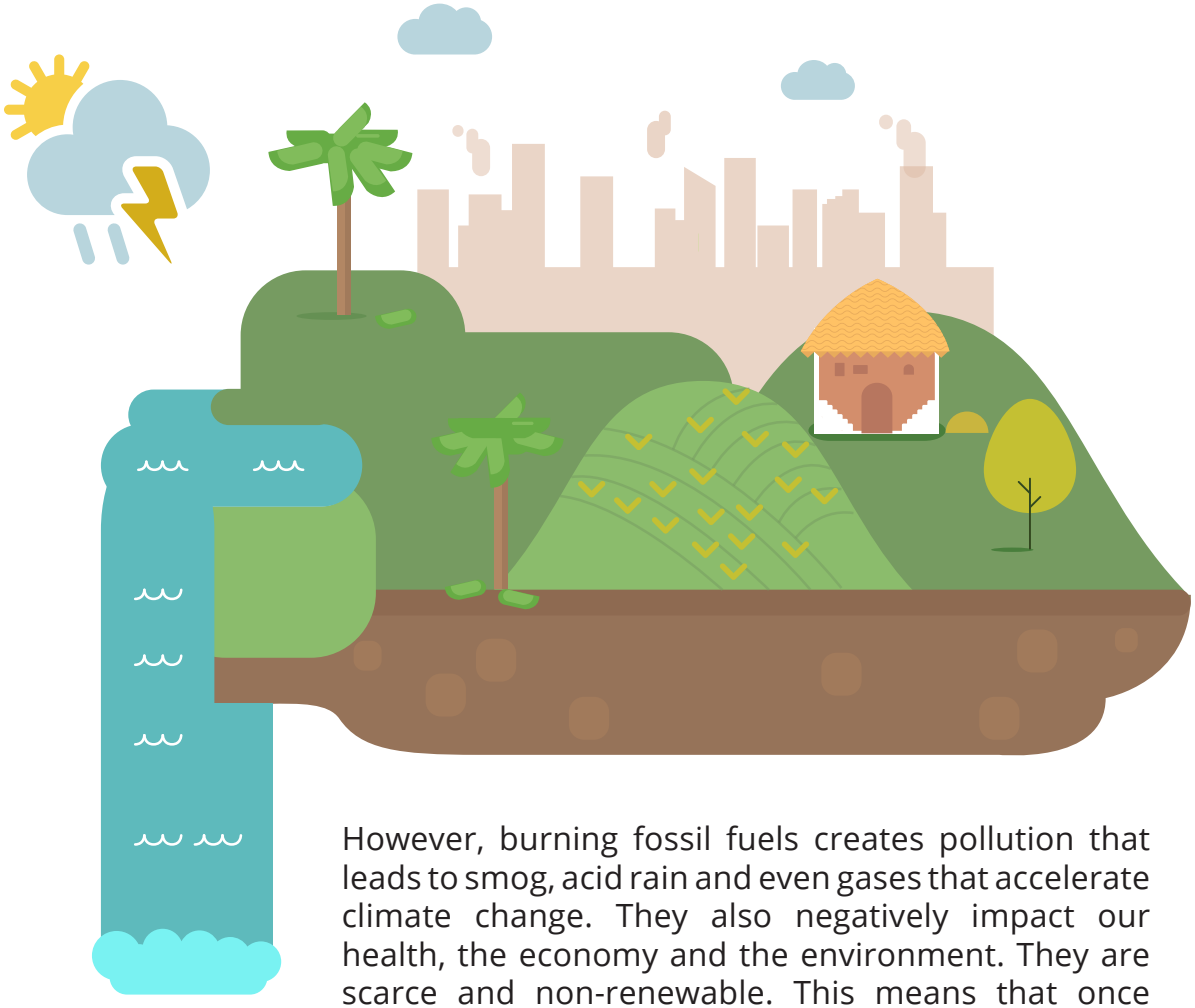
Did you know that we couldn't live without **ENERGY?**

But how was **ENERGY** discovered?

Energy has been used by humans for thousands of years in different ways, for example when the early humans needed to make fire to keep warm. Rubbing two wooded sticks together caused friction that created heat energy and led to fire. Using wood for building fires was our first major energy source.

Today, we get most of our energy from burning fossil fuels like coal, oil, uranium and natural gases. Most of these fossil fuels come from plants and animals that died millions of years ago when dinosaurs still roamed the earth. These materials composted over millions of years beneath the ground where they slowly became today´s fossil fuels.

Did you know that in the last 100 years, **1.6 trillion barrels of oil** have been used up? If we continue on our current consumption patterns, we will only have enough oil to last **40 years**.



Hmm.. so what kind of **energy** should we use?

However, burning fossil fuels creates pollution that leads to smog, acid rain and even gases that accelerate climate change. They also negatively impact our health, the economy and the environment. They are scarce and non-renewable. This means that once they are used up, they are gone forever. Our future generations can no longer use them.

