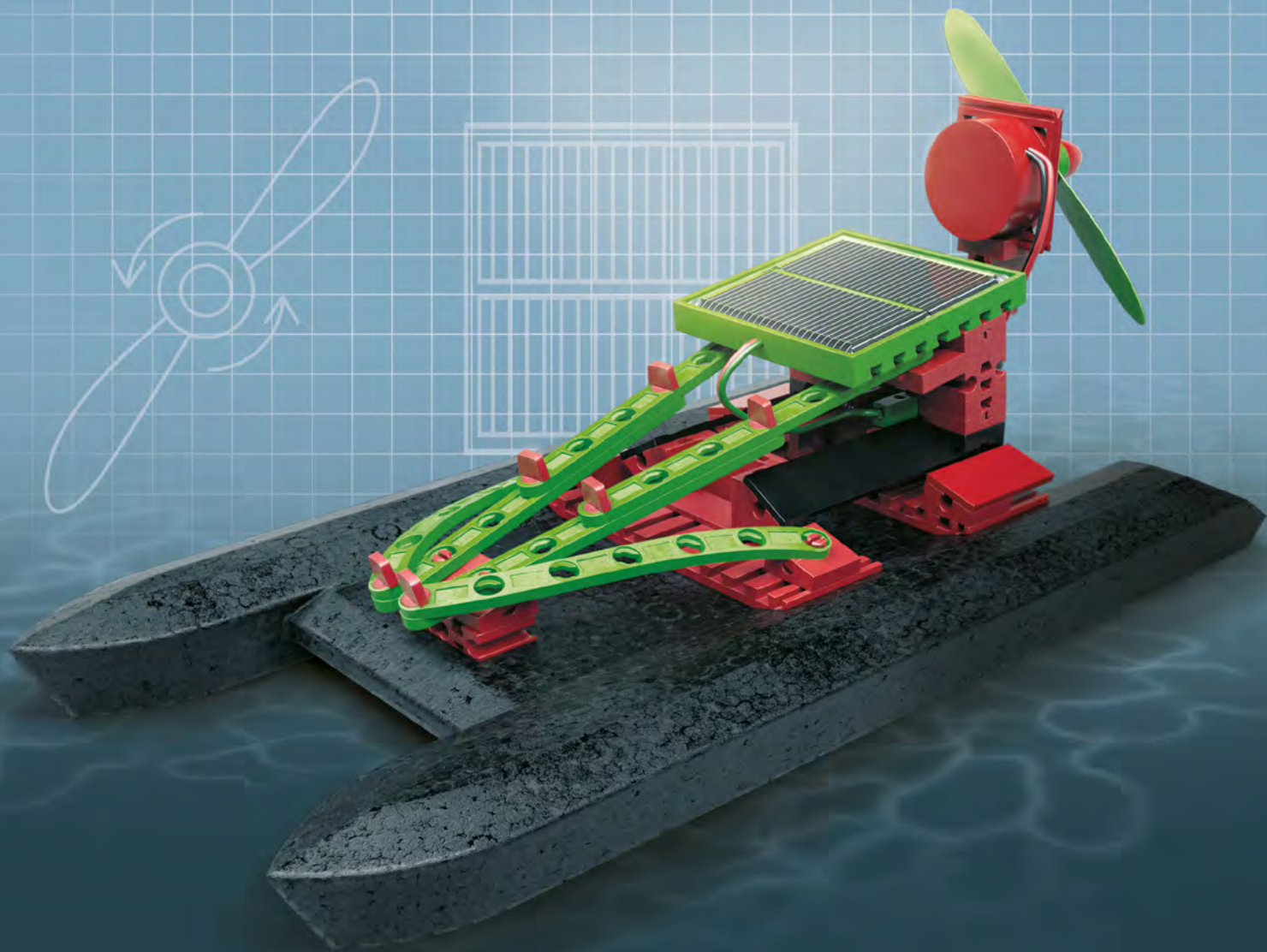


**fischertechnik** 

**PROFI**

Begleitheft  
Activity booklet  
Manual d'accompagnement  
Begeleidend boekje  
Cuaderno adjunto  
Folheto  
Libretto di istruzioni  
Сопроводительная инструкция  
附带说明书



**Solar Power**

**4 MODELS**

**Solar Power**

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## Welcome to the world of fischertechnik's PROFI line

Hello!

Congratulations on your purchase of the "PROFI Solar Power" Construction Set from fischertechnik. This construction set helps you learn the principles of solar power.



