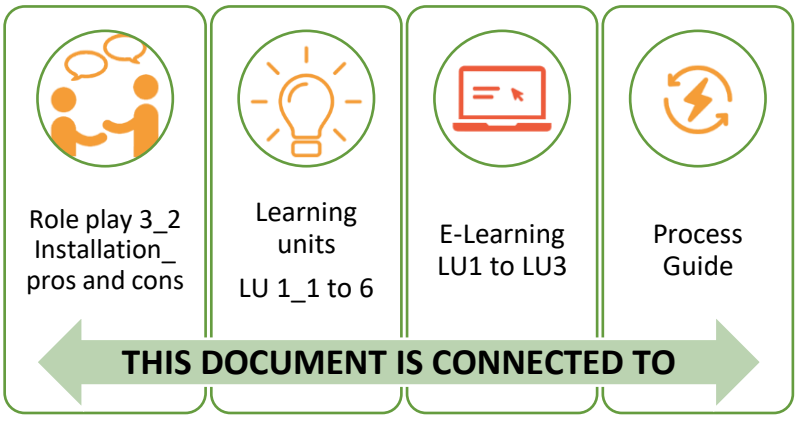
Our Solar Town

Learning Unit 3.2

Solar-thermal system_planning installation



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Learning Unit 3.2 - Learning Plan

Planning and installation of a solar-thermal system

Before you start to build a solar-thermal system a good planning is absolutely necessary. The most important things to consider when planning are:

- What kind of solar-thermal system do you want to build?
- Be familiar with the structure of the solar-thermal system you have chosen
- Connection of the solar collector to the house installation
- Determine the most suitable place for installation (see also ***Learning Unit 3_1 Site selection***)
- Determine the proper position and orientation of the solar collectors according to the sun
- Consider some legal aspects before installation depending on the country
- Do you want to build a plant? The ***Learning Unit 5_1 Practical realization*** helps you with the implementation in practice, the ***Process Guide*** might help with the planning and documentation

What kind of solar-thermal system do you want to build?

Solar-thermal systems (solar collectors) are the most simple and effective way to use solar energy. With 6.4 m^2 installed, a four-member household can meet all the hot water needs, most days of the year. Since the energy of the sun is free, we save a lot of money by heating hot water. In addition, we make a significant contribution to reduce the carbon footprint on the environment because solar-thermal is 100% carbon free.

We can separate solar thermal systems according to the fluids that are required for heat transfer:

- **Passive** - the sun is heating direct water, so we do not need additional devices for the operation, usually they are using it in geographically warmer regions (Greece).
- **Active**, where the sun heats the antifreeze fluid. To do so, it also requires a circulation pump connected to an additional energy source. It is used in geographically cooler areas (like Slovenia, Belgium or Austria).

Solar-thermal collectors are divided in two main categories:

- **Evacuated tube collectors**: the most common type of collector in America, Asia and Oceania. This particular type of collector utilizes glass tubes with high vacuum to reduce the heat loss.

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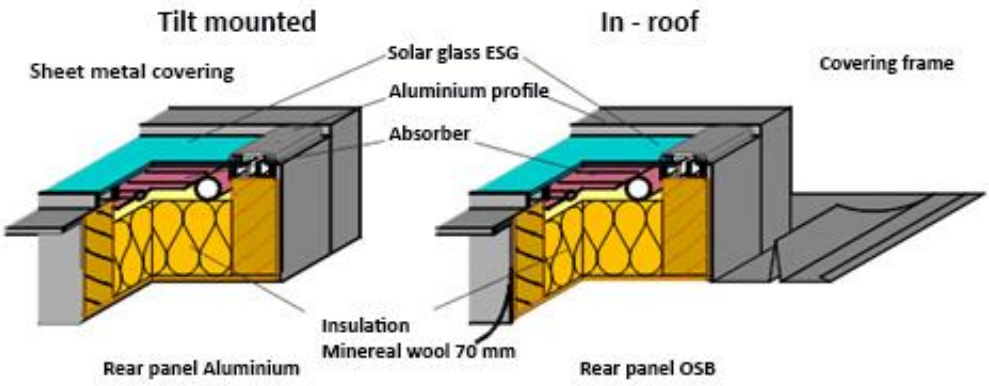
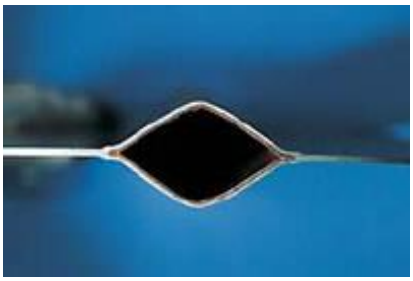
- **Flat plate collectors**: the most common type of collector in Europe and Africa with active insulation from the sun.

