ثانويـة التكنولوجيـا التطبيقيـة
Applied Technology High School

Technology Exploration-II

Module 2
Renewable Energy

PREPARED BY

Academic Services Unit

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Module 2:
Renewable Energy

Module Objectives

After the completion of this module, students should be able to:

- Define renewable energy.
- Compare Renewable and non renewable energy.
- Describe different ways of generating renewable energy.
- Conduct practical tasks to demonstrate the applications of solar cells, windmills and hydro turbines.

Module Contents

2.1 Introduction to Renewable Energy

Renewable energy is generated using natural sources that are easily available on earth. One common example of renewable energy is when the sun is used to heat up water to provide hot water in a house. This is known as Solar energy, i.e. energy provided by the sun.

There are many other types of renewable energy sources, examples include wind, tidal (energy produced by waves in oceans and seas), geothermal (underground heat) etc.

Figure 2.1: Solar and Wind Energy (Renewable)

What is the difference between renewable and non-renewable energy?

In Module 1 we investigated electrical energy and how we can generate and store this energy by using mechanical movement (a generator). This electrical energy is used in the form of electricity to power houses, machines, factories etc. In the real-world, generators used to produce electricity are powered by using some kind of fuel like diesel. This source of energy is non-renewable.

Non-renewable energy sources such as gas and oil, once used these resources CANNOT be used again, i.e. one day we will run out of gas, oil etc. That's why countries such as the UAE are looking to invest in renewable energy sources, because renewable energy is always there and will never run out.

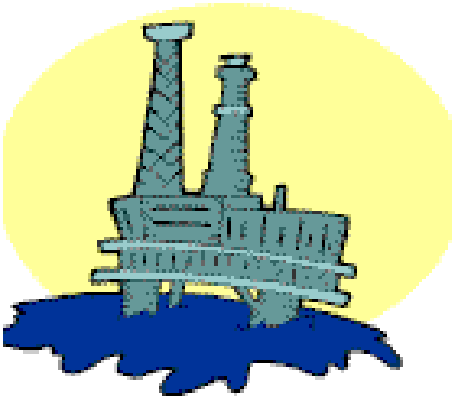

Figure 2.2: Oil rig (Non-Renewable)

Another reason for the increase in the use of renewable energy sources is that they provide energy with far less damage to the environment than renewable energy sources, because they do not produce much waste or pollution. However, renewable energy is still expensive to produce compared to non-renewable sources.

Class Activity:

The five images shown in Figure 2.3 below show ways of getting energy from different energy sources, can you name them and state whether renewable or non-renewable, the advantage and disadvantage of each? Hint: search the internet to help you find answers to some of these questions.

A

B

C

D

E

Figure 2.3

Picture	Energy Source	Energy Type		Advantage	Disadvantage
		Renewable	Non Renewable		
A	Gas		✓	Easy to transport	More dangerous than oil
B	geothermal	renewable		doesnot finish	uncontrollable expensive
C	wind	renewable		no pollution no waste products	expensive to use conditional to windy weather only
D	oil		non renewable	readily available for now	pollution will finish soon
E	solar (sun)	renewable		no pollution	only available in sunny weather

Table 2.1 Energy Sources

2.2 Solar Energy

The Sun has an immense output of energy. Only a small part of this energy is intercepted by the earth, reaching us in the form of visible light. The amount of power in the Sun's rays that reach Earth is measured in watts per square meter.

Solar energy can be captured, for example, by solar cells, as shown in Figure 2.4. Many solar cells assembled together are called solar panels. Solar panels are designed to capture the suns energy and convert it to more usable forms, such as heat or electricity.

Figure 2.4 Solar Panels

Technologies linked to solar energy are:

- **Passive solar energy**: in this system the energy in sunlight is used for light and heat. In passive solar building design the Sun's energy contribution is fully optimized by careful design of the building without using any additional mechanical equipment.

