Solar Workbook

SOLAFRICA

GO SOLAR!

IMPRINT

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First edition	**June 2015, developed in collaboration with Youth & United Nations Global Alliance (YUNGA), World Organization of the Scout Movement (WOSM) and Greenpeace**
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1. INTRODUCTION

This Workbook is written to help group leaders or teachers to teach and organise activities related to solar energy. In the workbook, you can find instruction sheets, templates and many resources for printing or copying. In the first part, there is an overview of all the activities with the basic information (age level, can be done indoor, can be done online, etc.), which makes it easier to find what you are looking for. In the end of the document, you will find some templates and materials.

This workbook is similar to the 'Action Kit' of the Earth Tribe's SgS Challenge Badge which soon will be available for download from *http://earthtribe.scout.org/scouts-go-solar.html*. It is part of the Solar Handbook available for download at the same web link shown above and on *https://solafrica.ch/en/projects/scouts-go-solar-switzerland/downloads/*, where you can find also some more experiments, templates and construction plans in different languages.

Apart from that, we are working on a Scouts go Solar database to share the most recent versions of the experiments and activities with you.

If you have any questions or you would like to share improvements of the experiments, new ideas etc. etc., you're very welcome to write to *scoutsgosolar@solafrica.ch*.

2. OBJECTIVES

The general objective of both the Solar Handbook and Workbook are 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

3. CLASSIFICATION OF THE EXPERIMENTS REGARDING AGE GROUP AND CONTEXT

Age groups:

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: 5 to 10 years old

Basic understanding is gained by curiosity driven experimentation

Level 2: 11 to 14 years old

Complex tasks that strengthen and demand more practical, analytical and interactive skills

Level 3: 15 years old and above

Combine and connect their analytical, practical and interactive skills, develop solutions adapted to specific situations

Context:

Many experiments can serve in meetings with scouts or other groups, **workshops, roadshows**, or they can be required to obtain one of the **badges**. While the time limit of a workshop or roadshow might oblige you to do a reduced version of an experiment, the same experiment can be done in more detail and in a more scientific manner with scouts who are following a badge programme.

Some experiments are marked as being appropriate for **'rainy days'** and others are marked **'online'** for activities which can be done in a remote way.

4. LIST OF EXPERIMENTS, TOOLS AND TOYS

*The following list shows most of the experiments, tools and toys which have been developed and used within the SgS project until 2021. The most popular items are printed in **bold**.*

Name	Age group	Rainy days compatible?	Online possible?	Comments
Chasing light	5-10 / 11-14	yes	no	Takes several days
Shadow thief	5-10	yes	no	Group game
What can the sun do for me?	5-10 / 11-14 / 15+	yes	yes	Brainstorming
Solar art (using lenses)	5-10 / 11-14 / 15+	no	no	Never without strong sunglasses!
Colours of solar energy (painted bottles)	5-10 / 11-14 / 15+	no	no	New: with balloons
Sundial	5-10 / 11-14 / 15+	Make it, test it later	no	Cardboard models
Solar and other energy sources	15+	yes	yes	Internet research, for rovers
Solar compass	5-10 / 11-14 / 15+	Explain it but not use it.	no	Does not work well near the Equator
Make sunglasses	5-10 / 11-14 / 15+	yes	no	The first activity
Your greenhouse	5-10 / 11-14 / 15+	no	no	
Ozone and sunburn	5-10 / 11-14 / 15+	yes	yes	Theory
Don't get a sunburn	5-10	yes	no	Group game
How to treat a sunstroke	11-14 / 15+	yes	yes	Theory
Ozone and breathing	11-14 / 15+	yes	yes	Theory
UV rays & SPF	11-14 / 15+	yes	yes	Theory (Could add UV bead experiments)
Solar box cooker	11-14 / 15+	Make it, test	no	Test with

		it later		simple recipe
Copenhagen solar cooker	11-14 / 15+	Make it, test it later	no	Easier to make than box cooker
Pure water (Sodis)	5-10 / 11-14 / 15+	Yes (no)	no	Theory; Try it out
Collect water (solar still)	5-10 / 11-14 / 15+	no	no	
Solar quiz	5-10 / 11-14 / 15+	yes	yes	Questions adapted to the age group
Have a solar lunch	5-10 / 11-14 / 15+	no	no	
Organize a solar introduction workshop (appetizer workshop, roadshow)	15+	Partly, but much better with sun	no	
Use / make a solar shower	11-14 / 15+	Make it, use it later	no	
Install a warm water collector	11-14 / 15+	Make it, use it later	no	
Photovoltaics (know the parts of a PV system)	11-14 / 15+	yes	yes, but better in place	
Use a solar charger	5-10 / 11-14 / 15+	yes	no	Already common for scouts in camps
Energy card game	11-14 / 15+	yes	no	Can be done completely (at least one hour) or short version
Tribunal Game	11-14 / 15+	yes	yes	Debate simulation
Energy in households (puzzle)		yes	no	
Tools and gadgets:	Make them: 15+, use them: (see below)		no	
Solar suitcase	11-14 / 15+	Make it, try it later	no	
Solar record player (spinning disc)	5-10 / 11-14 / 15+	Make it, try it later	no	
Your solar lamp	11-14 / 15+	yes	no	Great when using recycled container

