UNIT 9: Solar Energy

This unit is comprised of 2 activities which are outlined in table 9.1. These activities have been informed by the ENERGE Energy Literacy Framework. A guide to the ENERGE Energy Literacy Framework can be found in UNIT 0. **Unit 9: Solar Energy** investigates the power of the sun as a renewable source of energy and explores the practicality and cost-effectivity of solar as a renewable source of energy to generate power in any one region. Students engage in a number of hands-on activities that describe solar energy and how to calculate the amount of solar energy available at a given location and time of day on Earth using GIS tools. Students also have the opportunity to construct and test their own model solar water heater. In particular, the energy literacy outcomes, the associated skills & competencies addressed and how the activities link to the national curricula are outlined in tables 9.2-9.4.

OVERVIEW of UNIT 9 Solar Energy

Table 9.1 Activities and titles are given, the time required to complete the activity and the ISCED classification.

	Activity Title	**Estimated time (min)**	**Level**	
			ISCED 2	**ISCED 3**
Activity 9.1	Harvesting Solar Energy	45-60	X	X
Activity 9.2	How Efficient is Solar Energy ?	45-60	X	X

Activities Mapped to Subjects in National Curricula

Table 9.2 Activities are mapped to subjects in National Curricula.

	Science	**Technology & Informatics**	**Engineering**	**Mathematics**	**Home Economics**	**Geography**	**English**	**Design & architecture**	**Civics & politics**	**Society & Health**	**Business & Economics**
Activity 9.1	**X**	**X**	**X**			**X**		**X**			
Activity 9.2	**X**	**X**	**X**	**X**				**X**			**X**

Activities Mapped to Energy Literacy Characteristics

Table 9.3 Activities are mapped to Energy literacy Characteristics.

	C1	C2	C3	C4	C5
Activity 9.1	**X**		**X**		
Activity 9.2	**X**		**X**	**X**	

Skill & Competencies Addressed

Table 9.4 Activities are mapped according to Skills & Competencies addressed

	Decision Making	Problem Solving	Design/innovating	Data Analysing	Collaborating	Communicating	Research	Critical Thinking	Numeracy
Activity 9.1		X	X	X					X
Activity 9.2		X		X				X	X

Activity 9.1 Harvesting Solar Energy

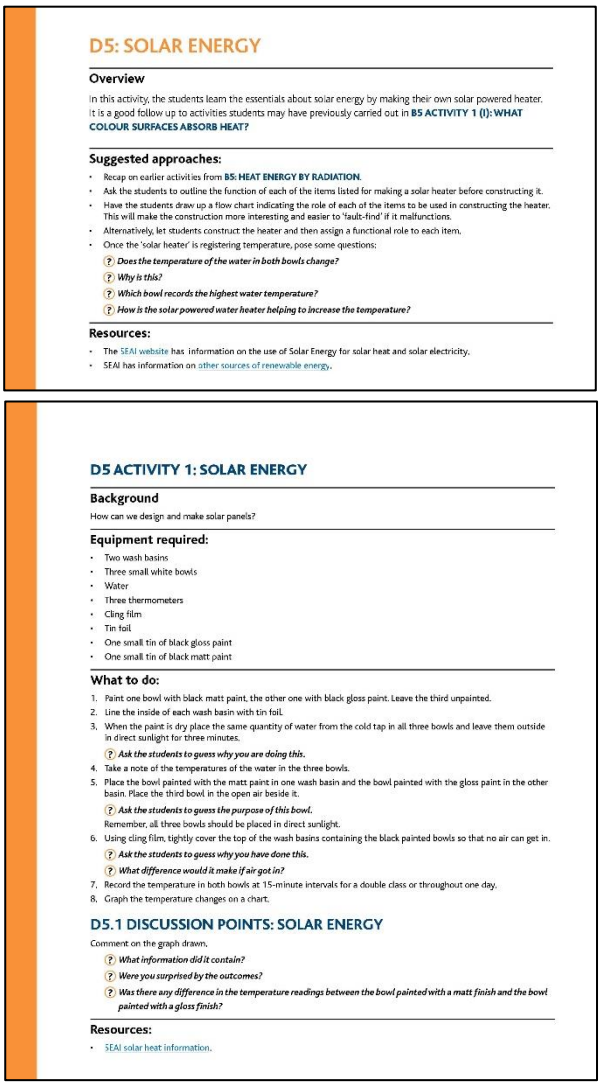
In this activity, students design and construct solar energy collectors that mimic those used by residences which capture solar energy and convert it to thermal energy to heat water. Students demonstrate the radiative and adsorbtion properties of different surfaces and explore their role in solar water heater designs. Students can appreciate how solar energy is a useful alternative to fossil fuel combustion.

This activity has been developed by the Sustinable Energy Authority in Ireland (SEAI) in collaboration with CASTeL at Dublin City University as part of the The SEAI Energy in Action programme. This Energy in Action programme provides a range of inquiry based activities that support the teaching and learning of energy at post-primary level in Ireland. Permission to promote this activity as part of ENERGE project has been granted.

Duration	
45-60 minutes	
Energy Literacy Characteristics addressed:	
C1	Grounded understanding of science and how energy is harnessed and used to power human activity
C3	Sensitive to the need for energy conservation and the need to develop alternatives to fossil fuel-based energy resources
Skills & Competencies addressed:	
• Creating/Design • Problem Solving • Data Analysis	• Collaborating • Communicating
Subject links in National Curricula:	
• Engineering • Technology • Design & Architecture	• Science • Geography
Level	
• ISCED 2 • ISCED 3	

Suggestions for use:

The Energy in Action programme provides a set of instructions for carrying out this activity which are made available to download in the materials section.



