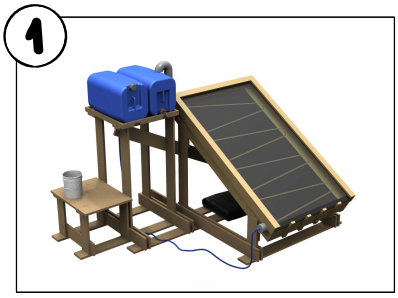
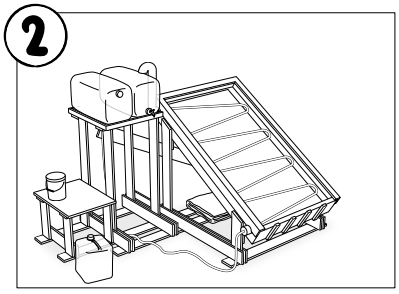
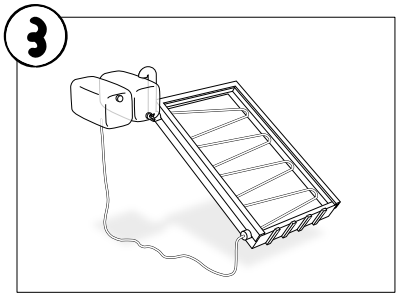
Working principle of the solar thermal water desinfections device



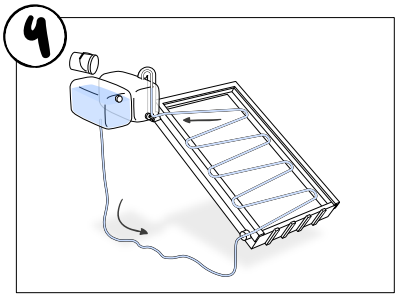
This is how the device looks like! The dimensions are ca. 2.7x2x2 meters. It improves water quality through heat treatment. Here we show how it works.



The angular part on the right is called “absorber”. It collects the sun’s radiation. The tanks on the left side are the input tank for the untreated and the output tank for the treated water. The wood construction holding the absorber at the defined angle and the tanks at the correct height is called rack.

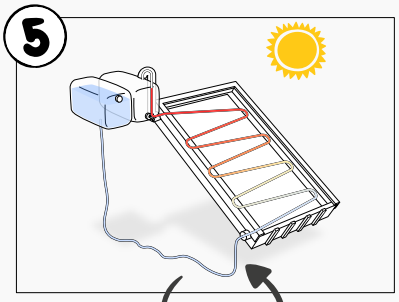


We don’t need the rack for the explanation, so we’ll hide it. The input tank is connected with the absorber through a tube (or pipe). In the middle, hidden behind the output tank, there is the insulated riser, from which the treated water will flow into the output tank.



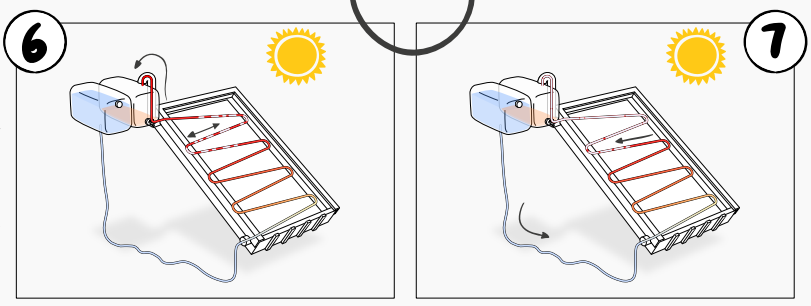
First of all the input tank is filled with the water that should be treated. Via the tube the water level in the absorber rises to the same fill height as the input tank.
It is important, that the water is clear and not chemically contaminated. A piece of fabric can be used to filter the water to a small degree.

The process

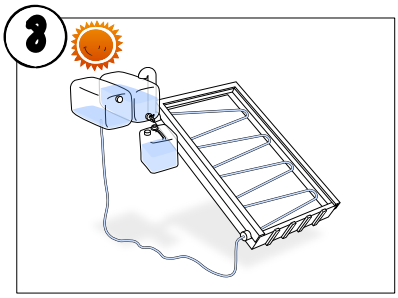


The sun heats the water in the absorber. A good insulation is very important.