Other ideas (not part of this Workbook):

Organize a solar cinema	5-10 / 11-14 / 15+	The screening itself yes	no	Check copyright issues
Organize a solar phone charging station, bar, etc.	15+	The use itself yes	no	
Organize a solar cooking competition	11-14 / 15+	no	no	
Do an 'energy study'	11-14 / 15+	yes	yes	
Fruit battery		yes	no	Not a recharge-able battery...
Solar beep	5-10 / 11-14 / 15+	Works outdoors even with clouds	no	
Solar campfire	5-10 / 11-14 / 15+	Make it, try it later	no	
Grasshopper race	5-10 / 11-14 / 15+	no	no	
Solar sumi	5-10 / 11-14 / 15+	no	no	
Understand greenhouse effect and climate change	11-14 / 15+	yes	yes	Theory
Set up a PV gadget table	5-10 / 11-14 / 15+	Yes, but better with sun	no	Include solar fountain

5. RAINY DAYS

It might sound strange to address this topic in a book 'about sunshine'. But in reality, it is one of our big concerns: What do we do if we have prepared an event or experiment and there is no sunshine on that specific day? It is most important to have a 'plan B' ready for this situation! We will see the strategies how to address the problem of unavailable sunshine and give a list of activities especially appropriate for rainy days or indoor events.

Strategies:

a) Widen the topic to "all renewable energies".

Present the other renewable energies like wind, water and biomass and try to have an activity ready which relates to these energies.

b) Do all the ('theoretical') stations and experiments of this workbook which do not need sunlight (or run with very little sunlight).

Check in the table above which experiments are recommended for rainy days or indoor events.

c) Build some solar device which you can use or try out later.

There are many gadgets, tools and toys which can be constructed during rainy days and tested another day – as soon as the sun is back.

d) Use a strong spotlight to run solar toys.

This is only advised for indoor events and small toys. You have to test it beforehand: Which ones of your gadgets (grasshoppers, toy cars, etc.) move under a spotlight? You might be astonished – the difference between 'real' sunlight and electrical light is huge, the sun is very strong! Most motors which are directly powered by a solar panel will not work using electrical light.

A list of activities especially appropriate for rainy days or indoor events:

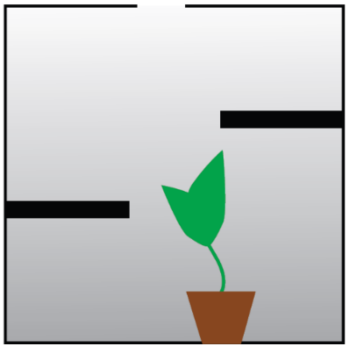
- Human power: Use bicycle-driven machines (blender, electricity generator, washing machine, …)
- You can transform bicycles into many, many funny machines (check the internet for ideas). They can be used on rainy days, but need a lot of storage space in between.
- More theoretical experiments and games like 'What can the sun do for me?', 'Energy Card Game', 'Tribunal Game', ...
- Parabolic dish phone: Use two parabolic cookers to communicate a secret code word. Both dishes are facing each other, two kids put their head at the place of the cooking pot, one speaks into the dish, the other hears the word. The other kids can make a lot of noise next to them. (For safety reason do this game only **without** sunshine).

6. EXPERIMENTS

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	5-10 / 11-14
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 with her/his feet the shadow of the fleeing children. 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	5-10
Time	5 - 10 minutes
Result / Aim	A fun introduction to the sundial
Materials	Field

What can the sun do for me?

Try to identify as many different uses as you can about what the sunlight can do for us in our daily life. Think outside of the box, there will be many more uses then you expect. Make a list of the uses you found.

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	5-10 / 11-14 / 15+
Time	1 hour (+ 1 day)
Result / Aim	Discover solar energy in our lives
Materials	-

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	5-10 / 11-14 / 15+
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	5-10 / 11-14
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 at the end of this workbook.

Why should you learn about the latitude? Can you travel with your sundial and use it in another country?

Age Level	5-10 / 11-14 / 15+
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 at the end of this workbook

Solar compass

Hold an analogue 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.

[1] 12 o'clock "winter time" if your country is using daylight-saving time.