Reading through this educational information and trying out the various models will introduce you to the subject of solar power step by step. Now we wish you a great deal of fun and success experimenting with your PROFI Solar Power Set.

Your team from

**fischertechnik** 

## Energy in your everyday life

Every single day, we need an enormous amount of energy. Let's take a look at a normal day:



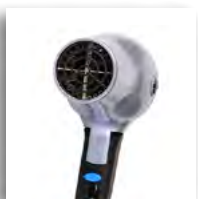
In the morning you are woken up by your radio alarm clock. This gets electricity from the socket.

After getting up, you switch on the light and shower with hot water, which has been heated by an oil or gas-fired central heating system. You then dry your hair with an electric hair dryer and brush your teeth with an electric toothbrush.



You make yourself a cup of tea or coffee for breakfast. You boil the water on an electric or gas range. The sandwich you eat during your break, was prepared the night before and stored in the refrigerator over night.

You take the bus or trolley to school, or your parents take you there in the car. Buses, trolleys and cars consume fuel.



We could continue to make a long list of things requiring energy. The list would be endless. Summing up, we all need an enormous amount of energy.

## Oil, Coal, Nuclear Power



And where does this energy come from? We get a large part of it from fossil fuels: natural gas, oil and coal. Nuclear power also covers part of our requirements for electricity. Unfortunately all of these methods of producing energy have various disadvantages:

- The earth's reserves on fossil fuel are limited.
- Combustion of oil and coal produces harmful substances (pollutants) that pollute the environment, as well as CO<sub>2</sub> which is responsible for continuous heat-up of the earth's atmosphere (global warming).
- Despite high safety standards, there is always a potential risk of a radioactive accident when nuclear energy is used. The process also produces radioactive wastes, which will continue to emit radioactivity a thousand years from now.

## Water and Wind



The invention of the water wheel was a milestone in the development of technology. Because this invention made it possible for humans to use mechanical energy in addition to muscle power – with the help of water power (hydropower).



Electric power can also be generated from wind. Humans have been harnessing wind energy for hundreds of years. The wind was used on the one hand for transportation by sailing ships or balloons; on the other hand, wind energy was used to do mechanical work with the help of windmills. Today high performance, state-of-the-art windmills are used for generating electric power on land and at sea.

## Solar Energy



Solar energy does not pollute the environment and is unlimited in terms of availability. It is an alternative form of energy. Here we speak of regenerative (renewable) energy sources, or renewables. With your PROFI Solar Power Construction Set you can examine how electrical power is produced from solar energy.

Unlike fossil fuels, unlimited quantities of this energy source are available, and none of the disadvantages described above occur when it is used.

Numerous models show you how these energy sources can be used to generate electricity and drive fischertechnik models.

## Energy

We constantly talk about energy, but what does it mean and how can it be measured?

We need energy:

- to accelerate a body or
- to move it against a force,
- to heat a substance,
- to compress a gas,
- to make electric current to flow and
- to emit electromagnetic waves.
- Plants, animals and human beings need energy to live.



The unit for measuring energy and work is the **joule (J)**.

If you want to know more about energy, you will find interesting articles on the Internet and in text books.

## Solar Power

### Basics

Solar power is the name given to energy produced by the sun through nuclear fusion, part of which reaches the earth as electromagnetic radiation (radiant energy). Most of this energy is used to heat our planet.



With the help of solar technology, solar power can be used in different ways:

- Solar collectors produce heat or thermal energy (to heat water or for space heating)
- Solar power plants generate electric energy by converting heat into water vapor (steam)
- Solar cookers or solar ovens heat meals
- Solar cells generate electric power directly (photovoltaics)

### Converting solar power into electricity



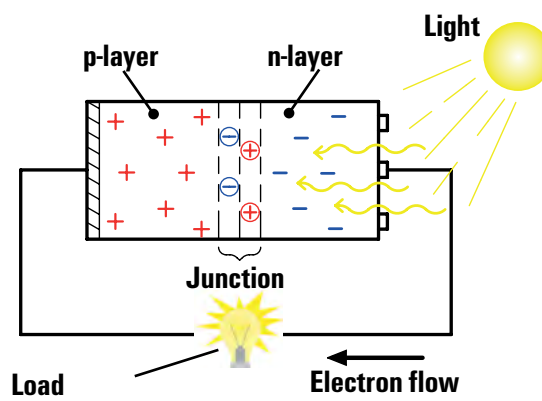
A solar cell or photovoltaic cell is an electrical component, which converts the radiant energy in light (usually sunlight) directly into electric energy. The physical principle of this conversion is called the photovoltaic effect. Solar cells should not be confused with solar collectors, with which the solar power heats up a transfer medium (usually hot water for heating).

