Inventor

Scout Handbook

The scout leader edition

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Text and images are "borrowed" from:

Science.dk
Scout lex 1998
Compiled by Don Juul Madsen

Hello!

Welcome to.

You have chosen that your scouts should spend some meetings on the "Inventor" badge.

It is great to be able to invent new things, or to invent new solutions to the problems that your scouts experience at scout camps, scout races, etc. This handbook cannot give the scouts an answer to the actual problems that they will face when they are on a trip, at camps or at races. That is something that they must invent themselves.
The Scout Handbook comes with some ideas of how others have solved a problem before. Your Scouts can use these ideas, or not, to come up with their own solution.

Contents

We are scouts because it's fun.
- and that's the most important thing!

But for it to be fun, you and your scouts have to put in the effort. It is often the activities that require the most effort that provide the best experience.

You will find that the more your practice a scout skill, the easier and more fun it will be to solve the various tasks.
This also applies to “inventing” solutions to problems. Start by giving them simple problems to invent a solution to. Gradually increase the difficulty.

Topics:

In this small handbook, the following topics will be reviewed:

- Nature's own energy sources.
- How scouts can utilize nature's energy sources.
- How we, as scouts, can save energy when we are scouting and/or at home.
- A little about CO2, the environment and climate.

How does one become an inventor?

“That's a really good question”

Try to get the scouts to answer the question. If you could ask some famous people, what would they say?

“Genius is 1% talent and 99% hard work”

- Albert Einstein -

"I haven't failed. I've just (invented) 10,000 ways that don't work."

- Thomas Alva Edison -

“I don't care that they stole my idea... I'm worried that they don't have any of their own.”

- Nikola Tesla -

And then a few quotes from a few fictional characters

“Promise me that you will always remember this: You are braver than you think, stronger than you seem, and smarter than you know.”

- Winnie the Pooh -

“I’ve never tried that before, so I’m sure I can do it.”

- Pippi Longstocking -

Try telling your scouts these quotes, or some other good inventor quotes, and ask them to think about why the different people said what they said.

- What do the scouts think the message is in these quotes?

Leaderadvice:

For scouts we use "leading by doing", which is letting the scouts try themselves. This means that the scouts themselves must (find) a solution to the problems that you as the leader give them.

We use tasks that the scouts have to find a solution to all the time for scouting.

It could be:

- Build a dining table.
- Light a fire without using matches.
- Solve a code/secret message.
- Go from A to B using a compass.

We probably think of inventions mostly as something physical that solves a problem. That is, a new thing that makes your scouts' and your everyday life easier and better.

But in this book, your scout is also an inventor if they can come up with a solution to a problem, without their solution having to be a physical thing.

“Well… how do my scouts become good at inventing?

The short answer is that they only become so by practicing and trying their hand at it – leading by doing.

This handbook cannot give you solutions to all the problems that you give your scouts, but it will come up with some examples that your scouts can think about, and perhaps use as a basis for making (inventing) their own solution.

Start with simple tasks/problems and let the scouts play/try their way to a solution.

A starting task could be to move a ball from one end of the scout hut to the other without the scouts touching the ball.

The next task could be to move water from A to B.

Can the scouts invent a way to make a raw egg survive a fall from the roof of the scout hut?

Try to come up with small tasks that your scouts have to figure out on their own.

Nature's own energy sources.

Nature (Earth) is full of energy, and much of our energy comes from the sun. Sun, wind and biofuel are energy sources that directly or indirectly come from the sun.

There are many sources of energy, for example:

- Solar cells
- Hydropower plants
- Wave energy
- Solar heating system
- Wood chip power plants
- Biogas power plants
- Coal power plants
- Waste-to-energy plants
- Wind turbines
- Geothermal energy
- Tidal system
- Straw power plants
- Natural gas power plants
- Oil power plants
- Nuclear power plants

Scouts do not need to know them all (and Scouts do not need to be able to remember them). Scouts just need to know that the different sources of energy have different impacts on nature and the environment. Scouts need to know that there will always be pollution/impact on nature, no matter which source of energy is used.

It is only a question of how great the pollution/impact is when a country chooses one source of energy over another.

To ensure that it is not completely impossible to compare the different sources of energy, it has been decided to divide the sources of energy into two groups.

1. Renewable energy
2. Non-renewable energy

The difference is that renewable energy sources continue to be formed, and non-renewable sources of energy can only be used once, and then it disappears (“forever”).

Renewable sources of energy are:

Solar energy.

Solar cells – here electricity is generated using sunlight.