Age Level	5-10 / 11-14 / 15+
Time	10 minutes
Result / Aim	Be aware of the "wandering" of the sun during the day Learn about a useful outdoor tool
Materials	Analogue watch

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:
    a. 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*)
    b. 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	15+
Time	2 - 3 hours
Result / Aim	Solar energy in different places on earth
Materials	Library/internet

B. IMPACTS OF THE SUN ON HEALTH & ENVIRONMENT

Make 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	5-10 / 11-14 / 15+
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 ◆ Template (see at the end of this Workbook)

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 (5-10 years old):

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

Level 2 (11-14 years old):

- 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 (15+ years old)

- 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	5-10 / 11-14 / 15+
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 a hole in the ozone layer 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?

Age Level	5-10 / 11-14 / 15+
Time	1 - 2 hours
Result / Aim	Understand why we need sun/UV protection
Materials	Library/internet/health consultant

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	11-14 / 15+
Time	1 - 2 hours
Result / Aim	Negative effects of the ozone on human beings
Materials	Library/internet

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	5-10
Time	15 minutes
Result / Aim	Icebreaker, fun introduction to personal health
Materials	Ball and decorations

UV rays and Sun Protection Factor (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	11-14 / 15+
Time	1 hour
Result / Aim	Learn about the different effects of UVA and UVB rays on our skin, and SPF
Materials	Examples of sun protection products, internet

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	11-14 / 15+
Time	1 - 2 hours
Result / Aim	Learn how to prevent sunstroke and to stay healthy
Materials	Health consultant/internet/library

C. USES OF SOLAR ENERGY

Solar box cooker

Build your own solar cooker.

You can view the instructions at http://solarcooking.org/plans/, other sites on the internet or from books.

You can also find an example for a very simple box cooker at the end of this workbook.

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

Age Level	5-10 / 11-14 / 15+
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

Copenhagen solar cooker

Another kind of a do-it-yourself solar cooker, made from simple materials

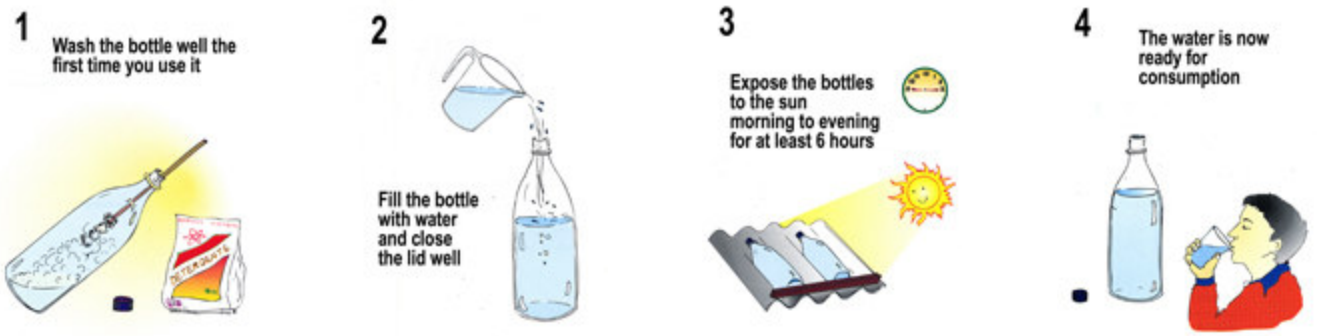
You can find de instructions at the end of this workbook, in the annex

Age Level	11-14 / 15+
Time	1 to 1,5 hours
Result / Aim	Construct your own parabolic solar cooker that can be easily assembled and disassembled and that can be used to prepare a solar meal.
Materials	• Cardboard • Scissors • Silver foil / aluminium foil • 2 Wooden boards (one with 12cm on each side, one with 20cm on each side) • Drill • A piece of string • 4 metal clips • The manual on how to build it (see annex of this workbook)

Pure water (SODIS Method)

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



Source: https://www.sodis.ch/methode/anwendung/index_EN.html

Age Level	5-10 / 11-14 / 15+
Time	15 minutes (6 hours)
Result / Aim	Make clean drinking water and learn how to explain the impact of UV rays 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

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	5-10 / 11-14 / 15+
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 annex of this Workbook). The green questions are for smaller kids, the yellow one are intermediate and the red ones are really difficult.

You should have at least two groups to compete each other. Add new questions.

Age Level	5-10 / 11-14 / 15+
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. See the section of “Tools and Gadgets” for the details.

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	11-14 / 15+
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	5-10 / 11-14 / 15+
Time	1 hour
Result / Aim	Eat renewable, see that it really works, reward from building a cooker
Materials	• Solar cooker • Cooking pot (ideally black and with lid) • Ingredients

Use / make 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 it with cold water).

