



STEAM4Climate Worksheet for students

Project: Sustainable housing

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1. Laying the foundations

The goal of this project is to use the design strategy of embedding solar panels to make a building sustainable.

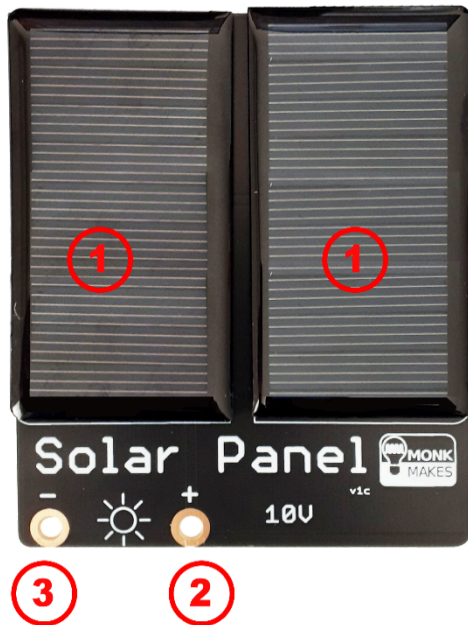
Before starting the hands-on work, discuss with your team what a solar panel does, and why it can be considered as a design strategy to help make buildings sustainable. You can search information online and document your answers below:

What does a solar panel do?

2. Step-by-step exploration

Creating the Circuit and observing the results

In this project, you will create a series of simple electrical circuits using a solar panel as a power source.



The solar panel contained in the STEAM4Climate toolkit has two photovoltaic (PV) cells **(1)** that harvest solar energy, thus converting sunlight into electricity. It also has two terminals for connecting the solar panel to other components or devices. The positive terminal + **(2)** is the voltage which supplies the electricity and the negative terminal – **(3)** is the ground.

Activity 1: How does a Solar Panel work and what parameters affect its efficiency?

Take the LED light from the STEAM4Climate toolkit and connect it to the Solar Panel by using two alligator clips.



Then try to do some of the followings:

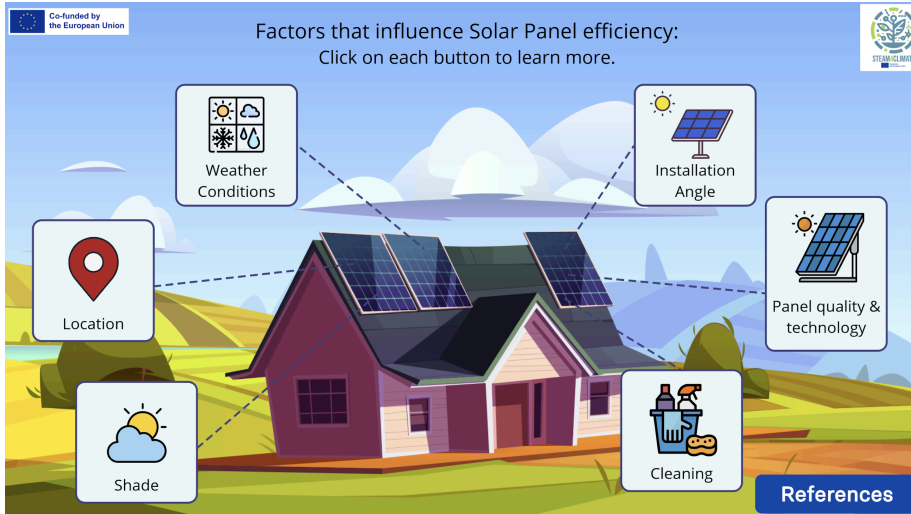
- move the circuit to different locations inside or outside the classroom
- change the orientation of the solar panel towards (or away of) the sun and its tilt angle
- partially or completely block direct sunlight by placing objects that act as shades
- add some dirt (e.g. leaves, soil) to the photovoltaic panels

Observe if and how the efficiency of the solar panel is affected by the above actions.

Note: Observe how dim or bright the light of the LED light is to see if the effectiveness of the solar panel is affected.

Check this [interactive animation](https://project-spaces.eu/learningcontent/steam4climate/scenario2/story.html)¹, which is also available and accessible through QR code to help you explore factors that affect the efficiency of the solar panels.