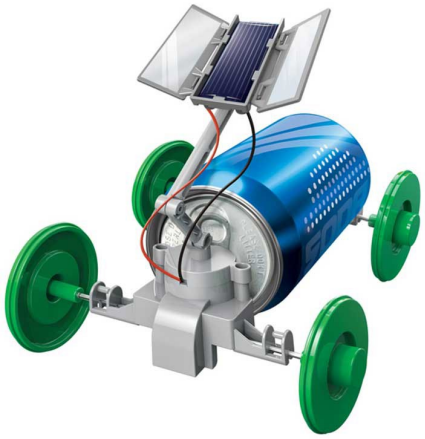
The scouts do not need to know how a solar cell works (the technical part). But very briefly, a solar cell works by "converting radiant energy into direct current using the so-called photoelectric effect. The photoelectric effect is the phenomenon that electrons are emitted from a surface when the surface is exposed to and absorbs quanta of electromagnetic radiation with a certain amount of photon energy. The positively and negatively charged atoms in the upper layer react to the solar radiation and migrate between the many layers in the solar cells."

In non-technical terms: when the sun's rays hit a solar cell, electricity is generated because two materials react differently to sunlight.

The picture 1is from sdu.dk

It is possible to buy small solar panels so your scouts can try to generate electricity using sunlight.

For example, you could buy solar cell building kits (https://naturlaboratoriet.dk/Produktkategori/Eksperimenter/Solar-robot-rover)



It is also possible to buy small solar cells that can be used to charge mobile phones.

If solar energy is something your scouts find fun and exciting, let them build different things with solar cells, such as a patrol box with solar cells on the sides to power the patrol's equipment.

Try asking your division, or local scout center if they have solar cell building kits and/or solar cell activities that your group can borrow, instead of going out and buying a lot of equipment that will only be used once.

Solar heating – here hot water is made using sunlight.

The picture 2is from sdu.dk

A solar heating system can be made easily if you have some scouts who are not afraid to use their hands.

DDS had a magazine called **Tandem** (1972 to 1997), where you could find a description of a patrol solar heating unit.

Can your scouts, based on this drawing, make a solar water heater that the patrol can take with them when they go on camps?

Can your scouts come up with ideas on how to make it more efficient. How about a stand to hold/system to drain the hot water?

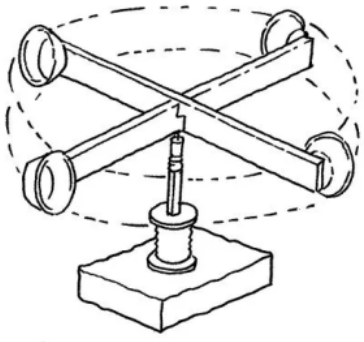
Wind energy.

- Wind turbines – here electricity is generated using the wind.

The picture 3is from Altinget.dk

There are many good guides on the internet for building your own wind turbine, for example here: https://www.experimentarium.dk/klima/byg-din-egen-vindmoelle/

Let your scouts look online and see if they can't find a building guide that they can use as inspiration for their own windmill.



The picture 4is from skoven-i-skolen.dk

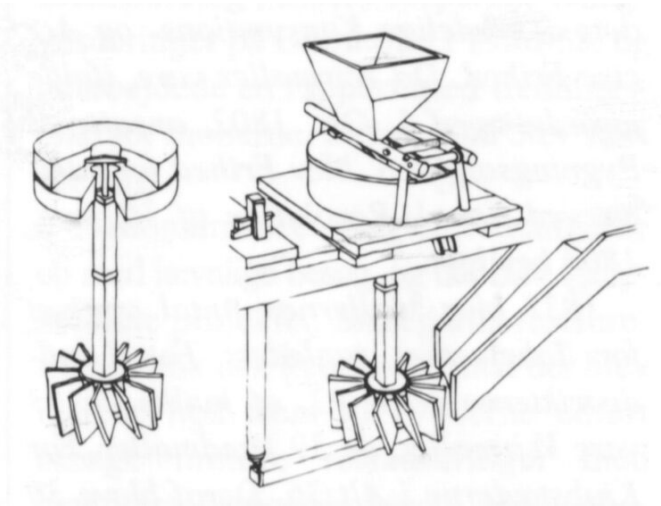
Water energy.

- Hydropower plants – here electricity is generated using flowing water.