In our Solartown project we are going to build this kind of collector in a school, 16m^2 in size, which is sufficient for a 500-l hot water tank.

The structure of a flat plate collector



- ESG 4mm solar glass (4mm thick tempered glass, for protection of the weather box)
- Collector absorber (Sunstrip absorber tape, copper tube with its high absorption rate (> 95%) ensures optimum utilisation of irradiated solar energy. It is filled with heat transfer fluid, which is water-propylene glycol blend with a proportion of antifreeze, adjusted to the local minimum temperatures)



- Copper tubes connections (welded to absorber strips so we can connect them to the system)
- Stone wool insulation (70 mm thick isolation that reduces heat losses on the collector)
- Rear wall of the collector (OSB or aluminium panel, depending on the type of mounting)
- Wooden frame construction painted in black to protect the wood and better absorption of the sun heat.

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Connection of the solar collector to the house installation

In order to connect the solar collector to the house installation, we need:

- Heat storage tank, with two separate coils (tube coils) so we can connect it to multiple energy sources
- Connecting pipes and valves
- Circulation pump
- Expansion vessel to regulate the pressure in the pipes
- Storage tank for storing excess of hot water (not necessary but highly recommended especially in winter time when there is not a lot of sun and hot water is drawn from it if needed)

Proper design and selection of the solar thermal system is the key to optimal performance and maximum efficiency.

Determine the most suitable place for installation

The most common place for collectors is a roof surface, where we need to make a static assessment of the building to determine if we need to strengthen the load-bearing structure of the system and anticipate whether we will need a crane for installation. The collector can also be mounted on the floor next to the building or on the facade.

Keep in mind, that the collector should not be mounted too far away from the spot, where the water is needed to avoid loss of heat. The connections from solar-thermal collectors to the heat storage tank and boiler should be as close as possible.

The ***Learning unit 3.2_Side selection*** and the ***Our Solartown-Planning Tool*** might help you with this point!

Determine the proper position and orientation of the solar collectors according to the sun

This will maximise efficiency and savings. Ideally, the collectors are pointing south and perpendicular to the sun's rays' incident angle, but above all, they should not be shaded during the day and throughout the year. For flat plate collectors, the normal inclination angle is 45 degrees. It is reasonable to observe the sunlight around and on the building the whole year. You can also check the data for sunshine duration in your home town.

- Sunshine duration data for **Slovenia**: https://meteo.arso.gov.si/met/en/climate/maps/
- Sunshine duration data for **Austria**: https://www.meinbezirk.at/niederoesterreich/c-freizeit/sonnenstunden-atlas-wie-viele-stunden-im-jahr-scheint-die-sonne-in-deiner-gemeinde_a2615885
- Sunshine duration data for **Greece:** http://climatlas.hnms.gr/sdi/?lang=EN
- Sunshine duration data for **Belgium**: https://www.statista.com/statistics/525928/hours-of-sunshine-in-belgium/

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The lifetime of the solar-thermal installation with regular inspection every 3 years and antifreeze fluid replacement (only in colder climates) every 5-7 years can be from 20-25 years or even longer.

Legal aspects depending on the country

Consider some legal aspects before installation depending on the country.

In **Slovenia** all we have to acknowledge is the Law on Construction of Buildings, and it is not necessary to acquire approvals or permits, unless we interfere with the building construction or the spatial plan. These are only investment maintenance works. It is recommended to obtain location information and a school permit or permit from the municipalities if we do not own the building.

In **Austria**, the regulations of the respective building code, the provisions of monument protection and, if applicable, the local building codes must be observed when installing a solar thermal system. In Austria, these are regulated on a federal state basis.