¹ <https://project-spaces.eu/learningcontent/steam4climate/scenario2/story.html>



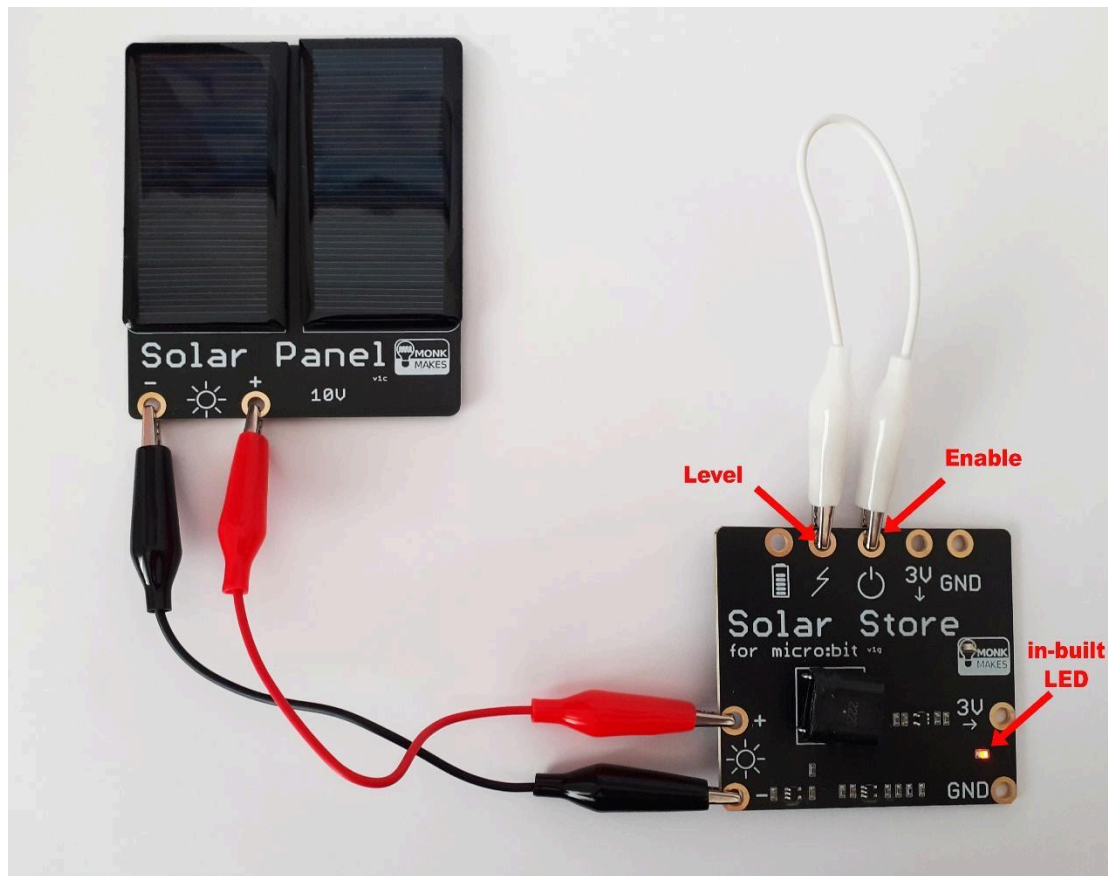
Use the following table to document your observations

Factor	Observation
Change of location	
Change of orientation or/and tilt angle	
Blocking direct light	
Adding some dirt	

Activity 2: How can solar energy harvesting be more efficient?

Even though the setting of the previous activity can use the harvested solar energy to light up a LED light, this solution has a major drawback. It can only work during the day because the harvested energy is directly used by the LED light and it is not stored to be used at any time. To create such a system you need to use a Solar Store component.

Find this component on the STEAM4Climate toolkit and connect it to the Solar Panel as shown in the image below (i.e. by respectively connecting the + and – terminals of the Solar Panel to the + and – terminals of the Solar Store, and by connecting the Level terminal to the Enable terminal of the Solar Store, so that the circuit works in stand-alone mode).



Try exposing the Solar Panel to sunlight (or another light source) and see whether the in-built LED lights up and how long it takes.

