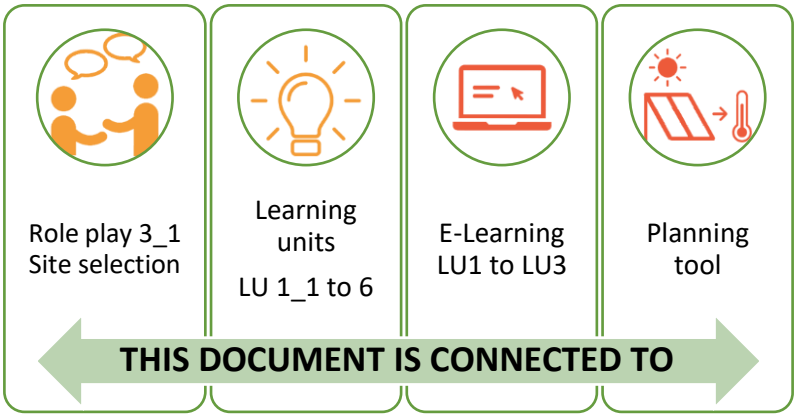
Our Solar Town

Learning Unit 3.1

Site selection



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Learning Unit 3.1 - Learning Plan

Site selection for a solar thermal system

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 in 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 reducing the carbon footprint on the environment because solar thermal is a renewable energy source and does not burn fossil fuels.

Before you start to build a solar thermal system, a good planning is necessary. The first step is to find and chose the best location, but there are also other aspects to keep in mind:

What should be taken into account before installing a solar thermal system?

- Determine the most suitable place for installation
- Find out the proper position and orientation of the solar collectors according to the sun
- What kind of solar thermal system do you want to build? Get familiar with the structure of the chosen solar thermal system (see ***Learning Unit 3.2_ Solar thermal system_planning installation***)
- Consider some legal aspects before installation, depending on the country (see ***Learning Unit 3.2_ Solar thermal system_planning installation***)
- Do you want to build a plant on your own? The ***Learning Unit 5_1_Practical realization*** helps you with the implementation in practice, the ***Process Guide*** might help with the planning and documentation

How to find the most suitable place for the solar thermal system

The use of solar heat in buildings is very common. A solar thermal system can have different sizes, starting with smaller systems for single-family houses and medium sized systems for bigger houses, municipal buildings, or commercial buildings. It can also be used for the supply of hot water or space heating in colder regions - or for a combination of both.

To find the best spot you have to answer the following questions:

- Where is the hot water needed?
- How much hot water is needed? This depends on the number of people and the use (hot water, space heating or both)
- Where to find adequate space to install the system?
- Where do I have a good orientation towards the sun?
- Where is a good spot for the solar thermal system to easily connect it to the existing installation of the house

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The ***Planning tool*** of “Our Solartown” helps you to find the best spot for the system. Moreover, you can compare different places and buildings.

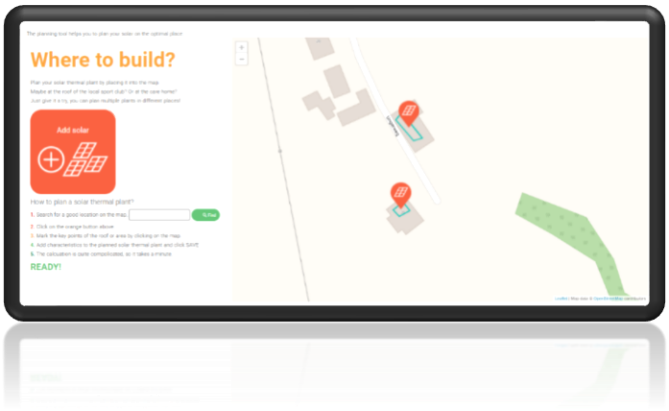
The planning tool can be found at the following link:

https://solartown.eu/symfony/public/map/

The *Planning tool* of Our Solartown

To find the best spot for your solar thermal system it is a good idea to compare different locations. The ***Planning Tool*** of Our Solartown can help you with your search and decision.
Before starting to work with the Planning Tool you have to log in to the ***Process Guide*** and choose the ***Planning Tool*** on the top of the website.
If you want to plan a solar thermal system you have to:

1. Search for a good location on the map
2. Click on the red button “Add solar”
3. Mark the key points of your plant on the map by clicking on the chosen area
4. Add the characteristics of your plant and click “Save”
5. The calculation is quite complicated, so it might take a minute.



