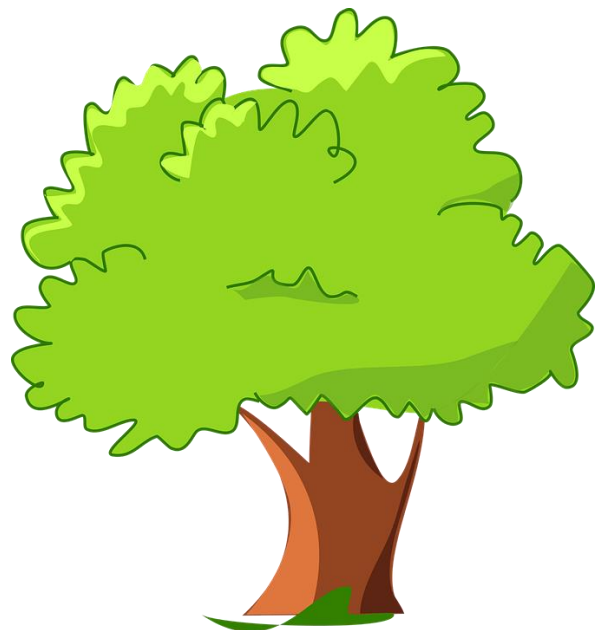
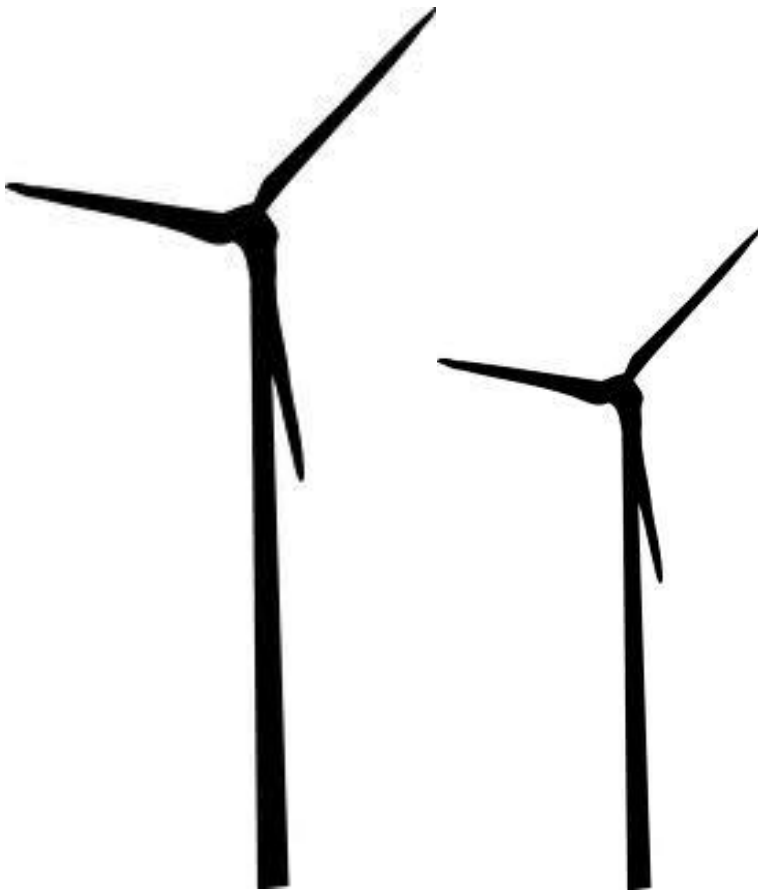
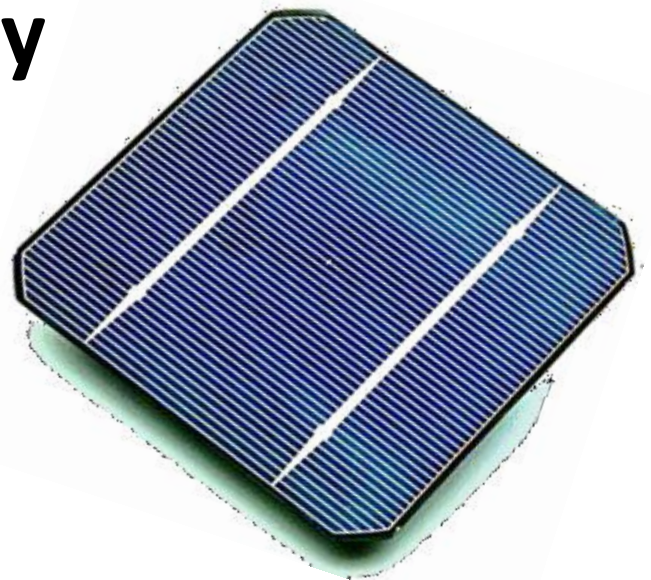




Renewable Energy School Program



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the company for knowledge dissemination and training, implemented the **Renewable Energy School Program** in 2009 with its aim to create awareness about renewable energy technologies like Solar and the Jatropha plant among our young generation.

Not only Renewable Energy Technologies are in the focus of the school program, also pollution of the environment and its preservation are important issues which are included in the curriculum of the Renewable Energy School Program.

Renewable Energy Technologies are, especially in countries like Tanzania with poor grid connection, a very good opportunity to increase electrification rates by off-grid power solutions like solar-home-systems.

But electrification is not the only aspect which the program has its focus on. Besides increasing electrification in rural areas, renewable energy technologies are also a **clean, sustainable, independent** and **future-oriented** solution of power supply.

KAKUTE Ltd. works closely together with **TAREA** (Tanzania Renewable Energy Association). Both have the vision and mission to increase power supply in Tanzania by using clean energy technologies.

As renewable energy technologies are not yet well known among Tanzanian citizens, the first step is to create awareness among our youth – Tanzania's future.

The following pages are a guideline for teaching about Renewable Energy Technologies and environmental issues in Primary Schools.

Different teaching lessons are listed up in detail, including experiments, background information for teachers, handouts and much more lesson ideas.

By teaching our children about environmental preservation and clean energy technologies, we can contribute to increase electrification and a cleaner and greener future.

With all our best regards,

Eng. Livinus Manyanga
Project Coordinator KAKUTE Ltd.

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Executive Secretary TAREA

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*The Teaching Units about Environment, Jatropha, Biogas and Solar were worked out by **Joshua Korhammer** and **Niklas Reichert** (Volunteers of KAKUTE Ltd. 2012/2013) in cooperation with **Mr. Aloys Ulomi** (former School Teacher and Ward Education Officer of Them, Arusha)*

Feel free to contact us for more information!



Figure 1 Kakute logo

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Figure 2 Tarea logo

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Renewable Energy School Program

by



Teaching Unit

- Environment -

The overall idea of this teaching unit is that the pupils get familiar with their environment, to understand problems like climate change, air and water pollution and also to know how to avoid these problems.

Teaching about the environment and its problems result in a better environmental awareness. This can contribute to a cleaner nature.

The teaching unit is worked out for nine teaching lessons.

One teaching lesson is equivalent to about 60 min.

Timetable:

Lesson Action

1st	Introduction to Environment
2nd	Necessity of trees
3rd	Plant a tree
4th	Water Pollution
5th	Air Pollution
6th	Fossil Energy & Climate Change
7th	Renewable Energy
8th	Test and Evaluation
9th	Results and Review

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Lesson 1: Introduction to Environment

At first there should be a brief introduction to the Environmental School Program and this Unit and what will be done. This will help the pupils to understand why they are doing this program and will excite them for this point. Five minutes should be enough to do this properly.

Necessary Materials:

- Board
- Small Pieces of Paper

Preparations:

Small pieces of paper should be prepared with the following words written on:

Streets	Trees & plants
Houses	Animals
Cars	Rivers
Rubbish / Waste	Mountains
Plastic	Lakes
Motorbikes	air
Bicycles	Sun
Buildings	Humans
Supermarkets	Rain
Smoke	Stones
	Soil
	Water
	Fruits
	Wood
	Wind
	Weather

First Activity:

Pupils should think about what belongs to their environment.

It is recommended to do the brainstorming outside of the classroom, so the pupils can see and feel their environment during the lesson. The words the pupils say should be written down so none of their contribution will be forgotten in the next step.

Second Activity:

The following activity requires a board, so it is recommended to do it within the classroom. The pupils already had their own ideas about which things belong to our environment. But in case they have not found all important aspects it is recommended to use the already prepared pieces of paper. Each pupil gets one piece of paper. The pupils now have to decide whether their word belongs to “Natural Environment” or “things produced by humans”.

After finishing, the table on the board should look like this:

Things produced by humans	Natural things
Streets	Trees & plants
Houses	Animals
Cars	Rivers
Rubbish / Waste	Mountains
Plastic	Lakes
Motorbikes	air
Bicycles	Sun
Buildings	Humans
Supermarkets	Rain
Smoke	Stones
	Soil
	Water
	Fruits
	Wood
	Wind
	Weather
	Smoke

The following table describes the exercises of different components of our environment:

Environment	Exercise
Streets	Transport
Houses	Sleep, Work
Cars	Transport
Rivers & Lakes	Water, Transport, Swimming, Fishes
Animals	Food & Work
Sun	Light & Warmth
Trees & Plants	Produce fresh air (oxygen), wood, firewood, charcoal, fruits, shadow
Waste	NO TASK! POLLUTES THE ENVIRONMENT

It is recommended to mention trees & plants and waste at the end. This is necessary to go on with necessity of trees in the next lesson and environmental pollution in one of the following lessons.

Lesson 2: Necessity of trees

This lesson deals with the topics air & oxygen and the necessity of trees. Pupils are primarily introduced to air: What is air and which ingredients are in the air.

The aim of this lesson is that to make the pupils understand the connection between plants, trees and oxygen which humans and animals need to stay alive.

Necessary materials:

- 3 different sizes of glasses
- Bowls
- Water
- Candles
- Piece of paper or cloth
- Tape
- Lighter/matchbox

Two experiments can be done in the classroom:

Small groups are formed by pupils or the teacher. Each group gets one handout which explains their tasks and the necessary materials. When the groups are finished with their experiment, they can proceed with another experiment.

In case of dealing with candles it is necessary to guarantee the security of the children.

The handouts of the experiments are mentioned here as well as they are attached to the annex of Teaching Unit – Environment (Lesson 2 – Has air a volume?; Lesson 2 – Candle Experiment; Page 28+29)

Group 1:

Subject: Has air a volume?

Tasks:

1. Read the description of this experiment.
2. Think about what will happen when you put the glass into the water. Will the paper be wet or will it stay dry? Write down your suggestions.
3. Do the experiment. Is the paper wet or dry? Was it easy to put the glass under the water? Write down what you noticed!
4. Suggest in your group why this happened and write down your explanation.

Description:

You have a bowl, a glass and a piece of paper. Your task is to fix the piece of paper with the cap inside the glass. Then you put the glass slowly upside down into the water untill the glass reaches the bottom. Wait some seconds and pull it out again.

Group 2:

Subject: Usage of Air

- Task:
1. Read the description of the experiment.
 2. Suggest what happens when you put a glass over the candle. In which way could the different sizes influence your suggestion? Write down your suggestions.
 3. Do the experiment and write down what you have noticed.
 4. Suggest in your group why this has happened. Write down your explanation.

Description:

Your given materials are:

- 1 candle
- 3 transparent glasses of different sizes

What to do:

1. Light the candle!
2. Put the smallest glass over the candle!
3. Write down what you have noticed!
4. Repeat the same with the bigger glasses and write down what you have noticed!

ALWAYS BE CAREFUL WHEN DEALING WITH FIRE. KEEP AWARE OF YOUR CLOTHES AND OTHER THINGS ON THE TABLE!

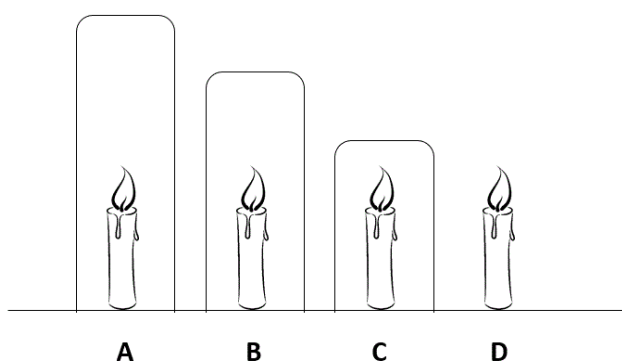


Figure 3 Candle experiment

Experiment of Group 2

General explanation group 1:

The water is not able to enter the glass because there is already air in the glass. Air is weighing less than water, so it rises up. The air is limited by the glass and cannot rise up any more; because of this the water cannot enter into the glass. So the piece of paper is still dry after pulling the glass out of the water.

Conclusion: Air is not nothing. Air has its own volume.

General explanation group 2:

Fire is in need of oxygen. By lighting a candle the fire uses oxygen (O_2) and converts it into carbon dioxide (CO_2). Carbon dioxide cannot be used to burn fire. When the glass is put over the candle, no new oxygen is able to enter the glass. So the candle uses up the oxygen till all oxygen has been burned and turned into carbon dioxide. When all the oxygen is used up the candle stops burning, because there is just carbon dioxide left inside the glass.

To understand the process happening in the glass when burning the candle, it is necessary to explain to the pupils that air is not just air. They have to understand that air consists out of different gases (oxygen and nitrogen).