When the water in the absorber is hot enough it starts to boil. Steam emerges in the absorber pipes (bubbles). The expanding steam pushes this hot water out of the riser into the output tank.



When the steam reaches the output and leaves the absorber, water from the input tank flows into the absorber again. The water is now a little bit cooler again and needs to be heated. This will happen quickly once the device heated up in the morning. Now the last steps repeat until the sun is not strong enough anymore.



At the end of the day the all of the water in the output tank got treated. If the sun is not strong enough to treat all the water there will be water left in the input tank.
The water in the output tank cooled down and should be used within one day. According to the need, water can be drawn off during the day.

In the evening or at the next morning the input tank is filled again or the absorber is covered to deactivate the device. There should always be water in the input tank, because the device can get very hot without water. To stop the device the absorber just has to be covered.

User Manual

SoWaDi – Solar thermal water disinfection

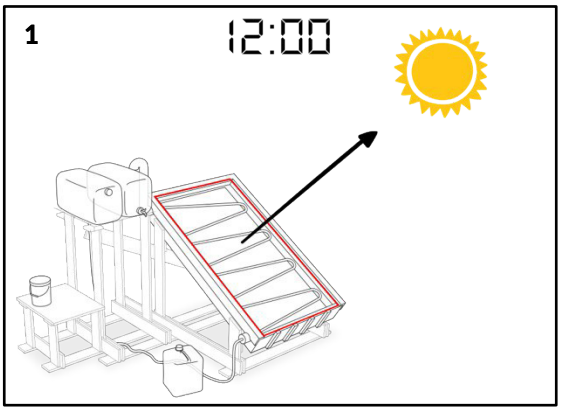
The following User Manual explains in detail what users of the SoWaDi devices have to do and when they have to do it in order for the devices to work properly and to keep in contact with the SoWaDi team in Germany.

The User Manual is therefore split up into three sections:

1. **Before the first use**
2. **Daily operation and data acquisition**
    - Every day
    - The daily protocol
3. **Maintenance**
    - Once every week
    - Once every month
4. **Shutdown and Startup**

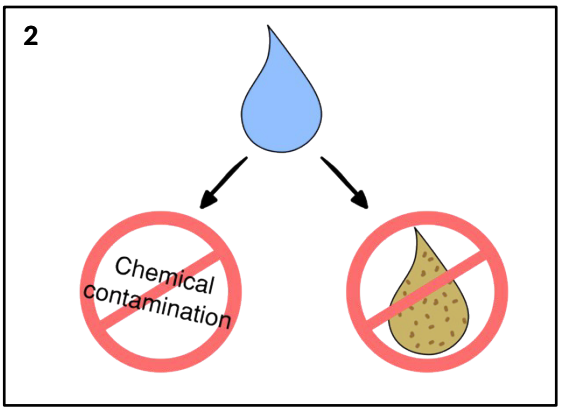
1 Before the first use

Before using the device for the first time, you should check a couple of things and clean the device. The following contains everything you need to do.



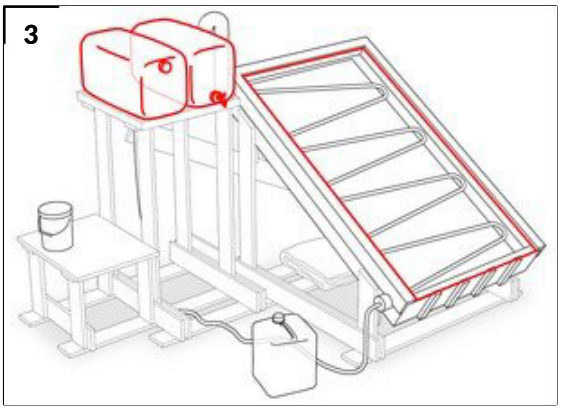
Is the device oriented correctly?

The front of the device needs to face the sun when it is at its peak. The sun reaches its peak at noon. There should not be any shadows cast over the device during the day (e.g. by trees or houses). Also, it should be sheltered from wind if possible.