We can use **RENEWABLE ENERGY!**

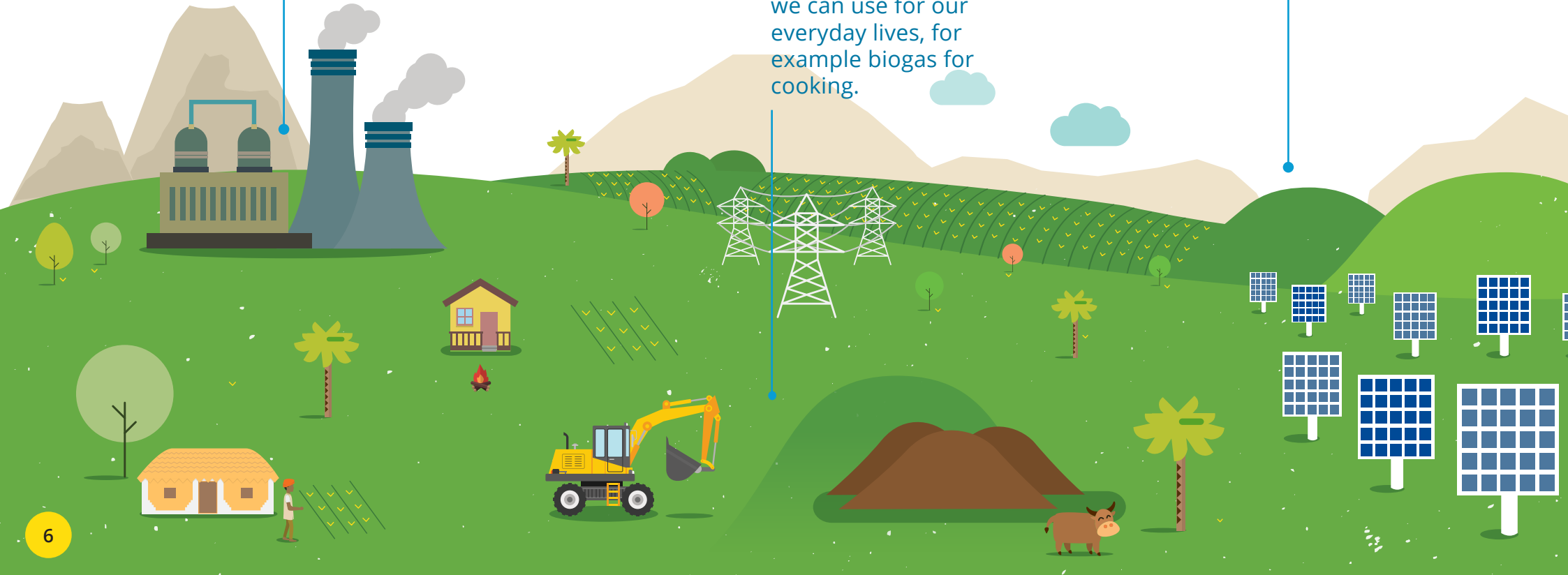
Renewable energy is energy that comes from sources that are replenished by nature such as sunlight, wind, hydropower, organic matter and the Earth's heat.

Renewable energy is also known as **cleaner energy** because no pollution is created when we use them. The type of renewable energy that can be used depends on location.

Geothermal energy uses the heat from under the ground and is commonly found in areas near a volcano.

Biomass energy can be used anywhere. When organic waste decomposes, it releases gases that can be captured to produce energy that we can use for our everyday lives, for example biogas for cooking.

A hot and sunny climate can use solar power.



Did you know know that the idea of using the Sun's power is not new? **Solar energy** was already used **2000 years ago** by the **ancient Chinese.** They lit fires using mirrors to concentrate the sun's energy.

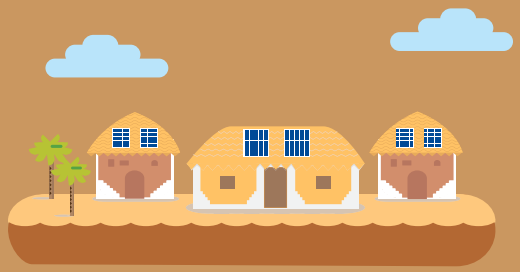
A place with strong and gusty winds can use wind energy.

Hydropower can be used if you live near a waterfall or a river.

Tidal and wave energy can be harnessed near a sea or ocean.

All these possibilities allow us to use more and more renewable energy. With your help we can use even more of it in the future by developing new and local technologies to make them cheaper to use!

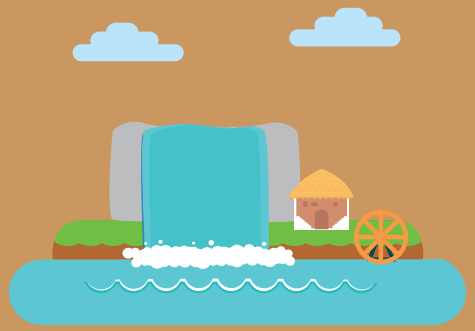
But for now, let's see how current **clean technologies** already work..



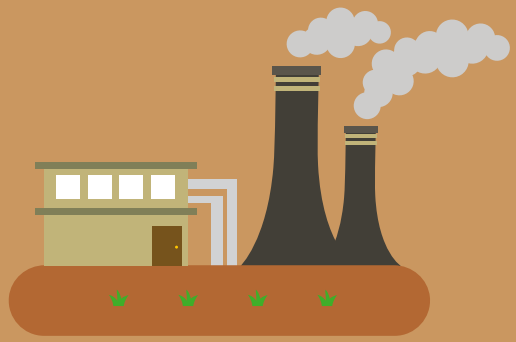
SOLAR POWER harnesses the energy of the sun with the help of solar panels that are installed on the roofs of houses and buildings. Solar energy can be used to heat up hot water for our baths and for electricity. It is also the cleanest and most abundant renewable source available.

WIND POWER is collected when wind pushes against the blades of wind turbines to make them spin around. When it is windy, the blades spin fast switching on a generator inside the turbine to create electricity.

Did you know that **75%** of the world's volcanoes are present around the Pacific Ocean called the **Ring of Fire**.

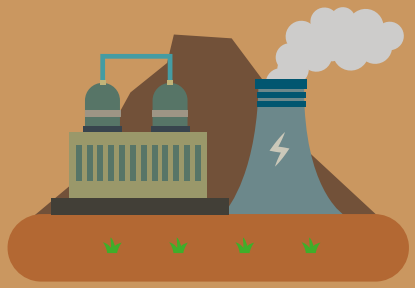


HYDROPOWER is created by the movement of water. Waterfalls and river currents create energy that can be converted into electricity for us to use. To harness the energy of the water, dams need to be built. A dam is a wall built at the end of a river to collect huge bodies of water needed to create manmade waterfalls and strong river currents. But also small rivers and currents can be used to generate electricity on a smaller scale. This is called micro or pico hydropower. Since the building of big dams often changes the flow of rivers and floods large areas, big hydropower projects can be problematic for people living in the areas it affects.