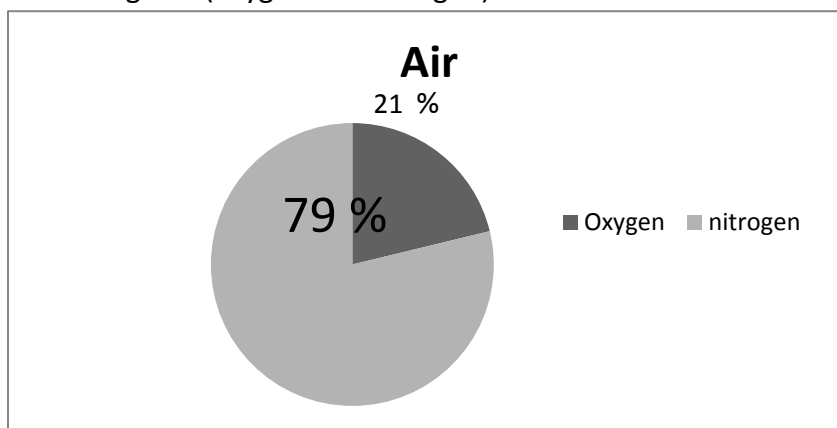


Figure 4 What is in our Air

Information for the teacher:

Actually air contains out of more than just oxygen and nitrogen. But for primary pupils it is enough to know oxygen and nitrogen. The real containments of air are:

- 78 % nitrogen (N_2)
- 21 % oxygen (O_2)
- 0,9 % Argon (Ar)
- 0,1 % trace gases

Oxygen is the gas which humans and animals use for breathing.

Nitrogen is just a gas which does not affect the life of humans.

By breathing oxygen, humans and animals breathe out carbon dioxide. Humans convert oxygen into carbon dioxide. This carbon dioxide rises up to the sky.

Information for the teacher:

Actually carbon dioxide is 1.5 times heavier than oxygen and nitrogen. Therefore it should sink to the ground. If this would happen all humans and animals would die as there would be only carbon dioxide left on the ground. But as there are different air circulations on our earth which are strong enough to carry the "heavy" carbon dioxide, the carbon dioxide gets mixed up with the whole air in our atmosphere. This is the explanation how the carbon dioxide reaches up into the atmosphere even though it is heavier than oxygen and nitrogen.

Comparison of a candle in a glass and humans in their environment:

Explanation: In the glass are no trees and plants. So the candle stops burning after all the oxygen is used. If a human lived in an environment without trees and plants he could not breathe anymore because there would be no reproduction of oxygen.

Conclusion: A candle in a glass can be compared to a human in an environment without trees, because the trees are producing the oxygen.

If the lesson is too long, or the knowledge is too much for the pupils is too much at once the lesson can be cut at this point. The rest of this lesson can be done in the beginning of the next lesson.

The pupils might not be aware of the function of trees and plants. The possibility is given to explain the principle of photosynthesis:

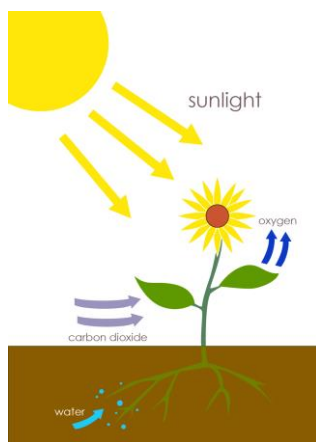
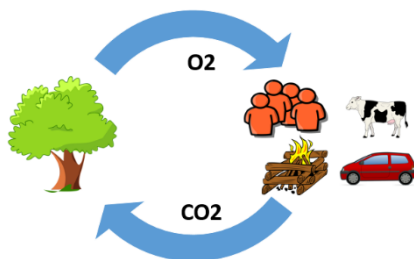


Figure 5 Photosynthesis

Photosynthesis is the principle when trees and plants use sunlight (light energy), carbon dioxide (CO_2) and water (H_2O) to produce oxygen (O_2) and sugar (their own "food"). They use the carbon dioxide which is produced by humans, animals and cars ... to produce fresh oxygen which the humans and animals need to live.

Connection between trees and humans:



O_2 = Oxygen

CO_2 = carbon dioxide

Figure 6 CO_2 – O_2 circulation

Without trees no oxygen! Without oxygen no life on earth!

Lesson 3: Plant a tree

If the last lesson was not concluded in one hour the last parts (principle of photosynthesis and connection between plants and humans) can be done with the pupils at this point. Otherwise a short repetition of the last lesson can be done.

Necessary Materials:

- Plastic bag for each pupil (or half of a plastic bottle)
- Soil
- Jatropha seeds (2 per pupil)
- Water
- Signs (so that every pupil can mark his/her tree)
- spades

As the Jatropha plant is also a part of the Renewable Energy School Program, it is recommended to plant Jatropha plants so they can later be used for further lessons.

The seeds will be planted into plastic bags, where they will grow until they are ready to put them into the ground outside.

How to plant Jatropha:

Step 1

Soak your Jatropha seeds in water for eight hours before planting them. This will soften the hull of the seed and encourage germination.

Step 2

Fill the large plastic bags with a mix made out of equal parts soil, sand and manure. Soak the soil in the bags thoroughly, and then press the seeds lightly into the wet mixture so that they are just underneath the surface. Leave the tops of the bags open. Then place the bags in a warm area. You should see a shoot emerge about six days after planting the seeds. Cut a couple of small holes in each of the corners of the bags so that the water which is too much can float out.

Step 3

Water the young plants two times a day for the next week. After one week you water the plants once a day for about eight weeks, after which the saplings are ready to be removed from the bag and transplanted into the ground.

Ideas for signs:

- a) Each pupil writes his name on a stone, using a water resistant pen, which he then puts into his plastic bag. Be sure that the stone is not lying on top of the seeds!
- b) Take the sprig of a tree and attach a paper with the pupils name written on it. Then you put the sprig into the plastic bag. Take care that the sprig is not stuck onto the seeds!

How to take care of your plant:

- Your plant needs enough sunlight. Put your plant in a place where it gets sunlight but isn't burned at midday.
- Your plant also needs enough water. Make sure to follow the instructions of watering your plant.

How to water your plant:

1 st week:	Water your plant the first day you plant it. Do not water it again in the first week.
2 nd week:	Water your plant two times per day. In the morning and in the midday before you leave school.
3 rd to 10 th week:	Water your plant one time per day.

Lesson 4: Water Pollution

This lesson is used to make the pupils aware of environmental pollution. The aim is that the pupils get a better understanding of how they pollute the environment. Another aim is to show them solutions how they can avoid polluting the environment. Therefore is the focus in this lesson set on “*Water Pollution*”. It has to be pointed out that most pollution results from human behaviour.

Necessary Materials:

- Stones
- Pieces of wood
- Ashes
- Caps of Soda bottles
- Cooking Oil
- Washing Powder
- Pieces of plastic bags
- Half of 1,5 Litre bottles (each group needs two)
- Small pieces of cloth/kanga
- Worksheet “Lesson 4 – Water Pollution” (Annex Page 30)

The Class can be split up into small groups. Each group gets a small bucket (or half of a plastic bottle) and the following materials:

- Stone
- Piece of wood
- Ash
- Cap of soda
- Pieces of plastic bags
- Cooking Oil
- Soap powder

Experiment Water Pollution:

Before the pupils do the experiment they have to write down which material will pollute the water and which material will not pollute the water. They also have to write down if the material is something natural or something produced by humans.

The following table is also printed on the worksheet for the pupils.

The worksheet can be found in the annex of Teaching Unit - Environment (Page 30).

Material	Pollution (Yes/No)	Natural	By humans
Stone	No	x	
Piece of wood	No	x	
Ash	Yes	x	x
Cap of Soda	Yes		x
Pieces of Plastic Bags	Yes		x
Cooking Oil	Yes	x	x
Soap Powder	Yes		x

All things produced by humans are polluting the water. But also some natural materials like oil (fossil energy produced by the nature but used by the humans) and ash (rest of burned firewood and coal but also produced by volcanoes) are polluting the water.

The experiment is based on the idea that the pupils have to try to clean their water after polluting it. Materials, which can help them and should be handed out to the pupils, are listed below:

- Another bucket (or half of an 1,5 Ltr. bottle)
- A small piece of cloth (piece of an old kanga)

None of the groups will achieve perfectly clean water as it is not possible to clean it with the materials given. The best way would be to filter the whole water through the piece of cloth into the other bucket. This experiment shows the pupils that they will not be able to clean the water once they have polluted it.

Additional Idea:

When all groups has finished "cleaning their water" it could be a fun method to have one pupil of each group to step in front of the class with their water. Then all the pupils will be able to see the different results from the groups. Ask each pupil "Would you ever drink this water?" to get the answer "No I would not!" from everybody. By asking them if they would drink dirty water which they polluted themselves, they will understand the problem of water pollution more.

The following table (concerning water pollution) can be filled out together with the pupils:

Water Pollution	Air Pollution
<p><i>Examples:</i></p> <ul style="list-style-type: none"> • washing clothes in the river • throwing waste into the rivers/lakes 	<p><i>Examples:</i></p>
<p><i>Problems:</i></p> <ul style="list-style-type: none"> • dirty water • drinking dirty water causes illness • the more water is polluted, the less drinking water exists -> water shortage 	<p><i>Problems:</i></p>
<p><i>How to avoid:</i></p> <ul style="list-style-type: none"> • Do not throw your waste into lakes and rivers • Wash your clothes in buckets and do not throw the dirty water back into the river • Reduce your waste: <ul style="list-style-type: none"> - Use plastic bags more than one time or even use cloth bags 	<p><i>How to avoid:</i></p>

Lesson 5: Air Pollution

Necessary materials:

- Handout “Air Pollution” (Annex Page 31)

The understanding of air pollution is very important and necessary for the further teaching on fossil energy, climate change and even renewable energy technologies. It is recommended to ask the pupils for their experiences with polluted air (e.g. cooking inside -> smoke burns the eyes)

After the pupils are finished working with the handout “Air Pollution” the lesson can go on by filling out the gaps of Air Pollution in the following table.

Water Pollution	Air Pollution
<i>Examples:</i> <ul style="list-style-type: none">• washing clothes in the river• throwing waste into the rivers/lakes	<i>Examples:</i> <ul style="list-style-type: none">• driving cars• burning waste• burning firewood, oil, coal, ... (for cooking & light)
<i>Problems:</i> <ul style="list-style-type: none">• dirty water• drinking dirty water causes illness• the more water is polluted, the less drinking water exists -> water shortage	<i>Problems:</i> <ul style="list-style-type: none">• smoke in the air can cause diseases• burning firewood, oil, coal and driving car emits carbon dioxide (CO₂)• CO₂ contributes to climate change
<i>How to avoid:</i> <ul style="list-style-type: none">• Do not throw your waste onto the ground and in lakes and rivers• Wash your clothes in buckets and do not throw the dirty water into the river• Reduce your waste:<ul style="list-style-type: none">- Use plastic bags more than one time or even use cloth bags	<i>How to avoid:</i> <ul style="list-style-type: none">• Do not drive car if it is not necessary. -> Walk, ride your bicycle or use public transport• Use improved cook stoves for cooking, they need less firewood• Use solar lamps instead of expensive oil lamps• Plant trees, they produce oxygen out of carbon dioxide

General explanation for environmental pollution:

Introducing foreign substances (plastic, fuel, carbon dioxide ...) into the nature (soil, water and air) which are mostly produced by humans is called environmental pollution.

These substances influence the natural environment in a bad way and can also be harmful for us humans as we depend on the environment around us.

Lesson 6: Fossil Energy & Climate Change

The aim of this lesson is to create a general understanding on fossil energy and to explain the connection of fossil energy, air pollution, greenhouse effect and climate change. As this lesson is very long and the pupils will get a lot of new knowledge it is highly recommended to split this lesson into two parts. A way to split this lesson could look like this:

- Part One: - Fossil Energy + Greenhouse Effect
- Part Two: - Global Warming + Repetition

Necessary Materials:

- Handout "Fossil Energy" (Annex Page 32)
- Handout "Greenhouse Effect" (Annex Page 33)
- Handout "Global Warming" (Annex Page 34)

There are different opportunities how to use the three handouts .

1st opportunity:

Each pupil gets each handout beginning with the *Fossil Energy* handout, followed by *Greenhouse Effect* handout and at last *Global Warming / Climate Change* handout.

Advantages:

- every pupil gets each handout
- every pupil can work on his own speed and is not depending on other pupils

Disadvantages:

- You need many paper copies (30 pupils = 90 paper copies)
- Some pupils are maybe working faster than other. So some will be finished with the lesson earlier than others.

2nd opportunity:

Different groups are created (4 pupils per group). Together they have to work on the handouts and answer the questions. Every group starts with Fossil Energy, following Greenhouse Effect and then Climate change/Global Warming.

Advantages:

- You don't need as many paper copies (30 pupils = 8 groups = 24 paper copies)
- The pupils might be able to answer the questions better when more people think together and share their ideas to get an answer.

Disadvantages:

- It is not guaranteed that each pupil is really working with the handout. Some may work harder than others and some pupil may not even care about the tasks.
- 24 paper copies are not as much as 90 copies, but still much.

3rd opportunity:

Different groups are created (4 pupils per group). Together they have to work on the handouts and answer the questions. Each group starts with a different handout. Once they are finished with answering the questions on their paper, the groups change their handout with other groups.

Advantages:

- You don't need many paper copies (30 pupils = 8 groups = 8 paper copies)
- The pupils might be able to answer the questions better when more people think together and share their ideas to get an answer.

Disadvantages:

- It is not guaranteed that each pupil is really working with the handout. Some may work harder than others and some may do not even care about the tasks.
- Some groups are maybe faster than others, so they will not be able change the paper copies on time and might have to wait for the other groups.

4th Opportunity:

The class is divided into three groups. Each group gets a different handout to work on. They get about 10-15 minutes time to read the text and answer the questions. After that time they have to give their handout to another pupil of another group. For working on all three different papers, the pupils will have a total time of 30 -45 min.

