SOLAR ENERGY HANDBOOK

A GUIDE FOR TEACHERS AND YOUTH LEADERS

SOLAFRICA.CH

YUNGA :: WOSM

IMPRINT

Edition and Layout: Solafrica, June 2015
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Developed in collaboration with:

YOUTH & UNITED NATIONS GLOBAL ALLIANCE (YUNGA) · SCOUTS Creating a Better World · GREENPEACE

The World Organization of the Scout Movement (WOSM) endorses this educational badge framework for use by Guides and Scouts around the world, who may adapt it as necessary to their local needs and requirements.

Many thanks go to:
Simone Pulfer, Joshiah Ramogi, Vânia Stolze and Kuno Roth for feedback and concept development.
Dr. Michael Götz and Retze Koen for solar technical advise.
Kandersteg International Scout Centre for hosting and support.

Design & Layout:
Rahel Inauen / www.studioapero.ch

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WELCOME

This handbook is designed to help create awareness, increase knowledge and develop the skills of children and young people with regard to solar energy. It aims to help group leaders or teachers to identify, plan, prepare for and realise solar learning opportunities. If you cannot find what you are looking for in this handbook, have a look at the links section (p. 34) or contact us at scoutsgosolar@solafrica.ch. Notice also the **Workbook** with additional material.

Day and night are defined by sunlight or its absence. The sun is fundamental to our life. Without it, we would freeze, no plants would grow, there would be no photosynthesis to produce the oxygen we breathe, and the darkness would depress us.

Therefore, the sun is the very first source of energy that made life on earth possible. Nevertheless, most people are not aware of how dependent we are on the sun, and how underutilised this form of energy is.
We invite you to learn about the sun and solar energy. Discover the possibilities of solar energy and how you can have fun with sunlight. Learn about the different uses of solar energy, and experience solar heating and photovoltaics.

We invite you to get active and use the power of the sun.

Maybe you can find some solutions for your own life or your community. At the end, every saved or renewably produced unit of energy means less pollution and a better future for all of us.

We invite you to share about solar energy.

Tell everyone what you have experienced. Show how you use the power of the sun. And invite them, to join you. Get inspired on scout.org and on wave.greenpeace.org (search for Scouts Go Solar).

We invite you to help others to follow your example and find their own unique way of using solar energy.

Be an inspiration for others and support them as much as you can.

BE SAFE & SOUND

Dear Leader

This handbook is designed to support you by providing a variety of solar activities.
Please read the following notes to ensure that the activities are safe for you,
your group as well as for the environment.

* Wash your hands after every activity.
* Don't look directly at the sun.
* Don't taste things unless you are certain they are not poisonous.
* Don't drink water from natural sources unless you are sure it is safe.
* Be particularly careful with mirrors, lenses and other reflecting material in direct sun light. Don't leave it unattended. Place it in a shaded space or cover after use.
* When using mirrors, lenses or other reflecting materials, always protect yourself from UV rays.
* When producing heat through sunlight, be sure that you protect your body from burns. Don't touch hot objects with your hands or fingers.
* Always apply sunblock and wear a hat when working under direct sunlight. Make sure that everyone drinks enough water.
* If you want to take pictures or videos of your activities, make sure that everyone in the picture or video (or their parents) has given her/his permission before you publish it.
* Treat nature and your environment with respect.
* It is better to leave nature as you found it. Never pick protected species. Before collecting plants or picking flowers, get permission. Only take what you really need and make sure you leave at least one third of anything you find in the wild.
* Be careful when working with plants or animals. Wear protection if necessary. Be gentle. Make sure they have appropriate food, water, shelter and air. When you're done, return them to where you found them.
* Recycle or reuse the materials used in the activities as much as possible.

Rules for working with electrical equipment

1. Avoid contact with energised electrical circuits. Treat all electrical devices as if they are live or energised.
2. Disconnect the power source before servicing or repairing electrical equipment.
3. Use only tools and equipment with non-conducting handles when working on electrical devices.
4. Never use metallic pencils or rulers, or wear rings or metal watchbands when working with electrical equipment. This rule is very easy to forget, especially when you are showing some electrical part by pointing it with a metallic pencil.
5. When it is necessary to handle equipment that is plugged in, be sure that your hands are dry and, when possible, wear nonconductive gloves, protective clothes and shoes with insulated soles. Turn over or cover a solar panel that cannot be disconnected.
6. If it is safe to do so, work with only one hand, keeping the other hand at your side or in your pocket, away from all conductive material. This precaution reduces the likelihood of accidents that result in current passing through the chest cavity.
7. Minimise the use of electrical equipment in cold rooms or other areas where condensation is likely. If equipment must be used in such areas, mount the equipment on a wall or vertical panel.
8. If water or chemical is spilled onto equipment, shut off the power at the main switch or circuit breaker and unplug the equipment. Never try to remove water or chemicals from equipment while energised.
9. If an individual comes in contact with a live electrical conductor, do not touch the equipment, cord or person. Disconnect the power source from the circuit breaker or pull out the plug using a leather belt. Stay very calm in order not to make the situation worse. Like in previous rules – always disconnect the power first.
10. Equipment producing a “tingle” should be disconnected, reported promptly or sent for repair.
11. Do not rely on grounding to mask a defective circuit nor attempt to correct a fault by inserting another fuse or breaker, particularly one of larger capacity.
12. Drain capacitors before working near them and keep the short circuit on the terminals during the work to prevent electrical shock.
13. Never touch another person’s equipment or electrical control devices unless instructed to do so.
14. Enclose all electric contacts and conductors so that no one can accidentally come into contact with them.
15. Never handle electrical equipment when hands, feet, or body are wet or perspiring, or when standing on a wet floor. Remember to wear gloves and shoes
16. When it is necessary to touch electrical equipment (for example, when checking for overheated motors), use the back of your hand. Thus, if accidental shock were to cause muscular contraction, you would not “freeze”.
17. Do not store highly flammable liquids near electrical equipment.
18. Be aware that interlocks on equipment disconnect the high voltage source when a cabinet door is open but power for control circuits may remain on. Read the single line diagram and wiring schemes – know your switchboard.
19. De-energise open experimental circuits and equipment to be left unattended.
20. Do not wear loose clothing or ties near electrical equipment.

Soldering rules

1. Work on a clean, hard, fireproof or fire-resistant surface.
2. Always place the soldering iron to its stand to avoid accidental burning.
3. Keep cables short and off your working area to prevent burning the isolation.
4. Only plug in your soldering iron when you need it and unplug it after use.
5. Never touch the "iron part" of your soldering iron. It gets very hot (over 300°degrees) and burnings are much more serious than those caused by common heat sources.
6. Hold wires and small parts to be heated with tweezers or clamps.
7. Work in a well-ventilated area.
8. Know where your fire extinguisher is and how to use it.
9. Read the soldering instructions on page 32.
10. Wash your hands after soldering.

FIRST AID

! It is important to know where and how you can get medical help.
Be prepared for the unexpected!

Electrical shock

1. Call the medical emergency service.
2. Separate the person from the current source (see rule 10 for Electrical Equipment).
3. Do CPR*, if necessary.
4. Check for other injuries.
5. Wait for medical emergency service.

*Cardio Pulmonary Resusciation

Burning

1. Immediately cool the affected area in cool water for 15 minutes.
2. Cover with a plaster. No cream is needed.
3. If the burn is more than 8 cm/3 inches in diameter, seek medical attention.

! Burning trough a soldering iron is usually a serious and very painful burning, although only a small surface is affected. Even if the iron is touched for half a second only, seek immediately to cool the burned area. Pain may be only be realised after a while, but immediate cooling is important!
The burnt skin should be protected to prevent infection and inflammation.

CREATING BEHAVIOURAL CHANGE

Past experiences with successful solar youth projects have made it clear that when working with young people and kids, the best learning effects and greatest motivation are achieved when they learn by doing. In the case of solar energy, this might be especially important, as many people lack experience and only have vague ideas about this source of energy and its practicality.

It is crucial that young people have "hands-on" experiences and learn from them. Due to their intense interest in global and environmental matters, young people are usually most motivated if what they learn enables them to do something and become active themselves. They want to make a difference.

How can you best prepare your group activities to promote behavioural change?

* Lead by example.
* Focus the aim of your activity on specific and achievable behavioural change e.g. "Turn off the light when leaving a room" rather than "Save energy".
* Encourage action planning and empowerment. Put young people in charge, let them choose their own activities and plan how to carry them out.
* Challenge current negative behaviour and tackle barriers to action.
* Encourage participants to scrutinise their current behaviour and think about how it could be changed. Everyone has excuses for why they don't behave in a particular way. Encourage young people to voice these excuses and then find ways around them.
* Practise skills until they become a habit.
* Spend time outdoors.
* Get families and communities involved.
* Make a public commitment.
* Monitor change and celebrate successes.

TIPS FOR UNDERTAKING ACTIVITIES WITH YOUR GROUP

* Plan ahead. Some activities may need preparations to be made a week before you execute them (e.g. What is the energy consumption of your household?)
* Be prepared. Read the instructions of your planned activity a week before to have enough time to get materials needed or to do research.
* Assemble all materials or check if the material is functioning and available for your activity.
* Get to know as much as possible about your topic. Naturally, children are very curious and ask questions you may not expect.
* It is always good to test an experiment if you have never done it before, to see if it works with your circumstances, especially the solar radiation and weather in your region.
* Plan alternative activities in case there is no sunshine.
* Take security precautions.
* Focus on a good balance between theoretical input and activity for the participants.
* If people are very much interested in a particular topic, do not interrupt them to stay with your “plan”. Self-motivated learning is most effective, support them.

HANDBOOK STRUCTURE

In the first part (p. 17), you will find **important background information** (theory) about solar energy, why it plays a central role in our lives, some technical information about its use and the risks related to the sun.

In the second part (p. 34), you will find a wide range of **activitie**s as well as **games**.

At the end of the handbook, you will find **additional resources and links**.
A separate document with practical worksheets for activities is available at solafrica.ch/scout-badge.

In this handbook, each part (background information and activities) is also separated into **four sections:**

A. Sun is life

B. Impacts of the sun on health and environment

C. Use of solar energy

D. Go solar!

These four sections should lead you through the book, helping you to find the information you are looking for.

A. Sun is life is an introduction to the sun, solar energy and how they are related to our lives.

B. Impacts of the sun on health and environment is about possible risks coming from the sun and how we can deal with these.

C. Use of solar energy is about the technologies used to harness the energy from the sun.

D. Go solar! gives inputs on how each and everyone can use solar energy and be an example for others, as well as the possibilities for whole communities to use solar energy.

The workbook

This handbook is written to help group leaders teach and organise activities related to solar energy.
A lot of practical material is available to make it even easier. In the workbook, you can find instruction sheets, templates and other resources for printing or copying.
The workbook can be downloaded from www.solafrica.ch/scout-badge.

OBJECTIVES AND AGE LEVELS

The general objective of the Scouts Go Solar Handbook for Leaders is to promote interest and understanding about the use of renewable energies as a strategy to protect the environment and respond to climate change.