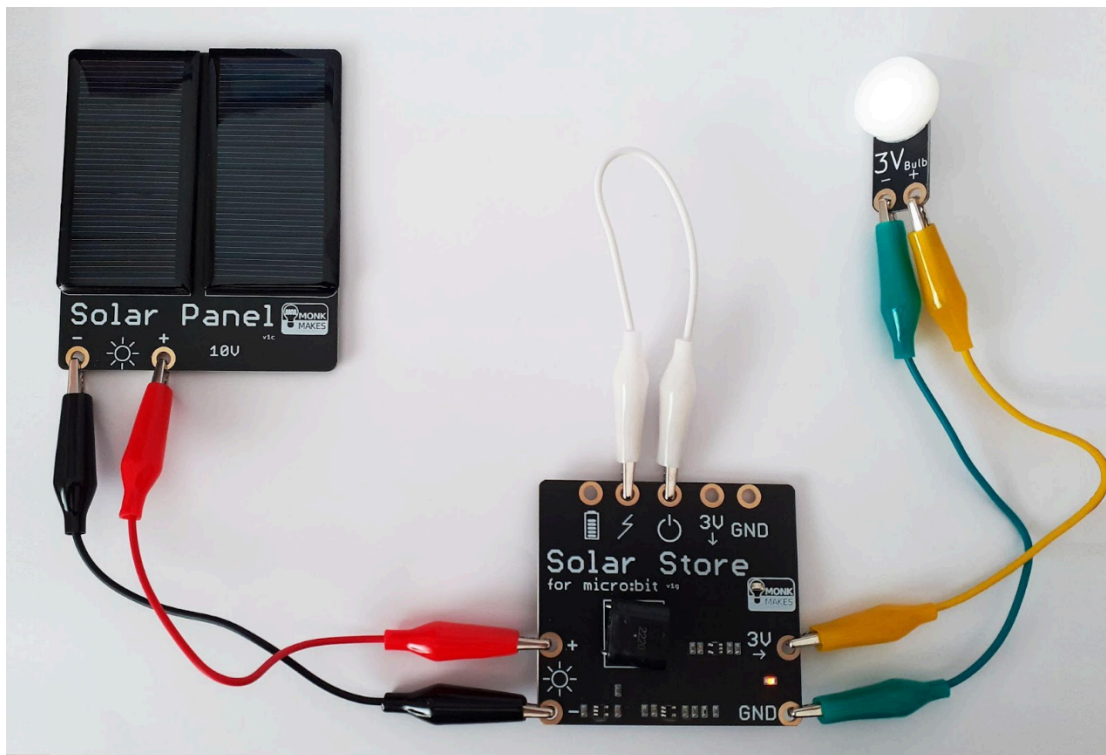
Note: the in-built LED indicates whether or not the Solar Store has enough energy to power a connected device.

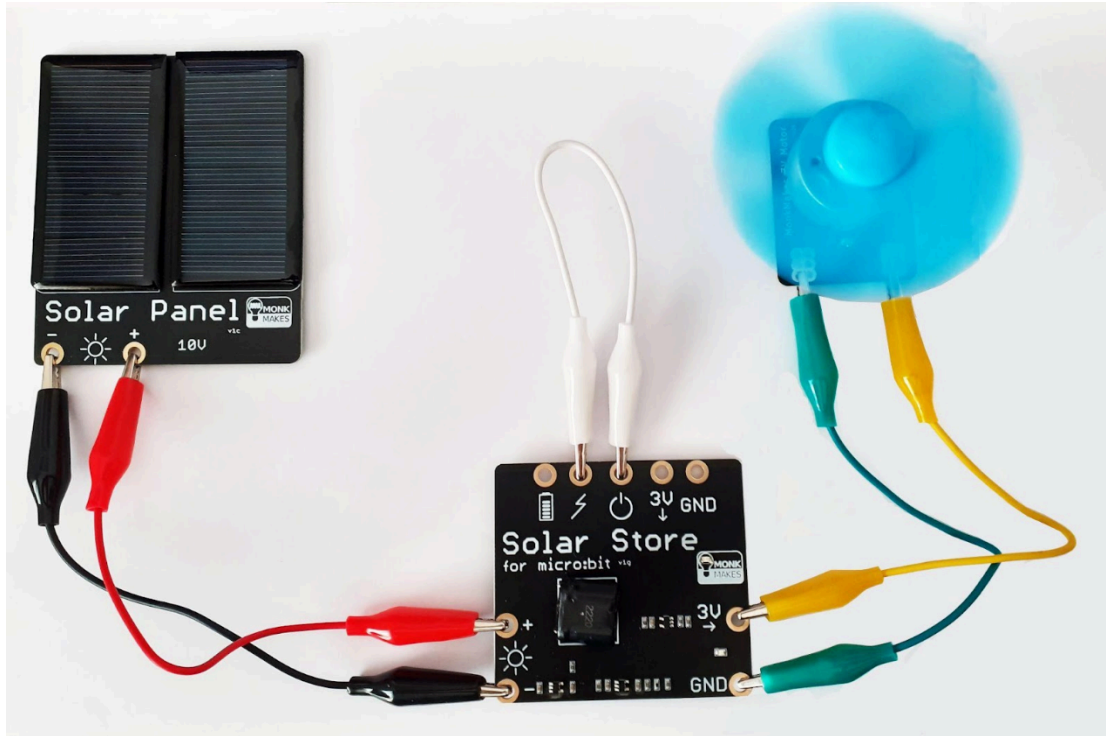
Use the following table to document your observations