Age Level	5-10 / 11-14 / 15+
Time	5 minutes - 1 hour
Result / Aim	Have a hot shower, see if it really works
Materials	Solar Shower Model or tank, tube and installation material

Install a warm water collector

For washing dishes or laundry.

Age Level	11-14 / 15+
Time	-
Result / Aim	Warm water washes more efficiently and can help guarantee a better hygiene
Materials	Solar collector

Use a Solar charger

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

Age Level	5-10 / 11-14 / 15+
Time	Depends
Result / Aim	Use renewable energy, recharge outdoors
Materials	Solar charger adapted to your device

Organize a Solar Introduction Workshop

Have a look at the general information about the Solar Introduction Workshop at the end of the Solar Handbook and read the instructions about the different stations further below.

Set a stand in a local market or any other public place to show your community the possibilities solar energy.

Age Level	15+
Time	1/2 day
Result / Aim	Get people involved, awaken interest in solar energy
Materials	◆ This Workbook ◆ Solar Centre Box or equivalent materials

Tribunal game

This role game is about discussion, presenting arguments & facts and defending a position. Two groups have to defend their position in front of a 'jury'. The jury accepts the proposal of the group which communicated better.

NB: **Fake arguments are allowed but have to be credible!** Use your imagination!

Starting situation: In a region, a new coal power plant is planned. Two groups meet for a 'hearing' at the regional government (regional council):

a) The company who offers to build the power plant argues in favour of coal and their project. The company might explain why solar energy would not be a good solution.
b) An NGO who presents arguments against coal and this project and proposes to build a solar power plant instead.

At the end of the meeting, the regional council will decide if the coal power plant will be built or if the solar option should be followed.

Preparing (20 minutes max.):
- Each group gives itself a name (company / NGO)
- Each group prepares arguments studying texts from Wikipedia and other sources (and **invents** new arguments)
- Each group decides who is the speaker in the meeting

Meeting:
- Each group gets 8 minutes to present their company / NGO and elaborate their position
- Later, each group can formulate 2 questions to the other group
- The regional council (jury) formulates one question to each of the groups
- Each group gets 6 minutes to prepare their answers
- Each group presents their answers in 4 minutes
- The regional council discusses (in private) which group has been more convincing and takes a decision
- The decision is presented to all participants of the meeting

Documents which can help preparing:
https://en.wikipedia.org/wiki/Coal-fired_power_station
https://en.wikipedia.org/wiki/Solar_energy

Age Level	11-14 / 15+
Time	1,5 hours
Result / Aim	Reflect about arguments in favour and against solar energy and how to present them in a convincing manner within a debate. Take another perspective on the topic and defend this position. Learn how to questions arguments and how to react on that.
Materials	nothing

Energy Card Game (full version)

The energy card 'game' is not a fun game, but a tool to visualize energy consumption in a household / solar home system / office / etc.

Preparation:

- Download the energy cards on https://solafrica.ch/en/projects/scouts-go-solar-switzerland/downloads/
- Print all A4 sheets, laminate them (optional), cut them to card size
- Prepare a scale. This can be a big sheet of paper (flip-chart size or more) with horizontal lines every 10cm or Post-its on a very large table or value tags on a long string. In a solar home system, every line corresponds to 100 Wh/day, in a grid connected household to 250 Wh/day
- Option: You might write the cost of the electricity (for instance in $/year) next to each kW/day value

Start playing:

Make groups of 2 to 10 people. At least one per group must be an 'expert' who knows the game and can consult about energy savings

Ask the groups to lay a card for every device they use:

a. in a typical day at an average house / an eco house / a waster's house or
b. a future solar home.

You can use the little number cards to change the 'hours per day' or 'runs' or 'number' etc. (If you use laminated cards, you can write these numbers with a whiteboard-marker on the cards). Each time the group puts a card on the table (and adapted the numbers if needed), they calculate the Wh/day of this device (by multiplication of the lower line) and lay it down in a position where the blue triangle corresponds to the Wh/day value on the scale. Only the y-axis is important (in this version), there is no order which card is more left or right.

Option: Each group might have an 'accountant' who writes each consumption value (Wh/day) on a flip-chart and calculates the total consumption in the end.

You can add new cards if needed (there are empty cards which you can fill by hand).
Use the 'stand-by' cards as the last ones. Count all devices which have 'stand-by' losses (separately by 'new devices' (= newer than 3 years) and 'old devices'; do not count cards which already show '24h/day'). The 'stand-by ??' sign helps you not to forget some.

Optimize your household:
Once you have a complete 'picture' of your typical day, you start discussing the consumption of your household. Try to optimize, starting with the biggest consumers. Try to 'shift cards down' by exchanging the model of a device, by reducing the number (of lamps for instance) or the hours of use per day, by stop using them, etc, etc.