Advantages:

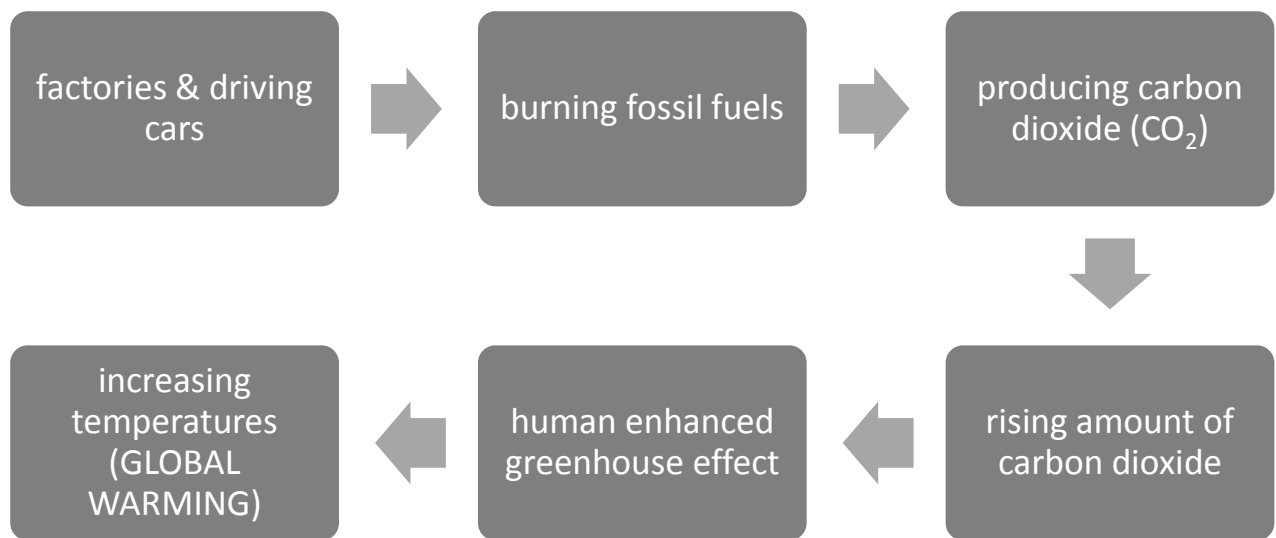
- Each pupil is working by himself.
- You only need one paper copy for each pupil (30 pupils = 30 paper copies)
- They are limited in their time and get trained in working good AND fast.

Disadvantages:

- Not every pupil will have answered the questions after the given time and may have to give his paper to another pupil before answering the questions

These are just ideas. Depending on the school and the class/pupils each teacher knows how to handle his pupils and how to let them work on the worksheets the best.

This figure explains the connection between fossil fuels and global warming.



Explanation:

When factories produce products or humans drive cars, we are in need of energy. This energy is mostly taken from fossil energies like gas, oil or coal. By burning fossil energies, carbon dioxide is produced. Carbon dioxide is the most produced greenhouse gas and contributes to the greenhouse effect enhanced by us humans. This means that we, by burning fossil energy, produce carbon dioxide. The more carbon dioxide gets produced, the stronger the greenhouse effect is influencing our climate. This results in higher temperatures on earth. Higher temperatures on earth are called Global Warming or also Climate Change.

Lesson 7: Renewable Energy

This lesson is supposed to create an overview about renewable energies. As it seems to be very difficult for the pupils to understand the difference between fossil and renewable energies, the focus will be set on this difference.

Sources of energy are for example:

→ Oil, Gas, Coal, Solar, Biogas, Hydro, Wind, Wood

Explanations:

Oil: A liquid that can be used as a source of energy by burning it to run machines or use oil lamps.

Natural Gas: By burning gas, you can cook or even create electricity through generators.

Coal: By burning coal you can create heat and electricity through generators.

Solar: A solar panel is able to convert sunlight into electricity.

Wind: A wheel on a tower starts to rotate through moving air and produces electricity through a generator.

Hydro: Wheels in the water start to rotate through moving water and produce electricity through a generator.

Biogas: Bacteria of cattle dung produce biogas by eating food waste. This biogas normally is used for cooking and also lightening.

Wood: Wood can be used as a source of energy by burning it for cooking or heating.

This table clarifies the type of energy and its influence on our environment:

You can try to fill out this from together with the Students, a blank version of this sheet can be found in the Annex.

Name	Solar	Wind	Hydro	Biogas	Wood	Natural Gas	Coal	Oil
Source	Sunlight	moving air	Moving water	Bacteria producing gas	Trees	Stored energy from millions of years ago		
Sort of Energy	Electricity Warmth	Electricity	Electricity	Gas	Firewood Charcoal	Electricity gas	Electricity Coal	Electricity Oil
Renewable (RE) or fossil Energy?	Renewable Energy sunlight every day	Renewable Energy wind every day	Renewable Energy moving water every day	Renewable Energy bacteria produce gas every day	Renewable Energy trees are growing slowly	Fossil Energy no reproduction of fossil energy		
Does it produce carbon dioxide	No	No	No	No	Yes	Yes	Yes	Yes
Does it support greenhouse effect?	No	No	No	No	Yes	Yes	Yes	Yes
Does it contribute to Global warming/ Climate Change?	No	No	No	No	Yes	Yes	Yes	Yes

Lesson 8: Test & Evaluation

This lesson can be used to revise the lesson and to let the pupils take a test about the subjects taught and the activities that were performed.

A draft for a test is added to the annex of Teaching Unit Environment (Lesson 8 – Test) (Page 35)

Lesson 9: Results and Review

In the last lesson the teaching about environment is finished.

An evaluation can be done together with the pupils and certificates can be given to the pupils.

Drafts for an evaluation (Page 36) and certificate (Page 82) are added to the annex.

Annex of Teaching Unit – Environment

	Page
1. Handout “Lesson 2 – Has air a volume?”	25
2. Handout “Lesson 2 – Candle Experiment”	26
3. Handout “Lesson 4 – Water Pollution”	27
4. Handout “Lesson 5 – Air Pollution”	28
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7. Handout “Lesson 6 – Climate Change & Global Warming”	31
8. Test about Environment	32
9. Evaluation of Environment phase	33

Group 1:

Subject: Has air a volume?

Tasks:

1. Read the description of this experiment.
2. Think about what will happen when you put the glass into the water. Will the paper be wet or will stay dry? Write down your suggestions.
3. Do the experiment. Is the paper wet or dry? Was it easy to put the glass under the water? Write down what you noticed!
4. Suggest in your group why this happened and write down your explanation.

Description:

You have a bowl, a glass and a piece of paper. Your task is to fix the piece of paper with the cap in the glass. Then you put the glass slowly upside down into the water till the glass reaches the bottom. Wait some seconds and pull it out again.

Group 1:

Subject: Has air a volume?

Tasks:

1. Read the description of this experiment.
2. Think about what will happen when you put the glass into the water. Will the paper be wet or will stay dry? Write down your suggestions.
3. Do the experiment. Is the paper wet or dry? Was it easy to put the glass under the water? Write down what you noticed!
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Description:

You have a bowl, a glass and a piece of paper. Your task is to fix the piece of paper with the cap in the glass. Then you put the glass slowly upside down into the water till the glass reaches the bottom. Wait some seconds and pull it out again.

Group 2:

Subject: Usage of Air

- Task:
1. Read the description of the experiment.
 2. Suggest what happens when you put a glass over the candle. In which way could the different sizes influence what you suggest? Write down your suggestions.
 3. Do the experiment and write down what you noticed.
 4. Suggest in your group why this happened. Write down your explanation.

Description:

Your given materials are:

- 1 candle
- 3 transparent glasses of different sizes

What to do:

1. Burn the candle!
2. Put the smallest glass over the candle!
3. Write down what you noticed!
4. Do the same with the bigger glasses and write down what you noticed!

ALWAYS BE CAREFUL WHEN DEALING WITH FIRE. KEEP CARE OF YOU CLOTHES AND OTHER THINGS ON THE TABLE!

Group 2:

Subject: Usage of Air

- Task:
1. Read the description of the experiment.
 2. Suggest what happens when you put a glass over the candle. In which way could the different sizes influence what you suggest? Write down your suggestions.
 3. Do the experiment and write down what you noticed.
 4. Suggest in your group why this happened. Write down your explanation.

Description:

Your given materials are:

- 1 candle
- 3 transparent glasses of different sizes

What you have to do:

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ALWAYS BE CAREFUL WHEN DEALING WITH FIRE. KEEP CARE OF YOU CLOTHES AND OTHER THINGS ON THE TABLE!

Subject: Water Pollution

This experiment is used to have a look on Water Pollution. Many rivers are full with waste, but in which way does this waste influence the water quality? In this experiment we will have a look on how the water looks like after we've put waste into it.

Tasks:

1. Read the description of the experiment!
2. Think about which material is pollution and which material not and also think about where the material comes from. Is it a natural material or is it produced by humans, or maybe both?
Fill out the table! (make a cross whether it is by nature or by humans)

Material	Pollution (Yes/No)	By Nature	By Humans
Stone			
Piece of Wood			
Ashes			
Cap of Soda			
Pieces of Plastic			
Oil			
Soap Powder			

3. Put the materials in the following order into the bucket filled with water:
 1. Stone
 2. Ash
 3. Piece of Wood
 4. Cap of Soda
 5. Pieces of Plastic
 6. Oil
 7. Soap Powder

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Fill out the table! (make a cross whether it is by nature or by humans)

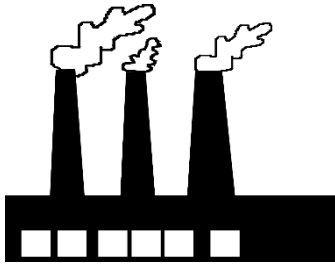
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Ashes			
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 4. Cap of Soda
 5. Pieces of Plastic
 6. Oil
 7. Soap Powder

Air Pollution

Air pollution occurs when gases, dust and smoke are introduced into the atmosphere in a way that makes it harmful to humans, animals and plants.

We humans always emit gases and smoke into nature. **Factories** are producing much smoke as they are in need of much energy to produce their products. We also emit much smoke and gases by driving **cars**, **burning waste**, burning **firewood** and coal for cooking and oil for lightning. By burning firewood, oil and coal for cooking and driving cars, we send much smoke and gases into nature.



Polluted air can cause different problems. Mostly in cities there is polluted air because of the many cars and busses driving through the town. Breathing this dirty air can influence your health.

Figure 7 Industry pollution

Also when you cook at home with fire-wood or charcoal you produce smoke. You may have recognized that it is not very pleasant to breathe this smoke as you have to cough. Also maybe your eyes get red or produce tears. **Breathing smoke every day in town and at home is harmful to your health.**



Figure 8 Car pollution

But how can you reduce air pollution?

As cars and busses are emitting harmful gases and smoke you can decide to **walk or ride your bike instead of driving a car.**

At home you can **use improved cooking stoves.** These cook stoves are in need of less firewood. So you reduce the smoke which is produced while cooking.



Figure 9 Save the planet

Carbon dioxide is one of the gases of air pollution. Trees can use this gas to create fresh oxygen. So they clean our air. You can support cleaning our air by **planting new trees and stop cutting them!**

You remember that factories are polluting the air while producing their products? So every new product which you buy has polluted the air during its production. **Reuse your things!** Do not use plastic bags just one time. Use them several times because every newly produced product pollutes the air during the production process.

Tasks: (write your answers on the back of the paper)

1. How do we pollute our air?
2. Which problems are caused by air pollution?
3. What can you do to reduce air pollution?

Fossil Energies

Fossil energy is energy generated from decayed plants that have accumulated below the earth. Millions of years ago, long before human beings existed, the sun had already initiated the growth of plants on land and in the ocean. They grew and died, were deposited underground and pressed by moving continents. The decay resulted in large amounts of coal, oil and natural gas named FOSSIL ENERGIES.

→ *Coal, oil and natural gas are fossil energy sources from millions of years ago.*

There are some **problems** by using fossil energies:

- Once you have burned oil, gas or coal you cannot use it another time. So one day all oil, coal and gas of the world will be used up because they are not reproduced.
 - **Coal will last for 192 more years!**
 - **Gas will last for 68 more years!**
 - **Oil will last for 43 more years!**
- Burning oil, coal and gas emits *carbon dioxide*. Carbon dioxide is a so called “*greenhouse gas*” which contributes to climate change. Climate change refers to the phenomenon that the temperature on the earth is increasing what causes different problems.

Tasks: *(write the answers on the back of the paper)*

1. Name three fossil energy sources!
2. How and when was the fossil energy sources created?
3. Why are fossil energies running out?
4. Why are fossil energies contributing to the increasing temperatures on earth?

Natural Greenhouse effect

The greenhouse effect is a natural interaction between sun and earth. The greenhouse effect is important. Without the greenhouse effect the earth would not be warm enough for humans to live and the average temperature of the earth would be -18°C . This means that it would be very cold, everywhere would be snow and ice and humans would not be able to live. But through the Greenhouse Effect, the average temperature on earth is 15°C .

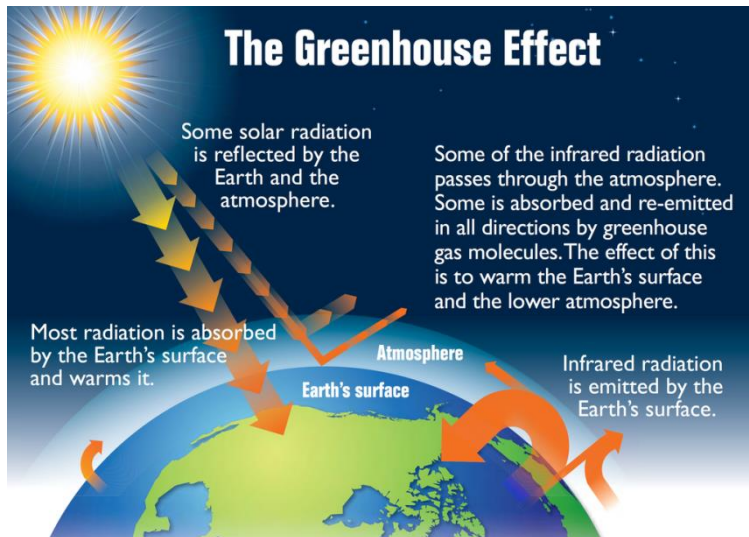


Figure 10 The greenhouse effect

Around the earth is the so called atmosphere. The atmosphere is built out of different gases. As the sun is shining sunlight reaches the earth. The earth reflects a part of the sunlight like a mirror. Some of the sunlight which gets reflected just passes out in space; some hits the greenhouse gases in the atmosphere. As the greenhouse gases are hit by the sunlight they reflect the sunlight back to earth. Because the sunlight cannot go back to space they heat up the earth and the atmosphere. Because of this warmth kept by the greenhouse gases we have a temperature being warm enough for human life on earth.