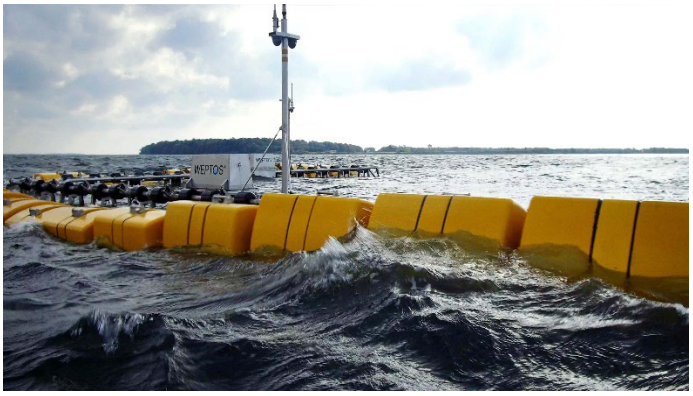
The picture 5is from alienenergy.dk

If you have a flowing stream near your scout hut, your scouts can try building a water mill. If you are lucky enough to have a working water mill nearby, take the scouts out there. If possible, let them see how the mill works. Have the scouts draw the mill wheel and the canal that brings the water to the mill

wheel. From the drawings, they can build their own mill wheel and canal?



- Wave power plants – here, electricity is generated using the movement of waves.



The picture 6is from tvsyd.dk

Wave power plants are one of the forms of energy that have not yet fully developed the structure to be able to produce electricity that is profitable. The system works by

the up and down movement of the waves driving a piston or turbine, which is connected to a generator.

- Tidal power plants – here electricity is generated using tidal movements.

The picture 7is from energy-supply.dk

There is also a type where a dam is built across a fjord and the water is utilized in the same way as a hydroelectric power plant.
It is not in all places in the world where the tides are strong that it is worthwhile to build this type of power plant.
The type shown in the picture works in much the same way as a windmill, just powered by flowing water instead of wind.

Biofuels.

The group of biofuels works in the same way, using plant material or manure from farm animals to produce electricity.

- Biogas

The picture 8is from naturfaget.dk/

Manure and organic household waste are made into biogas, which can be used in a gas generator to produce electricity.

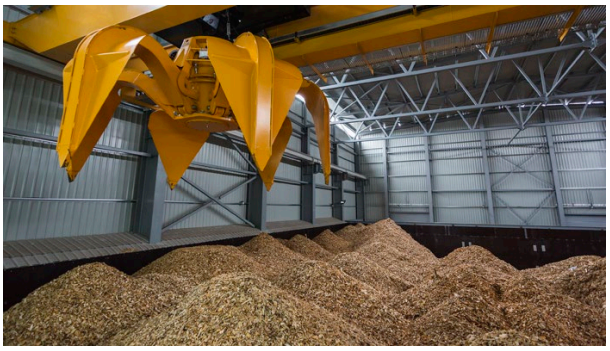
The biogas is sent into a gas turbine (“jet engine”) which is connected to a generator. The waste heat can be used to make hot water.

- Straw

The picture 9is from fritidsmarkedet.dk

Straw can be burned in a furnace (electricity and/or heat), or used to make biogas. Think of a straw furnace as a giant wood-burning stove. At the very large plant it is possible to make the hot water so hot that it is possible to drive turbines that can produce electricity (Avedøre power plant block 2). In the small plant, hot water (district heating) is just made either for a farm or for a small village.

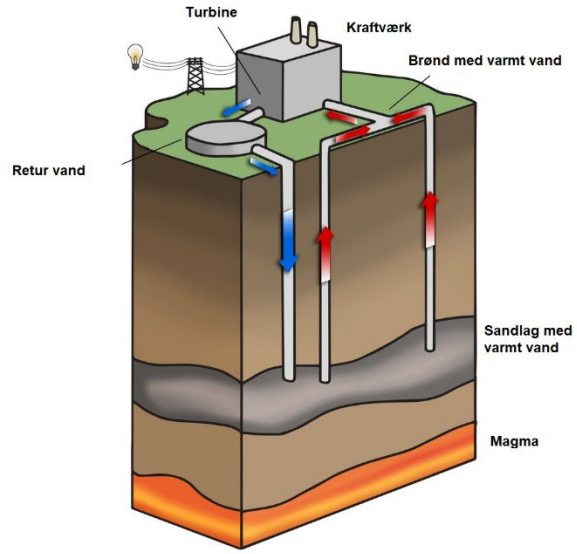
- Wood chips



The picture 10is from sodra.dk/

Wood chips can be burned by a stove and can be used to make both electricity and heat. Works in many ways like a straw stove or wood stove. A Wille stove works in many ways just like a plant that burns wood chips. Just much smaller.

Geothermal energy.



The image 11is from da.wikipedia.org

- For electricity production
  In Iceland and other places where the temperature in the underground is very high (hot), it is possible to use geothermal energy to drive electric turbines to produce electricity.