The important part of the 'game' is this discussion about which consumptions are high, low, hidden, useless, etc. and how you can reduce them.

Versions:

- A proven way to play the game is to make two groups, one calculates the 'eco house', the other the 'waster's luxury house'. All together discuss how to reduce consumption of the latter. Discuss also the cost of electricity per year for both households.
- If you don't have much time for this activity, check out it's short version below, as one of the stations for a solar introduction workshop (page 34 of this Workbook)

Comment about the 'A,B,C ..' energy label: These labels are defined by the European Union. In every class of device, the more economic models get the 'A' label, the energy wasters get 'G'. Use the values for 'A' if you talk about a new and relatively expensive model, use 'G'-values if you talk about an old and cheap model.

Age Level	11-14 / 15+
Time	1,5 - 2 hours
Result / Aim	Visualize energy consumption in a household /solar home system / office / etc. Debate about ways how to reduce this consumption
Materials	Energy Cards

7. TOOLS AND GADGETS

Solar Suitcase

The solar suitcase is one of the 'message carriers' of the 'Scouts go Solar' project. It is meant to have a double function: As a mobile source of light and electricity for scout camps in normal times and as an emergency unit to provide light and communication in case of disaster (as proposed by Philippine Scouts). There should be space enough inside the suitcase to transport other items than those related to electricity, i.e. use it as a suitcase...

In the beginning, mostly 'complete travel size' suitcases were built. Later, for easier travelling, systems for 'attaché case' type suitcases (as business people use them) were developed. Nowadays, the smallest versions are not much bigger than a lunchbox and use lithium ion batteries (not covered in our manual).

The suitcase can serve for light (LED lamps), to charge phones or other small electronic devices (via the USB connector), for music and radio (12V or USB), for computing (use a small laptop on the inverter or via a special car adapter for laptops) etc. DO NOT connect any 'heavy load' as a cooler box, fridge, large computer, coffee machine etc.! If you need a fan, connect a 12V fan from an old desktop computer.

Here are listed all the different components which are needed for a Solar Suitcase:

- Suitcase: hard shell with wheels, not too small
- Solar Panel: 12V, 20-40W
- Battery: 12V sealed (maintenance free) lead acid, 17-22 Ah
- Charge Controller: 12V, 6A or more
- Inverter: 12 V > 115V or 230V (according to power grid), 100-300W
- 3 or 4 light switches (rated at least 1A)
- 3 or 4 LED lamps: 12V OC LED lamps and sockets 3-7W each
- Wires:
    - 2m AWG14 or 2.5mm^2
    - 2 x 0.5m AGW12 or 4mm^2
    - 3-5m lamp AWG12 or 0.75mm^2
- Fuse and Fuse Holder: OC Fuse rated 10A (or 5A)
- Female car cigarette lighter (multi-socket)
- 12V USB adapter for cigarette lighter socket
- Attachment material: screws, cable ties, tape, etc.
- Optional: radio, ...

Tool List:

- Different sizes and types of screw drivers
- Wire cutter
- Wire stripper, if available
- Knife or cutter
- Pliers
- Power drill
- Saw
- Multimeter
- Soldering iron and tin/lead

Step-by-step instructions:
CAUTION: Do not build a 12V solar system unless there is an experienced person knowing about electricity and solar power in the group! The electricity is not lethal, but the power of the battery can be very harmful.

- The very first thing is to attach the fuse holder into the wire coming from the battery's plus pole. DO NOT INSERT the fuse yet. Attach the plus and minus wire solidly to the battery (using nuts and washers or special connectors. Do no use 'alligator clip style' connectors!)
- Attach the wires coming from the battery to the charge controller at the screw connectors with the 'battery' symbol. (Connect the battery plus to the plus symbol of the charge controller.)
- Keep the solar panel face down on the table in order not to produce electricity yet. Attach the solar panel to the screw connectors at the charge controller with the 'solar panel' symbol.
- Insert the fuse into the fuse holder at the plus pole of the battery. Check if the charge controller indicates the charge of battery. Put the solar panel into the sun or strong light and check if the 'charge' LED lights up.
- Disconnect the solar panel or put it face down on the table. Prepare wires from the charge controller to the inverter, to the lamps (passing through the interrupter) and to the female cigarette lighter connectors. All these wires must fit into the connectors (plus and minus) at the charge controller with the 'lamp' symbol.
- It is very probable that they do not fit all together into the connector, so you might have to solder connect all plusses and all minuses separately and prepare one plus and one minus wire which connect the connection point to the charge controller. You might use screw terminal wire connectors instead of soldering, if you find them.
- If the inverter does not have its own interrupter to shut it OFF, you need to insert another interrupter into its plus connection from the charge controller. The inverter should only be switched ON if you really need it; it loses too much electricity in its stand-by position. If all wires are connected, review all connections again. Isn't there any inversion of plus and minus?
- Replace the main fuse and reconnect the solar panel or lift it from the table and put it into the sun. Check all lamps and the inverter if they function well. In case of problems, refer to section 5. Secure the connections of the battery with insulating scotch tape so that no blank metal is visible anymore. Otherwise, any metal object like a screwdriver in your suitcase can induce a spark and set the suitcase on fire! Prepare a manual for your suitcase and keep it with the corresponding manuals of each device in a transparent folder which you attach inside the suitcase.
- Try out your suitcase in open and closed position. Is it comfortable to use? Is there a way for the cables of the panel and the lamps to 'leave' the closed suitcase without being pinched? Cut more openings, if needed.