D5: SOLAR ENERGY

Overview

In this activity, the students learn the essentials about solar energy by making their own solar powered heater. It is a good follow up to activities students may have previously carried out in **B5 ACTIVITY 1 (I): WHAT COLOUR SURFACES ABSORB HEAT?**

Suggested approaches:

- Recap on earlier activities from **B5: HEAT ENERGY BY RADIATION**.
- Ask the students to outline the function of each of the items listed for making a solar heater before constructing it.
- Have the students draw up a flow chart indicating the role of each of the items to be used in constructing the heater. This will make the construction more interesting and easier to 'fault-find' if it malfunctions.
- Alternatively, let students construct the heater and then assign a functional role to each item.
- Once the 'solar heater' is registering temperature, pose some questions:
  - ? *Does the temperature of the water in both bowls change?*
  - ? *Why is this?*
  - ? *Which bowl records the highest water temperature?*
  - ? *How is the solar powered water heater helping to increase the temperature?*

Resources:

- The SEAI website has information on the use of Solar Energy for solar heat and solar electricity.
- SEAI has information on other sources of renewable energy.

D5 ACTIVITY 1: SOLAR ENERGY

Background

How can we design and make solar panels?

Equipment required:

- Two wash basins
- Three small white bowls
- Water
- Three thermometers
- Cling film
- Tin foil
- One small tin of black gloss paint
- One small tin of black matt paint

What to do:

1. Paint one bowl with black matt paint, the other one with black gloss paint. Leave the third unpainted.
2. Line the inside of each wash basin with tin foil.
3. When the paint is dry place the same quantity of water from the cold tap in all three bowls and leave them outside in direct sunlight for three minutes.
   - ? *Ask the students to guess why you are doing this.*
4. Take a note of the temperatures of the water in the three bowls.
5. Place the bowl painted with the matt paint in one wash basin and the bowl painted with the gloss paint in the other basin. Place the third bowl in the open air beside it.
   - ? *Ask the students to guess the purpose of this bowl.*

   Remember, all three bowls should be placed in direct sunlight.
6. Using cling film, tightly cover the top of the wash basins containing the black painted bowls so that no air can get in.
   - ? *Ask the students to guess why you have done this.*
   - ? *What difference would it make if air got in?*
7. Record the temperature in both bowls at 15-minute intervals for a double class or throughout one day.
8. Graph the temperature changes on a chart.

D5.1 DISCUSSION POINTS: SOLAR ENERGY

Comment on the graph drawn.

- ? *What information did it contain?*
- ? *Were you surprised by the outcomes?*
- ? *Was there any difference in the temperature readings between the bowl painted with a matt finish and the bowl painted with a gloss finish?*

Resources:

- SEAI solar heat information.

Fig. 1 Activity 9.1 Energy in Action Activity Guide

Extensions to Activity:

Materials:

A. Activity 9.1 Student Handout 1

B. For the Solar Heater Model:

- Two plastic wash basins
- Three small white bowls
- Water (1 litre)
- 3 thermometers
- Cling film
- Aluminium foil
- One small tin of black gloss paint
- One small tin of black matt paint

Activity 9.2 How Efficient is Solar Energy?

In this activity, students identify and calculate how much solar energy is available for energy generation in their local region. Students then analyse the cost-effectiveness of installing solar panels on their school roof. This is important for determining the practicality of solar energy in that region as well as maximising the efficiency of solar energy technology. This activity has been developed by CASTeL as part of the ENERGE Project. The European Commission Solar Radiation GIS tool included in this activity is available under the Creative Commons license (CC BY 4.0).

Duration	
45-60 minutes	
Energy Literacy Characteristics addressed:	
C1	Grounded understanding of science and how energy is harnessed and used to power human activity.
C3	Sensitive to the need for energy conservation and the need to develop alternatives to fossil fuel-based energy resources.
C4	Cognisant of the impact of personal energy-related decisions and actions on the global community.
Skills & Competencies addressed:	
• Problem Solving • Research • Critical Thinking	• Data Analysis • Collaborating
Subject links in National Curricula:	
• Science • Engineering	• Geography • Technology
Level	
• ISCED 2 • ISCED 3	

Suggestions for Use:

1. Solar radiation data can be retrieved using the Solar Radiation GIS tool available by the European Commission at: http://re.jrc.ec.europa.eu/pvg_tools#MR. A set of instructions on how to access and retrieve data from the Solar Radiation GIS tool is provided below in the materials section.

2. The teacher should then provide student groups with information from the utility bills for the school – in particular, they should be given the monthly electricity costs in kWh.

3. Once the solar radiation and utility bill data has been obtained, students should organise this data into a table. A sample table has been provided. Students can then use their data table to answer the following questions:

   - Compare the number of kWh per month your school uses with the number of kWh/m^2/day that can be generated by the sample solar panel in the previous question.

   - A commercial solar panel has dimensions of 1.686 x 1.016 x 0.4 m and a power output of 300-350 W per 1 panel. Calculate how many square meters (m^2) of panels would be required to generate all the electricity needed to power your school for a month? Consideralso that commercial solar panels are generally accepted to be between 15 and 20% efficient.

Extensions to Activity:

Materials:

- Activity 9.2 Instructions for GIS tool
- Activity 9.2 Sample table