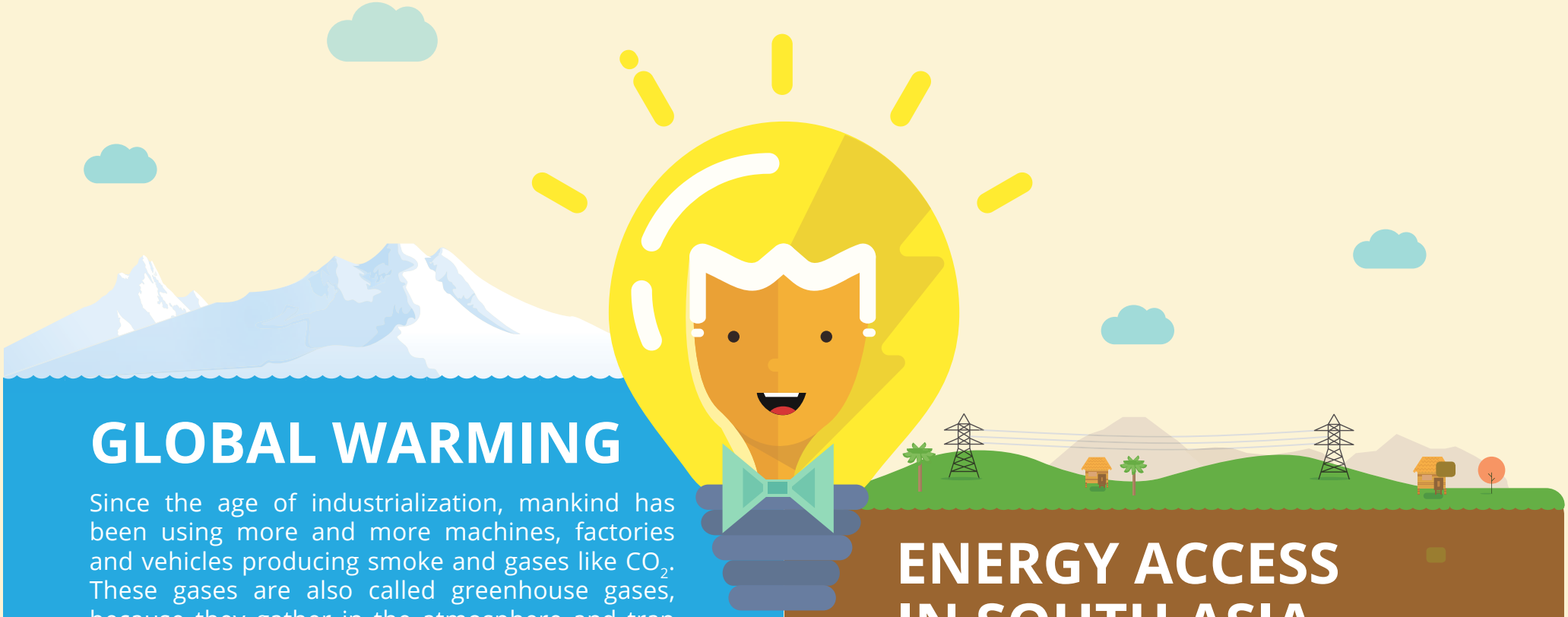
BIOMASS ENERGY can be harnessed from decomposing organic matter such as food waste. Landfills have plenty of decomposing organic matter that can be captured and turned into biofuels to be used for motor vehicles, cooking and electricity. Some rural areas also have animals and livestock that produce waste which can also be used to produce biogas. Some crops like sugarcane, corn or soybeans can be used to create Bioethanol when fermented under special conditions. Bioethanol can be used as fuel for cars or generators.

TIDES AND WAVES in the sea and ocean can be harnessed for energy. Turbines placed under the water spin around and switch on a generator to produce electricity when there are tidal current and waves present.



GEOTHERMAL ENERGY uses the heat within the Earth. The heat from a volcano's lava can be used to heat water to create steam that switches on turbines to generate electricity.

Did you know that the **sun** gives more energy to the Earth in **one hour** than the energy used by the entire world in **one year**?



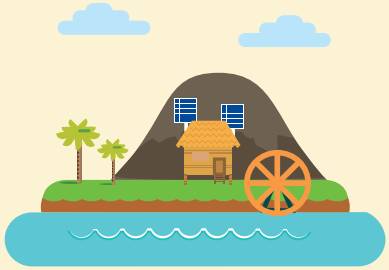
GLOBAL WARMING

Since the age of industrialization, mankind has been using more and more machines, factories and vehicles producing smoke and gases like CO_2. These gases are also called greenhouse gases, because they gather in the atmosphere and trap heat from the sun on the earth´s surface, just like in a greenhouse. This global warming causes ice sheets to melt and the sea and water levels to rise. While scientists are still researching all the effects of global warming, they already know that it causes the weather to be more extreme in many areas. Droughts, violent storms and heavy rains are the results.

ENERGY ACCESS IN SOUTH ASIA

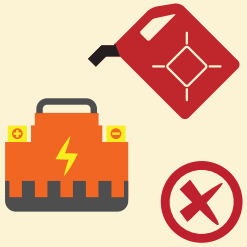
Did you know that one in four people in South Asia are living without access to electricity? Almost 80% of people use traditional fuels like wood or dung for cooking because they lack access to other sources of energy. That means more than 1 billion people have to rely on non-renewable sources of energy just for cooking.

WHAT RENEWABLE ENERGY CAN CHANGE FOR YOU!



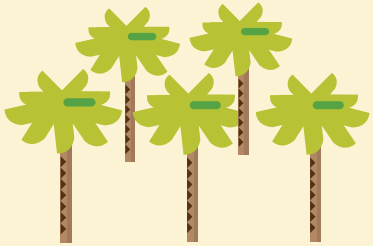
Now imagine your community, school or family has set up a small renewable energy project like solar panels or a small water mill. That means:

1



You will be using less kerosene or fuels for generators

2



You will be saving trees by needing less firewood

3

You will be saving money by consuming less electricity

4

You have now reliable access to electricity that allows you to set up a small business

5

You can install an electric pump giving you access to clean drinking water

6

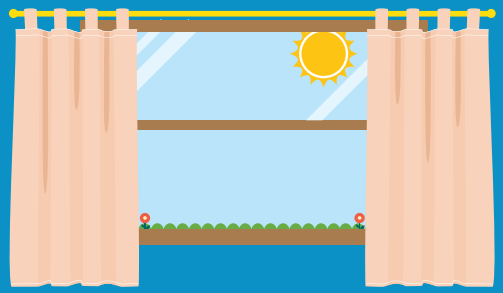
You are producing clean energy and won´t get sick by fumes and pollution from generators

HOW TO PRACTICE ENERGY EFFICIENCY

When we waste energy, we are overusing the Earth's resources and contributing to climate change. We cannot eliminate using electricity and fossil fuels in our lives because they make our lives convenient and safe. However, we can use energy more efficiently so that energy is not wasted and pollution is reduced.

We can become more energy efficient by making simple changes in our everyday lives. Energy efficiency starts with us! When everyone practices it we make the world a better place.

BRIGHT TIPS!