Solar record player (spinning disc)

The solar spinning disc is a great promotion and very fun activity! Kids as well as adults enjoy themselves with this toy. It's a kind of 'record player' which works directly from a solar panel (no battery). We attach a sheet of paper to the disc and let it spin. The kids can paint on the rotating paper using either feltpens or liquid color and brushes. Let them wear an apron to protect their cloth and be ready to get some paint yourself... The kids can adjust the speed of the disc playing with the angle of the solar panel or shading part of a cell.

Materials list:

- 1 solar panel 12V, 10W to 20W (it worked OK with 15W)
- 1 motor (find a motor which is strong, but slow), 12V
- Wires
- 1 switch
- 1 old gramophone record
- 1 wire connector with screws (size: the axle of the motor must fit inside)
- 1 screw that fits into the wire connector
- Nuts and washers
- 1 base (can be a wooden box)
- Attachment material
- 4 clips (office paper clips or pegs/cloth-pins)
- Watercolour and brushes or felt-pens
- Paper (optional: print your logo on it)
- Optional: 3-4 tiny wheels to support the disc
- Optional: A disc of plywood of the same size as the record
- Optional: Apron, cloth protection, 'painter's beret'

Step-by-step instructions:
The more 'tricky' part is attaching the disc (record) to the motor. Attach a screw in the hole in the centre of the disc. You might add glue to fix it. The disc should not turn on the screw.

1. Dismantle the wire connector from plastic parts. We only use the metal part inside with the two screws. Now you can just connect one end to the disc screw, the other end to the motor axle.
2. Fix the motor on a base, which might be a box. Optional: The little wheels are fixed in a way that the disc can turn on them without wobbling.
3. Connect the motor to the solar panel. Ideally, the panel can be adjusted to the sun angle.
4. Fix a sheet of paper to the disc (record), using the clips.
5. Put the solar panel into the sun and let the disc (record) spin. Use the brush and the watercolour or the felt-pens to create some solar art!

Tips:

- It's cooler if you make some fuzz about being an artist. Give them a 'beret' to feel like a French painter.
- You can print or stamp a 'Scouts go Solar' logo and website information on every paper before painting on it. The kids will take their painting home...
- If you leave the panel just laying around on the table, the kids can learn how to get more or less power moving it or they have to send away those kids who shade the panel -> the best learning effect!
- Very young kids tend to force a lot on the brush and stop the record...
- Not all records are alike, some melt very easily. If so, you can double them with a plywood disc.
- The base of the 'record player' can be a box in which all little parts (paint, apron, beret, motor, record, ...) and the solar panel fit.

Your solar lamp

The SgS Smartlamp is another one of the 'message carriers' of the 'Scouts go Solar' project. It is a 'flashlight' which is normally built using a 'parts kit'. First, we prepare the lamp core; all parts are attached or connected to a small PCB board by soldering. Then the core gets its unique case which can be a PET bottle (soft drinks, shampoo, etc.), any small box, etc. Even tennis balls, baseball caps, etc. have been transformed into lamps!

Construction manuals in several languages can be found on: *https://solafrica.ch/en/projects/scouts-go-solar-switzerland/downloads/*.

8. SOLAR INTRODUCTION WORKSHOP

The Solar Introduction Workshop (sometimes called appetizer workshop) has been designed either as introductory activity for a group or as a presentation for the community or members of the public. The Asian 'Solar Roadshows' are a variation of the solar workshops.

Each of the activities introduces you in a different way into the subject of solar energy. In the following, we present a set of workshop stations which have been used quite often and a proven timetable / agenda of such a workshop.

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 shown 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

Optional on sunny days: If you have a (slow cooking) solar cooker, you can fill it with raw cookies during the introduction and share the baked cookies during the feedback session.

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 themselves rather than by being told about it.