1. Search for a good location on the map

A good location could be the roof of a building, e.g., the school building, where the collector could be installed in-roof or tilt mounted on the roof.
Another choice could be to build a freestanding collector next to the building, where the water is used.

Freestanding solar thermal plants supporting the local distance heating (Austria).

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2. Click on the red button “Add solar”

Now you can move to step 3.

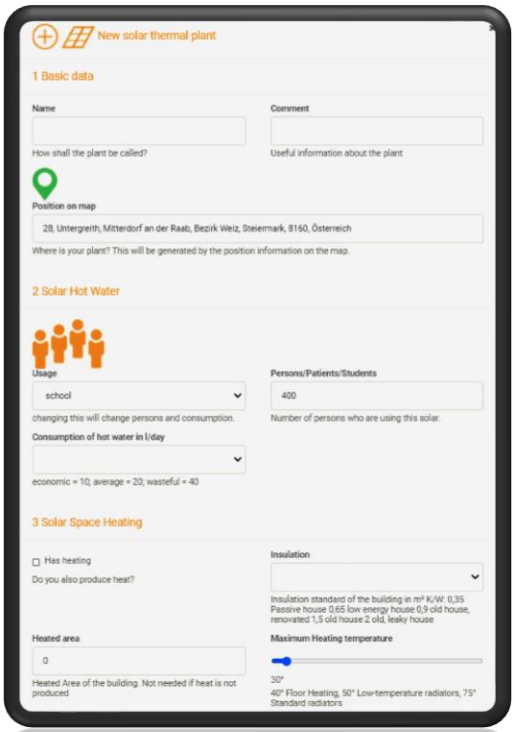
3. Mark the key points of your plant on the map by clicking on the chosen area

Once you found the right location you can mark the corner point of your solar thermal system. By adding the last point, a window will pop up where you can continue with the next step:

4. Add the characteristics of your plant and click “SAVE”

You have to fill in some data about your new solar thermal plant:

- **Name** of the plant
- Useful information about the plant (**Comment**)
- **Position** (will be added automatically)
- **Usage** (Type of building)
- Number of **persons** who are using this solar.
- **Consumption** of hot water in l/day (economic, average, wasteful)
- **Heating**: Do you also produce heat?
- **Heated area**
- **Insolation** of the building
- **Maximum heating temperature**
- **Available roof area in square meter** (Area based on drawn plant)
- **Collector area in square meter**
- Orientation of the solar = **Azimuth**
- Angle of the solar = **Inclination**
- **Energy source for heat** in the building
- **Price of currently used energy source in €/kWh**
- Information about the **building ownership**
- **When was the existing heating and warm water system erected?**
- **Comment** (on the ownership)
- **Overall rating of house ownership**



The calculation is a little bit complicated, so it will take a minute to get your results.

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The results

The ***Planning Tool*** will show the different results in the table below. Also, you can organise your projects by absolute, by person or by area.

Result table "*Your solar thermal plants*":

The result table of your solar thermal plants shows the following data:

- Saved greenhouse gases (GHG) in kg
- Heat demand total in kWh/a
- Useful heat total in kWh/a
- Excess heat total in kWh/a
- Specific collector output in kWh/m²
- Solar coverage in %
- Excess/Useful
- Rating of ownership
- Water usage type
- Insulation

To make the planning a little bit more intuitive, traffic light quick evaluations are shown in some columns.
You can experiment in your class to improve the results by editing the existing information and trying to change some input data.

Definition and connection between input and results:

Saved GHG in kg

GHG is short for greenhouse gases, so all emissions that impact the climate crisis. When energy is converted, greenhouse gases are produced, especially CO_2.

This **result** shows how much greenhouse gas is saved by replacing the current energy source with solar thermal energy.

Influenced by input values for	2) Solar Hot Water 3) Solar Space Heating 5) Energy price
Can be optimised by	4) Collector area in square meter
Target value	Value should be high.
Additional	Biomass has a lower value than solar thermal energy, so no greenhouse gases are saved when this energy source is replaced.

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Heat demand total in kWh/a

The **heat demand** indicates how much thermal energy is required for heating and hot water supply. It thus indicates a quantity of energy, or more precisely: a quantity of heat.

This **result** shows how much heat is required for the entered project.

Influenced by input values for	2) Solar Hot Water 3) Solar Space Heating
Can be optimised by - short term	2) Solar Hot Water Change of habits: Economic consumption of hot water.
Can be optimised by - long term	3) Solar Space Heating Improve the insulation of building.
Target value	Value should be as close as possible to the solar useful heat value.