Source of Light	In-built LED lights up	Time needed for the in-built LED to light up
-----------------	------------------------	--

Direct sunlight	YES/ NO	
Indirect sunlight	YES/ NO	
Torch		
...		

Now connect the LED light or the DC motor as shown in the following images and observe how long it takes for these devices to consume all the stored energy.





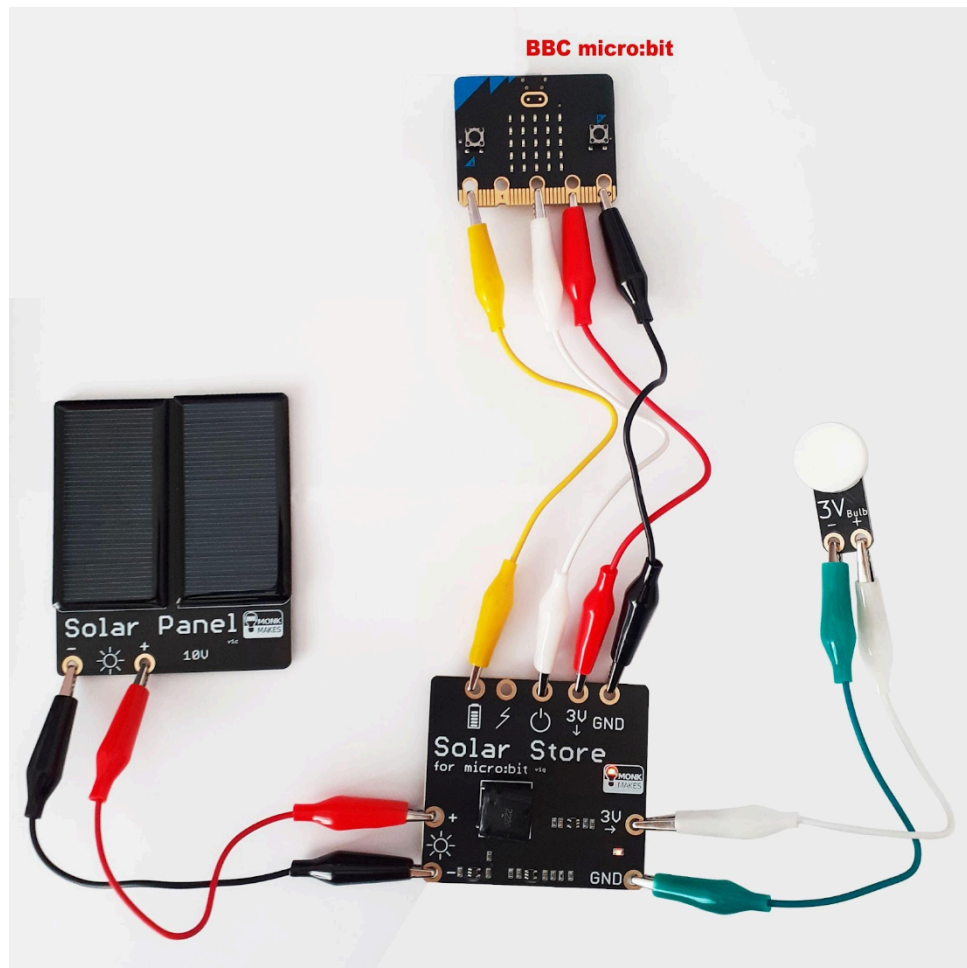
Use the following table to document your observations