Solar cells are made of silicon. The silicon blocks are sawn into approximately 0.5 millimeter thick layers (also known as wafers or discs). In the next step, the wafers are then doped (contaminated) with different foreign atoms (dopants), that is to say they are deliberately contaminated with impurities, causing an imbalance in the silicon structure. This produces two layers, the positive p-layer and the negative n-layer.

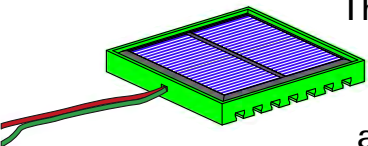
## Solar Power

In simple terms, the electric current is produced by electrons from the n-layer, excited by the incidental light, moving through the connected load (e.g. solar motor) to the p-layer. The more light (that is energy) that falls on the cell, the more mobile the electrons become.

When a solar cell is connected to a load, the electrons tend to move in this direction. You can imagine the current flow as being like a cycle with electrons constantly arriving at the n-layer and then traveling back to the p-layer. This flow of electrons causes electric current to flow and the motor rotates.



### Solar models with solar module



The solar module used in the PROFI Solar Power Construction Set consists of four solar cells connected in series. It supplies 2 V voltage and a maximum current of 200 mA. The solar motor has a nominal voltage of 2 V, but starts to turn at 0.3 V (at idle, that is, without the motor's shaft having to drive a model).

Build the ventilating fan model for the first two experiments (see assembly instructions).

#### Experiment 1:

Determine the brightness required to turn the motor. You can use a lamp with bulb to do this. Test the experimental setup outdoors in the sunshine too.



**Solar Power**

**Experiment 2:**

Perform experiments to find the answers to the following questions:

- How much light is required to turn the motor satisfactorily?
- Which lights sources are suitable for producing energy (yes) and which are not suitable (no)? See table.



Light source	Yes	No	Light source	Yes	No
Light bulb (incandescent)			LED spotlight		
Energy-saving lamp			Fluorescent lamp		
Halogen spotlight			Sun		

Build the solar vehicle model for the next two experiments (see assembly instructions).

**Experiment 1:**

Determine the brightness required to propel the vehicle. Is a greater amount of light required to move the vehicle than to turn the fan?



**Experiment 2:**

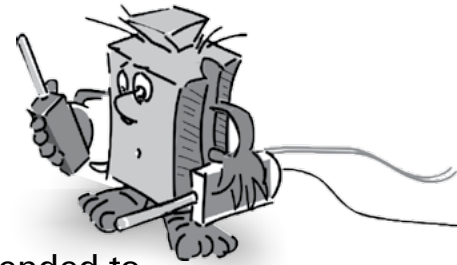
Test the effect of the light intensity on the vehicle's speed. How much time does the vehicle need to travel a distance of one meter?





## If something doesn't work right

If one of your models does not work right, please check the following trouble shooting chart. It provides a list of possible problems and the associated causes. Moreover the chart is intended to provide you with tips on how to eliminate the faults in each individual case.



Possible cause	Solution
Mechanical problems	<ul style="list-style-type: none"> <li>• Ensure that the movable components move smoothly and easily.</li> <li>• Are the components installed as described in the instructions?</li> </ul>
Electrical problems	<ul style="list-style-type: none"> <li>• Motor turns in wrong direction – polarity correct?</li> <li>• Solar module does not produce any voltage – wrong light source?</li> </ul>
Energy suppliers for solar module	<ul style="list-style-type: none"> <li>• Suitable: Sun, halogen lamp, incandescent light bulb.</li> <li>• Not suitable: Energy saving lamp or LED lamp!</li> </ul>
Benchmark for light energy	<ul style="list-style-type: none"> <li>• A 100 W incandescent light bulb is sufficient to turn the motor (without load) at a distance of approx. 40 cm.</li> </ul>

**Also recommended:  
PROFI Oeco Energy and PROFI Fuel Cell Kit**



In addition to "Solar power" as a renewable source of energy introduced in this construction set the [PROFI Oeco Energy](#) Construction Set offers intriguing glimpses into the subject of regenerative energy sources. Playing with this construction set allows you to learn a great deal more about the energy contained in wind and water. Moreover you can learn how to store electrical energy.

In combination with the Oeco Energy Construction Set, the supplementary [PROFI Fuel Cell Kit](#) provides a real highlight when it comes to renewable energy – the fuel cell. You can use this energy source to run models from the Oeco Energy Construction Set, as well as other technically interesting models.