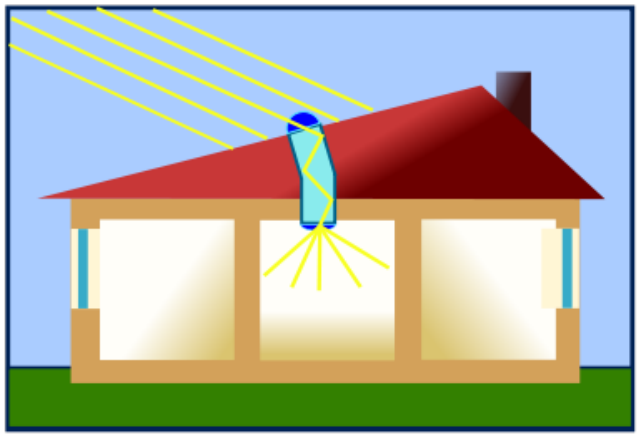

Figure 2.5 Passive Solar Energy

- **Active solar energy**: An example of this system is the solar water heating system shown in Figure 2.6. The Sun's heat energy is transferred to special fluids held in solar collectors. This fluid is pumped through pipes in water tanks and the heat energy transferred to the water.

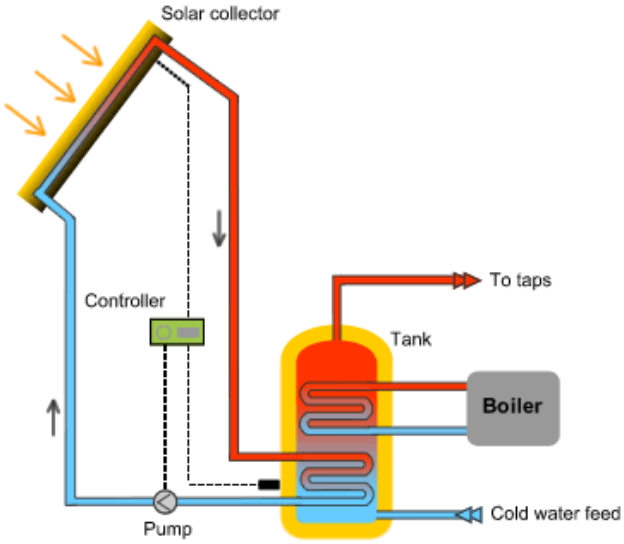

Figure 2.6 Active Solar Energy

- **Solar Cells**: In this system the energy in visible light from the Sun is converted directly into an electric current by means of solar cells. Using the photoelectric effect, loose electrons in the upper layer of the solar cell are caused to move, thus creating an electric current that can be used to operate an electrical device.

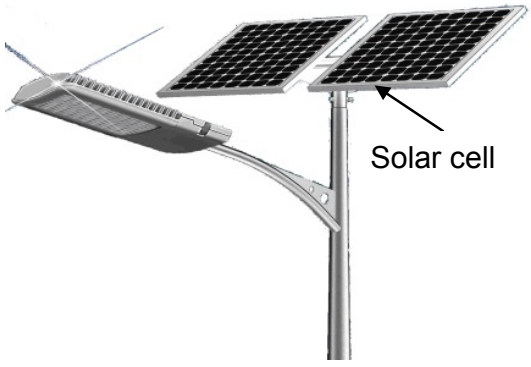

Figure 2.7 Solar Cells

2.3 Practical Activity 1: Collecting Energy from Light with the LEGO Solar Cell

A solar cell generates electrical energy when light falls on it. In this practical task you will see how to collect electrical energy from light with a solar cell.

Figure 2.8 LEGO solar cell

1. Build the ferris wheel model on pages 4-15 of the Solar building booklet.
2. Attach the motor and LEGO solar cell to the ferris wheel and place it near the light source.
3. Switch the lamp on. Be careful, the lamp can get very hot.

    a) Count how many turns the ferris wheel makes in one minute (rpm). Complete the first row of the table.

    b) What was the speed of your ferris wheel? _____109_____ rpm (rotations per minute).

4. Repeat step 3. This time, cover ¼ of the cell with thick card, then ½, then ¾ Complete the chart.

Cover	rpm
None	109
¼	82
½	52
¾	26

a) What happens? the wheel slows down

b) Explain why: the input of solar energy reduces so the output of electrical and mechanical energy also decreases

c) What happens when you move the light nearer to the solar cell?

the wheel starts to rotate faster

d) Would it be a good idea to use solar cells to drive a fairground ride? Explain your answer.

no, as it will not be safe. the wheel will stop rotating on cloudy day or rainy day.
this will not be safe for the kids riding the wheel, they will be stuck.