Up to a size of 100 m^2, you do not need a building permit for the installation. Nevertheless, it is advisable to inform the responsible authorities of the upcoming construction work in the event of uncertainties, regarding monument protection etc. in order to prevent any problems.

In all cases, it should be noted that the appropriate accident prevention measures should be taken for all installation work on the roof. An authorised person should carry out the installation and commissioning of a solar system.

In **Greece,** for the construction and operation of a solar thermal system, the rules of the Building Regulation, the provisions for the protection of monuments and, where appropriate, local rules on construction must be observed.
Appropriate accident prevention measures should be taken for all mounting operations on the roof.
Assembling and first operation of a solar thermal system should be performed by a professional.
All regulations are included detailed in the following laws:

- Building Energy Performance Regulation [Κανονισμός Ενεργειακής Απόδοσης Κτιρίων (ΚΕΝΑΚ 2017) (ΚΥΑ Α.Π. ΔΕΠΕΑ/οικ. 178581/30.06.17, ΦΕΚ 2367/Β/12–07–17)]
- New Building Regulation Law No.4067/2012 [Νέος Οικοδομικός Κανονισμός ΝΟΚ Ν.4067/2012]

In **Belgium** no other particular measure should be taken into account to install a solar thermal system. As all the other European countries, you need the permission of the landlord and you have to respect the security measures, the monument protection measures (if it is the case) and any other normal measure as you were installing anything else.

Do you want to build a solar-thermal plant in your school?

Our ***Learning Unit 5_1 Practical realization*** might be useful for you with lots of information about the necessary materials, tools and other requirements.

Have fun!

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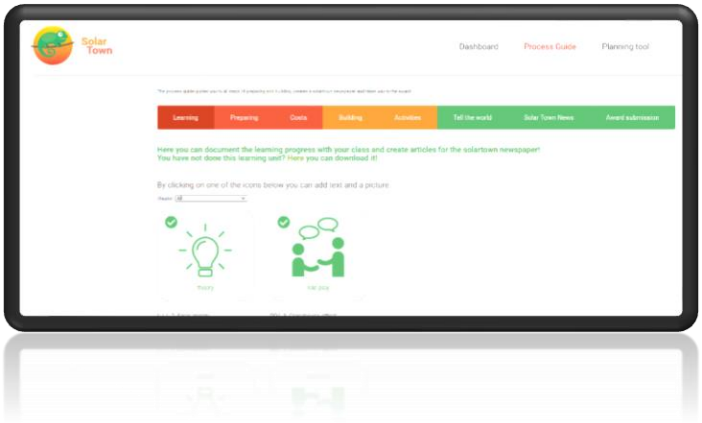
The *Process Guide* of Our Solartown

The ***Process Guide*** of Our Solartown is an online platform that accompanies the process from planning and construction of a solar thermal plant in a school to your Solartown Project documentation. Moreover, it provides support for the creation of a Solartown newspaper and takes you to the submission for the ***Our Solartown Award***.

The Process Guide contains following menu points:

- Learning
- Preparing
- Costs
- Building
- Activities
- Tell the world
- Solartown News
- Award submission



Learning:

Here you can document the learning progress with your class and create articles for the Solartown newspaper about our learning units' topics. Just click on the icons and start.

Preparing:

The page provides all the information and important things that should be considered before building the solar-thermal system. With the ***Process Guide*** is easy to document all your steps and preparations.
You have to take into account the following factors

- Site selection
- Legal aspects
- Obtain permissions
- Materials and costs
- Services and costs
- Tools
- Information (of neighbours and stakeholder)

Site selection

Determine the most suitable place for the installation: it could be on the ground next to the building, on the façade or on the roof. Additionally, you should consider the static assessment of the building. For the installation on the roof you might need a crane, which causes additional costs.

The ***Planning tool*** of "Our Solartown" helps you to find the best spot for the system. Moreover, you can compare different places and buildings.
The planning tool can be found at the following link:
https://solartown.eu/symfony/public/map/

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More information on the topic can be found in learning unit ***LU 3_2 Site selection***, the ***Implementation Guide*** and the ***Guide for Technicians*** of "Our Solartown".