Human Enhanced Greenhouse Effect

The mainly produced greenhouse gas is called carbon dioxide. Carbon dioxide is produced by burning oil, coal, firewood and charcoal. We humans burn a lot of oil, coal and gas, called fossil energies every day.

Carbon dioxide is one of the greenhouse gases in the atmosphere which heats up the atmosphere. The more we burn oil, coal, gas, firewood and charcoal, the more carbon dioxide is produced.

The problem is that the more carbon dioxide is produced, the more the atmosphere will be heated. This leads to increasing temperatures on earth.

Increasing temperatures on earth are called **GLOBAL WARMING**.

Tasks: (write your answers on the back of the paper)

1. Why is the natural greenhouse effect important for human life?
2. What is the name of the mainly produced greenhouse gas?
3. How are we humans influencing the greenhouse effect?
4. Is the average temperature on earth increasing when carbon dioxide gets produced?

Climate Change & Global Warming

Since humans are burning a lot of oil, gas and coal the air gets polluted as we produce a lot of carbon dioxide. Carbon dioxide together with other greenhouse gases is responsible for the increasing temperatures on earth because of the *greenhouse effect*.

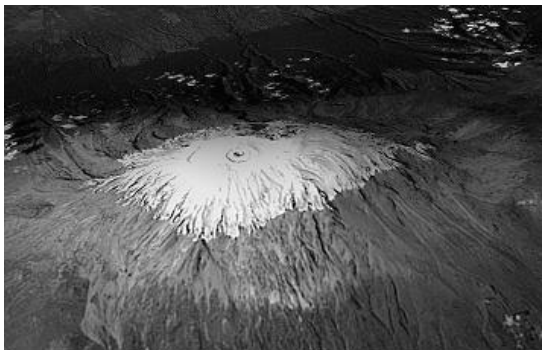
Increasing temperatures on earth are called **GLOBAL WARMING**.

Another problem is that we humans cut a lot of trees and use them for firewood. But the trees convert *carbon dioxide* into *oxygen*. So we burn a lot of oil, coal and gas and produce a lot of carbon dioxide, but we also cut the trees which can produce useful oxygen out of carbon dioxide.

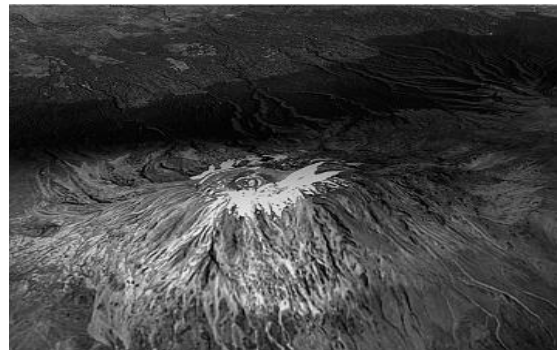
Increasing temperatures are dangerous for us humans, especially in African countries like Tanzania where it is already very hot.

Problems which result out of climate change are:

- More **dry seasons** will come up especially in countries near the equator like Tanzania. This causes a **lack of water**, so farmers cannot water their fields. This results in **less food** for the citizens. A lack of water also means less water to drink for humans.
- The **ice and snow** on Kilimanjaro **melts** until there will be no more ice and snow.
- As ice and snow is melting all over the world, the **sea level will rise** because more water reaches the sea. Cities like Dar es Salaam, Tanga and Stonetown at the coast will be in **danger of floods**.



*Figure 11 Snow on
Kilimanjaro Feb. 1993*



*Figure 12 Snow on
Kilimanjaro Feb. 2000*

Tasks: (write the answers on the back of the paper)

1. Why is it bad to cut all the trees?
2. Does emitting carbon dioxide contribute to Global Warming?
3. With climate change, there will be more dry seasons. Why are those dry seasons dangerous for us humans?
4. What is the problem when the sea level is rising?
5. Compare the two pictures of Kilimanjaro. What is the difference? Why is it like that?

RE School Program

- Test about Environment –

Name:

Standard:

Date:

Answer the following questions:

1. The following words describe different things which belong to our environment. Write next to the words if it they originate from our “*natural environment*” or are “*produced by humans*”.

- a) trees :
- b) streets :
- c) rivers :
- d) stones :
- e) houses :
- f) rubbish :

2. What is the name of the gas which is produced by plants and trees?

3. Write down 2 different examples of *Air Pollution*:

4. Write down 2 Problems which are caused by *Air Pollution*!

5. The following materials are put into a river. Tick whether it is pollution throwing it into the water or not:

	Pollution?	
	YES	NO
stone	<input type="checkbox"/>	<input type="checkbox"/>
soap powder	<input type="checkbox"/>	<input type="checkbox"/>
oil	<input type="checkbox"/>	<input type="checkbox"/>
wood	<input type="checkbox"/>	<input type="checkbox"/>
cap of soda	<input type="checkbox"/>	<input type="checkbox"/>

6. Is the average temperature on earth increasing?

☐ Yes ☐ No

7. Write down three different *Fossil Energy Sources*.

8. What is the name of the gas which is produced by us when we drive by car or burn wood and oil?

RE School Program

- Evaluation of Phase 1, Environment-

1	Which two parts did you like ...	
	...the most?	...the least?
Candle experiment	<input type="checkbox"/>	<input type="checkbox"/>
Planting trees	<input type="checkbox"/>	<input type="checkbox"/>
Water Pollution	<input type="checkbox"/>	<input type="checkbox"/>
Air Pollution	<input type="checkbox"/>	<input type="checkbox"/>
Fossil Energy	<input type="checkbox"/>	<input type="checkbox"/>
Greenhouse effect	<input type="checkbox"/>	<input type="checkbox"/>
Global Warming/Climate Change	<input type="checkbox"/>	<input type="checkbox"/>

2 How many new things did you learn? (tick for each subject just one gap)				
	Very much	Much	Not that much	nothing
Environment				
Trees				
Pollution				
Fossil Energy				
Greenhouse effect				
Global Warming				

3 How did you like the lessons overall? (write your statement)

4 What was your absolute favorite action during the teaching?

Renewable Energy School Program



Teaching Unit - Jatropha & Biogas -

The overall idea of this teaching unit is to explain and show pupils the advantages and possibilities of the Jatropha plant and biogas systems.

Practical activities like journeys, producing soaps and biogas experiments are listed in this teaching unit.

The teaching unit is worked out for a timeframe of 7 teaching lessons.

One teaching lesson is equivalent to about 60 min.

Timetable:

Lesson	Activity
1 st	Introduction to Jatropha
2 nd	Plant Jatropha Trees
3 rd	Produce Jatropha Soaps
4 th	Introduction to Biogas, build your own Biogas Plant
5 th	Journey to a Biogas Plant
6 th	Write Test and evaluate teaching
7 th	Results and Certificates

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Lesson 1: Introduction to Jatropha

In this lesson, the pupils will be introduced to Jatropha and its advantages.

The following text informs the teacher about Jatropha:

The Jatropha plant (full name “Jatropha Curcas”; Kiswahili = Mbono) is native to the American tropics (Mexico and Central America) but is cultivated in tropical and subtropical regions all over the world.

Jatropha reaches a height of 6m (20ft) lasts for about 50 years and grows even in very dry regions as it is not in need of much water.

Jatropha is a poisonous small tree. Eating Jatropha seeds results to vomiting and diarrhea. The Jatropha seeds contain 27 – 40% oil. This oil can be used for the production of biodiesel fuel, soap production, candle production it or can be used with special cook stoves for cooking or with oil lamps for lightning.

When the plant is 3 years old you get the first crops. From year to year the plant produces more and more crops until a maximum of 3 kg Jatropha seeds per year.

Out of 4 kg seeds, about 1 Liter Jatropha Oil can be produced.



Figure 13 Jatropha plant



Figure 14 Jatropha leaves and fruits



Figure 15 Dry fruits and seeds

Necessary Materials:

- Jatropha Seeds
- Jatropha Seed Cake
- Jatropha Oil
- Jatropha Oil lamp
- Jatropha Soap

If the pupils already planted Jatropha plants during the Teaching Unit about environment a short follow up outside with their plants can be done, how they were proceeding the last weeks/months.

Outside things like photosynthesis, benefits of trees or other important things out of the Teaching Unit “Environment” can be repeated.

Benefits of Jatropha:

- **Natural Fence:**

Animals are afraid of the plant as they get sick when they eat the leaves and seeds.

→ The plants can be used as a **natural fence** for fields to protect the crops from animals



Figure 16 Jatropha fence

- **Oil:**

By pressing the seeds you get oil. This oil can be used for several activities:

Lamps: light oil lamps by using Jatropha oil

Soaps:

By mixing Jatropha oil with a chemical liquid (caustic soda) you can produce soap.



Figure 17 Jatropha soap

- **Health:** Jatropha soap prevents you from skin diseases like fungus, ringworm, pimples, rashes and spots.
The latex of Jatropha leaves can be put on wounds to speed up the healing process.

- **Biogas:**

The Jatropha seed cake is an excellent material to run a biogas system. Out of 200 kg Jatropha seed cake you can get the same amount of biogas as with 1000 kg cattle dung.

- **Cooking:**

The Jatropha seed cake can be used for cooking using a special Jatropha cook stove.

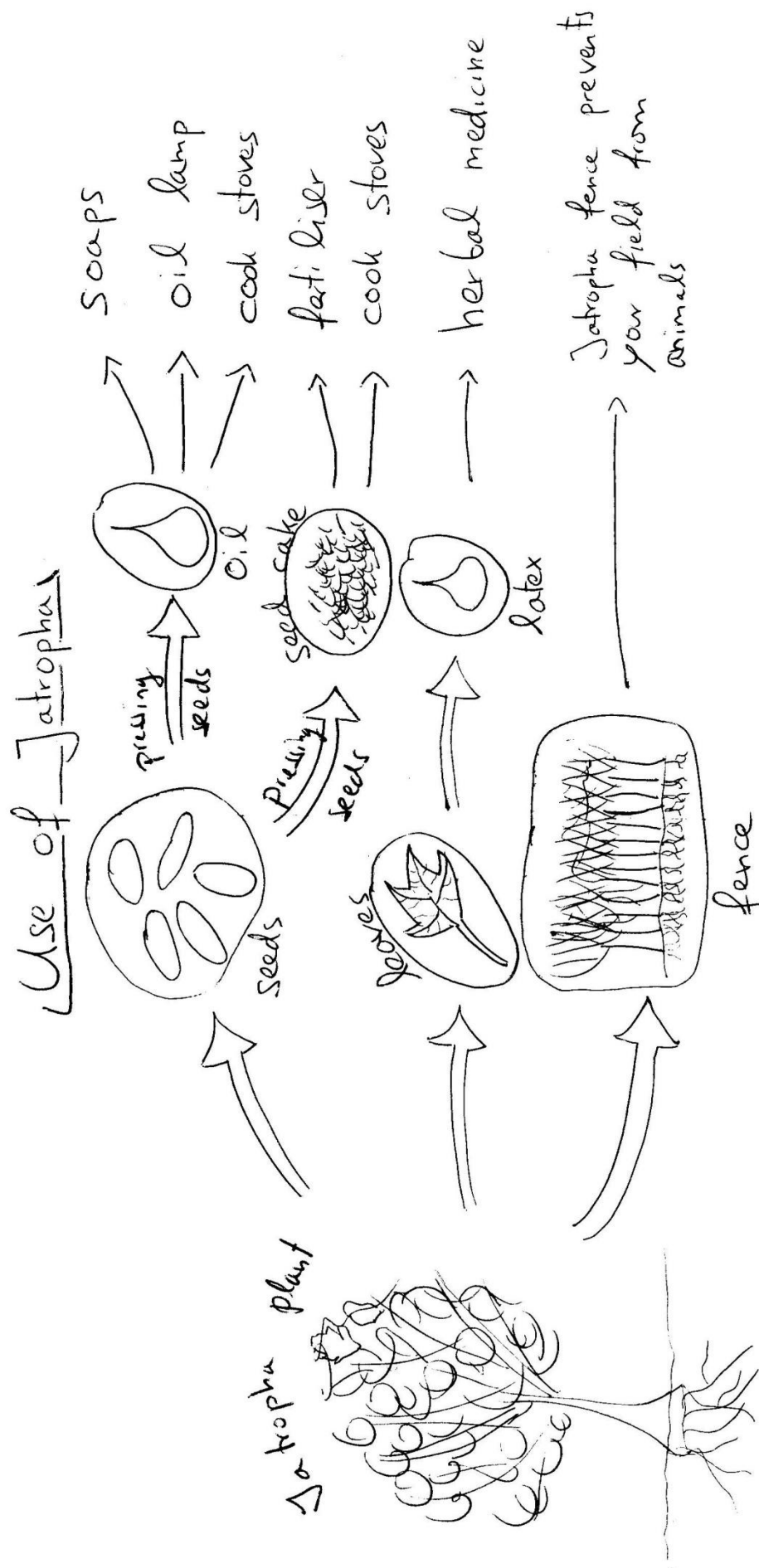


Figure 18 Use of Jathropa

Calculation:

This calculation can be done together with the pupils so they can realize that it is possible to earn money with Jatropha.