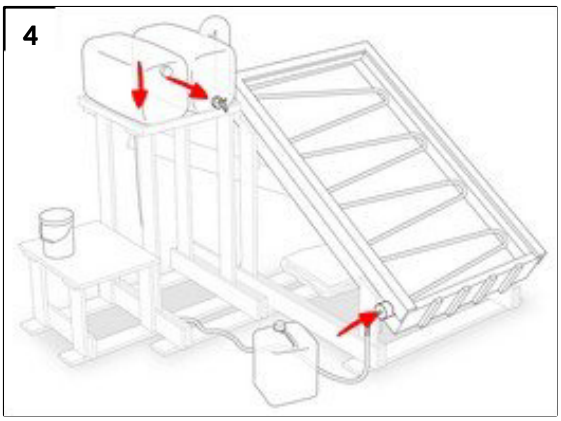
Is your water suitable?

The water you fill into the device has to be clear and free from chemical contamination (e.g. fluorine from the groundwater or heavy metals). Water from rainwater cisterns is a good choice.



Is the device cleaned?

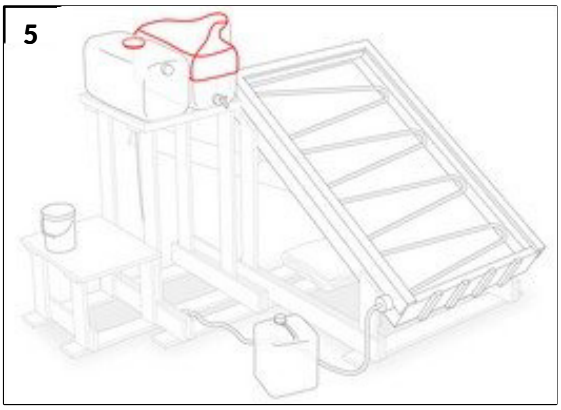
Clean the input and output containers thoroughly with soap and rinse with clean water. There cannot be any dirt left. Clean the glass plate in case it is dirty.



Is the device free of leaks?

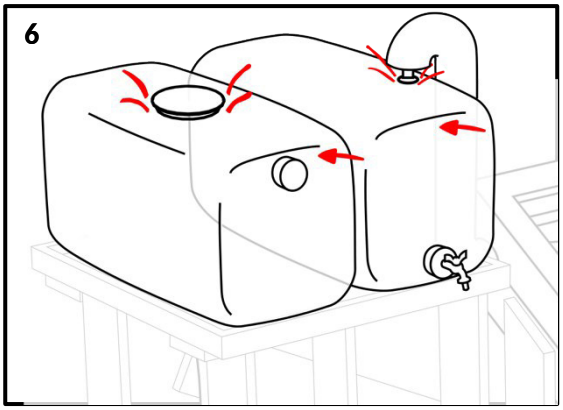
Check every connection that will be in contact with water for tightness. Check the following connections:

- Input container → Hose
- Hose → Pipe
- Output container → Water tap



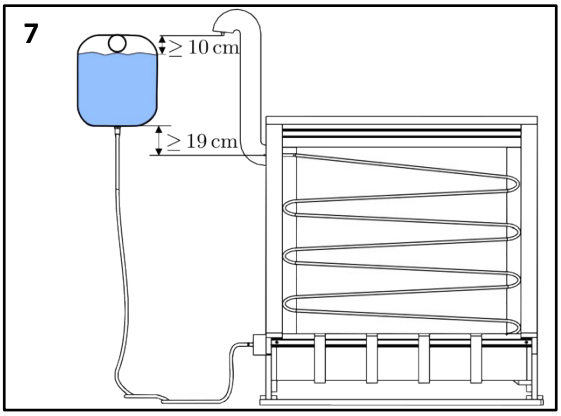
Are the containers protected from dirt?

The hole in the output container needs to be protected from dirt, but make sure that the water can still flow freely. Do not connect a hose to the outlet. The hole for filling the input container needs to be protected from dirt as well.



Is a pressure compensation possible in the containers?

The containers must not be entirely airtight. There has to be a small opening, (a tiny hole, a gap or something similar), so that air can flow in and out of the containers during operation. If this is not the case, drill a small hole above the water level (as shown by the arrows).