Useful heat in kWh/a

Solar **useful heat** is the heat that is actually used for hot water and heating. If the storage tank is already hot and no hot water is needed, the solar heat can no longer be used (surplus).

This **result** shows to what extent the heat supply corresponds to the heat demand.

Influenced by input values for	1) Basic data 2) Solar Hot Water 3) Solar Space Heating 4) Solar plant The larger the collector surface, the greater the yield of useful solar heat.
Target value	In Central Europe, well-dimensioned collectors can cover a part of the heat demand (hot water over 60%). If one were to aim for 100% coverage, the collector surface and storage tank would have to be huge, which makes neither ecological nor economic sense. Oversized systems provide a lot of surplus in summer and, in the absence of sunshine, too little solar heat is still generated in winter. Therefore, when planning a system, a compromise is made between solar benefits and system size.
Additional	The building types include consumption profiles for hot water (i.e., when how much hot water is needed) and typical building data for heating. The heating requirement is calculated from the climate data. The solar energy supply can also be determined from the inclination and orientation of the collector surface. By comparison with the heat demand, the solar useful heat (and the solar surplus) is calculated.

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Excess heat total in kWh/a

The solar **excess heat** is the heat that is **not** used for hot water and heating of the building. Normally, the hot collector releases it back into the ambient air. It would only be useful if the heat could be fed into a local or district heating network.

This **result** is the difference between heat demand and solar useful heat, two processes that take place at different times.

Influenced by input values for	1) Basic data 2) Solar Hot Water 3) Solar Space Heating 4) Collector area in square meter The smaller the collector surface, the less excess heat is generated.
Target value	Surplus should be as small as possible if not fed into district heating.
Additional	Excess heat occurs when the storage tank has already reached its maximum temperature and the collector could still supply heat through solar radiation. Suitable safety devices ensure that the high excess temperatures remain harmless.

Specific collector output in kWh/m²

The **specific collector output** shows the solar useful heat per m² of collector area for a whole year in the unit kWh/m²/year.

This **result** shows the yield that can be expected per m² of collector surface with the specified location, orientation and inclination. Shading is not considered in the tool.

Influenced by input values for	1) Basic data 2) Collector area in square meter The larger the collector surface, the smaller the specific collector yield.
Can be optimised by - short term	Orientation of the solar Angle of the solar Avoid shading on the solar
Target value	Value should be as high as possible.
Additional	The global solar radiation varies from place to place and is already stored in the tool depending on the site. The specific collector yield is also dependent on the construction of the collector, the values for the kit used were stored.

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Solar coverage in %

The **solar coverage** ratio indicates the percentage share of solar useful heat in the total demand for hot water or, in the case of partial solar heating, for space heating plus hot water. Solar coverage is often used as a parameter in planning.

Attention! Depending on whether pure hot water systems or systems with partial solar heating are chosen, different **results** are obtained.

Influenced by input values for	1) Basic data 2) Solar Hot Water 3) Solar Space Heating 4) Collector area in square meter The larger the solar plant, the higher the solar coverage.
Can be optimised by - short term	Wasting less water! Lesser hot water consumed means higher solar coverage.
Target value	If only hot water is produced, more than half of the energy requirement should be covered by solar energy. With partial solar heating, the solar coverage ratio is usually much lower and depends strongly on the climate and the building insulation.
Additional	The aim is to achieve maximum coverage with the solar thermal system but it can lead to energy surpluses (losses) in summer. Increasing the coverage can be more expensive and complex. On the contrary, systems with a low degree of coverage can use (almost) all the collector energy in summer. An additional heat source can compensate deficits and the system will be more cost-effective. The concept is mainly used for large-scale solar thermal plants, where the main focus is on economic efficiency. A higher solar coverage ratio is recommended for piece wood heating so that no heating is required in summer. The compromise solution is a need/cost optimised system. It is used for small systems (detached house) for solar thermal hot water. With a solar coverage rate of 70%, the hot water requirement can be covered in summer and the boiler can remain cold.

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Excess/Useful

The ratio of surplus to useful heat is a guideline for the planning of the solar thermal system. Assuming a given energy requirement, a larger solar thermal system naturally supplies more solar useful heat, but it is becoming increasingly common, especially in summer, for the storage tank to be full and for the system to produce a surplus.

The value indicates what proportion of the heat generated can actually be used.

Influenced by input values for	1) Basic data 2) Solar Hot Water 3) Solar Space Heating 4) Collector area in square meter
Can be optimised by - short term	Size of solar plant.
Target value	Value should be as low as possible.