Output Device	Time needed for consuming the stored energy
LED light	
DC motor	

Activity 3: Using the stored solar energy wisely

The solution of the second activity is more efficient than the solution of the first activity. However, the stored energy is used every time the solar store is fully charged. The optimal solution would be to create a system that uses the stored energy only when it is needed. To create such a system, take the BBC micro:bit board from the STEAM4Climate kit and connect it to the circuit of the 2nd activity, which uses the LED light component, as shown in the image below.

Note: By connecting the Charge% terminal to the P0 pin of the micro:bit, the micro:bit has access to the stored solar energy. This stored energy is distributed to the circuit when the Enable terminal is activated. The Enable terminal is connected to the P2 pin of the micro:bit. Therefore, when the P2 pin is pressed ($P2 = 1$), it allows the distribution of the stored solar energy to the circuit.

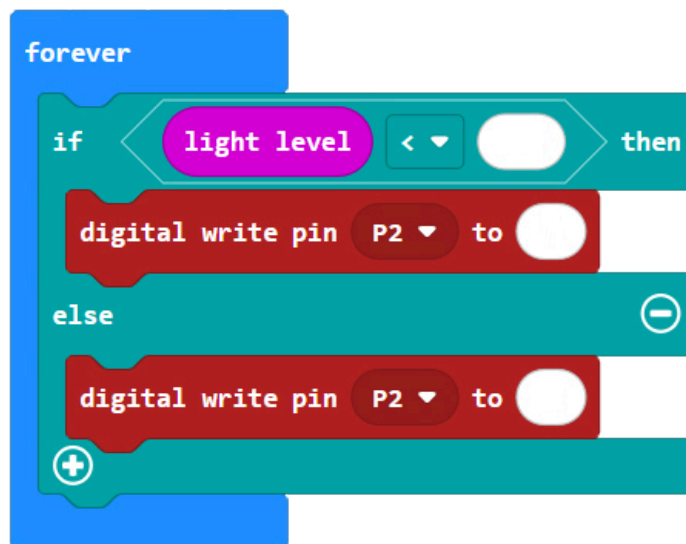


Now, let's program the micro:bit to use the stored energy to turn on the LED light, only when the detected ambient light is low (i.e. it's getting dark in the room). The level of the ambient light can be detected by using the built-in light sensor of the micro:bit (i.e. the LED display).

Let's open the Microsoft Makecode environment (<https://makecode.microbit.org/>) to program the micro:bit. ht

The following script is semi structured. Fill in the missing values to activate the Enable pin (i.e, P2), when the light level is below a certain threshold.

Note: By default, the light level ranges from 0 (dark) to 255 (brig).



Experiment with different light levels to find one that best suits the needs of the system being designed.

What are the benefits of this third solution? Can you think of other solutions that would make the system even more efficient?

You can write your thoughts and ideas here:

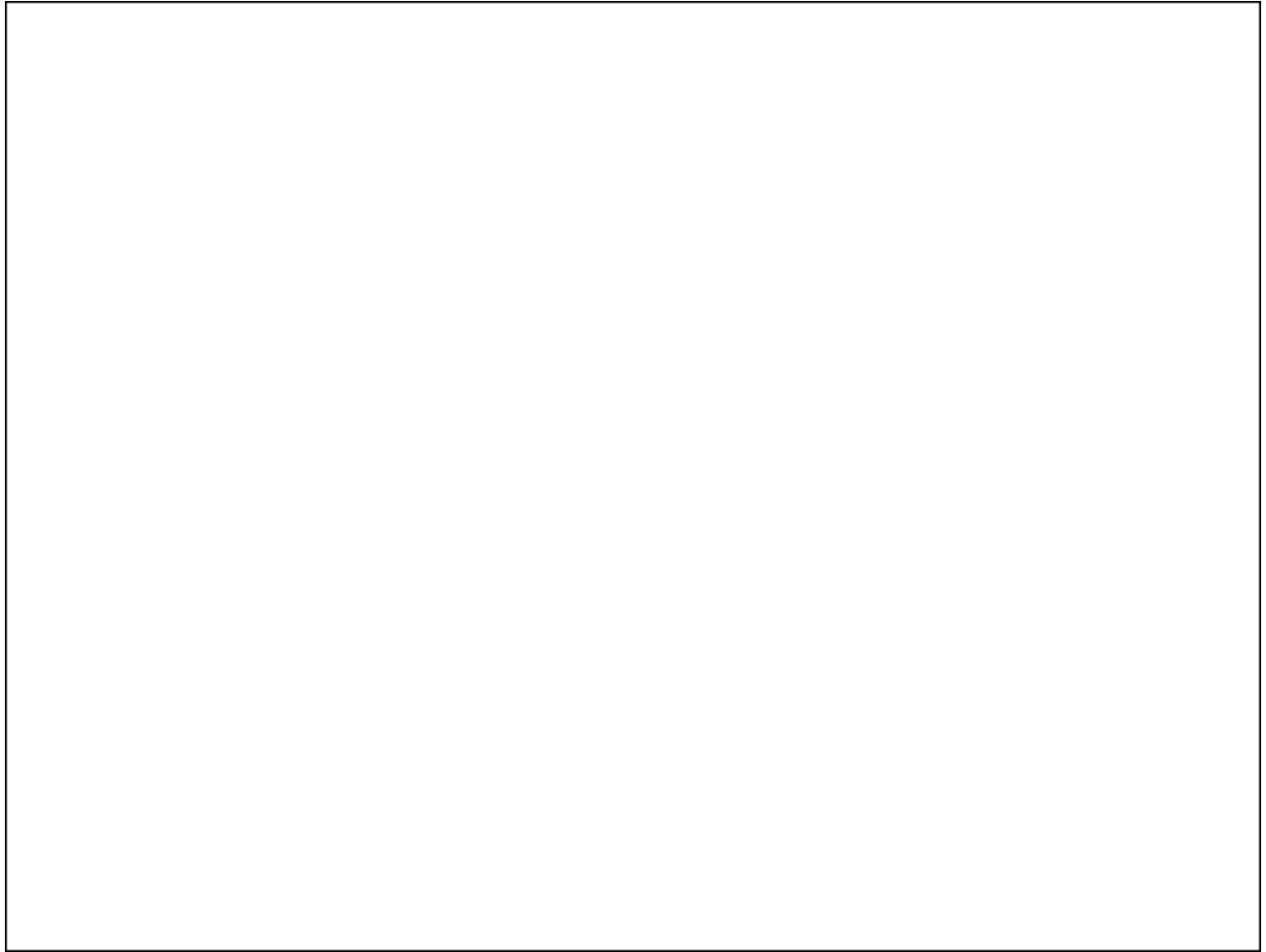
Activity 4: Unlocking the Crafting Process

Decide with your team which building you would like to create and how to embed the solar system into it (e.g., create the paper model of the school building and embed the system to light up a classroom).

Project Title:

.....

Sketch your model design below:



List the materials or everyday objects you'll need to bring your project to life:



Now it's time for some hands-on practice! Once your construction is complete, don't forget to take a picture or a short video. You can upload these to the STEAM4CLIMATE project repository with the help of your teacher(s).

Reflective questions

Take a moment to reflect on your project by answering the following questions:

- What was your project about?
- What new things did you learn during this process?
- How does this experience connect to the issue of climate change?
- What are your future plans or ideas for continuing this project?

Going-public Activity (Optional): Consider using your answers to create a poster that summarizes your project experience. You can also explore together with your teacher(s) opportunities to present your project to the public or your school community.

Extensions: Wind & Solar Together

In this optional activity, you will explore two different renewable energy sources—wind and solar—and think about how they can work together in a single system. **Design or sketch a model that integrates both wind and solar power.**

Consider how the wind turbine and solar panels can complement each other to maximize energy production and reflect upon the following questions:

- What are the advantages of using both wind and solar power in a single system?
- How could this system be used in real-world applications (e.g., homes, schools, or public spaces)?

Sketch your design below

visit

<https://project-spaces.eu/s4c/steam4climate-toolkit/steam4climate-toolkit-sustainable-housing/> or scan the QR code.