1 Use natural light as much as possible. During the day open windows to cool down the house and provide sunlight to do work. Use curtains made out of light fabrics like cotton or linen that allow cool air to enter and keep harsh sunlight out.

2 If your house is getting hot during the summer, give it some shadow by planting trees next to it.

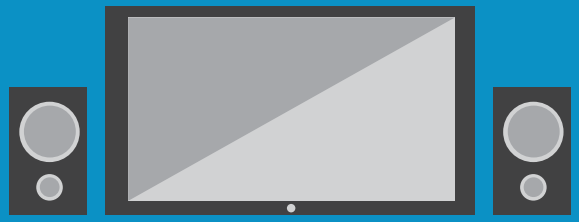
Safety Tip: Check which trees are growing in the area and how to nurture your trees. Ask your parents and neighbors for permission first. Make sure the trees are planted in the right position to provide maximum shadow for your house.

3 Try to walk or cycle to places nearby. It improves our health through exercise and improves the health of the planet by cutting down on pollution.

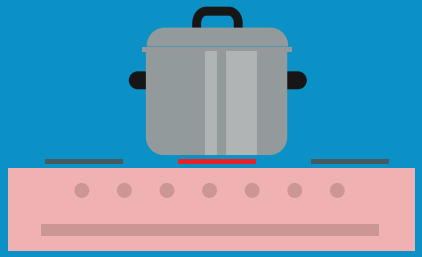
Safety Tip:
Never walk or cycle alone late at night and never walk or cycle on a busy road. Use designated sidewalks.

4 Take a cold shower. Reduce pollution and deforestation by not heating water.

Safety Tip: Never place appliances like a fan, television or mobile phone in or near water.

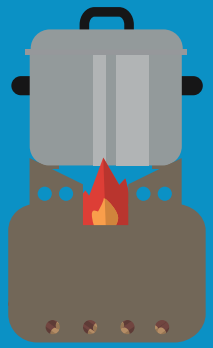


5 Switch off appliances like the television, lights or fan when there is no one in the room. Encourage your friends and family to enjoy the fresh air outside instead! Make sure to unplug chargers after charging electrical appliances to avoid "energy leaks".

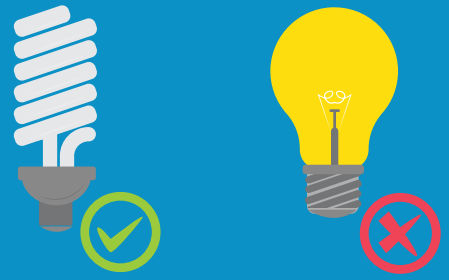


6 When boiling or cooking, keep the lid of pots and pans on, to conserve heat and reduce energy consumption.

Safety Tip: Take care when removing lids on cooking pots and pans as they can become very hot. Use a small towel or piece of cloth on the lid handle when removing them.



7 If you are using a traditional cooking stove, think about replacing it with an energy efficient one that uses less fuel like wood or coal. Save energy when cooking by using a "fireless cooking pot" that is well isolated to maintain heat over a long time and cook food while using minimal fuels. Use the Internet or ask your teacher about how to build one.



8 Using Compact Fluorescent Lamp (CFL) bulbs rather than regular incandescent bulbs help to save energy in the long term. Although they cost more upfront, they use less electricity and last 10 times longer. This saves money and our planet! See if your local community centre will exchange of your old incandescent bulbs for CFL ones or give you money to buy one.

9 Reuse and reduce. The production of materials like plastic bags and cups in factories uses a lot of energy, as well as its transportation to you. Most plastics are made out of fossil fuels. Using reusable shopping bags made out of jute, cloth and paper not only saves energy but also keeps our environment clean.

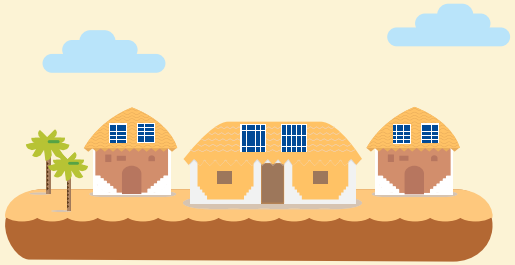
SOME MORE DETAILS ABOUT SOLAR ENERGY

Solar energy – is a renewable energy. The technology used to convert solar energy into electricity doesn't produce smoke or other pollutants. Tapping this energy doesn't usually destroy the environment. Unfortunately, the sun does not available in the night, and in some days, clouds and rains and natural conditions prevent the sun's powerful rays to reach us. This means that it is not always available, but with the help of batteries we can enjoy the solar energy even if the sun is not available.

India is a tropical country. India is a country blessed with enormous solar potential. About 90% of the solar potential remains unutilized. The sun's energy can be converted into an electrical energy and can be used to power up the electrical and electronics equipment. This can also be used for cooking through solar cookers, heating water through solar water heaters are the other ways.

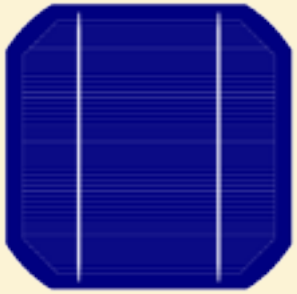
Advantages of using solar energy:

- Consistent throughout the year
- Solar energy can be used in remote places
- Can be used to power systems like calculators, watches etc.
- Easily available
- Produced in smaller quantities and ideal for use in tropical countries like India
- Cost saving

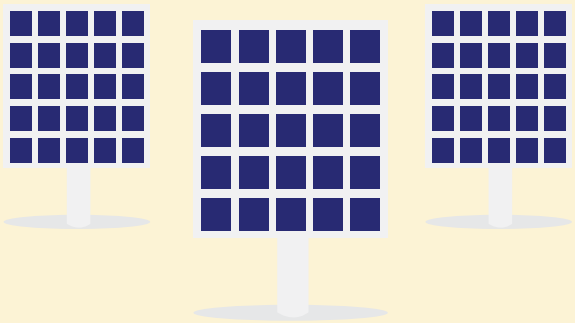


To build a standalone model of electricity generation unit, one would need a solar panel, a charge controller and a battery.

SOLAR CELL



To effectively convert solar energy into electrical energy, we need a solar panel. Solar panels are made of solar cells. A solar cell or photovoltaic cell is an electrical device that converts the energy of light directly into electricity by the photovoltaic effect. It is a form of photoelectric cell which, when exposed to light, can generate an electric current without being attached to any external voltage source.