Necessary facts for calculation:

- a) From one plant you get 3 kg Jatropha Seeds per year.
- b) Out of 4 kg you get 1 liter Jatropha Oil.
- c) 1 soap can be sold for 500 TZS.

1. From one plant you get 3kg seeds per year. How many kg do you get from four plants per year?

Answer: 12 kg

2. Out of 4 kg Jatropha seeds, you get 1 Liter Jatropha oil.
How much oil do you get out of 12 kg Jatropha seeds?

Answer:

$$\begin{array}{rclcl} & 4 \text{ kg} & = & 1 \text{ Liter} \\ 3 \times & 4 \text{ kg} = 12 \text{ kg} & = & 3 \text{ Liter} \end{array}$$

3. When you produce soaps, you mix Jatropha Oil with Caustic Soda (a chemical liquid).
Out of 1 Liter Oil, you can get up to 50 pieces of soap.
How many pieces of soap do you get out of 3 Liter oil?

Answer:

$$\begin{array}{rclcl} 1 \text{ Liter Oil} & = & 50 \text{ Soaps} \\ 3 \text{ Liter Oil} & = & 150 \text{ Soaps} \end{array}$$

4. One piece of soap can be sold for about 500 TZS.

- a) How much money do you get from 50 pieces of soap?
- b) How much money do you get from 150 pieces of soap?

Answer:

$$\begin{array}{rclcl} a) & 1 \text{ Soap} & = & 500 \text{ TZS} \\ & 50 \text{ Soaps} & = & 25.000 \text{ TZS} \end{array}$$

b) 150 Soaps = 75.000 TZS

We conclude:

Planting 4 Jatropha plants, you get 12 kg seeds per year. Out of 12 kg seeds you get 3 Liter Jatropha Oil. Out of 3 Liter Jatropha Oil you can produce up to 150 soaps. Selling one piece of soap for 500 TZS you get for up to 75.000 TZS for 150 pieces of soap. *(Note: it will take a couple of years until the plants will produce seeds)*

This calculation is valid for 4 plants.
Imagine you would plant 40 plants?

How much money can you earn with 40 plants?

Answer:

$$\begin{array}{rclcl} 4 \text{ Plants} & = & 75.000 \text{ TZS} \\ 40 \text{ Plants} & = & 750.000 \text{ TZS} \end{array}$$

Lesson 2: Plant Jatropha Plants

For this lesson, there are two different opportunities to design it. This depends on the previous activities. If the pupils already planted Jatropha seeds during the teaching lessons about environment, these small plants can be transplanted out of the bags. If they have not planted Jatropha seeds yet, this lesson can be used for planting seeds.

Opportunity 1: Plant a fence

Necessary Materials:

- Spades
- Water
- Jatropha Plants (at least 10 weeks old)

A School fence can be planted using the small Jatropha plants.

The original idea of a fence using Jatropha plants is to protect fields so that animals will not be able to eat the planted crops. Animals are afraid of eating Jatropha seeds and Jatropha leaves as they will vomit and get diarrhea after eating.

So the animals will not pass the fence and do not enter the field.

When planting the fence, the used Jatropha plants should be at least 10 weeks old. Otherwise they will not survive. To get a close fence the plants have to be planted in a distance of 20cm to each other.

Opportunity 2: Planting Jatropha seeds

Necessary Materials:

- Plastic Bag for each pupil
- Soil
- Jatropha seeds (2 per pupil)
- Water
- spades
- Signs that every pupil can mark his/her tree

The seeds will be planted into plastic bags, where they will grow until they are ready to put be outside into the ground.

It is important to put the plants into place where they are safe from rain. Too much rain will create hard mud in the bags and the seeds cannot grow.

Step 1

Before Jatropha seeds are ready to plant they have to be dried for at least two days in the sun. You will not be successful planting seeds without drying them first.

Step 2

Soak your Jatropha seeds in water for eight hours before planting. This will serve to soften the hull of the seed and encourage germination.

Step 3

Fill large plastic bags with a mix made of equal parts soil, sand and manure. Soak the soil in the bags thoroughly, and then press the seeds lightly into the wet mix so they are just underneath the surface. Leave the top of the bags open and place the bags in a warm area. You should see a shoot emerge within six days.

Cut some small holes in each corner of the bags so that the water which is too much can flow out.

Step 4

Water the young plants two times a day for the next week, and then once a day for about eight weeks. After that the saplings are ready to be removed from the bag and transplanted.

To guarantee that each pupil remembers his plant the pupils can produce some signs with their name on it which can be put to the plants.

Ideas for signs:

- c) Each pupil writes his name on a stone, which he puts into his plastic bag, using a water resistant pencil. Make sure that the stone is not lying on top of the seeds!
- d) Take a sprig of a tree and attach a paper with the name of the pupil written on. Then you stick the sprig into the plastic bag. Take care that the sprig is not stuck onto the seeds!

How to take care of your plant:

- Your plant needs enough sunlight. Not too much but also enough. Put your plant at a place where it gets sunlight but isn't burnt at midday.
- Your plant needs enough water. Make sure to follow the instructions of watering your plant.
- Insects like to eat the leaves of *Jatropha*. Eating them is not that big of a problem, because the plant will always keep on growing. But have a look sometimes and remove the insects from the plants.

How to water your plant:

- | | |
|---|---|
| 1 st week: | Water your plant the first day you plant it. Water it again after some days. But not too much, just a little bit. (Always depending on the condition of the soil) |
| 2 nd week: | Water your plant two times per day. In the morning and at midday before you leave school. |
| 3 rd to 10 th week: | Water your plant one time per day. |

Lesson 3: Producing Jatropha Soaps

This lesson consists of 2 units on two different days. The first day is used to produce the mixture and fill it into pipes. On the second day, the mixture will already be dry and ready to cut it into small pieces.

It is recommended to contact KAKUTE Ltd. to get more information about how to produce Jatropha soaps.

Necessary materials:

- 1 Liter Jatropha Oil
- 0,5 liter Caustic Soda
- 2 pipes (Ø 2 inch / 5cm; height: 11 to 14 inch/ 30 to 40 cm)
- 4 pieces of Plastic Bags
- 2 cords
- Big spoon
- Bucket (at least 3 liter volume)
- Measuring cup
- Stick
- Small plastic cup (Ø smaller than the pipe)
- twist

How to produce Jatropha soaps:

Day 1:

1. Measure 1 litre of Jatropha oil and fill it into the bucket.
2. Measure 0.5 litre of Caustic Soda. Add caustic soda into the mixture, adding small amounts into the mixture from time to time. Do not put in all of the caustic soda at once.
3. While filling the Caustic Soda into the bucket you have to agitate the mixture for about 10 to 15 minutes. Make sure to agitate it in just one direction the whole time.
4. Prepare the pipes while one pupil agitates the mixture. One end of the pipe has to be closed using a double lay of small pieces from a plastic bag. Use the cord to fix the plastic.
5. When the mixture is ready you can fill into the pipe. The end with the plastic bag on the end has to be on the bottom. Fill the pipes until a 3 cm/1,5 inch long space is left on the top of the pipe.
6. Place the filled pipes at a safe place where nobody will touche it. Keep care when carrying the pipes because the mixture can easily float out of the bottom as the fixed plastic bag is not stout. Keep your hand under the pipe when carrying it.

After one day (24 hours) the mixture is dry enough to remove it from the pipes.

If the mixture stays too long (more than 2 days) in the pipes it cannot be removed anymore as the mixture gets too hard.

Day 2:

7. Open the cord and remove the plastic from the bottom.
8. Turn the pipe upside down (the end with a little bit of space should be down)
9. Knock the pipe onto a table/ground to unfasten the mixture.
10. Take the stick, put the small plastic cup on the top and press the soap out of the pipe.
11. Press only 2 cm (1 inch) soap out of the pipe. Another pupil takes the twist, fixes it in his left and right hand and cuts small pieces of soap (1,5 cm/ 0,5 inch thick). While cutting another pupil should make sure that the cut soap does not fall down. He/She takes it and puts in on a table.
12. When finished with cutting the soaps place them on a table where they get dry for at least 7 days. After that the soap is ready for usage.

Information:

Out of 1 Liter Jatropha oil and 0,5 liter caustic soda you get about 40 to 50 pieces of soaps, depending on the diameter and height of the pipes and the thickness of the soaps.

Lesson 4: Introduction to Biogas

This lesson is used for introducing the pupils to biogas. In this lesson a small biogas plant will also be built together with the pupils so that they can get first experiences with biogas.

Necessary Materials:

- Big 1,5 Liter plastic bottle (each group one)
- Cattle dung
- Food for the bacteria (flour & sugar)

General information about Biogas and Biogas Systems:

A biogas system is producing biogas with the help of bacteria. These bacteria naturally come from cattle dung. They are in need of food like us humans. They can eat cattle dung but as well food waste like potatoes, rice, fruit peels and more. While eating they produce biogas. This gas can be burnt and used for cooking.

Materials which should not be put into a biogas system are for example:

- Stones
- Bones
- Orange peel
- Lemon peel
- Oil

Advantages of Biogas:

- Reduces the amount of firewood used for cooking
- Cattle dung and food waste can still be used to feed the bacteria
- The output of the biogas system is a very good dung for plants and trees
- Already two cows are enough to run a Biogas system

Disadvantages of Biogas:

- A biogas System has to be maintained carefully. Feeding the bacteria too much or too less influences the quality and amount of the biogas.
- The biogas can only be used together with the biogas plant. It cannot be filled into bottles.

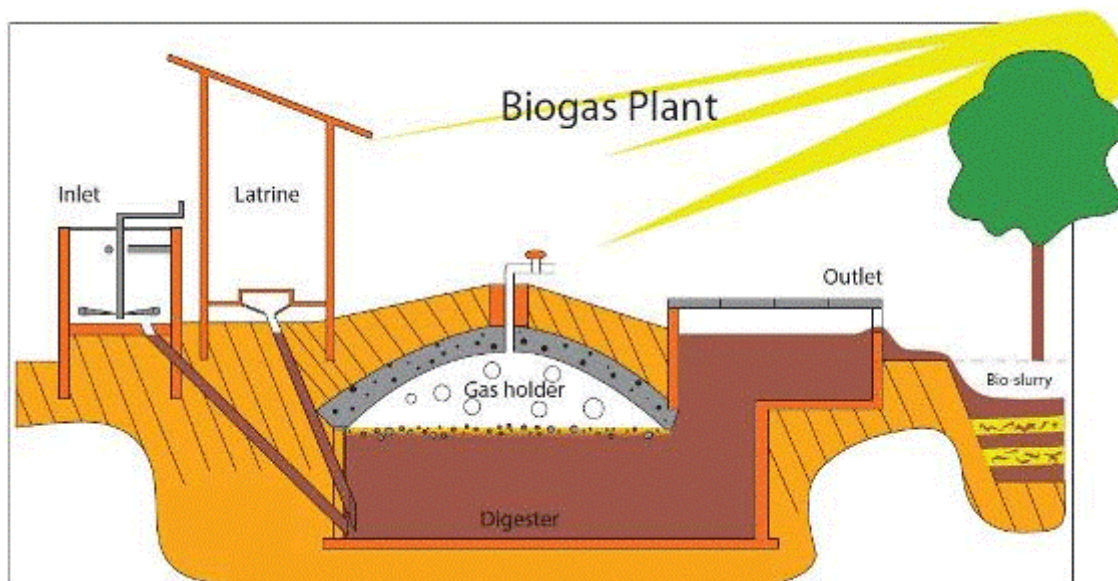


Figure 19 Biogas Plant

Each Biogas System contains an inlet, an outlet, a digester, a gas holder and a gas pipe. Also a stove is needed to burn the gas.

Inlet:

The Inlet of the Biogas System is used to fill the system with cattle dung, food waste and water. Depending on the system it has to be fed each day, or just once or twice per week. The Inlet can also be directly connected to the toilet. Especially at schools, a biogas system can be run with human faeces as there are enough people using the toilet to feed the system properly.

Digester:

In the digester the bacteria live in the mixture of cattle dung, food waste and water. There they eat and produce gas which moves up.

Gas holder:

The gas which moves up from the digester is hold in the gas holder, where it is ready to leave the system through the gas pipe.

Gas pipe:

The gas pipe can be closed and opened to use or not use the gas. The gas pipe is also connected to the stove where the gas is burnt and used for cooking.

Outlet:

By filling the system with material through the inlet, it gets more and more full. By filling the system, the same amount which gets into the system, will come out of the Outlet. New material comes in, old and used material goes out. This output material is very good dung for trees and plants.

Preparations for journey to a Biogas plant:

If a trip to a biogas plant is planned for the next teaching lesson, it is advisable to collect some questions together with the pupils before. The questions can be asked the day of the visit.

The following questions were collected together with pupils from Highridge Primary School before visiting the showground of CAMARTEC (Arusha).

1. How big is a biogas tank?
2. Does the cattle dung trickle away into the soil?
3. How many cows do you need at least for a biogas system?
4. Which amount do you have to put into the system?
5. Which materials can you put into a biogas plant?
6. How many times do you have to feed the system per week?
7. How long does it take until biogas is ready to use?
8. How long can you cook with a biogas plant?
9. What happens when you stop feeding the biogas system?
10. Can we use biogas only for cooking or are there also other possibilities to use biogas?
11. In which way does Biogas affect our environment?
12. What are the advantages and disadvantages of Biogas?

Experiment: Producing Biogas

This experiment is used to produce biogas in a plastic bottle.

Necessary Materials:

- Plastic bottle (1,5 Liter)
- Balloon
- Cattle dung
- Water
- Sugar
- Flour

How to do it:

A 1,5 Litre plastic bottle is filled with cattle dung and water until the bottle is half full. As the bacteria in the bottle need food you have to add a very little amount of sugar and flour into the bottle.