  The average temperature down through the earth increases by about 30 degrees for every kilometer you drill into the ground. In Iceland, in some places, they only have to go down a few meters to find water that boils.

- For heat production
  In countries with low temperatures underground (e.g. Denmark) it is not possible to generate electricity, but it is

possible to generate district heating. Approximately 5 geothermal heating plants have been built in Denmark.

Non-renewable sources of energy

Burning stored CO2

- **Coal**

The picture 12is from Aalborg Municipality.

Coal is organic material (dead plants) that has been exposed to pressure and temperature for many years (millions of years). The problem is that the coal contains CO2 which is released. To make electricity, or heat, the coal is burned in a furnace, where there are some water pipes that make it possible to turn the heat from the coal into steam, or hot water. The steam is used to drive an electric turbine, and the hot water is used to make district heating.

- **Natural gas**

Natural gas is plants and animals that have been exposed to heat and pressure, and where the organic material has been converted into gas (a bit like biogas, just over many years). Natural gas is not worth as much money as oil and is still in many places just vented out, or burned off, when the crude oil is extracted.

Natural gas, unlike biogas, was formed millions of years ago. This means that when natural gas is burned, CO2 is released that has been removed from the daily cycle, and now increases the amount of CO2 found in the air (the same thing happens with coal when it is burned).

Both natural gas and biogas are made from methane, and can therefore be used for the same purpose.

- **Oil**

  Oil or crude oil, like natural gas, has been formed by pressure and temperature over many years. Oil is more valuable than natural gas because it is easy to transport and contains a lot of energy per volume. It is also easier to convert crude oil into other products, such as plastic.

- **Waste**

Waste, or waste incineration, is a source of energy that we cannot call renewable, as it depends on what is in the waste that is burned. In the old days, it was found that waste took up too much space if they just threw it in a pile.

The picture The 13Dump in Sisimiut 2014

So, some people came up with the idea of burning it, then all that's left is ash, and the ash doesn't take up as much space as the waste. At a later point, some people found out that the heat from the combustion could be used to make district heating (hot water). Later, some people found out that they could also get enough hot water to drive a turbine and get electricity from the waste. Today, we try to avoid creating waste, and the waste that we do create, we try to sort so that there is as little waste as possible that has to be burned.

The image 14comes from skiltedesign-shop.dk/

Disposable sources of energy

You should understand “Non-renewable resources” as materials or substances that will not be regenerated in the foreseeable future. Much of the oil and natural gas that we burn today was formed millions of years ago, whereas the firewood from a tree can be regenerated within 20, 30, 50, 100 or 200 years, depending on the type of tree. Wood is therefore a renewable energy source, but oil and natural gas are a one-time source of energy.

Nuclear power

Nuclear power today primarily uses uranium as fuel. The uranium found on Earth was created when our solar system was formed, and no new uranium will be formed until our sun burns out and explodes (it will absorb the earth before that happens). Uranium and the other radioactive substances are therefore a “one-time source” of energy. Once we have used them, no more will be formed until about 3.6 billion years later, when our sun dies. Nuclear power extracts the energy that is released when the nucleus of uranium is split into new radioactive substances (the nucleus is split). A lot of heat is produced, which can then be used to drive a turbine that can make electricity.

We are NOT going to make our own nuclear reactor at the scout meetings. A scout has already done that.

Radioactive Boy lives! Student who sparked panic in 1996 after he built a nuclear reactor in his shed survived

- As 'The Radioactive Boy Scout' he built a nuclear reactor in his potting shed two decades ago and shut down a neighborhood of 40,000 in 1996
- Says the $60,000 clear up and burying his 'glowing shed' in the desert was just 'a total overreaction'

Hazard: Moon-suited EPA agents found 1,000 times the amount of normal background radiation

Nuclear power also has its problems, among other things because over 1500 million tons of tailings (crushed and chemically treated rock) have been produced, which poses an environmental problem as heavy metals and chemicals are released from the tailings pile into nature. Worldwide, there has not yet been a final repository for the radioactive waste that is generated in connection with the production of electricity from nuclear power plants. The waste is piling up in intermediate repositories, while states are working on a solution.

All sources of energy have their advantages and disadvantages. Each country must find the solution that gives them the most advantages and the fewest disadvantages when choosing which sources they want to use to generate electricity.

Try asking your scouts to investigate the advantages and disadvantages of the different sources of energy.

Let them try it themselves without any aids first, when they think they are ready, then ask them to search the internet for advantages and disadvantages of the different energy sources:

	Benefits	**Disadvantages**
Solar cells		
Wind turbines		
Hydropower plants		
Geothermal energy		
Wave energy		
Tidal system		
Solar heating system		
Straw power plants		
Wood chip power plants		
Natural gas power plants		
Biogas power plants		
Oil power plants		
Coal power plants		

Nuclear power plants		
Waste-to-energy plants		

How the wind, which always blows anyway, can be used to power a dynamo or machine.