Obtain Permissions

Before starting the project, you should ask the owner of the building for permission. In most cases, the school is owned by the municipality, but it might be also owned by the provincial or the national government. It would also be relevant to inform the neighbours if the construction will have any impact on their property or themselves.

Legal aspects

Some legal aspects must be considered, depending on the country (see above). You can find more information in the ***Implementation Guide*** and the G***uide for Technicians*** of "Our Solartown".

Materials and costs

Regarding the materials, we recommend buying a "Do-It-Your-Own-Kit" because most of the times, it is a cheaper and much easier option to get the needed materials.
Of course, you can also put together the material yourself. For the construction of a solar collector, you need:

Material	Number per collector
Squared timber for the frame	7 (2 x length, 5 x width)
Wooden plate for the back (if the collector is integrated into the roof)	preferably 4 separate wooden boards
Sheet metal for the back (if the collector is placed on a stand)	preferably 4 separate sheet metal components
Black varnish	approx. 1 l
Insulation material	4 plates
Absorber strips	Depending on the size of the collector (14 are in the kit)
Copper manifolds	2
Glass plate	preferably 4 separate glass plates
Rubber seal	2 x length, 5 x width plus safeguard
Bars for external frames	2 x length, 2 x width
Bars for glass fixation in the centre	3 x width
Nails, screws, solder, rivets	various
Trestles	6
Window cleaner	1
Cleaning paper	1 role
Cleaning cloth	2 - 3

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Services and costs

Some of the work needs to be implemented by a professional. To build the solar thermal system you will need a plumber, an installer and – in case the device is installed on the roof - a crane. This will result in additional costs.

Tools

The building of a solar thermal plant requires some tools (highlighted in the table below). The number of tools is tailored for 10 students. For a larger group, the number is correspondingly larger. In general, it is better to provide a few more tools and to have them in reserve.

Tools	Number for a group of 10 students
Brushes	5
Handsaw	2
Jigsaw	1
Drilling machine	1
Folding ruler	3
Cordless screwdriver	1
Steel wool, attachments for cordless screwdrivers	1-3
Hammer	5
Pliers	1
Screwdrivers, various sizes	1 each
Riveting pliers	1
Soldering iron	1
Blowtorch	1
Soldering paste with brush	1
Rubber hammer	1
Stanley knife	1
(Hand) vacuum cleaner	1
Pencils	3
Glass lifter	2

Information

Even If you do not need permissions, it is still good to inform neighbours and stakeholders about the project.

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Attention! To avoid losing your data in the ***Planning tool,*** please select the place for your plant first and add the necessary data afterwards.

Selecting one of your solar-thermal systems in the ***Planning tool*** you can see the following data:

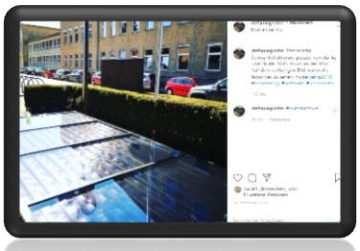
- the name of the plant
- the useful space heated in kWh/a
- the saved greenhouse gases in kg
- the solar coverage

Beyond that, you can see the energy cost in kWh, the cost of the solar thermal plant (if you filled the "preparing" tab) and you can calculate the estimated saved money per year and the return on investment (number of years = cost for solar thermal plant / estimated saved money).

Building:
This page is useful for schools that intend to build a solar-thermal system. Here you can document the building process from start to the end. Add photos, write your thoughts and share your opinion to create articles for the Solartown newspaper!

Activities:
Here you can document all the activities related to the project besides the building of the plant like excursions, posters, presentations, activities, etc.

Tell the world:
Under this section you can document media activities. Please share posts on social media, on bulletin board or any other publications (e.g. local newspapers, TV, radio) and upload print screens, photos or links to videos.



Solartown Newspaper:
Here you can choose the articles to be included in your Solartown Newspaper and created it. You will get a word document, that you can format and edit further.

Award submission:
When you are ready with the documentation of your Solartown project, you can submit your report to participate in the European Solartown Award.