You may also acquire:

* Teamwork and independent study skills
* Imagination and creativity
* Observation skills
* Cultural and environmental awareness
* Numerical and literacy skills
* Technical skills
* Research skills
* Presentation and public speaking skills
* The ability to present an argument and debate

The activities are divided into three age levels, with each level labelled according to the appropriate age group. As some activities may be interesting to more than one age group, the teacher or leader should use his/her judgement and select the most suitable activity for the group.

Level 1: Five to 10 years old
Basic understanding is gained by curiosity driven experimentation

Level 2: 11 to 15 years old
Complex tasks that strengthen and demand more practical, analytical and interactive skills

Level 3: 16 years old and above
Combine and connect their analytical, practical and interactive skills, develop solutions adapted to specific situations

PROPOSAL OF SOLAR BADGE PROGRAMME

The activities can be integrated with the Scouts Education and Training System (Youth Programme and Advancement) and the Scouts go solar project is part of the World Scout Environment Programme WSEP.
The Solar Badges are of two types, a special **Centre Badge** and the **normal Badge**.
(acquired upon completion of certain requirements):

Centre Solar Badge

Target groups:
Scouts of all ages who stay in a Scout Centre

Aim:
Learn the basics and techniques of solar energy, and have fun with solar energy.
These activities are meant to stimulate the interest of the participants in the topic.
Be as flexible as possible and prepare additional information.

Requirements:
Adapt the requirements to the circumstances in your centre, e.g. „complete 4 of the activities“.

* Participate in a solar workshop
* Draw a wooden sign for your group with the help of the sun (Solar Art)
* Use a solar compass on a hike
* Make popcorn with the parabolic cooker for your group
* Take a picture of the sunrise on a mountain
* Build a sundial
* Answer two questions about the Solar Installation in the Centre
* Make a solar grasshopper race

Solar Scout Badge

Target groups:

Scouts of all different ages

Aim:

To learn the basics in solar energy, the different solar technologies,
and to be able to use solar energy and technologies (depending on age group)

Requirements:

This is a proposal for a Solar Challenge Badge Programme that can be adapted according to your needs.

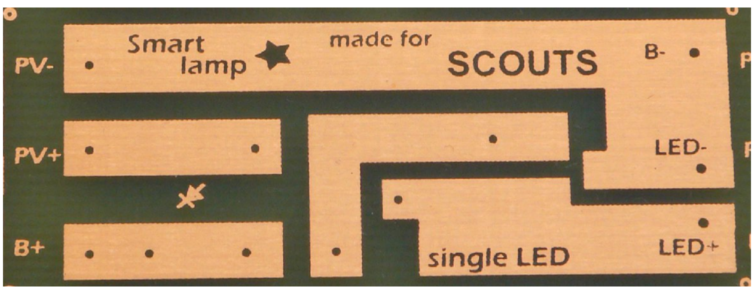
Activities	Level 1	Level 2	Level 3
SODIS / solar water disinfection	✓	✓	✓
Collect water from vegetation /purify water (condensation)		✓	✓
Build a box cooker/oven	✓	✓	✓
Solar art	✓	✓	✓
Sunglasses	✓	✓	✓
Coloured water heating bottles	✓		
Solar lamp		✓	✓
Compass		✓	✓
Sundial	✓	✓	✓
Greenhouse effect			Create and explain to your group
Cooking	Hot drinks, easy recipe (melt chocolate/ cheese)	More complex recipe, drinks	Cook a solar lunch for a small group
Community Service		e.g. build a solar installation on your local school, community/scout centre, etc.	

SOLAR MATERIAL

If you want to undertake some solar activities, you'll need solar material. In order to make it easy for you to get started, we have assembled some materials in the Solar Starter Kit.

The **Solar Starter Kit** is a material box for group leaders.
If you want to assemble the materials on your own, view the material lists at solafrica.ch/scout-badge or in the workbook.

Self-assembly kits are also available for the Scouts "Smartlamp".
Visit www.solafrica.ch/scout-badge to check for materials available.



A. SUN IS LIFE

The sun is in the centre of our lives. Not only because it is physically the centre of our planetary system, but also because it is the source of all energy on earth. Plants can't live without sunlight, as it is absolutely needed for photosynthesis. Animals need it for their well-being, for a moderate temperature of their environment and a functioning metabolism.

Sun is energy

The sun is the centre of our planetary system (solar system) and is composed mainly of the two elements - Hydrogen (74.9%) and Helium (23.8%). The sun is 4.57 billion years old and has a diameter of 1,391,980 km, whereas the earth's diameter is 12,756 km. The energy coming from the sun will be available for at least another five billion years.
That, in terms of human lifetime, is eternal.

The amount of solar energy reaching the surface of the earth is so huge that, in a year it is about twice as much as we will ever be able to obtain from all of the earth's non-renewable resources – coal, oil, natural gas, and mined uranium – combined. Or, in an hour, the solar energy reaching the earth (excluding 30% reflected by the atmosphere) is more than a year of the world's energy consumption. The sun is at a main distance of 150 million kilometres (at a light speed of 8 minutes and 19 seconds) from earth.

What is energy?

Energy is defined as the capacity of a system to perform work. The Greek word "energeia" means activity or operations.

Forms of energy include kinetic (movement), potential (stored in object), thermal (heat), gravitational, sound, light, elastic, electromagnetic, chemical and nuclear.

Energy can be divided in Primary energy (energy form found in nature, no conversion or transformation, e.g. light, heat, coal, fuel, wind, etc) and Secondary energy (energy carriers, e.g. batteries, petrol, etc). Final energy is the energy form that humans use, such as electricity or fuel. Final energy can be a primary energy, or be transformed once more to a secondary energy (example nuclear power: heat is transformed to kinetic energy, which is transformed to electricity in the generator).

Explanation	Unit + Formula
Energy is measured in joules.	J = W*s Wattseconds More common in electric current measurement is Wh (Watthour) or kWh (Kilowatthour = 1000 Wh).
Power is measured in watt.	W = J/s **Volt (V) * Ampere (A) = Watt (W)**
Electric potential (voltage) is measured in volt.	V = W/A
Electric current is measured in ampere.	A = W/V

1 For further information, consult the Teachers Handout on Renewable Energy

Use and production of energy

Everyday we use different forms of energy. Most people relate electricity to energy.
But also in many other ways we use energy, such as nutritional energy for our bodies, heat for our houses or fuel for our mobility. Let's have a closer look:

The world's total consumption of energy has increased significantly over the past few decades.

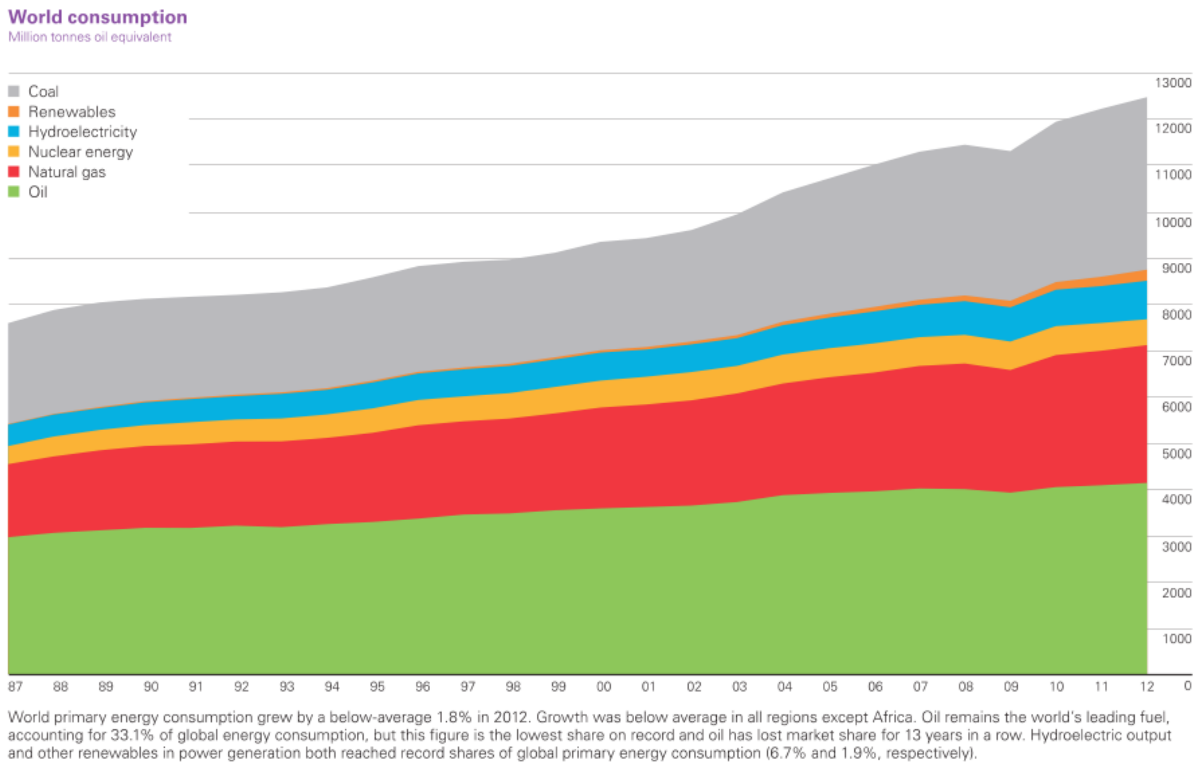


Image 1: World consumption of Primary energy (BP Statistical Review of World Energy June 2013)

The above diagram (Image 1) shows the world's consumption of Primary energy. Almost everywhere in the world, the consumption of energy is strongly increasing due to access to electricity , population growth and rising mobility. Compared to coal and fuel, renewable energies are used very little despite their enormous potential – they are renewable and will never end. Nevertheless, the change from fossil energy to renewable energy requires technological adaptation. While it involves cost, it is necessary as in the long term, it'll be all that we have, once the non-renewables are used up.

The production of energy is actually a transformation into Final energy. Energy in any form cannot be produced.
It's often transformed from one form into another. Final energy is the energy form we use as consumers.
Very common is the transformation into electricity, but also into heat or used directly.

The following table (**Image 2**) shows the world energy consumption by end-use sector (quadrillion Btu).
As shown in "Electricity Losses", sometimes more than half of the energy is lost during transformation or distribution. The electricity losses for transportation is very low, as there exists very little transportation using electricity.

	Energy End-use[2]	Electricity Losses[3]	Total Energy Use[4]	Share of Total Enery Use
End-use Sectors				
Commercial	29	34	62	12%
Industrial	200	66	266	51%
Residential	52	40	92	18%
Transportation	101	2	103	20%
Total End-use Sectors	382		524	
Electric Power Sector[4]	204			
Total Electricity Losses[3]	142			39%

Image 2: World energy consumption by end-use sector (quadrillion Btu) and shares of total energy use, 2011[1] (includes losses in electricity generation, transmission, and distribution)

1 This is the most recent year for which data are available at the time of update.
2 Energy end-use includes end-use of electricity but excludes losses.
3 Electricity losses includes losses in generation, transmission and distribution.
4 Total energy use includes electricity losses.
(http://www.eia.gov/tools/faqs/faq.cfm?id=447&t=3)

Transportation is, after the industrial sector, the biggest user of the world's energy. It is also the sector, which will grow most in the future, as shown in the following figure (**Image 3**). Although the total use of energy in transportation will grow, big differences in regions are expected. While non-OECD (Organisation for Economic Co-operation and Development) nations have a big potential to grow through economic and population growth with mostly an underdeveloped transportation sector. On the other hand, OECD countries will face declines in the transportation sector due to slow economic growth, higher energy efficiency and stable population levels.