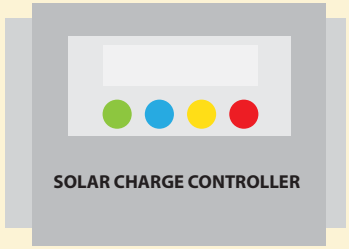
SOLAR PANELS

Solar panel is a collection of solar cell arrays. o increase their utility, a number of individual PV cells are interconnected together in a sealed, weatherproof package called a Panel (Module). For example, a 12 V Panel (Module) will have 36 cells connected in series and a 24 V Panel (Module) will have 72 PV Cells connected in series.

To achieve the desired voltage and current, Modules are wired in series and parallel into what is called a PV Array. The flexibility of the modular PV system allows designers to create solar power systems that can meet a wide variety of electrical needs.

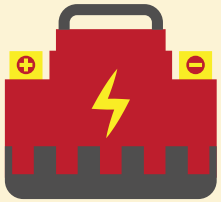
LIFESPAN

Most commercially available solar panels are capable of producing electricity for atleast twenty years.



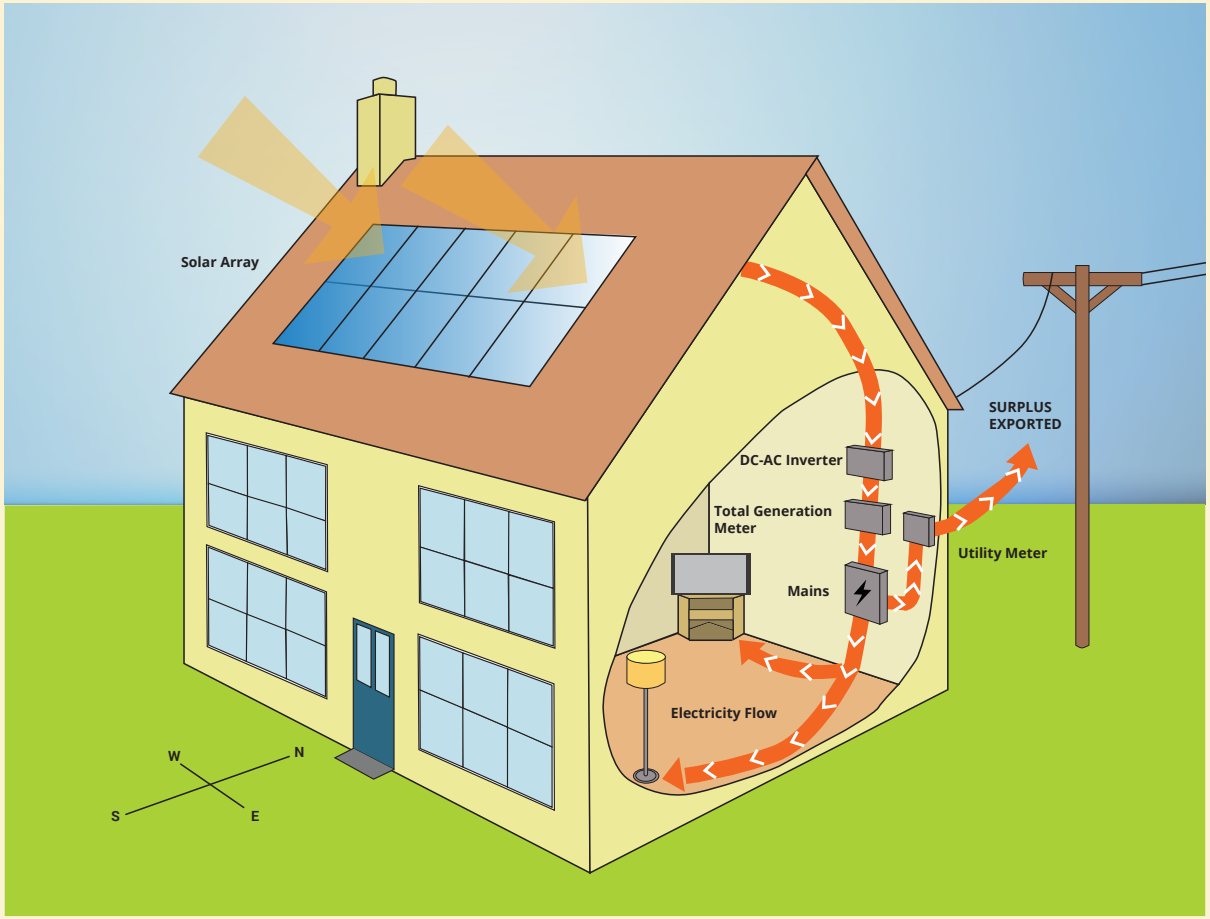
CHARGE CONTROLLERS

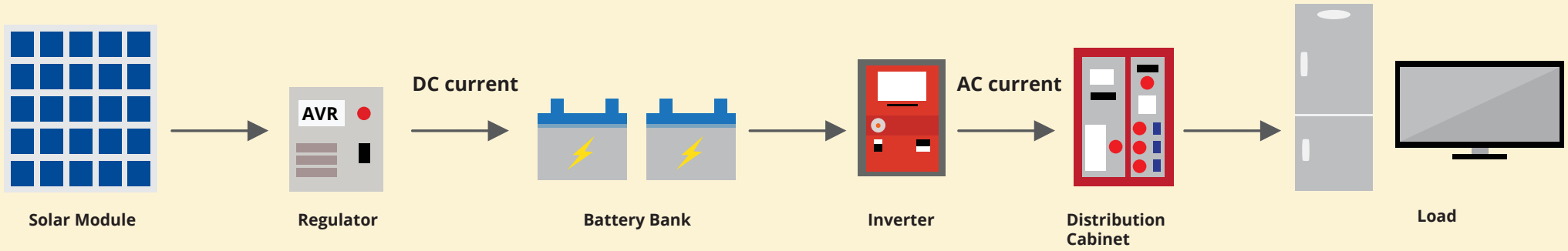
A solar charge controller is a voltage regulator, that prevents the battery from overcharging or under charging. The sun's energy is not always constant, sometimes the sky is clear and the current produced is high sometimes the sky is hazy and the output current is less. A charge controller thus regulates the voltage and current flow from the solar panels to the battery and circuits.