Is the input container positioned at the correct height?

The difference in height between the exit of the riser out of the box and the bottom of the input container has to be at least 19 cm. If this is not the case elevate the input container, e.g. by putting something underneath the container. Fill the input container with water until the height difference between the water level and the outlet of the riser is 10cm. This is the maximum amount of water you should fill into the container. Write down that amount and mark the water level on the container.

2 Daily operation and data acquisition

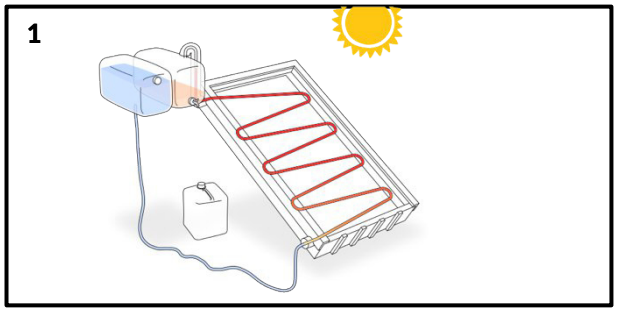
In order to make sure that the SoWaDi device runs without any problems and to send data to the SoWaDi team in Germany, different tasks are necessary. This list helps you to get an overview of the tasks.

2.1 Every day

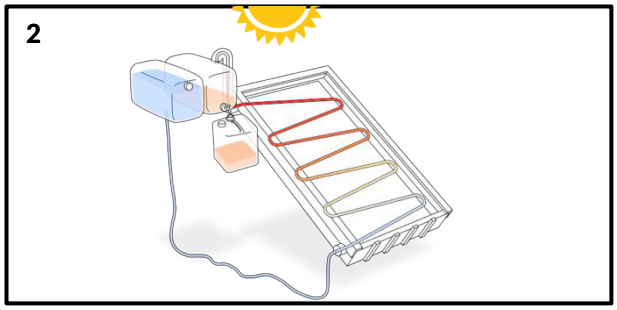
The daily tasks described below are necessary to ensure a trouble-free operation of the device. By recording the daily water output, the SoWaDi team in Germany can evaluate the systems performance better.

The following contains how to operate the device and what to look for while you do it.

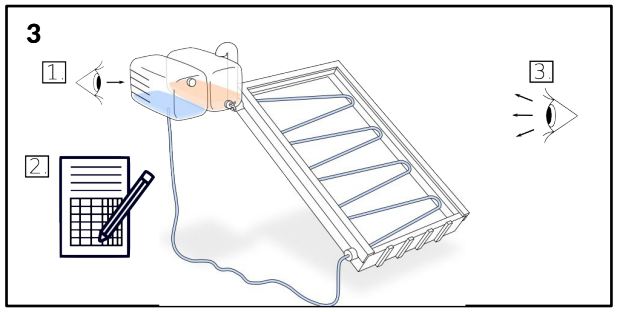
If the system was not running for a longer time, make sure to check Chapter 2 first.



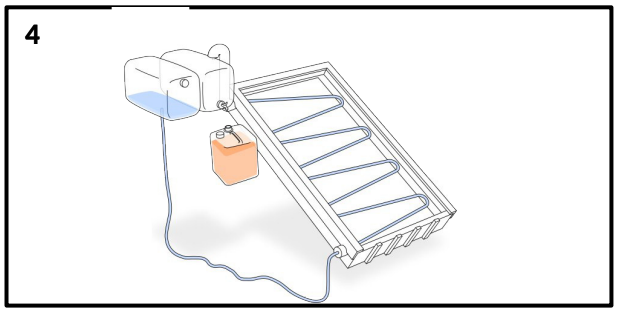
Let the device work
The device is working. Water in the absorber is being heated by the sun. When the water is hot enough it will start to boil and kill off pathogens. The resulting steam will periodically push out water.



