



SOLAR OVEN

Renewable Energy and Sustainability

Tomás Luís

Supervised by *Ana Freire*

Portugal



The 2030 Agenda and Sustainable Development



What is it?

UN global plan adopted in 2015, with 17 Sustainable Development Goals (SDGs) and 169 targets to eradicate poverty, protect the planet, and ensure peace and prosperity by 2030.



4 Main Pillars

People · Planet · Prosperity · Peace and Partnerships

It involves governments, businesses, and citizens with the principle of “leaving no one behind.”



Portugal in 2023

Around 61% of the indicators analysed showed positive progress. Moving towards a National Roadmap for Sustainable Development.

Sustainable Development Goals

The activity explicitly aligns with SDGs 4, 7, and 13.

ODS 4

Quality Education

Ensure inclusive, equitable, and quality education for all.

This activity develops scientific literacy, data literacy, and evidence-based reasoning.

ODS 7

Renewable and Affordable Energy

Ensure access to clean, affordable, reliable and sustainable energy.

The solar oven demonstrates in practice the capture and conversion of solar energy.

ODS 13

Climate Action

Take urgent action to combat climate change.

The study of renewable energies is fundamental to mitigating climate change.



Objectives

Objectives

- Investigate renewable energy systems in the context of natural hazards and human impact.
- Focus on solar and wind energy as climate change mitigation strategies.
- Design, build, and test low-cost models of a solar oven.
- Analyse the conversion of solar radiation into thermal energy.

Hypotheses & variables

Hypothesis:

A low-cost solar oven can reach temperatures high enough to cook food under real sunlight conditions.

Variables:

- Independent variable: presence or absence of clouds
- Dependent variable: temperature reached inside the oven
- Controlled variables: materials used, oven orientation



Theoretical Basis



Solar Radiation

The solar oven converts solar radiation into thermal energy. Portugal has an average daily irradiance in april of
 $\sim 500 \text{ W/m}^2$.

Will that be enough for cooking?



Energy transfer mechanisms

- Radiation – energy from the Sun to the solar oven
- Conduction – through the solid materials that make up the oven
- Convection – air circulation inside the solar oven



Renewable Resources vs. Fossil Fuels

Solar energy: inexhaustible, clean, no CO_2 emissions. This contrasts with fossil fuels, which cause climate change and are finite.



Efficiency and Optimisation

Energy conservation, thermal losses and optimisation strategies are being studied: black paint (absorption), aluminium (reflection) and transparent cover (greenhouse effect).



How does a solar oven work?

1

Fundraising

The transparent lid allows visible solar radiation to pass into the oven.

2

Reflection

The aluminium foil on the interior walls reflects and concentrates sunlight in the centre.

3

Absorption

The black-painted surface absorbs visible radiation and converts it into heat.

4

Retention

The transparent lid prevents heat from escaping (greenhouse effect). The thermal insulator reduces losses.



Materials and Procedure

Materials

- 2 cardboard boxes (one inside the other)
- Aluminium foil (sunlight reflection)
- Transparent lid (glass or hard plastic)
- Black paint (visible radiation absorption)
- Thermal insulator (newspaper, rock wool, etc.)
- Thermometer (to measure the internal temperature)
- Stopwatch

Procedure

1. Line the inside walls of the outer box with aluminium foil.
2. Paint the inside of the inner box black.
3. Place the thermal insulator between the two boxes.
4. Close with the transparent lid.
5. Orient the oven towards the sun and record the temperature every 10 minutes.
6. Test with and without sun (independent variable).



Data Analysis and Irradiance in Portugal



Portugal
April

≈ 500 W m⁻²

(12:00 - 14:00: Average irradiance
may reach 600 to 700 W m⁻²).

What to analyse?

- Temperature evolution over time (temperature vs. time graph).
- Comparison between conditions with and without sunlight.
- Calculation of the oven's thermal efficiency.
- Identification of energy losses (conduction, convection, radiation).
- Evaluation of optimisation strategies: black colour, aluminium, insulation.
- Analysis of the impact of design (lid angle, insulator thickness).

Record data in a table and present it in a graph with statistical processing.

Safety, Ethics, and Educational Impact

Security

- Do not look directly at the reflection of sunlight.
- Handle the heated oven with gloves.
- Teacher supervision during experiments.
- Do not touch the black surface when heated.

Ethics & Replication

- Low-cost activity — easily replicable in any school.
- Reused/recycled materials (cardboard boxes).
- Results documented with photos and videos.
- Data shared with the class and school community.

Pedagogical Impact

- Development of systemic thinking about the Earth.
- Scientific and data literacy.
- Evidence-based reasoning.
- Engagement with global sustainability challenges.

Considerations



The solar oven demonstrates the direct conversion of solar energy into thermal energy, proving the potential of renewable energies.



The activity connects the principles of physics with environmental sustainability and the global challenges of the 2030 Agenda.



Being low-cost and easily replicable, it promotes access to quality science education (SDGs 4, 7 and 13).



Data monitoring and analysis develop scientific literacy and evidence-based reasoning skills.

Designed to be easily transferable and scalable, this activity reinforces systemic thinking about the Earth.