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.

List of proposed Workshop Stations:

Instruction Sheets for Solar introduction Workshop

For each station, there is an instruction sheet to help you or the participants to understand the stations of the Introduction Workshop. You can copy them, so every Station has it's instruction sheet and doesn't need your explanations. lt might be necessary/helpful to translate them to your language. These stations are just a proposal. Of course, you can also exclude some, add others etc.

1. Thermal use of solar energy

Range of activities	a) Colour of solar energy (needs about +30 minutes waiting time) OR b) Solar Dart OR c) Solar Art
Objective	See how simple it is to use solar energy for heating purposes.
Description	ATTENTION: For doing Solar Dart and Solar Art it's a must to wear sunglasses, as the concentrated light of the sun can cause damage to the eyes. See and experience heat through solar energy. "Colour of solar energy" is best to be the starter, as it takes some more time. While it's running, you can do one of the other activities. Solar Dart as well as Solar Art can also serve as extra activity or bonus game if you need to fill a gap, as both are very popular.
Activity	a) Colour of solar energy: Plastic bottles painted in different colours (or covered with thin coloured paper), filled with water. Put them in the sunlight for some time and feel/measure the different temperatures of the water. Start at the beginning of the workshop as you need about 30 minutes time to leave it in the sun. Older participants can discuss about absorption and reflection of sunlight and luminous colours/light waves. b) Solar Dart: Six or more people hold mirrors focusing the sunlight onto the top of a thermometer, which is in the centre of a "dart board". The objective is to see the temperature rising because of the concentrated light of the sun. c) Solar Art: 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.
Materials	a) Colour of solar energy: Pet-Bottles 0.5l, painting colour/paper to wrap around bottles, thermometer, copy of temperature chart (see annex). b) Solar Dart: Small mirrors, thermometer, "dart board" from cardboard or wood c) Solar Art: Lenses, Sunglasses, Wooden boards
Leader required	No (For safety reasons, Solar Art should be supervised)
Optional activities	Build a box cooker, do solar cooking, use, build or explain a solar collector (water heating system)

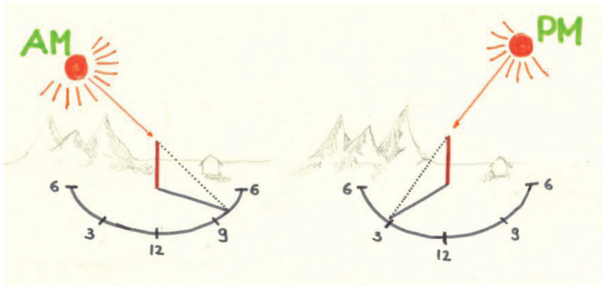
2. Sundial and compass

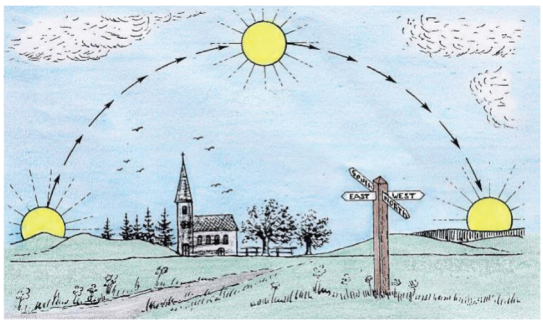
Objective	Understand the basics of the rotation of the earth and differences regarding the sun on the northern and southern hemisphere.
Description	A sundial can be used to read the time of the day. Learn how to position a sundial. If you know the time, you can also use the sun as a compass
Activity	Building a Sundial, Solar Compass Copy/print the sundial template on the next page and follow the instructions there. Once you have your sundial ready, you only need to position it in the right direction: ◆ It needs to be in the sun, so the pencil/stick can cast a shadow ◆ During the day, as this sundial is portable, you can change its place (for example inside a building) ◆ In the northern hemisphere, make sure that sundials points towards north. For the southern hemisphere, it must point south.
Materials	◆ Copy of Sundial template (see annex) ◆ String ◆ Cardboard ◆ Scissors ◆ Glue ◆ Compass ◆ Background information sheet ◆ Analogue watch
Leader required	No; print instruction sheet number 2 (below)
Optional activities	Explain the solar system with balloons Discuss the orientation of solar panels and collectors

Background and instructions sundial and solar compass

The earth rotates once about its own axis within 24 hours. As a result, we experience ‘day’ when your side of the earth faces the sun and ‘night’ when it faces away from it. The day begins with the first rays of sun that appear on the horizon. The sun then seems to traverse the sky on a big arc, reaching the highest point at noon and slowly descending until it disappears below the horizon in the evening. This is the course of the sun. The sun rises in the east, descending in the west.