5. Build the solar powered car on pages 20-23 of the Solar Building booklet.

6. Test the solar powered car. How can you make it go:
   a) Faster? by providing it maximum solar energy
   b) Slower? by covering the cell
   c) Name some good reasons for using a solar cell on a car.
   d) Name some problems with using a solar cell on a car.

7. Investigate how the speed of the car changes when the "lamp to cell" distance is changed. Draw a graph of your results.

Graph:

Conclusion:

What have you learned from this practical task? Explain in your own words.

solar energy is a powerful source of generating electrical energy however we cannot rely on it until we learn how to store it for cloudy and rainy days.

2.4 Wind Energy

Wind energy can be captured by wind turbines. Wind turbines are designed to capture the wind's energy and convert it into a more useful form, such as electricity. Technologies linked to wind energy are:

- **Wind turbines with a vertical axis** have a rotating axis and blades in a vertical position. They work equally effectively, irrespective of wind direction.
- **Wind turbines with a horizontal axis** have a rotating axis and blades in a horizontal position. They must be faced with respect to wind direction and are the most common type of wind turbine to be found, both onshore and offshore.
- **Other types of wind turbines, whether onshore or offshore**, can generate the same amount of power. The key issue of efficiency lies in where the turbines are placed. Offshore wind turbines are often considered more reliable due to the wide open spaces at sea where wind is able to gain energy. Onshore and offshore wind turbines have the same basic parts: tall towers, large turbine blades, axles, gears and a generator.

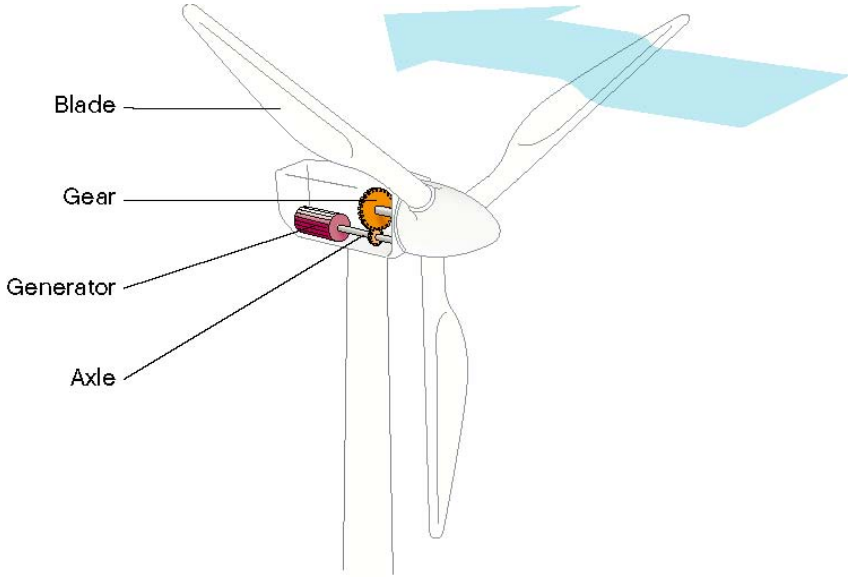

Figure 2.10 Wind Turbine Model

2.5 Practical Activity 2: Collecting Energy from the LEGO Windmill

Remember that you do work to lift weights. When you release the weights, they fall to the ground. Their potential energy is converted into kinetic energy. We can also store energy in a stretched elastic band.

Let's use the LEGO elastic band capacitor to store energy from the wind.