You've probably seen windmills all over the landscape. Most are modern mills (electricity) and a few are old mills (grain).

The windmill is an invention that has had a great impact on people throughout history. It has been used both to pump water out of the ground and to grind grain into flour. It is believed that the mill was invented in the 9th century in what is now Iran and Afghanistan. The first windmills came to Denmark in the 12th-13th centuries. They were called stub mills and had the problem that if the wind changed direction, the entire mill had to be moved. Therefore, they were replaced by the Dutch mill, whose upper part could be rotated.

Pipe mill – a stump mill

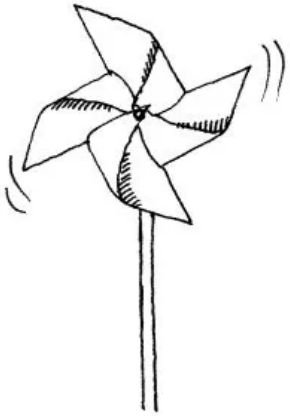
Nordskovmølle – a Dutch mill without its blades

It was Poul La Cour who built the first Danish windmill that produced electricity in 1891. So, windmills that produce electricity are not a new invention.

Have your scouts tried making a windmill?

If not, now is the time☺

Build your own paper windmill.
Make a small windmill out of paper.

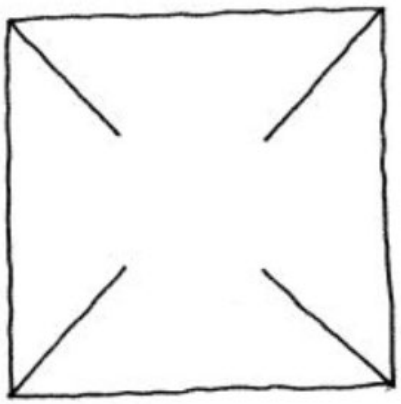


The picture 15is from https://skoven-i-skolen.dk/aktiviteter/vindmoelle-af-papir

You can't see the wind, but you can feel it and use it to create energy.

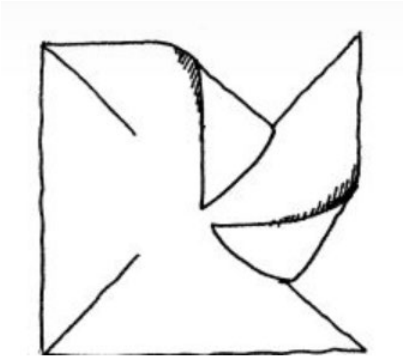
This is what your scouts should do

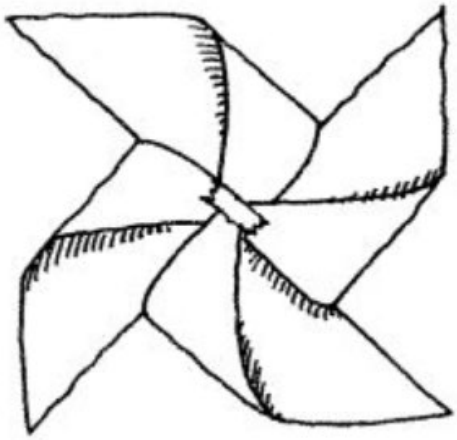
Cut a square piece of paper.



If the mill needs to have a color, color it before the scouts starts to cut.
Cut a slit from each corner, as shown in the drawing.

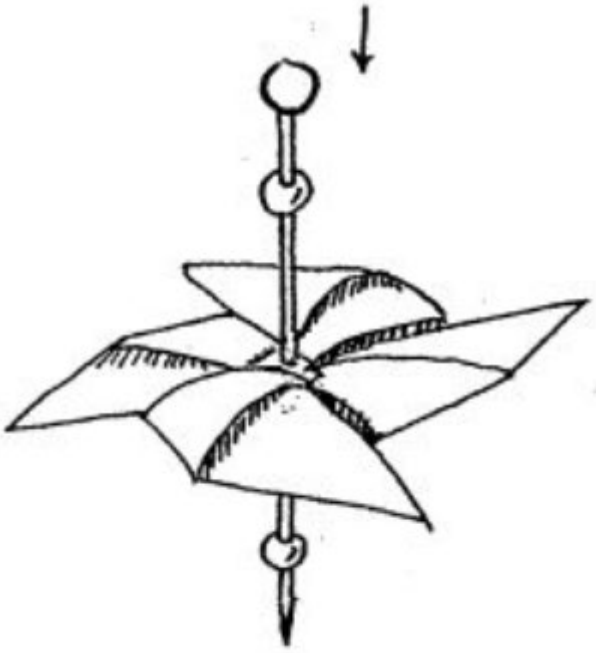
Fold the windmill as shown in the drawing.