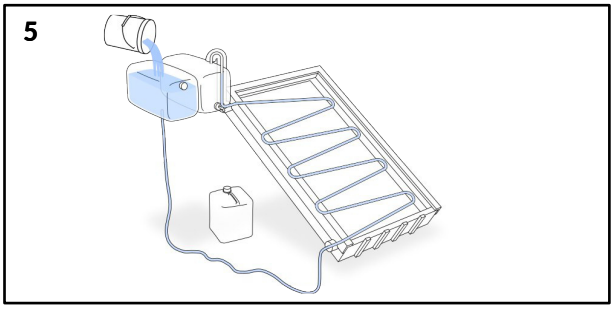
Take the water when required
As soon as **at least half a liter of water is in the output container** you can remove water from it into a clean container. This container should only be used for this purpose. Around noon the water will still be quite hot, in the evening it will have cooled down. The **water needs to be used up entirely at least the next day (24 hours)**.
Make sure that nobody contaminates the tap with their own container.



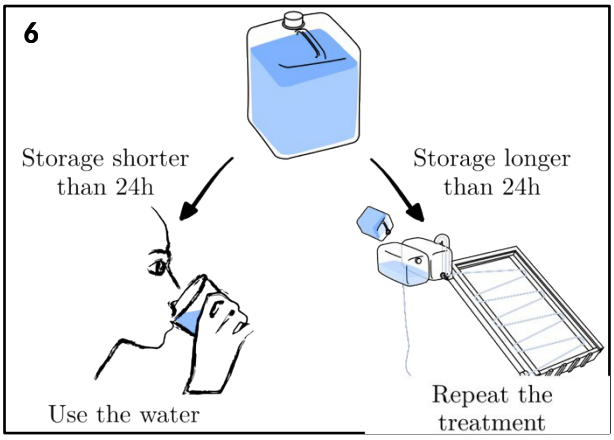
Fill in the daily protocol
1. Read the amount of water left in the input container using the fill level strokes.
2. Fill in the daily protocol (see below).
3. Visually check the device:
   Is the glass dirty? → Clean it!
   Is the wood or isolation moist? → Seal it!



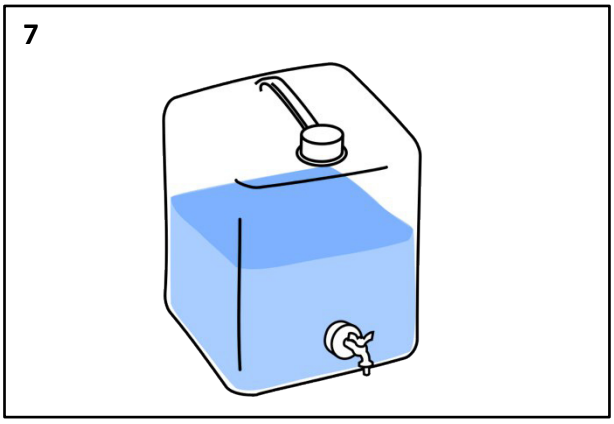
Empty the output container
Drain the entire output container.



Filling the device
Fill the device in the evening or early in the morning. Use untreated water and fill it into the input container until you have reached the maximum amount. If you want to ‘shut down’ the device, cover it or put it into the shade. The device must never be in the sun while it is empty.



Use the water within one day
After treating the water, use it within one day. If is it older than one day, pathogens can form again. In that case, pour it back into the input container and repeat the treatment.



Store the water properly
Treated water should be stored in plastic, ceramic, or metal containers, which have to be cleaned regularly. It needs an opening to pour the treated water in. That opening should be small and with a lid or cover. This prevents placing potentially contaminated items such as hands, cups, ladles or any type of objects into the stored water. It also needs a tap.

2.2 The daily protocol

In the daily protocol the water output and problems with the device are noted.

It is **very important** for the work of the SoWaDi-team in Germany that these **protocols are kept daily and that there are no gaps**. If, however, it should not have been possible to record the data, please be truthful and leave the field empty.

The following questions should be answered by filling in the protocol:

- How much water output did the device deliver in total today?
- Where there any problems with the device?
- How was the weather today? **(Only mark the appropriate weather situation)**
    - If there are irregularities, such as heavy rain in short periods of time, please write it down in the comment field.

The Output delivered by the device is calculated from the difference between the amount of water inside the input container at the evening and the evening before. For this it is necessary to always write down the amount of water before and after refilling the input container.