Sources:
https://core.ac.uk/download/pdf/67580662.pdf
https://www.knjiznica-celje.si/raziskovalne/4201004238.pdf
http://www.oekotech.biz
https://www.dnevnik.si/1042771557
https://www.sonnenkraft.com/en/home.html

Pictures:
http://www.oekotech.biz/default.asp
https://www.freepik.com/photos/background'>Background_photo_created_by_rawpixel.com_-www.freepik.com

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LEARNING UNIT 3.2: TEACHING PLAN

Learning Unit 3.1 - Teaching Plan
Solar-thermal system planning installation

In this unit, pupils learn what to consider when planning a solar-thermal system and become familiar with *Solar-thermal Process guide*.

TIME: 45 - 50 min / 90 – 100 min

CLASS ORGANISATION: frontal, group work

METHODOLOGY: discussion, work online, group work

LESSON GOALS:
Goals from the project: Energy

Pupils learn:
- planning how to build solar-thermal system
- how the solar-thermal system works

Additional goals:
- learn how to use *Solar-thermal Process guide*

MATERIALS:
- computers
- worksheets
- posters, markers

INTRODUCTION/MOTIVATION (10 min):
Pupils are divided into pairs and resolve worksheet 1 and 2. The teacher leads a discussion about operating and parts of the solar-thermal system.
Before starting to build a solar-thermal system, good planning is absolutely necessary.
The teacher asks the pupils, what they think are the most important things to consider?
Their ideas are written on a board like a mind map.

Possible answers from the pupils:
- site selection with the most sunshine
- materials
- services to connect the collectors on the house wiring
- tools
- elevator, etc.
- financing

The teacher should remind them about:
- legal aspects
- involvement of the building owner
- informing the neighbours
- permissions needed
- maintaining the collector once it is installed

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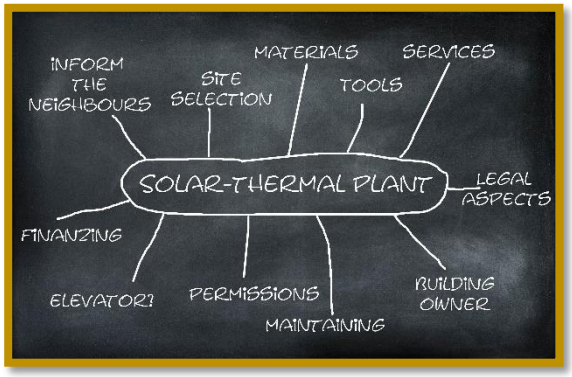
MAIN PART (35min/80 min):
The teacher and the pupils discuss about the mind map on the blackboard. Afterwards the class is divided in 4 groups. Each group will search the internet for information for the different topics.



The topics for the groups are:

1. Materials and tools
2. Permissions and legal aspects
3. Services and maintaining
4. Building owner and information of the neighbours

The **Site selection** with the ***Planning tool*** of Our Solartown is discussed in a separate learning unit ***LU 3_1 Site selection***.

The **Financing** of the solar-thermal plant is the topic of the learning unit ***LU3_3 Financing a solar plant***.

A lot of information about the actual building process of the solar-thermal system you can find in our learning unit ***LU 5_1_Practical realisation***.

At the end of the exercise, the different groups report their results and the class discuss about the different topics. You can use the content of the Preparing page of the Process Guide to compare the results.

The Process Guide of Our Solartown:

If the class wants to submit their Solartown project for the ***Solartown award*** and/or wants to build a solar-thermal plant, the teacher shows to the students the different pages of the ***Process guide***. A registration is necessary to start the process guide the first time.

In the ***Process guide***, choose ***Preparing***. Pupils can compare what they wrote on the table and work on with the content of the Process guide.

You can create articles for the Solartown newspaper (see also ***LU 4_2 Solar newspaper***) about the topics you learned, the building progress of your plant, the public relations work and other activities you have undertaken in the framework of the project. Moreover, you can document all the preparation needed to build the plant and calculate the costs, saved money per year and the return of investment.