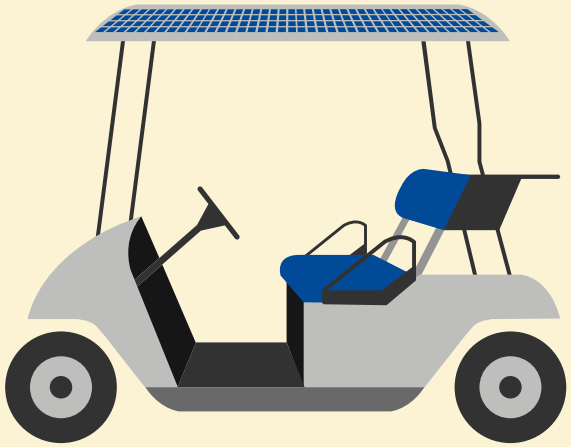


BATTERY

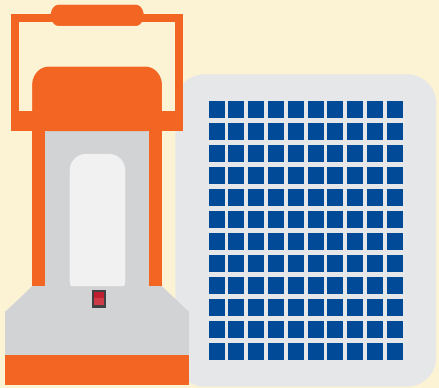
Battery is used to store the electrical energy and make it available when there is no sufficient sunlight. Sizing the battery sufficiently ensures the power is available without any downturns.


Solar Array
SURPLUS EXPORTED
DC-AC Inverter
Total Generation Meter
Utility Meter
Mains
Electricity Flow
W
N
S
E

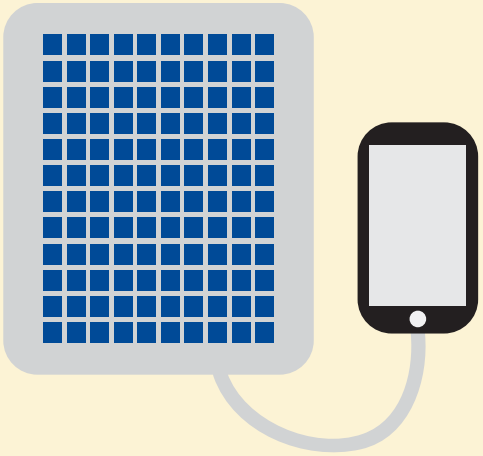

AVR
DC current
AC current
Solar Module
Regulator
Battery Bank
Inverter
Distribution Cabinet
Load



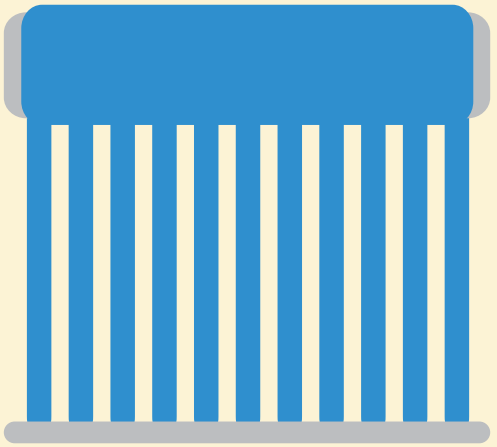
SOLAR CAR



SOLAR LANTERN



SOLAR MOBILE
PHONE CHARGER



SOLAR WATER HEATER

ENERGY EFFICIENT TECHNOLOGIES

Fortunately, we can use technologies that help us to consume less energy. This way, we can save resources and protect our environment even when our energy comes from non-renewable sources.

ENERGY SAVING IN ACTION

1 Indian Railway Saves Rs 400 crores in a year by transforming into Energy Efficient techniques through continuous energy auditing. Under Clean Development Mechanism, 14 lakhs CFL were replaced instead of incandescent bulbs in Railway residential Quarters. So far, Indian Railway bagged 18 National Energy Conservation Awards .

2 Around 100 traditional stoves used for noon meal scheme at government schools in Athoor block of Dindigul district were replaced with energy efficient stoves. The stoves are designed and fabricated by Rural Energy Centre-Gandhigram Rural Institute. The efficiency is 36% more than the MNRE(Ministry of New and Renewable Energy) guidelines, which means less consumption of firewood with negligible amount of smoke.

3 Gandhigram Rural Institute as a part of their community activities, conducted various competitions at Chettiyapatty, Dindigul district on 16th September 2014 in a government higher secondary school on quiz , essay and poster designing. The main objective of the competition was to create awareness among the student community on resource efficiency, waste management, renewable energy and safe environment. The duration of the competition was for one hour each and about 50 school children comprised of both male and female participated within the age group 12 to 16 years.

Whenever you are thinking about your own project and practicing **energy efficiency**: take caution and never put yourself or others in danger!

ENERGY QUIZ!

Note: There might be more than one correct answer.

1. During which of these activities do we use energy?

   a. Recharging our phones
   b. Cooking and switching on lights
   c. At both of the above

2. What is energy?

   a. The ability to do anything
   b. The ability to create light
   c. The ability to create heat

3. What is the most powerful source of energy we can use on earth?

   a. The sun
   b. The wind
   c. The heat within Earth

4. How did the first humans on Earth discovered fire?

   a. By rubbing two sticks of wood together
   b. During a volcanic eruption
   c. Through a burning meteorite

5. What problem was caused by the usage of firewood as an energy source?

   a. Millions of trees were cut down
   b. The fire created wasn´t warm and bright enough
   c. Gathering wood was hard for the early humans

6. How do we produce most of our energy today?

   a. Through solar power
   b. Burning wood
   c. Burning fossil fuels

7. Which of these are fossil fuels?

   a. Wood, Paper and Fabric
   b. Glass, Plastic and Steel
   c. Coal, Oil, Uranium and natural gases

8. What are the problems related to the use of fossil fuels?

   a. They create pollution
   b. They cause acid rain and accelerate climate change
   c. There are finite amounts of them

9. When were most of the fossil fuels we use today created?

a. Millions of years ago
b. We don´t know
c. Hundreds of years ago

10. Give (3) three examples for sources of renewable energy:

_____

_____

_____

_____

11. What are advantages of using renewable energies?

a. They are naturally replenished
b. They are easy and cheap to use
c. They create no pollution when being generated