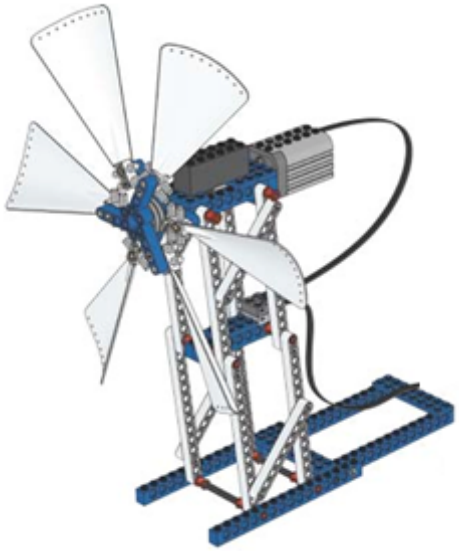

Figure 2.11 Wind Turbine

1. Build the windmill on pages 2-15 of the Wind building booklet.
2. Build the elastic band capacitor on pages 16-22 of the Wind building booklet and attach it to the windmill as shown in model-A on page 26 of the Wind building booklet.
3. Turn on the fan to charge the capacitor.

4. Turn off the fan. Unlock the capacitor to release its stored energy.
   a) What happens to the windmill?

      the windmill strats to rotate because of the energy in the capacitor

   b) What happens to the windmill?

      _____

   c) Where did the energy come from to charge the elastic band capacitor?

      from the mechanical energy of the windmill

5. Build the test car on pages 23-25 of the Wind building booklet.
6. Mark out a smooth test track.
7. Use the fan and windmill to recharge the elastic band capacitor.
8. Carefully remove the capacitor and put it on the car.
9. Put the car on the start line. Unlock the capacitor to release the stored energy. How far does the car travel? _____ (m)
10. Use a stopwatch to time the car over the test track. Find its average speed using the formula:
    Speed (m/s) = distance (m)/time (s)

2.6 Water Energy

Moving water has kinetic energy. This can be transferred into useful energy in different ways. For example:

Tidal Energy

Tidal energy simply uses the energy in the sea to generate electricity. There are several different ways in which the sea's energy can be used to create electrical power and tidal power is one of them (Figure 2.14).

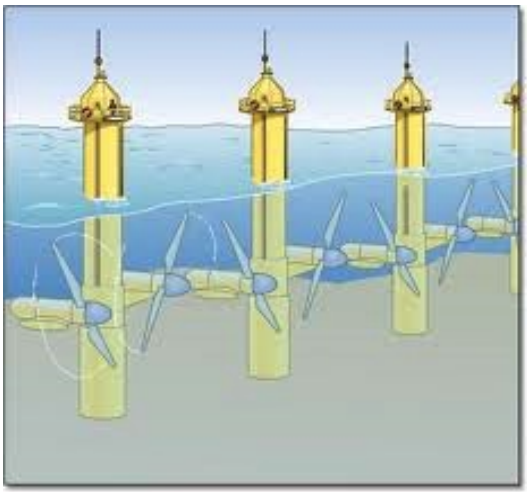

Figure 2.14 Tidal Energy

Tidal Barrages

Tidal barrages are built across the mouths of rivers. As water moves in or out of the river's mouth when the tide turns, the kinetic energy in the water is used to turn electricity generators (Figure 2.15).

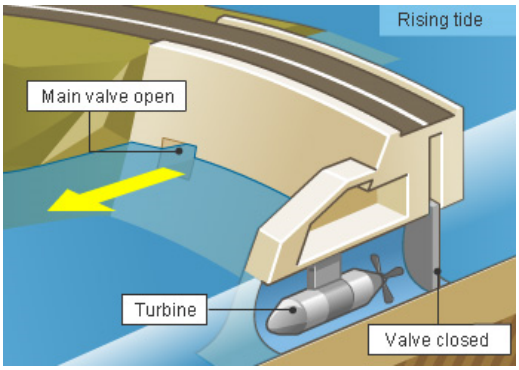

Figure 2.15 Tidal Barrage

Hydroelectric power

Hydroelectric power schemes store water high up in dams. The water has gravitational potential energy which is released when it falls. As the water rushes down through pipes, this stored energy is transferred to kinetic energy, which turns electricity generators (Figure 2.16).

Figure 2.16 Hydroelectric Power

Hydro turbines have the ability to convert the kinetic energy of moving water into electrical energy. They are used to generate electricity for large utility grids and in isolated locations for small communities or for single homes.