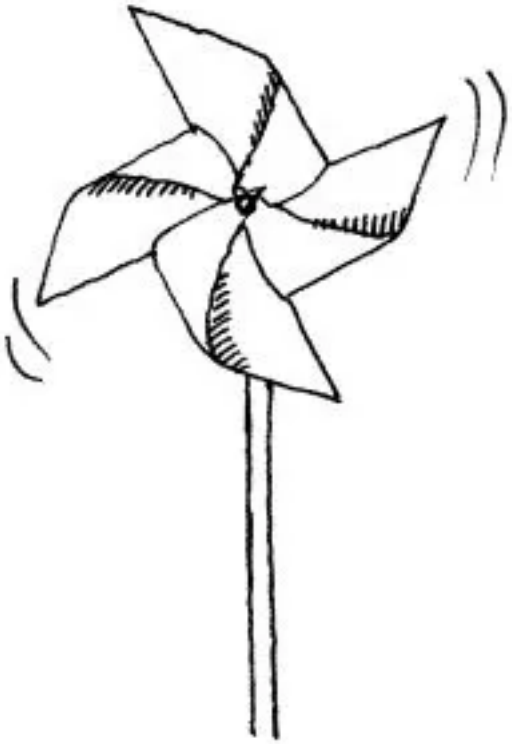


The scouts can try folding the corners in - and securing them with a piece of tape. It is important that the scouts fold the corners in from the same side all the way around. But the scouts do not need to use the tape.

Assemble the mill
Place the first bead on the needle. Then fold the corners in and secure with the needle. Place the second bead on.



Attach the windmill to the pin. The scouts should not press the pin too hard, as this will prevent the windmill from turning.

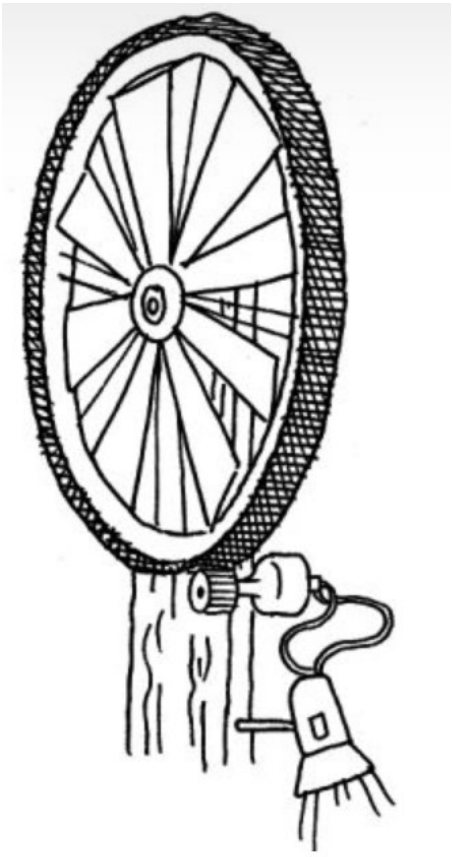


Out in the wind

Take the windmill outside and hold it up in the wind. It should face the flat side directly into the wind. Why do your scouts think it spins? Why do your scouts think you can make electricity with windmills?

Now that your scouts have tried making a simple windmill, it's time for them to make one that can produce electricity.

Make a wind turbine that can generate electricity



There are many different ways your scouts can build a windmill. One of the easiest is to use a bicycle wheel and then attach blades to the spokes. Remember that the blades must be angled or it won't turn. Find an old bicycle dynamo and your scouts just have to hang it up so they can get power.

- **Can your scouts invent a better windmill than the one shown here? For example, one that the patrol can take to summer camps and use to charge your cell phone.**
- **How about a fold-out windmill?**
- **One that is “only” made of biodegradable materials?**
- **A wind turbine that has a battery so you can store the power for the night (if there's no wind)?**

How the sun's rays can heat water, and get an idea of how they can be used to create electricity.

The sun can be used for many things. Your scouts can also use the sun's rays to cook food. Your scouts can cook food in a solar oven, or a solar cooker. If you or your scouts haven't tried this, it's time.

A solar cooker

The picture 16is from skoven-i-skolen.dk

A solar cooker can boil water and food using the sun's rays. It's a super smart invention that can save firewood and energy.