12. Since when have human beings been using renewable energies?

a. For more than one million years
b. Since 1999
c. For over 2,000 years

13. Which of these sources of renewable energy can be used everywhere?

a. Geothermal Energy
b. Biomass Energy
c. Tidal and Wave Energy

14. How exactly is Biomass energy being used?

a. Organic matter is being burned to release energy
b. Organic matter is being pressed into pellets that can be used as fuel
c. Organic matter releases energy when decomposing. This energy is being used

15. What is the problem with wasting energy?

a. Using too much energy generated from fossil fuels contributes to climate change
b. Too many people using electric energy at the same time can cause power outages
c. Using too much energy generated from fossil fuels causes pollution

16. Give (3) three examples for energy saving:

_____

_____

_____

9. When were most of the fossil fuels we use today created?

   a. ***Millions of years ago***
   b. We don´t know
   c. Hundreds of years ago

10. Give (3) three examples for sources of renewable energy:

    _____

    _____

    _____

    _____

11. What are advantages of using renewable energies?

    a. ***They are naturally replenished***
    b. They are easy and cheap to use
    c. They create no pollution when being generated

12. Since when have human beings been using renewable energies?

    a. For more than one million years
    b. Since 1999
    c. ***For over 2,000 years***

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    c. ***Using too much energy generated from fossil fuels causes pollution***

16. Give (3) three examples for energy saving:

    _____

    _____

    _____

ENERGY QUIZ!

Answer sheet*

1. During which of these activities do we use energy?

   a. Recharging our phones
   b. Cooking and switching on lights
   c. ***At both of the above***

2. What is energy?

   a. ***The ability to do anything***
   b. The ability to create light
   c. The ability to create heat

3. What is the most powerful source of energy we can use on earth?

   a. ***The sun***
   b. The wind
   c. The heat within the Earth

4. How did the first humans on Earth discovered fire?

   a. ***By rubbing two sticks of wood together***
   b. During a volcanic eruption
   c. Through a burning meteorite

5. What problem was caused by the usage of firewood as an energy source?

   a. ***Millions of trees were cut down***
   b. The fire created wasn´t warm and bright enough
   c. Gathering wood was hard for the early humans

6. How do we produce most of our energy today?

   a. Through solar power
   b. Burning wood
   c. ***Burning fossil fuels***

7. Which of these are fossil fuels?

   a. Wood, Paper and Fabric
   b. Glass, Plastic and Steel
   c. ***Coal, Oil, Uranium and natural gases***

8. What are the problems related to the use of fossil fuels?

   a. ***They create pollution***
   b. ***They cause acid rain and accelerate climate change***
   c. ***There are finite amounts of them***

Experimental Project: Hot water through solar power

(Kindly provided by Practical Action)

Materials and Equipment

- Cardboard panel, 2 feet wide X 4 feet long X 1 inch thick
- Aluminum foil (1 roll)
- 1 roll of tape
- Plastic bags (9); thick, approximately 2 mm, bags like compactor trash bags

    - The plastic bags should be 3 different colors and you should have 3 bags of each color.
    - You should use black trash bags, white trash bags and, one other color of trash bags.
    - The bags do not need to be identical sizes, but they should all be large enough to hold 2 liters (L) of water, and be of very similar thicknesses (approx 2mm).

- Scissors
- Thermometers (3), at least 10 inches long.
- 2-L container (1); a clean 2-L plastic soda bottle will work
- Kitchen string, cotton
- A Watch
- Pen and paper

Note: Make sure you pick a sunny day on which to try this science fair project and run the trials in the hottest part of the day with the most direct sunlight. If the project takes you multiple days, try to run the tests at the same time of day in the same spot every time.

Experimental Procedure

1. Take the cardboard panel and cover one of the large sides with aluminum foil. Tape the aluminum foil to the cardboard with tape so that the foil is securely attached to it.

2. Take three plastic bags, one of each color that you are using, and clip a small hole at the bottom of the bag with your scissors. The hole should be just big enough so that a thermometer can fit through it.

3. Carefully fit a thermometer through the holes in each of the bags. Push the thermometer through, about halfway up the thermometer (there should be a mark on your partial immersion thermometer showing how far it should be inserted into a liquid). Use tape to tape the bag securely around the thermometer. It should be tight enough that water will not leak out of the hole. **See Figure 1.**

4. Now fill the 2-L container with water. Empty the water into one of the bags. Carefully squeeze the air out of the bag and tie it closed. Have an adult help you with this step. Trim off the extra plastic from the top, using the scissors.

5. Repeat step 4 with one each of the other colored plastic bags. You should now have three different-colored batch solar collectors.

Figure 1. This image shows an example of a black bag batch solar collector sitting on top of a foil-covered Styrofoam panel.

Batch Solar Collector		Temperature of Water Over Time (°C)				
		Starting	After 15 mins	After 30 mins	After 45 mins	After 60 mins
Black	1					
	2					
	3					
White	1					
	2					
	3					
Orange	1					
	2					
	3					

6. Place the foil-covered panel in full sunlight. Place the three colored batch solar collectors on top of the foil-covered panel, next to each other. The collectors should all be in the Sun, and none of them in shade. Check the temperature of the water in each bag. Read each of the thermometers and record the readings on paper in a table, like the one shown below. These readings are the starting temperatures of the water in the batch solar collectors.

   a. The temperature readings should be in Celsius (°C) if possible. Celsius is the standard unit for temperature in most fields of science.

7. Let the three collectors sit in the sunlight for 15 minutes. Use a watch to time 15 minutes. After 15 minutes, look at the thermometers and record the water temperature for each batch solar collector in your table.

8. Let the batch solar collectors sit in the sunlight for another 15 minutes and record the temperature for each bag in your table. Continue to take readings every 15 minutes for a total of 60 minutes. You should have 5 total temperatures recorded for each bag: starting temperature, 15 minutes, 30 minutes, 45 minutes, and 60 minutes.

9. Repeat steps 2-8 two more times, with the other plastic bags, to make sure that your results are repeatable and accurate. Always record all of your observations.

10. Does the final temperature of the water depend on the color of the bag? Did one color always heat the water the most? Which color kept the water coolest? What can you learn about the use of solar energy through this experiment? Are there ways you can use the abilities of the different colors in your everyday life?

The Wind Power Challenge

(Kindly provided by Practical Action)

Ask the students to design a simple wind turbine capable of lifting a cup off the floor up to bench height. The winning team will be the one producing a machine that lifts the most weight.

For each group set out a tray containing the following materials. You will also need at least one hairdryer. Ensure all hairdryers are of the same power rating.