With the help of a sundial, one can use the course of the sun to measure time. Stick a pole into the ground and you can watch the shadow wander in the opposite direction of the sun throughout the day.





Question: In what direction (north, south, east, west) must the arrow of the sundial point so that the sundial indicates the correct time, if you are in the northern hemisphere?

And how would that be different if you are in the southern hemisphere?

There are different methods to find out where north is:

Purist method: North can be found by observing Polaris, the North Star, at night. In orientating the sundial, the point of the pencil or stick is actually being pointed to the North Celestial Pole, which is within 1° of the North Star. Thus, if you can find Polaris at the end of the Little Dipper, line up your dial by heading its point towards Polaris. You might want to record the orientation for your dial by making light pencil marks on a window still for future reference. Those in the southern latitudes will not be able to use this method, as there is no bright star near the South Celestial Pole.

Practical method: A magnetic compasss may be used to determine the north/south line, but, because of the difference between magnetic north and true north, the dial reading could be out by an hour or more depending on the local difference between magnetic and true north (or south, if in southern latitudes).

Lazy person’s method: To a first approximation, the orientation can be found by finding the orientation at any time from a clock or watch and orientating the dial, so the shadow shows the correct time. However, if left in this position, there could be an error of up to 30 minutes over the year as a result of what is known as the “equation of time”. Because of the Earth’s orbital motion around the sun, the solar day (approx.. 24 hours) is not exactly the same length from day to day, varying up to ± 16 minutes a day. However, if the orientation is carried out on April 15th, June 10th, September 1st or December 20th, this error will be negligible and any orientation made between April 15th and September 1st will be in error by, at most, a few minutes. (BUT don’t forget the effect of daylight savings time!).

3. Save energy!

Objective	Know why energy saving is very important. Have an idea which devices in a household are responsible for most of the energy consumption. Reflect about what the participants can do in their personal life to save energy.
Description	1. Discuss the importance of saving energy. What is the greenest energy of all? → the energy which you do not use! 2. Play the 'Energy Card Game'. If you have more time, you can do the complete game. If you have only 10-15 minutes, play a short version: Hand out only 12 cards, make groups and let them choose the 6 most important ones, taking into account energy consumption. "You are a group of students who will share a flat starting next month. Discuss which 6 of these 12 household appliances you will allow in your flat." 3. In the end, you can reflect what devices with high energy consumption you have at your home and how you could reduce this consumption. Apart from this, are there also other ways of saving energy?
Activity	Play the 'Energy Card Game', reflect about energy consumption
Materials	◆ Energy Cards ◆ Table with a Wh or kWh scale
Leader required	Yes
Optional activities	

4. Energy use in households

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.
Description	Four puzzles representing four houses of four different countries (USA, Singapore, Argentina and Botswana). The four puzzles represent in their size the total energy use of an average household of the respective country (per person). The different colours of the houses represent the following categories: cooking, cooling, water heating, lighting, heating, home appliances and others.
Activity	Resolve the puzzle. ➔ 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 (see annex)
Leader required	No
Further activities	Energy Card Game Make a list of energy saving measures for your friends and family (unless these are done in station 3) Discuss energy use per person of different countries. (Look up the data beforehand on *https://www.iea.org/countries*.)

5. Photovoltaics

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 an off-grid system.
Description	Show different solar gadgets and an off-grid-system with all parts visible.
Activity	Touch and try all material, match the name cards with the corresponding parts, explain their function (according to the age level of the participants). Afterwards, organise a solar car/grasshopper race, listen to solar radio...
Materials	Name cards for the different parts Small solar gadgets such as solar torch, radio, toys, etc.
Leader required	Yes (or name and describe all parts with cards)
Optional activities	Build a solar lamp as PV-model (see the corresponding instructions on *https://solafrica.ch/en/projects/scouts-go-solar-switzerland/downloads/*) Play with other solar gadgets

6. Solar Quiz

Objective	Learn some facts in a fun way
Description	The quiz is multiple-choice and divided into three levels of difficulty: green is rather easy (for younger kids), yellow is a little more difficult and red is really tough (for older kids or adults)
Activity	Answer questions from the Solar Quiz
Materials	Quiz cards (see annex)
Leader required	Leader can be the quiz master, form two groups to compete each other
Further activities	You are invited to make your own quiz cards and find new questions!

9. ANNEX

SUNGLASSES TEMPLATE

(sunglasses template for photocopying and cutting out)

SOLAR COOKER TEMPLATE

(solar cooker template for copying on larger board)

SUNDIAL TEMPLATE

TEMPERATURE CHART FOR COLOURS OF SOLAR ENERGY

ENERGY USE IN HOUSEHOLDS (PUZZLE)

SOLAR QUIZ