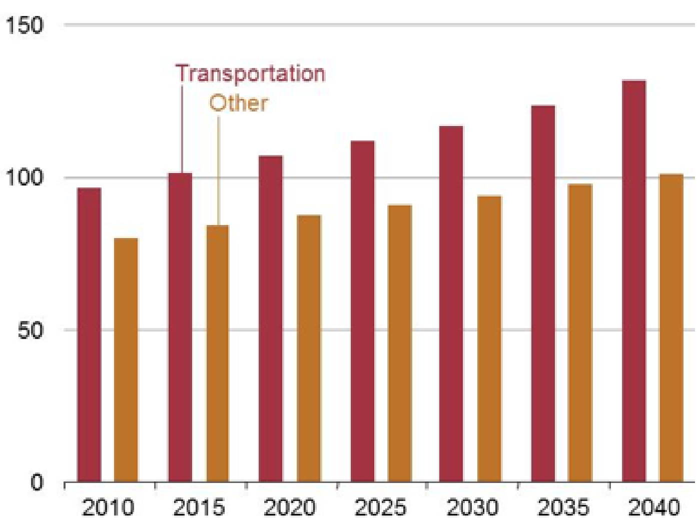


Image 3: World liquids consumption by end-use sector 2010-2040
"In the IEO2013 Reference case, world energy consumption in the transportation sector increases by an average of 1.1 percent per year. Petroleum and other liquid fuels are the most important component of transportation sector energy use throughout the projection. The transportation sector accounts for the largest share (63 percent) of the total growth in world consumption of petroleum and other liquid fuels from 2010 to 2040 (Figure 129), increasing by 36 quadrillion Btu as compared with an increase of 25 quadrillion Btu in the industrial sector and declines in all other end-use sectors."
(http://www.eia.gov/forecasts/ieo/transportation.cfmd)

Renewable and non-renewable energies

Everyday we use different forms of energy. Most people relate electricity to energy.
But also in many other ways we use energy, such as nutritional energy for our bodies, heat for our houses or fuel for our mobility.

Let's have a closer look:
The world's total consumption of energy has increased significantly over the past few decades.

> Renewable energy is energy that comes from resources,
> which are continually replenished (within the duration of a human lifetime).

SOLAR ENERGY is part of the renewable energies. Other renewable energies are:

GEOTHERMAL | BIOMASS | HYDROPOWER | WIND

All renewable energies still cover only 1% of the world's energy consumption.
Non-renewable energies are coal, oil, natural gas and nuclear (see also **Image 1**).

A comparison of renewable and non-renewable energy

	Renewable	Non-renewable
Power Density*	Low	High
Power Supply	Less mobile (but can be improved through technological development)	Highly mobile
Dependency	Dependent on weather (sun/wind), natural resources and technology	Independent from weather Dependent on natural resources and technology
Cost	Cheaper in the long term Cheaper regarding all related costs (e.g. impact on environment, health, etc.)	Cheaper in the short term Expensive regarding all related costs
Availability	Infinite No depletion	Finite Depleting
Environment	Little or no pollution Large-dimensioned projects may trigger environmental concerns	High level of pollution

*** Power density:** The amount of power per unit volume (renewable energies use more "space").

Solar energy

Everyday we use different forms of energy. Most people relate electricity to energy.
But also in many other ways we use energy, such as nutritional energy for our bodies,
heat for our houses or fuel for our mobility. Let's have a closer look:

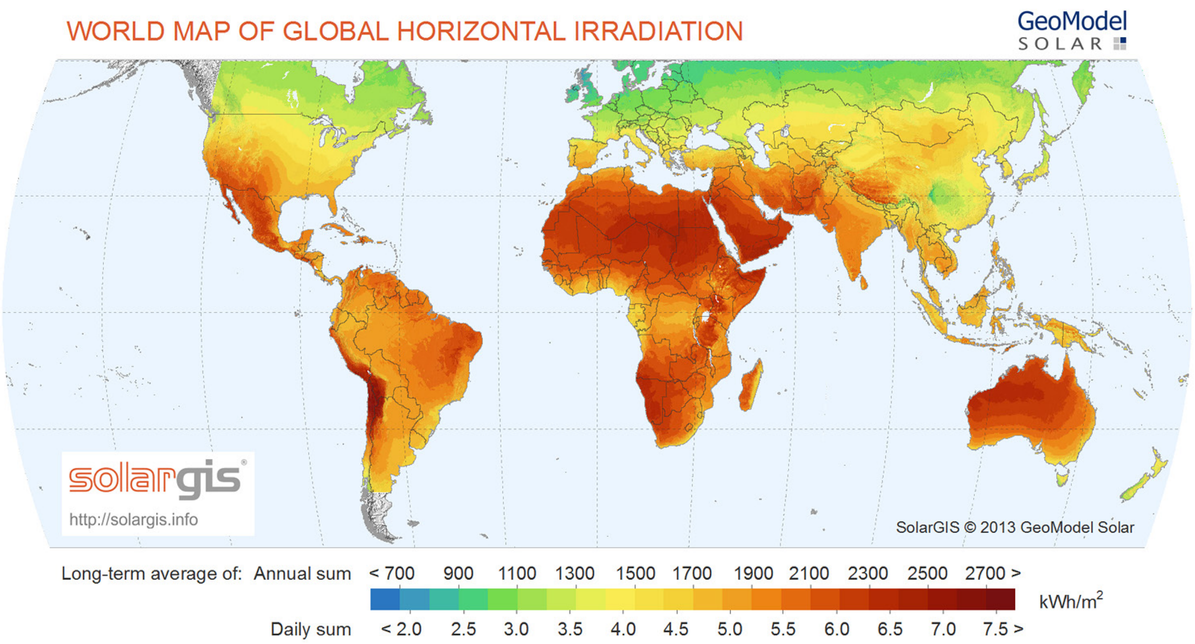
The world's total consumption of energy has increased significantly over the past few decades.

1. One hour of insolation is equivalent to the world's energy consumption for more than a year.
2. One year's worth of solar energy reaching the surface of the earth is twice the amount of all non-renewable resources, including fossil fuels and nuclear uranium.

Although this shows the enormous amount of energy reaching the earth, solar energy covers less than 1% of the world's energy production. The potential is huge, and even if the world's energy were to be produced by solar energy, we would only use a very small amount of the total energy reaching the earth. Although solar energy is not available all the time and throughout the earth, we are able to know when and where it is available through the rotation of the earth and the decline of the axis. While the use of solar energy is a little bit more complicated, it is not impossible.

Without the energy from the sun, there would be no life on earth. The atmosphere would not be heated, no sunlight means no photosynthesis and therefore no plant growth. The insolation defines our weather and the earth's climate. Solar energy is the source of our weather, and with the rotation of the earth, strong winds and currents in the sea rise (which we can and do use for energy production).

Even in our daily life, we use solar energy. We use daylight for our activities and use sunrays to dry our laundry. We need sunlight even for our health, to produce vitamin D in our skin and to make us happy. Some people use the sun to dry agricultural products, to produce salt from the sea, to bleach textiles, etc.



As seen in image 4, the irradiation is not the same in different locations in the world.
This is due to the globe form of the earth and declination of the earth axis (not the same irradiation over the year).
The local irradiation can be found on www.gaisma.com

B. IMPACTS OF THE SUN ON HEALTH & ENVIRONMENT

Although we need the sun and its energy for our survival, it can cause some problems for humans and other living species. If we do not get enough sunlight, we might get depressed as in some northern countries. Still, we need to protect ourselves from too much sunlight. Solar energy is a major factor in the equilibrium of our climate, and the current change in equilibrium has been attributed to human activity.

"THE DOSE MAKES THE POISON" (Paracelsus)

The greenhouse effect

What we call global warming is a relatively recent phenomenon. Over the last few decades, the surface temperature of the earth has been rising at almost twice the rate of the last hundred years. This rise in temperature is directly connected to the disequilibration of the greenhouse effect.

Life on earth is only possible because of the earth's atmosphere, a layered mix of gases that envelopes the planet. Without the atmosphere, the average temperature on earth would be -18°C/-0.4°F (instead of ca. 14°C/57.2°F). The most important of the greenhouse gases is water vapour.

The rays of the sun easily penetrate the atmosphere. Sunlight is absorbed by the earth and transformed into heat. However, instead of escaping through the atmosphere, some of the heat radiating off the earth is trapped by greenhouse gases. This feedback mechanism heats up the planet even more, not allowing it to cool off as much.

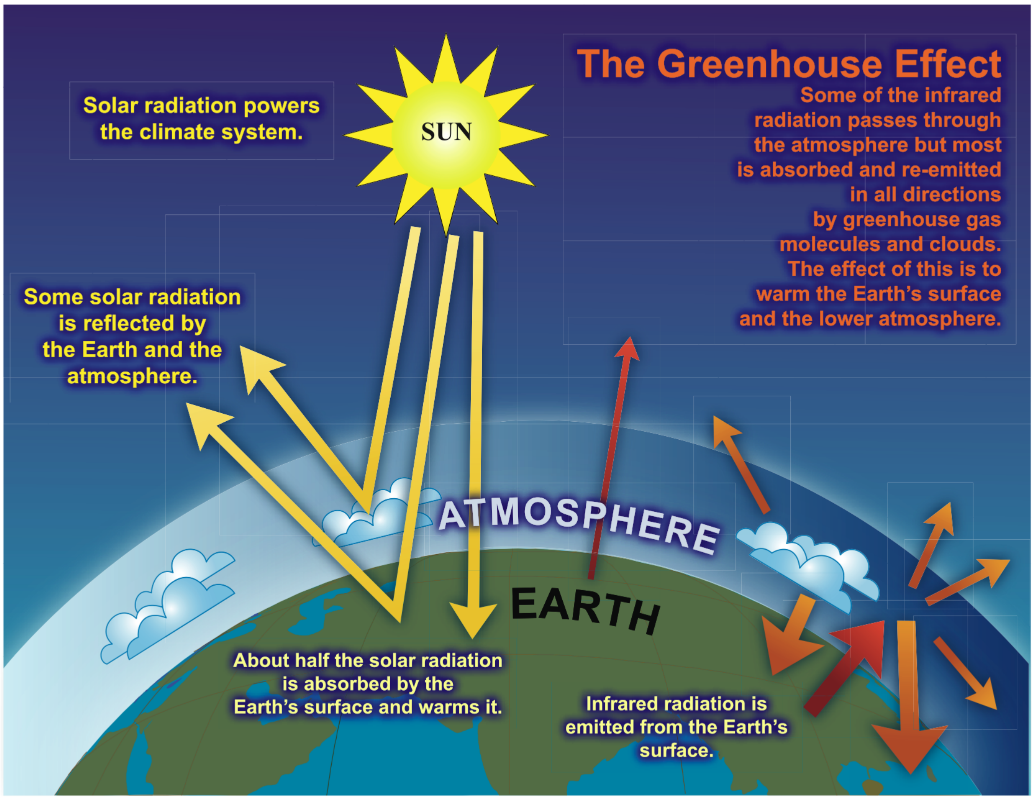


Image 5: The greenhouse effect (https://www.ipcc.unibe.ch/publications/wg1-ar4/faq/wg1_faq-1.3.html)

There is a difference between a natural greenhouse effect and a greenhouse effect caused by human activity. The natural greenhouse effect is a good thing since without it life on earth would not be possible due to very low temperatures. Without the greenhouse effect, the average temperature would be below zero degrees and would not allow life on earth. Some 60% of the natural greenhouse effect is caused by water vapour. Global warming further drives this greenhouse effect by increasing the evaporation of water. The warmer it gets, the more water vapour is emitted to the atmosphere. We cannot stop water from evaporating as long as the temperature keeps rising (due to other influences).