ASSESSMENT (5min):

You should proceed with the ***LU3_3 Financing*** in next teaching lessons. Before the pupils complete the ***Preparing site*** in the ***Process guide*** you should choose one of the planed solar-thermal plants in the ***Planning tool.*** **Otherwise all the data in the preparing page will get lost!**

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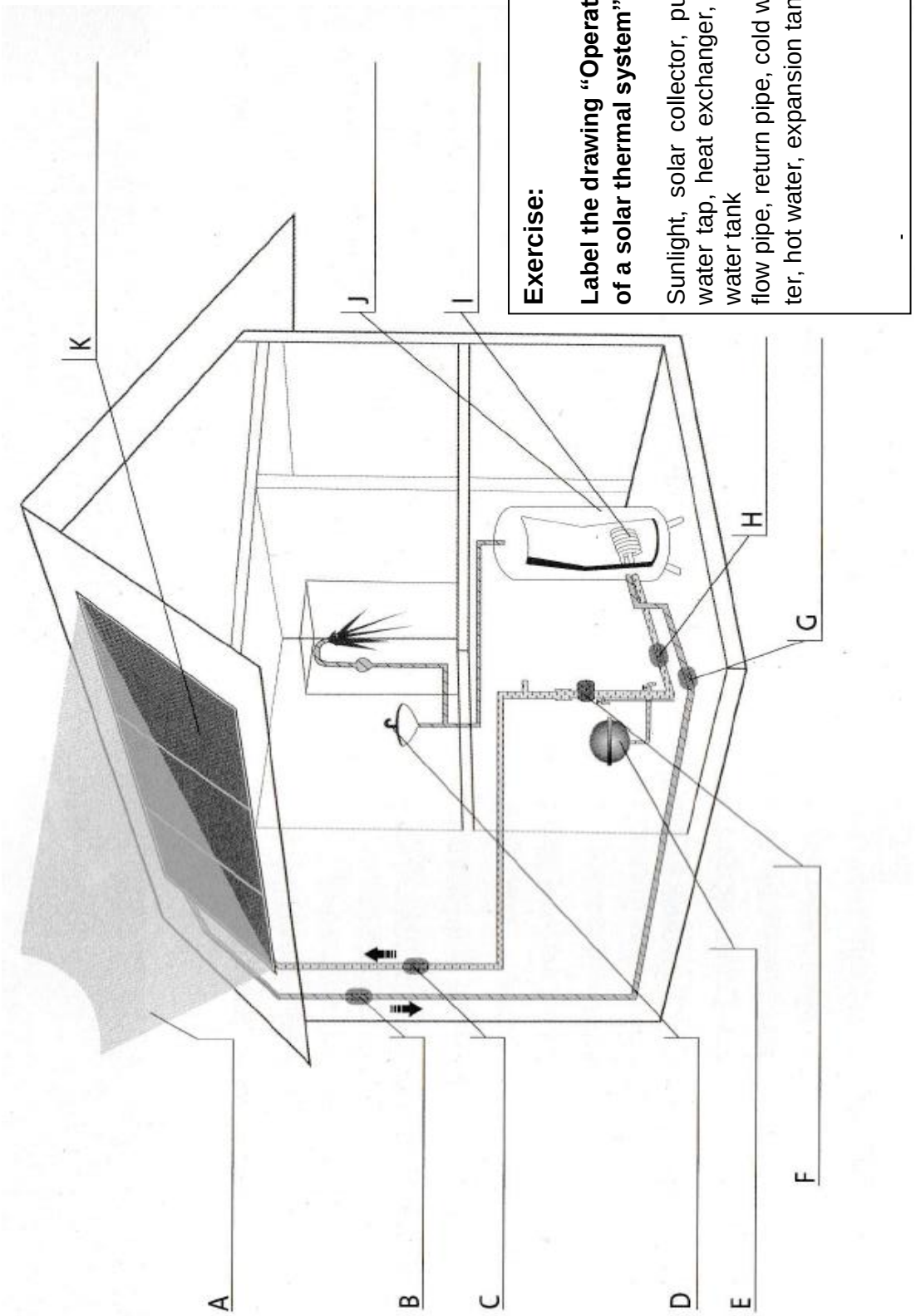
Learning unit 3.2 - Worksheet 1

Operation of a solar thermal system

Exercise:

Label the drawing "Operation of a solar thermal system":

Sunlight, solar collector, pump, water tap, heat exchanger, hot-water tank
flow pipe, return pipe, cold water, hot water, expansion tank