Solar dish

A solar cooker consists of a shiny dish that can focus the sun's rays on one point. If your scouts hang a pot in it where the sun's rays are focused, the pot will get hot enough to cook food. That point is called the focal point.

Your scouts probably know the system from a magnifying glass.

Instead of using a magnifying glass, the scouts must build a parabola and cover it with a mirror (tin foil) to collect the sun's rays into a point.

A solar oven

A solar oven is “two boxes” where the smaller one is inside the other. The smaller box has a lid made of acrylic or glass so that the sun’s rays can come in, but not out. Between the two boxes there is insulation so that the heat does not disappear. The outer box has a series of mirrors so that it is possible to get as much sunlight as possible into the smaller box.

The picture 17is from https://skoven-i-skolen.dk/aktiviteter/byg-en-solovn

Your scouts should now try to build their own solar oven, and see how high a temperature they can create inside the inner box. Has the temperature become high enough for you to bake a cake? Bake a bun? Or make a roast?

Power from the sun (solar cells)

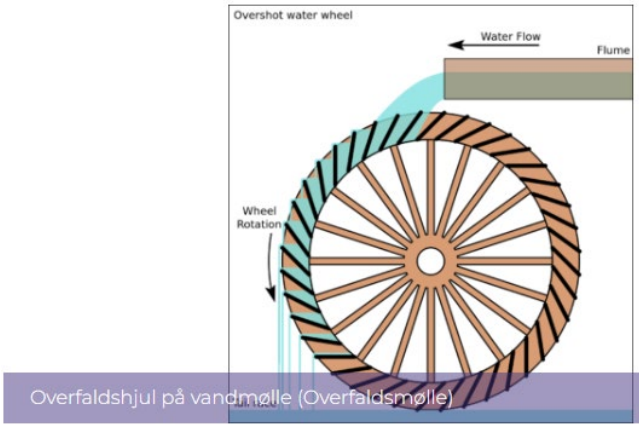
You can buy a solar cell at scouting stores or online to charge your cell phone when you are at summer camps. If you are very far from the nearest power outlet, a solar cell can be the best way to get power. However, the sun needs to be shining, it doesn't work at night. Can you invent a solar-powered refrigerator so you can have something cold to drink when you are at summer camps?

In the old days (the refrigerator) you had an earthen cellar where food was stored at about 8 to 10 degrees, year-round. When your scouts are at summer camps, they can do something similar to keep the food fresh.

The picture 18is from Spejderlex

How water can be used to power machines, and get an idea of how hydroelectric power can be used to generate electricity.

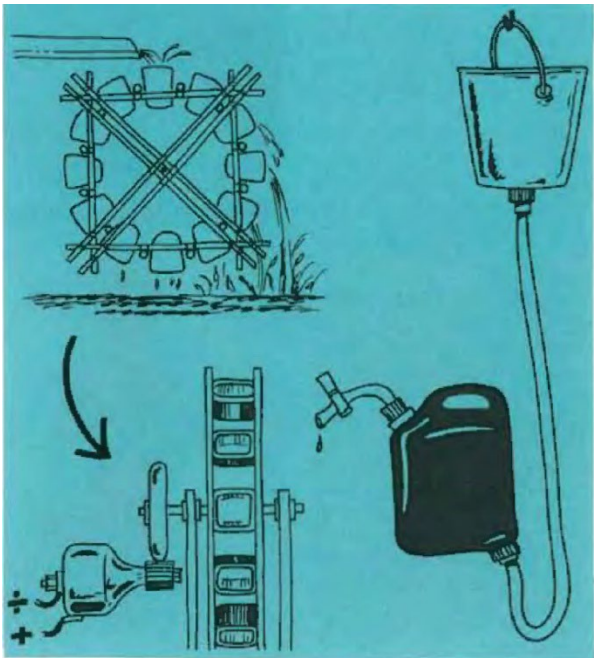
Water power has been used in Denmark since the year 1000 and the first water mills have been known since the year 300 BC.



Overfaldshjul på vandmølle (Overfaldsmølle)

In many places in the world, hydropower is still used to generate electricity. In Denmark, there are 8 hydroelectric power plants that produce a total of approx. 22 GWh of electricity per year. But they will probably be closed down in the future, as the environmental impact on the watercourse is large in relation to the electricity produced.

Your scouts will now have to make their own water mill.



The picture 19comes from scoutlex

What should the scouts' watermill look like?

Can your scouts make it generate electricity?

Is there a watermill near your scout hut that you and your scouts can visit and see how a watermill works?
Try to find a stream where the water flows quickly, so your scouts will have an easier time getting their water mills working. Remember that the scouts' mill wheels must be firmly attached, or the water will take the mill wheel with it.