Carbon dioxide causes 9 - 26% of the natural greenhouse effect compared to 60% of the man-made greenhouse effect, hence the great importance attached to reducing CO2 emissions. Unlike water vapour, we can directly influence CO2 emissions. We generate CO2 by burning fossil fuels (transport, heating, industry and power generation).

Some 20% of the man-made greenhouse effect are caused methane-emissions (cattle industry, agriculture). We can curb methane emissions by consuming less meat and milk, and reducing our use of fertilisers.

Our health

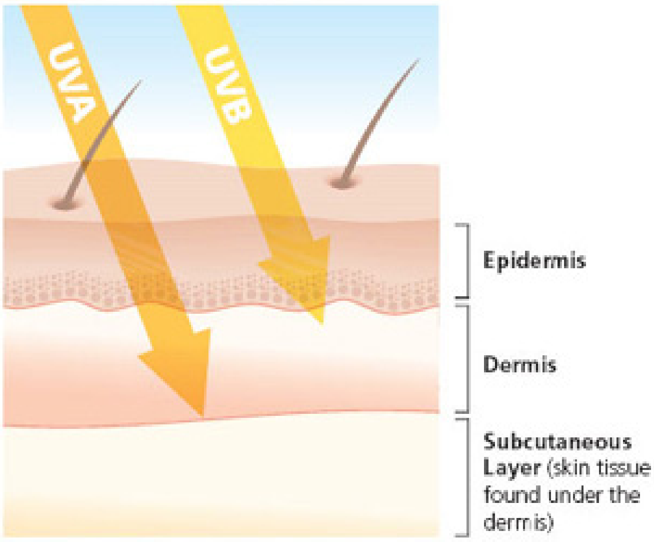
UV-Rays

The sun provides many vital functions for us. Keeping temperatures at an agreeable level is just one of them.
We need the rays of the sun on our skin to produce enough vitamin D. Through food alone we cannot assimilate sufficient vitamin D to keep our bodies healthy. But the sun is also important for our mental health. Especially in northern countries where sunlight is scarce for months at a time people with depression can be fortified through light therapy. The sun also has its dangers. The UV rays of sunlight can damage our skin no matter if it is dark or light. Everybody can get skin cancer.
UV-A radiation is chiefly responsible for the aging of our skin and affects even the deepest layers of our skin. UV-B radiation causes burning but over the longer term tans the skin and affords a natural protection from sunlight. UV-B radiation also helps prevent cancer (including skin cancer). Depending on the intensity of the radiation, the body may suffer temporary (sunburn) or permanent damage (skin cancer). Tanned or dark skin offers slightly better protection than light skin. Sunscreen increases the self-protection of the skin. However, depending on the Sun Protection Factor (SPF), sunburn or skin cancer may still occur. Here too, the atmosphere plays an important role because its ozone content absorbs a major part of the damaging UV radiation. The ozone level varies throughout the year and there may be seasonal peaks of damaging UV radiation, especially at the north and south poles.

Ozone

Ground level ozone is unrelated to the ozone layer and is bad for your health. It develops on very hot days with intensive sunshine, the result of complex chemical processes fuelled by the radiation of the sun.
Ground level ozone (also known as summer smog) can cause shortness of breath, headaches and limit physical fitness.

UV Radiation and the Skin



Heat & Hydration

On a sunny day, we may suffer if our body is exposed to too much heat. If we do not take precautions to protect ourselves, the result can be a sunstroke (also known as heat stroke). A sunstroke is considered a medical emergency! This means, the affected person should seek medical attention.

A heatstroke occurs, when your body is not able to regulate your body temperature anymore, due to excessive exposure to heat. Dehydration contributes to sunstroke. This happens, when your body excretes more water
(trough urination and sweating) than it takes in.

Signs (you can observe) of a sunstroke:

- High temperature
- Sweating stopps
- Red, hot and dry skin
- Rapid hartbeat
- Rapid breathing or hyperventilation
- Confusion, Disorientation and other behavioural changes
- Unconsciousness
- Muscle Cramps
- Vomiting

Symptoms (the patient describes):

- Headache
- Dizzyness
- Feeling hot/fever

You might observe a person has some discomfort before reaching a heat stroke.
Immediately seek to cool and hydrate the patient to avoid more severe symptoms as described above.
If the person shows signs of a heat stroke, be careful with rehydration and follow medical advice.
Giving the patient drinks can cause vomiting and be a risk, if the patient looses consciousness.
The body is in a shock state (like after loosing a lot of blood).

What to do in case of a Heat Stroke

1. Contact the medical emergency service.
2. Move the person to a cool, shady area.
3. Try to cool the persons body core temperature, for example with a fan while wetting the skin. Apply cooling packs on armpits, groin, neck or back.

Risk factors and Precautions

1. Dehydration

Drink plenty of fluids to keep your body hydrated.

Avoid caffeinated and alcoholic drinks (they dehydrate the body).

2. Exposure to heat

Stay in the shade and avoid being outside for the hottest time (11AM to 3PM) of the day. If you have activities outside, wear a hat that shades face, neck and ears and light-colored, loose-fitting clothing.

! You might want to provide drinks and Sunhats for your group during activities.

C. USE OF SOLAR ENERGY[2]

There are two ways we can use solar energy:
By utilising the radiation and heat the sun produces, and by producing electricity through solar cells. Both (thermal and photovoltaic) can be used directly or with an intermediate storage of the energy (heat/electricity).

Photo-thermal use of solar energy

The functional principle of using sunlight for thermal uses is simple, but has a high impact. A solar collector is operated to generate heat. It "collects" solar radiation and heats up a heat carrier – the heat can then be used for different purposes.

Heating houses and water

Commonly, it's used for solar water heaters (SWH): The sun heats up directly the water contained in a dark vessel. The heated water can then be used by the household or business or for heating buildings.
Besides the Collector, a tank (heat accumulator) is needed, to provide storage of the warm water.
Small hot water systems run without a pump due to convection that moves the heated and less dense water upwards. It's called a thermosyphon (Image 6).

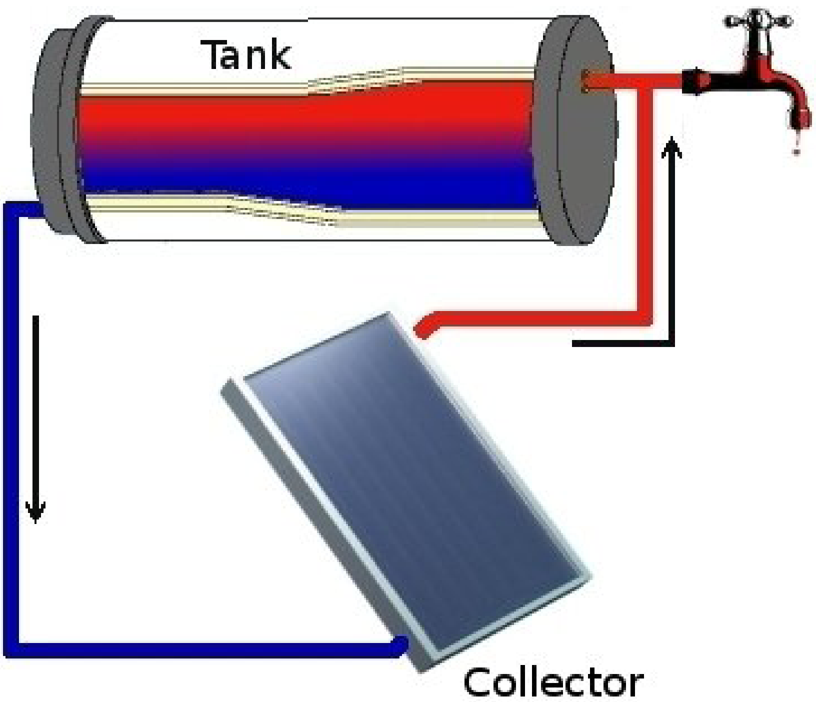


Image 6: Thermosyphon flow

2 For further information consult the Factsheet on Solar Energy on wave.greenpeace.org

More complex systems have two separate circuits (Image 7):

- one for the tap water heated in the tank
- a second circuit for the collector fluid

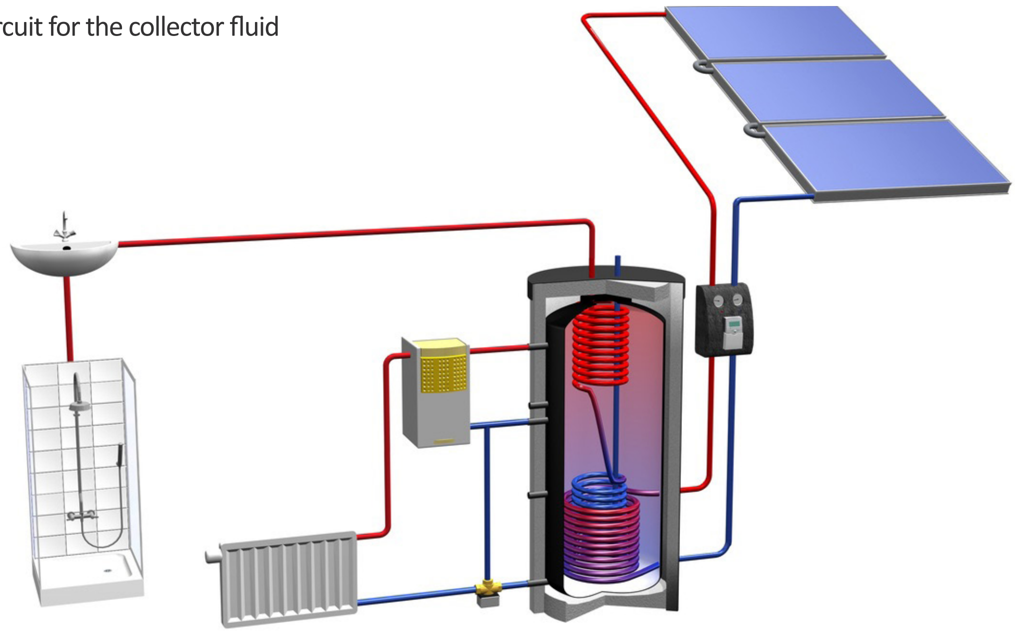


Image 7: Solar thermal system

Note:

Two things are important with a solar warm water collector: a heat-insulating container must enclose it and it must be black. Why black? Because a body that's black absorbs most of the light and therefore thermal energy.