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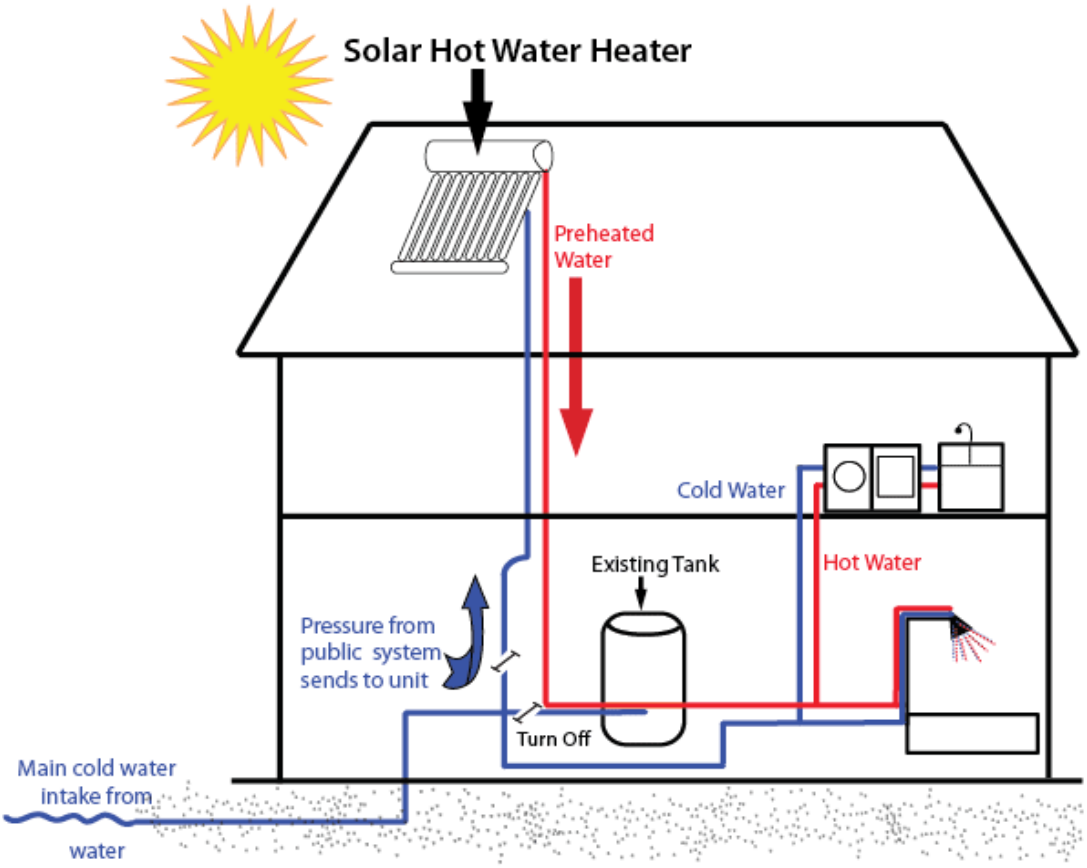
Learning unit 3.2 - Worksheet 2

How does a solar thermal system work?

Look closely at the picture and number the sentences in the correct order!



No.	Sentence
	At the bottom of the absorber sheet a bent tube is fixed.
	The sun rays penetrate through a glass sheet into the interior of the collector.
	Then the hot liquid is transported by a pump in a tank.
	There the sun rays hit a black-painted flat solar absorber made of sheet metal and heat it up.
	The cooled liquid is pumped back into the collector.
	This tube contains a liquid, which is heated via the sheet metal.
	The cold water is heated in the tank. You can use the warm water to shower or wash the dishes.

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Contacts:

WEBSITE: https://solartown.eu/

NATIONAL CONTACTS:

akaryon GmbH, Austria

Website: http://www.akaryon.com/

Climate Alliance Austria

Website: http://www.klimabuendnis.at/

Solar Heat Europe/ESTIF

Website: http://www.solarheateurope.eu/

KPE Pertouliou Trikkeon, Greece

Website: https://blogs.sch.gr/kpepertoul/

VseUK Institute, Slovenia

Website: http://www.vseuk.si

CONTACTS: SOLARTOWN.EU

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