After this an empty balloon gets used to close the bottle on the top.

What will happen?

After 2 to 4 days, the balloon will be filled with biogas. Depending on the quality of the balloon the balloon gets first filled and then from day to day the gas flows out through the balloon.

To get a good result you should not wait too long to show the filled balloon to the pupils as the gas has maybe distinguished after four days.

The biogas which is in the balloon cannot be burnt as there is not enough biogas in the balloon and the gas consists out of too much normal air.

But to understand how biogas gets produced it is enough that the pupils see the balloon being filled with “biogas”.

Explanation:

The bacteria in the bottle are eating the cattle dung, sugar and flour and are producing biogas. Gas has the characteristic to be less heavy than air. Therefore the gas goes up into the balloon. When too much biogas gets produced, there is overpressure in the bottle. As the plastic of the bottle cannot move away, it is the elastic balloon which gets stretched.

Lesson 5: Journey to a Biogas plant

This lesson is used to do a field trip to an operating biogas plant with the pupils. In Arusha it is possible to go to the showground of CAMARTEC based in Njiro (next to the Railways).

To organize such a trip, it is necessary to contact the “Project Coordinator Biogas” of CAMARTEC who is Mr. Shila (last updated 27/05/2013). We recommend communicating to the project coordinator at least 3 weeks before the trip.

At CAMARTEC there can be a big biogas system visited. As well the staff of CAMARTEC will be able to explain things about Biogas as well as about CAMARTEC itself.

We also recommend collecting questions together with the pupils before the trip so they will be able to ask CAMARTEC staff questions, what will show their interest in the trip.

Examples for questions are already mentioned in “Lesson 4 – Introduction to Biogas”

Lesson 6: Test & Evaluation

In this lesson the pupils will be taking a test about the activities done and the subjects taught.

Lesson 7: Results and Certificates

This lesson can be used for returning the test and to finish the teaching. Certificates can be handed out to the pupils and the teaching unit about Jatropha and Biogas is finished.

A draft for certificate is added to the annex (Page 82)

Further Possibility

If time and interest allows it there is the possibility to establish a compost with the pupil which is a way to turn organic waste into fertile soil.

More information about this can be found in the Annex of the Teaching Unit: Jatropha and Biogas.

Annex of Teaching Unit – Jatropha & Biogas

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1. Test about Jatropha & Biogas	50
2. Build a Compost	52

Renewable Energy School Program

- Test about Jatropha / Biogas –

Name:	Standard:	Date:
-------	-----------	-------

Theme: Jatropha

Answer the following questions:

1. What are the benefits of Jatropha?

5 Points

2. How is Jatropha oil produced?

1 Points

3. How can you use Jatropha seed cakes?

2 Points

4. How is Jatropha soap produced? Explain the four different steps.

4 Points

I.

II.

III.

IV.

5. What are the benefits of Jatropha soap?

3 Points

Theme: Biogas

Answer the following questions:

6. Draw an example of a biogas plant and name the different parts.

4 Points

7. What material can you put into a biogas plant?

2 Points

8. Bacteria are necessary for a biogas plant. What are they doing?

2 Points

9. For what you can use biogas?

2 Points

I.

II.

10. What are the advantages and disadvantages of biogas?

5 Points

<i>Advantages</i>	<i>Disadvantages</i>

Building a compost – A long term project

What is Compost?

Compost is a way to turn organic waste (For example: kitchen waste, leaves, a.s.o) back into fertile earth. The organic waste is decomposed by microorganisms and bacteria. Important is a good mixture of wetness and air supply. The end product is fertile earth which can be used as excellent fertilizer in the garden or in agriculture because it is rich of minerals and nutrients.

To build and maintain a compost doesn't need a lot of work. Nevertheless it's very important that there is a responsible person who cares about it. It is therefore necessary that a responsible teacher is selected who is in charge of the compost. If you need any assistance please contact KAKUTE.

How to build compost?

→ The easiest way to build a compost is to use a wooden structure, but it can also be done without.

1. First you have to select the right spot for your compost. It has to be built on free ground with no close surroundings. Please make sure it is directly build on soil and it is not in direct sunlight for the whole day.
2. Now we have to build the base. Take dry materials (cut twigs, dried weeds) and create a layer this is 10 to 20cm high.
3. To give your compost a good start it is recommended to spread some earth over you compost.
4. Now you can put leaves, kitchen waste and other organic materials on the first layer.
5. Make sure that the compost has a constant good wetness. When the compost falls dry the bacterias and microorganisms will die and the process of composting will stop.

If the Box is full, or after some time, you have to relocate the compost. Make sure that the top layer is the bottom layer after your work is done. So you basically turn the compost upside down.

What can I compost?

Nearly every organic material! But you have to keep in mind that bigger pieces (like wooden sticks) will take much longer time or will even not start to get composted. So to make your compost run properly, use small pieces! Also very helpful is fresh cattle dung because it contains a lot of bacterias. Also a good compost exist of many different materials!

Not suitable are:

Bones, food leftovers if cooked (will attract rats)

**Never put non-organic materials in the compost!
There is no way for the bacterias to deal with them.**

Renewable Energy School Program



Teaching Unit - Solar -

The overall objective of this teaching unit is to explain and show the advantages and possibilities of solar energy to the pupils and to increase their awareness of solar energy. The teaching unit is worked out for a time frame of 8 teaching lessons. One teaching lesson is equivalent to about 60 min.

Timetable:

Lesson Action

1st	Introduction into energy
2nd	The sun affects our daily life
3rd	Solar heating, solar cooker
4th	Photovoltaic
5th	Solar home system
6th	Advantages and disadvantages of solar
7th	Write test and evaluate teaching unit
8th	Results and certificates

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Lesson 1: Introduction to Energy

The first lesson can be used to give the pupils a first overview on the topic solar and the following lessons. Furthermore this lesson can be used to build up a certain knowledge about electricity.

The following idea of a quiz is one method talking with the pupils about solar, energy and energy in Tanzania.

Quiz

The class gets divided into 2 (or more) groups. After each question, each group has to write down their answer onto a piece of paper and has to hand it to the teacher. For some difficult questions there are already some possibilities of answers given to the groups.

Any group that has a correct answer gets a point.

At the end the group with the most points wins the quiz.

The underlined answer is the correct one!

1. Where do people burn more firewood? In Tanzania or Kenya?

a) Tanzania

b) Kenya

2. In which Tanzanian city most people have energy in their homes?

a) Arusha

b) Mwanza

c) Dar es Salaam

3. How many people live in Tanzania?

a) 25 Million

b) 43 Million

c) 87 Million

4. How many percent of all Tanzanian citizens have electricity in their house?

a) 100 %

b) 50 %

c) 15 %

→ 6.450.000 out of 43.000.000 Tanzanians have access to electricity

5. Which is the main source of electricity in Tanzania?
- a) Solar Energy
 - b) Hydro Energy
 - c) natural Gas
- more than 60 % of energy in Tanzania gets produced through hydro power systems
6. Where does solar energy come from?
- a) Rain
 - b) Sun
 - c) Dust
7. Is solar emitting carbon dioxide while producing electricity?
- a) Yes
 - b) No
8. Is solar energy a renewable energy or a fossil energy?
- a) Renewable
 - b) Fossil
- Explanation: As the sun is shining every day, it is a never ending source of energy. Therefore it belongs to "Renewable Energy Sources"*

Once the quiz is finished, the pupils can make their first experiences with solar energy. A Solar Study Light, Solar Cars and Solar Turtles are available at the office of KAKUTE Ltd.

Lesson 2: The sun affects our daily life

This lesson will teach the pupils about the effects of the sun and the sun energy on our daily life. There are a lot of impacts the sun has on our life, which we mostly do not recognize and sometimes do not even know in which way they are influencing us every day.

Experiments:

a) Thermal Energy of sun depending on shadow and sunshine

This experiment should lead the pupils to the conclusion that the amount of sun energy in a sunny place is higher than in a shady place. Depending on this, things in a shady place will not heat up as strong as things in direct sunlight.

Necessary materials:

- Two black pieces of metal

How to do it:

One piece of metal is put directly into sunlight and the other piece into shadow. The temperature of the two pieces of metal can be measured by hand or thermometer after about half an hour.

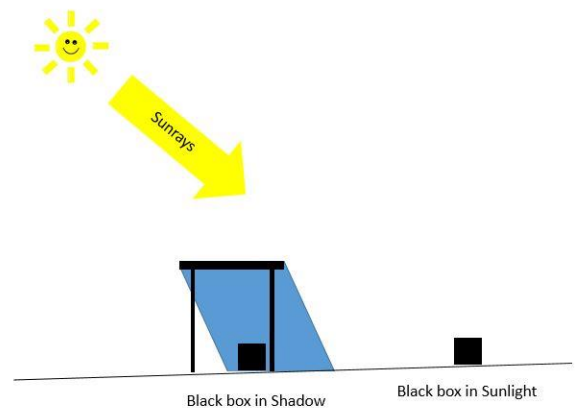


Figure 20 Sunshine and shadow

Explanation:

Depending on shadow and sunlight the two pieces of metal reach different temperatures. In the sunlight, the metal gets very hot; in the shadow it stays cool.

Referring to this experience the pupils can conclude that the sunlight is essential for the temperature of the metal.

→ Sun rays do not only provide light they also provide heat. ←

b) Absorption capacity of the sun light depending on different colours

This experiment deals with the different absorption capacity of the sunlight depending on different colours. For this experiment the colours black and white are recommended.

Necessary materials:

- Two pieces of metal (a white and a black one)
- Sunshine

How to do it:

Lay the black and white metal into sunlight.
After about half an hour the temperature of the metal can be measured by hand or thermometer.

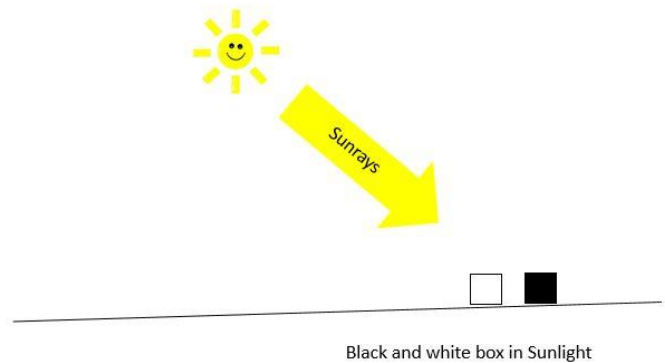


Figure 21 Colours in sunshine

Explanation:

The black metal piece will be warmer than the white piece.

The reason for this is that the colour black absorbs the sun rays better white, which is mainly reflecting the sunrays.

Black colour converts more sun energy into heat, than white colour.

→ Different colours have different potentials to absorb heat from the sun rays ←

c) Sun affects the rain

This experiment is very useful to explain how the sun affects the rain.

Necessary Material:

- Large glass or clear plastic kitchen bowl
- See-through plastic wrap
- Small stones
- Small glass (small enough to fit completely inside the bowl)
- Salt
- Water
- Sunshine
- Elastic band / string

How to do it:

First the small glass needs to be placed into the middle of the bowl. Then some water needs to be added to the bowl (but not into the small glass; make sure that the glass does not start to float). If the glass is not heavy enough and swims in the water, it has to be filled with some stones.

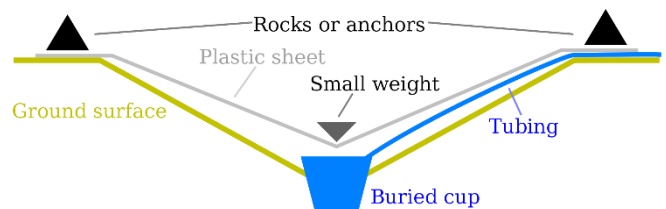


Figure 22 Water collector

Add a bit of salt into the water and stir it. Let the pupils have a taste of the water so that they can see that it tastes salty.

Cover the top of the bowl securely but slightly loosely using the food wrap, there should be a little 'give' left in the top – but not too much. Place the stone directly above the small glass, if you've got the tension of the cover right, this should mean that the weight of the stone makes a little depression on the plastic film, centred over the opening of the small glass. Put the whole bowl into direct sunshine, wait and watch.

At the end of the experiment the water out of the small glass can be tasted to see if it is still salty.

What will happen?

The small glass in the middle of the bowl will be filled more and more with water (depending on the sunshine, the water will be in there after 1 hour or maybe after 1 day). The water inside the glass will not taste salty.

Explanation:

As the sun warms the bowl, the water inside begins to heat up and as its temperature rises, it starts to evaporate. The water vapour produced condenses on the internal surface of the plastic film, forming tiny droplets, and once they get large enough, they run down at the the plastic film towards the lowest pointy created by the weight of the stone. As more and more water is collected the drops eventually become too heavy to stick onto the film any longer, and "rain" falls into the small glass.

In contrast to the water the salt does not evaporate and is left behind in the large bowl. So the water which is falling into the small glass is not salty anymore. This can be found out by the pupils by tasting it.