Water usage type

Hot water consumption: Subjective assessment of the consumption habits of the people using the building (economic, average or wasteful).
The value shows directly which consumption habit was chosen.

Influenced by input values for	2) Solar Hot Water Consumption of hot water.
Can be optimised by - short term	2) Solar Hot Water Change of habits: Economic consumption of hot water.
Target value	The value should be selected as low as possible ("green"). But it should be remembered that in practice this requires self-discipline of all building user. Saving on the consumption is more ecological than tuning the solar yield. Doing both will increases the effect exponentially.
Additional	This traffic light shows that the personal behaviour of the building users* has an influence on the heat demand. A larger solar installation would also give a better result in the ratio of surplus to useful heat if the use of hot water is higher - even if not sustainable. The first priority is to reduce consumption: In the case of hot water by better controlling the use (taking a short shower instead of a full bath, not letting hot water run off carelessly, ...), in the case of space heating by improving building insulation.

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Insulation

The insulation is made up of the different components of the insulation structure and building elements and is measured with the **heat transfer coefficient**, which is given in m² K/W.

The value directly indicates the insulation standard of the house that has been chosen.

Influenced by input values for	3) Solar Space Heating Insulation
Can be optimised by - long term	Improve insulation of building
Target value	Value should be green.
Additional	The lower the value, the better the house is insulated, and the less heat is lost. **Note**: A better insulated house means that less energy is required. As a result, the specific collector yield becomes smaller and the surface should/can be reduced. It must also be considered that less heat is required from the auxiliary heating system, which is also good for the environment. Insulation is key for a better result.

Rating of ownership

Self-assessment of the building to take into account manifold other factors that influence the site. Some, like the interest of the owner and the age of the heat system, are mentioned, others can also be taken into account and added into the comment field.

Rating is given by the user and shown without any calculation.

Influenced by input values for	6) Building ownership
Can be optimised by - short term	Orientation of the solar Angle of the solar Avoid shading on the solar
Target value	Should be green, ideally.
Additional	This parameter is included to show pupils that decisions cannot only be based on scientific-mathematical numbers, but also the human factor is key for the success of projects.

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Optimisation

The optimisation of a solar system is therefore a compromise solution:

A larger collector surface causes a:

- Higher solar coverage
- Higher solar useful energy

... that's what you want...

but at the same time also

- More surplus, higher surplus/benefit ratio
- Lower specific collector yield

... your system is oversized and more expensive.

Solution:
Weigh up solar coverage, useful energy, specific collector yield on the one hand (should be as high as possible) and surplus, surplus/benefit on the other (as low as possible).

Generate the ranking

The ***Planning Tool*** cannot decide on its own which of the planned project is “best”, as there are very different criteria to take into account. This needs at least two planned projects. The tool can “only” provide numbers to compare, so that the decision will be fact-based.
The ranking table can simplify the process:

Three criteria are shown, and the class should decide and explain, what is more important between

With this selection:	The system needs to provide …
Saved GHG	… the biggest impact on the climate crisis.
Solar coverage	… the best fit between heat demand and useful heat.
Ownership rating	… the biggest chance to have a long-lasting life.

Add the outcome to the 3 criteria and click “Rank” – a new column is shown in the result table that shows the ranking.

Select a project

If you have ranked a project and you are done with your planning, click on the Solartown-Logo in the first column to select the project. The values of this solar thermal plant will then be included into the process guide.

Appendix

The rules for the interpretation are valid for Central Europe with an annual global radiation sum of approx. 1100 kWh/m²/a.

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Learning unit 3.1 - Teaching Plan

Site selection

In this unite, pupils determine the most appropriate location for installation using the ***Planning Tool*** of Our Solartown. The pupils realise that there are many influencing factors to choose a good site for the solar thermal-system. Tools can help to provide facts, but the final decision is based on weighing these facts in a group discussion.

TIME: 45 min

CLASS ORGANISATION: frontal, group work

METHODOLOGY: discussion, work online with the ***Planning Tool***

LESSON GOALS:
Goals from the project: Energy
Pupils learn:

- calculating daily consumption of hot water at school

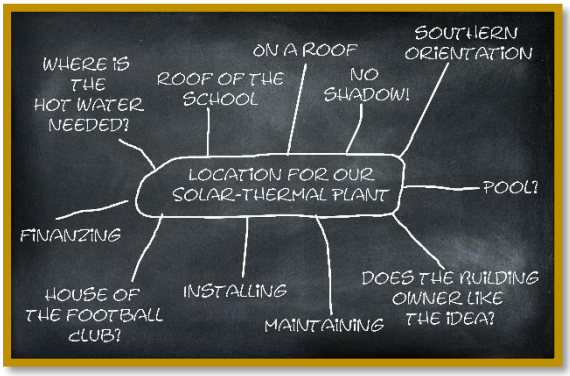
Additional goals:

- learn how to use the ***Planning tool*** of Our Solartown
- learn which factors can influence the site selection

MATERIALS:

- computers, projector

INTRODUCTION/MOTIVATION (15 min):
The teacher gives a short introduction to how solar panels work and discusses possible locations with the pupils. Their ideas can be written on a board like a mind map.