Conditions:

Solar collectors make sense wherever there is a demand for process heating water and where an irradiated surface is available. In addition to free surface and demand, space is needed for a central heat accumulator (tank). The unused potential is enormous and solar collectors are profitable with respect to the purse!

Swimming pools can be heated by this method as well.
There are also special devices like hay drying with air-collectors or solar cooling for offices.

Power production

Another method is whereby large mirrors concentrate sunlight into a single line or point. The heat created is used to generate steam. The hot and highly pressurised steam is used to power turbines, which generate electricity (solar power plant).

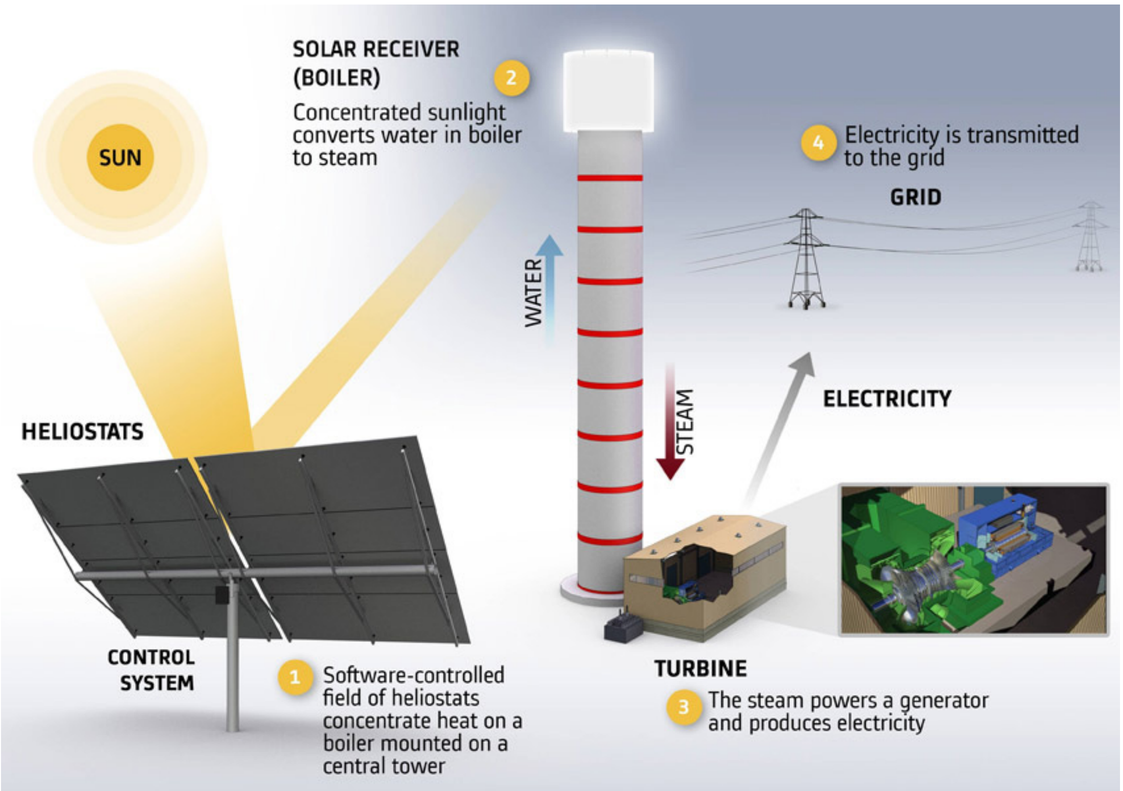


Image 8: Solar power plant

Cooking and conserving food[3]

The solar box and the parabolic mirrors have different advantages and disadvantages:
The solar box needs more time to heat up and doesn't produce heat quickly – therefore, it's a good solution for meals like bread, cakes, beans that don't need quick temperature changes and can be left in the heat without opening the box during a rather long period of time (Read "Instructions for a simple box cooker" in the workbook).

The parabolic mirror, on the other hand, produces heat quickly and can therefore be used to roast and cook things like omelettes, pasta or meat. In places where people are used to cooking with wood, both can be combined with an efficient stove because solar cooking can't replace the other way of cooking, it only supplements it. The special technology of an efficient stove saves wood and smoke.

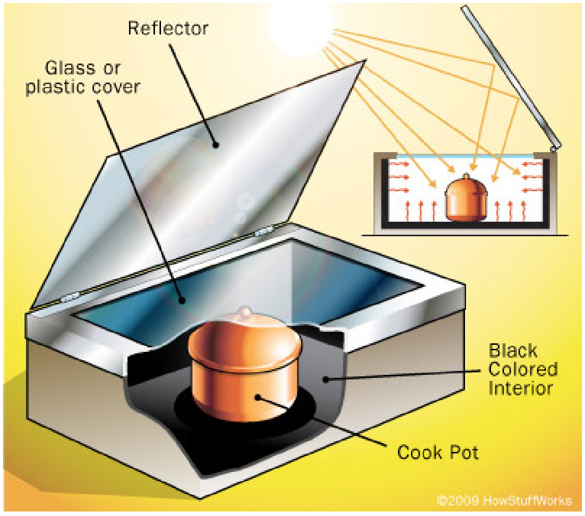


Image 9: Solar box

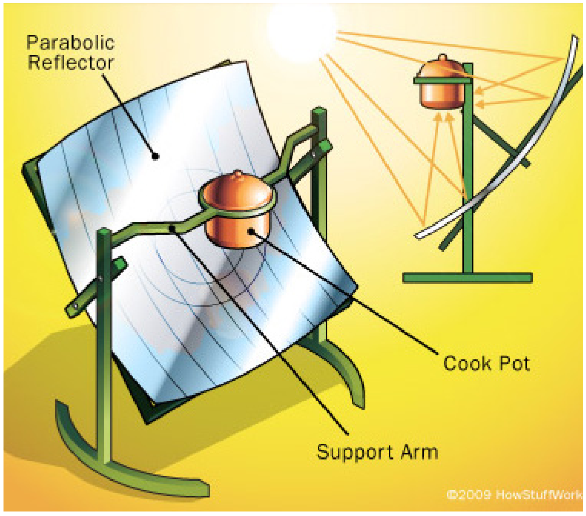


Image 10: Parabolic mirror

More information about solar cooking can be found on: http://www.solarcooking.org

Another possibility are solar dryers (Image 10). These constructions use heated air (flow) to dry all kind of food like fruits, vegetables or even fish. Drying time is short and the food can be placed in the shadow. This prevents degeneration of important substances, such as vitamins and provides better food quality. Even industrial production is possible in large dryers.

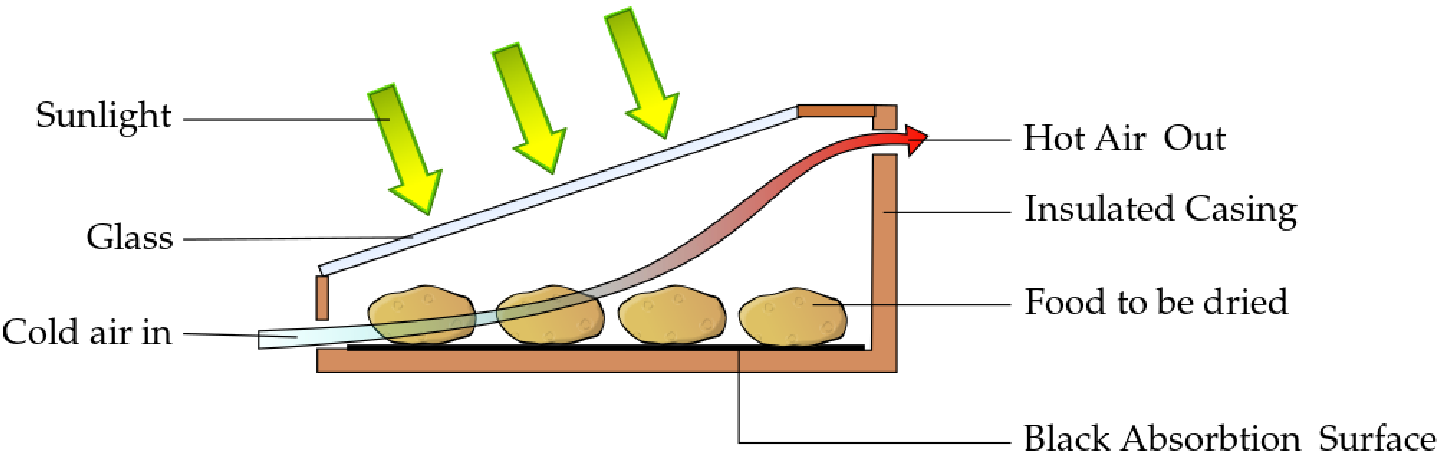
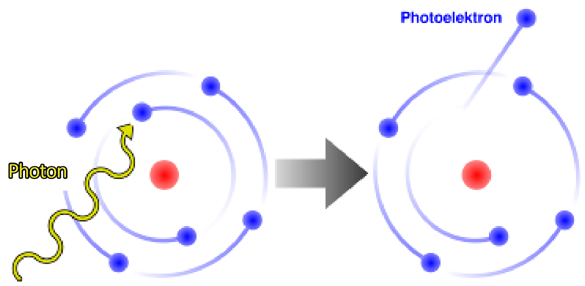


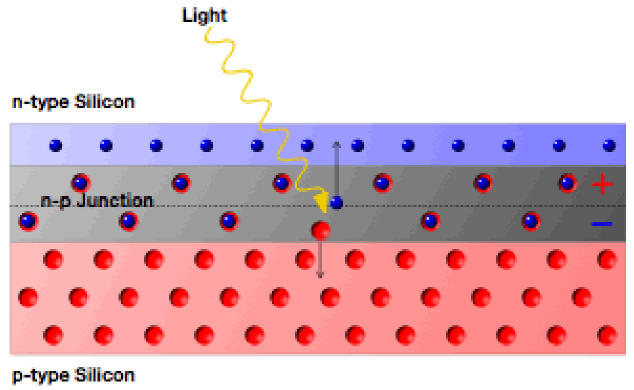
Image 10: Simple solar dryer example and function

3 For further information consult the **Factsheet on Solar Cooking** on wave.greenpeace.org

Photovoltaic use of solar energy

Photons coming from the sun "push" an electron from its position in the atom. It seeks a position on a neighbouring atom and starts a chain reaction. As the Photons give energy to the atoms, a "flow of electrons", which is also known as current or electricity begins. The main functional part of a photovoltaic system is the solar cell, which usually are assembled in one solar panel of a different size and therefore a different output.





In photovoltaic, two different systems exist for the use of solar energy.
You can either have your own Electricity System, which runs independently but needs storage or connect it to the public grid.

Off-grid photovoltaic system

You need a solar panel, cables, a battery for storage (for low insolation times or nights) and probably a charge controller to provide longer life for your battery.