The following picture explains the water cycle on the earth

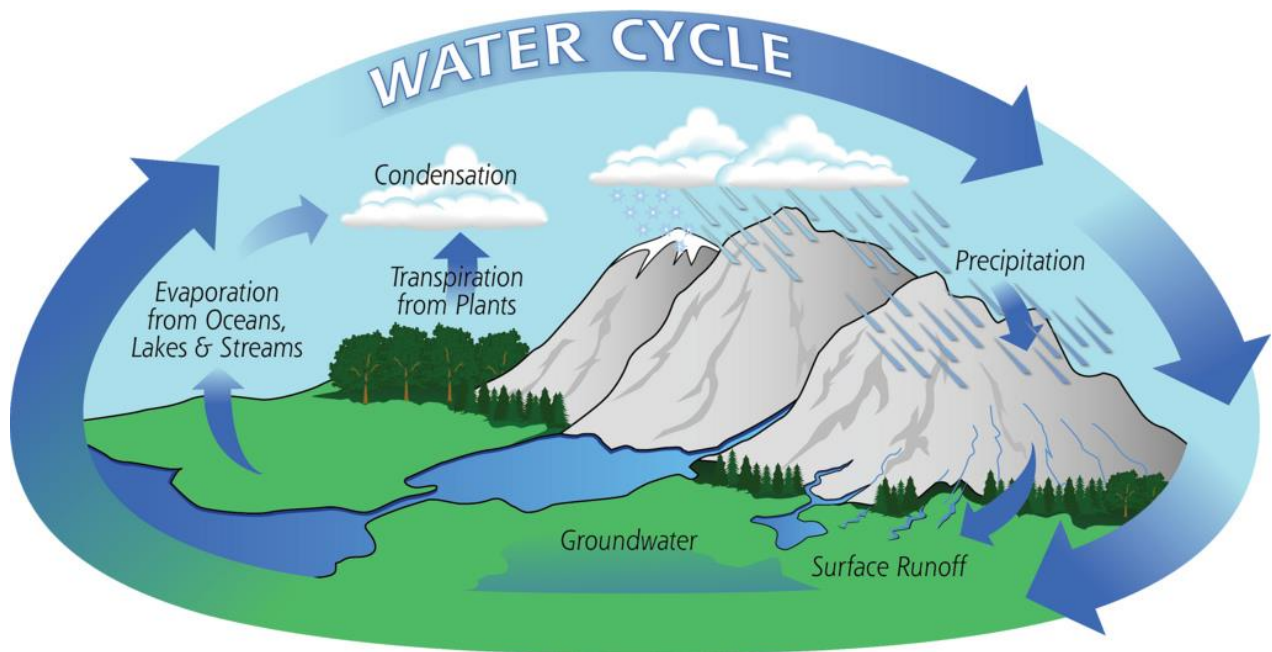


Figure 23 Water Cycle

Explanation: Water from oceans, lakes and land gets heated up and evaporates (Evaporation = hot water changes its characteristic of being liquid into gaseous). This gaseous water reaches the sky, it cools down and clouds get produced. The water which is stored in the clouds returns in form of rain back to earth, where it heats up again and evaporates again towards the sky. This way there is a never ending circle created.

Lesson 3: Solar Heating, Solar Cooker

The last lesson shall transfer knowledge about the way sun is influencing our environment and how it can be used in this lesson to figure out how humans can use these effects for their advantage.

There are different ways to benefit from the sun energy for humans. In the following lesson the pupils will be taught about using sun energy for solar heating.

The following experiments can be done with the pupils:

a) Focusing sun rays

This experiment should be a small introduction into the subject of how to convert sun energy into heat.

This experiment is using the property of a magnifying glass to bundle the sunrays at one point.

Necessary Materials:

- Magnifying glass
- Piece of thin paper (newspaper) or other flammable material (like dry leaves)
- Sunshine

How to do it:

Go outside and lay a thin piece of paper or other flammable material onto the ground. Take the magnifying glass and hold it over the paper or other flammable material so the glass is able to bundle the sun rays. Vary the height of the magnifying glass until the sun rays are bundled onto one point on the paper. Wait until the sun comes out and the material will start burning.



Figure 24 Sun on magnifying glass

If the sun is not strong enough to inflame the paper or any other flammable material you can also bundle the sun rays on your hand and feel the impact of it.

Explanation:

The magnifying glass bundles the sun rays to one small point if you hold the magnifying glass properly. Simultaneously to the sun rays also the sun energy is bundled onto one point and is heating up the paper or any other material. The flammable material will heat up until it inflames and some smoke and maybe even fire can be seen.

b) Water heating

In this experiment the pupils can experience how solar heating can be used to heat water.

Necessary materials:

- Bottle
- Black colour
- Water
- Sunshine

How to do it:

Colour a bottle with black colour and fill it with water. Measure the water temperature by hand or thermometer before you fill it inside the bottle. Put the bottle in the sun and wait a while. After this you can measure the water again by hand or by thermometer.

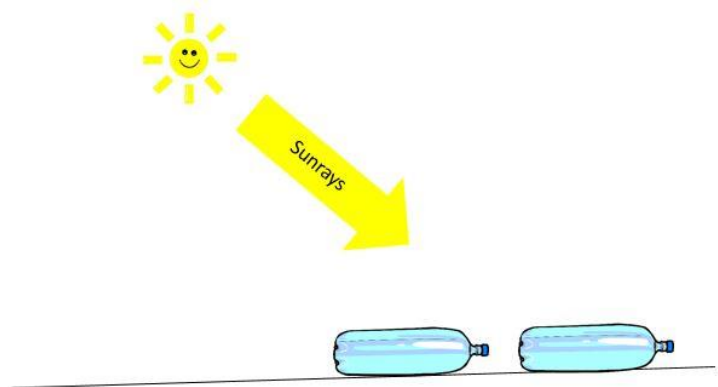


Figure 25 Sun on bottles

Explanation:

The sun rays heat up the water inside the bottle and the temperature of the water increases. Depending on the amount of water and sunshine the temperature will be higher or lower.

c) Solar Funnel Cooker

The Solar Funnel Cooker is using the attributes of reflecting sun rays and the heating character of black colour. This leads to a very good conversion of the energy of the sunrays into heat and to a working cooker.

A Solar Cooker is available at the office of KAKUTE Ltd.

The following pages are a guideline how to build a Solar Funnel Cooker.

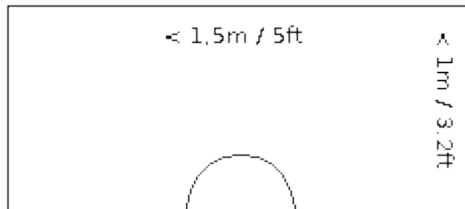
Necessary Materials:

- Flat Cardboard
- Aluminium foil
- Glue or sticky tape
- Stapler or small nails
- Box (normal size)
- Cooking-jar or vessel painted black
- Plastic bag
- Small block of wood

How to build a solar funnel cooker:

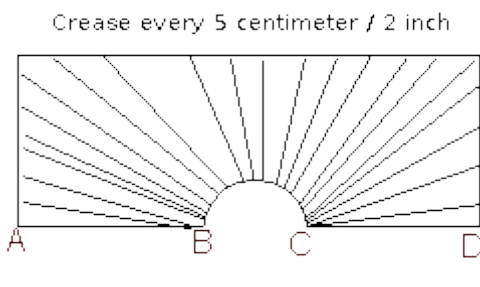
To build a solar funnel cooker you first need to prepare a few things:

First take the cardboard and lay it on the ground in front of you. Find the centre of the long edges and draw a half circle in that centre as it is shown in the diagram below. You do not have to be precisely.



*Figure 26 Build a solar cooker
– Step 1*

Make a series of folds into the cardboard radiating out from the hole. Try to fold the cardboard enough times so that there is a crease every 5cm / 2 inch or less on the outside edge. (Precision is not important here either).



*Figure 27 Build a solar cooker
– Step 2*

Lay it back flat and use the glue to cover one side smoothly with foil. Allow to dry. You can also use sticky tape. While it is drying, paint the outside of your glass jar and lid black. After the glue is dry, tape the foil edges down with clear tape. Then roll it into a funnel where A touches D, and B touches C. with the foil inside. Tape it so it stays in this shape.

Afterwards you take your funnel and put it with the little end into your box. The food or water you want to heat up you have to fill into the cooking-jar or vessel. Inside the box you put the filled cooking-jar or vessel which is standing on a small wood block and surround it using a plastic bag.

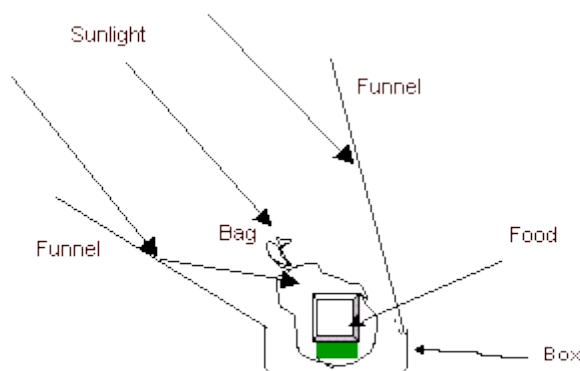


Figure 28 How a solar cooker works

How to use the solar funnel cooker:

The solar funnel cooker is very sensitive and only works properly if it is handled the right way.

The solar funnel cooker should always be faced directly towards the sun. This means that the angle of the cooker needs to be changed regularly. Furthermore the power of the cooker decreases a lot if clouds cover the sun.

With normal conditions half a litre of water will be heated up after half an hour or more.

Do not lay something flammable inside the cooker.

What will happen?

The water or food you have put in will get hot. Depending on the sunshine the time it takes to heat up the water or food can vary.

Explanation:

The funnel of the solar cooker has the function to point the sunrays at one point. The sunrays get reflected by the aluminium foil of the funnel so that all the sunrays come together at one point at the bottom of the box. The cooking-jar or vessel is placed at exactly this point, laying on a wood block and surrounded by a plastic bag. The amount of sun rays at the surface of the cooking-jar or vessel inside the solar cooker is much higher than outside of the solar cooker, because the funnel is reflecting the sunrays and leading all of them to one point. Furthermore the black colour has the effect that the sun energy is transformed with high efficiency into heat. The wood block is an isolator which does not transport heat very quickly and keeps the heat in the cooking-jar or vessel. Nearly the same function is overtaken by the plastic bag. The hot air cannot leak out of the plastic bag and is staying around the cooking-jar or vessel which is also protecting it from cooling out very quickly.

Lesson 4: Photovoltaic

This lesson can be used to take the next step on the way to use sun energy. The pupils can learn how to transform sun energy into electricity and how they can use this electricity.

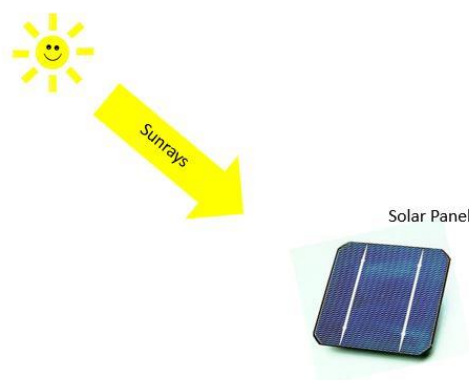
To attract the attention of the children the solar table experiment can be used for better understanding. This experiment is available at the KAKUTE office and can be borrowed for the lesson.

The circuit diagram and the technical data sheet are attached to the annex (Page 74 - 75).

First of all the different parts of the experiment should be shown and explained. Examples can be given to show up the content.

Solar Panel:

The solar panel is illuminated by sunrays and converts the sunlight directly into electricity. The amount of electricity depends on the size of the panel. The bigger a panel the more electricity the panel it can produce.



Fan:

The fan is converting electricity into movement.

Figure 29 Sunrays on solar panel

CD-Drive:

The CD-Motor is converting electricity into movement. The CD-Motor is an example for a DVD-Player.

Capacitor / Battery:

The battery stores the electricity for a while and can be used to run other appliances. The battery is an example for bigger batteries which are used for Solar Home Systems.

- How to use the battery:

First the battery needs to be charged. Therefore the panel has to be connected to the battery. After the battery has charged, the panel can be disconnected and the battery can be connected to other appliances. The battery is very small and the amount of energy is very little and only last for a short time. As the battery is not a real battery and just some connected “capacitors” it even discharges itself after a short time.

Mobile Charger:

The mobile charger is able to charge mobile phones. The electricity of the panel gets used to charge the battery of a phone.

LED / Lights:

The LEDs are converting electricity into light. The LED is an example for a bulb used in households.

Buzzer / Speaker:

The Buzzer is converting electricity into sound. The Buzzer is an example for a radio.

The following indicators are influencing solar:

1st: Shadow

2nd: Dust/dirt

3rd: Angle between solar panel and incoming sun rays

How to show the influences with the solar board:

1st: Shadow:

- Lay the panel in a sunny place
→ The electricity is very high
- Lay the panel in the shadow
→ The electricity is low
- Turn the Solar Panel to the ground to simulate darkness
→ There is no electricity (or just a little bit)

2nd: Dust/dirt:

- Put more and more dust and dirt (like foliage, soil, sand, etc.) on the panel
→ the electricity output will decrease more and more.

3rd: Angle between solar panel and incoming sunrays:

a) Hold the panel in an angle of 90° towards the sun.

→ The electricity output is very high.