Afterwards the pupils should complete the ***Worksheet*** of this learning unit. The worksheet has the same questions needed to create a solar thermal plant in the ***Planning Tool***. As these questions need some research the pupils are divided in smaller groups (as many groups as solar projects will be planned) and asked to find answers to these questions. Worksheet 1 you can find below.

MAIN PART (30min):
The teacher explains the use of the ***Planning tool*** to the pupils. You have to register and/or log in first.

The groups present their locations and complete the data for their project. The other groups can watch via the projector.

1. Directly on the ***map*** or writing in the search area, they select the town where the solar thermal system should be built, then enlarge the map to find the building or location.
2. Klick on ***+Add your Solar*** and determine the area of possible construction.

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3. The group answers the questions required with the information from the worksheet. After that, klick ***Save***.

4. *The* ***Planning tool*** needs some time to calculate

5. Then the next group chooses their location following step 1 to 4 until the solar thermal systems of all groups are added. All planed solar thermal systems will appear in the table "***Your solar thermal plants***".

6. The teacher explains the table and the calculated values.

7. The class discusses the ranking. Three criteria are shown and the class should decide and explain, how they want to weigh the results in these

With this selection:	**The project is favored which has …**
Saved GHG	… the biggest impact on the climate crisis.
Solar coverage	… the best fit between heat demand and useful heat.
Ownership rating	… the biggest chance to have a long-lasting life.

8. Add the outcome to the 3 criteria and click "Rank" – a new column is shown in the result table that shows the ranking.

ASSESSMENT (5min):

Based on all findings the pupils suggest the best location for installing a solar thermal system. The teacher leads the discussion whether a connection to the existing installation is possible and how useful this location is.

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LEARNING UNIT 3.1: WORKSHEET

Learning unit 3.1 – Worksheet

Planning a solar with the *Planning Tool* of Our Solartown

Name of the solar: _____

Comment/ Useful information about the plant: _____

_____

Site (the exact position and size is calculated in the *Planning Tool*):

_____

Usage:

☐ School ☐ Sport facility ☐ House ☐ Multi-family house

☐ Hospital ☐ Care home ☐ Restaurant

Number of people who are using this solar: _____

Consumption of hot water in litre/day _____

☐ Economic ☐ Average ☐ Wasteful

☐ Do you also produce heat? ***If not, no further input is needed in this section!***

Heated area in m^2? _____

☐ Is the hot water connected to heating?

Insolation:

☐ Passive house ☐ Low-energy house

☐ New house ☐ Old renovated house

☐ Old house ☐ Old leaky house

Insulation standard of the building in m^2 K/W: 0,35 Passive house 0,65 low energy house 0,9 old house, renovated 1,5 old house 2 old, leaky house

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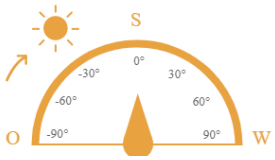
Maximum heating temperature: _____

40° Floor Heating 50° Low-temperature radiators 75° Standard radiators

Available roof area in in m²: _____

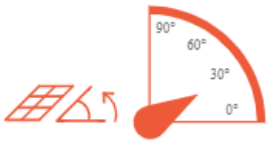
Collector area in m²: _____

Azimuth/Orientation of the solar: _____



0° = South

Inclination/Angle of the solar: _____



How is the hot water heated?

☐ Oil ☐ Gas ☐ District heating

☐ Biomass ☐ Electricity ☐ Solar thermal system

What is the current price of this energy source per kWh in €? _____

☐ Is the owner interested in erecting and maintaining the solar thermal plant?

☐ Is a renovation planned?

When was the existing heating and warm water system erected?

☐ < 5 years ☐ < 15 years ☐ > 15 years

Comment on Building ownership: _____

_____

_____

Your overall rating of house ownership?

☐ Good choice ☐ Medium choice ☐ Bad choice

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Contacts:

WEBSITE: https://solartown.eu/

CONTACTS: 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

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