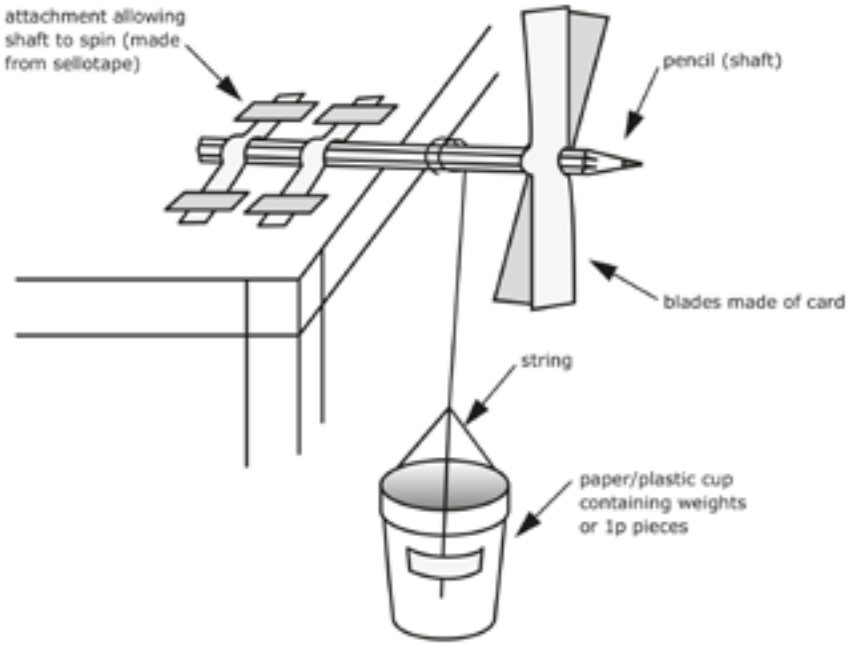
- Scrap card
- Tape
- Masking tape (optional)
- Pencils
- Scissors
- String
- Paper/ plastic cup
- Weights (gram weights or pennies)

Running the challenge:

Introduce the challenge by discussing how wind power has been used throughout history to power sailboats, mill grain for flour etc. and that now it is seen as one of the solutions to the major problem facing society. Introduce the different basic types of wind turbines, compare their design and discuss how they work. The main difference in design is that turbines producing electricity need to spin fast so have fewer (typically three), thinner blades. Those that harness wind power to drive machinery, such as water pumps and windmills, need a higher torque and to be more stable. They generally have a higher number of larger blades.

Set the challenge and discuss the variables that will be involved in making design decisions:

- Shape of the blades
- Size of blades
- Thickness of blades
- Number of blades
- How the shaft is attached to the desk



***Possible design**

Discuss how the design could be made as sustainable as possible, e.g.

• Reusing scrap material rather than new
• Reducing waste to a minimum (card, sellotape, string)
• Do they need to use a hairdryer?

You could introduce a prize for the most sustainable design as well as the one which lifts the most weight. Ask the students to think about how they want to make it a 'fair' test. This could include:

• Limiting the amount of materials (card, sellotape, string) that can be used for each group
• Ensuring all the hairdryers are of the same power rating
• Ensuring the hairdryer is a fixed distance away from the blades
• Allowing or not allowing students to touch the machine when it is operating

Discuss the design process. Students should be encouraged to research, design, build, test, evaluate then redesign. Divide the class into groups of about 4 and give them a time limit to complete the challenge, 30 minutes should be sufficient.

When time is up ask each group to demonstrate their machine in turn and briefly describe the process they went through in reaching the final design. Students could present the process they went through to a wider audience using a method of their choice e.g. in the form of a poster or a short video.

How to make your own Solar Bottle Light Bulb

(Idea taken from MyShelter Foundation)

Materials and Equipment

- 1.5 liter Soda Bottle
- 1'x1' Roof Sheet Material
- Purified Water
- Camera Film Dispenser
- Chlorine
- Rubber Sealant

Experimental Procedure

1. Fill the 1.5 liter clear soda bottle with purified water then add 3 tablespoons of liquid bleach and tightly seal the cap. Do not use tap water because this will allow the growth of moss.

2. Make a hole in the 1'x1' roof sheet material, just the same size of the bottle's circumference and insert the bottom part of the bottle leaving it exposed under the sunlight.

3. Next, make another hole on the roof of the house (same as the bottle's circumference) where you want to put the solar bulb and firmly fix the device.

4. Seal the roof with a sealant to prevent raindrops from getting inside the house. It will produce a light when the water inside the bottle bulb refracts and scatters the light inside the house.

*The solar bulb is expected to last up to two years before it needs changing.
*These lightbulbs need sunlight from the outside and will not be working at night.

Conducting a Survey on saving energy

Discuss the different types of electrical equipment you use at home. Make a list of this equipment either on the schoolboard or write it down. You can refer to this list while going through the survey at home. After you have completed the checklist, discuss it with your teacher and fellow students. Where can you save energy in your house?

Electrical Equipment	Survey Questions	Answer	Solution
Lights	How many lights do you have in your house?		
	Are there any lights left on when there is no one in the room? How many?		
	Is it possible to use natural light in your house?		
Fans	How many fans do you have in your house?		
	Is there a fan switched on in an empty room?		
	Can you open windows or doors for natural ventilation?		
Televesion	Do you have a television at home?		
	Is it switched on while no one is watching?		
Air-con	Do you have an air-con at home?		
	How many hours per day is it turned on?		
	Is the air-con turned on while there is no one in the room?		
	What temperature is the air-con set at?		
Stove	What equipment and fuel is used for cooking?		
	Can this equipment be replaced or adjusted to save energy?		
Other equipment	What other electrical equipment do you have in your house?		
	Are they turned on when they are not used? Which ones?		

Now think about the community you live in. What renewable energy and energy efficiency ideas do you have for your community? Try answering the following questions and discuss it with your teacher.

1. How many households in your community have access to electricity? Do you experience power outages? How often?

_____

_____

_____

_____

_____

2. Does your community practice energy efficiency? How does this happen?

_____

_____

_____

_____

_____

3. Where can energy efficient technologies be used to improve your community's energy efficiency?

_____

_____

_____

_____

_____

4. Which renewable energy technologies could be used in and around your community? (Think about your community's environmental aspects. Is there a river nearby? Is it sunny most of the day? Does it get windy?)

_____

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