	What to fill in
Amount of Water inside the Input Container	Write down how much water is in the input container in litres **before and after** refilling.
Problems	Note here if you have any problems with the device.
Clouds	Fill in how much sun you had today. Mark one of the following categories. • Sunny • Few clouds • cloudy If there are irregularities, such as for example fast changing cloudiness, please write it down in the comment field.
Rain	Note how much rain did you have today. Mark one of the following categories. • No Rain • Little rain • Much Rain If there are irregularities, such as for example heavy rain in the morning, please write it down in the comment field.
Comments	If there are any unusual features regarding the weather, please write them down here.

Location: **TZ01**	Amount of Water inside the **Input-Container [liter]**		**Problems**	**Clouds**			**Rain**			**Comments**
Weekday **and date**	**BEFORE** refilling	**AFTER** refilling		sunny	Few clouds	cloudy	No rain	Little rain	Much rain	
Monday, 03.02	40	60	None	X			X			No clouds all day
Tuesday, 04.02	35	60	None		X			X		Little rain around midday
Wednesday,										
Thursday,										
Friday,										

Example of the daily protocol

3 Maintenance

3.1 Maintenance - Once every week

Frequent cleaning is important for the safe operation of the SoWaDi device and problems with the system can be quickly found and fixed. In addition, constant contact with the SoWaDi team in Germany is ensured, so that problems can be treated faster.

Weekday in the evening	Take a photo of the last daily protocol page
	Clean the input and output container (with a brush)
	Clean the glass panes
	Clean the output at the water tap
	Is the wood or the insulation moist? → Seal it!
	Visually check whether the device works without any problems

3.2 Maintenance - Once every month

Another important field of tasks is the inspection of the device. The following questions will guide you through the inspection. Besides answering the questions, it is **necessary to take photos** for the SoWaDi team in Germany to get an understanding of the problems arising and to see how the abrasion of the device goes on over time.

Components	Questions concerning the component	Take photos of:
Entire device	Are there any other defects on the device? Is the rack stable?	Entire device
Containers	Did you have to clean the container? Were they dirty inside? Are there any depositions inside the Input container? Did the containers get cracks? Did the containers become fragile?	Input-Container from the inside, before cleaning!
Glass panes	Did the glass panes get cracks? Did the glass panes fog up? (especially in the morning)	Entire glass pane
Absorber	Is it wet inside the absorber? Where exactly?	
Wooden frame / rack	Are there any wooden parts infested with pests? How is the condition of the wood? Change in color? Any splitters?	
Plastic parts	Is there any damage on the hose connection?	
Rising pipe	Are there any deposits on the visible end of the rising pipe?	

If any problems with the device are found during inspection, inform the SoWaDi team in Germany via WhatsApp and try to repair on your own.

3.3 Remember to…

- never leave the device in the sun uncovered when there is no water in the input container. Otherwise, it can become extremely hot and break. That is why you always need to either:
    - have enough water in the input container, or
    - cover the device with a lightproof cloth or tarp, or
    - move the device into the shade.
      (For a shutdown of the device, see chapter 3)
- keep the glass clean.
- keep the containers clean.
- keep the device leak proof.
- keep the isolation material dry.
- Fill in the protocols.

4 Shutdown and Startup

Before extended periods of not using the device

Flush the device. Do this immediately before refilling the device. Follow these instructions:

1. Remove the output container and instead put a bucket which fits at least 15 liters under the riser pipe.
2. **Fill** the **input container** with about **10 liters** of water.
3. Lift the input container higher than the riser pipe. Now the water should flow out of the riser pipe into the bucket.
4. Put the input container in its original position and fill the water from the bucket back into the input container.
5. **Repeat** this procedure **2 to 3 times**.
6. Put the bucket under the connection of hose and pipe. Remove the hose from the pipe at this connection. Now water should run into the bucket and dirt will possibly be flushed with it.
7. After the device has run empty: **Check the connection between hose and copper-tube**. See if you can see any dirt or chalk in the tube or pipe. Please send pictures to the SoWaDi-team Germany.
8. **Cover the device** with a lightproof cloth or tarp or move it to the shade.
9. Take care that the device and containers will not get too dirty during storage.
10. **Do not use water from the device without prior disinfection.**