Grid-connected photovoltaic system

You need a solar panel, cables and an inverter. This system needs no storage, as the public grid is the "storage".

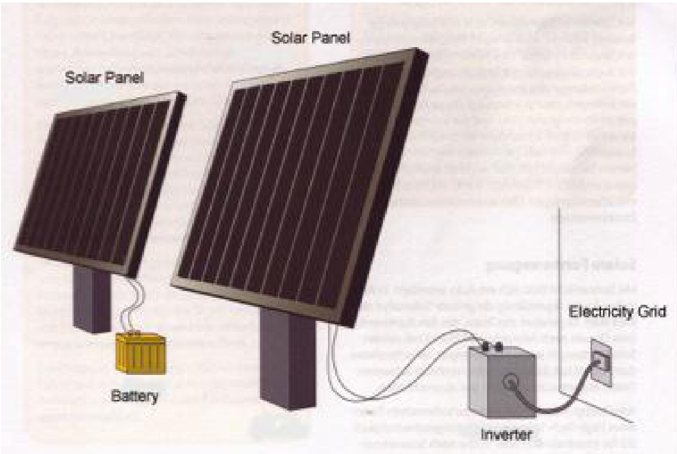


Image 11: Off-grid (left) and grid-connected (right) PV system

Direct use and storage

Whether it concerns heat or electricity, the energy from the sun is available all day, as long as the sun is shining.
For cooking, hot water and even electricity, we can use direct systems, which use the energy at the very moment it is "produced" (when the sun is shining on our device).
As we also need solar energy during night, we need to store energy. With hot water, it is rather simple with a heat accumulator or insulated water tank. For electricity, storage is a little bit more complicated. Usually, the energy is stored in batteries, which vary in type, power, size, etc. Additionally, with batteries we will need a charge controller, to prevent our batteries from geting damaged. And probably we will also need an Inverter to convert the energy produced (often 12 or 24 Volts) into the voltage of our devices (usually 115 or 230 Volts).

Misconceptions about solar energy

#1: The lifetime of a solar panel is too short for any reasonable energy output

A photovoltaic panel has a lifetime of approximately 30 years of constant energy production. After this time, it still can produce electricity, but efficiency will be reduced. Technical developments constantly increase both the efficiency and lifetime of solar panels.

#2: Energy consumed during production is larger than energy generated

The offset of the „grey energy" (all energy used for production) of a Solar panel is approximately two years. This means, in two years the energy generated by a solar panel is equal to the energy used to produce this solar panel.

#3: A solar panel releases more CO_2 during production than it can compensate

On the CO_2 emissions side a solar panel with a typical 25 years lifespan pays back its production-related emissions in 1.3 years time.

#4: Solar panels are environmentally unfriendly because they contain toxic metals

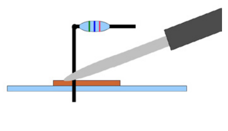
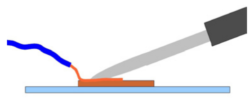
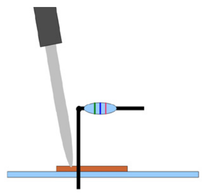
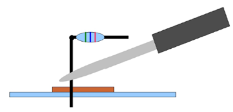
They are problematic at two points: During production process and at the end of their lifetime. The risk is manageable, as environmental standards for producing companies can be and are already set up. Inside one solar panel, there are very little amounts of these toxic metals and even at waste, you'd need a huge amount of solar panels assembled in one place to accumulate as much as would be harmful for the environment or humans. During use, the toxic metals are completely sealed inside the panel and would not get in contact with the environment.

Soldering instructions

You might use soldering to build your own Solar Torch or to make other electrical connections. Please have a look at the Safety Rules on ***page 8.***

Soldering is a method to join two parts of metal (copper, iron, ..) with the help of a third metal (tin). **The most important rule:** *first* heat both parts with the soldering iron, (only) *then* add the tin.
Soldering needs at least 3 hands! We best start working in pairs. Later we learn to get by with our two hands, smartly exchanging our tools...

1. Both metal parts must be clean (if they aren't, clean them with alcohol or file the surface if oxidized).
2. Join both parts with **gentle pressure** of the hot soldering iron. For best heat transfer, we do not use the tip of the iron, but the side of the tip, holding it slightly inclined (see pictures a and b)

			
a) Good: iron heats component and copper layer.	*b) Good: iron heats cable and copper layer.*	*c) Bad: The contacting surface is very small, the iron should be held inclined.*	*d) Bad: the iron hardly touches the copper layer, no pressure is applied.*

3. **Only when both metal parts are very hot**, we add tin, from ‚below' if possible. In theory, the tin does not touch the soldering iron, but only the parts to be connected. These parts should be hot enough that the tin melts by touching them. The soldering iron is not a brush ‚paining' liquid tin!
4. Now we wait a little moment, until the tin forms a nice ‚drop'.
5. We fix the position of our components for instance using a knife, screw driver of a small file and remove the soldering iron.
6. After a few seconds, the tin is solid and we can remove the knife, etc.
7. To check our solder joint, we gently pull the soldered element: if it holds mechanically, the electrical contact is usually ok as well. We also give it a ‚visual inspection'. If we are not happy with the result, we heat the solder joint again.

D. GO SOLAR!

All over the world, there is an urgent need to reduce CO2 emissions. It is all about getting involved to make a difference. A person who uses renewable energy saves non-renewable energies. As a leader you can be a good example and motivate others:

WE ARE NOT "A DROP IN THE OCEAN" BUT A

"CONSTANT DRIPPING THAT WEARS AWAY THE STONE".

With this handbook, you can get the ball rolling by creating more awareness of solar energy, which is affordable and available for everyone. At the end of the handbook, you can find more links to organisations and projects where you can learn more about solar energy.

INSTALL A PHOTOVOLTAIC SYSTEM

BUILD A SOLAR TORCH

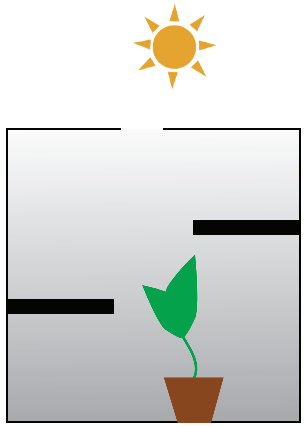
COOK YOUR FOOD WITH SOLAR ENERGY

A. SUN IS LIFE

Chasing light

Discover how a plant turns/grows towards the light.
You can either visit a sunflower field and observe it or take pictures of it at different times of the day.

You can also grow your own sunflower and observe it. Alternatively, grow a bean and put the seedling in a box. Cut a 1 cm x 1 cm hole on one side of the box or build a more complex box as shown in the picture. Make sure that there is no light coming into the box except from the hole you cut. Observe how your plant is growing after a few days.



Age Level	1 / 2
Time	One day/week
Result / Aim	Sunflowers turn towards the sun during the day The plant in the box will grow towards the source of light All plants need sunlight for living (photosynthesis), they only grow with sunlight
Materials	• Cardboard box • Cardboard • Tape/glue • Beans seedling • Knife/scissors • Camera for time-lapse photography

Shadow Thief

Somebody has to be the Shadow Thief and tries to catch the shadow of the fleeing children with her/his feet. Once he or she catches someone's shadow, the person who is caught loses her/his shadow and becomes the next Shadow Thief.

Age Level	1
Time	5 - 10 minutes
Result / Aim	A fun introduction to the sundial
Materials	Field

Solar art

Always wear sunglasses for this experiment!
Wear ultra strong sunglasses or sunglasses with an extra layer of UV absorbing black plastic.
You may use car window tint and glue it on the sunglasses.
Try to focus the sunlight with a lens on a wooden plank so that the wood gets slightly burned. You can make a drawing or write a text or your name. To make it easier, you can first draw lines with a pencil (not pen) on the wood. When you're done, put the lenses back in a closed container. If left in the sunlight, it may cause a fire. On the other hand, if you need a fire, you can easily light one with the help of the sun and a lens. For this activity, never leave children without supervision and keep a pail of water close by in case of emergency.

Age Level	1 / 2 / 3
Time	15 minutes - 1 hour
Result / Aim	Learn about the strength of sunlight, to "focus" and be creative Good introduction to the parabolic cooker
Materials	• Lens • Dark sunglasses with UV protection or darkened sunglasses • Wooden planks • Water

Colours of solar energy

Paint small PET plastic bottles in different colours, at least one black, one white. Alternatively, you can wrap coloured paper around the bottles. Fill them with water and measure their temperature.
Put the bottles in direct sunlight and after 30 minutes, measure their temperature again. What can you observe?

Advanced: Measure the temperature of different material surfaces in direct sunlight
(mirror, glass, dusty and clean glass, etc). What can you observe and what does it mean for the use of solar energy?

Age Level	1 / 2
Time	30 minutes
Result / Aim	Show how different colours absorb sunlight
Materials	• PET bottles • Different colours • Water • Thermometer

Sundial

Prepare a Sundial model and copy it for the kids, so they just have to cut and assemble it.
Older children can draw the model by themselves.
You can get the instructions to build a sundial at http://www.sundials.co.uk/projects.htm.
A template for a sundial model can be found in the workbook.
Why should you learn about the latitude? Can you travel with your sundial and use it in another country?

Age Level	1 / 2 / 3
Time	45 minutes
Result / Aim	Discover the changing position of the sun throughout the day and the axis of the earth
Materials	Refer to instructions

Solar and other energy sources

1. Research the energy matrix in your country. Identify the sources of energy and the potential of solar energy.

2. You need to find out

- the amount of energy the sun releases onto a surface the size of your country in a year
  (You can refer to the example at www.gaisma.com)
- the amount of electricity from various sources that is generated in your country in a year
  (Percentage coming from sun, hydroelectric, wind, etc.)

3. Find out about the most convenient ways to increase the sources of renewable energy in your country.
What is the most suitable renewable energy for your area and why?

4. Present the results of your research to your team or to the group.
Create a game in which the groups must link the number of kilowatts produced with the source.

Age Level	3
Time	2 - 3 hours
Result / Aim	Solar energy in different places on earth
Materials	Library/internet

Solar compass

Hold an analog watch horizontally and point the hour hand in the direction of the sun. Divide into half the angle between the hour hand and 12 o'clock[1]. If you are on the northern hemisphere, this direction shows you south, if you are on the southern hemisphere, it shows you the north. Advanced: Discuss how this compass works.

Age Level	1 / 2 / 3
Time	10 minutes
Result / Aim	Be aware of the "wandering" of the sun during the day Learn about a useful outdoor tool
Materials	Analog watch

4 12 o'clock "winter time" if your country is using daylight saving time.

B. IMPACTS OF THE SUN ON HEALTH & ENVIRONMENT

Sunglasses

Create your own sunglasses.

Copy the 3D glasses to a thick paper, cut them out and glue the dark film onto them, or simply glue the dark film onto the glasses of your sunglasses to have extra protection.