How can you and your scouts be more sustainable when you are scouting and at home?

It is important that we as scouts take care of our planet, we only have one. You should try to get your scouts to think about what things they buy or use.

- How many raw materials have been used?
- Are they natural materials (sustainable materials), or are they materials that can only be used once - and then thrown away?

Try to think about the following options to do something good for the environment and the climate:

- Use a wood-saving stove instead of a fire.

- Turn off the lights when you're not using them and save on heating (20 degrees instead of 24 degrees).
- Buy organic products.
- Buy products that are produced locally.
- Use reusable shopping bags (cloth) instead of plastic bags.
- Make food from scratch instead of buying ready-made meals.
- Use a mug, plate and regular cutlery instead of disposable cutlery.
- Buy fruits and vegetables that are in season.
- A scout should not be driven to meetings by car! We walk, or cycle, to the meetings.
- Buy things for the scout hut that are made to last for years, and not always the cheapest.

- Repair instead of throwing it away and buying new.
- Do not buy more food or other things than you and your scouts need.
- Buy things that have been used before, instead of new things.
- Sell or give away the things you no longer use, instead of throwing them away as trash.

CO2, energy sources, environment and climate.

CO2 and other greenhouse gases

CO2 is the most commonly used greenhouse gas when comparing different goods, materials, or services, but it is more correct to use CO2e, which stands for CO2 equivalent.

CO2 equivalent is a way of converting other greenhouse gases into an impact equivalent to CO2.

You have to think of the different greenhouse gases as different types of fruit, and it's hard to compare an apple to a banana. So, to avoid making a fruit salad out of it, you use a conversion factor.

- CO2 has a CO2e of 1
- Methane has a CO2e of 25
- Nitrous oxide, N2O has a CO2e of 310
- CFC gases have a CO2e of 4660

This means that 1 kg of CFC gas corresponds to 4660 kg of CO2.

If a product, material, or service emits different greenhouse gases, they are added together to form a CO2e value.

For example:

Milk's greenhouse effect

	kg CO2 equivalents
Methane	0.52
Nitrous oxide	0.47
CO2 from tractor	0.07
Purchased feed	0.14
Indirect energy	0.09
Displaced meat and wheat	-0.37
Total	0.90

CO2e emissions from other things that you know.

Milk chocolate emits 5.3 kg CO2e per kg (200 g of milk chocolate is equivalent to driving 8.7 km by car)

Beef produced in a typical Danish barn emits between 11 and 19 kg CO2e per kg

Potatoes, on the other hand, only have a climate impact of 0.2 kg CO2e per kg.

Cheese has an emission of 27.9 kg CO2e per kg.

Other "everyday" things CO2 emissions.

- One hour of video streaming emits 400 grams of CO2.
- For every minute you use TikTok, it emits 2.63 g. CO2.
- An email emits approximately 4g of CO2 per recipient of the email.
- A Google search emits approximately 7 grams of CO2

- Visiting a Facebook page (0.6 Mb) costs 1 g of CO2 per visit.

Energy sources, environment and climate

Energy sources also emit CO2e for every kWh (kilowatt-hour) they produce. Electricity has different impacts on the climate and the environment depending on how the electricity is produced.

	CO2e per kWh
Wind turbines	12 grams
Solar cells	20 grams
Hydropower plants	24 grams
Geothermal plants	45 grams
Nuclear power	165 grams
Biomass	180 grams
Biogas	230 grams
Natural gas	490 grams
Waste incineration	494 grams
Oil (diesel)	773 grams

Coal	820 grams

There is no consensus on how much the different energy sources emit, so you can find other values on the internet.

You just have to be careful where you find information. For example, websites that are in favor of nuclear power have lower CO2e emissions than websites that are against nuclear power.

Biogas has a large CO2e emission because people were not previously aware of leaks in the system and a "lot" of biogases was lost (which has a large CO2e value).

25 kg CO2e for every kg of methane that disappeared through the leaks.

Biogas producers have become very aware of this problem and have reduced methane emissions from their plants. In the long term, this will mean that electricity from biogas will

have lower CO2 emissions than the 230 g per kWh.

Own inventions:

Own inventions:

Notes :

The Scout Promise

I promise to keep the Scout Law.

Scouting Act

Anyone who is part of the Scout community does their best to:

- to find one's own faith and have respect for others'
- to protect nature
- to be a good friend
- to be considerate and help others
- to be trustworthy
- to hear the opinions of others and form one's own
- to take responsibility for family and society

Motto

Be prepared