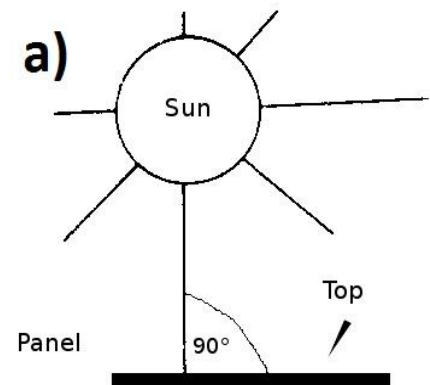


Figure 30 Panel in horizontal position

b) Turn the panel to an angle of 180° towards the sun

→ The electricity output is high

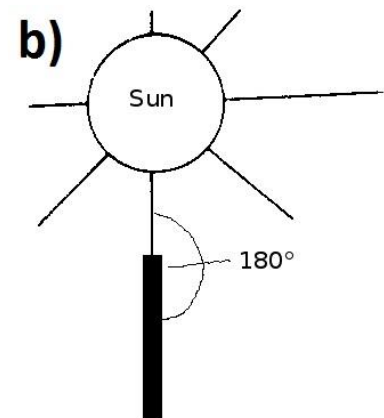


Figure 31 Panel in vertical position

c) Turn the panel to an angle of 270° towards the sun

→ The electricity output is low

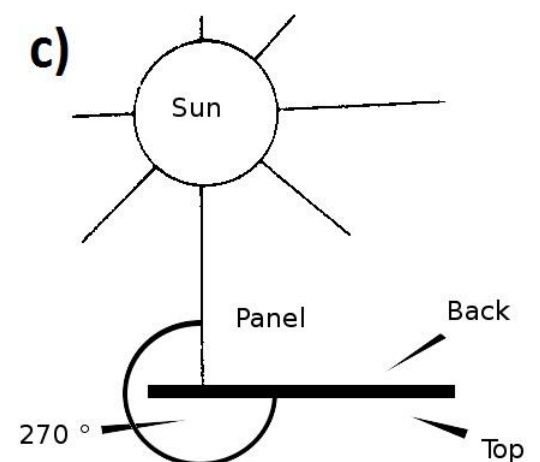


Figure 32 Panel facing ground

Lesson 5: Solar Home Systems

Optionally the pupils can make a field trip on this day. In Arusha, KAKUTE Ltd. offers schools to visit their show ground to have a closer look at Solar Home Systems and the appliances. In case of visiting the showground of KAKUTE Ltd. it is necessary to contact KAKUTE Ltd. (Contact information can be found on page 4)

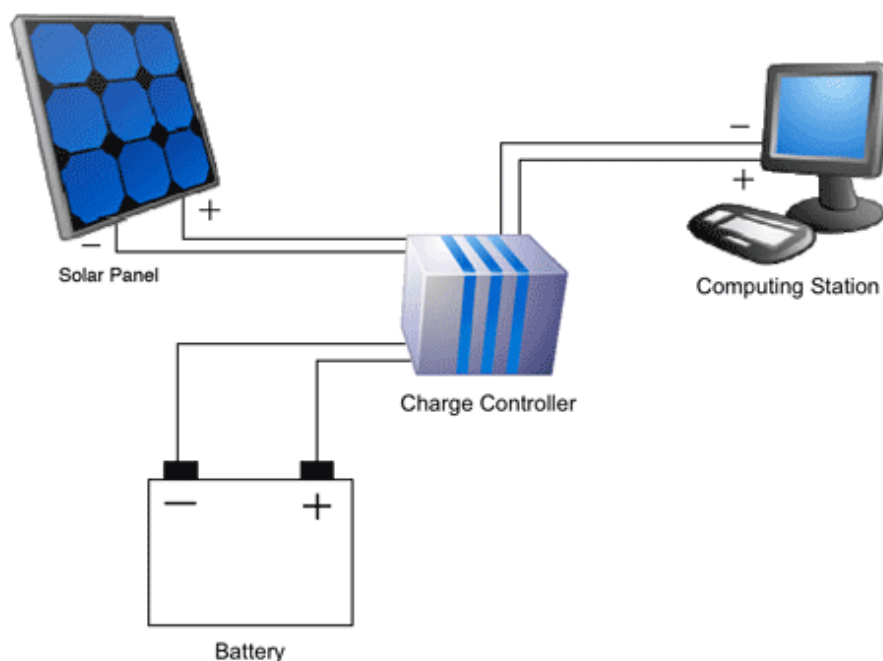


Figure 33 Solar home system

Solar Panel:

The Solar Panel is illuminated by sun rays and converts the sunlight directly into electricity. The amount of electricity a solar panel can produce, varies on the size and the material the panel is made of.

Battery:

The sun is shining only during daytime. To use the produced energy at night, it is necessary to store the energy in a battery. Each size of a solar panel needs of a fitting battery. Depending on its capacity, the battery can store a different amount of electricity.

Charge Controller:

The charge controller has the function to control the charge of the battery, which leads to a longer lifespan of the battery. Additionally the charge controller is the connection between battery, solar panel and appliances.

Inverter:

There are two different types of electric current: DC (Direct Current) and AC (Alternating Current). A solar panel always produces electricity in DC. Some devices can be used with DC, like special lights and mobile phone charger. Some appliances are just working with AC, like normal television or a hair cutter. Therefore an inverter is in need. An inverter is converting DC to AC. This enables you to use more devices with solar energy, as some devices are only working with DC and some only with AC.

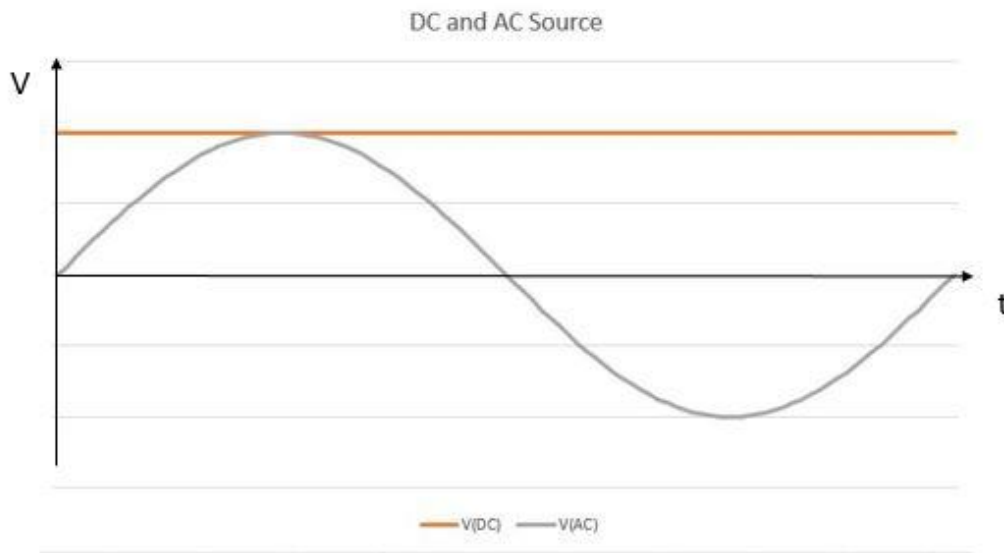


Figure 34 AC and DC Source

The professional explanation of an Inverter might be too difficult for the pupils. In this case the following alternative and simplified explanation can be used:

→ An inverter has the function to connect Solar Energy with plugs of normal appliances.

During the explanation of the different parts of the Solar Home System, the explained parts can be connected by the pupils.

To make sure the function of the battery is understood the panel and some appliances can be connected to the system. After a short time the panel can be disconnected from the battery and the pupils can see that the appliances are still working even though the panel is not connected to the battery anymore.

Lesson 6: Why Solar? Advantages and Disadvantages

This lesson can be used to figure out and list the advantages and disadvantages of solar energy together with the pupils.

Disadvantages of Solar:

- The costs for buying a big solar home system are high.
- A solar system has some limitations.
 - It is not able to power the same appliances like the national grid.
 - It is not able to power appliances for an unlimited time (depending on the sunshine and the charge of the battery)
- You are not able to cook using a solar system.
- A solar home system is dependent on sunshine.
 - During the night the solar panel is not producing any electricity.
 - During rain seasons the solar system does not generate energy very efficiently.
- Depending on the type of the battery, it may only last for 2-10 years. And buying a new battery can be expensive.
- It can also happen that parts of the solar system malfunction and have to be replaced. This also costs money.

Advantages of Solar:

- You only pay once for a solar home system. Afterwards you get energy for free! (You maybe have to pay for repairing the system if it breaks)
- There are plenty of different solar products for all prices and all kind of uses. If a whole solar home system is too expensive a cheaper product like a solar lamp can be bought.
- You are able to generate your electricity on your own, sun energy is for free
- You are not dependent on the energy of the national grid (TanESCO)
→ No more power cuts
- Especially rural areas which are not connected to the grid can profit from solar
- Solar energy is a clean and healthy source of energy because it is not polluting the environment
- Producing energy out of sunlight will be always possible because the sun is shining every day and is not limited
- It is quiet, there is no noise coming from generators

Even if solar products are more expensive than other products, you always have to keep in mind that in future you do not need to spend any more money on fuel. This is a big advantage towards products which are running on fossil energies.

Let us calculate together:

Necessary facts:

1. Price for 1 litre of oil: 2,200 TZS
2. 1 litre oil is enough for 1 month (in case of using the oil lamp 3 hours per day)
3. 1 Oil Lamp costs 5,000 TZS

1. When 1 litre oil is enough for 1 Month, how much money we spend per month?

Answer: 1 litre Oil = 2,200 TZS

2. How much money do we spend in one year (12 Months) ?

Answer: 1 Month = 2,200 TZS
 12 Months = 26,400 TZS

3. How much money do we spend in 2, 3, 4 and 5 years?

Answer: 2 years = 52,800 TZS
 3 years = 79,200 TZS
 4 years = 105,600 TZS
 5 years = 132,000 TZS

We conclude:

For an oil lamp, we spend 5,000 TZS to buy the lamp. Additionally we spend about 2,200 TZS for oil per month. This adds up to 26,400 TZS per year.

A good solar lamp is available from 35.000 TZS. Good solar lamps are also much brighter than oil lamps.

When buying a solar lamp you have no more expenses once you bought it.

A battery of a good solar lamp lasts for 5 years at least.

For an oil lamp, you spend 132,000 TZS for oil + 5,000 TZS for the lamp in 5 years.

For a solar lamp you spend just 35,000 TZS in 5 years and even after 5 years the solar lamp will go on to brighten your house.

Lesson 7: Test

This lesson is used to evaluate the teaching. Therefore a test can be written with the pupils.

An example of test is added to the annex of Teaching Unit - Solar. (Page 77 – 78)

Lesson 8: Results and Certificates

The last lesson can be used to return the written tests to the pupils and to hand out certificates.

An example of certificate is added to the annex (Page 82)

Annex of Teaching Unit – Solar

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Solar Experiment Board

- Technical data sheet -

The following data are valid for the different appliances of the Solar Experiment Board of the Renewable Energy School Program.

Last update: 18/07/2013

Solar Panel

	Power / Consumption	Volt	Ampere	Resistance
Max.	Max. 1.8 Watt	7V	Max. 0,26A	---

Appliances:

Computer Fan

	Power / Consumption	Volt	Ampere	Resistance
Max. :	1.56 Watt	12V	0.13A	---
Used with:	0.84 Watt	7V	0.12A	---

Resistance for Computer Fan

55 Ω (Series connection)

The maximum Amperage is too high for the computer Fan. Therefore a resistance with 55 Ohm connected in series connection to lower the amperage.

CD Drive

	Power / Consumption	Volt	Ampere	Resistance
Used with:	----	5.9V	---	---

Zener-Diode for CD-Drive

150 Ω (Series connection)

The maximum Voltage of the solar panel is too high for the CD Drive. Therefore a resistance with 150 Ω is connected in series connection to lower the voltage.

Capacitor

	Capacity	Volt	Ampere	Resistance
Max. :	6800uF	10V	---	---

To reach a higher capacity four 6800uF capacitor are connected parallel. Through this the capacity is enlarged to 27,200uF which is 0.0272F.

LED

	Power / Consumption	Volt	Ampere	Resistance
Used with:	---	1.5V	20mA	---

For a better notion three LED are connected in series connection.

Resistance for LED

1000 Ω (1k Ω) (Series connection)

The maximum Voltage is too high for the LED. Therefore a resistance with 1000 Ohm is connected in series connection to lower the Voltage. A very high resistance was chosen to have a clearer difference when the current is changing.

Phone Charger

Max. 24V

The Phone Charger transforms a higher Voltage to the needed Voltage of 5V to charge a mobile Phone. This part of the experiment only works with a bright sunshine.

Buzzer / Speaker

	Power / Consumption	Volt	Ampere	Resistance
Max. :	---	20V	0.001A	---
Used with:	---	7V	0.001A	---

Renewable Energy School Program

- Test about Solar –

Name:

Standard:

Date:

Write your answers just under the questions!

1. **The energy of the sunrays can be transformed into what kind of other energy?**

2. **If you want to heat up water in a bottle, which colour do you have to colour the bottle?**

3. **Explain the properties of the colours black and white in connection with the sunlight.**

Mark the right answer. Only one of the three is correct.

4. **Explain the property of aluminium.**
 - ☐ Aluminium can change sunrays into energy
 - ☐ Aluminium reflects sunrays
 - ☐ Aluminium absorbs sunrays

Mark the right answers. Two of the four answers are correct.

5. **How can Sunlight be concentrated to one point?**
 - ☐ I can use a magnifying glass
 - ☐ I can use a circle out of stones
 - ☐ I can use a Solar Panel
 - ☐ I can use a Solar Cooker

6. **If you transform the sun energy into heat, what can you do with it?**

7. Name at least 2 indicators which are decreasing the energy production of a solar panel:

8. Name at least 2 components of a Solar System and explain their functions:

9. Do you think solar is good or bad? Explain your answer!

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Teacher's Lesson Plan

Date	Subject	Class	Period	Time	Number of Pupils					
					Registered			Attended		
					Boys	Girls	Total	Boys	Girls	Total

Competence:

Main Object:

Main Topic:

Sub-topic:

Specific objectives:

Teaching Aids:

Reference:

Teaching Processes

Stages	Time	Teaching Activities	Learning Activities	Assessment
Introduction				
Developing Knowledge				
Application				
Reflection				
Consolidation				

Pupils' evaluation:

Teacher's evaluation:

Remark:

How to grade a test

It is recommended to write a test with 10 questions and a total amount of 30 points.

How to evaluate a test:

Maximum number of points: 30

Total points of the student: X

Percentage achieved = $X / 100 \%$

Grade	Percentage	Points
A	81 % – 100 %	25 – 30
B	61 % – 80 %	19 – 24
C	41% – 60 %	13 – 18
D	21 % – 40 %	7 – 12
E	0 % – 20 %	0 – 6



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