Age Level	1 / 2 / 3
Time	30 minutes
Result / Aim	Protect your eyes from harmful UV rays, while using your parabolic cooker or creating solar art
Materials	• Cardboard/very thick paper • Scissors/cutter • Dark plastic film with UV protection (go to a car tuning store and ask them for the darkest car window tint they have; it is the film they stick on the windows to darken them) • Glue

Your greenhouse

Build your own greenhouse and measure with two thermometers the difference inside and outside the greenhouse for about a week or throughout a day. You can grow a plant, one inside and one outside the greenhouse to discover the difference. What if the earth had no greenhouse effect?

1. Cut a rectangular hole in the lid of your box.
   Leave enough border to tape on the wrapping film and give your greenhouse stability.
2. Close the hole with wrapping film.
3. You can do the same with the sides of the box.

Level 1:

- What can you observe?
- How do the plants grow?
- What differences can you observe of the temperatures inside and outside?

Level 2:

- Of what is the world's "greenhouse" built?
- Draw a picture on how the Greenhouse Effect works.
- Why is it so important for us?

Level 3:

- Discuss the Greenhouse Effect of the earth.
- Which are the greenhouse gases and how do they influence the greenhouse effect?
- What is responsible for climate change?

Age Level	1 / 2 / 3
Time	1/2 day
Result / Aim	Understand how the Greenhouse Effect works
Materials	• Cardboard box with a lid • Knife/cutter/scissors • Wrapping film • Glue/Scotch tape

Ozone and sunburn

1. Identify if your region is under an ozone and how this affects your life.
2. Do you know your skin type? Identify your skin type and learn how to take care of your skin to protect it from sunlight.

Advanced: Why is the ozone good and bad for us in the same time? (Read also "Ozone and breathing")

Age Level	1 / 2 / 3
Time	1 - 2 hours
Result / Aim	Understand why we need sun/UV protection
Materials	Library/internet/health consultant

Don‘t get a sunburn

One child is the sun and tries to catch the other kids. If a child gets caught, it gets sunburn and becomes a sun as well. The children can use sun protection in the form of a ball (you can decorate it). The child with the ball cannot be caught. The game goes on for as long as it takes for the sun to catch all the humans.

Age Level	1
Time	15 minutes
Result / Aim	Icebreaker, fun introduction to personal health
Materials	Ball and decorations

How to treat a sunstroke

Ask a medical professional about ways to recognise and treat sunstroke. How is it different from a heatstroke? Note the precautions to take to prevent a sun/heatstroke. Integrate these precautions in all your group activities.

Age Level	2 / 3
Time	1 - 2 hours
Result / Aim	Learn how to prevent sunstroke and to stay healthy
Materials	Health consultant/internet/library

Ozone and breathing

Have you ever experienced "summer smog"? Find out at your regional weather service, if the ozone is measured and get the measurement data.
What does a high ozone level mean for your health? Remember why the ozone is important to us.

Age Level	2 / 3
Time	1 - 2 hours
Result / Aim	Negative effects of the ozone on hum
Materials	Library/internet

UV rays and SPF

Compare the different sun care products and its declaration of the SPF. Does it mention the SPF for both UVA and UVB rays? Calculate how much time you can stay in the sun with no protection and different SPF levels. What effects have the two different UV rays on your skin? What is the best protection for your skin?

Age Level	2 / 3
Time	1 hour
Result / Aim	Learn about the different effect of UVA and UVB rays on our skin, and SPF
Materials	Examples of sun protection products

C. USES OF SOLAR ENERGY

Sun one day – every day

Try to identify your daily activities that use sunlight. Find out on more possibilities of using sunlight or solar energy. Can you live one day in the coming week by relying only on solar energy? What if you had to do so for your whole life?

Age Level	1 / 2 / 3
Time	1 hour (+ 1 day)
Result / Aim	Discover solar energy in our lives
Materials	-

Solar box cooker

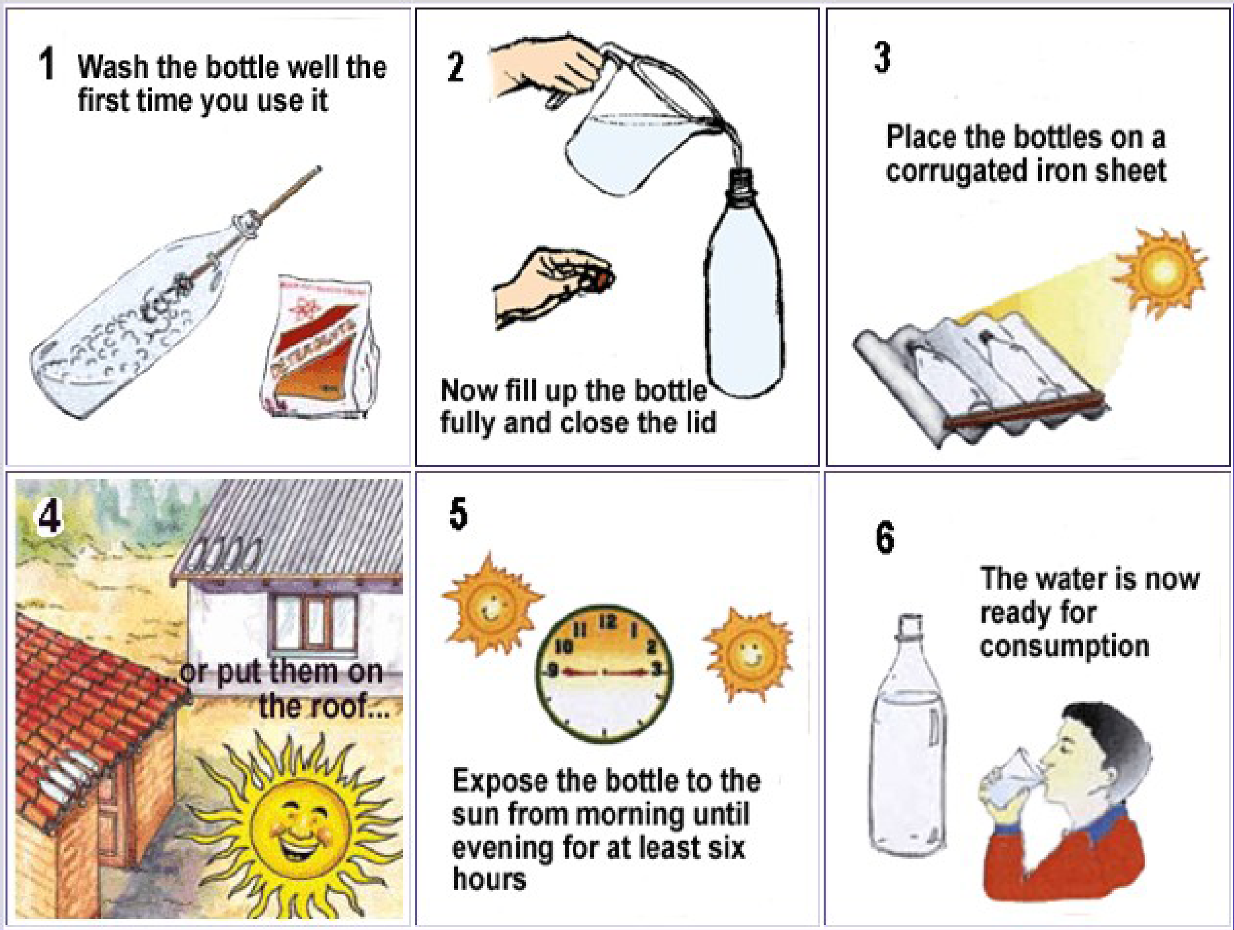
Build your own solar cooker.
You can view the instructions at **http://solarcooking.org/plans/** or other sites in the internet or from books.
You can also find an example for a very simple box cooker in the workbook.

You can experiment with different models of cookers. More efficient cookers are also a little bit more complex to build. Adapt to your purpose (experimenting, demonstrating, cooking, etc)

Age Level	1 / 2 / 3
Time	2 hours (or more for complex models)
Result / Aim	Experience the utility of solar energy
Materials	Varies according to the cooker you want to build

Pure water (SODIS Method)

1. Wash your bottle (transparent PET or glass) if you are using it for the first time.
2. Fill it with water from a natural resource such as a pond in the clean bottle. If the water is not clear, let it rest for some time. When the particles in the water have settled down as sediment, use the clear water above the sediment.
3. Put the bottle with water in direct sunlight for six hours during daytime.
4. Now your water is perfectly purified and can be used as drinking water.



Age Level	1 / 2 / 3
Time	15 minutes (6 hours)
Result / Aim	Make clean drinking water and learn how to explain the impact of UV rays
Materials	PET or glass bottle

Collect water

1. Dig a hole of approximately 30 cm (12 inches) deep and 60 cm (24 inches) in diameter in the ground.
2. Collect any fresh green vegetation from the nearby area and fill the hole with them.
   Weeds and/or lawn clippings are ideal in a suburban environment.
3. Place the jar in the centre of the hole and make sure it has a firm foundation,
   i.e. it is resting on the ground and not on the vegetation.
4. Cover the hole with a clear plastic sheet. Any coloured plastic sheet will work, but with a clear one you can see clearly what is happening. Use the stones to weigh down the edges of the plastic sheet.
5. Place the pebble in the centre of the sheet so that it makes a dip in the plastic sheet,
   which must be exactly above the jar in the hole.
6. Let the sun shine on the plastic sheet and observe what happens.

Age Level	1 / 2 / 3
Time	1.5 hours
Result / Aim	Collect water that is stored in vegetation & learn about the effect of condensation
Materials	• Shovel • Big jar • Plastic sheet • Big stones • Pebble

Solar quiz

Answer the questions of the solar quiz (see solafrica.ch/scout-badge).
You should have at least two groups to compete each other. Add new questions.

Age Level	1 / 2 / 3
Time	20 minutes
Result / Aim	Have fun with solar facts
Materials	Quiz cards/questions

Your solar lamp

Solder your own solar lamp from a self-assembling kit. Attention!
A soldering station gets a lot hotter than everyday "hot" materials,
be very careful not to burn yourself or any materials. Read the instructions carefully.

Age Level	2 / 3
Time	1 - 2 hours
Result / Aim	Learn about soldering, building a PV-model and how to make a solar lamp
Materials	• Self-assembling kit (e.g. Smart lamp) • Soldering station • Housing material

D. GO SOLAR!

Have a solar lunch

Why not use the solar box cooker or a parabolic cooker to make a meal for your group? Start with easy steps, like boiling water for tea/coffee, and then try more complex recipes. Basics like rice is easy for beginners.

Age Level	1 / 2 / 3
Time	1 hour
Result / Aim	Eat renewable, see that it really works, reward from building a cooker
Materials	• Solar cooker • Ingredients

Use clean water

If you have to rely on natural water resources that are not 100% safe,
purify your daily drinking water with the SODIS-Method.

Age Level	1 / 2 / 3
Time	5 minutes a day
Result / Aim	Learn about the importance of drinking clean water that will prevent diseases like diarrhoea and other infections Learn about safe resources that do not require boiling or chemical additives
Materials	PET or glass bottle

Organise a Solar Introduction Workshop[5]

Read the instructions in this handbook for the Solar Introduction Workshop (p. 36).
Set a stand in a local market or any other public place to show your community the possibilities of solar energy.