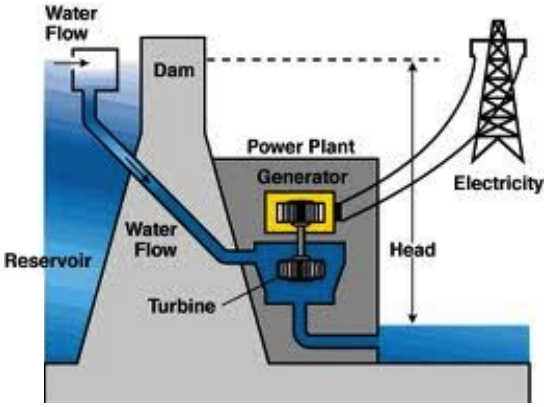

Figure 2.17 Hydroelectric Power Plant

2.7 Practical Activity 3: Collecting Energy from Water

Let's use a model waterwheel to collect energy from flowing water.

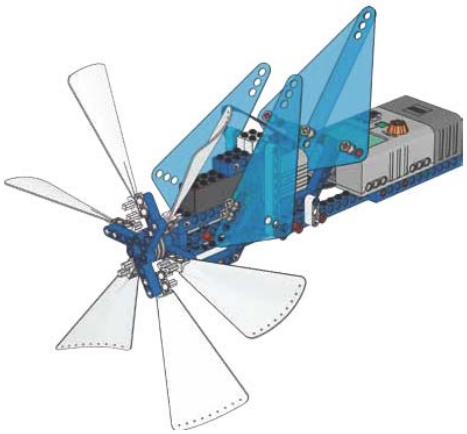

Figure 2.18 Waterwheel

1. Build the waterwheel on pages 2-14 of the Water building booklet.
2. Think about how you will provide consistent water flow.
   a) What happens to the waterwheel when you turn the tap on?

      the waterwheel starts rotating

   b) How did you make sure the water flow was consistent?

      by ensuring the tap is open at all times and we don't change the water flow using the tap

3. Count how many turns the waterwheel makes in one minute. This is its speed in rotations per minute (rpm). What was the speed of your waterwheel?

   _____ rpm.

4. Build the winch shown on pages 22-25 of the General building booklet. Add weights to the winch until the waterwheel stalls (can't lift anymore). What is the stalling force? _____ N.

5. Change the water flow to the waterwheel. Repeat step 3 and 4. What is the rpm and stalling force now?

   _____ rpm _____ N

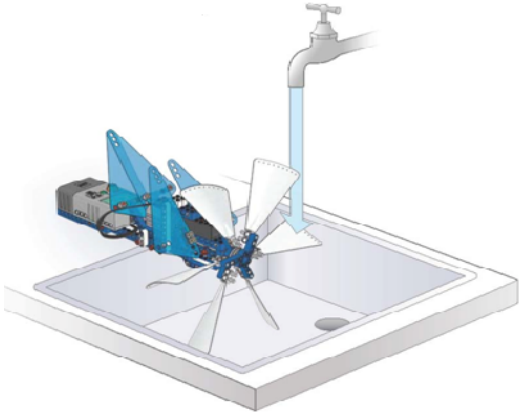

Figure 2.19 Hydro Turbine under Running Water

6. What form is the energy in:

   a) The water? kinetic energy

   b) The waterwheel? mechanical energy

   c) The weights at the top? potential energy

Conclusion:

What have you learned from this practical task? Explain in your own words.

_____

_____

_____

_____

2.8 Review Exercise

1. State two advantages of renewable energy sources:

it causes no pollution

it doesn't finish

2. Classify the following as renewable or non-renewable energy sources:

source	Renewable	Non-Renewable
Gas		NR
Wind	R	
Sun	R	
Water	R	
Coal		NR
geothermal	R	
Biomass	R	
Oil		NR

3. State three factors which could affect the efficiency of a wind turbine

1. the direction of the wind

2. weight of the wind blade

3. speed of the wind

most important the placement of the wind turbines!

4. In groups, discuss the advantages and disadvantages of one renewable energy source, as shown in table below. Present your findings to the rest of the class. Search the internet to help you answer some of these questions.

Group	Renewable energy source
1	Solar Cells
2	Wind Turbine
3	Tidal Wave
4	Hydro Turbine
5	Geothermal