Age Level	**3**
Time	1/2 day
Result / Aim	Get people involved, awaken interest in solar energy
Materials	• This handbook • Solar Centre Box or equivalent materials

5 See for example **"How to organize a Solar Training"** on wave.greenpeace.org

Have a solar shower

Build a solar shower with a black water tank and a tube (or set up a finished model).
Make sure the water is not heating too much to prevent burning (or mix with cold water).

Age Level	1 / 2 / 3
Time	5 minutes - 1 hour
Result / Aim	Have a hot shower, see if it really works
Materials	Solar Shower Model/tank/tube installation material

Install a warm water collector

For washing dishes or laundry.

Age Level	2 / 3
Time	-
Result / Aim	Warm water washes more efficiently and can help guarantee better hygiene
Materials	Solar collector

Solar charger

Use a solar charger e.g. for your mobile phone, your accumulators
(attention: use only rechargeable batteries!), your laptop, etc.

Age Level	1 / 2 / 3
Time	Varies
Result / Aim	Use renewable energy, recharge outdoors
Materials	Solar charger adapted to your device

SOLAR INTRODUCTION WORKSHOP

The Solar Introduction Workshop has been designed either as introductory activity for a group or as a presentation for the community or members of the public. Each of the activities introduces you in different ways into the subject of solar energy. The themes of each station in the workshop can be deepened in the Solar Challenge Badge activities. You can combine the stations as you like. Our experiences have showed us that the best way to organise the workshop is in a circuit. Each workstation should take about 15 minutes. Make sure you've got enough time for the whole workshop.

10 minutes	Introduction, explanations
120 minutes	Circuit (8 x 15 minutes = 120 minutes)
10 minutes	Feedback, conclusion
140 minutes	Total

Objectives

The objectives of this workshop are to:

- create solar energy awareness, knowledge and skills among young people
- get to know the nature of the sun better
- discover the possibilities of solar energy
- promote interest and understanding of the use of renewable energies as a strategy to protect the environment
- create awareness among young people about negative effects of the sun and how one can deal with these effects

Method

The workshop has originally been designed for Scouts, and like most of the Scout activities, it is based on the **"learning by doing"** method.
The learning progress takes place by doing and experiencing the activities.

Train the trainers

Alternatively, the Solar Introduction Workshop is a good setting to "Train the trainers".
Experience has shown that well-prepared and trained leaders drive the success of solar energy related activities.
Use the Solar Introduction Workshop as learning place for new leaders where they can gain experience in teaching and guiding on the subject of solar energy.
We wish you good luck and much fun conducting this workshop.

Description of workshop stations

On the following pages, each station is described in as detailed as possible.
Have a look at the instruction sheets for each station in the workbook (solafrica.ch/scout-badge).
It allows participants to work on their own without your explanations.

Thermal use of solar energy

Time	**a)** 15 minutes (+30 minutes waiting time) **b)** 10 minutes **c)** 15 minutes and many more
Objective	See how simple it is to use solar energy for heating purposes.
Describtion	See and experience heat through solar energy. Experiment with a solar cooker (box or parabolic). “Color of heat” is best to be the starter, the other activities can be done between other stations or as bonus game. Solar Art is very popular and people like to spend hours on it.
Activity	**a)** Color of heat: Bottles in different colours, filled with water. Put in the sunlight for a few minutes and feel/measure the different temperatures of the water. Start at the beginning of the Workshop as you need 30minutes time to leave it in the sun. Older participants can discuss about absorbtion and reflection of sunlight and luminous colors/light waves. **b)** Focusing of sunlight: Six or more people hold mirrors focusing the sunlight onto the top of a thermometer. The objective is to see the temperature rising because of the sun. **c)** Solar Art: Create drawings or texts with a magnifying glass and wood.
Materials	**a)** Color of Heat: Pet-Bottles 0.5l, painting color/paper to wrap around bottles, thermometer, copy of temperature chart (workbook). **b)** Focusing of sunlight: Small mirrors, thermometer (on a sight disc) **c)** Solar Art: Lenses, Sunglasses, Wooden boards
Leader required	No
Further activities	Use of solar energy, build a box cooker, solar cooking, solar collector (water heating system)

SOLAR INTRODUCTION WORKSHOP
STATION NR.2

Sundial

Time	20 minutes
Objective	Understand the basics of the rotation of the earth and differences regarding the sun on the northern and southern hemisphere.
Describtion	A sundial can be used to read the time of the day. Learn how to position a sundial.
Activity	
Materials	Copy of Sundial (workbook), string, cardboard, scissors, glue
Leader required	No; copy instructions from workbook
Further activities	

Energy resources and electricity use

Time	10 minutes
Objective	Know the potential in solar energy and compare to other energy forms and human needs.
Describtion	Cubes of different sizes represent the energy potential and energy consumption from solar energy and other energy sources of your country. How to calculate the solar potential: Ignoring clouds, the daily average irradiance for the earth is approximately 250 W/m2 (i.e., a daily irradiation of 6 kWh/m2), taking into account the lower radiation intensity in early morning and evening, and its near-absence at night. You can calculate the solar potential of your country with the following formula: **kWh/m2/day * m2** Get the **irradiation (kWh/m2/day)** for your location on www.gaisma.com and find out the size of the surface (km2 rsp. m2) of your country. **Note:** If you have a lot of water surface in your country, take this into account. If you multiply the result by 365 days you get the amount for one year and can compare it to the amount of energy produced/used in one year in your country (different resources). **Examples:** Average insolation in Berne, Switzerland: 3.24 kWh/m2/day (www.gaisma.com: Sum of all months, divided by 12) Surface of Switzerland: 41,285 km^2 = 41,285,000,000 m2 3.24 * 41,285,000,000 = 133’866’612 kWh/day Average insolation in Burkina Faso, Ouagadougou: 5.99 kWh/m2/day Surface of Ouagadougou: 274,200 km2 = 274,200,000,000 m2 5.99 * 274,200,000,000 =1,644,057,499 kWh/day It does not make sense to give a world average, as the insolation depends on many factors (angle of the surface, clouds, sun hours/day, etc.) and as seen in the examples above, insolation can vary a lot depending on the locality. The second factor for the solar potential is the surface of the country, which can also vary a lot. This is only theory and gives the amount of solar energy reaching your country. From this amount only about 10% can be technically used (efficiency of technologies + surface factors, not every square meter of a country can be covered with solar panels). But it gives an idea how much energy we actually get and how little we use it (or how much we spoil it by not using it). Now, you only need to transform the different amounts of energy into a cube. The smallest amount can be defined as the smallest cube. Be sure that all amounts are in the same dimension first (kWh/day or GWh/year). A cube is measured in volume, so the amount of Energy = the volume (e.g. m3). When you know the volume of each cube, you can calculate the side length of the cubes with 3√ or ^(1/3) for excel calculation.
Activity	Match the energy source cards to the corresponding cube.
Materials	Cubes (built of wood or paper), Cards with energy form
Leader required	No (maybe for discussion)
Further activities	

Energy use in households

Time	10 minutes
Objective	To learn that households of different countries (four examples) use a different amount of energy, for different household applications (seven categories). The most outstanding results are the following: Differences from "northern" countries and "southern" countries; energy efficiency (e.g. USA has the highest use); cooling vs. heating, etc.
Describtion	Four puzzles representing four houses of four different countries (India, USA, Singapore, Switzerland). The four puzzles represent in their size the total energy use of an average household of the respective country (per capita). The different colours of the houses represent the following categories: cooking, cooling, water heating, lighting, heating, home appliances and others.
Activity	**Older kids:** Talk about the countries and explain the meaning of the colours. Prepare some questions to discuss the "content" of the houses and what they show. **Younger kids:** Talk about the countries and what the colours represent. They only need to assemble the puzzle and answer some simple questions.
Materials	Puzzles cut from cardboard.
Leader required	No
Further activities	

SOLAR INTRODUCTION WORKSHOP
STATION NR.5

Renewable/non-renewable resources

Time	15 minutes
Objective	Know and classify different resources of an ecosystem
Describtion	Different expressions or pictures are classified as "renewable resources", "renewable ecosystem services" and "non-renewable resources". Definition renewable ecosystem services: Benefits people obtain from ecosystems in four categories: supporting, provisioning, regulating and cultural.
Activity	Distribute cards to the kids. All cards should be placed to one of the class cards "renewable resources", "renewable ecosystem services" and "non-renewable resources".
Materials	Laminated cards of different energy resources
Leader required	No
Further activities	

STATION NR.6

Photovoltaic

Time	10 minutes
Objective	Know the major parts of a photovoltaic system: Solar cell/panel, charge controller, inverter, load, (battery/public grid). Know the difference of a grid-connected and off-grid system.
Describtion	Show different solar gadgets and an off-grid-system with all parts visible.
Activity	Touch and try all material, organise a solar car/grasshopper race, listen solar radio...
Materials	Small solar gadgets such as solar torch, radio, toys, etc.
Leader required	Yes (or name and describe all parts with cards)
Further activities	Build a solar lamp as PV-model

SOLAR INTRODUCTION WORKSHOP
STATION NR.7

Storing electricity: how does a battery work?

Time	10 minutes
Objective	Understand how a battery (storing electricity) works
Describtion	Assemble a battery with a potato or fruit
Activity	Assemble all parts in right order to make a sound/light
Materials	Fruit, copper, zinc, wires with crocodile clips, beeber/bulb, wooden spit
Leader required	No
Further activities	Experiment with different materials (metals/vegetables/fruits) and with fruits wired together.

SOLAR INTRODUCTION WORKSHOP
STATION NR.8

Quiz

Time	10 minutes
Objective	Learn some facts in a fun way
Describtion	The quiz is divided into four categories: sun, electricity, energy uses, non-renewables/renewables.
Activity	Answer questions from the quiz
Materials	Quiz cards
Leader required	Leader can be the quiz master, build two groups to compete each other
Further activities	

FURTHER INFORMATION

The workbook

Additional material for activities. Download the workbook with instruction sheets and other practical material on www.solafrica.ch/scout-badge

Solar energy

- 10 slides about solar energy (presentation/pictures), which is also available in Spanish
- More information and pictures prepared for kids: http://www.eia.doe.gov/kids/
- More experiments, including construction plans and background: www.re-energy.ca
- www.wave.greenpeace.org (Web based active virtual exchange of experiences)

Instructions for solar cookers:

http://solarcooking.org/plans/

- Solar box cooker
- Parabolic cooker
- Panel cooker

Instructions for solar water heating

http://www.builditsolar.com/Projects/WaterHeating/water_heating.htm

- Solar shower
- Thermosyphon
- Others

Instructions to build a sundial

http://www.sundials.co.uk/projects.htm

Related organisations

- www.greenpeace.org
- www.scout.org
- www.solafrica.ch/scout-badge

This Solar Energy Handbook is designed to help create awareness, increase knowledge and develop the skills of children and young people with regard to solar energy. It aims to help group leaders or teachers to identify, plan, prepare for and realize solar learning opportunities. The handbook gives basic background information about solar energy and describes a lot of activities for groups. It has been developed by Solafrica with the support of Greenpeace, YUNGA, and the World Organization of the Scout Movement which endorses this educational badge framework for use by Scouts around the world.

SCOUTS GO SOLAR

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